Compilation on XJTLU Research Achievements
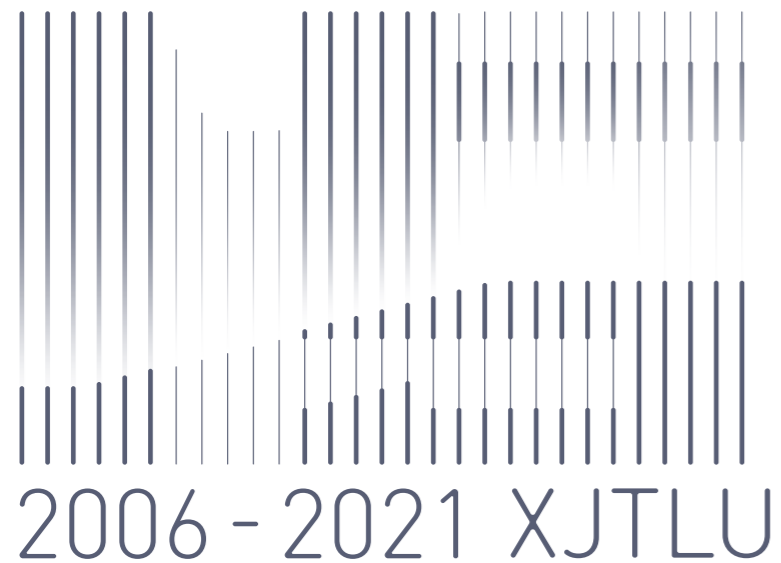
Research Grants

科研成果汇编
政府项目

Research Engagement and Innovation Office
科研生产力和创新办公室

Research Management Office
科研管理办公室

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Xi'an Jiaotong-Liverpool University
西交利物浦大学

2006 - 2021 XJTLU

2006 - 2021 XJTLU

PROF. YOUMIN XI
EXECUTIVE PRESIDENT OF XJTLU
PRO-VICE-CHANCELLOR OF THE UNIVERSITY OF LIVERPOOL

As a research-led university, XJTLU is keen to support our staff to use their wisdom to help people improve their quality of life by first class research. We are proud of the research spirit inherited from our parent institutions, the University of Liverpool and Xi'an Jiaotong University, and nurtured in the entrepreneurial process to bring this university to be a unique future-oriented international university. XJTLU is internationally recognised as a leading Chinese university for innovative education, and as an international university in China with a well-respected research reputation, especially in industry-linked research.

Our research has developed incredibly rapidly in a broad range of areas which address global natural and social issues, allowing us to grow in research strength while feeding significant outcomes back into society. Increasing the quality of research outputs is important in establishing a university, but so too is raising impact. As we celebrate the 15th anniversary, it's just the time to look back on the way we have come so far and the achievements we have made in research.

With great emphasis on both fundamental studies and applied research, XJTLU researchers are able to develop their full potential and fulfil their career development dreams while addressing the challenges of the 21st Century. As a research-led university, we will create a favourable research ecosystem by collaborating with the society, the industry, and the government. We welcome you to join our research community.

INTRODUCTION

Xi'an Jiaotong-Liverpool University (XJTLU) is an international joint venture university with independent legal entity and distinctive features. Approved by the Chinese Ministry of Education, XJTLU was founded in 2006 by Xi'an Jiaotong University and University of Liverpool. As a research-oriented university, the university places enhancing its research capabilities as its development priority. In recent years, taking advantage of the rich research and international resources from three universities of three countries, XJTLU has been constructing a research system that promotes ecological integration and value creation.

Equipped with modern research facilities, XJTLU provides its staff with international research environment to work in. Taking the advantages of the international resources of three universities, XJTLU has been actively establishing excellent partnerships with external entities such as local government, industrial partners, domestic and foreign institutions and other universities, and has worked hard to build a high-level research community and an excellent research reputation. Throughout the fifteen years since its founding, XJTLU has actively undertaken government research projects and has achieved remarkable results. According to statistics, from its establishment to 2020, XJTLU has undertaken a total of 324 scientific research projects at national, provincial and municipal levels, with approved scientific research funding of RMB 64,713,500, including 114 national projects with approved scientific research funding of RMB 38,605,000, 102 provincial projects with approved scientific research funding of RMB 11,994,000, 64 municipal projects with approved scientific research funding of RMB 7,235,000, and 44 other government projects, with research funding of RMB 6,879,400. It is particularly noteworthy that, as a Sino-foreign joint venture university, the awarded rate of the National Natural Science Foundation of China(NSFC) projects for young foreign scholars is as high as 30.77%, which is a high level among universities in China; the approval rate of the continuation projects of the NSFC also reaches 33%, which shows the high quality of our international research scholars. Meanwhile, in order to further improve the research level of XJTLU and deepen the social impact of the University on the local economic development, the Key Programme Special Fund (KSF) has been jointly funded by Suzhou Dushu Lake Science and Education Innovation Zone Management Committee, Suzhou Industrial Park Bureau of Science, Technology and Informatization and XJTLU since 2017. By the end of 2020, 93 projects had been approved with research funding of RMB 38,715,500.

With the strong support of all levels of the government and university leadership, XJTLU scholars have lived up to the expectations and achieved fruitful research results. According to the statistics from the Web of Science database, by the end of 2020, XJTLU scholars had published 3409 papers. There had been a total number of 26231 citations for those papers. In addition, from the establishment of the university to the end of 2020, XJTLU scholars had applied for 335 patents, including 240 inventions, 71 utility models, 3 designs, 9 Patent Cooperation Treaty (PCT), and 12 software copyrights. There were 123 authorized patents, including 50 inventions, 60 utility models, 3 designs, 1 Patent Cooperation Treaty (PCT), and 9 software copyrights. XJTLU scholars have actively interacted with the government and all sectors of the community, and their research influence has been widely disseminated in the academic community both at home and abroad.

XJTLU's research focuses on global social issues. Despite its late start, XJTLU has strived to strengthen its foundation, forge ahead, pioneer and innovate. Through the unremitting efforts of XJTLU researchers, we have achieved rapid growth in relevant disciplines over the past fifteen years. The 2006-2020 Compilation on XJTLU Research Achievements – Research Grants summarises the achievements of 196 completed government-funded research projects since the founding of the University, including 143 in natural sciences and 53 in social sciences. The projects cover 12 fields of natural sciences and social sciences at national, provincial and municipal levels including Artificial Intelligence, New Energy, Biomedical Engineering, Advanced Environmental Protection, Biomedical, Frontier New Materials, etc. Following the concept of sustainable development, XJTLU is committed to serving local economic and social development and further promoting the virtuous cycle of research inputs and outputs. We believe that XJTLU and its researchers will continue to work hard in the next fifteen years to achieve even more brilliant results and continue to promote research achievements to contribute to technological innovation, industrial upgrading and harmonious social development.

Contents

2. Provincial and Ministry-Level Projects

3. Municipal Projects

Part A:
Natural Sciences

Artificial Intelligence (AI)

The development of Artificial Intelligence is changing rapidly, and it has gradually come out of the laboratory and empowered the innovation and economic development of the Yangtze River Delta. The Department of Intelligent Science of Xi'an Jiaotong-Liverpool University (XJTLU) is affiliated with the School of Advanced Technology, and has obtained world-class achievements in the intelligent sciences areas including machine learning and computer vision. XJTLU is active in research and business cooperation with international and national research institutes and industry, and has obtained supporting funds from the National Natural Science Foundation of China (NSFC). By 2020, four research units in the field of AI have been established at XJTLU, including Suzhou Municipal Key Laboratory of Cognitive Computing and Applied Technology, Platform for Suzhou Municipal Key Lab of Virtual Reality Technology, Intelligent Computing and Financial Technology Laboratory, and AI University Research Centre.

1.National Projects

Project 1: High-Degree Information Fusion in Multi-Camera Video Surveillance

| Ming Xu

Application code: F030410 (Department of Information Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - General Programme

Technical fields: Machine Vision, Image Analysis, AI

Introduction: Based on the theory of machine vision and image analysis, the research of this project took intelligent video surveillance as the application background, and started to research the method of reliably detecting targets with medium density or above which are occluded by each other. According to the method of highly information fusion by homography mapping between image planes, we proposed a method of homography mapping polygon vertices in foreground area, which can realize highly foreground information fusion in real time, and proposed a method of estimating homography matrix based on multi-layer parallel plane by collecting data from pedestrians, which has wide application range and takes into account the uncertainty in the process of data collection. In addition, we also proposed to use homography mapping of color information in the image to identify static obstacles and false alarm in multi-view foreground detection. On the basis of multi-camera information fusion, we solved the issue of eliminating shadow areas in motion detection.

Keywords: Video Monitoring, Target Detection, Homography Transformation, Information Fusion

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI, SCI	Visual tracking of partially observable targets with suboptimal filtering	Ming Xu、Tim Ellis、Simon J. Godsill、Graeme A. Jones	IET Computer Vision	2011.01
(2)	EI, SCI	Robust object detection with real-time fusion of multiview foreground silhouettes	Ming Xu、Jie Ren、Dongyong Chen、Jeremy S. Smith、Zhechi Liu、Tianyuan Jia	Optical Engineering	2012.04
(3)	EI, ISTP	Multiview pedestrian localisation via a prime candidate chart based on occupancy likelihoods	Yuyao Yan, Ming Xu, Jeremy S. Smith	IEEE International Conference on Image Processing (ICIP), pp. 2334-2338, Beijing, China, October 2017.	2017/09/17-2017/09/20
(4)	EI, SCI	Multi-view and multi-plane data fusion for effective pedestrian detection in visual surveillance	Jie Ren, Ming Xu, Jeremy S. Smith, Shi Cheng	Multidimensional Systems and Signal Processing, 27 (4): 1007-1029, Springer, 2016.	2016.10
(5)	EI, SCI	Multi-view visual surveillance and phantom removal for effective pedestrian detection	Jie Ren, Ming Xu, Jeremy S. Smith, Huimin Zhao, Rui Zhang	Multimedia Tools and Applications, 77 (14): 18801-18826, Springer, 2018.	2018.05
(6)	EI, SCI	Generalized vertical projection histograms using multi-plane homology	Yuyao Yan, Ming Xu, Jeremy S. Smith	IET Electronics Letters, 55(10): 593-595, 2019	2019.05
(7)	EI, SCI	Moving Shadow Detection via Binocular Vision and Colour Clustering	Lei Lu, Ming Xu, Jeremy S. Smith, Yuyao Yan.	IET Computer Vision, pp. 665-673, 14(8), 2020..	2020.12
(8)	EI, SCI	Multicamera people detection using logic minimization	Yuyao Yan, Ming Xu, Jeremy S. Smith, Mo Shen, Jin Xi	Pattern Recognition, pp. 1-14, Vol. 112, Article No. 107703, 2021..	2021.04
(9)	EI, ISTP	REAL-TIME DETECTION VIA HOMOGRAPHY MAPPING OF FOREGROUND POLYGONS FROM MULTIPLE CAMERAS	Xu, Ming、Ren, Jie、Chen, Dongyong、Smith, Jeremy、Wang, Guifen	2011 IEEE International Conference on Image Processing	2011/9/11-2011/9/14
(10)	EI, ISTP	PRUNING PHANTOM DETECTIONS FROM MULTIVIEW FOREGROUND INTERSECTION	Jie Ren、Ming Xu、Jeremy S. Smith	2012 IEEE International Conference on Image Processing	2012/09/30-2012/10/03
(11)	EI, ISTP	Cast Shadow Removal in Motion Detection by Exploiting Multiview Geometry	Ming Xu、Lei Lu、Tianyuan Jia、Jie Ren、Jeremy S. Smith	2012 IEEE International Conference on Systems, Man, and Cybernetics	2012/10/14-2012/10/17
(12)	EI, ISTP	A colour statistical Approach to phantom pruning in multi-view detection	Jie Ren、Ming Xu、Jeremy S. Smith	2012 IEEE International Conference on Systems, Man, and Cybernetics	2012/10/14-2012/10/17
(13)	EI, ISTP	Robust Localisation of Pedestrians with Cast Shadows Using Homology in A Monocular View	Ming Xu、Tianyuan Jia、Lei Lu、Jeremy S. Smith	2012 IEEE International Conference on Systems, Man, and Cybernetics	2012/10/14-2012/10/17
(14)	EI, ISTP	A multiview approach to robust detection in the presence of cast shadows	Ming Xu、Jie Ren、Dongyong Chen、Jeremy S. Smith、Zhechi Liu	2011 Sixth International Conference on Image and Graphics	2011/8/12-2011/8/15
(15)	EI, ISTP	Multi-view pedestrian detection using occupancy colour matching	Jie Ren, Ming Xu, Jeremy S. Smith.	IEEE International Conference on Multimedia Big Data (BigMM), pp. 300-305, Beijing, China, 2015	2015/04/20-2015/04/22

2）Others

Awards: Ming Xu、Tim Ellis、Simon J. Godsill、Graeme A. Jones ，2012 IET 计算机视觉最佳论文奖，Institution of Engineering and Technology (IET), IET Computer Vision Premium Award, Best Paper Prize, 2012/11/22，已标注

Project 2: Cross-Domain and Collective Pattern Classification Theory and Applications

| Kaizhu Huang

Application code: F060301 (Department of Information Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - General Programme

Technical fields: Pattern Recognition, Computer Vision, Artificial Intelligence

Introduction: This project researches the theoretical methods and application of interdisciplinary overall pattern classification with respect to independently identically distributed data of many heterogeneous disciplines. The method of interdisciplinary overall pattern recognition is intended to utilize the complementarity and correlation of interdisciplinarily heterogeneous data, and break the assumption of independently identical distribution of data in the disciplines, and does not classify each sample independently. It, however, performs multi-discipline collaborative learning, and process the intradisciplinary data with the same characteristics as a whole and classify them simultaneously, so as to effectively use the connection between the disciplines and between the data to improve the recognition performance. The research goal is completed very well in this project. Specifically, 1) we have developed a series of overall pattern recognition and machine learning algorithms with good innovation performance, good theoretical value and practicality. With respect to the generative models, discriminative models and neural network, we have expanded and developed the overall pattern recognition algorithm. 2) We published 2 academic writings (in English) and a series of high-level papers-29 papers published in major international journals of machine learning and pattern recognition including 21 SCI papers and 6 IEEE Trans papers; and 17 papers published in major international academic conferences, exceeding our research goal. Our research achievements won four championships in the ICDAR 2015, the Best Candidate Paper Award in ICONIP 2017 and the Best Student Paper Award in BICS 2018. 3) We have issued a set of interdisciplinary overall recognition databases for researchers, including such data as facial expression, multi-pose data and handwritten character.

Keywords: Interdisciplinary, Overall Identification, Heterogeneous Data, Non-Independently Identical Distribution

Key issues solved: We solved the problem that the relationship between data can not be effectively used by traditional pattern recognition, and developed a new frame of pattern classification that is able to recognize using overall information of the data.

Research achievements:

1）Copyrights

No.	Category	Title	Author(s)
(1)	Book	Deep Learning: Fundamentals, Theory, and Applications	Kaizhu Huang; Amir Hussain; Qiufeng Wang; Rui Zhang
(2)	Book	Semi-Supervised Learning: Background, Applications and Future Directions	Guoqiang Zhong; Kaizhu Huang

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE, EI	Learning imbalanced classifiers locally and globally with one-side probability machine	Kaizhu Huang; Rui Zhang ; Xu-Cheng Yin	Neural Processing Letters	2015
(2)	SCIE, EI	Introduction to cognitively-inspired knowledge discovery	Kaizhu Huang; Rui Zhang; Xiaobo Jin; Amir Hussain	Cognitive Computation	2018.6.20
(3)	EI	Field Support Vector Machines	Kaizhu Huang; Haochuan Jiang; Xu-Yao Zhang	IEEE Transactions on Emerging Topics in Computational Intelligenc	2017
(4)	SCIE, EI	Maximum margin semi-supervised learning with irrelevant data	Yang, Haiqin; Huang, Kaizhu; King, Irwin; Lyu, Michael R.	Neural Networks	2015.10
(5)	SCIE, EI	Joint learning of unsupervised dimensionality reduction and Gaussian mixture model	Xi Yang; Kaizhu Huang; Y. J. Yannis; Rui Zhang	Neural Processing Letters	2016
(6)	SCIE, EI	Learning from few samples with memory networks	Shufei Zhang; Kaizhu Huang; Rui Zhang; Amir Hussain	Cognitive Computation	2018.12.1
(7)	SCIE	DE2: Dynamic ensemble of ensembles for learning nonstationary data	Yin, Xu-Cheng; Huang, Kaizhu; Hao, Hong-Wei	Neurocomputing	2015.10.1
(8)	EI	Learning Latent Features with Infinite Non-negative Binary Matrix Tri-factorization	Xi Yang; Kaizhu Huang; Rui Zhang; Amir Hussain	IEEE Transactions on Emerging Topics in Computational Intelligence	2018.12.1
(9)	SCIE, EI	A New Two-layer Mixture of Factor Analyzers with Joint Factor Loading Model for the Classification of Small Dataset Problems	Xi Yang; Kaizhu Huang; Rui Zhang; Amir Hussain; Yannis Goulermas	Neurocomputing	2018.1.1
(10)	SCIE, EI	Three-Dimensional Local Energy-Based Shape Histogram (3D-LESH)-Based Feature Extraction– A Novel Technique	Summrina Kanwal Wajid; Amir Hussain; Kaizhu Huang	Expert Systems with Applications	2018.1.1
(11)	SCIE, EI	Pair-wise Loss for Optimizing NDCG Approximately	Xiao-Bo Jin; Guang-Gang Geng; Guo-Sen Xie; Kaizhu Huang	Information Sciences	2018
(12)	SCIE, EI	MTC: A Fast and Robust Graph-Based Transductive Learning Method	Zhang, Yan-Ming; Huang, Kaizhu; Geng, Guang-Gang; Liu, Cheng-Lin	IEEE Transactions on Neural Networks and Learning Systems	2015.9
(13)	SCIE, EI	A fast projected fixed-point algorithm for large graph matching	Lu, Yao; Huang, Kaizhu; Liu, Cheng-Lin	Pattern Recognition	2016.12
(14)	SCIE, EI	Cross-Modality Interactive Attention Network for Multispectral Pedestrian Detection	Xu Yang; Lu Zhang; Zhiyong Liu; Shifeng Zhang; Kaizhu Huang; Amir Hussain; Hong Qiao	Information Fusion	2019.1.1

(15)	SCIE, EI	IAN: The Individual Aggregation Network for Person Search	Jimin Xiao; Yanchun Xie; Tammam Tillo; Kaizhu Huang; Yunchao Wei; Jiashi Feng	Pattern Recognition	2019.1.1
(16)	SCIE, EI	Stochastic Conjugate Gradient Algorithm with Variance Reduction	Xiao-Bo Jin; Xu-Yao Zhang; Kaizhu Huang; Guang-Gang Geng	IEEE Transactions on Neural Networks and Learning Systems	2019.1.1
(17)	SCIE, EI	Banzhaf Random Forests: Cooperative Game Theory Based Random Forests with Consistency	Jianyu Sun; Guoqiang Zhong; Kaizhu Huang; Junyu Dong	Neural Networks	2018.1.1
(18)	SCIE, EI	Guided Policy Search for Sequential Multi-Task Learning	Fanzhou Xiong; Biao Sun; Xu Yang; Kaizhu Huang; Hong Qiao; Amir Hussain; Zhi-Yong Liu	IEEE Transactions on Systems Man and Cybernetics-Systems	2018.1.1

3）Others

Awards:

(1) X. C. Yin; C. Yang; J. B. Hou; W.Y. Pei; X. Yin; K. Huang, ICDAR Robust Reading Competition Championship, ICDAR, 其他，其他，2015.9.28

(2) Haochan Jiang; Kaizhu Huang; Rui Zhang, ICONIP 2017 Best Paper Finalist Award, Asian Pacific Neural Network Society, 最佳候选论文奖，其他，2017.11.15

(3) Haochuan Jiang; Kaizhu Huang; Rui Zhang; Amir Hussain, BICS 2018 Best Student Paper Award, International Conference on Bio-inspired Cogntive Systems 2018, 其他，其他，2018.7.8

Project 3: Research on Incremental Attribute Learning - Theory, Algorithms and Applications

|　Sheng-Uei Guan

Application code: F020508 (Department of Information Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - General Programme

Technical fields: Data Analysis, Machine Learning

Introduction: Incremental learning is a kind of machine learning training method that gradually imports feature attributes into prediction models. This is a "Divide and Conquer" machine learning strategy, which is different from the conventional learning method of importing all feature attributes at one time. During incremental learning, the prediction model will import one or more feature attributes each time to train the training set. The latter training will be based on the results of the previous training so as to keep improving the results. Upon the three years of scientific research, the theoretical framework related to incremental learning has been established, the correlation measure of feature attributes has been deduced, and the preprocessing, sorting and grouping of feature attributes has been developed, ant it is proved that the learning strategy of incremental learning can be successfully applied to Pattern Classification, Regression and timing problems through Neural Networks (NNs), Genetic Algorithms (GAs) and Particle Swarm Optimization (PSO) and other intelligent computing methods, and the satisfying results have been achieved.

Similar to the traditional machine learning, incremental learning can improve its accuracy through proper Data Preprocessing. Through the research, we found that proper preprocessing can effectively improve the effect of incremental learning. For example, Feature Selection can not only improve the accuracy of pattern classification, but also effectively reduce the calculation scale and shorten the training time. However, because incremental learning gradually introduces the input feature attributes into the predictor, so it also has its own unique preprocessing methods besides the traditional data preprocessing process. For example, to decide which feature attributes should be imported first and which should be imported later, incremental learning requires Feature Ordering preprocessing. Incremental learning can import one or more feature attributes at a time. Thus, which feature attributes are put together without interfering with each other needs to be handled by Feature Grouping. Feature sorting and feature grouping are different from traditional data preprocessing methods, which are unique to incremental learning.

First, in this project, the incremental learning and the existing preprocessing process of incremental learning were reviewed, the preprocessing method and process of Feature Ordering were developed, several different methods of Feature Ordering and Grouping of classification problems were discussed and the different Feature Ordering and Grouping methods were compared. The Feature Ordering method of incremental learning for classification and regression problems were discussed, the method of using Feature Ordering and Feature Selection at the same time were discussed and the Feature Ordering of timing problems were also discussed.

Keywords: Feature Attribute, Incremental Learning, Neural Network, Genetic Algorithm, Swarm Intelligence

Key issues solved: Classification, regression, feature ordering method of incremental learning based on timing issues.

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI, SCI, ISTP	Investigation of Neural Networks for Function Approximation	Sibo Yang、T.O. Ting、K.L. Man、Sheng-Uei Guan	Procedia Computer Science	2013

(2)	EI, SCI, ISTP	DEM: Direct Estimation Method for Photovoltaic Maximum Power Point Tracking	Jieming Ma、K.L. Man、T.O. Ting、N. Zhang、Sheng-Uei Guan、Prudence W.H. Wong	Procedia Computer Science	2013
(3)	EI, SCI, ISTP	Input Space Partitioning for Neural Network Learning	Sheng-Uei Guan	International Journal of Applied Evolutionary Computation	2013
(4)	EI, SCI, ISTP	Incremental Hyperplane Partitioning for Classification	Sheng-Uei Guan	International Journal of Applied Evolutionary Computation	2013
(5)	SCI	EEG Eye State Identification Using Incremental Attribute Learning with Time Series Classification	Ting Wang, Sheng-Uei Guan, Ka Lok Man, T.O. Ting	Mathematical Problems in Engineering	2014
(6)	EI, SCI, ISTP	"Statistical Discriminability Estimation for Pattern Classification based on Neural Incremental Attribute Learning",	Ting Wang, Sheng-Uei Guan, Sadasivan Puthusserypady[3], Prudence W.H. Wong, DOI: 10.4018/ijaec.2014040103, 37-57, Vol. 5, Issue 2,	International Journal of Applied Evolutionary Computation (IJAEC)	2014
(7)	EI, SCI, ISTP	"A PSO Based Incremental Hyper-sphere Partitioning Approach to Classification",	Binge Zheng, Sheng-Uei Guan, Jinghao Song,	International Journal of Applied Evolutionary Computation (IJAEC),	2014
(8)	EI, SCI, ISTP	"Incremental Hyper-sphere Partitioning for Classification",	Jinghao Song, Sheng-Uei Guan, Binge Zheng,	International Journal of Applied Evolutionary Computation (IJAEC),	2014
(9)	SCI	"Optimized Neural Incremental Attribute Learning for Classification based on Statistical Discriminability",	Ting Wang, Sheng-Uei Guan,	International Journal of Computational Intelligence and Applications (SJR: 0.25) (IJCIA),	2014
(10)	SCI	"Output Effect Evaluation Based on Input Features in Neural Incremental Attribute Learning for Better Classification Performance"	Ting Wang, Sheng-Uei Guan, Ka Lok Man, Jong Hyuk Park, Hui-Huang Hsu,	Symmetry Journal	2015

Project 4: Quantitative Analysis of Extreme Risk Aggregations with Its Applications in Risk Management

| Chengxiu Ling

Application code: A011004 (Department of Mathematical and Physical Sciences)

Programme category: National Natural Science Foundation of China (NSFC) – Young Scientists Fund

Introduction: Focusing on the fund project of Quantitative Analysis of Extreme Risk Aggregations with Its Applications in Risk Management, I conducted in-depth research, with the main research results lying in the following three aspects:

1. Proposed the Weibull index of tail extremum analysis, the robust estimators of risk measure and researched their asymptotic properties, and applied them to virtual currency, weather extremum and other data for empirical analysis; and investigated the second-order asymptotic effect of stochastic contraction risk, and numerical analysis further illustrated its accuracy. Finally, the Haezendonck-Goovaerts risk, the expectile analysis and the asymptotic analysis of stochastic contraction scale risk were analyzed by using our results.

2. The tail asymptotic behavior of Gaussian array sequence statistical vector and the risk measure of multi-dimensional Gaussian risk contagion were investigated, the traditional risk contagion risk measure in the Gaussian risk situation was expanded, the heavy-tailed multidimensional spillover risk tail under the classical multidimensional normal transformation was developed, and they were applied to matching of medical multiple detection and other image processing fields.

3. The stationary process, the asymptotic distribution of extremum of self-similar process and other processes and the joint asymptotic distribution of extremum of stationary random field on discrete lattice points and extremum on continuous interval were researched. Its asymptotic dependencies included asymptotic independence, complete dependencies and certain dependencies, depending on the fineness of the discretization lattice points being sparse, dense and Pickands type. Our results extended the related results of Gaussian stationary processes and laid a theoretical foundation for the discrete-continuous analysis of more extensive stationary processes such as Chi-square processes.

The main scientific discoveries and innovations are briefly described as follows:

1. Compared with many classical estimators, the established position invariant estimator of non-negative extremum index with adjustment parameters had considerable flexibility, and the data-driven optimization of adjustment parameters avoided the difficulty of selecting upper order statistics.

2. For the Drees' inequality, one of the tools for higher-order asymptotic analysis based on generalized stochastic contraction risk model, the original second-order correlation results were developed, and it can be applied to many fields of extremum analysis.

3. Stability analysis in correlation analysis of discrete-continuous extremum of stationary process accurately depicted various asymptotic dependencies and pointed out the omission of lattice point setting in discrete analysis in literature.

The obtained research results further enriched and developed the existing research issues, developing and forming new related research methods in extremum theory. The research results have been recognized by the Academic Circles, and six academic papers have been published in internationally renowned extreme value, probability theory, top actuarial journals as Extremes, Insurance: Mathematics and Economics.

Keywords: Extremum Theory, Extremum Index, Asymptotic Analysis, Stationary Process, Risk Contagion

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE, SSCI	Comparison Inequalities for Order Statistics of Gaussian Arrays	Kryszytof Debicki#; Enkelejd Hashorva#; Lanpeng Ji#; Chengxiu Ling#*	Alea (Rio de Janeiro): Latin American Journal of Probability and Mathematical Statistics	2017
(2)	SCIE	Extremes on different grids and continuous time of stationary processes	Chengxiu Ling; Zuoxiang Peng; Zhongquan Tan*	Journal of Mathematical Analysis and Applications	2018
(3)	SCIE, SSCI	Tail asymptotics of generalized deflated risks with insurance applications	Chengxiu Ling*; Zuoxiang Peng	Insurance: Mathematics and Economics	2016

Project 5: High Performance Preconditioning for Multigroup Radiation Diffusion Equations

| Shengxin Zhu

Application code: A011705 (Department of Mathematical and Physical Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - Young Scientists Fund

Introduction: Multi-group Radiation Diffusion Equations (MGRDEs) is a kind of strongly nonlinear coupled partial differential equations in non-equilibrium state. MGDREs is one of the important links in simulating multi-media radiation hydrodynamics under extreme conditions. Usually, the fully implicit scheme is used, and the corresponding algebraic equations are large in scale and often ill-conditioned. Currently, solving such algebraic equations often takes more than 80% of the total time of numerical simulation of radiation hydrodynamics. Because the solution of fluid dynamics equations is also required as the solution of MRGDs, for this kind of radiation fluid dynamics issues, the grid size that a single CPU can handle is small, so that it is not suitable for coarse-grained parallel. It is very challenging to design efficient parallel preprocessing algorithms for this kind of issue. To give full play to the efficiency of supercomputers, it is necessary to design parallel methods according to the characteristics of issues and parallel computers. This project aims at the physical characteristics of MGRDs and the heterogeneous multi-core architecture of supercomputers. It studies the preprocessing technology, which can keep the local characteristics of the issue to accelerate the convergence of iterative method, and designs a high-performance preprocessing algorithm, which has satisfying adaptability, fast convergence speed, high parallel efficiency and satisfying scalability to MGRDs, and tests, optimizes and evaluates the new algorithm on heterogeneous multi-core parallel computers.

With the support of this project, we carried out in-depth research:

1. The design achieved the presorting multi-wavefront sparse direct method that is suitable for multi-group equations. The method is robust and can be applied to equations with large difference in condition numbers among groups.
2. The approximation method of Jacobi matrix for a class of nonlinear iterative issue was constructed so that while the approximate Jacobi matrix keeping the main information of Jacobi matrix, it can discard the complicated calculation which is huge in computation but can be ignored in theory.
3. A numerical homogenization method based on generalized oscillatory spline function was constructed, the approximation properties of rough space of generalized oscillatory spline function and the attenuation properties and preprocessing estimation of localized generalized oscillatory spline function were given. This method provided a solution for solving many difficult diffusion problems, such as the classical SPE10 question.
4. A remapping algorithm of radiation hydrodynamics was improved, and the original 289 types of the algorithm were reduced to 34 types.

During the implementation of this project, three articles were officially published in the journal, three articles were accepted, three reports on national defense science and technology industry were written and two manuscripts were completed. These research results deepened our understanding of Multi-group Radiation Diffusion Equations, and some of the results can be directly applied to this topic and other frontier topics. Some results cannot directly serve the Multi-group Radiation Diffusion Equations, but they lay a foundation for our continuous research in this direction. During the research, two doctoral students (in studying) were jointly enrolled and trained around this topic to cultivate reserve research strength for this direction.

Keywords: Multi-Wavefront Parallel Sparse Direct Method, Large-Scale Sparse Algebraic Equations, Preprocessing, Local Property Preserves Basis Function

Key issues solved:

A. Explored the approximation method of rough space with better approximation of local microstructure of the issue and the design of coarse space in related multi-level preprocessing algorithm and the issue of selecting the core mathematics.

B. Applied the rough space approximation theory preserving the local microstructure of the issue and designed the parallel preprocessor with satisfying parallel scalability, fast convergence speed and being suitable for solving Multi-group Radiation Diffusion Equations.

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI, ISTP	Symmetric Sweeping Algoithms for Overlaps of Quadrilateral Meshes of the Same Connectivity	Xihua XU; Shengxin Zhu	Lecture Notes in Computer Scinece	2018.06.30
(2)	EI	Fast calculation of restricted maximum likelihood methods for unstructured high-throughput data	Shengxin Zhu	2017 IEEE 2nd International Conference on Big Data Analysis (ICBDA)	2017.03.10-2017.03.12
(3)	EI	Information splitting for big data analytics	Shengxin Zhu; Tongxiang Gu; Xiaowen Xu; Zeyao Mo	International conference on cyber enabled distributed computing and knowledge discorvery	2016.10.13-2016.10.15
(4)	EI	Learning with Linear Mixed Model for Group Recommendation Systems	Baode Gao; GuangPeng Zhan; Hanzhang Wang; YIming Wang; Shengxin Zhu	2019 11th International Conference on Machine Learning and Computing(accepted)	2018.02.22-2018.02.24
(5)	EI	Censorious young: knowledge discovery from high-throughput movie rating data with lme4	Zhiyi Chen; Shengxin Zhu; Qiang Niu; Xin Lu	2019 IEEE International Conference on Big Data Analysis	2018.03.20-2018.03.25

2）Others

(1) 辐射输运方程迭代方法研究与发展建议，国防科技报告；28 页，文件号：020104.1-2015ZJ-J-03 作者， 朱圣鑫，姚彦忠， 谷同祥，中国工程物理研究院归档报告（公开）

(2) 高性能并行迭代方法，国防科技工业科技报告，国防科工局基础课题先进高效的并行算法子课题，报告文长 37 页，朱圣鑫，谷同祥，国防科工局

(3) JPSOL 技术手册，国防科技工业科技报告，赵伟波，徐小文，朱圣鑫，国防科工局

Project 6: Identification of Location Spoofing to Wireless Localization in Non-Line-of-Sight Conditions

| Dawei Liu

Application code: F0105 (Department of Information Sciences)

Programme category: National Natural Science Foundation of China (NSFC) – Young Scientists Fund

Introduction: With the wide application of Wireless Positioning technology in smart phones and Internet of Things, the security and reliability of Wireless Positioning system has been paid more and more attention. Of which, position spoofing is the most serious security threat. As early as 2003, the report of the U.S. Department of Transportation pointed out that malicious attackers can spoof GPS positioning users by forging signals, resulting in abnormal positioning results, and even completely paralyzing GPS functions in a certain area. In recent years, more and more researches have begun to focus on this issue, and the main research directions include the ways to find abnormal positioning results caused by malicious users and to eliminate such anomalies. Another reason for abnormal positioning results is the NLOS propagation of wireless signals. The positioning error of existing Wireless Positioning System can reach 589m in NLOS environment, while the general error is only tens of meters. The way to detect NLOS propagation and to eliminate its influence has always been one of the hot spots in research of Wireless Positioning System. In this project, a set of abnormal error detection mechanism was designed through the research of position spoofing signal and NLOS signal, which solved the issue of positioning spoofing identification in NLOS environment. The research results provided theoretical basis and technical support for abnormal error detection and identification of wireless positioning, and provided a basis for relevant Departments to develop the industry standards, regulations and policies.

Keywords: Wireless Network, Location Spoofing, GPS/Beidou, Radio Signal, NLOS Propagation

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	Identification of Location Spoofing in Wireless Sensor Networks in Non-Line-of-Sight Conditions	Liu Dawei*; Xu Yuedong; Huang Xin	IEEE Transactions on Industrial Informatics	2018
(2)	SCIE	Experimental Analysis on Weight K-Nearest Neighbor Indoor Fingerprint Positioning	Hu, Jiusong#; Liu, Dawei#*; Yan, Zhi; Liu, Hongli*	IEEE Internet of Things Journal	2019
(3)	SCIE	Context-Aware Human Activity and Smartphone Position-Mining with Motion Sensors	Zhiqiang Gao; Dawei Liu*; Kaizhu Huang; Yi Huang	Remote Sensing	2019
(4)	SCIE	A Handshake Protocol With Unbalanced Cost for Wireless Updating	Cai Jiaren; Huang Xin*; Zhang Jie; Zhao Jiawei; Lei Yaxi; Liu Dawei; Ma Xiaofeng	IEEE Access	2018

Project 7: Study on Integrated Energy-Efficiency Optimization Model for Trains with On-board Energy Storage Devices

| Shaofeng Lu

Application code: F0302 (Department of Information Sciences)

Programme category: National Natural Science Foundation of China (NSFC) – Young Scientists Fund

Introduction: The current urban rail transit system is facing great pressure to improve energy efficiency. However, using the energy storage equipment to recover regenerative braking energy is one of the effective ways to save energy in urban transit train. For the small capacity of onboard energy storage device, the quality of energy storage device can directly affect train operation and other issues, the project proposed to build an overall optimization model of train energy efficiency based on onboard energy storage device, applied mixed integer programming algorithm to find the optimization, revealed the energy-saving mechanism of train operation with onboard energy storage device and promoted the expansion of energy-saving technology theory in urban rail transit industry.

The overall optimization model considered the following two issues: 1. Optimization of charging and discharging strategy of onboard energy storage device under the constraint of train operation. 2. Optimization of energy-saving operation of trains under the constraint of charging and discharging of on-board energy storage devices. The optimization model unified the charging and discharging strategies of train operation and onboard energy storage device in one model for solution, which is beneficial to fully understand the dynamic relationship between them and provided a theoretical basis for developing a set of train operation strategies with overall optimization characteristics.

According to our experimental research on the train operation with onboard energy storage device between the two platforms, the energy consumption of train operation with onboard energy storage device can be reduced by nearly 11.6%. Our research revealed the related characteristics of trains loaded with onboard energy storage devices. Specifically, it includes: When the capacity of the onboard energy storage device increases, the train will perform more regenerative braking operations and higher initial State of Energy of the energy storage device, that is, the energy storage device contains more available energy at the beginning of train operation, which brings more traction operations, but it will affect the recovery of regenerative braking energy of the train, and the loss caused by charging and discharging of energy storage devices can affect the charging frequency of energy storage devices.

On the basis of train operation on the two platforms, specially, this project team also expanded the research on the operation characteristics of trains loaded with onboard energy storage devices between the multiple platforms. Through the proposed Bi-level optimization model, we have successfully achieved the overall optimization of train operation time, charging and discharging management of onboard energy storage devices and energy-saving operation of trains. In a real case, the overall optimization results proposed by us can achieve different energy saving effects compared with different examples. Of which, compared with the example without energy storage device, the optimization results of multi-platform loaded with onboard energy storage device can achieve an energy-saving rate of nearly 23.77%.

In addition, a lot of meaningful explorations were made on different application objects in this project. The optimization model proposed in this project will make an active exploration in the application of the fast-developing energy storage devices in the urban rail transit system and the energy-saving strategy field of electrified rail transit.

Keywords: Urban Rail Transit, Onboard Energy Storage Device, Overall Optimization Model, Mixed Integer Programming, Train Energy-Saving Operation Control

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	Train Speed Trajectory Optimization With On-Board Energy Storage Device	Wu, Chaoxian; Zhang, Wenrui; Lu, Shaofeng*; Tan, Zhaoxiang; Xue, Fei; Yang, Jie	IEEE Transactions on Intelligent Transportation Systems	2019
(2)	SCIE	Adaptive Partial Train Speed Trajectory Optimization	Tan, Zhaoxiang; Lu, Shaofeng*; Bao, Kai; Zhang, Shaoning; Wu, Chaoxian; Yang, Jie; Xue, Fei	Energies	2018
(3)	SCIE	Day-ahead electric vehicle aggregator bidding strategy using stochastic programming in an uncertain reserve market	Han, Bing; Lu, Shaofeng*; Xue, Fei; Jiang, Lin	IET Generation Transmission & Distribution	2019
(4)	SCIE	Structural and Hierarchical Partitioning of Virtual Microgrids in Power Distribution Network	Xu, Xiaotong*; Xue, Fei; Lu, Shaofeng; Zhu, Huaiying; Jiang, Lin; Han, Bing	IEEE Systems Journal	2019
(5)	EI	Partial speed trajectory optimization for urban rail vehicles with considerations on motor efficiency	Lu, Shaofeng; Yang, Jie; Xue, Fei; Ting, Tiew On; Zhu, Huaiying	2017 IEEE 20th International Conference on Intelligent Transportation Systems (ITSC)	2017.10.10-2017.10.12
(6)	EI	Hydrogen Consumption Minimization for Fuel Cell Trains Based on Speed Trajectory Optimization	Zheng Huang; Chaoxian Wu; Shaofeng Lu; Fei Xue	Proceedings of the 4th International Conference on Electrical and Information Technologies for Rail Transportation (EITRT) 2019: Novel Traction Drive Technologies of Rail Transportation	2019.10.25-2019.10.27
(7)	EI	Optimization of Speed Profile and Energy Interaction at Stations for a Train Vehicle with On-board Energy Storage Device	Wu, Chaoxian; Lu, Shaofeng*; Xue, Fei; Jiang, Lin; Yang, Jie	2018 IEEE Intelligent Vehicles Symposium (IV)	2018.6.10-2018.6.12
(8)	EI	A speed trajectory optimization model for rail vehicles using mixed integer linear programming	Tan, Zhaoxiang; Lu, Shaofeng*; Xue, Fei; Bao, Kai	2017 IEEE 20th International Conference on Intelligent Transportation Systems (ITSC)	2017.10.8-2017.10.12
(9)	EI	Optimization for train speed trajectory based on pontryagin's maximum principle	Bao, Kai; Lu, Shaofeng*; Xue, Fei; Tan, Zhaoxiang	2017 IEEE 20th International Conference on Intelligent Transportation Systems (ITSC)	2017.10.10-2017.10.12
(10)	EI	Optimization of neutral section location on high-speed railways with consideration of train operations	Miao, Rui; Wu, Chaoxian; Lu, Shaofeng*; Xue, Fei; Tian, Zhongbei; Hillmansen, Stuart;	Sustainable Buildings and Structures: Building a Sustainable Tomorrow: Proceedings of the 2nd International Conference in Suatinable Buildings and Structures (ICSBS 2019)	2019.10.10-2019.10.12
(11)	EI	Smart Construction for Urban Rail Transit based on Energy-efficient Bi-directional Vertical Alignment Optimisation	Wu, Chaoxian; Lu, Shaofeng*; Xue, Fei; Jiang, Lin; Gong, Guobin	sustainable Buildings and Structures: Building a Sustainable Tomorrow: Proceedings of the 2nd International Conference in Sustainable Buildings and Structures (ICSBS 2019)	2019.10.10-2019.10.12

[12]	EI	Electric vehicle charging and discharging scheduling considering reserve call-up service	Han, Bing; Lu, Shaofeng*; Xue, Fei; Jiang, Lin	2017 International Smart Cities Conference (ISC2),	2017.9.10-2017.9.12
[13]	EI	A two-stage electric vehicles scheduling strategy to address economic inconsistency issues of stakeholders	Han, Bing; Lu, Shaofeng*; Xue, Fei; Jiang, Lin; Zhu, Huaiying	2017 IEEE Intelligent Vehicles Symposium (IV)	2017.10.10-2017.10.12
[14]	EI	Integrated Train Speed Profiles optimization Considering Signaling System and Delay	Wu, Chaoxian; Lu, Shaofeng; Xue,Fei; Jiang, Lin	2018 International Conference on Intelligent Rail Transportation (ICIRT)	2018.12.20-2018.12.22
[15]	EI	Earth Potential as the Energy Storage in Rail Transit System-on a Vertical Alignment Optimization Problem	Wu, Chaoxian; Lu, Shaofeng; Xue, Fei; Jiang, Lin	018 21st International Conference on Intelligent Transportation Systems (ITSC)	2018.10.10-2018.10.12

2）Others

Awards:

(1) "未来交通系统" 国际学生征文大赛一等奖，IEEE 智能交通系统学会，自然科学，国际学术奖，2018（许斌）

(2) 苏州工业园区紧缺人才补助计划，苏州工业园区，科研人才补助奖励，其他，2017（卢少锋）

Project 8: DASH-Based Interactive 3-D Video System Modeling

| **Jimin Xiao**

Application code: F010803 (Department of Information Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - Young Scientists Fund

Technical fields: Virtual Reality

Introduction: Multi-view video is popular with users because of its excellent viewing experience. According to the request of users, the demand of interactive multi-view video stream providing seamless view switching is also increasing. However, it is a challenging task to provide stable and high-quality multi-view video through streaming, which must allow real-time scene switching under the limited bandwidth. In this project, the research group proposed a seamless multi-view video system assisted by Convolutional Neural Networks (ConvNet) to meet the challenge. The proposed method solves this problem from the two perspectives. First, an onvNet-assisted multi-view video representation method was proposed, which provided flexible interactivity without affecting the compression efficiency of multi-view video. Second, the research group developed a network bandwidth allocation mechanism guided by viewpoint switching model to provide seamless view switching and adapt to network bandwidth fluctuations. These two modules worked closely together to provide users with an optimized viewing experience. They can be integrated into any existing multi-view video streaming framework to improve the overall performance.

Considering the user's behavior of viewpoint switching in streaming transmission, the research group designed a new streaming cache framework to improve the user's experience of multi-view video streaming on DASH. The research group introduced multi-view switching rules to prefetch the possible switching viewpoints in order to eliminate the delay of viewpoint switching. Aiming at the introduced rules, an optimal bit rate allocation scheme was proposed to allow clients to maximize the video quality. In addition, we found that video quality and playback jamming probability were conflict factors under this framework, and both of them were essential for user's Quality of Experience (QoE). This project has solved the contradiction between them properly. The experimental results proved the effectiveness of the method in seamless multi-view flow.

The project solved the contradictions between the flexibility of video view transmission and redundancy mining in multi-view video transmission. The flexibility of view transmission and high multi-view compression ratio distortion performance were also realized. The optimal cache issue of multi-view video in DASH transmission was also solved. According to the network situation and user's view switching habits, the calculation method of the optimal cache size was proposed to obtain the optimal user's user's Quality of Experience (QoE).

Keywords: Multi-View Video, Deep Convolutional Neural Networks, Interactive Transmission, Depth Image

Research achievements:

1）Patent

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
[1]	发明专利	授权	一种基于图像处理的多功能指示器实现方法	CN2015106867645	ZL2015106867645	罗天明；李硕存；程飞

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
[1]	SCIE	IAN: The Individual Aggregation Network for Person Search	Jimin Xiao; Yanchun Xie; Tammam Tillo; Kaizhu Huang; Yunchao Wei; Jiashi Feng	Pattern Recognition	2019.01.01
[2]	SCIE	Correlation Filter Selection for Visual Tracking Using Reinforcement Learning	Yanchun Xie; Jimin Xiao; Kaizhu Huang; Jeyarajan Thiyagalingam; Yao Zhao	IEEE Transactions on Circuits and Systems for Video Technology	2018

(3)	SCIE	Convolutional Neural Network for Intermediate View Enhancement in Multiview Streaming	Li Yu; Tammam Tillo; Jimin Xiao; Marco Grangetto	IEEE TRANSACTIONS ON MULTIMEDIA	2018.01.01
(4)	SCIE	QoE-Driven Dynamic Adaptive Video Streaming Strategy With Future Information	Li Yu; Tammam Tillo; Jimin Xiao	IEEE TRANSACTIONS ON BROADCASTING	2017.09.01
(5)	SCIE	Siamese network ensemble for visual tracking	Chenru Jiang; Jimin Xiao; Yanchun Xie; Tammam Tillo; Kaizhu Huang	Neurocomputing	2018.1.1
(6)	SCIE	Video Streaming Adaptation Strategy for Multiview Navigation Over DASH	Chao Yao; Jimin Xiao; Yao Zhao; Anlong Ming	IEEE TRANSACTIONS ON BROADCASTING	2018.12.1
(7)	SCIE	Region-Based Multiple Description Coding for Multiview Video Plus Depth Video	Chunyu Lin; Yao Zhao; Jimin Xiao; Tammam Tillo	IEEE TRANSACTIONS ON MULTIMEDIA	2018.05.01
(8)	SCIE	Texture Plus Depth Video Coding Using Camera Global Motion Information	Fei Cheng; Tammam Tillo; Jimin Xiao; Byeungwoo Jeon	IEEE Transactions on Multimedia	2017.11.1
(9)	SCIE	Depth Map Down-Sampling and Coding Based on Synthesized View Distortion	Chao Yao; Jimin Xiao; Tammam Tillo; Yao Zhao; Chunyu Lin; Huihui Bai	IEEE TRANSACTIONS ON MULTIMEDIA	2016.10.1
(10)	SCIE	Cooperative Bargaining Game-Based Multiuser Bandwidth Allocation for Dynamic Adaptive Streaming Over HTTP	Hui Yuan; Xuekai Wei; Fuzheng Yang; Jimin Xiao; Sam Kwong	IEEE TRANSACTIONS ON MULTIMEDIA	2018.12.1
(11)	SCIE	End-to-End Distortion-Based Multiuser Bandwidth Allocation for Real-Time Video Transmission Over LTE Network	Hui Yuan; Huayong Fu; Ju Liu; Jimin Xiao	IEEE TRANSACTIONS ON BROADCASTING	2017.06.01
(12)	SCIE	Multiview video plus depth transmission via virtual-view-assisted complementary down/upsampling	Zhi Jin; Tammam Tillo; Jimin Xiao; Yao Zhao	EURASIP Journal on Image and Video Processing	2016.04.29
(13)	SCIE	An effective CU size decision method for quality scalability in SHVC	Xiaoni Li; Mianshu Chen; Zhaowei Qu; Jimin Xiao; Moncef Gabbouj	Multimed Tools and Applications	2017.01.01
(14)	EI	Packetization Strategies for MVD-based 3D Video Transmission	Xue ZHANG; Yao ZHAO; Tammam TILLO; Chunyu Lin; Jimin Xiao ; Anhong Wang	VCIP 2016 : Visual Communications and Image Processing	2016.11.27-2016.11.30
(15)	EI	3D VIDEO SUPER-RESOLUTION USING FULLY CONVOLUTIONAL NEURAL NETWORKS	Yanchun Xie; Jimin Xiao; Tammam Tillo; Yunchao Wei; Yao Zhao	2016 IEEE International Conference on Multimedia and Expo	2016.7.11-2016.7.15

Project 9: Brain Storm Optimization Algorithm and Its Applications to Wireless Sensor Networks

| Yuhui Shi

Introduction: The current urban rail transit system is facing great pressure to improve energy efficiency. However, using the energy storage equipment to recover regenerative braking energy is one of the effective ways to save energy in urban transit train. For the small capacity of onboard energy storage device, the quality of energy storage device can directly affect train operation and other issues, the project proposed to build an overall optimization model of train energy efficiency based on onboard energy storage device, applied mixed integer programming algorithm to find the optimization, revealed the energy-saving mechanism of train operation with onboard energy storage device and promoted the expansion of energy-saving technology theory in urban rail transit industry.

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In addition, a lot of meaningful explorations were made on different application objects in this project. The optimization model proposed in this project will make an active exploration in the application of the fast-developing energy storage devices in the urban rail transit system and the energy-saving strategy field of electrified rail transit.

Research achievements:

1）Copyrights

No.	Category	Title	Author(s)
(1)	Book	Emerging Research on Swarm Intelligence and Algorithm Optimization	Yuhui Shi
(2)	Book	Experimental Study on Boundary Constraints Handling in Particle Swarm Optimization: From Population Diversity Perspective	Shi Cheng, Yuhui Shi, Quande Qin
(3)	Book	Large-Scale Global Optimization via Swarm Intelligence	Shi Cheng, Tiew On Ting, Xin-She Yang
(4)	Book	Population Diversity of Particle Swarm Optimizer Solving Single and Multi-Objective Problems	Shi Cheng, Yuhui Shi, Quande Qin
(5)	Book	Hybrid Metaheuristic Algorithms: Past, Present, and Future	Tiew On Ting, Xin-She Yang, Shi Cheng, Kaizhu Huang

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Brain storm optimization algorithm: a review	Cheng, Shi, Qin, Quande , Chen, Junfeng, Shi, Yuhui	Artificial Intelligence Review	2016.12.01
(2)	SCI	Particle Swarm Optimization With Interswarm Interactive Learning Strategy	Qin, Quande, Cheng, Shi , Zhang, Qingyu, Li, Li, Shi, Yuhui	IEEE Transactions on Cybernetics	2016.10.01
(3)	SCI	Hybrid brain storm optimisation and simulated annealing algorithm for continuous optimisation problems	Jia, Zhengxuan, Duan, Haibin , Shi, Yuhui	International Journal of Bio-Inspired Computation	2016.01.01
(4)	SCI	InteractiveLearning Environment for Bio-Inspired Optimization Algorithms for UAV PathPlanning	Haibin Duan , Pei Li, Yuhui Shi, Xiangyin Zhang, Changhao Sun	IEEE Transactions on Education	2015.11.01
(5)	SCI	Advanced discussion mechanism-based brain storm optimization algorithm	Yang, Yuting , Shi, Yuhui, Xia, Shunren	Soft Computing	2015.10.01
(6)	SCI	Biomimicry of parasitic behavior in a coevolutionary particle swarm optimization algorithm for global optimization	Qin, Quande , Cheng, Shi , Zhang, Qingyu, Li, Li, Shi, Yuhui	Applied Soft Computing	2018.12.1
(7)	SCI	An Improved Brain Storm Optimization with Differential Evolution Strategy for Applications of ANNs	Cao, Zijian , Hei, Xinhong, Wang, Lei, Shi, Yuhui, Rong, Xiaofeng	Mathematical Problems in Engineering	2015.01.01
(8)	SCI	Artificial Bee Colony Algorithm with Time-Varying Strategy	Qin, Quande , Cheng, Shi , Zhang, Qingyu, Li, Li, Shi, Yuhui	Discrete Dynamics in Nature and Society	2015.01.01
(9)	SCI	A decoupling receding horizon search approach to agent routing and optical sensor tasking based on brain storm optimization	Qiu, Huaxin , Duan, Haibin , Shi, Yuhui	Optik	2015.01.01
(10)	SCI	Multiple strategies based orthogonal design particle swarm optimizer for numerical optimization	Qin, Quande , Cheng, Shi , Zhang, Qingyu, Wei, Yiming, Shi, Yuhui	Computers & Operations Research	2015.8.01
(11)	SCIE	Multiview video plus depth transmission via virtual-view-assisted complementary down/upsampling	Zhi Jin; Tammam Tillo; Jimin Xiao; Yao Zhao	EURASIP Journal on Image and Video Processing	2016.04.29
(12)	SCIE	An effective CU size decision method for quality scalability in SHVC	Xiaoni Li; Mianshu Chen; Zhaowei Qu; Jimin Xiao; Moncef Gabbouj	Multimed Tools and Applications	2017.01.01
(13)	EI	Packetization Strategies for MVD-based 3D Video Transmission	Xue ZHANG; Yao ZHAO; Tammam TILLO; Chunyu Lin; Jimin Xiao ; Anhong Wang	VCIP 2016 : Visual Communications and Image Processing	2016.11.27-2016.11.30
(14)	EI	3D VIDEO SUPER-RESOLUTION USING FULLY CONVOLUTIONAL NEURAL NETWORKS	Yanchun Xie; Jimin Xiao; Tammam Tillo; Yunchao Wei; Yao Zhao	2016 IEEE International Conference on Multimedia and Expo	2016.7.11-2016.7.15
(15)	EI	Enhanced brain storm optimization algorithm for wireless sensor networks deployment	Chen, Junfeng , Cheng, Shi, Chen, Yang, Xie, Yingjuan, Shi, Yuhui	6th International Conference on Swarm Intelligence	2015.6.25-2015.6.28
(16)	EI	Random grouping brain storm optimization algorithm with a new dynamically changing step size	Cao, Zijian , Shi, Yuhui, Rong, Xiaofeng, Liu, Baolong, Du, Zhiqiang, Yang, Bo	6th International Conference on Swarm Intelligence	2015.6.25-2015.6.28
(17)	EI	An effective cooperative coevolution framework integrating global and local searchfor large scale optimization problems	Zijian Cao, Lei Wang, Yuhui Shi, Xinhong Hei, Xiaofeng Rong, Qiaoyong Jiang, Hongye Li	2015 IEEE Congress on Evolutionary Computation	2015.5.25-2015.5.28
(18)	EI	Brain Storm Optimization Algorithm in Objective Space	Yuhui Shi	2015 IEEE Congress on Evolutionary Computation	2015.5.25-2015.5.28
(19)	EI	An Improved Fireworks Algorithm with Landscape Information for Balancing Exploration and Exploitation	Junfeng Chen, Qiwen Yang, Jianjun Ni, Yingjuan Xie, Shi Cheng	2015 IEEE Congress on Evolutionary Computation	2015.5.25-2015.5.28
(20)	EI	Brain Storm Optimization with Chaotic Operation	Zhensu Yang, Yuhui Shi	7th International Conference on Advanced Computational Intelligence	2015.3.27-2015.3.29
(21)	EI	An Adaptive Brain Storm Optimization Algorithm for Multiobjective Optimization Problems	Xiaoping Guo, Yali Wu, Lixia Xie, Shi Cheng, Jing Xin	2015 International Conference on Swarm Intelligence	2015.6.25-2015.6.28
(22)	EI	Brain Storm Optimization Algorithms with K-medians Clustering Algorithms	Haoyu Zhu, Yuhui Shi	7th International Conference on Advanced Computational Intelligence	2015.3.27-2015.3.29
(23)	EI	Maintaining population diversity in brain storm optimization algorithm	Cheng S., Shi Y., Qin Q., Ting T.O., Bai R.	2014 IEEE Congress on Evolutionary Computation	2014.7.6-2014.7.11
(24)	EI	A Novel Hybrid Algorithm for Mean-CVaR Portfolio Selection with Real-World Constraints	Quande Qin, Li Li, Shi Cheng	2014 International Conference on Swarm Intelligence	2014.10.17-2014.10.20
(25)	EI	Swarm Intelligence in Big Data Analytics	Cheng Shi, Yuhui Shi, Quande Qin, Ruibin Bai	Intelligent Data Engineering and Automated Learning–IDEAL 2013	2013.10.20-2013.10.23

(26)	EI	Solutions Clustering Analysis in Brain Storm Optimization	Shi Cheng, Yuhui Shi, Quande Qin, Shujing Gao	The 2013 IEEE Symposium on Swarm Intelligence, (SIS 2013)	2013.4.16-2013.4.19
(27)	EI	Particle Swarm Optimization in Regression Analysis: A Case Study	Shi Cheng, Chun Zhao, Jingjin Wu, Yuhui Shi	2013 International Conference on Swarm Intelligence	2013.6.12-2013.6.15
(28)	EI	Particle Swarm Optimization based Nearest Neighbor Algorithm on Chinese Text Categorization	Shi Cheng, Yuhui Shi, Quande Qin	The 2013 IEEE Symposium on Swarm Intelligence, (SIS 2013)	2013.4.16-2013.4.19
(29)	EI	Examples Initialization in Chinese Text Categorization	Shi Cheng, Yuhui Shi, Quande Qin	The Third IEEE International Conference on Information Science and Technology (ICIST 2013)	2013.3.23-2013.3.25

Project 10: Research on Robust Recognition Method of Oracle Bone Inscriptions

| Qiufeng Wang

Key Laboratory of Oracle Information Processing-Key Laboratory - Open Project

Introduction: Currently, the character recognition technology has made great progress, but the performance of Oracle Bone Inscriptions recognition was not enough. For the complex layout of Oracle Bone Inscriptions books, mixed types of ancient characters, irregular handwriting and other difficulties, in this project, a method combining character detection and language discrimination was proposed to extract images of Oracle Bone Inscriptions, and a method combining Oracle Bone Inscriptions recognizer in the adversarial learning framework was also researched to improve its classification accuracy and generalization. The purpose of this project is to improve the recognition performance of Oracle Bone Inscriptions and popularize the interpretation of ancient Chinese characters and ancient books. It also promoted the further development of character recognition technology.

Keywords: Adversarial Learning, Oracle Bone Inscriptions Recognition, Low Quality Image, Handwriting Recognition

Key issues solved:

1. Generative Adversarial Net technology was used to generate Oracle Bone Inscriptions so as to supplement a few samples, and the number balance among various samples has been achieved. To better use the generated samples for the training of Oracle Bone Inscriptions classifier, we integrated the classifier into the framework of Generative Adversarial Net to form an adversarial learning among Oracle Bone Inscriptions generator, true and false discriminator of Oracle Bone Inscriptions and category recognizer of Oracle Bone Inscriptions to realize the end-to-end training of Oracle Bone Inscriptions recognition.

2. Training sample Mix-Up technology was used. The training samples (image features and categories) were mixed in the process of classifier training respectively to generate false sample for assisting the training. Considering the unbalance of Oracle Bone Inscriptions, we considered the number of category samples in the process of mixing samples, which is beneficial to the generation of a few category samples. The method enlarged the classification interface of a few samples and improves its classification performance.

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI	Mix-Up Augmentation for Oracle Character Recognition with Imbalanced Data Distribution	李菁，王秋锋，张锐，黄开竹	ICDAR2021	2021.9.2

Project 11: Study on Linguistic Context in Document Recognition

│ Qiufeng Wang

Programme category: Tencent-China Computer Federation

Introduction: In this project, the complex document situation was faced, including the foreground complex (such as handwriting, multilingual) and the background complex (such as natural scenes, network images) and the character recognition research was carried out. In this project, we researched data generation, classifier performance optimization, language discrimination and other contents. This project has broad application prospects, such as identifying and understanding pictures and characters on social platforms, and helping to build information security.

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Generative Adversarial Classier for Handwriting Characters Super-Resolution	Zhuang Qian, Kaizhu Huang, Qiu-Feng Wang, Jimin Xiao, Rui Zhang	Pattern Recognition	2020
(2)	SCI	Improving Deep Neural Network Performance by Integrating Kernelized Min-Max Objective	Qiu-Feng Wang; Kai Yao; Rui Zhang; Amir Hussain; Kaizhu Huang	Neurocomputing	2020
(3)	SCI	Residual attention-based multi-scale script identification in scene text images	Mengkai Ma, Qiu-Feng Wang*, Shan Huang, Shen Huang, Yannis Goulermas, Kaizhu Huang	Neurocomputing	2021
(4)	EI	An Interactive and Generative Approach for Chinese Shanshui Painting Document	Le Zhou, Qiu-Feng Wang, Cheng-Hung Lo, Kaizhu Huang	ICDAR	2019
(5)	EI	Improving Image Caption Performance with Linguistic Context	Yupeng Cao, Qiu-Feng Wang, Kaizhu Huang and Rui Zhang	BICS	2019
(6)	EI	Improving script identification by integrating text recognition information	Yupeng Cao, Jing Li, Qiu-Feng Wang, Kaizhu Huang, Rui Zhang	ICONIP	2019

Project 12: A Study of Document Recognition Based on the Internet Multi-Modal Contents

│ Qiufeng Wang

Programme category: State Key Laboratory of Pattern Recognition- Open Project

Introduction: In this project, Internet contents were used to improve the performance of current document recognition. The starting point is that context information plays a great role in the process of human document recognition. However, the current document recognition system does not make use of context knowledge satisfactorily. Thus, by using the resources on the Internet, this project can get a more accurate language context model so as to improve the performance of document recognition.

Key issues solved:

(1) Quick retrieval of related documents. Aiming at the current document recognition, we researched a fast retrieval algorithm to quickly find the relevant text information in the Internet text database so as to obtain the correlative text set.

(2) Adaptive updating of language model. According to the correlative text set, we researched the way to update the current language model quickly so that the new language model can be more suitable for the current document recognition.

(3) Weakly supervised learning of model parameters. Traditional over-segmentation recognition model training needs to mark every character position. But this strong supervised learning algorithm needs a lot of manpower to mark samples. In this project, the training model was based on only string-level markup text (instead of character-level markup) so as to reduce the training cost of the model and improve its applicability.

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Large-scale Ensemble Model for Customer Churn Prediction in Search Ads.	Qiu-Feng Wang, Mirror Xu, and Amir Hussain	Cognitive Computation	2019
(2)	EI	Improving script identification by Integrating Text Recognition Information	Yupeng Cao, Jing Li, Qiu-Feng Wang, Kaizhu Huang, and Rui Zhang	26th International Conference on Neural Information Processing	2019

Project 13: Fuzzy Cognitive Swarm Optimized Clustering Methods

| Kam Fung Yuen

Application code: F0602 (Department of Information Sciences)

Programme category: National Natural Science Foundation of China (NSFC) – Young Scientists Fund

Technical fields: Data Analysis, Risk Assessment

Introduction: Clustering algorithm is an important and widely used pattern recognition technology in the field of data analysis. According to a considerable number of research results, intelligent algorithms (including cluster intelligent algorithm and genetic algorithm) and network cognition methods (including basic network cognition method and fuzzy network cognition method) have certain advantages and advancements in optimizing clustering algorithms. To resolve the optimization problem of clustering algorithms, this project reviews, compares and analyzes the existing network cognitive methods and evolutionary cluster intelligence methods. Finally, we have developed a series of clustering algorithms optimized by evolutionary cluster intelligence and network cognitive methods, and used open data sets in different fields such as data analysis, recommendation system, and graph segmentation to test the newly proposed method. This project focuses on optimizing existing algorithms and expanding the application prospects of new algorithms, which expands the scope of research from the planned "Improve clustering algorithms with cluster intelligence algorithm" to "Optimize clustering algorithms with multiple optimization algorithms and network cognitive methods"; the application direction of the proposed new algorithm covers many fields such as decision-making problems, data analysis, graph segmentation, recommendation system and so on. During the project, many graduate students and undergraduates were trained, and the project team published a total of ten academic papers. Three of them are core journal papers (two are indexed by SCI/EI, and one is indexed by EI), and seven are international conference papers (six are indexed by EI). In addition, the project team developed a financial risk prediction app on the iOS and Android platforms based on the research results.

Keywords: Clustering Algorithm, Cluster Intelligent Algorithm, Genetic Algorithm, Network Cognitive Method, Data Analysis

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE, SSCI, EI	The fuzzy cognitive pairwise comparisons for ranking and grade clustering to build a recommender system: An application of smartphone recommendation	Yuen Kevin Kam Fung	Engineering Applications of Artificial Intelligence	2017.05
(2)	SCIE, SSCI, EI	Particle Swarm Optimized Density-Based Clustering and Classification: Supervised and Unsupervised Learning Approaches	Chun Guan ; Kevin Kam Fung Yuen	Swarm and Evolutionary Computation	2019.02
(3)	EI	Towards Multiple Regression Analyses for Relationships of Air Quality and Weather	Kevin Kam Fung Yuen	Journal of Advances in Information Technology	2017
(4)	EI	Towards A Canonical Particle Swarm Optimized Direct Least Squares Prioritization Method for Ratio Pairwise Comparison: An Application of Mutual Fund Selection	Kevin Kam Fung Yuen	the Ninth International Conference on Developments in e-Systems Engineering (DeSE2016)	2016.08.31-2016.09.02
(5)	EI	Towards A Genetic Direct Least Squares Prioritization Method for Pairwise Reciprocal Matrices: Application of Asset Portfolio Selection	Kevin Kam Fung Yuen	International Conference of Machine Learning and Cybernetics (ICMLC) 2016	2016.07.10-2016.07.13
(6)	EI	Towards an MCDM-based evaluation framework for regression algorithms	Yao Di; Kevin Kam Fung Yuen	IEEE International Conference on Smart Computing (SMARTCOMP)	2017.05.29-2017.05.31
(7)	EI	Towards a Hybrid Approach of K-Means and Density-Based Spatial Clustering of Applications with Noise for Image Segmentation	Chun Guan; Kevin Kam Fung Yuen; Qi Chen	2017 IEEE International Conference on Internet of Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (SmartData)	2017.6.21-2017.6.23
(8)	EI	Towards a recommendation approach for university program selection using Primitive Cognitive Network Process	Qingzhi Hu; Kevin Kam Fung Yuen; Paul Craig	2017 International Conference on Service Systems and Service Management	2017.6.16-2017.6.18
(9)	EI	Towards a Hybrid Approach of Self-Organizing Map and Density-Based Spatial Clustering of Applications with Noise for Image Segmentation	Qi Chen; Kevin Kam Fung Yuen; Chun Guan	10th International Conference on Developments in eSystems Engineering	2017.6.14-2017.6.16

Project 14: Design Methods and Tools to Support the Digital Manufacturing Process of Personalised Smart Textile Products

| Martijn ten Bhömer

Application code: E051002(Department of Engineering and Materials Sciences)

Programme category: National Natural Science Foundation of China (NSFC)-International Young Scientists Programme

Introduction: During this one-year project, the focus was on establishing new design methods and tools to support the digital manufacturing process and its stakeholders (primarily company and end-user) in order to create personalised smart textile products. We focused specifically on the development of new design methods and tools because it's normally the role of the designer in a project to find a balance between creating design opportunities and guaranteeing adequate product quality. Therefore, the main research question of this project was: Which new design methods and tools can be used during the development process of smart textile products that make use of the capabilities of the digital manufacturing process to support personalization during the full life-cycle? Within this larger research framework three activities have been undertaken.

1. A case study has been conducted which explored the potential of predictive software design tools for fashion designers who are developing personalized advanced functionalities in textile products.
2. Four student projects have been initiated that focused on the design and development of personalized smart textiles, as well as personalized production using 3D printing.
3. An international network meeting is being organized in which international participants will share insights about personalized manufacturing during workshops and keynote speeches.

The project has resulted in 3 conference publications, 1 journal publication, 2 local, 1 national and 1 international design prizes. Furthermore, work has been presented during academic conference in Hong Kong and during the internationally renowned Dutch Design Week in The Netherlands.

Keywords: Industry 4.0, Smart Textiles, Personalisation, Wellbeing, Industrial Design

Research achievements:

1）Others

Competitions:

- July 3, 2018, Third prize in the China-US Young Maker Competition Suzhou Division for Yoga Suit project.

- August 18, 2018, Excellence Award during the China-US Young Maker Competition National Final in Beijing (best 25 teams out of 75 teams), Yoga Suit project

- September 9, 2018, Xi'an Jiaotong-Liverpool University, Cluster winner (Industrial Technology), SURF project "EvoPosture"

- October 16, 2018, Barcelona, Spain - Reshape 2018 Sensing Materialities. EvoPosture Finalist (Best 10 projects out of global submissions)

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2. Provincial Projects

Project 1: Interferenceless Machine Learning – Research and Applications

| Sheng-Uei Guan

Technical fields: Machine Learning, Intelligent Computing

Programme category: Jiangsu Science and Technology Programme - Basic Research Plan (Natural Science Foundation) - General Programme

Introduction: The research conducted in this project is the theory, algorithm and application of Input/Output Attribute Partitioning and Grouping (hereinafter referred to as 'Grouping Learning'). Now, both at home and abroad, the research on group learning is still in its infancy, and the related theories/algorithms are not perfect, and the related applications are also lacking. Through the research of this project, the algorithms and measurement indexes related to multi-level learning of input attributes using canonical correlation were listed, a theoretical framework of multi-level ensemble learning of input attributes can improve the practical application model of existing patterns and bring new improvements to the structure of some existing intelligent computing methods, such as neural network, genetic algorithm, support vector machine and swarm intelligence. The research of this project indicated that grouping learning can be independent of neural network, genetic algorithm and other specific intelligent algorithms, and can be implemented in many ways, which is a learning strategy different from other methods.

Keywords: Feature Attribute, Group Learning, Machine Learning

Key issues solved: Usually, the traditional learning methods introduce all the input and output attributes at one time, and then let the machine learn and solve the issue. Or, the feature selection and other preprocessing work shall be done for all sample feature attributes first and then all selected feature attributes are imported at one time for machine learning so as to solve the issue. However, the results of such learning methods are often inaccurate. In addition, with the explosive growth of data and the emergence of high-dimensional data, such complex issues often cannot be effectively solved by traditional learning methods.

The applicant's machine learning team of this project applied the method of group learning, with Neural Networks (NNs) and Genetic Algorithms (GAs) as the main research methods. Through the research, it is proved that group learning and its training strategy are superior to conventional machine learning methods.

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI, EI	EEG Eye State Identification Using Incremental Attribute Learning with Time Series Classification	Ting Wang, Sheng-Uei Guan, Ka Lok Man, T. O. Ting	Mathematical Problems in Engineering	2014
(2)	EI	Optimized Neural Incremental Attribute Learning for Classification based on Statistical Discriminability	Ting Wang, Sheng-Uei Guan, Kalok Man, T. O. Ting	International Journal of Computational Intelligence and Applications (IJCIA)	2014
(3)	SCI	Output Effect Evaluation Based on Input Features in Neural Incremental Attribute Learning for Better Classification Performance	Ting Wang, Sheng-Uei Guan, Ka Lok Man, Jong Hyuk Park, Hui-Huang Hsu	Special Issue Advanced Symmetry Modelling and Services in Future IT Environments, Symmetry Journal	2015.1

(4)	SCI, EI	Neural Incremental Attribute Learning in Groups	Fangzhou Liu, Ting Wang, Sheng-Uei Guan, Ka Lok Man	International Journal of Computational Intelligence Systems	2015.6
(5)	EI	Regression based on Neural Incremental Attribute Learning with Correlation-based Feature Ordering	Ting Wang, Sheng-Uei Guan, Ka Lok Man, T. O. Ting	the 7th IEEE International Conference on Cybernetics and Intelligent Systems (CIS) and the 7th IEEE International Conference on Robotics, Automation and Mechatronics (RAM)	2015.7.15-2015.7.17
(6)	EI	Linear Feature Sensibility for Output Partitioning in Ordered Neural Incremental Attribute Learning	Ting Wang, Sheng-Uei Guan, Jiemin Ma, Fangzhou Liu	2015 International Conference on Intelligence Science and Big Data Engineering (IScIDE 2015)	2015.6.14-2015.6.16
(7)	EI	Maximum Gaussian Mixture Model for Classification	Jiehao Zhang, Xianbin Hong, Sheng-Uei Guan, Xuan Zhao, Xin Huang, Nian Xue	the 8th International Conference on Information Technology in Medicine and Education (ITME 2016)	2016.12.23-2016.12.25

2）Others

Awards:

1. Fangzhou Liu, received the best paper award at the International Conference on Computing and Technology Innovation (CTI 2015), May 27–28, 2015, University of Bedfordshire, Luton, United Kingdom

2. David Afolabi, received the best prize award at the International Conference on Computing and Technology Innovation (CTI 2015), May 27–28, 2015, University of Bedfordshire, Luton, United Kingdom

3. David Olalekan Afolabi, won PhD Poster Award at XJTLU, 2015

4. Best Paper Award, Ting Wang, Sheng-Uei Guan, Hui-Huang Hsu, JongHyuk Park, KaLok Man, "Classification Capacity Evaluation Per Feature based on Neural Incremental Attribute Learning", the 6th FTRA International Conference on Information Technology Convergence and Services (ITCS-14), Taipei, Taiwan, October 16-18, 2014

Project 2: Multi-Objects Detection and Recognition Based on Deep Learning

| Rui Zhang

Technical field: Artificial Intelligence (AI)

Programme category: The Natural Science Foundation of the Jiangsu Higher Education Institutions of China - General Programme

Introduction:

This project is a comprehensive research subject with basic research orientation and combination of theory and practice. Our main research and development goal is to develop a set of key algorithms and technologies for multi-target detection, recognition and understanding to meet the actual needs of various applications. The algorithms and technological breakthroughs include

1. the way to realize high-precision multi-target detection in complex background;
2. the way to recognize the detected objects efficiently;
3. the way to detect and identify the object information for data mining and understanding, and then sum up the rules.

Many aspects of research are involved, including the research of machine learning theory including deep learning, and the processing and analysis technology of multimedia scene data. Currently, the research in the field of deep learning is very active. However, a common problem is that a lot of data are required and its model optimization is difficult. We hope to optimize the deep learning model by understanding the specific scene data so as to obtain a model with high running efficiency and excellent performance. Here, a lot of researches on machine learning theory and model optimization technology are required.

Keywords: Target Detection, Deep Learning, Pattern Classification

Key issues solved:

1. We achieved the task of target detection and recognition for many different targets, including characters in images, objects and people in videos.
2. Explored the high-precision and high-efficiency target detection and recognition methods.
3. Researched the object detection and recognition in difficult scenes, such as object detection and recognition problem with zero samples and few samples, and text target recognition problem with multi-pose, multi-style and low resolution.

Main innovations and achievements:

1. An end-to-end neural network framework for degraded text target detection and recognition in low resolution was implemented. The network innovatively unified the target generator, recognizer and discriminator in a common network, and realized a high-precision and high-efficiency deep learning framework. The achievements were published in Pattern Recognition 2020, the international first-class journal.
2. Two frameworks for multi-attitude target detection and global recognition were implemented.
   i. A unified deep learning framework integrating style neural network and target recognition ejaculation network was implemented,
   ii. Multi-attitude target detection and overall frame recognition were carried out by using generated countermeasure neural network. The overall attributes between data were fused effectively and an efficient optimization method was put forward. This series of research has greatly improved the recognition performance of various targets, such as faces and characters. The method was published at the International Conference on Brain-inspired Cognitive System, and won the Best Student Paper Award, and the extended paper was accepted by Cognitive Computation 2020, an international recognised journal.

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Generative adversarial classifier for handwriting characters super-resolution	Zhuang Qian, Kaizhu Huang, Qiufeng Wang, Jimin Xiao, Rui Zhang	Pattern Recognition	2020
(2)	SCI	Improving DNN Performance with Kernelized Min-Max Objective	Qiufeng Wang, Kai Yao, Rui Zhang, Amir Hussain, Kaizhu Huang	Neurocomputing	2020
(3)	SCI	A Novel Deep Density Model for Unsupervised Learning	Xi Yang, Kaizhu Huang, Rui Zhang, Yannis Goulermas	Cognitive Computation	2019
(4)	SCI	Special Issue Editorial: Cognitively-Inspired Computing for Knowledge Discovery	Kaizhu Huang, Rui Zhang, Xiaobo Jin, Amir Hussain	Cognitive Computation	2018
(5)	EI	Improving Script Identification by Integrating Text Recognition Information	Yupeng Cao, Jing Li, Qiu-Feng Wang, Kaizhu Huang, Rui Zhang	Australian. Journal of Intelligent Information Processing Systems	2019
(6)	EI	Improving Image Caption Performance with Linguistic Context	Yupeng Cao, Qiu-Feng Wang, Kaizhu Huang, Rui Zhang	International Conference on Brain Inspired Cognitive System	2019
(7)	EI	Self-focus Deep Embedding Model for Coarse-Grained Zero-Shot Classification	Guanyu Yang, Kaizhu Huang, Rui Zhang, John Yannis Goulermas, Amir Hussain	International Conference on Brain Inspired Cognitive System	2019
(8)	EI	Style Neutralization Generative Adversarial Classifier	Haochuan Jiang, Kaizhu Huang, Rui Zhang, Amir Hussain	International Conference on Brain Inspired Cognitive System	2018

Project 3: Robust Imbalanced Learning Based on Min-Max Theory and Its Application

| **Rui Zhang**

Technical field: Artificial Intelligence (AI)

Programme category: The Natural Science Foundation of the Jiangsu Higher Education Institutions of China - General Programme

Introduction:

Based on the idea of local and global learning, we researched the unbalanced learning method of max-min theory, and also researched the basic problems in learning theory: dimension reduction, feature extraction and large-scale classification. The results of this project include the publication of 2 international conference papers, the publication (or receiving) of 5 international journal papers, including 3 SCI index articles. In addition, we also applied for a patent. The specific research contents are as follows:

1. Research on Local and Global Unbalanced Learning Methods

   Based on the local and global ideals, we modified the famous max-min probability machine model, and then derived our One-side Probability Machine. In this method, the idea of large boundary was adopted for important data, and the idea of max-min probability machine was adopted for unimportant data. We proved the effectiveness of our method theoretically and also verified our algorithm on several databases. The results indicated that our method is robust and has high accuracy for unbalanced learning problems. The achievement was published in Neural Processing Letters, an international mainstream SCI magazine.

2. Research on the Basic Theory of Machine Learning

   We also researched the basic theoretical problems of machine learning, including dimension reduction, feature extraction, large-scale classification, small sample learning, ensemble learning of fusion classification and clustering, which were described respectively below.

   i. Feature extraction

      We researched the feature extraction method for large-scale data. Previous feature extraction methods often can't have both scalability and discrimination ability. We used random projection method to increase the scalability of our method, and we also used the discriminant criterion of machine learning to improve the discriminant ability of our method. Our method has been demonstrated on several large-scale databases. The method was published in the WSDM (SDA workshop), an international first-class conference, and its extended version was published in BMC Big Data Analytics, an international magazine.

   ii. Dimension reduction

      Aiming at the famous Gaussian mixture model in machine learning, we proposed a new method of reducing dimension and learning model simultaneously. The method can improve the effectiveness of Gaussian mixture model more than the previous methods in which dimension reduction and model learning are carried out independently. We applied our method to the clustering, and the experimental results indicate that our method greatly improved the original method of independent dimension reduction and model learning. The achievement was published at the IJCNN 2015, an international conference, and the expanded version was published in Neural Processing Letters, an international mainstream SCI journal of machine learning.

   iii. Pattern classification

      In addition, we also researched the method of face recognition using a small number of samples. Our greatest contribution is to propose a face enhancement method that automatically filters out sunglasses so that we can recognize faces robustly. Our method is published in the International Journal of Machine Learning and Computing.

   iv. Learning problem of small samples

      Traditional statistical machine learning methods include unbalanced data learning methods, which often require

a large number of samples. We researched the way to simulate human memory mechanism, and then proposed a small sample learning method, and implemented our algorithm on neural network. The experiments indicate that the classification accuracy can be greatly improved when the number of samples is less. The paper has been accepted by Cognitive Computation, an international journal of SCI.

v. Ensemble learning method integrating classification and clustering

Usually, the traditional ensemble learning methods only consider the results of ensemble of multiple classifiers, but in fact, the results of clustering analysis can effectively supplement and improve the final classification effect. We proposed a method of building data approximate graph by using the clustering results, and discussed the way to improve the accuracy of ensemble learning by combining clustering analysis and classifier. We have fully discussed the method and submitted a patent.

Keywords: Robust, Unbalanced Learning, Classifier

Key issues solved:

1. The way to use robust local learning method to constrain a small number of positive samples and suppress the noise or outliers that may exist in data is a key scientific issue in this subject.

2. The way to use global learning to constrain the overall information of a large number of negative samples in probability so as to overcome the issue of positive information drowning caused by huge negative data and describe it as a convex problem is a key scientific issue in this subject.

3. The way to integrate the local learning of positive samples and the global learning of negative samples into a minimum-maximum learning framework is an important key scientific issue in this subject.

4. The way to describe or relax the above model as a convex programming issue is a key scientific issue in this subject.

Research achievements:

1）Patent

No.	Category	Status	Patents Title	Application no.	Inventor(s)
(1)	发明	审查	融合分类和聚类的集成分类识别方法	CN201710123864.6	黄开竹，张锐，侯翠琴，夏迎炬

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI	Two-layer mixture of factor analyzers with joint factor loading	Yang, Xi and Huang, Kaizhu and Zhang, Rui and Goulermas, John Yannis	2015 International Joint Conference on Neural Networks (IJCNN)	2015
(2)	EI	SDRNF: generating scalable and discriminative random nonlinear features from data	Chu, Haoda and Huang, Kaizhu and Zhang, Rui and Hussian, Amir	Big Data Analytics	2016
(3)	SCI	Learning imbalanced classifiers locally and globally with one-side probability machine	Huang, Kaizhu and Zhang, Rui and Yin, Xu-Cheng	Neural Processing Letters	2015
(4)	EI	Unsupervised dimensionality reduction for gaussian mixture model	Yang, Xi and Huang, Kaizhu and Zhang, Rui	International conference on neural information processing	2014
(5)	EI	Robust one-shot facial expression recognition with sunglasses	Jiang, H and Huang, K and Mu, T and Zhang, R and Ting, TO and Wang, C	International Journal of Machine Learning and Computing	2016
(6)	SCI	Learning from few samples with memory network	Zhang, Shufei and Huang, Kaizhu and Zhang, Rui and Hussain, Amir	Cognitive Computation	2018

Project 4: Intelligent Multi-Camera Video Surveillance

| Ming Xu & Bailing Zhang

Technical fields: Automation, Artificial Intelligence (AI)

Programme category: Jiangsu Science and Technology Programme - Basic Research Plan (Natural Science Foundation)

Introduction: Video surveillance means to monitor the activities of specific places through the cameras. Currently, the video surveillance system in China is realized by operating multiple closed-circuit television monitors and recording to save the data. Intelligent video surveillance system can automatically detect, track and identify the moving targets in real time by computer, and distinguish target behavior and events. This project focuses on solving several important problems that plague the intelligent video surveillance system now. Its success will greatly promote the practicality and popularization of intelligent video surveillance system.

Keywords: Video Surveillance, Target Detection and Tracking, Pattern Recognition

Key issues solved:

1. It systematically solved the problems that target detection is sensitive to environmental changes and prone to false alarms. Based on the geometric model of computer vision, we used information redundancy among multiple cameras to eliminate shadows in moving target detection.

2. We researched the way to make full use of some effective observation data in single camera target tracking. Using symbolic computation and Monte Carlo simulation, we proved that the method of estimating the 'Observation' at unobservable side from the observable side is optimal when the trajectory of the target changes during the occlusion

3. The information fusion strategy was chosen to solve the problem of rapid combination growth when the probabilistic matching between the target and the observed data was adopted in multi-camera target tracking. We gave up feature fusion and adopted foreground image fusion method. To apply the method to real-time video surveillance system, we only mapped the corner points of the foreground region polygon so that it had the advantages of image fusion and high efficiency of feature fusion.

4. The temporal and spatial continuity of image sequences was used to classify and recognize the moving objects. Color distribution of each object along the central axis was used for observation. K-Mean method and Gaussian mixture model method were used to cluster and learn model parameters online. The method is more accurate and stable than the original method of target average color or color histogram. The reason is that the former one considers the covariance and spatial distribution information of colors.

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI, EI	Visual tracking of partially observable targets with suboptimal filtering	M. Xu, T. Ellis, S. J. Godsill and G. Jones	IET Computer Vision	2011.01
(2)	SCI, EI	Robust object detection with real-time fusion of mutliview foreground silhouettes	M. Xu, J. Ren, D. Chen, J. Smith, Z. Liu and T. Jia	SPIE Optical Engineering	2012.04
(3)	EI	Real-time detection via homography mapping of foreground polygons from multiple cameras	M. Xu, J. Ren, D. Chen, J. Smith and G. Wang	Proc. IEEE International Conference on Image Processing (ICIP'2011)	2011/9/11-2011/9/14
(4)	EI	A multiview approach to robust detection in the presence of cast shadows	M. Xu, J. Ren, D. Chen, J. Smith and Z. Liu	Proc. International Conference on Image and Graphics (ICIG'2011)	2011/8/12-2011/8/15
(5)	EI	Pruning Phantom Detections from Multiview Foreground Intersection	Jie Ren、Ming Xu、Jeremy S. Smith	2012 IEEE International Conference on Image Processing	2012/09/30-2012/10/03
(6)	EI	Cast Shadow Removal in Motion Detection by Exploiting Multiview Geometry	Ming Xu、Lei Lu、Tianyuan Jia、Jie Ren、Jeremy S. Smith	2012 IEEE International Conference on Systems, Man, and Cybernetics	2012/10/14-2012/10/17
(7)	EI	A colour statistical Approach to phantom pruning in multi-view detection	Jie Ren、Ming Xu、Jeremy S. Smith	2012 IEEE International Conference on Systems, Man, and Cybernetics	2012/10/14-2012/10/17
(8)	EI	Robust Localisation of Pedestrians with Cast Shadows Using Homology in A Monocular View	Ming Xu、Tianyuan Jia、Lei Lu、Jeremy S. Smith	2012 IEEE International Conference on Systems, Man, and Cybernetics	2012/10/14-2012/10/17

2）Others

Awards:

Ming Xu、Tim Ellis、Simon J. Godsill、Graeme A. Jones，2012 IET 计算机视觉最佳论文奖，Institution of Engineering and Technology (IET), IET Computer Vision Premium Award, Best Paper Prize, 2012/11/22，已标注

Project 5: Analysis and Management of Bio-Medicine Image

| Bailing Zhang

Programme category: Jiangsu Science and Technology Programme - Basic Research Plan (Natural Sicence Foundation) - General Programme

Introduction: Development of intelligent analysis, retrieval and management system of biological images will promote the development of biomedical equipment industry in China. In the competition of biomedical imaging industry, besides the development of related hardware such as imaging equipment, the research of a series of basic theories of biomedical image analysis and processing and the development of corresponding software systems play an important role. Computer technology can effectively help us to take biomedical images as a comprehensive information resource, and establish a complete set of biomedical image information database system for collection, processing, analysis, management and publish so as to meet the needs of biomedical research.

In this project, computer vision, image processing and machine learning theories and methods were used to solve a series of problems in biological image informatics, including extraction and expression of biological microscopic image feature information, automatic classification of biological microscopic image, especially the classification and recognition of cell division morphology; and analysis of temporal and spatial characteristics of biological image sequences to explore the dynamics of cells and living tissues. This project also explored the semantic information and feature information of biological image data, solved image retrieval and query by ontology, and researched and constructed an intelligent biological image data management and data support system for analysis tools and analysis means.

Key issues solved:

1. The multi-scale feature expression of biological microscopic images were researched to indicate that curvelet transform has superior characteristics in various microscopic image analysis;
2. The problem of multi-feature fusion and random subspace classifier ensemble was solved to realize high-reliability phenotype recognition of microscopic images;
3. The multi-precision fractal feature expression and classification recognition method of neural salience micro-image were proposed;
4. The Random Projection Forest algorithm of phenotype recognition was proposed for RNAi screening;
5. For the classification of subcellular phenotypic microscopic images, a decision template algorithm based on classifier ensemble was proposed.

Research achievements:

1) Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	基于集成级联架构的生物显微图像高可靠性分类方法	CN201210499577.2	ZL201210499577.2	张百灵、张云港
(2)	发明	授权	用于生物细胞显微镜图像分类的特征子空间集成方法	CN201210572602.5	ZL201210572602.5	张百灵、张云港
(3)	发明	授权	基于多分辨率分形特征的神经树突棘图像分类方法	CN201210567451.4	ZL201210567451.4	张百灵、张云港

2) Copyright

No.	Category	Title	Author(s)
(1)	Book Chapter	Breast Cancer Histological Image Classification with Multiple Features and Random Subspace Classifier Ensemble	Yungang Zhang, Bailing Zhang, Wenjin Lu

3) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI	Serial Fusion of Random Subspace Ensembles for Subcellular Phenotype Images Classification	B.Zhang and T.Pham	Int. J. of Bioinformatics Research and Applications (IJBRA)	2013
(2)	EI	Phenotype Recognition with Combined Features and Random Subspace Classifier Ensemble	B.Zhang and T.Pham	BMC Bioinformatics 2011	2011
(3)	EI	Phenotype Recognition by Curvelet Transform and Random Subspace Ensemble	B.Zhang, Y.Zhang, W.Lu and G.Han	Journal of Applied Mathematics and Bioinformatics	2011
(4)	EI	Two-stage Hybrid Classifier Ensembles for Subcellular Phenotype Images Classification	B.Zhang and P. Tuan	International Journal of Biometrics and Bioinformatics	2010
(5)	EI	Breast Cancer Diagnosis from Biopsy Images with Highly Reliable Random Subspace Classifiers Ensemble	Yungang Zhang, Bailing Zhang	Machine Vision and Applications	2013
(6)	EI	Highly Reliable Breast Cancer Diagnosis with Cascaded Ensemble Classifiers	Yungang Zhang, Bailing Zhang, Frans Coenen and Wenjin Lu	International Joint Conference on Neural Networks (IJCNN 2012)	2012
(7)	EI	Two-stage hybrid classifier ensembles for subcellular images classification	B. Zhang	3rd International Conference on Bioinformatics and Biomedical Technology	2011.3.25-2011.3.27
(8)	EI	Subcellular Phenotype Images Classification by MLP Ensembles with Random Linear Oracle	B.Zhang and G.Han	5th International Conference on Bioinformatics and Biomedical Engineering	2011.5.10-2011.5.12
(9)	EI	Breast Cancer Diagnosis from Biopsy Images by Serial Fusion of Random Subspace Ensembles	B.Zhang	4th International Conference on BioMedical Engineering and Informatics	2011.10.15-2011.10.17
(10)	EI	Multiresolution fractal analysis and classification of neurite images	B.Zhang and W.Lu	Proceeding of 2010 3rd International Conference on Biomedical Engineering and Informatics (BMEI2010)	2010
(11)	EI	Classification of Malignant Lymphomas by Classifier Ensemble with Multiple Texture Features	B.Zhang and W.Lu	Proceeding of 2010 International Conference on Life System Modeling and Simulation (LSMS'10)	2010

Project 6: Improving Natural Scene Chinese Text Recognition by Integrating Contexts

| Qiufeng Wang

Programme category: The Natural Science Foundation of the Jiangsu Higher Education Institutions of China- General Programme

Introduction: In view of the lack of performance of Chinese natural scene text detection and recognition nowadays, inspired by the fact that human beings can make full use of context information to recognize scene text, the following three aspects of research will be carried out for this project:

1. Representation of language context information. The starting point of this project comes from the full consideration of context information when people recognize scene text, especially the language context knowledge. However, the knowledge has been cultivated in people's daily communication for a long time, and there is no clear rule. Thus, the way to express the language knowledge effectively is a key issue in this project. The commonly used N-gram language model or dictionary information has obvious shortcomings. For example, N-gram only considers the relationship between adjacent characters. With the increase of N, its data is sparser (leading to zero probability problem) and its complexity is higher. In practice, N=3 is generally used, so that only the connection between three adjacent characters is considered. However, in an open and arbitrary natural scene, the dictionary information does not exist.

2. Optimal path evaluation criteria based on multi-context integration. End-to-end recognition framework including detection and recognition is a trend of scene text recognition. Under such a framework, the way to effectively fuse multiple information is a key issue. It includes two parts: 1. The framework based on Bayesian decision theory needs a complete set of probability distribution. However, the reality is that it is difficult for us to get the true probability distribution of different context models, especially the language context model mentioned earlier. Thus, the way to modify Bayesian decision function under the condition of deviation probability distribution is a key problem in this project; 2. The way to effectively get the parameters of different context models in the decision function is also a key problem.

3. Efficient search algorithm. With the integration of context model, path evaluation in candidate grid becomes more and more complex. With the increase of path length, the complexity of search space increases exponentially. Thus, the way to find the optimal recognition path quickly and accurately is a key problem to be solved urgently in the face of the recognition framework integrating multiple context models.

In addition, the representation of geometric context information is also very important, but it is not a key problem, because it can be solved well after proper implementation and continuous improvement now.

Key issues solved:

The research and development of this project focuses on two core technologies in scene text recognition: character recognizer and language model. Of which, the function of the character recognizer is to obtain the corresponding character category according to the input image. Here, we need to consider distinguishing similar characters of Chinese characters. For this purpose, we proposed a deep neural network classifier based on the minimum-maximum kernel function criterion. In addition, because the deep neural network needs a large number of samples, we also researched the use of generating countermeasure network technology to generate samples. The language model is used to judge whether the sentence of recognition result is smooth and whether the context of characters is reasonable. Considering the different semantics of words in different contexts, we researched the adaptive algorithm of language model by searching texts with relevant semantics from large-scale corpus in the process of recognition so as to improve the recognition rate of recognition documents.

In this project, for neural network classifier, we proposed a combination of minimum-maximum training criteria. By minimizing the intra-class distance and maximizing the inter-class interval, combined with kernel skills, the training criteria were mapped into kernel space for unified optimization. For training samples, we proposed a method of using cycle Generative Adversarial Networks (cycle-GAN) to generate Chinese landscape painting documents. For the problem of language model

adaptation, we proposed an unsupervised language model adaptation algorithm using Internet text to improve the performance of document recognition. In addition, this project also tried some innovations in zero-sample and large-scale integration models, such as proposing a discriminant zero-sample learning algorithm based on Center Loss.

Research achievements:

1）Patent

No.	Category	Status	Patents Title	Application no.	Inventor(s)
(1)	发明	申请	基于互联网检索的中文文档识别方法	CN201811395481.5	王秋锋、黄开竹

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI	Nonconvex matrix completion with Nesterov's acceleration	Xiao-Bo Jin, Guo-Sen Xie, Qiu-FengWang, Guoqiang Zhong and Guang-Gang Geng	Big Data Analytics	2018
(2)	SCI	Large-scale ensemble model for customer churn prediction in search ads	Qiu-Feng Wang, Mirror Xu, Amir Hussain3	Cognitive Computation	2019
(3)	SCI	Large-scale ensemble model for customer churn prediction in search ads	Qiu-Feng Wang, Mirror Xu, Amir Hussain3	Cognitive Computation	2019
(4)	SCI	Discriminant Zero-shot learning with center loss	Xiao-Bo Jin, Guo-Sen Xie, Kaizhu Huang, Heling Cao, Qiu-Feng Wang	Cognitive Computation	2019
(5)	EI	An Interactive and Generative Approach for Chinese Shanshui Painting Document	Le Zhou, Qiu-Feng Wang, Kaizhu Huang and Cheng-Hung Lo	ICDAR	2019
(6)	SCI	Improving deep neural network performance by integrating kernelized Min-Max objective	Qiu-Feng Wang, Kai Yao, Rui Zhang, Amir Hussain, Kaizhu Huang	Neurocomputing	2020

Project 7: Energy Management Strategies Optimisation For Urban Rail Transportation System

| Shaofeng Lu

Programme category: The Natural Science Foundation of the Jiangsu Higher Education Institutions of China- General Programme

Introduction: Rail transit is a powerful driving force for the development of national economy. With the massive development of rail transit system, the energy consumption brought by rail transit is increasing day by day, and the situation of energy-saving and emission reduction is becoming increasingly severe. As an important part of rail transit, urban rail transit in China will continue to face great pressure such as improving energy efficiency and reducing energy consumption. Among many energy-saving technologies of rail transit, the optimization of train running speed curve is considered to have outstanding effectiveness. In the past, the optimization methods for train speed curve operation include optimal control, coasting control and cooperative control of train operation in rail transit power grid, etc.

This project is different from the previous 'Perfect Speed Curve Optimization Technology' between two stations, and the 'Partial Speed Curve Optimization Technology' based on mathematical programming algorithm was put forward. The project proposed a complete mixed integer programming mathematical optimization model, which focuses on the train running curves in the process of acceleration and deceleration in urban rail transit system. In the transient process of acceleration and deceleration, the speed of the train is considered to increase monotonously or decrease monotonously, and the extreme slope condition is not considered. The method proposed in this project can quickly find the speed curve of trains under the constraints of fixed running time and running distance by setting maximizing regenerative braking energy and minimizing traction energy as objective equations, which can be used in automatic train running and driver-assisted driving system. The operation time of the method is short, and it has outstanding practicability for online operation. Through mathematical modeling, computer simulation and optimization, the project indicates that the method researched in the project has satisfying robustness and effectiveness.

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Partial Train Speed Trajectory Optimization Using Mixed-Integer Linear Programming	Lu, Shaofeng and Wang, Ming Qiang and Weston, Paul and Chen, Shuaixun and Yang, Jie	IEEE Transactions on Intelligent Transportation Systems	2016
(2)	EI	Speed trajectory optimisation for electric vehicles in eco-approach and departure using linear programming	Lu, Shaofeng and Xue, Fei and Ting, Tiew On and Du, Yang	IET International Conferences on Intelligent and Connected Vehicles (!CV 2016), China	2016
(3)	EI	A two-stage electric vehicles scheduling strategy to address economic inconsistency issues of stakeholders	Han, Bing and Lu, Shaofeng and Xue, Fei and Jiang, Lin and Zhu, Huaiying	2017 IEEE Intelligent Vehicles Symposium (IV)	2017
(4)	SCI	Three-stage electric vehicle scheduling considering stakeholders economic inconsistency and battery degradation	Han, Bing and Lu, Shaofeng and Xue, Fei and Jiang, Lin and Xu, Xiaotong	IET Cyber-Physical Systems: Theory & Applications	2017

3. Municipal Projects

Project 1: Integrating Language Model in Natural Scene Chinese Text Recognition

| Qiufeng Wang

Technical field: Electronic Information – Software

Programme category: Suzhou Science and Technology Development Planning Programme – Key Industrial Technology Innovation – Prospective Applied Basic Research Project

Introduction: Throughout the ages, character has been one of the important tools for us to record, communicate and disseminate information. As we have accumulated a lot of character information in our daily lives, such as various books, newspapers and magazines, handwritten notes, letters, bank bills, personnel files, classic ancient books, and natural scene texts recorded by smart handheld devices. In recent years, with the rapid development and high popularity of electronic computers, electronic paper documents will further improve people's work efficiency and promote the further development of national economy. Document recognition technology, as one of the key means, has broad application prospects. Character recognition technology has always been one of the important research contents in the field of pattern recognition. In recent decades, there has been great development and progress, and corresponding products have been put into practical applications in some specific occasions, such as Optical Character Recognition (OCR) products widely circulated in the market, including Hanwang OCR, Tsinghua Wentong OCR and Shuguang OCR. But these products basically stay in printed text with neat background, which is difficult to be recognized. With the progress of society and the development of related technologies, the objects faced by character recognition are constantly expanding, from single word recognition to document recognition, from printed recognition to handwritten recognition, from scanned document recognition with simple background to natural scene text recognition with complex background or ancient books recognition with low-quality images. Facing these complicated character recognition problems, the current character recognition technology has not been completely solved, so that the researchers are required to carry out further research.

The research and development of this project focuses on two core technologies in document recognition: character recognizer and language model. Of which, the function of the character recognizer is to obtain the corresponding character category according to the input image. Here, we need to consider distinguishing similar characters of Chinese characters. For this purpose, we proposed a deep neural network classifier based on the minimum-maximum kernel function criterion. In addition, the language model is used to judge whether the sentence of recognition result is smooth and whether the context of characters is reasonable. Considering the different semantics of words in different contexts, we researched the adaptive algorithm of language model by searching texts with relevant semantics from large-scale corpus in the process of recognition so as to improve the recognition rate of recognition documents.

Keywords: Chinese Scene Document Recognition, Language Model, Model Fusion, Cluster Search, Weakly Labeled Sample

Key issues solved:
1. We used the recognition strategy twice to get the initial recognition results, and then used the cosine similarity to sort the similarity values between corpus documents and initial recognition documents to search for related documents, carried out further train to get a matching language model, and finally fused with the original N-Gram model to get an adaptive language model.
2. We improved the classification accuracy of the classifier by minimizing the intra-class distance and maximizing the loss function of the inter-class interval.
3. By researching the weakly supervised learning method of document recognition model parameters, we solved the problem of the way to avoid the need of character position marking in the training process and improved the training efficiency, thus adding more training samples and improving the recognition performance.
4. Through adversarial learning method, we solved the problem of recognition of curved text in natural scene documents

to a certain extent. We also used the cyclic Generative Adversarial Net technology to generate landscape painting documents.

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no.	Inventor(s)
(1)	发明	申请	基于互联网检索的中文文档识别方法	CN201811395481.5	王秋锋、黄开竹

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Improving Deep Neural Network Performance by Integrating Kernelized Min-Max Objective	Qiu-Feng Wang; Kai Yao; Rui Zhang; Amir Hussain; Kaizhu Huang	Neurocomputing	2020.3.10
(2)	EI	An Interactive and Generative Approach for Chinese Shanshui Painting Document	Le Zhou, Qiu-Feng Wang, Cheng-Hung Lo, Kaizhu Huang	IEEE Proc. 15th ICDAR	2019.9.20
(3)	EI	Improving script identification by integrating text recognition information	Yupeng Cao, Jing Li, Qiu-Feng Wang, Kaizhu Huang, Rui Zhang	Australian Journal of Intelligent Information Processing Systems	2019.12.12
(4)	EI	Weakly Supervised Learning for Over-Segmentation Based Handwritten Chinese Text Recognition	Zhen-Xing Wang; Qiu-Feng Wang; Fei Yin; Cheng-Lin Liu	ICFHR 2020	2020.9.7

Project 2: Platform for Suzhou Municipal Key Lab of Virtual Reality Technology

| Yong Yue

Technical fields: Virtual Reality Technology and Application, Augmented Reality Technology and Applications, Virtual Rapid Prototyping, Virtual Manufacturing, Building Information Model

Programme category: Institutional Development and Innovation Project – Key Platform – New Construction

Introduction: From January 2017 to October 2018, Xi'an Jiaotong-liverpool University undertook the construction and implementation of the platform of Suzhou Virtual Reality Technology Key Laboratory Platform, a key platform construction project of Science and Education Innovation Zone. During the implementation of this project, Xi'an Jiaotong-liverpool University invested more than RMB 3.2 million in project construction, including RMB 2.8075 million in fixed assets; established a virtual engineering center with a laboratory area of 739m².

During the construction of the laboratory platform, it successfully applied for 3 National Natural Science Foundation of China, 1 Provincial Science and Technology Plan Project, 1 Suzhou Science and Technology Plan Project, 1 Scientific Research Cooperation Project with other provincial universities and 1 Provincial Excellent Course; and seven horizontal and enterprise cooperation projects with a total amount of RMB 1.19 million were obtained. The laboratory released 4 open topics on the platform, 20 students with Bachelor's-Master's-Doctor's degrees participating in this project, and obtained 22 achievements.

In terms of scientific and technological innovation, the laboratory has applied for 10 national patents of invention. Before the end of this project, it obtained 2 software copyrights, published 16 SCI retrieval papers and 10 EI papers, organized 1 international conference, participated in 20 domestic and international conferences and trained 8 Dr. postgraduates and 10 postgraduates.

As of October 2018, the laboratory introduced an academician of the Art Institution of the Royal Society and Distinguished Professor of Chang Jiang Scholars as the academic leader in the field of virtual reality, and introduced 10 doctors, including 3 senior technical titles. Five members of the laboratory were promoted to senior title and one member was promoted to a professor title. The platform construction project was implemented according to the scheduled plan and achieved the established goals.

Based on the construction achievements of virtual laboratory platform, the Virtual Engineering Center of Xi'an Jiaotong-liverpool University was established in 2019, which is equipped with Christie high-performance large-screen 3D interactive system, NVIDIA DGX-2, Visionary Render professional rendering software, VR workstation and other advanced equipment. Work closely with the Virtual Engineering Center of Liverpool University and the industry to promote innovation through research and development and provide users with new technical solutions. A number of research and development projects were undertaken, including water environment monitoring and three-dimensional modeling and visualization, multi-functional intelligent unmanned ship for water environment monitoring, virtual interactive Tai Chi exercise system, intelligent planning and modeling of refractive surgery, virtual construction safety management of construction site, virtual planning of the best evacuation path of buildings in case of fire, real-time positioning and navigation of library books based on augmented reality, and building environment teaching tools based on virtual reality. Serving as an authorized training center of Unity the relevant training was conducted.

Keywords: Virtual Reality, Augmented Reality, Virtual Engineering, Virtual Environment, Visualization, Building Information Model, Water Environment Monitoring

Key issues solved:

1. Multi-modal intelligent interaction in virtual environment, including text input, multi-user interaction and interaction in different environments, realized efficient interaction between users and systems in virtual environment.
2. Water environment monitoring based on unmanned ship, research and development of multi-functional intelligent unmanned ships, collect spatial data of water quality and water environment physical geomorphology in real time, in-

depth analysis and fusion of various data, establish a three-dimensional water environment model with hierarchical visualization function according to application requirements, display various water quality parameters, riverbed and bank, siltation, flood discharge, water environment capacity and other characteristics accurately and vividly, and provide technical support for comprehensive water environment management. Cooperated with the government and enterprises (including Huawei) to carry out early warning and detection of blue-green algae, and the tests were carried out in Jinji Lake and Dushu Lake in Suzhou.

3. VR interactive Tai Chi motion system, the Panoramic VR cameras and motion collection equipment are used to collect the movements of professional motion of professional master of Tai Chi to form a virtual performance demonstration. Users can choose the practice environment (park, hilltop or riverside) to increase immersion, or other users are remotely connected to practice together, thus becoming a social and entertainment platform.

4. Safety risk identification, assessment and prevention methods at construction site, with the progress of the project, the BIM model is constructed, the working status of operators is monitored in real time, and an alarm is given immediately in case of danger, thus forming real-time and effective construction safety management.

5. For LASIK surgical assistant project, the historical cases of LASIK surgery are analyzed through machine learning, the surgical parameters and effect prediction are obtained, and patient vision with ray tracing method are simulated to provide reference for surgery.

6. Real-time book search navigation system in library, a mobile phone is needed to retrieve the target book information fuzzily, positions of user and book are located in real time, and the automatic route planning algorithm is realized. Based on Unity and augmented reality technology, the navigation arrow and the shortest path are generated, and the user is guided intuitively in place. It can also retrieve library data and display book information in real time.

7. Virtual reality-based building environment teaching tool enables students to experience virtual buildings and apply new designs in virtual reality environment. Feedback from 50 students of different majors indicates the need for recognition and expansion of this tool.

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	一种虚拟环境下交互行为的控制方法及控制系统	CN201710580993.8	ZL201710580993.8	梁海宁，史昱玮，陆飞羽，岳勇
(2)	发明	授权	基于双时间窗口验证的水质监测噪音数据实时检测方法	CN201710523755.3	ZL201710523755.3	岳勇，朱晓辉，张晋，张一新，王威
(3)	发明	授权	基于双向水流的水质监测网络多目标优化部署方法	CN201710288461.7	ZL201710288461.7	岳勇，朱晓辉，张一新，王威
(4)	发明	授权	一种建筑工地安全风险识别、评估和防范方法	CN201710620154.4	ZL201710620154.4	张澄、岳勇

2）Copyrights

No.	Status	Category	Title	Author(s)	Application no.	Certificate no.
(1)	已获取	软著	虚拟英语语言学习工具	梁海宁等	2021SR0162229	6886546
(2)	已获取	软著	无人水质监测船控制与水质数据可视化系统	李铭盛、朱晓辉等	2020SR0759995	5638691
(3)	已获取	软著	LASIK 手术助理系统（LASIK Assistance)	岳勇、王威等	2019SR0177448	3598205
(4)	已获取	软著	VRSVT 三位几何体可视化软件【简称：VRSVT】V1.0	梁海宁、岳勇等	2019SR0177081	3597838
(5)	已获取	软著	火灾模拟与逃生路径讯优系统	张澄等	2019SR0176801	3597558
(6)	已获取	软著	无人船水质监测船后台管理系统	李铭盛、朱晓辉等	2019SR1106062	4526810
(7)	已获取	软著	水环境监测与污染实时预警系统	岳勇、朱晓辉、刘海	2017SR406022	1991306
(8)	已获取	软著	无线传感水质监测后端管理系统	岳勇、朱晓辉、缪平	2017SR480896	2066180

3）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	Collaborative behavior, performance and engagement with visual analytics tasks using mobile devices	Lei Chen, Hai Ning Liang, Feiyu Lu, Konstantinos Papangelis, Ka Lok Man and Yong Yue	Human-Centric Computing and Information Sciences, 10: 47, 2020	2020
(2)	SSCI	Health Benefits of Digital Videogames for the Aging Population: A Systematic Review,	Wenge Xu, Hai-Ning Liang, Nilufar Baghaei, Bing Wu Berberich, and Yong Yue	Games for Health Journal, 24 Jun 2020	2020
(3)	EI	3D Modeling and Visualization of River Systems	Mingyang Sheng, Yong Yue, Xiaohui Zhu	2020 International Conference on Computer Engineering, Multimedia Technologies (CEMT2020), Shenyang, 25-26 December 2020	2020
(4)	EI	Workload, Presence and Task Performance of Virtual Object Manipulation on WebVRD	Wenxin Sun, Mengjie Huang, Rui Yang, Jingjing Zhang, Liu Wang, Ji Han and Yong Yue	3rd IEEE International Conference on Artificial Intelligence & Virtual Reality (AIVR 2020), Utrecht, Netherlands (online), pp358-361 14-18 December 2020	2020
(5)	EI	A Comprehensive Survey and Analysis on Path Planning Algorithms and Heuristic Functions	Bin Yan, Tianxiang Chen, Xiaohui Zhu, Yong Yue, Bing Xu, Kai Shi	Arai K., Kapoor S., Bhatia R. (eds) Intelligent Computing. SAI 2020. Advances in Intelligent Systems and Computing, vol 1228	2020
(6)	EI	An Improved Schematic Human Eye Model for Human Vision Simulation	Wei Wang, Yong Yue	2nd International Conference on Advances in Computer Technology, Information Science and Communications (CTISC 2020), pp27-33, 16-17 July 2020	2020
(7)	EI	Exploration of Hands-free Text Entry Techniques for Virtual Reality	Xueshi Lu, Difeng Yu, Hai-Ning Liang, Wenge Xu, Yuzheng Chen, Xiang Li, Khalad Hasan	2020 IEEE International Symposium on Mixed and Augmented Reality (ISMAR)	2020
(8)	EI	An Improved APFM for Autonomous Navigation and Obstacle Avoidance of USVs	X Zhu, Y Yue, H Ding, S Wu, MS Li, Y Hu	16th International Conference on Informatics in Control, Automation and Robotics (ICINCO 2019), Prague, Czech, July 2019	2019
(9)	SCIE	Designing an Optimized Water Quality Monitoring Network with Reserved Monitoring Locations	Xiaohui Zhu, Yong Yue, Prudence W.H. Wong, Yixin Zhang and Hao Ding	Water, 11(2): 713, 2019	2019
(10)	SCIE	Accuracy Control of Fiber Cable's Outer Diameter with Algorithms of Filtration, Prediction and PID Controller	Xiaohui Zhu, Yong Yue, F Hu, J Shou, J Zhang and K Cao	Arabian Journal for Science and Engineering, 1-17, 2019	2019
(11)	EI	Directional Motion-based Interfaces for Virtual and Augmented Reality Head-mounted Displays	Wenge Xu, Haining Liang, Yong Yue	2018 International Computers, Signals and Systems Conference (ICOMSSC)	2018
(12)	SCI	Optimum Water Quality Monitoring Network Design for Bidirectional River Systems	Xiaohui Zhu, Yong Yue, Prudence W. H. Wong, Yixin Zhang and Jianhong Tan	International Journal of Environmental Research and Public Health	2018

[13]	SCI	Evaluating Immersion, Presence, and Emulator Sickness in Virtual Reality Games based on First- and Third-Person Viewing Perspectives	Diego Monteiro, Hai-Ning Liang, Wenge Xu, Marvin Brucker, Vijayakumar Nanjappan and Yong Yue	Journal Computer Animation & Virtual Worlds (CAVW), John Wiley Press.	2018
[14]	SCI	Infrared Motion Detection and Electromyographic Gesture Recognition for Navigating 3D Environments	Keyu Chen, Hai-Ning Liang, Yong Yue and Paul Craig	Journal Computer Animation & Virtual Worlds (CAVW), John Wiley Press	2018
[15]	EI	Using Imbalanced Learning: A Case Study in Refractive Surgery Outcome Prediction	Wei Wang, Yong Yue, Ahmed Elsheikh and Fangjun Bao	9th International Conference on Information Technology in Medicine and Education, Hangzhou, China, 19-21 October 2018	2018
[16]	EI	Intelligent Planning for Laser Refractive Surgeries	Wei Wang, Yong Yue, Ahmed Elsheikh and Fangjun Bao	Journal of Physics Conference Series, 2018	2018
[17]	EI	A Hybrid Approach to Detection and Recognition of Dashboard Information in Real-time	Yu Tao, Yong Yue, Paul Craig	4th International Conference on Systems and Informatics (ICSAI 2017), Hangzhou, China, 11-13 November 2017	2017
[18]	A&HCI	Resource Optimization based on BIM and Construction Process Simulation	Gan, Z., and Zhang, C.	Frontiers of Architectural Research, 2017, 5(26), 28-30	2017
[19]	EI	An Educational Tool based on Virtual Construction Site Visit Game	Zhang C., Lu, Y., Xu, R., Ye, X., Shi, Y. and Lu, P.	Modern Applied Science. Vol. 11, No.8, August 2017. Canadian Center of Science and Education	2017
[20]	EI	A Real-Time Anomaly Detection Algorithm for Water Quality Data using Dual Time-Moving Windows	Jin Zhang, Xiaohui Zhu, Yong Yue, Prudence WH Wong	Seventh International Conference on Innovative Computing Technology (INTECH 2017)	2017

4）Others

No.	Technical Standard Title	Target Value	Actual Value
(1)	开发系统	2 套	已完成系统开发工作，2 项 Copyright 已申报完成

Project 3: Research and Development of Artificial Intelligent (AI) Chip Based on ARM Architecture

| Chun Zhao

Technical fields: Chips, Microelectronics, Semiconductors, Artificial Intelligence Hardware

Programme category: Key Programme Special Fund (KSF) – Applied Technology Research Programme

Introduction:

To speed up the development of artificial intelligence industry, the Three-year Action Implementation Plan for Artificial Intelligence in 'Internet Plus' formulated by the National Development and Reform Commission, the Ministry of Science and Technology, the Ministry of Industry and Information Technology and the Central Network Office was officially issued in May 2016. It is planned that by 2018, the industry, service and standardization system of artificial intelligence will be basically established, breakthroughs in core technologies will be achieved, a number of leading artificial intelligence backbone enterprises in the world will be cultivated, and a 100 billion-level artificial intelligence market application scale will be formed. Especially, in the aspect of smart wearable devices, the Three-year Action Implementation Plan for Artificial Intelligence in 'Internet Plus' provides specific descriptions and guidance for embedded artificial intelligence chips. Efforts will be made to break through lightweight operating systems, low-power and high-performance chips and other key technologies. As the upstream of the industrial chain, artificial intelligence chip is also the link with the highest technical requirements and added value, and its industrial value and strategic position are far greater than the application layer innovation. As the chip is at the top of the artificial intelligence industry chain, the way to develop embedded artificial intelligence chips to lead the upgrading of core technologies, cultivate and expand strategic emerging industries, promote product innovation with technological innovation, better meet the consumer demand brought by embedded artificial intelligence, and lead, create and expand new consumer demand has become our focus. This project is dedicated to developing embedded artificial intelligence chips based on ARM Cortex-M4 architecture to meet the hardware computing control requirements of lightweight operating systems and artificial intelligence algorithms for intelligent hardware, and the main application scenarios include smart homes, smart robots, smart hardware and smart wearable devices.

Upon the R&D, the embedded artificial intelligence chip of this project is designed and developed by ARM Cortex-M4 architecture, and the 130nm semiconductor process is selected, and the main frequency can reach 48MHz. Through optimization design, the working current of the embedded artificial intelligence chip can be effectively controlled within 400mA when it works at full load. In terms of chip physical size, a single embedded artificial intelligence chip can be controlled within 6mm x 6mm through rich layout design experience of R&D team. The embedded artificial intelligence chip is matched with FLASH at 32k and above and the SRAM at 6k and above, has a 12-bit analog conversion module (ADC), supports USM2.0 application module and has a rated operating voltage of 3.3V. Basically, it meets the operation requirements of lightweight operating system and artificial intelligence algorithm for intelligent hardware. For the research and development content of the specific project, the corresponding research scheme is conducted around the following functional modules: the central processing unit (ARM Cortex-M4 core is applied. When the main core chip works at full load, the main frequency can be up to 48MHz), digital IP (program space FLASH, SRAM, various bus/communication interfaces (SPI, UART, IIC, MAC Ethernet, USB, CAN), specifically designed chips, multiple timers and multiple PWM modules for communication or expansion with external devices or various sensors), analog or digital-analog hybrid IP (ADC, DAC module, high-precision operational amplifier, high-speed and high-precision comparator, LDO power supply module, DC/DC power supply module), chip technology (advanced semiconductor manufacturing technology of 130nm embedded flash memory).

Key issues solved:

This project focuses on the design of embedded artificial intelligence chip. The key lies in the specification design of the top layer of the chip as well as the technical development and IP integration of each IP module. The main key technical problems are as follows:

1.Selection of chip fabrication process

According to the comparison of performance parameters, the research team finally selected the semiconductor process

that meets the design requirements of this project, that is, the FS13Q7P8 process of GSMC. This process is 0.13um Flash process of Dual Gate and it supports dual voltage of 1.5V and 5V operation. Namely, the operating voltage of the internal digital part is 1.5V, and the chip interface voltage ranges from 2.5V to 5.5V, which can meet most embedding applications. The operating voltage of the analog module is 2.7V to 5.5V, which can maximize the performance and parameters of the analog circuit of the chip.

2.Design and verification of chip architecture and bus

The research team of central processing unit adopts the ARM Cortex-M4 core. The main system of the chip is composed of 32-bit multi-layer AHB bus matrix, which can realize the access from the main control bus to the controlled bus so that the system can realize concurrent access and efficient operation even when multiple high-speed peripherals run simultaneously.

3.Analog IP design and verification of chip

The schematic design, layout design and verification of digital-analog hybrid IP have been completed. The research progress of digital-analog hybrid IP includes: high precision 12-bit ADC, high-speed PLL, 8MHz oscillator, ultra-low speed oscillator, OSC 4-32MHz crystal oscillator circuit, 1.5V Capless LDO, power supply reset, low voltage detection and other power supply circuits.

4.Digital IP design and verification of chip

The embedded artificial intelligence chip of this project has fast running speed and computing ability. In addition to ARM Cortex-M4 kernel, it also includes the following digital IP (design and verification have been completed): program memory FLASH control module, static memory SRAM (32 bits wide), serial peripheral interface SPI/I2S, universal serial data bus UART, integrated interconnected serial bus I2C, universal serial bus USB, timer and PWM, chip clock management module.

5.System design and verification of chip

The system design of the chip should be a bottom-up way, which first designs each module separately and then integrates it. Analog simulation takes the module as a unit to simulate each electrical index and adjust the circuit design to ensure that each unit meets the design specifications. Finally, Synopsys XA software is used for digital-analog mixed simulation to eliminate the interface errors of digital and analog circuits.

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	申请	基于氧化锆和氧化镧的透明薄膜晶体管器件及其制备方法	CN201911299226.5		方欲晓，赵春，赵策洲，杨莉
(2)	发明	申请	基于纳米簇介电层的柔性纳米纤维氧化镓锡晶体管及其制备方法	CN201911299235.4		赵天石，赵春，赵策洲，杨莉，仇成虎，冯江帆
(3)	发明	申请	基于自燃烧法的双元高介电常数绝缘层的制备方法	CN201911299283.3		刘启晗 赵春 赵策洲 杨莉
(4)	实用新型	授权	一种双氧化层 RRAM	CN201920491530.9	ZL201920491530.9	沈棕杰，赵春，赵策洲，杨莉，罗天，张艺，孙艺
(5)	实用新型	授权	一种基于二维半导体材料薄膜晶体管	CN201920491617.6	ZL201920491617.6	赵天石 赵春 赵策洲 杨莉 于水长
(6)	实用新型	授权	一种基于硅酸铪的金属氧化物半导体电容器件	CN201920491337.5	ZL201920491337.5	方欲晓，赵春，赵策洲，杨莉

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Comproportionation Reaction Synthesis to Realize High-Performance Water-Induced Metal-Oxide Thin-Film Transistors	Q H Liu, Chun Zhao, I Z Mitrovic, W Y Xu, L Yang and C Z Zhao	Advanced Electronic Materials	2020
(2)	SCI	Enhancement on the performance of eco-friendly solution-processed InO/AlO thin-film transistors via lithium incorporation	T S Zhao, Chun Zhao, J F Zhang, I Z Mitrovic, E G Lim, L Yang, T Song and C Z Zhao	Journal of Alloys and Compounds	2020
(3)	SCI	Advances of RRAM Devices: Materials, Resistive Switching Mechanisms and Bionic Synaptic Application	Z J Shen, Chun Zhao, Y F Qi, W Y Xu, Y N Liu, I Z Mitrovic, L Yang, C Z Zhao	Nanomaterials	2020
(4)	SCI	Effect of electrode area on resistive switching behavior in translucent solution-processed AlOx based memory device	Y F Qi, Z J Shen, Chun Zhao and C Z Zhao	Journal of Alloys and Compounds	2019
(5)	SCI	Aqueous solution-processed AlOx dielectrics and their biased radiation response investigated by an on-site technique	Y X Fang, Chun Zhao, S Hall, I Z Mitrovic, W Y XU, L Yang, T S Zhao, Q H Liu and C Z Zhao	Radiation Physics and Chemistry	2019
(6)	SCI	Bias-stress stability and radiation response of solution-processed AlOx dielectrics investigated by on-site measurements	Y X Fang, Chun Zhao, I Z Mitrovic, S Hall, L Yang and C Z Zhao	Microelectronic Engineering	2019

Project 4: Wireless Localization in Non-Line-of-Sight Conditions

| Dawei Liu

Programme category: Suzhou Science and Technology Development Planning
Programme - Others

Introduction: Wireless positioning is considered as the most promising development direction in the wireless Internet era. From the early aircraft navigation to today's electronic maps, environmental monitoring and social networks, wireless positioning is more and more widely used in all aspects of social production and life. However, it also faces two kinds of challenges: NLOS propagation of positioning signals and positioning spoofing by malicious users.

NLOS propagation of wireless signals has long been considered as the main error source of wireless positioning systems. Usually, the positioning error of CDMA system is tens of meters, but it can be up to 589 meters in NLOS environment. There are similar problems in wireless sensor network positioning and wireless local area network positioning. As a result, the way to detect NLOS propagation and to eliminate its influence is one of the hot spots in the research of wireless positioning system.

Another big challenge faced by wireless positioning system comes from positioning spoofing by malicious users. In 2003, the US Department of Transportation reported that civil GPS signals were at risk of being forged.

Forged GPS signals may lead to serious positioning errors, and even lead to complete paralysis of GPS functions in a certain area. In recent years, more and more researches have begun to focus on the security issues in wireless positioning, and the main research directions include the ways to find abnormal positioning results caused by malicious users and to eliminate such anomalies.

Since both NLOS propagation and positioning spoofing may cause positioning errors, when we face various positioning errors, the first problem to be solved is to determine their sources, whether they originate from NLOS propagation, positioning spoofing or both. The existing research on NLOS propagation and security mechanism has ignored this basic problem. You cant find a solution by proper way if the questions are not answered.

Through the analysis of wireless positioning signals, a set of wireless positioning security mechanism suitable for NLOS environment is designed for the project, which solves the problem of identifying error sources in wireless positioning system under error environment. The research results provide theoretical basis and technical support for the security of wireless positioning system in China, and provide a basis for relevant Departments to develop the industry standards, regulations and policies.

Key issues solved:

1. Robust positioning error detection. Our previous research has proved that the traditional consistency analysis cannot effectively detect the wireless positioning errors in some areas. This is also one of the key problems to be solved in this topic. By using different signal measurement methods and different consistency measurement methods, we successfully solved this problem.

2. Error identification method based on user similarity. The way to define the similarity of adjacent users and the way to define the degree of similarity are the key problems to be solved in similarity research. We proposed a set of boundary values of similarity and gave the strict mathematical proof.

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI	An Improved IEEE 802. 15. 6 Password Authenticated Association Protocol	X. Huang, D. Liu, et al.	IEEE/CIC ICCC 2015 Symposium on Selected Topics in Communications	2015
(2)	EI	Analysis of Location Spoofing Identification in Cellular Networks	Wei Y, Liu D.	International Conference on Mobile, Secure and Programmable Networking	2015
(3)	EI	Identifying malicious attacks to wireless localization in bad channel conditions	Liu D.	2014 IEEE MiSeNet	2014
(4)	EI	Linear programming algorithms for sensor networks node localization	Xu K, Liu H, Liu D, et al.	2016 IEEE International Conference on Consumer Electronics (ICCE)	2016
(5)	EI	S cenar10 Based Secure Risk Assessment	R. Fu, X. Ban, X. Huang, and D. Liu.	Electronics, Communications and Networks IV	
(6)	EI	Wi-Fi Access Point Roaming: Challenges and Potential Solutions	Wang L, Zhao Y, Afolabi D, D, Liu.	8th IEEE International Conference on Network-Based Information Systems (NBiS)	2015
(7)	EI	Dynamic Sensor Selection in Heterogeneous Sensor Network	Ma Y, Hou F, Ma S, and D. Liu.	IEEE 83rd Vehicular Technology Conference (VTC Spring)	2016

2）Others

序号	研发技术指标名称	合同目标值	实际完成值
1	完成定位鉴别算法设计	1 套	设计了 1 套定位鉴别算法
2	建立实验平台	1 套	开发了 1 套基于 matlab 的仿真实验平台

Project 5: Intelligent Scene Understanding Based on Deep Neural Networks

| Kaizhu Huang

Programme category: Key Programme Special Fund (KSF) – Applied Technology Research Programme

Introduction:

The development of intelligent scene understanding technology based on deep learning in this project means the automatic detection, identification, recognition and understanding of targets in the scene through sensors so as to achieve the purpose of machine intelligence. Intelligent scene understanding is an important application field of artificial intelligence, which can be widely used in many occasions of social life. Typical application examples include unmanned supermarket system, supermarket without queuing and unmanned checkout, and intelligent catching and escaping system (the public cameras are automatically used to identify and alarm suspects or vehicles). This project will use deep learning to develop high-precision and high-efficiency scene understanding technology. The development of this subject technology is expected to be combined with social security, tourism service, smart city construction and other related projects in Suzhou Industrial Park District.

Since the implementation, the project has progressed smoothly. 2 software copyright applications and 6 patents have been submitted, including 5 invention patents and 1 utility model patent. In addition, 2 English books on deep learning and machine learning have been published. 30 papers have been published, including 17 papers in international journals and 13 papers in international conferences, including 15 papers indexed by SCI and 15 papers indexed by EI. In addition, with the support of this project, 6 postgraduates are trained. There are additional 12 new national, provincial and horizontal projects in the project team, including 3 general projects of National Natural Science Foundation of China.

Keywords: Scene Understanding, Pattern Recognition

Key issues solved:

The main & key problems we solved are as follows:

1. We have implemented end-to-end learning for multiple scenes. The three steps of feature extraction, target detection and target recognition in the scene are combined for overall training, which makes the performance better.

2. We have implemented a deep learning model optimization method for multiple scenes. In the specific field of scene data analysis, the basic characteristics of data are fully exploited so as to optimize the deep learning model, make the model have better structural characteristics and reduce the running complexity of the model.

3. We implemented the compression and expression of scene data. Facing the real-time analysis of large-scale scenes, we have developed an effective expression to store and calculate a large amount of data.

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	申请	一种光伏串列的阴影遮挡检测方法、装置和设备	CN202010010649.7		马洁明等
(2)	发明	申请	辈于少量样本的内含多种归一化处理的风格字符生成方法	CN201910933634.5		黄开竹、江浩川等
(3)	发明	申请	基于互联网检索的中文文档识别方法	CN201811395481.5		王秋锋、黄开竹等
(4)	发明	申请	基于少量样本的风格字符生成方法	CN201810683657.0		黄开竹、江浩川等
(5)	发明	申请	一种串联型光伏电板遮挡自动检测系统及方法	CN201811264554.7		马洁明等
(6)	实用新型专利	授权	一种串联型光伏电板遮挡自动检测系统	CN201821753690.8	ZL201821753690.8	马洁明，毕自强

2）Copyright

No.	Status	Category	Title	Author(s)	Application no.	Certificate no.
(1)	授权	计算机软件著作	基于移动平台的在线动作识别系统 V1.0	黄开竹，许浩田，张锐，靳小波	2020SR0935411	5814107
(2)	授权	计算机软件著作	低分辨率条件下的动作实时检测系统 V1.0	黄开竹，许浩田，张锐，靳小波	2020SR0932157	5810853

3）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI	Adversarial Rectification Network for Scene Text Regularization	Jing Li, Qiufeng Wang, Rui Zhang, Kaizhu Huang	ICONIP	2020
(2)	EI	Towards Better Forecasting by Fusing Near and Distant Future Visions	Jiezhu Cheng, Kaizhu Huang, Zibin Zheng	AAAI	2020
(3)	EI	Reliability Does Matter: An End-to-End Weakly Supervised Semantic Segmentation Approach	Bingfeng Zhang, Jimin Xiao, Yunchao Wei, Mingjie Sun, Kaizhu Huang	AAAI	2020
(4)	EI	Self-Focus Deep Embedding Model for Coarse-Grained Zero-Shot Classification	Guanyu Yang, Kaizhu Huang, Rui Zhang, John Goulermas and Amir Hussain	BICS'19	2019
(5)	EI	Action Recognition in Videos with Temporal Segments Fusion	Yuanye Fang, Kaizhu Huang, Qiufeng Wang and Rui Zhang	BICS'19	2019
(6)	EI	Improving Image Caption Performance with Linguistic Context	Yupeng Cao, Qiufeng Wang, Kaizhu Huang and Rui Zhang	BICS'19	2019
(7)	EI	Fine-Grained Image Classification with Object-Part Model	Jinlong Hong, Kaizhu Huang, Hai-Ning Liang, Rui Zhang and Xinheng Wang	BICS'19	2019
(8)	EI	MPSSD: Multi-Path Fusion Single Shot Detector	Shuyi Qu, Kaizhu Huang, Amir Hussain, Goulermas Yannis	IJCNN'2019	2019
(9)	EI	Joint Multi-Label Attention Networks for Social Text Annotation	Hang Dong, Wei Wang, Kaizhu Huang and Frans Coenen	NAACL-HLT 2019	2019
(10)	EI	W-Net: One-Shot Arbitrary-Style Chinese Character Generation with Deep Neural Networks	Haochuan Jiang, Guangyu Yang, Rui Zhang, Kaizhu Huang	ICONIP'2018	2018
(11)	EI	Improving DNN Performance with Kernelized Min-Max Objective	Kai Yao, Kaizhu Huang, Rui Zhang, Amir Hussain	ICONIP'2018	2018
(12)	EI	Style Neutralization Generative Adversarial Classifier	Haochuan Jiang, Kaizhu Huang and Rui Zhang	BICS'2018	2018
(13)	EI	Rolling Forecasting Forward by Boosting Heterogeneous Kernels	Di Zhang, Yunquan Zhang, Qiang Niu, and Xingbao Qiu	Pacific-Asia Conference on Knowledge Discovery and Data Mining	2018
(14)	SCI	Automated Social Text Annotation with Joint Multi-Label Attention Networks	Dong, Hang; Wang, Wei; Huang, Kaizhu; Coenen, Frans	IEEE Transactions on Neural Networks and Learning Systems	2020
(15)	SCI	Novel Artificial Immune Networks-based Optimization of Shallow Machine Learning (ML) Classifiers	Summrina Kanwal Wajid, Amir Hussain, Kaizhu Huang	Expert Systems with Applications	2020

[16]	SCI	Segmentation Mask Guided End-to-End Person Search	Dingyuan Zheng, Jimin Xiao, Kaizhu Huang	Signal Processing: Image Communication	2020
[17]	SCI	Style Neutralization Generative Adversarial Classifier	Haochuan Jiang, Kaizhu Huang*, and Rui Zhang, Amir Hussain	Cognitive Computation	2020
[18]	SCI	Correlation Filter Selection for Visual Tracking Using Reinforcement Learning	Yanchun Xie, Jimin Xiao, Kaizhu Huang, Jeyarajan Thiyagalingam, Yao Zhao	IEEE Transactions on Circuits and Systems for Video Technology	2020
[19]	SCI	A Novel Deep Density Model for Unsupervised Learning	Xi Yang, Kaizhu Huang*, Rui Zhang, Yannis Goulermas	Cognitive Computation	2019
[20]	SCI	Maximum Power Point Estimation for Photovoltaic Strings Subjected to Partial Shading Scenarios	Jieming Ma, Haochuan Jiang, Ziqiang Bi, Kaizhu Huang*, Xingshuo Li, Huiqing Wen	IEEE Transactions on Industry Applications	2019
[21]	SCI	Cross-Modality Interactive Attention Network for Multispectral Pedestrian Detection	Lu Zhang, Zhiyong Liu, Shifeng Zhang, Xu Yang, Kaizhu Huang, Amir Hussain, Hong Qiao	Information Fusion	2019
[22]	SCI	Guided Policy Search for Sequential Multi-Task Learning	Fanzhou Xiong, Biao Sun, Xu Yang, Kaizhu Huang, Hong Qiao, Amir Hussain, Zhi-Yong Liu	IEEE Transactions on Systems Man and Cybernetics-Systems	2019
[23]	SCI	Learning Latent Features with Infinite Non-negative Binary Matrix Tri-factorization	Xi Yang, Kaizhu Huang*, Rui Zhang, Amir Hussain	IEEE Transactions on Emerging Topics in Computational Intelligence	2018
[24]	SCI	Banzhaf Random Forests: Cooperative Game Theory Based Random Forests with Consistency	Jianyu Sun, Guoqiang Zhong, Kaizhu Huang, Junyu Dong	Neural Networks	2018
[25]	SCI	A New Two-layer Mixture of Factor Analyzers with Joint Factor Loading Model for the Classification of Small Dataset Problems	Xi Yang, Kaizhu Huang*, Rui Zhang, Amir Hussain, Yannis Goulermas	Neurocomputing	2018
[26]	SCI	Three-Dimensional Local Energy-Based Shape Histogram (3D-LESH)-Based Feature Extraction- A Novel Technique	Summrina Kanwal Wajid*, Amir Hussain, Kaizhu Huang*	Expert Systems with Applications	2018
[27]	SCI	Approximately optimizing NDCG using pair-wise loss	Xiao-Bo Jin, Guang-Gang Geng, Guo-Sen Xie, Kaizhu Huang	Information Sciences	2018
[28]	SCI	A review on Multi-task Metric Learning	Peipei Yang, Kaizhu Huang, Cheng-Lin Liu, Amir Hussain	BMC Big Data Analytics	2018
[29]	SCI	Mining concise patterns on graph-connected itemsets	Di Zhang, Yunquan Zhang, Qiang Niu, and Xingbao Qiu	Neurocomputing	2019
[30]	SCI	Solving shifted linear systems with restarted GMRES augmented with error approximations	Rui-Rui Wang, Qiang Niu, Xiao-Bin Tang, and Xiang Wang	Computers and Mathematics with Applications	2019

Project 6: Research and Development of an Intelligent Unmanned Surface Vehicle for Water Quality Monitoring

| Yong Yue

Technical field: Environmental Protection - Prevention and Remediation of Water Pollution

Programme category: Suzhou Science and Technology Development Planning Programme - Key Industrial Technology Innovation - Prospective Applied Basic Research Project

Introduction: 'Research and Development of an Intelligent Unmanned Surface Vehicle for Water Quality Monitoring' (Project No.: SYG201837) is a forward-looking applied research project in Suzhou, which started and ended from July 2018 to June 2020. Through the joint efforts of all members of the project team, according to the contents agreed in the Contract, many achievements have been made in algorithm theory, system integration, software research and development, and the scheduled objectives have been achieved. In this project, the issue that the traditional water environment monitoring technology based on point source monitoring can't grasp the water quality status and pollution situation of the whole monitoring area in detail was focused, and an intelligent unmanned water quality monitoring ship with autonomous cruise and obstacle avoidance capability was developed. The research results can be applied to routine water quality monitoring and pollution emergency monitoring of lakes and rivers, river depth and siltation investigation, river 3D model construction and other water environment related fields.

In this project, the unmanned ships with multi-parameter water quality monitoring sensors, GPS modules, sounders, electronic compasses and 4G network systems was integrated, and full coverage water environment monitoring in monitoring areas such as lakes and rivers by developing autonomous cruise and obstacle avoidance algorithms for unmanned ships was realized. The research group developed cloud-based data acquisition and real-time communication programs and Android-based ship control system APP in order to obtain water quality monitoring data in real time and master the status of unmanned ships during cruising. Users can remotely control unmanned ships through mobile APP, plan cruise paths of unmanned ships, start autonomous cruise of unmanned ships or manually operate unmanned ships to sail. The ship-borne real-time video, real-time heading speed to user APP and other real-time transmission of data was also realized, which was convenient for users to grasp the environmental conditions around unmanned ships and the navigation status of unmanned ships in time. Upon the two years' R&D, the research group has made a series of achievements in autonomous cruise and obstacle avoidance algorithm of unmanned ships, obstacle detection based on steroscopic vision, laser radar and millimeter wave radar, remote real-time control of unmanned ships, real-time transmission of water quality monitoring data and data visualization, and applied for relevant patents and soft works. Currently, the technologies of unmanned ships for water quality monitoring are relatively mature, and the primary work now includes:

1. Expanded the functions and application scope of unmanned ships, optimized the deployment of detection station network, collected spatial data of water quality and water environment physical geomorphology in real time, analyzed and integrated all kinds of data comprehensively and deeply, established a three-dimensional water environment model with hierarchical visualization function according to application requirements, displayed various water quality parameters, riverbed banks, siltation, flood discharge, water environment capacity and other characteristics accurately and vividly, and provided new technical support for comprehensive water environment management.

2. Carried out special cooperation with Huawei and relevant Government Departments to conduct early warning and detection of cyanobacteria in Jinji Lake and Dushu Lake scenic spots.

3. Cooperate with Jiangsu Zhongzhi Qicheng Intelligent Environmental Technology Co., Ltd. to speed up the industrialization of unmanned ships.

Keywords: Intelligent Obstacle Avoidance Algorithm, Machine Steroscopic Vision, Water Quality Monitoring, Unmanned Ship, Autonomous Cruise

Key issues solved:

1. By studying and comparing the obstacle detection accuracy, detection range and computational complexity of laser radar, millimeter wave radar and binocular camera, the obstacle detection and obstacle avoidance algorithm based

on laser radar and millimeter wave radar was developed, and by improving the angle potential field method and integrating it with PID control method, the key issue of autonomous cruise and obstacle avoidance of unmanned ship in complex environment was solved.

2. The recognition algorithm of aquatic plants based on machine vision was researched. By collecting a large number of aquatic plant pictures and labeling them, the mask-r-cnn algorithm was trained to recognize aquatic plants and floating objects on the river, which solved the issue that laser radar and millimeter wave radar cannot detect aquatic plants and floating objects on the river.

3. By integrating unmanned ships with 4G communication and cloud computing, the functions of real-time collection, transmission and display of water quality data, remote visual control of unmanned ships and real-time display of tracks were realized; and the operation area of unmanned ships has been greatly improved through 4G communications. The unmanned ship also supported the communication mode based on data transmission radio, which made it also suitable for sparsely populated areas without 4G signals.

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	基于双向水流的水质监测网络多目标优化部署方法	CN201710288461.7	ZL201710288461.7	岳勇，朱晓辉，张一新，王威
(2)	发明	授权	基于双时间窗口验证的水质监测噪音数据实时检测方法	CN201710523755.3	ZL201710523755.3	岳勇，朱晓辉，张晋，张一新，王威
(3)	发明	受理	一种基于改进角度势场法的无人船自主避障方法	CN201910514788.0		岳勇、朱晓辉等
(4)	发明	受理	一种无人船控制系统	CN202010429881.4		岳勇，朱晓辉，言斌

2）Copyrights

No.	Status	Category	Title	Author(s)	Application no.	Certificate no.
(1)	已获取	软著	无人船水质监测船后台管理系统	李铭盛，朱晓辉等	2019SR1106062	
(2)	已获取	软著	光缆生产数据集成分析系统	管润玮，朱晓辉等	2019SR0195220	
(3)	已获取	软著	无人水质监测船控制与水质数据可视化系统	李铭盛，朱晓辉等	2020R11L349189	5638691

3）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Accuracy Control of Fiber Cable's Outer Diameter with Algorithms of Filtration, Prediction and PID Controller	朱晓辉，岳勇等	Arabian Journal for Science and Engineering	2019
(2)	SCI	Designing an Optimized Water Quality Monitoring Network with Reserved Monitoring Locations	朱晓辉，岳勇等	Water	2019
(3)	EI	4G-based Remote Manual Control for Unmanned Surface Vehicles	朱晓辉，岳勇等	3rd International Conference on Computer Science and Application Engineering	2019
(4)	EI	An Improved APFM for Autonomous Navigation and Obstacle Avoidance of USVs.	朱晓辉，岳勇等	ICINCO	2019
(5)	EI	A Comprehensive Survey and Analysis on Path Planning Algorithms and Heuristic Functions	朱晓辉，岳勇等	Computing Conference	2020
(6)	EI	3D Modeling of Riverbeds Based on NURBS Algorithm	杨凯原，朱晓辉等	ICWIP	2020

Project 7: Gaming Technologies for the Ageing Population

| Haining Liang

Programme category: Key Programme Special Fund (KSF) – Applied Technology Research Programme

Introduction:

The aging population in China is growing rapidly. By 2019, there are about 170 million elderly people aged 65 and above in China, accounting for 12.6% of the total population, and the population aged 60 and above has reached 250 million, accounting for 18.1% of the total population, which is still growing exponentially. It is estimated that by 2050, the elderly population in China will reach 400 million, accounting for 28.1% of the total population, while the population over 60 years old will reach 483 million, accounting for 34.1% of the total population.

Currently, the game technology for the elderly and virtual reality head-mounted displays (VR HMDs) is scarce in game software market of China. This project aimed to develop the application of game technology for the elderly in China for two main reasons:

1. Provide a variety of entertainment choices for the elderly and enrich their retirement life.
2. Encourage the elderly to maintain physical and mental health through physical exercise and lifelong learning activities. A healthy and happy life for this group will bring many economic and social benefits, such as reducing the burden on the medical system and creating a more harmonious and stable society. In addition, this project aimed to promote the design, development and sales of such products.

In this project, the game technology development is based on VR HMDs, which is compatible with ordinary TV screens (more than 30 inches is recommended). It is divided into the following two key products for this project:

1. Virtual reality Tai Chi game. This game used virtual reality technology to create an immersive game experience. The elderly can follow the Virtual Avatar of Tai Chi master to learn and practice Tai Chi. To increase the professionalism of the game, the scoring system of Tai Chi virtual reality game scores based on the actions of Tai Chi master, and users can watch the actions of Tai Chi masters in real time. To increase the interest of the game, users can choose other landmark attractions as the background for practice, such as Shenzhen Plaza, San Francisco Bridge and Gym. In addition, users can take screenshots and record screen games, communicate with friends, and make games a connection point between social interaction and entertainment.
2. Virtual reality English learning games. This game is specially designed for the elderly who are eager to learn a new language. The game used virtual avatars of well-known media people to teach how to pronounce, and users can practice pronunciation of words for different projects. According to the language learning model, the system could recognize the movements of mouth, lips and face, and provided guidance on how to correctly use the movements of face and mouth to pronounce accurately. The system is accompanied by a speech mode for the elderly to train in speech. In addition, the system also has a variety of built-in games for users to review their knowledge.

Keywords: Virtual Reality, Head-Mounted Display (HMD), Game Technology, Elderly People

Key issues solved:

1. The issue of Tai Chi motion data capture was solved by using wearable motion capture technology based on inertial measurement unit.
2. Through the user-centered design method, in this project, two text input methods were innovatively proposed: RingText and BlinkText. This method solved the issue of efficient and friendly text input during text chat in virtual reality games.
3. In this project, the skeleton vector data sets of users and Tai Chi master combined with multi-dimensional dynamic time warping technology to solve the issue of Tai Chi movement comparison.
4. In this project, by defining the maximum angle difference between two corresponding skeleton vectors as 90°, using eight skeleton vectors comprehensively, and combining with multi-dimensional dynamic time warping technology, the scoring system of Tai Chi action game was solved.
5. In this project, through the depth information recorded by depth sensor and combined with the data set based on point cloud processing method, the issue of reading visual features of dynamic recording users was solved.
6. In this project, by converting user's speech into Mel-Frequency Cepstral Coefficients (MFCCs), the issue of pronunciation and intonation recognition through speech pattern was solved.
7. In this project, by using the user dynamic data model and dynamic time warping algorithm, the issue of establishing the following reading accuracy scoring system based on the user mouth model was solved.

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	一种虚拟环境下交互行为的控制方法及控制系统	CN201710580993.8	ZL201710580993.8	梁海宁、史昱玮、陆飞羽、岳勇
(2)	发明	授权	一种虚拟环境下视野外目标的可视化方法	CN201711005248.7	ZL201711005248.7	梁海宁、俞迪枫、樊凯旋、张恒、Vijayakumar Nanjappan（维贾雅库马尔 南加潘）
(3)	发明	实审	虚拟现实环境下基于双摇杆控制器的文本输入方法	CN201810711539.6		梁海宁、俞迪枫
(4)	发明	实审	用于移动虚拟现实头戴式显示器的无驻留文本输入方法	CN201810711473.0		梁海宁、徐温格、岳勇
(5)	发明	实审	一种虚拟、增强或混合现实头显运动方向识别方法及系统	CN201810890022.8		梁海宁、徐温格、赵宇轩、陈蕾
(6)	发明	实审	一种虚拟现实环境下三维几何物体可视化的方法与系统	CN201810908468.9		梁海宁、陆飞羽
(7)	发明	实审	一种虚拟现实环境下降眩晕感的方法	CN201910423347.X		梁海宁、王佳林、Diego Vilela Monteiro（界古）
(8)	发明	实审	一种压力传感器及其制备方法和应用、包含其的可穿戴智能织物	CN201910662448.2		King-Tong Lau、Minde Zhu、Vijayakumar Nanjappan、Hai-Ning Liang
(9)	发明	实审	3D 眩晕症的检测方法、装置、设备和存储介质	CN202010754321.6		梁海宁、王佳林、Diego Vilela Monteiro（介古）、徐温格
(10)	发明	实审	一种虚拟现实环境下莫你重量和重心的设备和方法	CN202010885890.4		梁海宁、Diego Vilela Monteiro（介古）、徐温格、王娴
(11)	发明	实审	用于情感调节的可穿戴系统和方法	CN202011013551.3		梁海宁、姜梦琦、马泰（Martijn ten Bhömer）
(12)	发明	实审	弯曲程度检测单元、装置、方法、及可穿戴设备	CN202011013534.X		梁海宁、姜梦琦、李康

2）Copyrights

No.	Status	Category	Title	Author(s)	Application no.	Certificate no.
(1)	授权	软著	VRSVT 三维几何体可视化软件	陈蕾	2019SR0177081	3597838

3）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	Results and Guidelines From a Repeated-Measures Within-Subjects Experiment Comparing Standing and Seated Full-body Gesture-Based Immersive Virtual Reality Exergames	Wenge Xu, Hai-Ning Liang, Qiuyu He, Xiang Li, Kangyou Yu, Yuzheng Chen	JMIR Serious Games, 8(3), e17972.	2020
(2)	SCI	BioMove: Biometric User Identification from Human Kinesiological Movements for Virtual Reality Systems	Ilesanmi Olade, Charles Fleming, Hai-Ning Liang	Sensors 2020, 20, paper #2944.	2020
(3)	SCI	Health Benefits of Digital Videogames for the Aging Population: A Systematic Review	Wenge Xu, Hai-Ning Liang, Nilufar Baghaei, Bing Wu Berberich, Yong Yue	Games for Health Journal, 9(6), 16 pages.	2020
(4)	SCI	Studying the Effect of Display Type and Viewing Perspective on User Experience in Virtual Reality Exergames	Wenge Xu, Hai-Ning Liang, Zeying Zhang, Nilufar Baghaei	Games for Health Journal, 9(4), 10 pages.	2020
(5)	SCI	Modeling Endpoint Distribution of Pointing Selection Tasks in Virtual Reality Environments	Difeng Yu, Hai-Ning Liang, Xueshi Lu, Kaixuan Fan, Barrett Ens	ACM Transactions on Graphics 38(6), Article 218. Presented at SIGGRAPH Asia'19, Brisbane, Australia.	2019
(6)	SCI	Design and Evaluation of Techniques for Visualizing Off-Screen and Occluded Targets in Virtual Reality Environments	Difeng Yu, Hai-Ning Liang, Kaixuan Fan, Heng Zhang, Charles Fleming, and Konstantinos Papangelis	IEEE Transactions on Visualization and Computer Graphics.	2019
(7)	SCI	RingText: Dwell-free and hands-free Text Entry for Mobile Head-Mounted Displays using Head Motions	Wenge Xu, Hai-Ning Liang, Yuxuan Zhao, Tianyu Zhang, Difeng Yu, Diego Monteiro, and Yong Yue	IEEE Transactions on Visualizations and Computer Graphics, 25(5), 1991-2001.	2019
(8)	SCI	Design of Interactions for Handheld Augmented Reality Devices Using Wearable Smart Textiles: Findings from a User Elicitation Study	Vijayakumar Nanjappan, Rongkai Shi, Hai-Ning Liang, Haoru Xiao, Kim Lau, Khalad Hasan	Applied Sciences 9 (15), 3177.	2020
(9)	SCI	Evaluating the Effects of Collaboration and Competition in Navigation Tasks and Spatial Knowledge Acquisition within Virtual Reality Environments	Hai-Ning Liang, Feiyu Lu, Yuwei Shi, Vijayakumar Nanjappan, Konstantinos Papangelis.	Future Generation Computer Systems. Elsevier	2018
(10)	SCI	Evaluating Enjoyment, Presence, and Emulator Sickness in VR Games Based on First- and Third-Person Viewing Perspectives	Diego Monteiro, Hai-Ning Liang, Wenge Xu, Marvin Brucker, Vijayakumar Nanjappan and Yong Yue	Journal Computer Animation & Virtual Worlds (CAVW), volume 29, Issue 3-4, e1830, 12 pages. John Wiley Press.	2018
(11)	SCI	Infrared Motion Detection and Electromyographic Gesture Recognition for Navigating 3D Environments	Keyu Chen, Hai-Ning Liang, Yong Yue and Paul Craig.	Journal Computer Animation & Virtual Worlds (CAVW), volume 29, Issue 3-4, e1829, 12 pages. John Wiley Press.	2018
(12)	EI	VirusBoxing: A HIIT-based VR Boxing Game	Wenge Xu, Hai-Ning Liang, Xiaoyue Ma, Xiang Li	Extended Abstracts of the 2020 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '20 EA)	2020
(13)	EI	Exploration of Hands-free Text Entry Techniques For Virtual Reality	Xueshi Lu, Difeng Yu, Hai-Ning Liang, Wenge Xu, Yuzheng Chen, Xiang Li, Khalad Hasan	IEEE International Symposium on Mixed and Augmented Reality (ISMAR '20)	2020
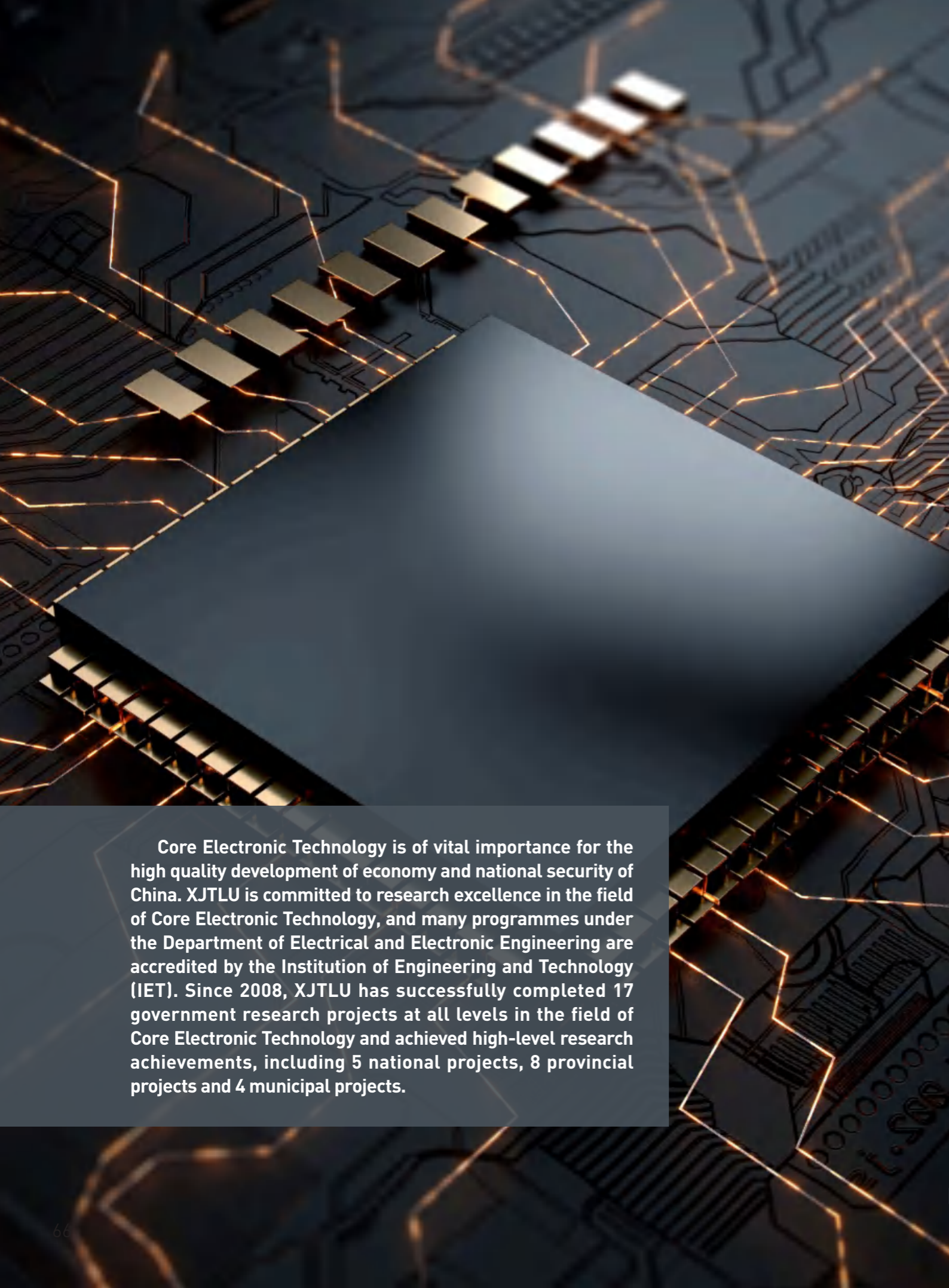
Core Electronic Technology

Core Electronic Technology is of vital importance for the high quality development of economy and national security of China. XJTLU is committed to research excellence in the field of Core Electronic Technology, and many programmes under the Department of Electrical and Electronic Engineering are accredited by the Institution of Engineering and Technology (IET). Since 2008, XJTLU has successfully completed 17 government research projects at all levels in the field of Core Electronic Technology and achieved high-level research achievements, including 5 national projects, 8 provincial projects and 4 municipal projects.

1.National Projects

Project 1: Analysis of Energy Deadband and Operating Modes in the Bidirectional DC-DC Converter with Multi-Phase-Shift Modulation

| Huiqing Wen

Application code: E070602 (Department of Engineering and Material Sciences)

Programme category: National Natural Science Foundation of China (NSFC) – Young Scientist Fund

Technical fields: Energy Storage Power Conversion System

Introduction: In this research project, we explored the efficiency optimization design of bidirectional DC converter in energy storage field, applied multi-phase shift modulation to suppress the disadvantages of traditional single phase shift modulation; analyzed the influence of dead area, tube voltage drop and other non-ideal factors, and established an accurate power flow model and verifies it by experiments; analyzed the working characteristics of different sub-modes of multi-phase shift modulation, proposed the optimal working mode based on output power segmentation, and proposed the solution algorithm of phase shift combination pair; in view of the disadvantages of time domain analysis, the subject started from frequency analysis, established a unified reactive power mathematical model, and solved the optimal phase shift variable group based on thousand Lagrange multiplier algorithm; based on the characteristics of reactive current distribution, a converter efficiency optimization algorithm based on minimum reactive power loss was proposed, this algorithm can not only take into account the effective value of inductor current, reactive power, soft switching and other optimization objectives, but also naturally include the influence of tube voltage drop and other non-ideal factors. The specific research work includes the following four aspects:

1. Multi-phase shift modulation control strategy and optimal working mode analysis: In view of the defects of single phase shift control, including high return power and soft switching loss under light load, the project team members analyzed the return power, soft switching and efficiency under multi-phase shift modulation, established the corresponding mathematical model, and built an experimental platform for detailed experimental research.

2. Based on harmonic analysis, a general reactive power model is established, and three-level phase-shift modulation is used to suppress reactive power to improve efficiency. Members of the research group establish a general reactive power mathematical model based on frequency harmonic series analysis method, and propose a three-level general phase-shift modulation strategy to suppress reactive power.

3. Analysis of dead area, tube voltage drop and other non-ideal factors and establishment of power flow model: dead area, tube voltage drop and other non-ideal factors have great influence on the operation performance of DAB converter, especially when the input voltage is low. Thus, the research group analyzed the influence of dead area, tube voltage drop and other main non-ideal factors, modified the traditional power flow model, improved the accuracy of the model and guided the design of DAB converter to improve the efficiency.

4. The efficiency optimization method of converter based on minimum reactive power loss was proposed: Different optimization objectives, such as peak current, RMS current, reactive power, soft switching and return power, can be adopted for the efficiency optimization of converter. Basically, the previous optimization started from one aspect, and it often failed to take into account other optimization objectives and the effect was effective. Starting from the return power distribution, the research group proposed an efficiency optimization method based on minimum reactive power loss, which can not only take into account different optimization objectives, but also take into account the influence of tube voltage drop and other non-ideal factors.

Keywords: Three-Level Phase Shift Modulation, Reactive Power Suppression, Dead Area Effect, Minimum Return Power Loss.

Research achievements:

1) Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	一种基于最小无功功率损耗的直流变换器效率优化方法	CN201510246621.2.	ZL201510246621.2.	文辉清
(2)	发明	授权	一种适用双向全桥直流变换器的统一双移相控制方法	CN201510249008.6.	ZL201510249008.6.	文辉清
(3)	发明	授权	一种基于双移相调制直流变换器的移相变量组合优化方法	CN201510246582.6.	ZL201510246582.6.	文辉清
(4)	发明	授权	双主动全桥直流变换器的优化控制方法	CN201910410567.9	ZL201910410567.9	卜庆雷 、文辉清

2) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	Minimize Reactive Power Losses of Dual Active Bridge Converters using Unified Dual Phase Shift Control	Wen, Huiqing; Su, Bin	Journal of Electrical Engineering & Technology	2017.3
(2)	SCIE	Hybrid-mode interleaved boost converter design for fuel cell electric vehicles	Wen, Huiqing; Su, Bin	Energy Conversion and Management	2016.8.15
(3)	SCIE	Operating modes and practical power flow analysis of bidirectional isolated power interface for distributed power systems	Wen, Huiqing; Su, Bin	Energy Conversion and Management	2016.3.1
(4)	SCIE	Reactive Power and Soft—switching Capability Analysis of Dual-Active-Bridge DC-DC Converter with Dual-Phase-Shift Control Journal of Power Electronics	Huiqing Wen; Bin Su	Journal of Power Electronics	2015.1.18
(5)	SCIE	Hybrid Control and Protection Scheme for Inverter Dominated Microgrids	Xu, Xiaotong; Wen, Huiqing; Jiang, Lin; Hu, Yihua	JOURNAL OF POWER ELECTRONICS	2017.5
(6)	SCIE	Minimum-Current-Stress Boundary Control Using Multiple-Phase-Shift based Switching Surfaces	Haochen Shi;Huiqing Wen;Zhenyan Cao;Yihua Hu;Lin Jiang	IEEE Transactions on Industrial Electronics	2020.8
(7)	SCIE	Minimum-Current-Stress Scheme of Three-Level Dual Active Bridge DC-DC Converters with the Particle Swarm Optimization	Yi Wang;Huiqing Wen;Yinxiao Zhu;Haochen Shi;Qinglei Bu;Yihua Hu;Yong Yang	IEEE Transactions on Transportation Electrification	2021.4
(8)	SCIE	Fault Diagnosis and Tolerant Control of Dual-Active-Bridge Converter With Triple-Phase Shift Control for Bidirectional EV Charging Systems	Huiqing Wen;Jinglin Li;Haochen Shi;Yihua Hu;Yong Yang	IEEE Transactions on Transportation Electrification	2020.12
(9)	SCIE	Robust LMI-LQR Control for Dual-Active-Bridge DC–DC Converters With High Parameter Uncertainties	Peizhou Xia;Haochen Shi;Huiqing Wen;Qinglei Bu;Yihua Hu;Yong Yang	IEEE Transactions on Transportation Electrification	2020.2
(10)	SCIE	Efficiency Optimization of DC Solid-State Transformer for Photovoltaic Power Systems	Haochen Shi;Huiqing Wen;Yihua Hu;Yong Yang;Yiwang Wang	IEEE Transactions on Industrial Electronics	2019.5

Project 2: Research on Spin and Mechanical Coupling Effects

| Hao Yu

Application code: A040208 (Department of Mathematical and Physical Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - Young Scientists Fund

Introduction: This project is based on the research of the coupling effect of spin and mechanical rotation or stress. LLG equation, kinematics equation and boundary conditions, spin-stress tensor coupling Hamiltonian, spin lattice Monte Carlo simulation and other calculations are used to explore the microscopic mechanism and macroscopic dynamic process of mechanical coupling effect, and establish the physical image of spin-magnetization-mechanical coupling. It provides physical basis and theoretical basis for developing a new type of spin flow detection, generation and control device. The main research results include:

1. Stress research of the spin valve component based on the spin transfer torque effect, the stress of nano-spin valve was researched.
2. Research on the velocity law of domain wall motion driven by spin-polarized current, the functional dependence of the velocity of domain wall on current density and temperature was obtained, which successfully explained the previous experimental results.
3. Research on hysteresis loop dynamics of nano-magnet or spin system based on LLG equation, the energy dissipation and dispersion relation of hysteresis loop and the dynamic evolution law of loop were calculated.
4. Design of submicron/nano rotating motor based on spin transfer torque effect, a micro rotating machine based on spin flow was given.
5. Research on brain cognition and capacity of a brain model based on lattice matrix, the proportion of brain capacity with the best cognitive success rate was obtained. Development of this project is of great significance to enhance the means of spin control and develop a new generation of spintronics devices.

Keywords: Spintronics, Angular Momentum Coupling, Spin and Mechanical Rotation, Magnetization Dynamics

Research achievements:

1） Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	自旋极化电流驱动的亚微米／马达及其制作方法	CN201510639455.2	ZL201510639455.2	于昊
(2)	实用新型专利	授权	基于铁酸铋的光电传感器元件	CN201520770161.9	ZL201520770161.9	于昊

2） Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Nonlinear dynamics of magnetization evolution in orthogonal spin torque devices: Phases and classification.	Yuan Hui, Zheng Yang, Hao Yu*	AIP Advances	2021.01

3）Others

（1） 江苏省自然科学基金面上项目《铁酸铋微米单晶的可控制备与光伏特性研究》（BK2012637）省拨款 10 万，地方匹配 5 万元，2013-2015.

（2） 苏州市科技计划项目《高灵敏度且低成本的磁场传感器装置及技术研究》（SYG201304）市拨款 8 万元，地方匹配 4 万元，2013-2015.

Project 3: Dielectric Relaxation and Frequency Dependence of HfO2 Doped by Lanthanide Elements

| Cezhou Zhao

Application code: F040601 (Department of Information Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - General Programme

Introduction: Doped hafnium oxide is a newly discovered gate oxide dielectric with higher dielectric constant. In this project, its application in 22nm integrated circuit technology was researched. Objectives of this research are: On the basis of existing research, the dielectric constant of doped hafnium oxide can be increased to over 40 by inhibiting the dielectric relaxation of doped hafnium oxide. For this purpose, the following six aspects were researched in this project:

1. Consideration of extrinsic dispersion and extraction of k value.
2. Mathematical and physical models of dielectric relaxation of doped Hafnium oxide.
3. Influence of growth conditions and annealing conditions on dielectric relaxation of doped Hafnium oxide.
4. Influence of grain size on dielectric relaxation.
5. Mechanism and control of dielectric relaxation.
6. In order to analyze the reliability of lanthanide hafnium oxide dielectric, a method for measuring leakage current and flat band voltage drift of dielectric film was established.

In addition, the influence of dipole moment formed by oxygen vacancy and electron trap on dielectric relaxation was also researched.

Keywords: 22nm Technology, Doped Hafnium Oxide, Dielectric Constant, Dielectric Relaxation, High-k Medium

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	实用新型专利	授权	一种可程控智能微电流测量显示系统	CN201120545871.3	ZL201120545871.3	桑迟，魏小莽，赵策洲
(2)	实用新型专利	授权	脉冲 I–V 与脉冲 C–V 半导体参数自动测量装置	CN201020676494.2	ZL201020676494.2	魏小莽，赵策洲，周云龙
(3)	发明	授权	脉冲 I–V 与脉冲 C–V 半导体参数自动测量装置和方法	CN201010602838.X	ZL201010602838.X	魏小莽，赵策洲，周云龙
(4)	实用新型专利	授权	脉冲实时场效应管阈值电压参数自动测量装置	CN201120536047.1	ZL201120536047.1	赵策洲；黄鼎；魏小莽
(5)	发明	授权	脉冲实时场效应管阈值电压参数自动测量装置及其方法	CN201110429047.6	ZL201110429047.6	赵策洲；黄鼎；魏小莽

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Dielectric relaxation of La–doped zirconia caused by annealing ambient	C. Z. Zhao, M. Werner, S. Taylor, P. R. Chalker, A. C. Jones, and Chun Zhao	Nanoscale Research Letters	2011
(2)	SCI	Extrinsic and intrinsic frequency dispersion of high–k materials in capacitance–voltage measurements	Jing Tao, Ce Zhou Zhao, Chun Zhao, P. Taechakumput, M. Werner, S. Taylor, P.R. Chalker	Materials	2012
(3)	SCI	Thermal Stability of Neodymium Aluminates high–k dielectric deposited by Liquid Injection MOCVD using single source Heterometallic Alkoxide precursors	P. Taechakumput, C. Z. Zhao, S. Taylor, M. Werner, P. R. Chalker, J. M. Gaskell, H. C. Aspinall, A. C. Jones, and Susu Chen	Journal of Nanomaterials	2012
(4)	SCI	Dielectric Relaxation of Lanthanide–based Ternary Oxides: Physical and Mathematical Models	Chun Zhao, Ce Zhou Zhao, Jing Tao, Matthew Werner, Steve Taylor and Paul R. Chalker	Journal of Nanomaterials	2012
(5)	SCI	Advanced CMOS Gate Stack: Present Research Progress	Chun Zhao, Ce Zhou Zhao, Matthew Werner, Steve Taylor and Paul R. Chalker	ISRN Nanotechnology	2012
(6)	SCIE	A review of recent progress in lasers on silicon	Zhou Fang, Qiu Yu Chen, Ce Zhou Zhao	Optics & Laser Technology	2013
(7)	SCIE	Achievements and Challenges of CdTe Solar Cells	Zhou Fang, Xiaochen Wang, H. C. Wu, and C. Z. Zhao	International Journal of Photoenergy	2011
(8)	EI	A Novel Technique for Arthmetic Elements Standard Cell Library Establishment Based on Tanner Tools	Chun Zhao, Ce Zhou Zhao, Bin Da	Advanced Materials Research	2012
(9)	EI	Dielectric Relaxation of Lanthanide–based Ternary Oxides	Ce Zhou Zhao, J. Tao, Chun Zhao, M. Werner, S. Taylor, and P. R. Chalker	IEEE ICSICT–2012, the 11th International Conference on Solid–State and Integrated Circuit Technology	2012.10.29-2012.11.01
(10)	EI	Dielectric Relaxation Model in High–k Materials: Simplified Kohlrausch–Williams–Watts Function	Peng Fei Wang, Chun Zhao, Ce Zhou Zhao, and Gang Liu	IEEE ICSICT–2012, the 11th International Conference on Solid–State and Integrated Circuit Technology	2012.10.29-2012.11.01
(11)	EI	Standard Cell Library Establishment and Simulation for Scan D Flip–Flops based on 0.5 Micron CMOS Mixed Signal Process	Chun Zhao, W. Zhang, C. Z. Zhao, K. L. Man, J. Ma, T. T. Jeong and J. K. Seon	International SoC Design Conference (ISOCC)	2011.11.17-2011.11.18
(12)	EI	Performance–Effective Compaction of Standard Cell Library for Edge–triggered Latches Utilizing 0.5 Micron Technology	Chun Zhao, W. Pan, C. Z. Zhao, K. L. Man, J. Choi, J. Chang	International SoC Design Conference (ISOCC)	2011.11.17-2011.11.18

Project 4: Research on the Converter Topology and Optimization of Coordinated Control for DC Microgrid with Energy Storage Devices

| Huiqing Wen

Programme category: State Key Laboratory of New Energy Power System (North China Electric Power University)

Introduction: DC micro-grid system includes three parts: solar energy, wind energy and other distributed generation units, batteries, supercapacitors and other energy storage components, and power converter interface. Based on the typical structure and operation analysis of DC micro-grid, mathematical models of photovoltaic cells, bidirectional DC converters and batteries were established, and the photovoltaic access topology of DC micro-grid converters was analyzed, the efficiency optimization method of converters based on reactive power loss was researched, and the maximum power point tracking (MPPT) control strategy based on ß parameters was studied to improve dynamic response speed and reduce static error. Control of DC micro-grid system is divided into millisecond converter control, second DC bus control and hour overall energy scheduling control. Specifically, the battery is controlled by voltage subsection droop, and each converter can automatically switch its working mode only through bus voltage without additional communication network, and the power flow characteristics of different modes and the mode switching criteria were studied. According to the complementary characteristics of energy and power density of battery and supercapacitor, the battery was designed to absorb low-frequency power pulsation. Supercapacitor absorbs high frequency power pulsation. Moreover, the self-adaptive droop control based on charge state was used to realize the balance of battery power distribution. In order to improve the life of energy storage elements, the maximum charge and discharge current was researched in this project.

Keywords: DC Micro-Grid, Adaptive Droop Control, Collaborative Control, Power Conversion, Efficiency Optimization

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	An Improved MPPT Method for PV system with Fast-Converging Speed and Zero Oscillation	Xingshuo li, Huiqing Wen, Lin Jiang, Weidong Xiao, Yang Du, Chenhao Zhao	IEEE Transactions on Industry Applications	2016.08
(2)	SCI	An Improved Beta Method with Auto-scaling Factor for Photovoltaic system	Xingshuo Li, Huiqing Wen, Lin Jiang, Yihua Hu, Chenhao Zhao	IEEE Transactions on Industry Applications	2016.06
(3)	SCI	Hybrid-mode interleaved boost converter design for fuel cell electric vehicles	Huiqing Wen, Bin Su	Energy Conversion and Management	2016.08
(4)	SCI	Synchronous buck converter based low-cost and high-efficiency sub-module DMPPT PV system under partial shading conditions	Hengyang Luo, Huiqing Wen, Xingshuo Li, Lin Jiang, Yihua Hu	Energy Conversion and Management	2016.10
(5)	SCI	Minimize Reactive Power Losses of Dual Active Bridge Converters using Unified Dual Phase Shift Control	Wen, H. & Su, B.	Journal of Electrical Engineering & Technology	2016.12
(6)	EI	A fuzzy logic controller with beta parameter for maximum power point tracking of Photovoltaic systems	Xingshuo Li, Huiqing Wen	IPEMC 2016	2016.5
(7)	EI	Distributed MPPT control under partial shading condition	Hengyang Luo, Huiqing Wen, Xingshuo Li	IPEMC 2016	2016.5
(8)	EI	Shadowing effect on the power output of a photovoltaic panel	Sonia Veerapen, Huiqing Wen	IPEMC 2016	2016.5
(9)	EI	Perturbation Optimization of Maximum Power Point Tracking of Photovoltaic Power Systems Based on Practical Solar Irradiance Data	Yang Du, Xingshuo Li, Huiqing Wen, Weidong Xiao	COMPEL 2015	2015.6
(10)	EI	Design and evaluation of a solar based single inductor multiple outputs LED lighting	Haiyan Xu, Huiqing Wen, Xingshuo Li	G 2015	2015.10

Project 5: Topology of AC Miorogriol and Coordinated Control

| Huiqing Wen

Programme category: State Key Laboratory of Electrical Insulation of Power Equipment (Xi'an Jiaotong University)

Introduction: The cooperative control mechanism of AC micro-grid system was established on different time scales, and the corresponding simulation and experimental platforms were built to research the operation modes of converters in AC micro-grid under wind speed or load changes, power grid faults and other different working conditions. Specifically, based on the topology of AC micro-grid system, in this project, the simulation model of photovoltaic cell was established, the topology and decoupling method of micro-inverter were analyzed, and quasi-PR control was researched to realize grid connection without static error, the optimization method of converter efficiency based on reactive power loss was studied to solve the problem that the transmission disturbance observation method cannot ensure both steady-state accuracy and tracking time, the maximum power point tracking (MPPT) control strategy based on ß parameters was put forward to improve dynamic response speed and reduce static error. The droop control principle of AC micro-grid was researched, the mathematical model of voltage source micro-grid inverter was derived, the voltage and current closed-loop control system was designed, the control and parameter design method of power loop were researched, the factors that affect the analysis of active power and reactive power when multiple inverters were connected in parallel and in isolated island mode were analyzed, the imbalance of parallel commutation and power distribution was reduced by correcting the traditional droop control method by compensating the voltage drop of the line, the grid-connected pre-synchronization was designed to reduce the grid-connected impulse current and to realize the smooth switching between the grid-connected and islanding modes of the micro-grid inverter. The voltage and frequency reference values were also introduced to keep the output power of the inverter constant, thus realizing the constant power control when the inverter was connected to the grid.

Keywords: AC Micro-Grid, Droop Control, Power Conversion, Inverter Grid Connection

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	An Improved MPPT Method for PV system with Fast-Converging Speed and Zero Oscillation	Xingshuo li, Huiqing Wen, Lin Jiang, Weidong Xiao, Yang Du, Chenhao Zhao	IEEE Transactions on Industry Applications	2016.08
(2)	SCI	An Improved Beta Method with Auto-scaling Factor for Photovoltaic system	Xingshuo Li, Huiqing Wen, Lin Jiang, Yihua Hu, Chenhao Zhao	IEEE Transactions on Industry Applications	2016.06
(3)	SCI	Hybrid-mode interleaved boost converter design for fuel cell electric vehicles	Huiqing Wen, Bin Su	Energy Conversion and Management	2016.08
(4)	SCI	Synchronous buck converter based low-cost and high-efficiency sub-module DMPPT PV system under partial shading conditions	Hengyang Luo, Huiqing Wen, Xingshuo Li, Lin Jiang, Yihua Hu	Energy Conversion and Management	2016.10
(5)	SCI	Minimize Reactive Power Losses of Dual Active Bridge Converters using Unified Dual Phase Shift Control	Wen, H. & Su, B.	Journal of Electrical Engineering & Technology	2016.12

2.Provincial Projects

Project 1: Dynamic Adaptive Streaming over HTTP for Multi-View Video Using Multiple Servers

| Jimin Xiao

Technical fields: Electronic Information

Programme category: Jiangsu Science and Technology Programme - Basic Research Plan (Natural Science Foundation) - Young-Scholar Programme

Introduction: Multi-view video is popular with users because of its excellent viewing experience. According to the request of users, the demand of interactive multi-view video stream providing seamless view switching is also increasing. However, it is a challenging task to provide stable and high-quality multi-view video through streaming, which must allow real-time scene switching under the limited bandwidth. In this project, the research group proposed a seamless multi-view video system assisted by Convolutional Neural Networks (ConvNet) to meet the challenge. The proposed method solves this problem from the two perspectives. First, a ConvNet-assisted multi-view video representation method is proposed, which provides flexible interactivity without affecting the compression efficiency of multi-view video. Second, the research group developed a network bandwidth allocation mechanism guided by viewpoint switching model to provide seamless view switching and adapt to network bandwidth fluctuations. These two modules worked closely together to provide users with an optimized viewing experience. They can be integrated into any existing multi-view video streaming framework to improve the overall performance.

Considering the user's behavior of viewpoint switching in streaming transmission, the research group designed a new streaming cache framework to improve the user's experience of multi-view video streaming on DASH. The research group introduced multi-view switching rules to prefetch the possible switching viewpoints in order to eliminate the delay of viewpoint switching. Aiming at the introduced rules, an optimal bit rate allocation scheme was proposed to allow clients to maximize the video quality. In addition, we find that video quality and playback jamming probability are conflict factors under this framework, and both of them are essential for user's Quality of Experience (QoE). This project has solved the contradiction between them properly. The experimental results proved the effectiveness of the method in seamless multi-view flow.

Keywords: Dynamic Adaptive Streaming over HTTP (DASH), Quality of Experience (QoE)

Key issues solved:

1. The contradictions between the flexibility of video view transmission and redundancy mining in multi-view video transmission were solved. The flexibility of view transmission and high multi-view compression ratio distortion performance were also realized.

2. The cache problem of multi-view video in DASH transmission was solved. According to the current network situation and user's view switching habits, the calculation method of the optimal cache size is proposed to obtain the optimal user's ' Quality of Experience (QoE).

Research achievements:

1) Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	基于运动信息的单目相机获取深度信息的方法	CN201510535760.7	ZL201510535760.7	罗天明，蒋琛儒，程飞
(2)	发明	授权	一种基于图像处理的多功能指示器实现方法	CN201510686764.5	ZL201510686764.5	罗天明，李硕存，程飞

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Convolutional Neural Network for Intermediate View Enhancement in Multiview Streaming	Li YU, Tammam TILLO, Jimin XIAO, Marco GRANGETTO	IEEE Transactions on Multimedia	2018
(2)	SCI	Cooperative Bargaining Based Multi user Bit Allocation for Dynamic Adaptive Streaming over HTTP	Hui Yuan, Xuekai Wei, Fuzheng Yang, Jimin Xiao, Sam Kwong	IEEE Transactions on Multimedia	2018
(3)	SCI	Texture plus Depth Video Coding Using Camera Global Motion Information	Fei CHENG, Tammam TILLO, Jimin XIAO, Byeungwoo Jeon	IEEE Transactions on Multimedia	2017
(4)	SCI	QoE-driven Dynamic Adaptive Video Streaming Strategy with Future Information	Li Yu, Tammam TILLO, Jim in XIAO	IEEE Transactions on Broadcasting	2017
(5)	SCI	End-to-End Distortion-Based Multiuser Bandwidth Allocation for Real-Time Video Transmission Over LTE Network	Hui Yuan, Huayong Fu, Ju Liu, Jimin Xiao	IEEE Transactions on Broadcasting	2017
(6)	SCI	Depth Map Down-Sampling and Coding Based on Synthesized View Distortion	Chao YAO, Jimin XIAO, Tammam TILLO, Yao ZHAO, Chunyu LIN, Huihui BAI	IEEE Transactions on Multimedia	2016
(7)	SCI	Siamese Network Ensemble for Visual Tracking	Chenru Jiang, Jimin Xiao, Yanchun Xie, Tammam Tillo, Kaizhu Huang	Neurocomputing	2018
(8)	SCI	An Effective CU Size Decision Method for Quality Scalability in SHVC	Xiaoni Li, Mianshu Chen, Zhaowei Qu, Jimin Xiao, Moncef Gabbouj	ltimedia Tools and Applications	2017
(9)	SCI	Multiview video plus depth transmission via virtual-view-assisted complementary down/up-sampling	Zhi JIN, Tammam TILLO, Jimin XIAO, Yao ZHAO	EURASIP Journal on Image and Video Processing	2016
(10)	EI	30 Video Super-Resolution Using Fully Convolutional Neural Networks	Yanchun Xie, Jimin Xiao, Tammam Tillo, Yunchao Wei, Yao Zhao	IEEE International Conference on Multimedia and Expo 2016 (ICME)	2016

Project 2: Novel Numerical and Computational Techniques for Remote Densor Based Monitoring of Water Quality

| Yong Yue

Technical fields: Electronic Information - Sensor Networks - Intelligent Sensing and Processing

Programme category: Jiangsu Science and Technology Programme - Basic Research Plan (Natural Science Foundation) - General Programme

Introduction: Based on the three optimization objectives of meeting management needs, reducing costs and improving monitoring efficiency, this research carries out study on the multi-objective optimization theory and method of water environment monitoring network. Considering the factors of tidal sediment, pollution detection time, pollution detection success rate, the importance of monitoring points and special management needs, the algorithm of multi-objective optimal deployment of water environment monitoring network and water quality data analysis is researched. The main research contents are as follows:

1. Aiming at the water environment of rivers with different flow directions at different times affected by tides, the multi-objective optimal deployment of monitoring network under two-way flow based on particle swarm optimization is researched. The experimental results indicate that the optimal deployment scheme of monitoring network for two-way flow is significantly different from that for one-way river, and the multi-objective particle swarm optimization can obtain better Pareto frontier than genetic algorithm.

2. In practical application, it is often necessary to set up some special monitoring points to meet specific management needs. Thus, considering the multi-objective optimization deployment of water environment monitoring network under pre-selected monitoring points, and taking the minimum pollution detection time, the maximum pollution detection probability and the maximum monitoring point centrality as the optimization objectives, the particle swarm optimization is improved to achieve the final optimization result, which can not only include these special monitoring points, but also meet the three optimization objectives. The experimental results indicate that the final optimization scheme can ensure that the optimal Pareto frontier can be obtained on the basis of including all pre-selected monitoring points.

3. The noise data processing method based on double time windows is researched, which filters the noise data collected by water quality monitoring network and improved the accuracy of the data.

4. Combining sensors with mobile communication networks, a prototype system of water quality monitoring based on wireless sensor network was developed. Solar energy and rechargeable battery technology were used to provide long-term electric energy for wireless sensor nodes, and 4G network is used to improve data transmission speed and reliability. Corresponding software and hardware systems are developed and integrated to realize remote real-time monitoring of river water environment, and the method of locating pollution sources by using sensor node location and pollution events is researched.

5. In order to further reduce the cost of water environment monitoring and improve the coverage of water environment monitoring, the research group combined monitoring sensors with unmanned ship technology, and developed unmanned water environment monitoring ships and achieved the initial results.

Keywords: Graph Theory, Particle Swarm Optimization, Optimal Deployment of Nodes, Automatic Analysis and Location of Pollution Sources

Key issues solved:

1. The optimal deployment algorithm of water quality monitoring network solved the key problem of multi-objective optimization in the deployment of water quality monitoring network. The monitoring network can be quantitatively analyzed, and the average pollution detection time and the success rate of pollution detection under different optimization schemes can be accurately calculated. It can not only be evaluated and optimized by the existing water quality monitoring network, but also provide an optimized deployment scheme for the follow-up water quality monitoring network construction.

2. The pollution source location algorithm solved the problem of quickly locating the pollution location when the pollution event is detected by the monitoring network, and won time for handling the pollution event in a timely manner.
3. Wind energy and solar energy complementary power supply scheme provided reliable power supply for long-term stable operation of wireless sensor monitoring points, and solved the problem of independent power supply for field monitoring points.

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	基于双时间窗口验证的水质监测噪音数据实时检测方法	CN201710523755.3	ZL201710523755.3	岳勇、朱晓辉、张晋、张一新、王威
(2)	发明	授权	基于双向水流的水质监测网络多目标优化算法	CN201710288461.7	ZL201710288461.7	岳勇、朱晓辉、张一新、王威
(3)	发明	审查	水质污染扩散预警可视化方法	CN201710505488.7		岳勇，朱晓辉，刘婉，贾露，喻纪文，胡兆鹏

2）Copyrights

No.	Status	Category	Title	Author(s)	Application no.	Certificate no.
(1)	获得	软著	水环境监测与污染实时预警系统	岳勇、朱晓辉、刘婉	2017SR406022	1991306
(2)	获得	软著	无线传感水质监测后端管理系统	岳勇、朱晓辉、缪平	2017SR480896	2066180

3）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Optimum Water Quality Monitoring Network Design for Bidirectional River Systems	Zhu, X., Yue, Y., Wong, P. IV., Zhang, Y., & Tan, J.	International Journal of Environmental Research & Public Health	2018
(2)	EI	Designing an Unmanned Surface Vehicle for Water Quality Monitoring	Zhu, X., Yue, Y., et al.	Innovative Computing Technology (INTECH), 2018 Eighth International Conference	2018.8
(3)	EI	Designing an Optimal Water Quality Monitoring Network	Zhu, X., Yue, Y., Zhang, Y., Wong, P. IV., & Tan, J.	International Conference on Intelligence Science	2017.10
(4)	EI	A Dynamic Data Visualization for Water Quality Monitoring Network	Chen X, Zhu X, Yue Y, et al.	Seventh International Symposium on Computers & Informatics(ISCI2017)	2017.7
(5)	EI	A real -time anomaly detection algorithm for water quality data using dual time-moving windows	Zhang, J., Zhu, X., Yue, Y., & Wong, P. IV.	Seventh International Conference on Innovative Computing Technologies (INTECH 2017)	2017.8
(6)	EI	Novel numerical and computational techniques for remote sensor based monitoring of freshwater quality	Zhu, X., Yue, Y., Wong, P., Zhang, Y., & Meng, J.	IEEE International Conference of Online Analysis and Computing Science	2016.5

Project 3: Detect Positioning Error in Wireless Networks

| **Dawei Liu**

Technical fields: Electronic Information - Sensor Networks - Intelligent Sensing and Processing

Programme category: Jiangsu Science and Technology Programme - Basic Research Plan (Natural Science Foundation) - Young-scholar Programme

Introduction: With the wide application of wireless positioning technology, the security of wireless positioning system has been paid more and more attention. The main security threat faced by wireless positioning system comes from positioning spoofing by malicious users. In 2003, the US Department of Transportation reported that GPS civil signals can be forged, and the forged GPS signals may lead to abnormal positioning results, and even cause complete paralysis of GPS functions in a certain area. In recent years, numerous researches have begun to focus on the security issues in wireless positioning, and the main research directions include the ways to find abnormal positioning results caused by malicious users and to eliminate such anomalies.

Another reason for abnormal positioning results is the NLOS propagation of wireless signals. The positioning error of CDMA system can reach 589m in NLOS environment, while the general error is only tens of meters. There are similar problems in other positioning system, such as the wireless sensor network positioning and wireless local area network positioning. Thus, the way to detect NLOS propagation and to eliminate its influence has always been one of the hot spots in research of Wireless Positioning System.

In this project, a set of abnormal error detection mechanism is designed through the research of positioning spoofing signal and NLOS signal, which solves the issue of positioning spoofing identification in NLOS environment. The project was carried out strictly according to the plan, with 10 papers published, 1 invention patent applied, 4 graduate students trained and all technical indicators completed. The research results provided theoretical basis and technical support for abnormal error detection and identification of wireless positioning, and provided a basis for relevant Departments to develop the industry standards, regulations and policies.

Keywords: Wireless Positioning, Location Security, NLOS Propagation

Key issues solved:

1. The problems were found out by detecting the positioning error on the periphery of convex hull. Traditional consistency analysis can not effectively act on the convex hull of wireless positioning nodes. It means that the alternatives must be found. On the one hand, the alternatives designed by us can find any positioning errors on the periphery of convex hull, on the other hand, it will not introduce new failure problems.
2. Fingerprint acquisition method based on user data. It is the basis of establishing a perfect fingerprint database to discover those safe and reliable users in unknown areas, measure their wireless signals and calculate the degree of NLOS propagation. By analyzing the similarity of adjacent users, we solved the problem of the way to find those safe users from a small number of users.
3. Implementation of distributed authentication technology for positioning spoofing. We focused on solving the security problem of distributed protocols. On the basis of traditional research, combined with the unique geometric constraints of wireless location, we designed a set of secure and reliable authentication methods.

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI	An Improved IEEE 802.15.6 Password Authenticated Association Protocol	X. Huang, D. Liu, et al	IEEE/CIC I CCC 2015 Symposium on Selected Topics in Communications	2015

(2)	EI	Analysis of Location Spoofing Identification in Cellular Networks	Wei Y, Liu D.	International Conference on Mobile, Secure and Programmable Networking	2015
(3)	EI	Identifying malicious attacks to wireless localization in bad channel conditions	Liu D.	2014 IEEE MiSeNet	2014
(4)	EI	Linear programming algorithms for sensor networks node localization	Xu K, Liu H, Liu D, et al.	2016 IEEE International Conference on Consumer Electronics (ICCE)	2016
(5)	EI	Dynamic Sensor Selection in Heterogeneous Sensor Network	Ma Y, Hou F, Ma S, and D. Liu.	IEEE Vehicular Technology Conference (VTC Spring)	2016
(6)	EI	Wi-Fi Access Point Roaming: Challenges and Potential Solutions	L. Wang, Y. Zhao, D. Afolabi, D, Liu.	18th IEEE International Conference on Network-Based Information Systems (NBiS)	2015
(7)	EI	A Role-Based Access Control System for Intelligent Buildings	N. Xue, C. Jiang, X.Huang and D. Liu	International Conference on Network and System Security	2017
(8)	EI	MuVi: Multi-view Video Aware Transmission over MI MO Wireless Systems	Z. Chen, X. Zhang, et al	IEEE Transactions on Multimedia, accepted to appear	2017
(9)	EI	Temporal Coherence-Based Deblurring Using Non-Uniform Motion Optimization	C. Qiao, RWH. Lau, et al	IEEE Transactions on Image Processing	2017
(10)	EI	Identification of Location Spoofing in Wireless Sensor Networks in Non-Line-of-Sight Conditions	Dawei Liu	IEEE Transactions on Industrial Informatics	2017

Project 4: Development of Novel Substrates for Single Molecule Conductance Measurement

| Li Yang

Technical fields: Electronic Information - Information Functional Materials and Devices - Microelectronic Materials and Devices

Programme category: Jiangsu Science and Technology Programme – Basic Research Plan (Natural Science Foundation) - Young-scholar Programme

Introduction: In this research, a metrological method for characterizing the electrical transport of new non-gold substrates (ITO, graphene, doped diamond-like carbon films or other conductive materials) was developed. By exploring the interaction between the new substrate and the terminal groups of molecular lines, the influence of the new electrode on the electrical properties of molecular junctions was established. Interface chemistry was used to control the arrangement among band edge, surface state and electronic state of molecular bridge chain so as to obtain effective control of new molecular junctions on nano scale, support the development of new and emerging electronic devices, and enhance the potential of measuring electrical transport in complex molecules.

The project is dedicated to developing new substrates for single molecular electronic devices, including indium tin oxide (ITO), graphene, doped diamond-like carbon films and substrates prepared by atomic layer deposition (ALD). Develop the functional terminal chemical groups that can match the monomolecular junctions formed by the new substrates, and the rectifier molecular junctions are obtained by controlling the interfacial chemistry. Provide the design principle of new substrate-molecule-metal molecule junction, and master the repeatable and accurate electron transport measurement method and electron transport mechanism at single molecule level.

Through the implementation of this project, there are a series of complete preparation processes of high-quality graphene substrate materials with independent intellectual property rights, and establish the relationship between process parameter optimization and graphene conductive film performance. The research team already has the complete experimental conditions for in-situ construction of single molecular junctions and measurement of charge transport of asymmetric molecular junctions, and theoretically simulates the influence of band structure between terminal groups of molecular lines and substrates on charge transport at semiconductor-molecule interface, which can realize molecular junctions controlled by molecular line length and anchoring groups.

Keywords: Single Molecule Conductivity, Scanning Tunneling Microscope, New Substrates

Key issues solved: In this project, a series of complete preparation processes of high-quality graphene substrate materials with independent intellectual property rights was developed, and the relationship between process parameter optimization and graphene conductive film performance was established. The project demonstrated that graphene can be used to replace metal as electrode material, and established complete experimental conditions for in-situ construction of single molecular junctions and measurement of charge transport of asymmetric molecular junctions. For the reliable measurement of electrical characteristics of single molecule junction, the corresponding gold/molecule/graphene asymmetric molecular junction was constructed and the conductance of single molecule was measured. The charge transport mechanism of the new molecular junction was mastered, and the influence of band structure between the terminal group of molecular line and the substrate on the charge transport at the semiconductor-molecule interface was simulated theoretically so that the molecular junction controlled by the length of molecular line and anchoring group could be realized.

Research achievements:

1）Patent

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	用石墨烯电极构筑分子节的方法及测量分子电导的方法	CN201610145493.7	ZL201610145493.7	杨莉，张骞，刘龙龙，陶舒晖，赵策洲，理查·尼克斯

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Optically probing the interaction between monolayer MoS2 and single-wall carbon nanotube	Weitao Su, Long Jin, Dexuan Huo, Li Yang	Optical and Quantum Electronics	2017
(2)	SCI	Graphene as a promising electrode for low-current attenuation in nonsymmetric molecular junctions	Qian Zhang, Longlong Liu, Shuhui Tao, Congyi Wang, Cezhou Zhao, Cesar Gonzalez, Yannick J. Dappe, Richard J. Nichols, Li Yang	Nano Letters	2016
(3)	SCI	Charge transport through dicarboxylic-acid-terminated alkanes bound to graphene-gold nanogap electrodes	Longlong Liu, Qian Zhang, Shuhui Tao, Cezhou Zhao, Eman Almutib, Qusiy Al-Galiby, Steve Bailey, Colin J. Lambert, Jun Du, Li Yang	Nanoscale	2016
(4)	SCI	Oxygen passivation in photoluminescence enhancement of rhombic monolayer MoS2	Weitao Su, Long Jin, Xiaodan Qu, Dexuan Hou, Li Yang	Physical Chemistry Chemical Physics	2016
(5)	SCI	Tuning photoluminescence of single-layer MoS2 using H2O2	Weitao Su, Hong Lei Dou, Jinwei Li, Dexuan Huo, Ning Dai, Li Yang	RSC Advance	2015
(6)	SCI	Enhancing photoluminescence of Trion in Single layer MoS2 using p-type aromatic molecules	Weitao Su, Hong Lei Dou, Dexuan Huo, Weijie Song, Ning Dai, Li Yang	Chemical Physics Letters	2015

Project 5: Total Ionizing Dose Effects in La-Based Ternary High-k Gate Dielectrics

| Cezhou Zhao

Technical field: Manufacturing Technology of New Generation Military Integrated Circuit and Aerospace Integrated Circuit

Programme category: Jiangsu Science and Technology Programme - Basic Research Plan (Natural Science Foundation) - General Programme

Introduction: The current situations at home and abroad are as follows:

1. The research on radiation response mechanism of high-k media under X-ray or gamma-ray radiation environment focuses on the research group of Professor Fleetwood and Professor Schrimpf of Vanderbilt University and Professor Lucovsky of North Carolina State University. They researched the over-radiation response mechanism of Al2O3, ZrO2, HfO2 and other [49-59] high-k dielectric materials with physical thickness greater than 4nm.

2. There are few reports on radiation response and over-radiation response of lanthanide doped ZrO2 (such as LaZrO2, lanthanide doped HfO2 (such as CeHfO2) and other new high-k media.

3. There are few reports on leakage current and reliability of ultra-thin high-k media under X-ray or gamma-ray radiation environment.

The characteristics and innovations of this project are as follows:

1. The mechanism of defects in LaZrO2, CeHfO2 and other new high-k media during irradiation was researched.

2. The defect generation mechanism of LaZrO2, CeHfO2 and other new high-k medium after radiation was researched.

3. Radiation-induced leakage currents and reliability of ultra-thin LaZrO2, CeHfO2 and other new high-k media were researched.

4. The radiation hardening process and annealing conditions of LaZrO2, CeHfO2 and other new high-k media were researched.

Key issues solved:

1. Characterization of x-ray and gamma-ray radiation responses

2. Radiation response mechanism of a new high k medium

3. Radiation damage mechanism of ultra-thin high-k medium

4. Radiation reinforcement technology of high-k medium

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	实用新型专利	授权	一种 PN 结瞬时电容能谱测量系统	CN201520179615.5	ZL201520179615.5	吴京锦，赵策洲，刘晨光
(2)	实用新型专利	授权	一种半导体器件瞬态电容的测试系统	CN201520179612.1	ZL201520179612.1	吴京锦，赵策洲，刘晨光
(3)	发明	授权	一种 PN 结瞬时电容能谱测量方法和系统	CN201510140554.6	ZL201510140554.6	吴京锦，赵策洲，刘晨光

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Real time and on-site r-ray radiation response testing system for semiconductor devices and its applications	Yifei Mu, Ce Zhou Zhao, Chun Zhao, Yanfei Qi, Yutao Cai, Ivona Z. Mitrovic, Stephen Taylor, Paul R. Chalker	Nuclear Inst. and Methods in Physics Research	2016.4
(2)	SCI	Electrical property and interfacial study of HfxTi1-xO2 high permittivity gate insulators deposited on germanium substrates	ACCEPTED TO BE PUBLISHED	Materials	2015
(3)	SCI	Review on Non-Volatile Memory with High-k Dielectrics: Flash for Generation Beyond 32 nm	Chun Zhao, Ce Zhou Zhao, Stephen Taylor and Paul R. Chalker	Materials	2014
(4)	SCI	Hysteresis in Lanthanide Aluminate Oxides Observed by Fast Pulse CV Measurement	Chun Zhao, Ce Zhou Zhao, Qifeng Lu, Xiaoyi Yan, Stephen Taylor and Paul R. Chalker	Materials	2014
(5)	SCI	Hysteresis in Lanthanide Zirconium Oxides Observed Using a Pulse CV Technique and including the Effect of High Temperature Annealing	Qifeng Lu, Chun Zhao, Yifei Mu, Ce Zhou Zhao, Stephen Taylor and Paul R. Chalker	Materials	2015
(6)	SCI	Dielectric relaxation of high-k oxides	Chun Zhao, Ce Zhou Zhao, Matthew Werner, Steve Taylor and Paul Chalker	Nanoscale Research Letters	2013
(7)	SCI	Dielectric Relaxation in Lanthanide Doped/Based Oxides Used for High-k Layers	Ce Zhou Zhao, Stephen Taylor, Chun Zhao, and Paul R. Chalker	Advanced Materials Research	2014
(8)	EI	Radiation Response Analyzer of Semiconductor Dies	Mu Yifei, Zhao Cezhou, Su Shengmao, Zhao Yue, Ivona Mitrovic, Stephen Taylor and Paul Chalker	IEEE 20th International Symposium on the Physical and Failure Analysis of Integrated Circuits	2013.7
(9)	EI	IMPACT OF CERIUM OXIDE'S GRAIN SIZE FOR DIELECTRIC RELAXATION	Chun Zhao, Ce Zhou Zhao, Matthew Werner, Steve Taylor, Paul Chalker and Peter King	IEEE 20th International Symposium on the Physical and Failure Analysis of Integrated Circuits	2013.7
(10)	EI	Radiation response of high-k oxides based on an on-site and real-time measurement	Ce Zhou Zhao, Yifei Mu, Stephen Taylor, and Paul R. Chalker	THE 3rd INTERNATIONAL CONFERENCE ON THE ADVANCEMENT OF MATERIALS AND NANOTECHNOLOGY	2013.11
(11)	EI	Radiation Tolerant DC Characteristics of InAs/GaAs Quantum-Dot Diodes	Yifei Mu, Sang Lam, Cezhou Zhao, N. Babazadeh, Richard A. Hogg, K. Nishi, K. Takemasa, and M Sugawara	IEEE 11th Conference on Electron Devices and Solid-State Circuits	2015.6.1-2015.6.4
(12)	EI	A Semi-Automated Real-Time Gamma Radiation Response Measurement System for Semiconductor Device Characterisation	Yifei Mu, Yanfei Qi, Sang Lam, and Cezhou Zhao	IEEE 12th International Conference on Electronic Measurement & Instruments	2015.7.16-2015.7.19

Project 6: Transfer Efficiency Improvement with GaN HEMT for the Wireless Power Transmission System

| Wen Liu

Programme category: The Natural Science Foundation of the Jiangsu Higher Education Institutions of China - General Programme

Introduction: For the wireless charging technology of electric vehicles, a circuit system based on the third generation wide band gap semiconductor material Gallium Nitride (GaN) power electronic device was proposed, and the influence of device parameters and different circuit topologies on electromagnetic resonant wireless charging efficiency was researched and expounded. The high switching speed and high breakdown voltage of GaN devices were used to improve the power transmission efficiency, and a wireless charging prototype with an output power of 1kW was realized. The highest efficiency of the whole machine was over 85%, and the wireless charging distance was over 15cm.

The main contents of the project include: 1. The transmission efficiency and physical size problems of electromagnetic resonant wireless charging circuit were solved through GaN devices. Compared with traditional silicon devices, GaN devices have higher withstand voltage, faster switching speed and higher working frequency. 2. A suitable electromagnetic resonant coil is designed for magnetic resonance. The influence of various parameters including winding mode on resonant frequency was researched and determined; self-inductance, equivalent coil resistance, radiation resistance and other factors were researched quantitatively, and the effects of magnetic shielding devices were compared. 3. The prototype of wireless charging system for electric vehicles was realized, and the influence of different loads on charging efficiency was researched.

Keywords: GaN, WPT, Wireless Charging

Key issues solved:

1. Practical research contents and key technologies

The application of GaN devices to improve the transmission efficiency of wireless power was researched in this project. For wireless charging technology for electric vehicles, a circuit system based on the third generation wide band gap semiconductor material Gallium Nitride (GaN) power electronic device was proposed, and the system model was realized initially, the effects of various device parameters and circuit topology on the transmission efficiency/output power of wireless charging system for electromagnetic resonance electric vehicle were studied and clarified, and the high switching speed of GaN devices was used to improve the power transmission efficiency. Through theoretical analysis, modeling calculation and simulation, the hardware design of the whole system including power transmitter and receiver was completed, of which, the changing relationship between transmission efficiency, maximum output power and transmission distance, resonant frequency, load and other parameters were studied through MATLAB and Saber simulation. It was found that the quality factor was positively correlated with the transmission efficiency, but increasing the quality factor will increase the capacitance stress and limit the power output of the system; and the stress of each element could be reduced by increasing the coupling coefficient of the coil.

The main contents of the project include:

i. The transmission efficiency and physical size problems of electromagnetic resonant wireless charging circuit were solved through GaN devices. Compared with traditional silicon devices, GaN devices have higher withstand voltage, faster switching speed and higher working frequency.

ii. A suitable electromagnetic resonant coil was designed for magnetic resonance. Various parameters, including the influence of winding mode on resonant frequency, was researched and determined, and self-inductance, equivalent coil resistance, coupling coefficient and other factors were researched quantitatively.

iii. The wireless charging system was initiallyrealized, and the influence of different loads on charging efficiency was researched, including the stability of the system under load disturbance, jumping and other situations.

2. Project innovation

Through theoretical analysis, calculation and circuit simulation, the hardware design of the whole system including power transmitter and receiver was completed. The circuit parameters were commissioned foroptimal transmission efficiency, and the

electromagnetic resonance circuit coil design was researched and achieved. For system hardware boards:

i. Isolated MOSFET driving circuit was designed.
ii. Device and line layout was optimized to reduce loss and signal attenuation and increase system stability.
iii. The loss caused by the driving circuit was reduced by integrating the driving circuit.

Finally, the control relationship between transmission efficiency and various parameters and the influence of different resonant compensation topologies on transmission efficiency were researched.

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no.	Inventor(s)
(1)	发明	申请	无线充电控制系统及装置	CN202010272734.0	王翰清，刘雯，朱永生，赵策洲
(2)	发明	申请	一种降低宽禁带半导体器件接触欧姆电阻的方法	CN201710527475.X	孙瑞泽，梁永齐，赵策洲，蔡宇韬

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI	High Efficiency WPT System for Electric Vehicles with LCL-S and SS compensation	Yuan Li, Yuhao Zhu, Wen Liu, Yongsheng Zhu, Yi Pei, Huiqing Wen, Cezhou Zhao,	IFEEC	2020 年 02 月 27 日
(2)	EI	A full GaN-Integrated Sawtooth Generator based on Enhancement-mode AlGaN/GaN MIS-HEMT for GaN Power Converters	Xueteng Li, Miao Cui, Wen Liu	ICICDT	2019 年 08 月 08 日
(3)	SCI	Monolithic GaN Half-Bridge Stages With Integrated Gate Drivers for High Temperature DC-DC Buck Converters	MIAO CUI, RUIZE SUN, QINGLEI BU, WEN LIU, HUIQING WEN, ANG LI, YUNG C. LIANG, CEZHOU ZHAO	IEEE Access	2019 年 08 月 08 日
(4)	EI	The Impact of AlGaN Barrier on Transient VTH Shifts and VTH Hysteresis in Depletion and Enhancement mode AlGaN/GaN MIS-HEMTs	Bohan Lu, Miao Cui, Wen Liu	ICICDT	2019 年 12 月 09 日

Project 7: Nonlinear Compensation Techniques for Micro-Positioning Stage Driven by Piezoelectric Actuators

| Min Chen

Programme category: The Natural Science Foundation of the Jiangsu Higher Education Institutions of China - General Programme

Introduction: Precision fretting platform has important applications in microelectronics engineering, optical precision engineering, high-precision manufacturing system, nano-science and technology and other fields. Actuator and transmission mechanism are the two important factors that determine the accuracy of fretting platform. For the current research, few coupling considers the compensation between the nonlinearity of fretting platform structure and the nonlinearity of piezoelectric driving materials. To improve the positioning and transmission accuracy of precision fretting platform and the reliability of compliant mechanism, finite element method was applied in this project to optimize the flexible hinge structure of micro platform so as to weaken the piezoelectric hysteresis nonlinearity. Stability analysis was conducted to the flexible hinge to ensure the fatigue reliability of the structure in order to obtain a longer service life. Finally, it was further verified by experiments. The optimized platform structure was obtained through research, and displacement output was implemented more accurately.

Key issues solved:

1) Nonlinear compensation modeling of piezoelectric intelligent thin-walled structure

To provide a more accurate model for the design and application of piezoelectric smart structures, based on the assumption of first-order shear deformation and the consideration of the nonlinear constitutive relation of piezoelectric materials and various geometric nonlinear theories (including von Kármán nonlinearity, medium rotation angle nonlinearity and large rotation angle nonlinearity), the geometrically nonlinear finite element model of piezoelectric smart thin-walled structure under strong actuating voltage was established, and the correctness and accuracy of the model were verified by the experimental data in the literature.

2) Lower limit analysis of stability of flexible hinge:

Relying on the finite element method and mathematical programming, a stability lower limit numerical analysis model was established for flexible hinge structure to solve stability load so as to ensure that the structure is in fatigue safety area. According to the limit and shakedown theorem, the limit and shakedown analysis was finally reduced to a mathematical programming for solving the maximum (lower limit of shakedown) and minimum (upper limit of shakedown) values. For shakedown analysis, before the development of large-scale optimization algorithms and software, the key was to construct a suitable residual stress field and deal with nonlinear yield conditions. The residual stress field was established by using stress function method and finite element method, and the 8-node non-conforming element was adopted in order to meet the accuracy and reduce the scale of mathematical programming.

3) Fatigue reliability optimization design of piezoelectric fretting platform

In the optimization design of the platform, the mathematical formula of flexible hinge width b and the mathematical formula of fretting platform thickness d were taken as optimization parameters, and the mathematical formula of maximum von Mises equivalent stress σ_{eqv} was taken as the goal. With the typical piezoelectric fretting platform as the research object, the static and dynamic models were established, and then the fatigue reliability was calculated based on the stress-strength model. When the life of models was 5×10^6, the reliability could be up to 99.9999%. Considering the interaction between platform and flexible hinge, response surface methodology was used to optimize multi-scale parameters.

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	基于曲线柔性单元的晶格结构柔性铰链	CN201810020947.7	ZL201810020947.7	陈敏，温欣，张顺琦，王翔

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Modeling techniques for active shape and vibration control of macro-fiber composite laminated structures.	Zhang SQ, Chen M, Zhao G Z, et al	Smart Structures & Systems	2017

Project 8: Spectroscopy Study of Two-Dimensional Electron Gas in AlInN/GaN Heterojunction

| **Changcheng Zheng**

Introduction:

The research object of this project was lattice-matched AlInN/AlN/GaN heterojunction. This project focused on the basic spectroscopic properties of AlInN/AlN/GaN heterojunction, including:

1. By measuring and analyzing the photoluminescence spectrum and time-resolved spectrum of AlInN/AlN/GaN heterojunction at low temperature and variable temperature and comparing with the spectrum results of GaN, the luminescence characteristics related to two-dimensional electron gas were researched, including two-dimensional electron gas and hole recombination mechanism, photo-generated carrier migration between GaN and two-dimensional electron gas, influence of two-dimensional electron gas on exciton radiation recombination process in GaN, exciton formation and recombination dynamics, electron/exciton-phonon interaction mechanism and other physical processes. Moreover, the evolution of Photoluminescence Spectroscopy of gallium nitride with temperature is a relatively complex process. At low temperature, the emission spectral lines of gallium nitride in exciton region were the bound exciton emission peaks and phonon sidebands. With the increase of temperature, the bound exciton will gradually break away from the binding center and become a free exciton, which will enhance the luminescence related to the free exciton. The emission peak of the bound exciton and its phonon sidebands gradually disappear, and the phonon sidebands of the free exciton gradually increases. With the further increase of temperature, the contribution of phonon becomes more obvious. The evolution of these emission peaks with temperature is very important to determine their physical mechanism. Through time-resolved Photoluminescence Spectroscopy measurement, the characteristic time information of exciton energy levels, their phonon sidebands and the generation and recombination process of two-dimensional electron gas and holes could be obtained, along with the rising speed, falling speed and mechanism of each energy level (single exponential process, double exponential process or other complex processes). These information obtained from time-resolved spectra was helpful to further research the recombination mechanism and dynamic process of excitons in two-dimensional electron gas and gallium nitride as well as the exciton-phonon interaction mechanism.

2. By measuring, comparing and analyzing the Raman spectra of AlInN/GaN heterojunction and GaN materials at room temperature and variable temperature, the phonon vibration modes of each component in AlInN/GaN heterojunction and their evolution with temperature were researched. Because the coefficient of thermal expansion of AlInN and GaN (as well as the coefficient of thermal expansion of sapphire) are different, the temperature change may be of great significance in the related applications of AlInN/GaN heterojunction and similar materials.

Research achievements:

1） Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Band-gap engineering of porous BiVO4 nanoshuttles by Fe and Mo co-doping for efficient photocatalytic water oxidation	Liu, R., Ren, J., Zhao, D., Ning, J., Zhang, Z., Wang, Y., Zhong, Y., Zheng, C., & Hu, Y.	Inorganic Chemistry Frontiers	2017.10

(2)	SCI	Development of Modulation p- Doped 1310 nm InAs/GaAs Quantum Dot Laser Materials and Ultrashort Cavity Fabry-Perot and Distributed-Feedback Laser Diodes	Qizhu Li, Xu Wang, Ziyang Zhang, Hongmei Chen, Yuanqing Huang, Chuncai Hou, Jie Wang, Ruiying Zhang, Jiqiang Ning, Jiahua Min, and Changcheng Zheng	ACS Photonics	2017.12
(3)	SCI	Electrospinning preparation of Sn4+-doped BiFe03 nanofibers as efficient visible-light-driven photocatalyst for 02 evolution	Jiabin Ren, Dian Zhao, Huanhuan Liu, Yijun Zhong, Jiqiang Ning, Ziyang Zhang, Changcheng Zheng, Yong Hu	Journal of Alloys and Compounds	2018.6

3. Municipal Projects

Project 1: Au-Free Ohmic Contact and CMOS Thin Film Technology for GaN HEMT Devices

| Wen Liu

Technical fields: Advanced Manufacturing and Automation - Micro-Fabrication System Technology

Programme category: Suzhou Science and Technology Development Planning Programme - Key Industrial Technology Innovation - Prospective Applied Basic Research Project

Introduction: The operating principle of GaN high electron mobility transistor (GaN HEMT) is based on the built-in polarization electric field generated by the piezoelectric effect and the spontaneous polarization effect of AlGaN/GaN heterojunction, the high concentration two-dimensional electron gas is generated at the AlGaN/GaN interface to form a conductive channel. The most common way to realize enhanced gallium nitride HEMT is to use the groove enhanced structure, which is formed by etching the gate region to thin the AlGaN barrier layer above the two-dimensional electron gas. However, the threshold voltage realized by this method is too low (generally, it is less than 1V). Thus, it is necessary to increase the dielectric layer in order to increase the threshold voltage. Selection of dielectric layer is also very important. For example, there is a high density interface state at the interface between dielectric layer and AlGaN barrier layer, and the on-resistance is large, which will increase the threshold instability of the device and have a great impact on the switching efficiency of the device.

Gallium nitride semiconductor material has the advantages of wide band gap and high voltage withstand ability, which has aroused great interest of researchers and can be widely used in electronic devices with high temperature, frequency and power. At room temperature, with its 3.4Ev band gap, strong interatomic binding force, stable chemical properties, large critical breakdown electric field, high saturated electron mobility and satisfying temperature resistance, it is widely used as a high-frequency and high-power device.

Keywords: Metal-Free Process, Growth of Insulating Film, CMOS Process, Ohmic Contact, GaN

Key issues solved:

1. Development of GaN metal-free process; Au pollution during CMOS process could be controlled by metal-free preocess. Titanium nitride is a commonly used metallized interconnection material in CMOS process because it has better electrical conductivity, chemical stability, high hardness and high temperature characteristics, and after the rapid annealing at high temperature, it can keep metal edges flat and ensure the reliability of HV devices. To realize the CMOS compatible process in GaN device fabrication, the metal-free ohmic contact process was researched in this project. Titanium nitride (TiN) was used as the protective layer of ohmic contact instead of metal, and the conventional metal system containing Au was removed toreduce the on-resistance of the device, successfully keeping the on-resistance within 150 milliohms.

2. Preparation technology of high quality insulated gate; advanced passivation gate dielectric was used to reduce interface state; the mature LPCVD insulating film growth technology in CMOS was adopted, and the film quality was improved by optimizing the growth conditions of gate dielectric and the treatment methods before gate dielectric growth. Through further improving the interface state of semiconductor/dielectric layer, manufacturing fabricate high-quality insulated gate dielectric, and reducing gate leakage current and frequency scattering, a gate voltage level of 650V was achieved so that the device can be applied to conversion circuits with higher voltage and higher power.

Research achievements:

1) Patents

No.	Category	Status	Patents Title	Application no.	Inventor(s)
(1)	发明	实审	一种降低宽禁带半导体器件欧姆接触电阻的方法	CN201710527475.X,	孙瑞泽，梁永齐，赵策洲，蔡宇韬
(2)	发明	实审	一种电动汽车的无线充电系统	CN201810545996.2	沈棕杰，刘雯，朱永生 赵春，赵梓伊，赵策洲
(3)	发明	实审	金属氧化物薄膜晶体管及其制备方法	CN201811589966.8	刘启晗，赵春，赵策洲，杨莉，王琦男

2) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Monolithic Integration Design of GaN-based Power Chip Including Gate Driver for High-Temperature DC-DC Converters	Miao Cui, Qinglei Bu, Yutao Cai, Wen Liu, Huiqing Wen, Cezhou Zhao	Japanese Journal of Applied Physics.	2019
(2)	SCI	Effect of Surface Treatment on Electrical Properties of GaN Metal Insulator-Semiconductor Devices with Al2O3 Gate Dielectric	Yutao Cai, Wen Liu, Miao Cui, Ruize Sun, Yung. C Liang, Huiqing Wen, Li Yang, Siti Supardan, Ivona Z. Mitrovic, Stephen Taylor, Paul R. Chalker and Cezhou Zhao*,	Japanese Journal of Applied Physics,	12 March 2020, Vol 59,No,4
(3)	EI	Evaluations and Applications of GaN HEMTs for Power Electronics,	Huiqing Wen; Wen Liu; Cezhou Zhao	Proc. 14th IEEE ICSICT	2018.10.31-11.03
(4)	EI	Characterization of Transient Threshold Voltage Shifts in Enhancement- and Depletion-mode AlGaN/GaN Metal-Insulator-Semiconduct or (MIS)-HEMTs	Miao Cui; Yutao Cai; Sang Lam; Wen Liu et al	Proc. 2018 IEEE International Conference on Electron Devices and Solid State Circuits (EDSSC)	2018.6.6-2018.6.8
(5)	EI	A full GaN-Integrated Sawtooth Generator based on Enhancement-mode AlGaN/GaN MIS-HEMT for GaN Power Converters	Xueteng Li, Miao Cui, and Wen Liu	the 17th IEEE international conference on IC design and technology (ICICDT), Suzhou, China.	2019
(6)	EI	The impact of AlGaN barrier on transient VTH shifts and VTH hysteresis in depletion and enhancement mode AlGaN/GaN MIS-HEMTs	Bohan.Lu, Miao Cui, and Wen Liu*.	the 17th IEEE International Conference on IC Design and Technology (ICICDT), Suzhou, China, Jun,17-19,	Jun. 17-19, 2019.

Project 2: Multi-Domain Collective Classification Based on Deep Neural Networks

| Kaizhu Huang

Technical fields: Electronic Information - Other

Programme category: Suzhou Science and Technology Development Planning Programme - Key Industrial Technology Innovation - Prospective Applied Basic Research Project

Introduction: This project attempted to use the multi-domain overall pattern recognition method of deep learning to carry out overall collaborative processing and recognition of data for domain problems. Compared with traditional methods, our research did not classify and identify a single sample independently, but processed a group of samples with the same characteristics as a whole and classified them simultaneously. For this project, we took full account of the complementary characteristics between domains as well as the links between data within domains. Effective use of this information can be expected to greatly improve the performance of pattern classification. This technology can be applied to many practical scenes with overall data characteristics, such as character recognition, multi-pose face recognition, multi-accent speech recognition and other important applications.

During the implementation of the project, we achieved the goal of the project well. Specifically, we used two different deep learning networks to learn the overall features and classification features of data, and then combined the two networks effectively, and proposed an efficient and high-precision training and optimization method. The depth network could effectively utilize the overall characteristics of data and greatly improved the performance of pattern recognition. In addition, we also did research on the application of other global recognition methods in various pattern classification. Excellent results have been achieved during the implementation of the project. In the multi-pose face recognition standard database and multi-accent recognition standard database, the recognition effect has reached the best effect on this data set at present, of which, the test result of multi-pose face database was 100% (90% of the intended target), and the recognition rate of multi-accent recognition standard database was 81.36% (80% of the intended target). We have published 11 international papers (4 for the intended target), including 5 SCI index papers (2 for the intended target) and 6 EI index papers (2 for the intended target), and actually applied for 2 papers (2 for the intended target). In addition, we won the Best Candidate Paper Award at the 2017 International Conference on Neural Information Processing and the Best Student Paper Award at the 2018 International Conference on Brain-inspired Cognitive Systems.

Keywords: Deep Learning, Integral Recognition, Artificial Intelligence

Key issues solved:

1. We proposed a new recognition framework, which used two deep neural networks to learn the global characteristics and category characteristics of data respectively and fused them effectively.
2. We proposed a new method inspired by deep learning, which combined style matrix and kernel method with a global framework of global support vector machine.
3. We proposed a method to transform style samples by using the generator of confrontation network to identify them.

Research achievements:

1) Patents

No.	Category	Status	Patents Title	Application no.	Inventor(s)
(1)	发明	审查	基于少量样本的风格字符生成方法	CN201810683657.0	黄开竹、江浩川、张锐等
(2)	发明	审查	基于互联网检索的中文文档识别方法	CN201811395481.5	王秋锋、黄开竹等

2） Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI	Improve Deep Learning with Unsupervised Objective	张舒飞、黄开竹、张锐、Amir Hussain	2017 International Conference on Neural Information Processing	2017
(2)	EI	Field Support Vector Regression	江浩川、黄开竹、张锐、Amir Hussain	2017 International Conference on Neural Information Processing	2017
(3)	EI	Deep Mixtures of Factor Analyzers with Common Loadings: A Novel Deep Generative Approach to Clustering	杨曦、黄开竹、张锐等	2017 International Conference on Neural Information Processing	2017
(4)	EI	Field Support Vector Machines	江浩川、黄开竹、张锐、Amir Hussain	IEEE TRANSACTIONS ON EMERGING TOPICS IN COMPUTATIONAL INTELLIGENCE	2017
(5)	EI	Style Neutralizati on Generative Adversarial Classifier	江浩川、黄开竹、张锐、Amir Hussain	2018 International Conference on Brain Inspired Cognitive Systems	2018
(6)	EI	A review on multi-task metric learning	杨沛沛、黄开竹、Amir Hussain	Big Data Analytics	2018
(7)	SCI	Special Issue Editorial: Cognitively-Inspired Computing for Knowledge Discovery	黄开竹、张锐、靳小波、Amir Hussain	Cognitive Computation	2018
(8)	SCI	Three- Dimensional Local Energy-Based Shape Histogram (3D-LESH): A Novel Feature Extraction Technique	Summrin a Wajid, Amir Hussain, 黄开竹	Expert Systems With Applications	2018
(9)	SCI	A new two- layer mixture of factor analyzers with joint factor loading model for the classificati on of small dataset problems	杨曦、黄开竹、张锐等	Neurocomputing	2018
(10)	SCI	Approximately optimizing NDCG using pair-wise loss	靳小波、黄开竹等	Information Sciences	2018
(11)	SCI	Guided Policy Search for Sequential Multitask Learning	熊方舟、黄开竹、刘智勇等	IEEE TRANSACTIONS ON CYBERNETICS: SYSTEMS	2018

3） Others

建立整体识别多姿态人脸标准数据库和整体识别多口音标准数据库

Project 3: Suzhou Municipal Key Laboratory of Cognitive Computation and Applied Technology

| Kaizhu Huang

Technical fields: Electronic Information – Other

Programme category: Suzhou Science and Technology Development Planning Programme – Technology Innovation Carrier Project – Key Discipline Laboratory

Introduction:

1. High performance intelligent computing

Research on the cognitive inspiration and understand massive information quickly and accurately; research on the cognitive heuristic strategies and intelligent computing algorithms; research on the approximation, parallelism, scalability and distribution of the algorithm; and design of a reusable research and development core algorithm platform.

2. Cognitive Machine Learning and Pattern Recognition

Research on the next generation machine learning method inspired by cognition, that is, multi-layer deep learning method from the perspectives of theory, structure, algorithm and application with focus on theories and applications in cross-domain, cross-media and overall recognition.

3. Massive multimedia information processing

Research on high-speed preservation, search, coding, extraction, matching and other key technologies; research on the application of deep learning and sparse representation in multimedia information; and research on the correlation technology among video, text, image and speech.

4. Typical new technology application research group

Research on integration technology and introduction of typical applications, such as mobile service system, distributed smart grid design, medical and health assistance system, individual life recommendation system and intelligent monitoring.

Research achievements:

1） Patents

No.	Category	Status	Patents Title	Application no.	Certificate no./ Authorisation no.	Inventor(s)
(1)	发明	审查	基于少量样本的风格字符生成方法	CN201810683657.0		黄开竹、江浩川、张锐等
(2)	发明	审查	基于互联网检索的中文文档识别方法	CN201811395481.5		王秋锋、黄开竹等
(3)	发明	审查	一种电动汽车的无线充电系统	CN201810545996.2		沈棕杰、刘雯等
(4)	发明	审查	微纳线制备装置及微纳结构	CN201910149242.X		方欲晓、赵春等
(5)	发明	审查	基于最小功率追踪算法的光伏子模块功率差额变换技术	CN201810844849.5		楚冠英、文辉清、叶召阳
(6)	发明	审查	一种基于直流功率变换的光伏组件老化检测装置及方法	CN201711473047.X		李星硕、文辉清
(7)	发明	授权	一种基于 β 参数的多峰值最大电功率跟踪控制方法	CN201710172473.3	ZL201710172473.3	李星硕、文辉清

(8)	发明	审查	一种基于改进角度势场法的无人船自主避障方法	CN201910514788.0		岳勇、朱晓辉等
(9)	发明	审查	融合分类和聚类的集成分类识别方法	CN201710123864.6		黄开竹、张锐、夏迎炬、候翠琴

2）Copyrights

No.	Status	Category	Title	Author(s)	Application no.	Certificate no.
(1)	授权	软著	火灾模拟与逃生路径寻优系统	张澄	2019SR0176801	软著登字第 3597558 号
(2)	授权	软著	VRSVT 三维几何体可视化软件	陈蕾	2019SR0177081	软著登字第 3597838 号
(3)	授权	软著	LASIK 手术助理系统	岳勇	2019SR0177448	软著登字第 3598205 号

3）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Three-stage electric vehicle scheduling considering stakeholders economic inconsistency and battery degradation	B. Han, S. Lu*, F. Xue, L. Jiang, and X. Xu	IET Cyber-Physical Systems: Theory & Applications	2017
(2)	SCI	Video Streaming Adaptation Strategy for Multiview Navigation over DASH	Chao Yao, Jimin Xiao, Yao Zhao, Anlong Ming,	IEEE Transactions on Broadcasting	2018
(3)	SCI	Visual aesthetic understanding: sample-specific aesthetic classification and deep belief map visualization	Chao Zhang, Ce Zhu, Xun Xu, Yipeng Liu, Jimin Xiao, Tammam Tillo	Signal Processing: Image Communications	2018
(4)	SCI	Siamese Network Ensemble for Visual Tracking	Chenru Jiang, Jimin Xiao, Yanchun Xie,Tammam Tillo, Kaizhu Huang	Neurocomputing	2018
(5)	SCI	Region-based multiple description coding for multiview video plus depth video,	Chunyu lin, Yao Zhao, Jimin Xiao, Tammam Tillo,	IEEE Transactions on Multimedia	2018
(6)	SCI	Zero-Shot Learning via Attribute Regression and Class Prototype Rectification	Changzhi Luo, Meng Wang, Kaizhu Huang, Jiashi Feng,	IEEE Transactions on Image Processing	2018
(7)	SCI	Mining Concise Patterns on Graph-Connected Itemsets	D. Zhang, Y.-Q. Zhang, Qiang Niu and X. B. Qiu	Neurocomputing	2019
(8)	SCI	Hierarchical Meta-learning in Time Series Forecasting for Improved Interference-less machine learning	David Afolabi, Sheng-Uei Guan, Ka Lok Man, Prudence W.H. Wong, Xuan Zhao	Symmetry	2017
(9)	SCI	Structural Evaluation for Distribution Networks with Distributed Generation Based on Complex Network	F. Xue, Y. Xu, H. Zhu, S. Lu, T. Huang, and J. Zhang	Complexity	2017
(10)	SCI	Interrelation of structure and operational states in cascading failure of overloading lines in power grids	F. Xue, E. Bompard, T. Huang, L. Jiang, S. Lu, and H. Zhu,	Physica A: Statistical Mechanics and its Applications,	2017
(11)	SCI	Guided Policy Search for Sequential Multi-Task Learning	Fanzhou Xiong, Biao Sun, Xu Yang, Kaizhu Huang, Hong Qiao, Amir Hussain, Zhi-Yong Liu	IEEE Transactions on Systems Man and Cybernetics-Systems	2018
(12)	SCI	Texture plus Depth Video Coding Using Camera Global Motion Information	Fei CHENG, Tammam TILLO, Jimin XIAO, Byeungwoo Jeon	IEEE Transactions on Multimedia	2017
(13)	SCI	Reducing and Stretching Deep Convolutional Activation Features for Accurate Image Classification	Guoqiang Zhong, Shoujun Yan, Kaizhu Huang, Junyu Dong	Cognitive Computation	2018
(14)	SCI	Bidirectional flyback based isolated-port submodule differential power processing optimizer for photovoltaic applications	Guanying Chu, Huiqing Wen, Lin Jiang, Yihua Hu, Xingshuo Li	Solar Energy	2017
(15)	SCI	Cooperative Bargaining Based Multiuser Bit Allocation for Dynamic Adaptive Streaming over HTTP	Hui Yuan, Xuekai Wei, Fuzheng Yang, Jimin Xiao, Sam Kwong	IEEE Transactions on Multimedia	2018
(16)	SCI	Reactive power Minimization in Bidirectional DC-DC converters Using A Unified-Phasor-Based Particles Swarm Optimization	Haochen Shi, Huiqing Wen, Yihua Hu, Lin Jiang	IEEE Transactions on Power Electronics	2018
(17)	SCI	Style Neutralization Generative Adversarial Classifier	Haochuan Jiang, Kaizhu Huang* and Rui Zhang, Amir Hussain	Cognitive Computation	2019
(18)	SCI	Personal Mobile devices at work: factors affecting the adoption of security mechanisms	H. N. Liang, C. Fleming, K. L. Man	Multimedia Tools and Applications	2019
(19)	SCI	Local rigidity of minimal surfaces in a hyperquadric Q2	Jie Fei, Jun Wang	Journal of Geometry and Physics	2018
(20)	SCI	Rigidity of minimal surfaces in a hyperquadric Q4	J Fei, J Wang	Differential Geometry and its Applications	2019
(21)	SCI	Minimal two-spheres with constant curvature in the quaternionic projective space	Jie Fei, Chiakuei Peng, Xiaowei Xu	Science China Mathematics	2018
(22)	SCI	Classification of homogeneous holomorphic two-spheres in complex Grassmann manifolds	J Fei	Differential Geometry and its Applications	2019
(23)	SCI	Detection and assessment of partial shading scenarios on photovoltaic strings	J. Ma, X. Pan, KL. Man, X. Li, H. Wen, TO. Ting	IEEE Transactions on Industry Applications	2018
(24)	SCI	Maximum Power Point Estimation for Photovoltaic Strings Subjected to Partial Shading Scenarios	J. Ma, H. Jiang, Z. Bi, K. Huang, X. Li, H. Wen	IEEE Transactions on Industry Applications	2018
(25)	SCI	Predicting Seminal Quality via Imbalanced Learning with Evolutionary Safe-Level Synthetic Minority Over-Sampling Technique	J. Ma, DO. Afolabi, J. Ren, A. Zhen	Cognitive Computation	2019
(26)	SCI	A Conformal Split-ring Loop as a Self-resonator for Wireless Power Transfer	J. Wang, M. P. Leach, E. G. Lim, Z. Wang, Z. Jiang, R. Pei, and Y. Huang	IEEE Access	2019
(27)	SCI	Investigation of magnetic resonance coupling circuit topologies for wireless power transmission	J. Wang, M. Leach, Z. Wang, E.G. Lim and Yi Huang	Microwave and Optical Technology Letters	2019
(28)	SCI	Banzhaf Random Forests: Cooperative Game Theory Based Random Forests with Consistency	Jianyu Sun, Guoqiang Zhong, Kaizhu Huang, and Junyu Dong	Neural Networks	2018
(29)	SCI	IAN: The Individual Aggregation Network for Person Search, Pattern Recognition	Jimin Xiao,Yanchun Xie, Tammam Tillo, Kaizhu Huang, Yunchao Wei, and Jiashi Feng	Pattern Recognition	
(30)	SCI	Speed Tracking Based Energy-Efficient Freight Train Control through Multi-Algorithms Combination	J. Yang, L. Jia, Y. Fu, and S. Lu	IEEE Intelligent Transportation Systems Magazine	2017

(31)	SCI	Introduction to the Special Issue on Cognitively-inspired Computing for Big Data Mining and Knowledge Discovery	Kaizhu Huang*, Rui Zhang, Xiaobo Jin, Amir Hussain	Cognitive Computation	2018
(32)	SCI	Large-scale location-aware services in access: Hierarchical building/floor classification and location estimation using Wi-Fi fingerprinting based on deep neural networks, (Extended version of the FOAN 2017 paper)	Kyeong Soo Kim, Ruihao Wang, Zhenghang Zhong, Zikun Tan, Haowei Song, Jaehoon Cha, and Sanghyuk Lee	Fiber and Integrated Optics	2018
(33)	SCI	Recent Advancements in Big Data Technologies and Applications in Computing, IoT and Computer Engineering Technology	Ka Lok Man, Ou Owen Liu, Danny Hughes, and Chao Lu	Journal of Universal Computer Science	2018
(34)	SCI	Emerging Approaches and Advances in Big Data	Ka Lok Man, and Kevin Lee	Symmetry	2019
(35)	SCI	Adaptive Incremental Genetic Algorithm for Task Scheduling in Cloud Environments	K. Duan, S. Fong, S. Siu, W. Song, S. S. Guan	Symmetry	2018
(36)	SCI	Convolutional Neural Network for Intermediate View Enhancement in Multiview Streaming	Li Yu, Tammam Tillo, Jimin Xiao, and Marco Grangetto	IEEE Transactions on Multimedia	2018
(37)	SCI	Advanced Internet of Things and Big Data Technology for Smart Human-Care Services,	M Kim, K L Man, and N Helil	Journal of Sensors	2019
(38)	SCI	Nipon Theera-Umpon, Simplified Neural Network Model Design with Sensitivity Analysis and Electricity Consumption Prediction in a Commercial Building	Moon Keun Kim, Jaehoon Cha, Eunmi Lee, Van Huy Pham, Sanghyuk Lee,	Energies 2019	2019
(39)	SCI	Open-Circuit Fault Diagnosis of Dual Active Bridge DC-DC Converter With Extended-Phase-Shift Control	M Zheng, H Wen, H Shi, Y Hu, Y Yang, and Y Wang	IEEE Access	2019
(40)	SCI	New reclosing scheme of distribution system for utilization of BESS using wavelet transform	PARK Keon-Woo, KIM Chul-Hwan, LEE Sang-Hyuk, RHEE Sang-Bong	J. Cent. South Univ	2018
(41)	SCI	A Survey on an Emerging Area: Deep Learning for Smart City Data	Qi Chen, Wei Wang, Fangyu Wu, Suparna De, Ruili Wang, Bailing Zhang, and Xin Huang	IEEE Transactions on Emerging Topics in Computational Intelligence	2019
(42)	SCI	Attention-based Recurrent Neural Network for Traffic Flow Prediction	Qi Chen, Wei Wang, Xin Huang, and Hai-ning Liang	Journal of Internet Technology	2019
(43)	SCI	Solving shifted linear systems with restarted GMRES augmented with error approximation	R.-R. Wang, Qiang Niu, X.-B Tang and X. Wang	Computers and Mathematics with Applications	2019
(44)	SCI	Three-Dimensional Local Energy-Based Shape Histogram (3D-LESH)-Based Feature Extraction-A Novel Technique	Summrina Kanwal Wajid*, Amir Hussain, and Kaizhu Huang*,	Expert Systems with Applications	2018
(45)	SCI	Multiobjective beampattern optimization in collaborative beamforming via NSGA-II with selective distance	S Jayaprakasam, SKA Rahim, CY Leow, TO Ting, and A.A. Eteng	IEEE Transactions on Antennas and Propagation	2017

(46)	SCI	Well-balanced central WENO schemes for the sediment transport model in shallow water	S. G. Qian, G. Li, F. J. Shao and Qiang Niu	Computational Geosciences	2018
(47)	SCI	Learning with memory networks from fewer samples	Shufei Zhang, Kaizhu Huang*, Rui Zhang, Amir Hussain	Cognitive Computation	2018
(48)	SCI	User-elicited dual-hand interactions for manipulating 3D objects in virtual reality environments	V Nanjappan, H N Liang, F Lu, K Papangelis, Y Yue, and K L Man	Human-centric Computing and Information Sciences	2018
(49)	SCI	Stochastic Conjugate Gradient Algorithm with Variance Reduction	Xiao-Bo Jin, Xu-Yao Zhang, Kaizhu Huang, and Guang-Gang Geng	IEEE Transactions on Neural Networks and Learning Systems	2018
(50)	SCI	Pair-wise Loss for Optimizing NDCG Approximately	Xiao-Bo Jin, Guang-Gang Geng, Guo-Sen Xie, and Kaizhu Huang*,	Information Sciences	2018
(51)	SCI	A Novel Deep Density Model for Unsupervised Learning	Xi Yang, Kaizhu Huang*, Rui Zhang, Yannis Goulermas,	Cognitive Computation	2018
(52)	SCI	A New Two-layer Mixture of Factor Analyzers with Joint Factor Loading Model for the Classification of Small Dataset Problems	Xi Yang, Kaizhu Huang*, Rui Zhang, Amir Hussain, Yannis Goulermas	Neurocomputing	2018
(53)	SCI	Introduction to the Special Issue of Advances in Graph Algorithm and Applications	Xu Yang, Zhi-Yong Liu, Kaizhu Huang, and Cheng-Lin Liu	Neurocomputing	2019
(54)	SCI	Cross-Modality Interactive Attention Network for Multispectral Pedestrian Detection	Xu Yang, Lu Zhang, Zhiyong Liu, Shifeng Zhang, Kaizhu Huang, Amir Hussain, and Hong Qiao	Information Fusion	2019
(55)	SCI	A novel beta parameter based fuzzy-logic controller for photovoltaic MPPT application	Xingshuo li, Huiqing Wen, Yihua Hu, Lin Jiang	Renewable energy	2019
(56)	SCI	A novel sensorless photovoltaic power reserve control with simple real-time MPP estimation	X Li, H Wen, Y Zhu, L Jiang, Y Hu, and W Xiao	IEEE Transactions on Power Electronics	2018
(57)	SCI	Forecasting Based Power Ramp-Rate Control Strategies For Utility-Scale PV Systems	Xiaoyang Chen, Yang Du, Huiqing Wen, Lin Jiang, and Weidong Xiao	IEEE Transactions on Industrial Electronics	2018
(58)	SCI	Modified Beta Algorithm for GMPPT and Partial Shading Detection in Photovoltaic Systems,	Xingshuo Li, Huiqing Wen, Yihua Hu, Lin Jiang, and Weidong Xiao	IEEE Transactions on Power Electronics	2018
(59)	SCI	Structural and Hierarchical Partitioning of Virtual Microgrids in Power Distribution Network	X. Xu, F. Xue, S. Lu, H. Zhu, L. Jiang, and B. Han	IEEE Systems Journal	2018
(60)	SCI	Optimized Sizing and Scheduling of Hybrid Energy Storage Systems for High-speed Railway Traction Substation	Yuanli Liu, Minwu Chen, Shaofeng Lu, Yinyu Chen, and Qunzhan Li	Energies	2018

(61)	SCI	Spatial Indexing for Data Searching in Mobile Sensing Environments	Yuchao Zhou, Suparna De, Wei Wang, Klaus Moessner, and Marimuthu S. Palaniswami	Sensors	2017
(62)	SCI	Harmonic Distortion Caused by Single-Phase Grid-Connected PV Inverter	Y. Du and D.D.C.Lu	Power System Harmonics: Analysis, Effects and Mitigation Solutions for Power Quality Improvement	2018
(63)	SCI	Designing Localized MPPT for PV Systems Using Fuzzy-Weighted Extreme Learning Machine	Y. Du, K. Yan, Z. Ren and W. Xiao	Energies	2018
(64)	SCI	Missing Data Estimation in Mobile Sensing Environments	Yuchao Zhou, Suparna De, Wei Wang, Ruili Wang, and Klaus Moessner	IEEE Access	2018
(65)	SCI	Fast Iterative Semi-Blind Receiver for URLLC in Short-Frame Full-Duplex Systems With CFO	Y .Liu, X Zhu,Y. Jiang, EG Lim, and Y Huang	IEEE Journal on Selected Areas in Communications	2019
(66)	SCI	Correlation Filter Selection for Visual Tracking Using Reinforcement Learning	Yanchun Xie, Jimin Xiao, Kaizhu Huang, Jeyarajan Thiyagalingam, and Yao Zhao	IEEE Transactions on Circuits and Systems for Video Technology	2019
(67)	SCI	Wideband Loop Antenna with Split Ring Resonators for Wireless Medical Telemetry	Z. Jiang, Z. Wang, M. Leach, Y. Huang, E. G. Lim, J. Wang, and R. Pei	IEEE Antennas and Wireless Propagation Letters	2019
(68)	SCI	Simplified Neural Network Model Design with Sensitivity Analysis and Electricity Consumption Prediction in a Commercial Building	Moon Keun Kim, Jaehoon Cha, Eunmi Lee, Van Huy Pham, Sanghyuk Lee, and Nipon Theera-Umpon	Energies	2019
(69)	SCI	New reclosing scheme of distribution system for utilization of BESS using wavelet transform	PARK Keon-Woo, KIM Chul-Hwan, LEE Sang-Hyuk, and RHEE Sang-Bong	J. Cent. South Univ	2018
(70)	SCI	Verifying Secure Authentication Protocol for Communication between IoT-based Medical Devices	Nipon Theera-Umpon, Kun-Hee Han, Woo-Sik Bae, and Sanghyuk Lee	Journal of Universal Computer Science	2018
(71)	SCI	Monolithic Integration Design of GaN-based Power Chip Including Gate Driver for High-Temperature DC-DC Converters	Miao Cui, Qinglei Bu, Yutao Cai, Ruize Sun, Wen Liu, Huiqing Wen, Sang Lam, Yung C. Liang, Ivona Z. Mitrovic, Stephen Taylor, Paul R. Chalker and Cezhou Zhao	Japanese Journal of Applied Physics	2019
(72)	SCI	Designing an Optimized Water Quality Monitoring Network with Reserved Monitoring Locations	Zhu, X., Yue, Y., Wong, P.W., Zhang, Y. and Ding, H.	Water	2019
(73)	SCI	Accuracy Control of Fiber Cable's Outer Diameter with Algorithms of Filtration	Zhu, X., Yue, Y., Hu, F., Shou, J., Zhang, J. and Cao, K.	Prediction and PID Controller. Arabian Journal for Science and Engineering	2019
(74)	SCI	Day-Ahead Electric Vehicle Aggregator Bidding Strategy using Stochastic Programming in an Uncertain Reserve Market	Bing Han, Shaofeng Lu*, Fei Xue and Lin Jiang	IET Generation, Transmission and Distribution	2019
(75)	SCI	Node Type Distribution and Its Impacts on Performance of Power Grids	Fei Xue, Shaofeng Lu, Ettore Bompard, Ciwei Gao, Lin Jiang and Xiaoliang Wang	IEEE Access	2019
(76)	SCI	Train Speed Trajectory Optimization With On-Board Energy Storage Device	C. Wu, W. Zhang, S. Lu*, Z. Tan, F. Xue, and J. Yang	IEEE Transactions on Intelligent Transportation Systems	2018
(77)	SCI	Adaptive Partial Train Speed Trajectory Optimization	Zhaoxiang Tan, Shaofeng Lu*, Kai Bao, Shaoning Zhang, Chaoxian Wu, Jie Yang and Fei Xue	Energies	2018

Project 4: Development of Technology for High-Performance GaN Power Electronic Devices Based on Si Substrate

| Cezhou Zhao

Programme category: Key Programme Special Fund (KSF) – Applied Technology Research Programme

Introduction: Currently, the development direction of GaN power electronic device application circuit is to form independent and complete functional modules directly facing the terminal application, including GaN power core devices, device drivers, protection circuits and peripheral passive devices. Highly integrated GaN power integration technology will achieve high performance, high working safety, high speed and high temperature endurance that traditional Si power chip technology cannot achieve. GaN power electronic devices can be fabricated on silicon substrates, thus heterogeneous integration has become the main research direction of GaN power integration technology. In 2009, MIT reported the fabrication of Si-GaN-Si chips by chip bonding and selective etching, which integrated Si MISFET and GaN HEMT. In the same year, W J Chen. et al reported GaN-on-Si switching mode Boost converter, and K Y Wong. et al realized monolithic integration of high-voltage power devices and peripheral low-voltage devices. Meanwhile, Hong Kong University of Science and Technology first reported the monolithic GaN Boost converter with power transistor and power rectifier, and developed the prototype of GaN intelligent power integration technology platform on this basis. Back then there were few reports on GaN application system in China, but in recent years, Beijing Jiaotong University has adopted GaN devices made by EPC Company to construct Boost converter based on coupled inductance, which was used in the front stage circuit of 500W micro inverter; and GaN-HEMT device made by Transphorm Company was also used to research the high frequency miniature inverter. However, there is still a big gap between the overall level of GaN device design, process manufacturing and application verification of actual samples and the international advanced technology. Thus, with the promotion and support of the government, this project gradually promoted the development of GaN technology in the way of production, education and research, and contributed to the development of GaN power devices in China.

The project was proceeded normally as planned under the organization of the director of the research group. The cooperative company was responsible for substrate materials and material technology, and Xi'an Jiaotong-Liverpool University was responsible for the preparation and testing of GaN power electronic devices. To ensure the safety of power electronic system and reduce the cost and complexity of the system, the research and development of devices focused on the enhanced (normally-turned off) power switching devices with positive threshold voltage in AlGaN/GaN/Si structure. The implementation of this project will accelerate the research and development and industrialization of GaN materials and related core devices, and greatly promote the development of Jiangsu Province in the next generation of consumer electronics, smart grid, electric vehicles and other industries, which is of immeasurable significance to the current and future industrial development of Jiangsu Province:

1. Break up the monopoly of foreign GaN device technology and realize "high-tech manufacturing" from Jiangsu, China. Fill the gaps in domestic GaN device design technology and process technology, realize the product technology route with independent intellectual property rights, and enhance the core competitiveness of GaN technology.

2. With GaN semiconductor devices as the traction, drivethe rapid development of the next generation consumer electronics, smart grid and electric vehicles. Promote Jiangsu to become a highland for the development of nitride semiconductor industry in China, lead the rapid development of the future industry, and lay a satisfying foundation for the future industrial development.

Key issues solved:

In this project, GaN/AlGaN surface treatment technology was used to increase the operating current of silicon-based gallium nitride triode devices and reduce drain & current leakage (1A and 10μA respectively). The on-resistance (6 Ωmm) was reduced through the CMOS compatible metal-free process of GaN devices; a large breakdown voltage (more than 800V) was implemented through PECVD dielectric passivation process and ALD gate oxide process; and the corrected threshold voltage (→1V) was achieved by multi-step groove gate preparation technology. Details of the key problems solved are as follows:

1.Development of GaN metal-free process

The purpose of metal-free process technology is to control Au pollution in CMOS process. Titanium nitride has better electrical conductivity, chemical stability, high hardness and high temperature characteristics, so after the rapid annealing at high temperature, it can keep metal edges flat and ensure the reliability of HV devices, and it is a commonly used metallized interconnection material in CMOS process. To realize the CMOS compatible process in GaN device fabrication, the metal-free ohmic contact process was researched in this project. Titanium nitride (TiN) was used as the protective layer of ohmic contact instead of metal, and the conventional metal system containing Au was removed;

2.Preparation technology of high quality insulated gate

Advanced passivation gate dielectric was used to reduce interface state; the mature LPCVD/PECVD insulating film growth technology in CMOS was adopted, and the film quality was improved by optimizing the growth conditions of gate dielectric and the treatment methods before gate dielectric growth. Higher voltage level was achieved through further improvement of the interface state of semiconductor/dielectric layer and manufacturing of fabricate high-quality insulated gate dielectric to reduce gate leakage current and frequency scattering.

3.Fabrication technology of groove gate

GaN devices with normal turn-off voltage Vth → 1~ 2V were fabricated by groove gate delamination technology.

Research achievements:

1) Patents

No.	Category	Status	Patents Title	Application no./Authorisation no.	Certificate no.	Inventor(s)
(1)	发明	一审	一种氮化镓表面的硫醇处理方法	CN201711170935.4		蔡宇韬,赵策洲等
(2)	发明	受理	一种基于自组装的石墨烯 - 硅复合电极材料及其制备方法	CN201711170924.6		刘晨光,赵策洲等
(3)	发明	受理	一种包裹型的硅负极材料及其制备方法	CN201711170946.2		赵胤超,赵策洲等
(4)	发明	一审	金属氧化物薄膜晶体管及其制备方法	CN201811589966.8		刘启含,赵策洲等
(5)	发明	一审	柔性衬底的薄膜晶体管及其制备方法	CN201811591079.4		刘启含,赵策洲等
(6)	发明	一审	一种等离子体增强型溶液燃烧法制备的薄膜晶体管	CN201920970572.0		刘启含,赵策洲等
(7)	发明	受理	基于镧氧化物的 RRAM 制备方法	CN201911049301.2		沈宗杰,赵策洲等
(8)	新型实用专利	授权	一种 CTM 存储器	CN201920491559.7	ZL201920491559.7	方欲晓,赵策洲等
(9)	发明	受理	基于纳米簇介电层的柔性纳米纤维氧化镓锡晶体管及其制备方法	CN201911299235.4		赵天石,赵策洲等
(10)	发明	受理	基于氧化锆和氧化镧的透明 TFT 器件及其制备方法	CN201911299226.5		赵天石,赵策洲等
(11)	发明	一审	一种掺杂金属氧化物的阻变式随机存取存储器	CN201920971159.6		沈宗杰,赵策洲等
(12)	新型实用专利	授权	一种用双氧水提高抗辐射性的薄膜晶体管器件	CN201920977069.8	ZL201920977069.8	方欲晓,赵策洲等
(13)	发明	提交申请	一种优化氮化镓高电子迁移率晶体管钝化的方法	CN201910836312.9		蔡宇韬,赵策洲等

[14]	发明	提交申请	一种实现低导通电阻的增强型氮化镓晶体管的方法	CN201910836167.4		蔡宇韬，赵策洲等
[15]	发明	提交申请	一种提升氮化镓晶体管击穿电压的方法	CN201910836553.3		蔡宇韬，赵策洲等
[16]	发明	提交申请	基于自燃烧法的双元高介电常数绝缘层的制备方法	CN201911299283.3		刘启含，赵策洲等
[17]	新型实用专利	授权	一种柔性纳米纤维氧化锌锡的场效应晶体管	CN201921399635.8	ZL201921399635.8	赵天石，赵策洲等

2） Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Effect of Surface Treatment on Electrical Properties of GaN Metal Insulator-Semiconductor Devices with Al2O3 Gate Dielectric	Y. Cai, ···C. Zhao	Japanese J. Applied Physics, vol. 59, no. 4, 041001	2020
(2)	SCI	Effect of High-k Passivation Layer on High Voltage Properties of GaN Metal-Insulator-Semiconductor Devices	Y. Cai, ···C. Zhao	IEEE Access, vol. 8, 2995906	2020
(3)	SCI	Monolithic integration design of GaN-based power chip including gate driver for high-temperature DC–DC converters	M. Cui, ···C. Zhao	Japanese J. Applied Physics, vol. 58, no. 5, 056505	2019
(4)	SCI	Monolithic GaN Half-Bridge Stages With Integrated Gate Drivers for High Temperature DC-DC Buck Converters	M. Cui, ···C. Zhao	IEEE Access, vol. 7, 2958059	2019
(5)	EI	"Characterization of Transient Threshold Voltage Shifts in Enhancement-and Depletion-mode AlGaN/GaN Metal-Insulator-Semiconductor (MIS)-HEMTs	M. Cui, ··· C. Zhao	The 14th IEEE International Conference on Electron Devices and Solid-State Circuits	June 6-8, 2018
(6)	EI	Evaluations of GaN-on-Si devices for Power Electronics Applications	Huiqing Wen, Wen Liu, Cezhou Zhao	14th IEEE International Conference on Solid State and Integrated Circuit Technology	Oct. 2018
(7)	EI	The Impact of Etch Depth of D-mode AlGaN/GaN MIS-HEMTs on DC and AC Characteristics of 10 V Input Direct-Coupled FET Logic (DCFL) Inverters	M. Cui, ···C. Zhao	17th IEEE International Conference on IC Design and Technology (ICICDT)	July, 2019
(8)	EI	AlGaN/GaN Metal-Insulator-Semiconductor (MIS)-HFETs Based DC-DC Boost Converters with Integrated Gate Drivers	M. Cui, ···C. Zhao	10th International Conference on Power Electronics and ECCE Asia	2019
(9)	EI	Effect of High-k Passivation Layer on Electrical Properties of GaN Metal-Insulator-Semiconductor Devices	Y. Cai, ···C. Zhao	17th IEEE International Conference on IC Design and Technology (ICICDT)	July, 2019
(10)	SCI	Comproportionation Reaction Synthesis to Realize High-Performance Water-Induced Metal-Oxide Thin-Film Transistors	Q. Liu,···C. Zhao	Advanced Electronic Materials	April, 2020
(11)	SCI	Enhancement on the Performance of Eco-friendly Solution Processed InO/AlO Thin-film Transistors via Lithium Incorporation	T. Zhao,···C. Zhao	Journal of Alloys and Compounds	March 2020

New Energy Technology

New Energy Technology is an essential basis for measuring the level of high-tech development of a country or region, and also a strategic high point of the new round of international competition. New energy technology is becoming a dynamic and most promising strategic field. By the end of 2020, XJTLU had successfully completed 13 governmental research projects at all levels in the field of New Energy Technology, including 3 national projects, 5 provincial projects and 5 municipal projects. XJTLU has established the Suzhou Municipal Key Lab of New Energy Techniques. XJTLU's representative team participated in the Solar Decathlon China in 2021 and successfully made it to the finals.

1.National Projects

Project 1: Research on Power Optimization Method for Distributed Photovoltaic Systems Based on Field-Support Vector Regression

| Jieming Ma

Application code: F0214 (Department of Information Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - Young Scientists Fund

Technical fields: Photovoltaic Power Generation, Algorithm Performance Optimization

Introduction: Improving the energy-saving efficiency of photovoltaic system in complex environment has always been a research hotspot and difficulty in photovoltaic application field. Most of the existing power optimization methods are based on sampled data for maximum power point tracking control, but they often ignore the 'style' difference of output characteristics and mix data information, which cannot achieve ideal power control effect. On the basis of analyzing the environmental characteristics of distributed photovoltaic system, in this project, the following research was carried out around power optimization:

1. Analyzed the system output characteristics in shadow environment quantitatively, and researched the nonlinear style normalization transformation method so that 'multi-style' characteristic data was transformed into 'single style' data satisfying independent and identical distribution;
2. Sought a data learning method for 'new style' data, and build a power optimization model based on style-support vector regression framework to predict the maximum power point accurately;
3. Established the model algorithm control mechanism and constructed environment adaptive photovoltaic controller to realize real-time and efficient system power optimization.

By researching the electrical characteristics of photovoltaic system under shadow occlusion, the project team defined the environmental quantitative analysis parameters for distributed photovoltaic system, researched the local shadow detection method and found that the environmental parameters can be evaluated accurately through the electrical characteristics of photovoltaic system. According to the different 'style' curves of photovoltaic power curves under different shading conditions, a nonlinear style normalization transformation method was established, and the maximum power point position can be accurately predicted by de-style processing. Simulation experiments and hardware experiments have verified that the maximum power point tracking method guided by the model can effectively improve the output power of photovoltaic system. The research method can be applied to the design of photovoltaic controller, and has a satisfying application prospect.

Keywords: Distributed Photovoltaic System, Shadow Occlusion, Support Vector Machine, Data Style, Power Optimization

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	实用新型专利	授权	一种串联型光伏电板遮挡自动检测系统	CN201821753690.8	ZL201821753690.8	马洁明
(2)	发明	实审	一种特性失配光伏组串的功率峰数测量方法	CN202010363393.8		马洁明
(3)	发明	实审	一种光伏串联的阴影遮挡检测方法、装置和设备	CN202010010649.7		马洁明
(4)	发明	实审	一种串联型光伏电板遮挡自动检测系统及方法	CN201811264554.7		马洁明
(5)	发明	实审	光伏串列阴影信息检测方法、最大功率点追踪方法及系统	CN202010321887.X		马洁明

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	Detection and Assessment of Partial Shading Scenarios on Photovoltaic Strings	J. Ma, X. Pan, K.L. Man, X. Li, H. Wen, T.O. Ting	IEEE Transactions on Industry Applications	2018/04/30
(2)	SCIE	Maximum Power Point Estimation for Photovoltaic Strings Subjected to Partial Shading Scenarios	J. Ma, H. Jiang, Z. Bi, K. Huang, X. Li and H. Wen	IEEE Transactions on Industry Applications	2018/06/21
(3)	SCIE	Maximum Power Point Estimation for Photovoltaic Strings Subjected to Partial Shading Scenarios	Z. Bi, J. Ma, K.L. Man, J.S. Smith, Y. Yue and H. Wen	IEEE Transactions on Industry Applications	2018/08/05
(4)	SCIE	An Enhanced 0.8Voc-model-based Global Maximum Power Point Tracking Method for Photovoltaic Systems	Z. Bi, J. Ma, K. Wang, K.L. Man, Y. Yue and J.S. Smith	IEEE Access	2018/09/18
(5)	SCIE	Identification of Partial Shading Conditions for Photovoltaic Strings	Q. Ren, K.L. Man, M. Li, B. Gao, and J. Ma	International Journal of Distributed Sensor Networks	2018/12/17
(6)	EI	Intelligent design and implementation of blockchain and Internet of things-based traffic system	J Ma, Z Bi, KL Man, H Dai, Z Wu	2018 7th International Conference on Renewable Energy Research and Applications (ICRERA)	2019/01/03
(7)	EI	Identification of Partial Shading in Photovoltaic Arrays Using Optimal Sensor Placement Schemes	J. Ma, Z. Bi, K.L. Man, J.S. Smith and Y. Yue	2018 International SoC Design Conference (ISOCC)	2019/03/17
(8)	EI	Automatic shading detection system for photovoltaic strings	Z. Bi, J. Ma, K. L. Man, J. S. Smith, Y. Yue and H. Wen	ChemPhysChem2019 IEEE International Conference on Environment and Electrical Engineering and 2019 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe)	2019/06/26
(9)	EI	Global MPPT Method for Photovoltaic Systems Operating under Partial Shading Conditions using the 0.8VOC Model	J. Ma, Z. Bi, K. L. Man, H. Liang and J. S. Smith	2019 IEEE International Conference on Environment and Electrical Engineering and 2019 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe)	2016/06/13
(10)	EI	Predicting the Global Maximum Power Point Locus using Shading Information	J. Ma, Z. Bi, K. L. Man, Y. Yue and J. S. Smith	2019 International SoC Design Conference (ISOCC)	2019/06/25
(11)	EI	A Novel Global Maximum Power Point Tracking Method based on Shading Detection	J. Ma, K. Wang, K. L. Man, H-N. Liang, X. Pan	2020 IEEE International Conference on Environment and Electrical Engineering and 2019 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe)	2020/04/09

No.	Category		Patents Title	Application no.	Authorisation no.	Inventor(s)
(12)	EI		An Analytical Model for a Photovoltaic Module Under Partial Shading Conditions	K. Wang, D. Hong, J. Ma, K. L. Man, K. Huang and X. Huang	2020 IEEE International Conference on Industrial Informatics	2020/08/20
(13)	EI		Maximum Power Point Tracking of Photovoltaic Systems Using Deep Q-networks	Z. Bi, J. Ma, K.L. Man, Y. Yue and J.S. Smith	2020 International SoC Design Conference (ISOCC)	2020/08/13

Project 2: Investigation into Graphene Enabled Three-Dimensional Lithium-Sulfur Batteries for Enhanced Power and Capacity

| Li Yang

Application code: B020405 (Department of Chemical Sciences)

Technical fields: New Energy Technology, Energy Storage Devices

Programme category: National Natural Science Foundation of China (NSFC) – International Young Scientists Programme

Introduction: As an attractive substitute for the lithium ion batteries, lithium-sulfur (Li-S) batteries have been widely investigated for the past decades, because the theoretical energy densities are almost an order of magnitude greater than the state-of-the-art Li-ion battery, 3 times greater than the conventional batteries. However, the development of lithium-sulfur batteries is being hampered by lack of understanding of the complexity of the sulfur-cathode during reduction and oxidation. Also lithium-sulfur batteries suffer from the issue of high internal resistance due to fact that sulfur is an electrical insulator resulting in poor performance.

In this project, high quality graphene substrates were successfully prepared and key parameters were established. The resulting as-prepared graphene composite with sulfur to fabricate the sulfur cathode with graphene conductive network was used for Li-S batteries. Understanding the mechanism of the lithiation/deliathiation process, the electrochemical and chemical processes occurring during charge and discharge of the cathode and anode, and the specific capacity and cycling stability performance have been investigated.

Keywords: Lithium Ion Battery, Sulfur Loading, Graphene Foam, Free Standing, Enhanced Capability

Key issues solved:

1. A light-weight and free-standing graphene foam (GF) interlayer placed between sulfur cathode and separator was developed to improve the electrochemical performance of lithium-sulfur batteries. The results show excellent stability and reversibility of the Li-S cell with the GF/GF@ZnO interlayer.
2. The cyclic voltammetry (CV), and electrochemical impedance spectroscopy (EIS) were used to study the electrode during the reaction. The specific capacity and cycling stability performance were measured by battery testing system. The relationship between the morphology, electrochemical reactions, and sulfur loading with Li-S batteries performance were evaluated systematically.

Research achievements:

1) Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	The preparation of a branch-like nitrogen doped graphene nano-tube and its application as cathode material in Li-S battery.	CN201711170934.X	ZL201711170934.X	Li Yang
(2)	发明	授权	A Li-S battery with a nitrogen-doped graphene foam interlayer.	CN201711006380.X	ZL201711006380.X	Li Yang
(3)	发明	授权	A Li-S battery with a graphene foam interlayer deposited by nitrogen doped porous carbon nano-rods.	CN201711006349.6	ZL201711006349.6	Li Yang

2） Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Light-weight Free-standing Graphene Foam-based Interlayer towards Improved Li-S Cells	Ruowei Yi, Chenguang Liu, Yinchao Zhao, Laurence J. Hardwick, Yinqing Li, Xianwei Geng, Qian Zhang, *Li Yang, *Cezhou Zhao	Electrochimica Acta	2019
(2)	SCI	Graphenecontacted single molecular junctions with conjugated molecular wires	Shuhui Tao, Qian Zhang, Chunhui He, Xiangfei Lin, Ruochen Xie, Cezhou Zhao, Chun Zhao, Alexander Smogunov, Yannick J. Dappe, Richard J. Nichols, *Li Yang	ACS Applied Nano Materials	2019
(3)	SCI	Isothermal Sulfur Condensation into Carbon Nanotube/Nitrogen-doped Graphene Composite for High Performance Lithium–Sulfur Batteries	Xianwei Geng, Ruowei Yi, Zhiming Yu, Cezhou Zhao, Yinqing Li, Qiuping Wei, Chenguang Liu, Yinchao Zhao, *Bing Lu, *Li Yang	Journal of Materials Science: Materials in Electronics	2018
(4)	SCI	Porous activated carbons derived from pleurotus eryngii for supercapacitor applications	Yudan Yuan, Ruowei Yi, Yi Sun, Jianqiao Zeng, Jiaqi Li, Jiahao Hu, Yinchao Zhao, Wei Sun, Chun Zhao, *Li Yang, *Cezhou Zhao	Journal of Nanomaterials	2018
(5)	SCI	Carbon-Contacted Single Molecule Electrical Junctions	Chunhui He, Qian Zhang, Shuhui Tao, Cezhou Zhao, Chun Zhao, Weitao Su, Yannick J. Dappe, Richard J. Nichol, *Li Yang	Physical Chemistry Chemical Physics	2018
(6)	SCI	Technical effects of molecule-electrode contacts in graphene-based molecular junctions	Qian Zhang, Shuhui Tao, Yinqi Fan, Cezhou Zhao, Chun Zhao, Weitao Su, Yannick J. Dappe, Richard J. Nichols, *Li Yang	Journal of Physical Chemistry C	2018
(7)	SCI	Effect of Asymmetric Anchoring Groups on Electronic Transport in Hybrid Metal/Molecule/Graphene Single Molecule Junctions,	Chunhui He, Qian Zhang, Yinqi Fan, Cezhou Zhao, Chun Zhao, Jingyao Ye, Yannick J. Dappe, Richard J. Nichol, *Li Yang,	ChemPhysChem	2019
(8)	SCI	The facile fabrication of light-weight dual-functional modified separator towards high performance Li-S batteries	Ruowei Yi, Xiangfei Lin, Yinchao Zhao, Chenguang Liu, Yinqing Li, Laurence J. Hardwick, *Li Yang, *Cezhou Zhao, Xianwei Geng, Qian Zhang,	ChemElectroChem	2019
(9)	SCI	Enhanced Electrochemical Performance by GeOx-Coated MXene Nanosheet Anode in Lithium-ion Batteries	Chenguang Liu, Yinchao Zhao, Ruowei Yi, Hao Wu, Wenbin Yang, Yinqing Li, Ivona Mitrovica, Stephan Taylor, Paul Chalker, *Li Yang, *Cezhou Zhao	Electrochimica Acta	2020
(10)	SCI	Facile Preparation of Co3O4 Nanoparticles Incorporating with Highly Conductive MXene Nanosheets as High-Performance Anodes for Lithium-Ions Batteries	Yinchao Zhao, Chenguang Liu, Ruowei Yi, Ziqian Li, Yanbing Chen, Yinqing Li, Ivona Mitrovica, Stephan Taylor, Paul Chalker, *Li Yang, *Cezhou Zhao	Electrochimica Acta	2020
(11)	SCI	A high conductivity and effective polysulfides adsorption of TiC-TiO2/SWCNT/S composite for stable Li-S batteries	Xianwei Geng, Ruowei Yi, Xiangfei Lin, Chenguang Liu, Yi Sun, Yinchao Zhao, Yinqing Li, Ivona Mitrovica, *Li Yang, *Cezhou Zhao	Journal of Alloys and Compounds	2020
(12)	SCI	Improved pseudocapacitances of supercapacitors based on electrodes of nitrogen-doped Ti3C2Tx nanosheets with in-situ growth of carbon nanotubes	Yi Sun, Ruowei Yi, Yinchao Zhao, Chenguang Liu, Yudan Yuan, Xianwei Geng, Weixuan Li, Zhichen Feng, Ivona Mitrovic, *Li Yang, *Cezhou Zhao	Journal of Alloys and Compounds	2020
(13)	SCI	Nitrogen-Doped Hierarchical Porous Activated Carbon Derived from Paddy for High-Performance Supercapacitors	Yudan Yuan, Yi Sun, Zhichen Feng, Xingjian Li, Ruowei Yi, Wei Sun, *Cezhou Zhao, *Li Yang	Materials	2021

3） Others

Awards:

1. National Key Lab of Material Processing and Die & Mould Technology Opening Fund, "Coating performance matching and control mechanism of lithium sulfur battery electrode paste", project code P2019-019, (01/2019-12/2020) Project Value 50K RMB.

2. Key Program Special Fund in XJTLU, "Investigation into next generation Lithium batteries for enhanced power and capacity", project code KSF-A-04, (07/2017-06/2020) Project Value 1M RMB.

3. Best Poster Prize, Jiangsu Province Postgraduate Functional Nano Materials Research Forum, Suzhou, 04/11/2018

Project 3: Coating Performance Matching and Control Mechanism of Lithium Sulfur Batteries

| Li Yang

Programme category: Key Laboratory – Open Project

Technical fields: New Energy Technology, Energy Storage Devices

Introduction: In recent years, lithium-sulfur batteries based on lithium anode and sulfur anode have become very promising lithium ion batteries because of their high energy density. In this project, first, the pole piece and intermediate layer of cone sulfur battery were taken as the research object and the slurry composition in the lamellar was taken as the research variable; Micron and nano sulfur particles, conductive carbon black, carbon nanotubes, carbon nanosheets and MXene were used for the proportioning, the behavior of different types of slurry applied with thousands of electrodes was tested, and finally a carbon nanoplates/two-dimensional carbonized chin nanoplates (MXene) composite interlayer with excellent performance was obtained. Second, the high-frequency capacitance change of silicon composite electrode was measured by a simple device, and the volume expansion effect of sulfur positive electrode and silicon negative electrode was researched. By measuring the capacitance curve of silicon composite negative electrode during charging and discharging, the stress and fragmentation trend of the battery during charging and discharging was finally obtained. This work is expected to further establish an electrical mechanical model and further quantify the related performance of the battery electrode.

Keywords: Lithium Ion Battery, High Energy Density

Key issues solved:

1. For this research, the positive electrode and intermediate layer of lithium-sulfur battery was taken as the research object, the slurry composition in the plate sheet was taken as the research variable, and the behavior of using thousands of electrodes in different types of slurry was tested by adjusting the component content in the slurry, including sulfur powder, conductive agent, adhesive, and adopting different types of components, such as micron and nano sulfur particles, conductive carbon black, carbon nanotubes, carbon nanoplates and MXene.

2. Electrodes of lithium-sulfur battery were assembled into button cell. Through the cyclic performance test, cyclic voltammetry test, electrochemical impedance test, battery rate discharge performance test, battery self-discharge test, lithium ion diffusion coefficient measurement, shuttle effect coefficient measurement and other tests of lithium-sulfur battery positive electrode button cell under different radiation pressures, the optimal scheme for different formulations of electrode was obtained according to the test results to achieve the optimal balance between energy density and comprehensive performance.

3. Scanning electron microscope (SEM) was used to observe the surface and cross section of the electrode before and after the rolling processing. The influence of radiation pressure on the deformation and evolution process of electrode material was analyzed from the microstructure, and the influence mechanism of different parameters was analyzed from the microstructure: Through SEM observation of electrode surface and internal section after charge-discharge cycle, it was confirmed that the internal gap of the battery can also effectively contain the final product lithium sulfide, which prevented it from precipitating on the electrode surface and increasing the internal impedance of the electrode, resulting in performance degradation.

4. The volume expansion effect of sulphur positive electrode and silicon negative electrode was simulated, and the high frequency capacitance change of silicon composite electrode was measured by setting up a simple device. At high frequency, the equivalent circuit of button cell can be regarded as a series connection of capacitor and resistor. The test system can be used to determine the change trend of stress and comminution in the electrode for the change of capacitance and anode material with great volume change during lithium/lithium removal.

Research achievements:

1) Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	实用新型专利	授权	一种氛和珈掺杂钙钦矿太阳能电池	CN201920970530.7	ZL201920970530.7	耿显蔽，赵春，赵策洲，杨莉，尹力
(2)	实用新型专利	授权	封装太阳能电池	CN201920253119.8	ZL201920253119.8	耿显载，赵春，赵策洲，杨莉，尹力
(3)	发明	实审	一种掺氮碳纳米片/MXene复合纳米材料、其制备方法和用途	CN202010052371.X		孙艺，易若讳，赵胤超，刘晨光袁宇丹，李韦萱，杨莉，赵策洲
(4)	发明	实审	超级电容器、超级电容器电极材料及其制备方法	CN202010106709.5		袁宇丹，邓航，李星渐，孙艺，孙伟，赵春，杨莉，赵策洲

2) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Enhanced Electrochemical Performance by GeOx-Coated MXene Nanosheet Anode in Lithium-ion Batteries	Chenguang Liu, Yinchao Zhao, Ruowei Yi, Hao Wu, Wenbin Yang, Yinqing Li, Ivona Mitrovica, Stephan Taylor, Paul Chalker, *Li Yang, *Cezhou Zhao	Electrochimica Acta	2020
(2)	SCI	Facile Preparation of Co3O4 Nanoparticles Incorporating with Highly Conductive MXene Nanosheets as High-Performance Anodes for Lithium-Ions Batteries	Yinchao Zhao, Chenguang Liu, Ruowei Yi, Ziqian Li, Yanbing Chen, Yinqing Li, Ivona Mitrovica, Stephan Taylor, Paul Chalker, *Li Yang, *Cezhou Zhao	Electrochimica Acta	2020
(3)	SCI	Improved pseudocapacitances of supercapacitors based on electrodes of nitrogen-doped Ti3C2Tx nanosheets with in-situ growth of carbon nanotubes	Yi Sun, Ruowei Yi, Yinchao Zhao, Chenguang Liu, Yudan Yuan, Xianwei Geng, Weixuan Li, Zhichen Feng, Ivona Mitrovic, *Li Yang, *Cezhou Zhao	Journal of Alloys and Compounds	2020
(4)	SCI	A high conductivity and effective polysulfides adsorption of TiC-Ti02/SWCNT/S composite for stable Li-S batteries	Xianwei Geng, Ruowei Yi, Xiangfei Lin, Chenguang Liu, Yi Sun, Yinchao Zhao, Yinqing Li, Ivona Mitrovica, *Li Yang, *Cezhou Zhao	Journal of Alloys and Compounds	2021
(5)	SCI	Charge Transport in Hybrid Platinum/Molecule/Graphene Single Molecule Junctions	Chunhui He, Qian Zhang, Tingwei Gao, Chenguang Liu, Zhenyu Chen, Cezhou Zhao, Chun Zhao, Richard J. Nichol, *Yannick J. Dappe, *Li Yang	Physical Chemistry Chemical Physics	2020

2.Provincial Projects

Project 1: Exploring the Mechanism of Chromium Poisoning in Solid Oxide Fuel/Electrolyzer Cells (SOFC/SOEC) and Its Impact on the Electrochemical Properties of Inorganic Materials

| Elena Konysheva

Technical fields: New Energy and Efficient Energy Saving – Hydrogen Energy – Hydrogen Energy Utilization Equipment

Programme category: Jiangsu Science and Technology Programme – Basic Research Plan (Natural Science Foundation) – General Programme

Introduction: Developing green power generation and energy storage methods is one of the priority tasks to protect global resources and solve environmental problems at home and abroad. Solid oxide fuel cell (SOFC) converts the chemical energy of fuel (hydrogen, natural gas, methanol, gasoline and ammonia) and oxidant (air or oxygen) into water as a single chemical product. Fuel cell technology has made remarkable progress and outstanding achievements. The efficiency of solid oxide fuel cell (SOFC) can exceed 60%. Solid oxide electrolytic cells (SOEC) electrolyze water and/or CO_2 into pure hydrogen and/or syngas. The electrochemical performance of SOFC and SOEC devices is easily affected by chromium deposition in the electrodes. Oxides with perovskite, double perovskite and layered perovskite Ruddlesden-popper structures present the mixed ionic electronic conductivity and can be used as cathodes in SOFC. The composite cathode formed by mixing these oxides with a certain proportion of electrolyte can improve the electrochemical performance.

In this project, chromium poisoning mechanism of electrode materials in oxygen-containing environment was researched. Currently, we have explored the influencing factors of controlling the adsorption of Cr gaseous substances by materials with high mixed ions and electronic conductivity under controlled humidity and non-electric conditions. In addition, another aspect of research was to develop some new materials to show better electrochemical performance in chromium-containing environment so as to prolong the service life of fuel cells and commercialize their technologies.

Keywords: Green Power Generation Fuel Cell Technology, New Bi-Functional Electrode Materials

Key issues solved: In the initial stage, the optimum synthesis method (solid, sol-gel or hydrothermal method) has been explored, and the proportion of initial precursors has been adjusted to obtain some single-phase compounds.

The delamination problem has been proved in the electrolysis process of solid oxide electrolytic cell (SOEC). In this case, the electrode is physically separated from the electrolyte so that electrolysis cannot occur. It is necessary to optimize the calcination conditions and interface roughness so as to determine the mechanism of chromium poisoning under SOEC conditions.

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Quantitative characterization of Cr-adsorption on CeO_2, pure and doped $BaCeO_3$ and its impact on the electrochemical performance of Ce containing complex oxides	Y. Hou, J. Wu, E. Yu. Konysheva	International Journal Hydrogen Energy	2016
(2)	SCI	Forous ceramics based on yttrium and scandium-cerium doped ZrO_2 with fluorite structure: Impact of chromium on conductivity	X. Zhang, E. Yu. Konysheva	Solid state Ionics	2018
(3)	SCI	Influence of Chromia on conductivity of $Ce_{0.9}Gd_{0.1}O_2$ electrolyte in solid oxide fuel cells	E. Yu. Konysheva	Russian Journal Electrochenistry	2018

Project 2: The Research on Controllable Preparation and Photovoltaic Properties of Single Crystals of Bismuth Ferrite Micron

| Hao Yu

Programme category: Jiangsu Science and Technology Programme – Basic Research Plan (Natural Science Foundation) – General Programme

Introduction: In this project, high-quality micron single crystal $BiFeO3$ (hereinafter abbreviated as BFO) was prepared by hydrothermal method at low cost, the crystal growth direction was selected under the control conditions, and then the current transport properties of BFO were researched by using conductive atomic force probe, which revealed the relationship between energy band structure, polarization direction and electrical transport studied the influence of doping on the conductivity of the system, and then explained its novel photovoltaic effect and explored the methods to enhance its photovoltaic efficiency. In this project, the growth control of micron single crystal grown in different orientations (001) and (111) of BFO and the growth control of K-doped BFO nanowires was implemented. In addition, the diode characteristics and photovoltaic characteristics of BFO were discovered. The diode properties and photovoltaic properties of PN junction are different from those of traditional PN junction, which depend on its iron polarization rather than internal electric field. In this project, a photoelectric sensing element method was also invented based on BFO, which can be used to prepare photoelectric sensing devices in visible/ultraviolet band by using the visible band gap of BFO. These novel properties contain unconventional conductive mechanisms. A clear research of its materials science and physics will greatly develop bismuth ferrite-based magnetic, ferroelectric and photoelectric coupling multifunctional devices, and also have reference significance for the development of other transition metal oxide photovoltaic materials.

Keywords: Bismuth Ferrite, Photovoltaic Effect, Micron Single Crystal

Key issues solved:

Material control of high quality BFO synthesis: hydrothermal growth mechanism and lattice orientation control mechanism of BFO. The growth morphology of BFO microcrystals can be controlled by changing the reaction conditions (pH temperature) ((001)-grown square and (111)-grown hexagonal microcrystals were obtained). Interface mechanism of BFO transport properties and photovoltaic properties and polarization voltage control mechanism: the anisotropy of transport behavior and the influence of interface on conductivity and photovoltaic performance was researched. A method for measuring the electrical and photoelectric properties of microcrystalline materials by conducting atomic force microscope was developed.

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	自旋极化电流驱动的亚微米／马达及其制作方法	CN201510639455.2	ZL201510639455.2	于昊

Project 3: Investigation of the Minimization Strategies for DC-Link Surge Voltage of Electric Vehicle Inverters

| Huiqing Wen

Programme category: The Natural Science Foundation of the Jiangsu Higher Education Institutions of China - General Programme

Introduction: The working mode, circuit parameter optimization and the relationship between output voltage ripple and overshoot in cascade boost circuit of electric vehicle were analyzed; the output voltage overshoot and suppression strategy of bidirectional DC/DC converter of electric vehicle were analyzed; the working condition of electric vehicle includes frequent start-stop, acceleration and deceleration working conditions of electric vehicles in actual operation was analysed and the influence of operating conditions of electric vehicle motor drive system on IGBT over-voltage failure characteristics was researched.

Keywords: Electric Vehicle, Parasitic Parameters, Voltage Overshoot, Laminated Bus Bar, Finite Element Analysis

Key issues solved: The accurate simulation model of inverter drive system including main parasitic parameters was established, the parasitic inductance of basic converter unit was estimated by comparing the transient voltage and current of switch, and the voltage spike at IGBT turn-off was analyzed by simulation and test.

Research achievements:

1）Patent

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	一种基于最小无功功率损耗的直流变换器效率优化方法	CN201510246621.2.	ZL201510246621.2	文辉清

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Practical Implementation of an Interleaved Boost Converter for Electric Vehicle Applications	Wen, H. & Su, B.	Journal of Power Electronics	2015.7
(2)	SCI	Nonactive Power Losses Minimization in a Bidirectional Isolated DC-DC Converter for Distributed Power System	Wen, H., Xiao, W., & Su, B.	IEEE Transactions on Industrial Electronics	2014.12
(3)	SCI	Reactive Power and Soft-Switching Capability Analysis of Dual-Active-Bridge DC-DC Converters with Dual-Phase-Shift Control	Wen, H. & Su, B.	Journal of Power Electronics	2015.1
(4)	EI	Reactive Power Loss Optimization Method for Bi-directional Isolated DC-DC Converters	Wen, H.	The seventh International Power Electronics Conference	2014.6
(5)	EI	Modelling and MPPT Control of DFIG Wind Energy System	Sijie Cai, Huiqing Wen	The 4th IET Renewable Power Generation Conference (RPG 2015)	2015.10
(6)	EI	Design and Evaluation of a Solar Based Single Inductor Multiple Outputs LED Lighting	Haiyan Xu, Huiqing Wen*, Xingshuo Li	The 4th IET Renewable Power Generation Conference (RPG 2015)	2015.10
(7)	EI	Investigation on Transmission Efficiency for Magnetic Materials in a Wireless Power Transfer System	Chi Zhang, Huiqing Wen	The 11th IEEE International Conference on Power Electronics and Drive Systems (PEDS 2015)	2015.6

Project 4: Mismatch Phenomenon of Building PV Array under Partial Shading Conditions and Differential Power Processing Solution

| Huiqing Wen

Technical fields: New Energy and Efficient Energy-Saving - Solar Energy - Solar Building Integration

Programme category: Jiangsu Science and Technology Programme – Basic Research Plan (Natural Science Foundation) - General Programme

Introduction: The purpose of this project is to explore a DPP-oriented MPPT control method based on β parameters, which is used to solve the problem of battery mismatch in building photovoltaic power generation system so as to improve the overall power generation efficiency and reduce the power generation cost. If this technology can effectively improve the tracking performance and reliability, it can be applied to photovoltaic roofs, photovoltaic curtain walls, photovoltaic daylighting roofs and other photovoltaic power generation systems of buildings, and promote the wide application of renewable energy in green buildings.

Keywords: Solar Energy Building Integration, Power Decoupling Control of DPP Converter with Differential Power Processing

Key issues solved: The research results of this project include the following parts:

Research result I: Research on MPPT Control with Variable Step Size Based on β Parameter

Research result II: Systematic Comparison of Various MPPT Algorithms Including Steady-state and Dynamic Characteristics

Research result III: Comparison of Different DPP Schemes and Analysis of Power Flow

Research result IV: Control and Protection of DPP Photovoltaic System

In a word, the purpose of this project is to establish the power flow model in different time scales and different local shadow modes to reveal the energy conversion relationship of building photovoltaic system converters, to analyze the influence of different shadow shading modes on the output power mismatch of photovoltaic modules, to establish the power flow mathematical model in different time scales, to research a new circuit topology and suppress bus voltage ripple by power decoupling, and to research the internal circulating power between building photovoltaic structure control modules based on differential power processing to solve the module mismatch problem. Upon nearly three years of intense scientific research, the research group has completed the scientific research tasks drawn up in this research topic and achieved the expected research results. In this project, the problem of battery mismatch in building photovoltaic power generation system can be solved so as to improve the overall power generation efficiency and reduce the power generation cost. If this technology can effectively improve the tracking performance and reliability, it can be applied to photovoltaic roofs, photovoltaic curtain walls, photovoltaic daylighting roofs and other photovoltaic power generation systems of buildings, and promote the wide application of renewable energy in green buildings.

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	申请	一种基于功率增量法的多峰值最大电功率跟踪方法	CN201710194987.9		李星硕，文辉清
(2)	发明	申请	一种基于功率差值变换的光伏组件老化检测方法	CN201711477130.4		李星硕，文辉清

(3)	发明	申请	一种基于直流功率变换的光伏组件老化检测装置及方法	CN201711473047.X		李星硕，文辉清
(4)	发明	申请	基于最小功率追踪算法的光伏子模块功率差额变换方法	CN201810844849.5		楚冠英，文辉清，叶召阳
(5)	发明	申请	基于无电流传感器的最大电功率跟踪方法	CN201810844900.2		李星硕，文辉清
(6)	发明	授权	基于等效电压参考线模型的全局最大电功率点跟踪方法	CN201811328363.2	ZL201811328363.2	李星硕，文辉清
(7)	发明	授权	新型光伏储备功率控制方法	CN201811364143.5	ZL201811364143.5	李星硕，文辉清
(8)	发明	申请	一种基于 β 参数的多峰值最大电功率跟踪控制方法	CN201710172473.3		李星硕，文辉清
(9)	实用新型	授权	一种基于功率差值变换的光伏组件老化检测装置	CN201721893616.1	ZL201721893616.1	李星硕，文辉清
(10)	实用新型	授权	一种基于直流功率变换的光伏组件老化检测装置	CN201721900367.4	ZL201721900367.4	李星硕，文辉清

2） Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Efficiency Optimization of DC Solid–State Transformer for Photovoltaic Power Systems	Haochen Shi, Huiqing Wen, Yihua Hu, yong yang, Yiwang Wang	IEEE Transactions on Industrial Electronics	2019/4
(2)	SCI	Elimination of Photovoltaic Mismatching with Improved Submodule Differential Power Processing	Guanying Chu, Huiqing Wen, Yong Yang, Yiwang Wang	IEEE Transactions on Industrial Electronics	2019/4
(3)	SCI	A novel global maximum power point tracking algorithm for photovoltaic system with variable perturbation frequency and zero oscillation	Sonia Veerapen, Huiqing Wen, Xingshuo Li, Yang Du, Yong Yang, Yiwang Wang, Weidong Xiao	Solar Energy	2019/2
(4)	SCI	Drift-Free Current Sensorless MPPT Algorithm in Photovoltaic Systems	Xingshuo li, Huiqing Wen, Yihua Hu, Lin Jiang	Solar Energy	2019/1
(5)	SCI	A Novel Sensorless Photovoltaic Power Reserve Control With Simple Real-Time MPP Estimation	Xingshuo Li, Huiqing Wen, Yinxiao Zhu, Lin Jiang, Yihua Hu, Weidong Xiao	IEEE Transactions on Power Electronics	2018/11
(6)	SCI	A novel power-increment based GMPPT algorithm for PV arrays under partial shading conditions	Xingshuo li, Huiqing Wen, Guanying Chu, Yihua Hu, Lin Jiang	Solar Energy	2018/7
(7)	SCI	A novel beta parameter based fuzzy-logic controller for photovoltaic MPPT application	Xingshuo li, Huiqing Wen, Yihua Hu, Lin Jiang	Renewable Energy	2018/6
(8)	SCI	Bidirectional flyback based isolated-port submodule differential power processing optimizer for photovoltaic applications	Guanying Chu, Huiqing Wen, Lin Jiang, Yihua Hu, Xingshuo Li	Solar Energy	2017/12
(9)	EI	Design and Optimization of PV-Isolated-Port Photovoltaic Differential Power Porcessing System	Guanying Chu, Huiqing Wen	2018 IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)	2018/12
(10)	EI	A Novel Photovoltaic String Model Based on the Lambert w Function for Partial Shading Conditions	Yadi Ma, Huiqing Wen, Xingshuo Li	2018 IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)	2018/12
(11)	EI	A Novel Power Incremental GMPPT Method based on Modified Voltage Lines for Photovoltaic System	Xingshuo Li, Huiqing Wen, Yang Du, Lin Jiang, Yihua Hu, Weidong Xiao	2018 IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)	2018/12
(12)	EI	An Improved Equivalent Model for a Long PV String under Partial Shading Conditions	Xiaoyang Wang, Huiqing Wen, Xingshuo Li	2018 International Power Electronics Conference (IPEC-Niigata 2018 -ECCE Asia)	2018/10
(13)	EI	Evaluations of GaN-on-Si devices for Power Electronics Applications	Huiqing Wen, Wen Liu, Cezhou Zhao	2018 14th IEEE International Conference on Solid-State and Integrated Circuit Technology (ICSICT)	2018/10
(14)	EI	Design and optimization of the PV-virtual-bus differential power processing photovoltaic systems	Guanying Chu, Huiqing Wen, Zhaoyang Ye, Xingshuo Li	2017 IEEE 6th International Conference on Renewable Energy Research and Applications (ICRERA)	2017/11
(15)	EI	A novel PV faults diagnosis method based on the structure of differential power processing	Xingshuo Li, Huiqing Wen, Guanying Chu, Zhaoyang Ye	2017 IEEE 6th International Conference on Renewable Energy Research and Applications (ICRERA)	2017/11
(16)	EI	Minimum-power-tracking for PV-PV differential power processing systems	Zhaoyang Ye, Huiqing Wen, Guanying Chu, Xingshuo Li	2017 IEEE 6th International Conference on Renewable Energy Research and Applications (ICRERA)	2017/11
(17)	EI	A modified MPPT technique based on the MPP-locus method for photovoltaic system.	Xingshuo Li, Huiqing Wen, Weidong Xiao	IECON 2017 - 43rd Annual Conference of the IEEE Industrial Electronics Society	2017/10
(18)	EI	Hierarchical coordinated control for DC microgrid with crowbar and load shedding control	Huiqing Wen, Kai Zheng, Yang Du	2017 IEEE 3rd International Future Energy Electronics Conference and ECCE Asia (IFEEC 2017 - ECCE Asia)	2017/6
(19)	EI	Design of a novel MPPT algorithm based on the two stage searching method for PV systems under partial shading	Sonia Veerapen, Huiqing Wen, Yang Du	2017 IEEE 3rd International Future Energy Electronics Conference and ECCE Asia (IFEEC 2017 - ECCE Asia)	2017/6
(20)	EI	Control and Protection of DC Microgird with Battery Energy Storage System	Huiqing Wen, Weiqiang Zhu	IEEE INTERNATIONAL CONFERENCE ON POWER ELECTRONICS, DRIVES AND ENERGY SYSTEMS	2016/12
(21)	EI	Evaluation of different Maximum power point tracking techniques by using EN 50530 dynamic test standard	Xingshuo Li, Huiqing Wen	IEEE INTERNATIONAL CONFERENCE ON POWER ELECTRONICS, DRIVES AND ENERGY SYSTEMS	2016/12

[22]	EI	Evaluation of Different Maximum Power Point Tracking (MPPT) Techniques based on Practical Meteorological Data	Xingshuo Li, Huiqing Wen, Yihua Hu	6th International Conference on Renewable Energy Research and Applications	2016/11
[23]	EI	Control Method for Flyback based submodule Integrated Converter with Differential power Processing Structure	Guanying Chu, Huiqing Wen, Yihua Hu	6th International Conference on Renewable Energy Research and Applications	2016/11
[24]	EI	Modeling and Analysis of Coordinated Control Strategies in AC Microgrid	Huiqing Wen, Huan Yu, Yihua Hu	6th International Conference on Renewable Energy Research and Applications	2016/11

Project 5: PV System Output Power Smoothing Control Method Based on Very Short-Term Forecasting

| Yang Du

Programme category: The Natural Science Foundation of the Jiangsu Higher Education Institutions of China - General Programme

Introduction: Based on the rapid growth of photovoltaic grid-connected capacity and the realistic demand of power balance adjustment in smart grid in the future, in this project, a new solution for the specific application of climbing rate control from the perspective of improving the self-discipline control ability of photovoltaic system was proposed.

The purpose of this research is to explore a climbing rate control method without energy storage or reducing energy storage capacity. Based on the ultra-short-term power prediction system, cloud movement and irradiation changes can be perceived in advance, thus actively changing the operation mode of photovoltaic system and energy storage system before irradiation changes. The research of this project will play an important role in increasing the access of photovoltaic power generation and reducing the phenomenon of light abandonment.

Key issues solved:

The developed experimental prototype reaches the following indexes by collecting the real data of the outdoor experimental platform and combining with simulation calculation:

- The success rate of climbing rate violation event forecast is over 98.5%
- The power prediction accuracy is over 93%
- The success rate of smooth control is over 93.2% (which can be greatly improved through system design optimization)
- The power loss rate caused by smoothing control without energy storage is 0.64% (sunny) and 12.4% (cloudy)
- Under the condition of less energy storage, the power demand of energy storage equipment decreases by 50%, and the power demand decreases by 75%
- The cost of a single sensor is RMB 50, which is small in size and convenient to be installed

Research achievements:

1) Copyright

No.	Category	Title	Author(s)	Publication Date
(1)	Book chapter	Harmonic Distortion Caused by Single-Phase Grid-Connected PV Inverter In book: Power System Harmonics - Analysis, Effects and Mitigation Solutions for Power Quality Improvement	Y. Du and D.D.C.Lu	2018.5

2) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Forecasting based Power ramp rate control strategies for Grid-tied PV systems	X. Chen, Y. Du, H. Wen, L. Jiang and W. Xiao	IEEE Transactions on Industrial Electronics	2019
(2)	SCI	MPPT Perturbation Optimization of Photovoltaic Power Systems Based on Solar Irradiance Data Classification	K. Yan, Y. Du and Z. Ren	IEEE Transaction on Sustainable Energy	2019
(3)	EI	Cloud Motion Tracking System Using Low-Cost Sky Imager For PV Power Ramp-Rate Control	C. Zhang, Y. Du, X. Chen and D. D. C. Lu	IEEE International Conference on Industrial Electronics for Sustainable Energy Systems (IESES)	2018

3.Municipal Projects

Project 1: Investigation into Next Generation Lithium Ion Batteries for Enhanced Power and Capacity

| Li Yang

Technical fields: New Energy Technology, Energy Storage Devices

Programme category: Key Programme Special Fund (KSF) – Applied Technology Research Programme

Introduction:

Combined the previous experience of lithium ion battery preparation and two-dimensional material synthesis and application of the undertaking unit, in this project, the practical high-performance lithium-sulfur batteries and different new high-performance negative electrode materials batteries were developed. The research team realized the preparation of high-density and high-quality graphene foam and high-quality thin-layer MXene nanoplates through different precursors, and tested and characterized the quality and properties of two-dimensional materials by various means. Based on these one-dimensional and two-dimensional materials, the research team used a variety of composite methods to prepare composite electrodes for lithium-ion batteries with excellent performance. This improved the intercalation and removal ability of lithium ions, greatly prolonged the cycle times of batteries, shortened the charging time of lithium-ion batteries, and obtained lithium-ion batteries with high energy density, high stability and excellent rate performance. The specific completions are as follows:

1. A new flexible electrode structure with silicon-copper alloy Nano-flowers grown on three-dimensional foam graphene was prepared by a simple method. After 500 cycles, the capacity was maintained at 1269mAhg-1, and the retention rate could reach 73%, indicating the excellent electrochemical stability of the electrode structure.

2. Nano-sized zinc oxide particles were modified on graphene three-dimensional network structure by atomic layer deposition method, and a three-dimensional self-supporting lightweight composite material was obtained, which was applied to the interlayer of lithium-sulfur battery, effectively improving the overall energy density and cycle stability of the battery.

3. Application of one-dimensional carbon nanotubes in lithium-sulfur batteries and silicon negative batteries was explored. The capacity performance and cycle performance of the composites were optimized by adjusting the ratio of carbon nanotubes and other parameters.

4. A new two-dimensional MXene material was developed and prepared, and its application in germanium and cobalt oxide anode materials was explored. In germanium negative battery, different aqueous binders and non-aqueous binders were innovatively used, which regulated the microstructure of the electrode and indicated different electrochemical properties. It has brought great inspiration to the later regulation of electrode materials and electrode structure based on MXene.

5. Carbon black/polyethylene dioxythiophene-poly (styrene sulfonate) slurry was prepared by a simple and large-scale physical mixing method, and it was applied to the separator modification of lithium-sulfur battery, which made the general sulfur/carbon cathode keep the reversible capacity of 699 mAh/g even under the high current of 2C. The interlayer has satisfying lifting effect, simple preparation and is suitable for industrial production.

6. Two-dimensional titanium carbide nanosheets (MXene) were grown by in-situ carbon nanoplates and doped with nitrogen and nickel (N-M@CN) by one-step method, and the composites were prepared into interlayer slurry, which was used for diaphragm modification coating. Under the combined action of the two, the interlayer coating can greatly improve the specific capacity cycle performance of sulfur cathode, and also has a satisfying performance for cathode with high sulfur content.

7. A test system for high frequency capacitance response of battery was built, and the electrode stress changes of silicon negative electrode during charge-discharge cycle were observed in situ. The pulverization of active materials during the first charge-discharge and subsequent cycles of silicon negative electrode was also simulated according to the observed data, and the corresponding stress-capacitance model was established.

8. 13 SCI papers have been published, 9 patents are under trial, and 5 patents are authorized.
9. Five conference presentations were submitted to international conferences related to science and industry.
10. 5 doctoral students and 5 master students were trained.

Keywords: Lithium Ion Battery, Interlayer, Two-Dimensional Material, High Energy Density

Key issues solved:

The preparation of high-density and high-quality graphene foam and high-quality thin-layer MXene nanoplates through different precursors was realized, and the quality and properties of two-dimensional materials were tested and characterized by various means. Based on new one-dimensional and two-dimensional materials, a series of new negative electrode, sulfur positive electrode and separator/interlayer materials with high performance were developed to fully understand the reduction and oxidation pathways in lithium-sulfur batteries and lithium-silicon batteries, research the mechanism of lithium intercalation/delithium process, and master the electrochemical and chemical processes during the charging and discharging of positive and negative electrodes. In terms of lithium-sulfur battery, the polysulfide adsorption capacity of sulfur cathode was greatly improved, and then the specific capacity cycle performance of sulfur cathode was improved, and the cathode material of lithium-sulfur battery with high performance and high sulfur content was obtained. In terms of new negative electrode materials, the conductivity of negative electrode materials was significantly improved by different electrode material composite methods, and the stress and fragmentation caused by volume expansion were alleviated. A new negative electrode of lithium ion battery with stable cycle performance and high rate performance was obtained.

Research achievements:

1) Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	氮掺杂多孔碳纳米棒的泡沫石墨烯片为中间层的锂硫电池	CN201711006349.6	ZL201711006349.6	杨莉，易若玮，赵策州
(2)	发明	授权	氮掺杂的泡沫石墨烯片为中间层的锂硫电池及其制备方法	CN201711006380.X	ZL201711006380.X	易若玮，杨莉，赵策州，刘晨光，赵胤超，耿显葳
(3)	发明	授权	一种用于超级电容器的碳基复合材料的制备方法	CN201711170904.9	ZL201711170904.9	袁宇丹，曾剑桥，赵胤超，孙伟，杨莉　赵策洲
(4)	发明	实审	一种基于自组装的新型石墨烯-硅复合电极材料制备方法	CN201711170924.6		刘晨光，顾敏学，赵胤超，易若玮，杨莉，赵策洲
(5)	发明	授权	一种三维树枝状氮掺杂石墨烯纳米管的制备及其应用	CN201711170934.X	ZL201711170934.X	易若玮，杨莉，赵策洲，赵胤超，刘晨光，耿显葳
(6)	发明	实审	一种锂-硫电池的导电高聚物复合物的中间层的制造方法	CN201711170978.2		易若玮，杨莉，赵策洲，刘晨光，赵胤超，耿显葳
(7)	发明	实审	一种包裹型的硅负极材料及其制备方法	CN201711190946.2		赵胤超，程紫檀，刘晨光，易若玮，杨莉，赵策洲
(8)	发明	授权	一种用于超级电容器的聚丙烯腈/二硫化钼复合材料的制备方法	CN201711481492.0	ZL201711481492.0	袁宇丹，李佳琦，孙艺，赵胤超，刘晨光，孙伟，杨莉，赵春，赵策洲
(9)	发明	实审	铜碳硅复合负极片的制备方法及其应用	CN201811442520.2		赵胤超，刘晨光，宋皓伟，易若玮，杨莉，赵策洲
(10)	发明	实审	基于石墨烯的纳米花形硅铜合金电极材料及其制备方法与应用	CN201811442530.6		刘晨光，赵胤超，易若玮，杨莉，赵策洲

[11]	发明	实审	锂硫电池用复合隔膜、其制备方法及应用	CN201811442542.9		易若玮，杨莉，赵策洲，袁宇丹，刘晨光，赵胤超，耿显葳，林向飞
[12]	发明	实审	锂离子电池电极应力原位测量系统	CN201811442546.7		刘晨光，赵胤超，易若玮，杨莉，赵策洲
[13]	发明	实审	铜硅复合负极片的制备方法及其应用	CN201811443302.0		赵胤超，刘晨光，皮里全，易若玮，杨莉，赵策洲
[14]	发明	实审	锂硫电池用复合正极片、其制备方法及应用	CN201811449059.3		易若玮，杨莉，赵策洲，袁宇丹，刘晨光，赵胤超，林向飞

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
[1]	SCI	Isothermal Sulfur Condensation into Carbon Nanotube/Nitrogen-doped Graphene Composite for High Performance Lithium–Sulfur Batteries	Xianwei Geng, Ruowei Yi, Zhiming Yu, Cezhou Zhao, Yinqing Li, Qiuping Wei, Chenguang Liu, Yinchao Zhao, Bing Lu, Li Yang	Journal of Materials Science: Materials in Electronics	2018/04/30
[2]	SCI	Carbon-contacted single molecule electrical junctions	Chunhui He, Qian Zhang, Shuhui Tao, Cezhou Zhao, Chun Zhao, Weitao Su, Yannick J Dappe, Richard J Nichols, Li Yang	Physical Chemistry Chemical Physics	2018/06/21
[3]	SCI	Porous Activated Carbons Derived from Pleurotus eryngii for Supercapacitor Applications	Yudan Yuan, Ruowei Yi, Yi Sun, Jianqiao Zeng, Jiaqi Li, Jiahao Hu, Yinchao Zhao, Wei Sun, Chun Zhao, Li Yang, Cezhou Zhao	Journal of Nanomaterials	2018/08/05
[4]	SCI	Technical Effects of Molecule–Electrode Contacts in Graphene-Based Molecular Junctions	Qian Zhang, Shuhui Tao, Yinqi Fan, Cezhou Zhao, Chun Zhao, Weitao Su, Yannick J Dappe, Richard J Nichols, Li Yang	The Journal of Physical Chemistry C	2018/09/18
[5]	SCI	Graphene-Contacted Single Molecular Junctions with Conjugated Molecular Wires	Shuhui Tao, Qian Zhang, Chunhui He, Xiangfei Lin, Ruochen Xie, Cezhou Zhao, Chun Zhao, Alexander Smogunov, Yannick J Dappe, Richard J Nichols, Li Yang	ACS Applied Nano Materials	2018/12/17
[6]	SCI	A light-weight free-standing graphene foam-based interlayer towards improved Li-S cells	Ruowei Yi, Chenguang Liu, Yinchao Zhao, Laurence J Hardwick, Yinqing Li, Xianwei Geng, Qian Zhang, Li Yang, Cezhou Zhao	Electrochimica Acta	2019/01/03
[7]	SCI	Alloyed Cu/Si core-shell nanoflowers on the three-dimensional graphene foam as an anode for lithium-ion batteries	Chenguang Liu, Yinchao Zhao, Ruowei Yi, Yi Sun, Yinqing Li, Li Yang, Ivona Mitrovic, Stephen Taylor, Paul Chalker, Cezhou Zhao	Electrochimica Acta	2019/03/17
[8]	SCI	Effect of Asymmetric Anchoring Groups on Electronic Transport in Hybrid Metal/Molecule/Graphene Single Molecule Junctions	Chunhui He, Qian Zhang, Yinqi Fan, Cezhou Zhao, Chun Zhao, Jingyao Ye, Yannick Dappe, Richard Nichols, Li Yang	ChemPhysChem	2019/06/26
[9]	SCI	Fabrication of a light-weight dual-function modified separator towards high-performance lithium-sulfur batteries	Ruowei Yi, Xiangfei Lin, Yinchao Zhao, Chenguang Liu, Yinqing Li, Laurence J Hardwick, Li Yang, Cezhou Zhao, Xianwei Geng, Qian Zhang	ChemElectroChem	2016/06/13
[10]	SCI	3D-structured multi-walled carbon nanotubes/copper nanowires composite as a porous current collector for the enhanced silicon-based anode	Yinchao Zhao, Chenguang Liu, Yi Sun, Ruowei Yi, Yutao Cai, Yinqing Li, Ivona Mitrovic, Stephen Taylor, Paul Chalker, Li Yang, Cezhou Zhao	Journal of Alloys and Compounds	2019/06/25
[11]	SCI	Facile preparation of Co3O4 nanoparticles incorporating with highly conductive MXene nanosheets as high-performance anodes for lithium-ion batteries	Yinchao Zhao, Chenguang Liu, Ruowei Yi, Ziqian Li, Yanbing Chen, Yinqing Li, Ivona Mitrovic, Stephen Taylor, Paul Chalker, Li Yang, Cezhou Zhao	Electrochimica Acta	2020/04/09
[12]	SCI	A high conductive TiC–TiO2/SWCNT/S composite with effective polysulfides adsorption for high performance Li–S batteries	Xianwei Geng, Ruowei Yi, Xiangfei Lin, Chenguang Liu, Yi Sun, Yingchao Zhao, Yinqing Li, Ivona Mitrovic, Rui Liu, Li Yang, Cezhou Zhao	Journal of Alloys and Compounds	2020/08/20
[13]	SCI	Enhanced electrochemical performance by GeOx-Coated MXene nanosheet anode in lithium-ion batteries	Chenguang Liu, Yinchao Zhao, Ruowei Yi, Hao Wu, Wenbin Yang, Yinqing Li, Ivona Mitrovic, Stephen Taylor, Paul Chalker, Rui Liu, Li Yang, Cezhou Zhao	Electrochimica Acta	2020/08/13

Project 2: Research on the Intelligent PV Module Aging Detection and Fault Diagnosis Based on the GaN Power Integration Technique

| Huiqing Wen

Technical fields: New Energy and Energy-Saving – Solar Energy

Programme category: Key Industrial Technology Innovation – Prospective Applied Basic Research Project

Introduction: In this project, the main advantages of the third generation wide band gap semiconductor gallium nitride (GaN) materials, such as fast electron saturation drift speed and high breakdown field strength, will be utilized completely so that they could be applied to high-power electron energy conversion, wind energy, solar energy converters and other aspects. Specifically, the typical photovoltaic aging modes, including discoloration, delamination, fragmentation and hot spots, were focused in this project. A PV module aging detection and fault diagnosis technology based on gallium nitride device and differential power processing (DPP) technology was proposed by analyzing the main methods of PV module aging detection, including electroluminescent method, ultraviolet fluorescence method, infrared image analysis method and I-V curve measurement method. In this project, the defect that ultraviolet fluorescence method and electroluminescence must run in a light-tight box and are not suitable for outdoor testing, the shortcomings of tedious detection steps, and non-intuitive results and inability to be digitized by infrared image analysis method could be solved. The bottleneck of detection speed of I-V curve measurement method could also be broken through, and a new photovoltaic module aging detection device could be developed. Thus, the findings could greatly reduce the difficulty and cost of photovoltaic module aging and troubleshooting, and promote the development of renewable energy industry.

During the implementation of this research project, on the basis of the established research plan, combining with the research practice in the process of project implementation and referring to the latest research progress in this research field domestically and internationally, the members of research group confirmed the converter topology and corresponding control algorithm based on Differential Power Processing (DPP) structure, researched the relationship function between the output side current of the converter and the aging of photovoltaic modules. By measuring the direction and magnitude of the input side current of the converter, the influence of switching noise was suppressed and the measurement accuracy was improved, the DPP structure control algorithm was determined and the minimum power optimization algorithm was adopted to improve the energy output and transmission efficiency. The characteristics of GaN Field Effect Transistor (FET) were also researched, including static and dynamic characteristics at high temperature and high frequency. The influence of stray capacitance and inductance in high frequency driving circuit was researched, the layout design of driving circuit and suppress high frequency oscillation optimized. The integrated power module based on GaN power device was also researched and developed, including driving circuit, protection circuit and heat dissipation components, the integrated parameters was extracted, and the internal current and temperature distribution was analyzed. Part of the research results of this project have been published in well-known SCI journals in the electrical field.

Keywords: GaN Power Integration Unit, Photovoltaic Aging, Differential Power Processing, Stray Inductance, Power Density

Key issues solved:

The research results of this project include the following parts:

Research result I: Development of Integrated Power Module Based on GaN Device

Research result II: Research on Application of GaN Devices in Renewable Energy

Research result III: Research on Power Flow Analysis and Control Optimization of DPP

Research result IV: Aging Detection Technology of Photovoltaic Module Based on DPP Structure

In a word, the purpose of this research is to develop a Gallium Nitride (GaN) power integration unit compatible with Si-CMOS process, which can significantly reduce the cost and highlight the unique advantages of gallium nitride materials. For this purpose, the main goal of this project is to develop gallium nitride power integration technology compatible with low-cost

Si-CMOS process, and realize gallium nitride power integration unit with high efficiency and high power density, which is used in the fields of aging detection and fault diagnosis of photovoltaic modules. Related circuit protection design and technical implementation scheme of the whole system will also be carried out while implementing the project. Upon nearly three years of intense scientific research, the research group has completed the scientific research tasks drawn up in this research topic and achieved the expected research results. For details, please refer to the research situation of research objectives. From the research results of this research topic, it can be seen that the topic selection of this research is satisfying in theory, strong in application, better in breakthrough point, accurate and feasible. In this project, the defect that ultraviolet fluorescence method and electroluminescence must run in a light-tight box and are not suitable for outdoor testing, the shortcomings of tedious detection steps, and non-intuitive results and inability to be digitized by infrared image analysis method could be solved. The bottleneck of detection speed of I-V curve measurement method could be broken through, and a new photovoltaic module aging detection device could be developed, thus greatly reducing the difficulty and cost of photovoltaic module aging and troubleshooting and promoting the development of renewable energy industry.

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	申请	一种基于功率差值变换的光伏组件老化检测方法	CN201711477130.4		李星硕，文辉清
(2)	发明	申请	一种基于直流功率变换的光伏组件老化检测装置及方法	CN201711473047.X		李星硕，文辉清
(3)	发明	申请	基于最小功率追踪算法的光伏子模块功率差额变换方法	CN201810844849.5		楚冠英，文辉清，叶召阳
(4)	发明	申请	基于无电流传感器的最大电功率跟踪方法	CN201810844900.2		李星硕，文辉清
(5)	发明	授权	基于等效电压参考线模型的全局最大电功率点跟踪方法	CN201811328363.2	ZL201811328363.2	李星硕，文辉清
(6)	发明	授权	新型光伏储备功率控制方法	CN201811364143.5	ZL201811364143.5	李星硕，文辉清
(7)	发明	申请	一种基于 β 参数的多峰值最大电功率跟踪控制方法	CN201710172473.3		李星硕，文辉清
(8)	实用新型专利	授权	一种基于功率差值变换的光伏组件老化检测装置	CN201721893616.1	ZL201721893616.1	李星硕，文辉清
(9)	实用新型专利	授权	一种基于直流功率变换的光伏组件老化检测装置	CN201721900367.4	ZL201721900367.4	李星硕，文辉清

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Efficiency Optimization of DC Solid–State Transformer for Photovoltaic Power Systems	Haochen Shi, Huiqing Wen, Yihua Hu, yong yang, Yiwang Wang	IEEE Transactions on Industrial Electronics	2020.5
(2)	SCI	Elimination of Photovoltaic Mismatching with Improved Submodule Differential Power Processing	Guanying Chu, Huiqing Wen, Yong Yang, Yiwang Wang	IEEE Transactions on Industrial Electronics	2020.4
(3)	SCI	A novel global maximum power point tracking algorithm for photovoltaic system with variable perturbation frequency and zero oscillation	Sonia Veerapen, Huiqing Wen, Xingshuo Li, Yang Du, Yong Yang, Yiwang Wang, Weidong Xiao	Solar Energy	2019.2

[4]	SCI	Drift-Free Current Sensorless MPPT Algorithm in Photovoltaic Systems	Xingshuo li, Huiqing Wen, Yihua Hu, Lin Jiang	Solar Energy	2019.1
[5]	SCI	A Novel Sensorless Photovoltaic Power Reserve Control With Simple Real-Time MPP Estimation	Xingshuo Li, Huiqing Wen, Yinxiao Zhu, Lin Jiang, Yihua Hu, Weidong Xiao	IEEE Transactions on Power Electronics	2018.11
[6]	SCI	A novel power-increment based GMPPT algorithm for PV arrays under partial shading conditions	Xingshuo li, Huiqing Wen, Guanying Chu, Yihua Hu, Lin Jiang	Solar Energy	2018.7
[7]	SCI	A novel beta parameter based fuzzy-logic controller for photovoltaic MPPT application	Xingshuo li, Huiqing Wen, Yihua Hu, Lin Jiang	Renewable Energy	2018.6
[8]	SCI	Power rating analysis and protection for photovoltaic-isolated port based differential power processing system	Peng Dong, Huiqing Wen, Guanying Chu, Yong Yang, Yiwang Wang	Solar Energy	2019.11
[9]	SCI	Low-Complexity Power-Balancing-Point Based Optimization for Photovoltaic Differential Power Processing	G. Chu, H. Wen, Y. Hu, L. Jiang, Y. Yang and Y. Wang	IEEE Transactions on Power Electronics	2020.3
[10]	EI	Design and Optimization of PV-Isolated-Port Photovoltaic Differential Power Porcessing System	Guanying Chu, Huiqing Wen	2018 IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)	2018.12
[11]	EI	A Novel Photovoltaic String Model Based on the Lambert w Function for Partial Shading Conditions	Yadi Ma, Huiqing Wen, Xingshuo Li	2018 IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)	2018.12
[12]	EI	A Novel Power Incremental GMPPT Method based on Modified Voltage Lines for Photovoltaic System	Xingshuo Li, Huiqing Wen, Yang Du, Lin Jiang, Yihua Hu, Weidong Xiao	2018 IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)	2018.12
[13]	EI	An Improved Equivalent Model for a Long PV String under Partial Shading Conditions	Xiaoyang Wang, Huiqing Wen, Xingshuo Li	2018 International Power Electronics Conference (IPEC-Niigata 2018-ECCE Asia)	2018.10
[14]	EI	Evaluations of GaN-on-Si devices for Power Electronics Applications	Huiqing Wen, Wen Liu, Cezhou Zhao	2018 14th IEEE International Conference on Solid-State and Integrated Circuit Technology (ICSICT)	2018.10

[15]	EI	Design and optimization Of the PV-virtual-bus differential power processing photovoltaic systems	Guanying Chu, Huiqing Wen, Zhaoyang Ye, Xingshuo Li	2017 IEEE 6th International Conference on Renewable Energy Research and Applications (ICRERA)	2017.11
[16]	EI	A novel PV faults diagnosis method based on the structure of differential power processing	Xingshuo Li, Huiqing Wen, Guanying Chu, Zhaoyang Ye	2017 IEEE 6th International Conference on Renewable Energy Research and Applications (ICRERA)	2017.11
[17]	EI	Minimum-power-tracking For PV-PV differential power processing systems	Zhaoyang Ye, Huiqing Wen, Guanying Chu, Xingshuo Li	2017 IEEE 6th International Conference on Renewable Energy Research and Applications (ICRERA)	2017.11
[18]	EI	A modified MPPT technique based on the MPP-locus method for photovoltaic system.	Xingshuo Li, Huiqing Wen, Weidong Xiao	IECON 2017-43rd Annual Conference of the IEEE Industrial Electronics Society	2017.10
[19]	EI	An Adaptive Ramp-Rate Control for Photovoltaic System to Mitigate Output Fluctuation	Q. Xu, H. Wen, Y. Zhu and X. Li	APPEEC 2019 IEEE PES Asia-Pacific Power and Energy Engineering Conference	2019.12
[20]	EI	Modeling and Simulation Test for Voltage Multiplier and an LLC Resonant Inverter as a Voltage Equalizer	X. Wang, H. Wen and Y. Zhu	APPEEC 2019 IEEE PES Asia-Pacific Power and Energy Engineering Conference	2019.12
[21]	EI	Power generation and performance analysis of Bi-facial vs Mono-facial 10KW Photovoltaic power station	H. D. M. R. Perera and H. Wen	2019 18th International Conference on Optical Communications and Networks (ICOCN)	2019.8
[22]	EI	Differential Power Processing based Photovoltaic Power Systems: A Review	H. Wen, C. Lin and G. Chu	2019 18th International Conference on Optical Communications and Networks (ICOCN)	2019.8
[23]	EI	Performance of Submodule Level Differential Power Processing Architecture In Mismatched PV Systems	P. Dong, H. Wen, G. Chu and B. Xu	2019 IEEE 10th International Symposium on Power Electronics For Distributed Generation Systems (PEDG)	2019.6

[24]	EI	An Adaptive Constant Power Generation Control Scheme with Simple MPP Estimation for Photovoltaic Systems	Y. Zhu, H. Wen, G. Chu and X. Li	2019 10th International Conference on Power Electronics And ECCE Asia (ICPE 2019 - ECCE Asia)	2019.5
[25]	EI	Evaluation of MPPT and APC Performance Connected with Different DC Load Types	X. Li and H. Wen	2019 10th International Conference on Power Electronics And ECCE Asia(ICPE 2019 - ECCE Asia)	2019.5
[26]	EI	Design and Evaluation of GaN-based Over Temperature Protection Circuit	L. Kang, H. Wen, Q. Bu and W. Liu	2019 International Conference on IC Design and Technology (ICICDT)	2019.6
[27]	EI	Design of GaN-based Voltage Reference Circuit for a Wide-Temperature-Range Operation	X. Chen, H. Wen, Q. Bu and W. Liu	2019 International Conference on IC Design and Technology (ICICDT)	2019.6
[28]	EI	Experimental Comparison of AlGaN/GaN-on-Si Schottky Barrier Diode With and Without Recessed Anode	Q. Bu, Y. Cai, M. cui, H. Wen and W. Liu	2019 International Conference on IC Design and Technology (ICICDT)	2019.6
[29]	EI	Design and Evaluation of AlGaN/GaN High Electron Mobility Transistor Comparator	B. Sun, H. Wen, Q. Bu and W. Liu	2019 International Conference on IC Design and Technology (ICICDT)	2019.6

Project 3: Graphene-Based Lithium Ions Batteries

| Li Yang

Technical fields: New Energy and Energy-Saving - New Battery with High Efficiency

Programme category: Suzhou Science and Technology Development Planning Programme – Key Industrial Technology Innovation – Prospective Applied Basic Research Project

Introduction: In this project, combining the experimental basis of preparing graphene materials from Xi'an Jiaotong-Liverpool University and the conductive graphene paste from Suzhou Graphene Nanotechnology Co., Ltd., a practical graphene/silicon-based lithium battery was developed. With the catalyst as the precursor, the research team realized the growth and preparation of high-density and high-quality three-dimensional graphene, continuously optimized the composite process, explored the preparation of foamed nickel three-dimensional graphene filled with nickel catalyst and its composite materials, and finally obtained graphene with a thickness of 1-10 layers. In the design of new lithium battery, a flexible lithium ion battery anode material with three-dimensional graphene as slip ring and silicon-copper alloy Nano-flower with hollow structure as active material was developed, and a lithium ion battery with high capacity energy storage, high cycle stability and excellent rate capacity performance was obtained.

Keywords: Lithium Battery, Flexible Anode Material, Three-Dimensional Graphene, High Capacity

Key issues solved:

1. Preparation technology of three-dimensional grid graphene with controllable density: In this project, high-quality three-dimensional graphene network structure was grown by adjusting the structure and size of catalyst and using chemical vapor deposition. To improve the mechanical, electrical and thermal properties of graphene grown from nickel foam, a three-dimensional graphene preparation with controllable density was developed by loading nickel salt on nickel foam, and the electrical and thermal conductivity of the composites were obviously improved.

2. Preparation technology of graphene/silicon-based electrode materials with high capacity three-dimensional grid: Graphene three-dimensional network structure developed in the early stage was used as the slip ring part of the electrode, the flexible cathode material of lithium ion battery with hollow-structure silicon-copper alloy Nano-flower as active material was prepared. The three-dimensional graphene network structure provided excellent magnification performance for the electrode, and the compounding of copper greatly improved the conductivity of silicon. However, because of its unique stress distribution, the hollow Nano-flower-like structure could greatly slow down the stress of silicon during the expansion of lithium intercalation, prevent the electrode structure from collapsing and the active material from breaking away from the slip ring, thus improving the cyclic stability of the whole material system. Moreover, the high thermal conductivity of graphene can quickly export the heat in the operation of the battery and improve the safety of the battery. Through the battery performance test, the excellent electrochemical stability of the electrode structure was presented.

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
[1]	发明	授权	一种三维树枝状氮掺杂石墨烯纳米管的制备及其应用	CN201711170934.X	ZL201711170934.X	易若玮，杨莉，赵策洲，赵胤超，刘晨光，耿显葳
[2]	发明	授权	氮掺杂多孔碳纳米棒的泡沫石墨烯片为中间层的锂硫电池	CN201711006349.6	ZL201711006349.6	杨莉，易若玮，赵策洲，刘晨光，赵胤超，耿显葳
[3]	发明	授权	氮掺杂的泡沫石墨烯片为中间层的锂硫电池及其制备方法	CN201711006380.X	ZL201711006380.X	易若玮，杨莉，赵策洲，刘晨光，赵胤超，耿显葳

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Isothermal Sulfur Condensation into Carbon Nanotube/Nitrogen-doped Graphene Composite for High Performance Lithium–Sulfur Batteries	Xianwei Geng, Ruowei Yi, Zhiming Yu, Cezhou Zhao, Yinqing Li, Qiuping Wei, Chenguang Liu, Yinchao Zhao, *Bing Lu, *Li Yang	Journal of Materials Science: Materials in Electronics	2018
(2)	SCI	Porous activated carbons derived from pleurotus eryngii for supercapacitor applications	Yudan Yuan, Ruowei Yi, Yi Sun, Jianqiao Zeng, Jiaqi Li, Jiahao Hu, Yinchao Zhao, Wei Sun, Chun Zhao, *Li Yang, *Cezhou Zhao	Journal of Nanomaterials	2018
(3)	SCI	Assembly of highly stable aqueous dispersions and flexible films of nitrogen-doped graphene for highperformance stretchable supercapacitors	Qi Zeng, Zaka Ullah, Mingliang Chen, Huitao Zhang, Ruibing Wang, Lina Gao, Liwei Liu, *Guanhong Tao, *Qi Li	Journal of Materials Science: Electronic Materials	2017
(4)	SCI	Significant enhancement of metal heat dissipation from mechanically exfoliated graphene nanosheets through thermal radiation effect	Junxiong Hu, Jianbao Xu, Chao Zhu, Zaka Ullah, Fengkui Liu, Weiwei Li, Yufen Guo, *Xinluo Zhao, *Liwei Liu	AIP advances	2017
(5)	SCI	Self-assembly of urchin-like porphyrin/graphene microspheres for artificial photosynthetic production of formic acid from CO2	Qi Li, Qi Zeng, Lina Gao, Zaka Ullah, Hui Li, Yufen Guo, Weiwei Li, Ying Shi, *Guanhong Tao, *Liwei Liu	Journal of Materials Chemistry A	2017
(6)	SCI	Low resistivity of graphene nanoribbons with zigzag-dominated edge fabricated by hydrogen plasma etching combined with Zn/HCl pretreatment	Fengkui Liu, Rubing Wang, Jianbao Xu, Junxiong Hu, Weiwei Li, Yufen Guo, Yuting Qian, Wei Deng, Zaka Ullah, Zhongming Zeng, Mengtao Sun, *Liwei Liu	Applied Physics Letters	2017
(7)	SCI	Ultra-broadband graphene-InSb heterojunction photodetector	Jianbao Xu, Junxiong Hu, Rubing Wang, Qi Li, Weiwei Li, Yufen Guo, Fengkui Liu, Zaka Ullah, Long Wen, *Liwei Liu	Applied Physics Letters	2017
(8)	SCI	Fast batch production of high-quality graphene films in a sealed thermal molecular movement system	Jiaobao Xu, Junxiong Hu, Qi Li, Rubing Wang, Weiwei Li, Yufen Guo, Yongbo Zhu, Fengkui Liu, Zaka Ullah, Guocai Dong, Zhongming Zeng, *Liwei Liu	Small	2017

3）Others

1. 制备出高性能的石墨烯，成功研发了催化剂生长高密度三维石墨烯的一种方法以及基于填充镍催化剂的泡沫镍三维石墨烯及其复合材料的制备。石墨烯的厚度在 1-10 层，存在不均匀性。（详见论文 4（第三页 8-10 行）和论文 8（第 7 页左 5-8 行，25-28 行）。）

2. 开发出高能量密度、高循环稳定性的石墨烯 / 硅基锂电负极材料，开发了一种以三维石墨烯为集流器，附着中空结构的硅铜合金纳米花为活性材料的柔性锂离子电池负极材料，在 1.6A/g 电流密度下可达到 1730mAhg-1 的稳定比容量（约为石墨电极的 6 倍）。在 500 个循环过后，还能维持在 1269mAhg-1，容量保持率可以达到 73%，展现了电极结构优良的电化学稳定性。（发明专利（Application no.201711170946.6 和 201711190946.2），技术报告 29-30 页（图 21-23，投稿中））

Project 4: Intelligent Fault - Tolerant Control for Photovoltaic Systems Based on Environmental Perception

| Jieming Ma

Technical fields: New Energy and Energy-Saving - Solar Energy

Programme category: Suzhou Science and Technology Development Planning Programme - Key Industrial Technology Innovation - Prospective Applied Basic Research Project

Introduction: In this project, the intelligent photovoltaic fault-tolerant control system based on environmental perception was developed. The system realized fault-tolerant power control by learning 'Multi-style' sampling data in error state, and improved fault-tolerant ability and energy-saving efficiency of photovoltaic system. The researched method is the core technology of the new intelligent photovoltaic controller.

The research team has completed the research contents stipulated in the Research Task Contract according to the annual plan and achieved remarkable results. The research contents are divided into the following three aspects:

1. In terms of environmental perception, shadow matrix was used to describe the information of shadow occlusion ratio and occlusion intensity. A shadow matrix recognition method based on the improved tabu search was proposed to detect running errors caused by shadow occlusion. This method provided the necessary environment information for the maximum power point tracking controller to improve the global maximum power point tracking performance.

2. In terms of maximum power point prediction, according to the different electrical characteristics of photovoltaic systems under different shadow conditions, a domain support vector machine model was proposed to predict the irradiance received by components and the position of maximum power point. Experiments indicated that PV output characteristics are different in different local shadow environments, and the proposed method can effectively reduce the prediction error caused by multi-style data and improve the prediction accuracy;

3. In terms of maximum power point tracking, a hybrid maximum power point tracking scheme combining maximum power point prediction model was proposed. Experiments indicated that the proposed method not only avoids the probability of tracking falling into local search, but also keeps the robustness of the traditional climbing maximum power point method. Based on the built model and intelligent photovoltaic fault-tolerant control system, the project team has applied for 1 utility model patent and 4 invention patents, and currently authorized 1 utility model patent and published 13 research papers, including 5 SCI index papers and 8 EI index conference papers. In this project, the main technologies with obvious benefits were completed, the efficient and stable maximum power point tracking effect was achieved, and the technical support and data accumulation for the development of a new intelligent roof photovoltaic controller were provided.

Keywords: Environmental Perception, Fault Diagnosis, Data Style Learning, Fault-Tolerant Prediction Model, Fault-Tolerant Control

Key issues solved:

(1) How to use the electrical features to identify the environment of photovoltaic system

The environmental perception method researched does not need irradiance meter to collect solar irradiance. However, based on the analysis of the electrical characteristics of photovoltaic system, the error information (shadow information) of photovoltaic system was calculated by tabu search, which effectively solved the problem of electrical feature recognition.

(2) How to learn the 'Multi-style' electrical characteristic data

In this project, a maximum power point prediction method based on domain support vector regression was proposed, which solved the regression prediction problem for 'Multi-style' electrical characteristic data. The domain regression model used normalizes the 'Multi-style' data into the 'Single-style' data and then made predictions. Experiments indicate that it is an efficient prediction method.

(3) How to build a fault-tolerant prediction model

The project team proposed a hybrid maximum power point tracking scheme integrating the maximum power point

prediction model and guided the maximum power point prediction results to the traditional maximum power point method. Experiments indicate that the proposed method not only avoids the probability of tracking falling into local search, but also maintains the robustness of the traditional climbing maximum power point method.

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	一种串联型光伏电板遮挡自动检测系统	CN201821753690.8	ZL201821753690.8	马洁明，毕自强
(2)	发明	申请	一种特性失配光伏组串的功率峰数测量方法	CN202010363393.8		马洁明，王康石，文家乐
(3)	发明	申请	一种串联型光伏电板遮挡自动检测系统及方法	CN201811264554.7		马洁明，毕自强
(4)	发明	申请	一种光伏串联的阴影遮挡检测方法、装置和设备	CN202010010649.7		马洁明
(5)	发明	申请	光伏串列阴影信息检测方法、最大功率点追踪方法及系统	CN202010321887.X		毕自强，马洁明，文家乐

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	Detection and assessment of partial shading scenarios on photovoltaic strings	J. Ma, X. Pan, K.L. Man, X. Li, H. Wen, T.O. Ting	IEEE Transactions on Industry Application	2018.6
(2)	SCIE	Maximum Power Point Estimation for Photovoltaic Strings Subjected to Partial Shading Scenarios	J. Ma, H. Jiang, Z. Bi, K. Huang, X. Li and H. Wen	IEEE Transactions on Industry Applications	2018.11
(3)	SCIE	Intelligent design and implementation of blockchain and Internet of things–based traffic system	Q. Ren, K.L. Man, M. Li, B. Gao, and J. Ma	International Journal of Distributed Sensor Networks	2019.7
(4)	SCIE	Identification of Partial Shading Conditions for Photovoltaic Strings	Z. Bi, J. Ma, K. Wang, K.L. Man, Y. Yue and J.S. Smith	IEEE Access	2020.5
(5)	SCIE	An Enhanced 0.8Voc-Model-Based Global Maximum Power Point Tracking Method for Photovoltaic Systems	Z. Bi, J. Ma, K.L. Man, J.S. Smith, Y. Yue and H. Wen	IEEE Transactions on Industry Applications	2020.8
(6)	EI	Identification of Partial Shading in Photovoltaic Arrays Using Optimal Sensor Placement Schemes	J Ma, Z Bi, KL Man, H Dai, Z Wu	2018 7th International Conference on Renewable Energy Research and Applications (ICRERA)	2018.10
(7)	EI	Automatic shading detection system for photovoltaic strings	J. Ma, Z. Bi, K.L. Man, J.S. Smith and Y. Yue	2018 International SoC Design Conference (ISOCC)	2018.11
(8)	EI	Global MPPT Method for Photovoltaic Systems Operating under Partial Shading Conditions using the 0.8VOC Model	Z. Bi, J. Ma, K. L. Man, J. S. Smith, Y. Yue and H. Wen	2019 IEEE International Conference on Environment and Electrical Engineering and 2019 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe)	2019.6
(9)	EI	Predicting the Global Maximum Power Point Locus using Shading Information	J. Ma, Z. Bi, K. L. Man, H. Liang and J. S. Smith	2019 IEEE International Conference on Environment and Electrical Engineering and 2019 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe)	2019.6
(10)	EI	A Novel Global Maximum Power Point Tracking Method based on Shading Detection	J. Ma, Z. Bi, K. L. Man, Y. Yue and J. S. Smith	2019 International SoC Design Conference (ISOCC)	2019.11
(11)	EI	An Analytical Model for a Photovoltaic Module Under Partial Shading Conditions	J. Ma, K. Wang, K. L. Man, H-N. Liang, X. Pan	2020 IEEE International Conference on Environment and Electrical Engineering and 2019 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe)	2020.6
(12)	EI	Maximum Power Point Tracking of Photovoltaic Systems Using Deep Q-networks	K. Wang, D. Hong, J. Ma, K. L. Man, K. Huang and X. Huang	2020 IEEE International Conference on Industrial Informatics	2020.6
(13)	EI	A Novel Global Maximum Power Point Tracking Technique based on Shading Detection for Photovoltaic Strings	Z. Bi, J. Ma, K.L. Man, Y. Yue and J.S. Smith	2020 International SoC Design Conference (ISOCC)	2020.10

Project 5: The Platform Improvement on Suzhou Municipal Key Lab (New Energy and Environmental Protection Technique): New Solar Cells and Li Batteries Based on Graphene

| Cezhou Zhao

Technical fields: Nanotechnology, Advanced Manufacturing, Energy and Environmental Protection

Programme category: Institutional Development and Innovation Project - Key Platform - Promotion

Introduction: After one and a half years of construction based on Upgrading and Construction of New Energy Battery Based on Graphene in Suzhou Key Laboratory of New Energy Technology, a series of complete preparation processes of high-capacity persistent three-dimensional grid graphene with independent intellectual property rights were owned, and the relationship between atomic layers, doping and defects of graphene and the properties of graphene conductive films was established through his project. Currently, the key laboratory has complete experimental conditions for the R&D of lithium batteries and thin film solar cells. Based on the laboratory's mastery of the technology of depositing three-dimensional graphene by chemical vapor deposition, the R&D of lithium batteries and photovoltaic cells has been carried out. In cooperation with Dongguan Hongde Battery Co., Ltd., the production line was designed, built, modulated and the application market was promoted.

Focusing on the graphene-lithium new energy battery, the first target of platform upgrading, we designed a flexible lithium ion battery cathode material with three-dimensional graphene as the skeleton and silicon-copper alloy as the active material. This unique structure can slow down the volume expansion of silicon intercalated with lithium, and greatly improve the conductivity of silicon, which greatly improves the cycle performance and rate performance of silicon-based lithium batteries. At 0.35 Ag-1 current, the specific capacity of Si-Cu alloy Nano-flower/graphene composite electrode material can reach 2087 mAhg-1, which is 6 times of the existing commercial graphite negative electrode. After 390 cycles, the electrode can still maintain 73.4% capacity, and the cycle performance of the battery is very stable. In addition, the research team also started with the cathode design of lithium ion batteries. By wrapping a layer of poly-modified and reduced graphene oxide on the sulfur particles, a conductive network structure was formed so that current can be conducted among different sulfur particles to improve electrochemical reaction, fully improve the conductivity of sulfur, promote the utilization rate of sulfur and improve the specific capacity of lithium-sulfur battery. The developed electrode indicated extremely high initial discharge specific capacity of 1420 mAhg-1. After 10 cycles, it was stable at about 750 mAhg-1. Compared with the general S-C electrode (the initial discharge specific capacity was ~ 450 mAhg-1, and the stability specific capacity after cycle was ~ 350 mAhg-1), both of them were significantly improved. With the support of platform construction, the project of 'Development of Graphene Silicon-Based Lithium Battery with High Capacity and Durable Three-Dimensional Network' was funded by Suzhou Industrial Technology Innovation Project (Key Industry Technology Innovation - Prospective Study) in 2016.

Focusing on graphene-semiconductor photovoltaic cells, the second target of platform upgrading, and the research team established a model of graphene/CdTe/CdS solar cells by using SCAPS3.3 software, and theoretically simulated the performance of solar cells under different parameter settings. In addition, the research team started with metal-organic coordination chemistry and used solvent engineering to obtain high-efficiency perovskite solar cells, with an average cell efficiency of 11.94%. The formation mechanism of perovskite thin films was deeply researched, and several new halogen perovskite intermediates were found during spin-coating and different annealing time. This discovery is of great significance for people to further research the formation mechanism of perovskite film, improve its film quality, and improve the stability and efficiency of batteries.

R&D of the project has promoted the technological progress of the enterprise, improved the competitiveness of the enterprise, and achieved remarkable economic benefits (such as Dongguan Hongde Battery, Suzhou Graphene Nanotechnology Co., Ltd., Wuxi Alkene Crystal Carbon Energy New Material Technology Co., Ltd). During platform construction, 14 papers were submitted in Nano Letters, Nanoscale, Materials and other foreign core journals, of which 10 papers have been published, 1 paper has been offered and 3 papers are under review. A total of 28 domestic patents have been applied, including 3 invention patents, 8 utility model patents, 10 invention patents under review and 7 invention patents are under submission. 9 scientific research projects were applied for, of which 5 were approved. A total of 13 doctoral students and 3 master students were trained.

Research achievements:

1) Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	碲铜化合物纳米材料的制备方法	CN201510050155.0	ZL201510050155.0	吴京锦，赵策洲
(2)	发明	授权	基于石墨烯的柔性碲化镉薄膜太阳能电池及其制备方法	CN201510140153.0	ZL201510140153.0	吴京锦，赵策洲，赵胤超
(3)	发明	授权	氟化石墨烯作为高阻层的太阳能电池及其制备方法	CN201510339381.0	ZL201510339381.0	吴京锦，赵策洲，赵胤超
(4)	实用新型专利	授权	基于石墨烯的柔性碲化镉薄膜太阳能电池	CN201520181122.5	ZL201520181122.5	吴京锦，赵策洲，赵胤超
(5)	实用新型专利	授权	一种锗基 MOS 器件	CN201520779331.X	ZL201520779331.X	陆骐峰，吴京锦，赵策洲
(6)	实用新型专利	授权	一种碲化镉薄膜太阳能电池	CN201520732043.9	ZL201520732043.9	吴京锦，赵策洲，赵胤超
(7)	实用新型专利	授权	一种用于真空温度测量的无线温度传感器装置	CN201520726600.6	ZL201520726600.6	吴京锦，刘晨光，汤楚帆，赵策洲，柳銎
(8)	实用新型专利	授权	一种制备致密硫化镉薄膜的装置	CN201520721634.6	ZL201520721634.6	吴京锦，刘晨光，赵策洲，汤楚帆，柳銎
(9)	实用新型专利	授权	一种半导体器件瞬态电容的测试系统	CN201520179612.1	ZL201520179612.1	吴京锦，赵策洲，刘晨光
(10)	实用新型专利	授权	一种 PN 结瞬时电容能谱测量系统	CN201520179615.5	ZL201520179615.5	吴京锦，赵策洲，刘晨光
(11)	实用新型专利	授权	基于石墨烯夹层结构的柔性透明导电薄膜	CN201520154437.0	ZL201520154437.0	吴京锦，赵策洲，赵胤超
(12)	发明	授权	一种半导体器件 γ 射线辐射响应的实时在线测试系统	CN201610518949.X	ZL201610518949.X	慕轶非，赵策洲
(13)	发明	授权	用石墨烯电极构筑分子节的方法及测量分子电导的方法	CN201610145493.7	ZL201610145493.7	杨莉，张骞，刘龙龙，陶舒晖，赵策洲，理查·尼克斯
(14)	发明	授权	一种三维树枝状氮掺杂石墨烯纳米管的制备方法及其在锂硫电池正极材料中的应用	CN201711170934.X	ZL201711170934.X	易若玮，杨莉，赵策洲，赵胤超，刘晨光，耿显葳
(15)	发明	授权	一种用于超级电容器的碳基复合材料的制备方法	CN201711481492.0	ZL201711481492.0	袁宇丹，曾剑桥，赵胤超，孙伟，杨莉，赵策洲
(16)	发明	申请	一种降低宽禁带半导体器件接触欧姆电阻的方法	CN201710527475.X		孙瑞泽，梁永齐，赵策洲，蔡宇韬

2) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Total Ionizing Dose Response of Low-Dose-Rate Gamma Ray Radiation on Hafnium Oxide Based MOS Devices Observed by Pulse CV and On-site Measurements	Yifei Mu, Ce Zhou Zhao*, Qifeng Lu, Chun Zhao, Yanfei Qi, Sang Lam, Ivona Z. Mitrovic, Stephen Taylor, and Paul R. Chalker	IEEE Tran. Nuclear Science	2017

(2)	SCI	Capacitance-voltage characteristics measured through pulse technique on high-k dielectric MOS devices	Qifeng Lu, Yanfei Qi, Ce Zhou Zhao*, Chun Zhao, Stephen Taylor, Paul R. Chalker	Vacuum	2017
(3)	SCI	Charge transport through dicarboxylic-acid-terminated alkanes bound to graphene-gold nanogap electrodes	Longlong Liu, Qian Zhang, Shuhui Tao, Cezhou Zhao, Eman Almutib, Qusiy Al-Galiby, Steven W. D. Bailey, Iain Grace, Colin J. Lambert, Jun Du and Li Yang*	Nanoscale	2016
(4)	SCI	Effects of Rapid Thermal Annealing on the Structural, Electrical, and Optical Properties of Zr-Doped ZnO Thin Films Grown by Atomic Layer Deposition	Jingjin Wu, Yinchao Zhao, Ce Zhou Zhao*, Li Yang, Qifeng Lu, Qian Zhang, Jeremy Smith and Yongming Zhao	Materials	2016
(5)	SCI	Graphene as a promising electrode for low-current attenuation in nonsymmetric molecular junctions	Qian Zhang, Longlong Liu, Shuhui Tao, Congyi Wang, Cezhou Zhao, César González, Yannick J. Dappe, Richard J. Nichols, and Li Yang*	Nano Letters	2016
(6)	SCI	Design of power integrated circuits in full AlGaN/GaN MIS-HEMT configuration for power conversion	Ruize Sun, Yung C. Liang*, Yee-Chia Yeo, Yun-Hsiang Wang, and Cezhou Zhao	Phys. Status Solidi A	2016
(7)	SCI	Realistic Trap Configuration Scheme with Fabrication Processes in Consideration for the Simulations of AlGaN/GaN MIS-HEMT Devices	Ruize Sun, Yung C. Liang*, Yee-Chia Yeo, Yun-Hsiang Wang and Cezhou Zhao	IEEE Journal of Emerging and Selected Topics in Power	2016
(8)	SCI	Real time r-ray radiation response testing system for semiconductor devices and its applications	Yifei Mu, Ce Zhou Zhao*, Chun Zhao, Yanfei Qi, Yutao Cai, Ivona Z. Mitrovic, Stephen Taylor, Paul R. Chalker	Nuclear Inst. and Methods in Physics Research, B	2016
(9)	SCI	Effects of rapid thermal annealing on structural, chemical, and electrical characteristics of atomic-layer deposited lanthanum dopedzirconium dioxide thin film on 4H-SiC substrate	Way Foong Lim,Hock Jin Quah, Qifeng Lu, Yifei Mu, Wan Azli Wan Ismail, Bazura Abdul Rahim,Siti Rahmah Esa, Yeh Yee Kee,Ce Zhou Zhao, Zainuriah Hassan, Kuan Yew Cheong,*	Applied Surface Science	2016
(10)	SCI	Au-free AlGaN/GaN MIS-HEMTs with Embedded Current Sensing Structure for Power Switching Applications	Ruize Sun,Y. C. Liang, Cezhou Zhao	IEEE Transactions on Electron Devices	2017
(11)	SCI	Total Dose Effects and Bias Instabilities of (NH4)2S Passivated Ge MOS Capacitors with HfxZr1-xOy Thin Films	Yifei Mu, Ce Zhou Zhao, Chun Zhao, Qifeng Lu, Yanfei Qi, Yuxiao Fang, Ruowei Yi, Li Yang, Ivona Z. Mitrovic, Stephen Taylor, and Paul R. Chalker	IEEE Tran. Nuclear Science	2017
(12)	SCI	Investigation of Anomalous Hysteresis in MOS Devices with ZrO2 Gate Dielectrics	Qifeng Lu, Yanfei Qi, Ce Zhou Zhao, Chenguang Liu, Chun Zhao, Stephen Taylor and Paul R. Chalker	IEEE Transactions on Device and Materials Reliability	2017
(13)	SCI	Symmetry effects on attenuation factors in graphene-based molecular junctions	Qian Zhang, Shuhui Tao, Ruowei Yi, Chunhui He, Cezhou Zhao, Weitao Su, Alexander Smogunov, Yannick J. Dappe, Richard J. Nichols, Li Yang	The Journal of Physical Chemistry Letters	2017

Frontier New Materials

The field of Frontier New Materials represents the direction of the new scientific and technological revolution, and is a key area to cultivate new momentum for development and gain new competitive advantages in the future. From 2016 to 2020, XJTLU's research teams in the field of Frontier New Materials have published over 350 scientific papers. By the end of 2020, XJTLU had successfully completed 12 government research projects at all levels, including 6 national projects, 3 provincial projects and 3 municipal projects in the field of Frontier New Materials.

1.National Projects

Project 1: Total Ionizing Dose Effects in Lanthanide Doped HfO2 and Ultrathin HfO2 Gate Dielectrics

| Cezhou Zhao

Application code: A050403 (Department of Mathematical and Physical Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - General Programme

Introduction: In this project, the radiation response and damage mechanism of high dielectric constant media (such as Hf02, Zr02, HfZrOx, LaA103, NdA103, LaZrOx and HfTi02, etc.) during and after gamma ray radiation were researched, including:

1. Pulsed capacitance-voltage, pulsed current-voltage and pulsed on-the-fly techniques under irradiation conditions were reported, and the defect generation and annealing in these high dielectric constant dielectrics (referred to as high-k dielectrics for short) during and after irradiation were characterized by these techniques.
2. By optimizing the growth conditions and annealing conditions of these media, the radiation hardening processes introduced by these high-k dielectrics were researched.
3. The radiation induced leakage current in $HfxZrlxOy$ oxide increased with the increase of Zr composition under radiation condition.
4. Experimental data indicate that the effect of primary electron traps and oxygen vacancies on radiation response depends on the bias conditions applied during radiation.
5. The effects of high-k dielectric structure on the generation of interface state, hole collapse and de-collapse and flat band voltage drift were researched.

Keywords: High Dielectric Constant Medium, Gamma Radiation Response, Total Dose Radiation Effect, Defects Caused by Radiation, Radiation Hardening

Research achievements:

1) Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	一种 PN 结瞬时电容能谱测量系统	CN201520179615.5	ZL201520179615.5	吴京锦；赵策洲；刘晨光
(2)	发明	授权	一种半导体器件瞬态电容的测试系统	CN201520179612.1	ZL201520179612.1	吴京锦；赵策洲；刘晨光
(3)	发明	授权	一种半导体器件 γ 射线辐射响应的实时在线测试系统	CN201610518949.X	ZL201610518949.X	慕轶非；赵策洲
(4)	发明	申请	一种 PN 结瞬时电容能谱测掀方法和系统	CN201510140554.6	ZL201510140554.6	吴京锦；赵策洲；刘晨光

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI	Dielectric Relaxation in Lanthanide Doped/Based Oxides Used for High-k Layers	Ce Zhou Zhao; Stephen Taylor; Chun Zhao; Paul R. Chalker	Advanced Materials Research	2014.12.1
(2)	SCIE	Review on Non-Volatile Memory with High-k Dielectrics: Flash for Generation Beyond 32 nm	Chun Zhao; Ce Zhou Zhao; Stephen Taylor; Paul R. Chalker	materials	2014.7.15
(3)	SCIE	Hysteresis in Lanthanide Aluminum Oxides Observed by Fast Pulse CV Measurement	Chun Zhao; Ce Zhou Zhao; Qifeng Lu; Xiaoyi Yan; Stephen Taylor; Paul R. Chalker	materials	2014.10.13
(4)	SCIE	Hysteresis in Lanthanide Zirconium Oxides Observed Using a Pulse CV Technique and including the Effect of High Temperature Annealing	Qifeng Lu; Chun Zhao; Yifei Mu; Ce Zhou Zhao; Stephen Taylor; Paul R. Chalker	materials	2015.7.29
(5)	SCIE	Electrical Properties and Interfacial Studies of HfxTilx02 High Permittivity Gate Insulators Deposited on Germanium Substrates	Qifeng Lu; Yifei Mu; Joseph IV. Roberts; Mohairuned Althobaiti; Vinod R. Dhanak; Jingjin Wu; Chun Zhao; Ce Zhou Zhao; Qian Zhang; Li Yang; Ivona Z. Mitrovic; Stephen Taylor; Paul R. Chalker	materials	2015.12.2
(6)	SCIE	Real-time and on-site c-ray radiation response testing system for semiconductor devices and its applications	Yifei Mu; Ce Zhou Zhao; Yanfei Qi; Sang Lam; Chun Zhao; Qifeng Lu; Yutao Cai; Ivona Z. Mitrovic; Stephen Taylor; Paul R. Chalker	Nuclear Instruments and Methods in Physics Research B	2016.1.22
(7)	SCIE	Effects of Rapid Thermal Annealing on the Structural, Electrical, and Optical Properties of Zr-Doped ZnO Thin Films Grown by Atomic Layer Deposition	Jingjin Wu; Yinchao Zhao; Ce Zhou Zhao; Li Yang; Qifeng Lu; Qian Zhang; Jeremy Smith; Yongming Zhao	materials	2016.8.13
(8)	SCIE	Capacitance-voltage characteristics measured through pulse technique on high-k dielectric MOS devices	Qifeng Lu; Yanfei Qi; Ce Zhou Zhao; Chun Zhao; Stephen Taylor; Paul R. Chalker	Vacuum	2017.1.1
(9)	SCIE	Total Ionizing Dose Response of Hafnium-Oxide Based MOS Devices to Low-Dose-Rate Gamma Ray Radiation Observed by Pulse CV and On-Site Measurements	Yifei Mu; Ce Zhou Zhao; Qifeng Lu; Chun Zhao; Yanfei Qi; Sang Lam; Ivona Z. Mitrovic; Stephen Taylor; Paul R. Chalker	IEEE TRANSACTIONS ON NUCLEAR SCIENCE	2017.1.1
(10)	SCIE	Investigation of Anomalous Hysteresis in MOS Devices With Zr02 Gate Dielectrics	Qifeng Lu; Yanfei Qi; Ce Zhou Zhao; Chenguang Liu; Chun Zhao; Stephen Taylor; Paul R. Chalker	IEEE TRANSACTIONS ON DEVICE AND MATERIALS RELIABILITY	2017.7.25
(11)	SCIE	Total Dose Effects and Bias Instabilities of (NH4)2S Passivated Ge MOS Capacitors with HfxZrl-x0y Thin Films	Yifei Mu; Yuxiao Fang; Ce Zhou Zhao; Chun Zhao; Qifeng Lu; Yanfei Qi; Ruowei Yi; Li Yang; Ivona Z. Mitrovic; Stephen Taylor; Paul R. Chalker	IEEE TRANSACTIONS ON NUCLEAR SCIENCE	2017.11.1

Project 2: Nanomaterial Composite Synthesis to Achieve Visible Light Active Photocatalysts for Applications in Environmental Degradation

| Graham Dawson

Application code: B010205 (Department of Chemical Sciences)

Technical field: Nanomaterial Surface Modification

Programme category: National Natural Science Foundation of China (NSFC) - International Young Scientists Fund

Introduction: We have prepared several composite materials from nanotubes of titanium dioxide and investigated their applications in water splitting and surface enhanced Raman scattering.

The surface enhanced Raman scattering of trititanate nanotubes (TiNT) modified with enediol ligands was investigated and it was found that the functional group dramatically affects the enhancement observed. For TiNT-4-nitrocatechol, a SERS enhancement is seen; however, when dopamine is attached, no signal is seen. The relative band gap positions upon 785 nm laser excitation are proposed to explain the observed phenomenon. This attachment is investigated by solid state NMR and UV/Vis spectroscopy to offers further insights into catechol coatings of nanomaterials and SERS by the chemical method. We expect this non noble metal containing composite material to have applications in bioimaging and bio and chemical detection.

A TiO_2 nanotube array-Au nanoparticle-MoS_2 core–shell photoanode was constructed with the intention to fulfill the efficient transfer of photo-generated carriers to the photoelectrode's surface. Au nanoparticles were decorated by a drop casting method, and the MoS_2 layer was deposited above the Au nanoparticles using a photoreduction-annealing process. Au nanoparticles were well dispersed on the inner wall of the TiO_2 nanotubes and covered by the MoS_2 layer, forming a core–shell nanostructure. The MoS_2 layer significantly improved the attachment between Au nanoparticles and TiO_2 NTAs, resulting in increased PEC stability and performance. Attributed to the excitation of Au nanoparticles' localized surface plasmon resonance effect and visible light utilization of MoS_2, the TiO_2 NTAs-Au-MoS_2 core–shell photoanode exhibits greatly enhanced photocurrent density. An increase from 67 μA/cm2 to 234 μA/cm2 under Xe lamp illumination and from 2.6 μA/cm2 to 12.6 μA/cm2 under visible light illumination (> 420 nm) compared with the TiO_2 NTAs was observed.

Keywords: Nanotubes, Surface Modification, SERS, Water Splitting

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	MoS2/Au Sensitized TiO2 Nanotube Arrays with Core Shell Nanostructure for Hydrogen Production	Xiaorong Cheng*, Yuhua Lu, Shoulin Gu, Graham Dawson*	Nano	2017
(2)	SCIE	SERS of trititanate nanotubes: selective enhancement of catechol compounds, ChemistrySelect	Ruochen Liu, Edmund Morris, Xiaorong Cheng, Eric Amigues, Kim Lau, Baekman Kim, Yuanhang Liu, Zhipeng Ke, Sharon E. Ashbrook, Michael Bühl and Graham Dawson*	ChemistrySelect	2018
(3)	SCIE	The photocathodic properties of a Fe2O3 wrapped CuFeO2 layer on ITO glass for water splitting	Xiaorong Cheng*, Jianming Ding, Yangjiang Wu, Graham Dawson	Chemical Physics	2018
(4)	SCIE	Plasmonic enhanced Cu2O-Au-BFO photocathodes for solar hydrogen production	Xiaorong Cheng,* Shoulin Gu, Anthony Centeno and Graham Dawson	Scientific reports	2019

Project 3: Charge Transport in Single Molecules Junctions with Novel Two-Dimensional Contacts

| Li Yang

Application code: B020405 (Department of Chemical Sciences)

Technical fields: New Energy Technology, Energy Storage Device

Programme category: National Natural Science Foundation of China (NSFC) - Young Scientists Fund

Introduction: As an attractive substitute for the lithium ion batteries, lithium-sulfur (Li-S) batteries have been widely investigated for the past decades, because the theoretical energy densities are almost an order of magnitude greater than the state-of-the-art Li-ion battery, 3 times greater than the conventional batteries. However, the development of lithium-sulfur batteries is being hampered by lack of understanding of the complexity of the sulfur-cathode during reduction and oxidation. Also lithium-sulfur batteries suffer from the issue of high internal resistance due to fact that sulfur is an electrical insulator resulting in poor performance.

In this project, high quality graphene substrates were successfully prepared and key parameters were established. The resulting as-prepared graphene composite with sulfur to fabricate the sulfur cathode with graphene conductive network was used for Li-S batteries. Understanding the mechanism of the lithiation/deliathiation process, the electrochemical and chemical processes occurring during charge and discharge of the cathode and anode, and the specific capacity and cycling stability performance have been investigated.

Keywords: Lithium Ion Battery, Sulfur Loading, Graphene Foam, Free Standing, Enhanced Capability

Key issues solved:

1. A light-weight and free-standing graphene foam (GF) interlayer placed between sulfur cathode and separator was developed to improve the electrochemical performance of lithium-sulfur batteries. The results show excellent stability and reversibility of the Li-S cell with the GF/GF@ZnO interlayer.

2. The cyclic voltammetry (CV), and electrochemical impedance spectroscopy (EIS) were used to study the electrode during the reaction. The specific capacity and cycling stability performance were measured by battery testing system. The relationship between the morphology, electrochemical reactions, and sulfur loading with Li-S batteries performance were evaluated systematically.

Research achievements:

1） Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	The preparation of a branch-like nitrogen doped graphene nano-tube and its application as cathode material in Li-S battery.	CN201711170934.X	ZL201711170934.X	Li Yang
(2)	发明	授权	A Li-S battery with a nitrogen-doped graphene foam interlayer.	CN201711006380.X	ZL201711006380.X	Li Yang
(3)	发明	授权	A Li-S battery with a graphene foam interlayer deposited by nitrogen doped porous carbon nano-rods.	CN201711006349.6	ZL201711006349.6	Li Yang

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	Light-weight Free-standing Graphene Foam-based Interlayer towards Improved Li-S Cells	Ruowei Yi, Chenguang Liu, Yinchao Zhao, Laurence J. Hardwick, Yinqing Li, Xianwei Geng, Qian Zhang, *Li Yang, *Cezhou Zhao	Electrochimica Acta	2019
(2)	SCIE	Graphenecontacted single molecular junctions with conjugated molecular wires	Shuhui Tao, Qian Zhang, Chunhui He, Xiangfei Lin, Ruochen Xie, Cezhou Zhao, Chun Zhao, Alexander Smogunov, Yannick J. Dappe, Richard J. Nichols, *Li Yang	ACS Applied Nano Materials	2019
(3)	SCIE	Isothermal Sulfur Condensation into Carbon Nanotube/Nitrogen-doped Graphene Composite for High Performance Lithium–Sulfur Batteries	Xianwei Geng, Ruowei Yi, Zhiming Yu, Cezhou Zhao, Yinqing Li, Qiuping Wei, Chenguang Liu, Yinchao Zhao, *Bing Lu, *Li Yang	Journal of Materials Science: Materials in Electronics	2018
(4)	SCI	Porous activated carbons derived from pleurotus eryngii for supercapacitor applications	Yudan Yuan, Ruowei Yi, Yi Sun, Jianqiao Zeng, Jiaqi Li, Jiahao Hu, Yinchao Zhao, Wei Sun, Chun Zhao, *Li Yang, *Cezhou Zhao	Journal of Nanomaterials	2018
(5)	SCIE	Carbon-Contacted Single Molecule Electrical Junctions	Chunhui He, Qian Zhang, Shuhui Tao, Cezhou Zhao, Chun Zhao, Weitao Su, Yannick J. Dappe, Richard J. Nichol, *Li Yang	Physical Chemistry Chemical Physics	2018
(6)	SCI	Technical effects of molecule-electrode contacts in graphene-based molecular junctions	Qian Zhang, Shuhui Tao, Yinqi Fan, Cezhou Zhao, Chun Zhao, Weitao Su, Yannick J. Dappe, Richard J. Nichols, *Li Yang	Journal of Physical Chemistry C	2018
(7)	SCIE	Effect of Asymmetric Anchoring Groups on Electronic Transport in Hybrid Metal/Molecule/Graphene Single Molecule Junctions,	Chunhui He, Qian Zhang, Yinqi Fan, Cezhou Zhao, Chun Zhao, Jingyao Ye, Yannick J. Dappe, Richard J. Nichol, *Li Yang,	ChemPhysChem	2019
(8)	SCIE	The facile fabrication of light-weight dual-functional modified separator towards high performance Li-S batteries	Ruowei Yi, Xiangfei Lin, Yinchao Zhao, Chenguang Liu, Yinqing Li, Laurence J. Hardwick, *Li Yang, *Cezhou Zhao, Xianwei Geng, Qian Zhang,	ChemElectroChem	2019
(9)	SCIE	Enhanced Electrochemical Performance by GeOx-Coated MXene Nanosheet Anode in Lithium-ion Batteries	Chenguang Liu, Yinchao Zhao, Ruowei Yi, Hao Wu, Wenbin Yang, Yinqing Li, Ivona Mitrovica, Stephan Taylor, Paul Chalker, *Li Yang, *Cezhou Zhao	Electrochimica Acta	2020
(10)	SCIE	Facile Preparation of Co3O4 Nanoparticles Incorporating with Highly Conductive MXene Nanosheets as High-Performance Anodes for Lithium-Ions Batteries	Yinchao Zhao, Chenguang Liu, Ruowei Yi, Ziqian Li, Yanbing Chen, Yinqing Li, Ivona Mitrovica, Stephan Taylor, Paul Chalker, *Li Yang, *Cezhou Zhao	Electrochimica Acta	2020

3）Others

Project 4: Molecular Simulation Study of Hydrogen/Methane Storage Applications of Nanoporous Materials

| Lifeng Ding

Application code: B030104 (Department of Chemical Sciences)

Technical field: Green Energy Storage

Programme category: National Natural Science Foundation of China (NSFC) – Young Scientists Fund

Introduction: Nanoporous materials have great application potential in the storage of energetic gases. This project conducts theoretical simulation and mechanism research on the adsorption and storage of energetic gas in a variety of different nanoporous materials based on theoretical methods such as Grand Canonical Monte Carlo (GCMC), Molecular Dynamics (MD) and Density Functional Theory (OFT). We first propose the use of nanoporous materials to store a mixture of hydrogen and methane, so as to increase the combustion heat density that the nanoporous material can absorb, and promote the combustion efficiency and rate of the energetic gas in the engine of the motor vehicle. The research has summarized the structure of nanoporous materials, such as the rational relationship between porosity, pore size, surface functional groups and the total amount of adsorption of energetic gas. Finally, this project rationally modifies nanoporous materials by embedding C60 and grafting aromatic functional groups, which effectively improves the performance of nanoporous materials for storing energetic gases. The research of this project will improve the simulation methods and related mechanisms of nanoporous materials for storing energetic gases, and provide an effective way to improve the performance of nanoporous materials for storing energetic gases, which plays a positive role in promoting the practical use of nanoporous materials for storing energetic gases.

Keywords: Nanoporous Materials, Storage of Energetic Gases, Grand Canonical Monte Carlo, Density Functional Theory, Computer-Aided Material Design

Key issues solved:

1. Use molecular simulation technology to characterize and screen the existing huge nanoporous material lattice database. Further summarize the theoretical basis for the adsorption and diffusion of hydrogen and methane in nanoporous materials. Especially, summarize and quantify the void structure of nanoporous materials, and the relationship between the surface functional groups of the voids and the hydrogen/methane in the adsorption and diffusion in nanoporous materials.

2. Based on the theoretical basis summarized in the first point, we will use a computer to graft and modify the existing nanoporous materials with functional groups, and design a hypothetical nanoporous material with superior adsorption performance. These hypothetical nanoporous materials with superior performance will greatly shorten the development time of synthetic chemists in the laboratory, and reduce its investment in synthetic development.

3. We also need to evaluate the impact of some impurity gases on existing and designed hypothetical nanoporous materials to store methane and hydrogen, and further pave the way for the application of nanoporous materials in the industry.

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Molecular simulation studies of hydrogen enriched methane (HEM) storage in Covalent Organic Frameworks	Liao, Jiawei; Yazaydin, A. Ozgur; Yang, Siyuan; Li, Fan; Ding, Lifeng	Microporous and Mesoporous Materials	2016. 9. 1
(2)	SCI	Modification of COF-108 via impregnation/functionalization and Li-doping for hydrogen storage at ambient temperature	Ke, Zhipeng; Cheng, Yuanyuan; Yang, Siyuan; Li, Fan; Ding, Lifeng	International Journal of Hydrogen Energy	2017.4.20
(3)	SCI	Understanding the Effect of Ligands on C2H2 Storage and C2H2/CH4, C2H2/CO2 Separation in Metal-Organic Frameworks with Open Cu (II) Sites	Ji, Yujin; Ding, Lifeng; Cheng, Yuanyuan; Zhou, Hao; Yang, Siyuan; Li, Fan; Li, Youyong	JOURNAL OF PHYSICAL CHEMISTRY C	2017. 11. 2
(4)	SCI	Understanding Water Adsorption and the Impact on CO2 Capture in Chemically Stable Covalent Organic Frameworks	Ge, Y.; Zhou, H.; Ji, Y.; Ding, L. *; Cheng, Y.; Wang, R.; Yang, S.; Liu, Y.; Wu, X.; Li, Y.	JOURNAL OF PHYSICAL CHEMISTRY C	2018.9
(5)	SCI	Barely porous organic cages for hydrogen isotope separation	M Liu, L Zhang, M. Little, V Kapil, M Ceriotti, S Yang, L Ding, D Holden, D He, R Clowes, S Chong, G Schütz, L Chen, M Hirscher, A I Cooper.	Science	2019.9
(6)	SCI	Porous MOF – 205 with multiple modifications for efficiently storing hydrogen and methane as well as separating carbon dioxide from hydrogen and methane	Xu, Genjian; Meng, Zhaoshun; Liu, Yuzhen; Guo, Xiaojian; Deng, Kaiming; Ding, L.; Lu, Ruifeng;	International Journal of Energy Research	2019.10
(7)	SCI	Single-Crystal to Single-Crystal Conversion Scheme for a Two-Dimensional Metal-Organic Framework Bearing Linear Cd 3 Secondary Building Units	Chao, M. Y.; Chen, J.; Hao, Z. M.; Tang, X. Y.; Ding, L. *; Zhang, W. H.; Young, D. J.; Lang, J. P. A	Crystal Growth Design	2019.9
(8)	SCI	Understanding the Effect of Host Flexibility on the Adsorption of CH4, CO2 and SF6 in Porous Organic Cages	Yang, S.; Chen, L.; Holden, D.; Wang, R.; Cheng, Y.; Wells, M.; Cooper, A. I.; Ding, L*.	Zeitschrift für Krist. – Crystal Material	2019.7

Project 5: Research on Spin and Mechanical Coupling Effects

| Hao Yu

Application code: A040208 (Department of Mathematical and Physical Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - Young Scientists Fund

Introduction: This project is based on the research of the coupling effect of spin and mechanical rotation or stress. LLG equation, kinematics equation and boundary conditions, spin-stress tensor coupling Hamiltonian, spin lattice Monte Carlo simulation and other calculations are used to explore the microscopic mechanism and macroscopic dynamic process of mechanical coupling effect, and establish the physical image of spin-magnetization-mechanical coupling. It provides physical basis and theoretical basis for developing a new type of spin flow detection, generation and control device. The main research achievements include:

1. Stress research of the spin valve component based on the spin transfer torque effect, the stress of nano-spin valve was researched.
2. Research on the velocity law of domain wall motion driven by spin-polarized current, the functional dependence of the velocity of domain wall on current density and temperature was obtained, which successfully explained the previous experimental results.
3. Research on hysteresis loop dynamics of nano-magnet or spin system based on LLG equation, the energy dissipation and dispersion relation of hysteresis loop and the dynamic evolution law of loop were calculated.
4. Design of submicron/nano rotating motor based on spin transfer torque effect, a micro rotating machine based on spin flow was given.
5. Research on brain cognition and capacity of a brain model based on lattice matrix, the proportion of brain capacity with the best cognitive success rate was obtained. Development of this project is of great significance to enhance the means of spin control and develop a new generation of spintronics devices.

Keywords: Spintronics, Angular Momentum Coupling, Spin and Mechanical Rotation, Magnetization Dynamics

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	自旋极化电流驱动的亚微米／马达及其制作方法	CN201510639455.2	ZL201510639455.2	于昊
(2)	实用新型专利	授权	基于铁酸铋的光电传感器元件	CN201520770161.9	ZL201520770161.9	于昊

2）Publication（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Nonlinear dynamics of magnetization evolution in orthogonal spin torque devices: Phases and classification.	Yuan Hui, Zheng Yang, Hao Yu*	AIP Advances	2021.01

Project 6: Investigation of Polariton Behavior and Exciton-Phonon Interaction in Zinc Oxide under Two-Photon Excitation

| Changcheng Zheng

Application code: A040405 (Department of Mathematical and Physical Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - Young Scientists Fund

Introduction: Zinc oxide material is an important representative of the third generation semiconductor materials, with wide direct band gap (Eg ~ 3.37 eV), large exciton binding energy (~ 60 meV), high quality bulk single crystals, thin films and various morphologies of nanostructures, which make it have broad application prospects in new generation optoelectronic devices, light emitting diodes, laser diodes, solar cells, medical imaging and many other fields. Previous researches on the optical properties of zinc oxide focused on linear optical properties, while the research on its nonlinear optical properties is much less.

In this project, we researched the exciton behavior and the temperature effect of exciton-phonon interaction in high-quality ZnO single crystal under two-photon excitation by careful temperature-varying photoluminescence and time-resolved luminescence. We measured the photoluminescence (PL) spectra of zinc oxide single crystal under single photon and two photon excitation conditions from 15K to 300K. Significant difference of luminescence peaks near the band edge was clearly observed, and the self-absorption phenomenon of band edge luminescence in ZnO crystal was proved to be the main reason for this difference by collecting luminescence signals laterally. Some results have been published in Science Bulletin, 2017, 62: 1525-1529. To further research the exciton luminescence mechanism and exciton-phonon interaction mechanism in zinc oxide under different excitation conditions, we measured the time-resolved spectra of zinc oxide at low temperature and variable temperature. The two-electron transition peaks of the bound exciton under two-photon excitation can be observed directly at low temperatures, and the relaxation time of the first-order phonon satellite line peaks was significantly longer than that under single-photon excitation. This may be due to the fact that under the condition of two-photon excitation, in the effective excitation region, excitons were bound and then recombined, but the emitted photons were reabsorbed, and this process was repeated continuously, which led to the prolongation of the lifetime of emission peak related to bound excitons. Relevant results will be discussed with peer experts and papers will be written at the 9th National Zinc Oxide Academic Conference held in Zhenjiang, Jiangsu Province in 2019.

The experimental data and research results of this project will have a deeper understanding of the interaction mechanism between light and matter in semiconductor materials under two-photon (multi-photon) excitation. This will also provide knowledge base and guidance for the practical application of zinc oxide and other semiconductor materials in related fields.

Keywords: Zinc Oxide, Two-Photon Excitation, Activator, Exciton-Phonon Interaction

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	Who make transparent ZnO colorful? – Ion implantation and thermal annealing effects	Chen Y N ; Zheng C C; Ning J Q; Wang R X; Ling C C; Xu S J	Superlattices and Microstructures	2016.11
(2)	SCIE	Extinction of the zero-phonon line and the first-order phonon sideband in excitonic luminescence of ZnO at room temperature: the self-absorption effect	Ye Honggang ; Su Zhicheng; Tang Fei; Zheng Changcheng; Chen Guangde; Wang Jian; Xu Shijie	Science Bulletin	2017.11.30

| (3) | SCIE | Band-gap engineering of porous BiVO4 nanoshuttles by Fe and Mo co-doping for efficient photocatalytic water oxidation | Liu Ren ; Ren Jiabin; Zhao Dian; Ning Jiqiang; Zhang Ziyang; Wang Yongjiang; Zhong Yijun; Zheng Changcheng; Hu Yong | Inorganic Chemistry Frontiers | 2017.12 |
| (4) | SCIE | Development of Modulation p-Doped 1310 nm InAs/GaAs Quantum Dot Laser Materials and Ultrashort Cavity Fabry-Perot and Distributed-Feedback Laser Diodes | Li Qizhu ; Wang Xu; Zhang Ziyang; Chen Hongmei; Huang Yuanqing; Hou Chuncai; Wang Jie; Zhang Ruiying; Ning Jiqiang; Min Jiahua; Zheng Changcheng | ACS Photonics | 2018.03 |

2. Provincial Projects

Project 1: Multiscale Optimization Design of Metal Matrix Composite Piezoelectric Smart Structures Using Shakedown Theorem

| Min Chen

Technical fields: Equipment Manufacturing - Machinery Manufacturing

Programme category: Jiangsu Science and Technology Programme - Basic Research Plan (Natural Science Foundation) - Young-Scholar Programme

Introduction: Usually, Metal Matrix Composites (MMCs) takes metal as the continuous phase and fiber whisker or particle as the reinforcing matrix, with a series of advantages, such as satisfying mechanical properties, such as strength stiffness fatigue wear resistance and design. With MMCs as matrix material, piezoelectric smart structures composed of integrated piezoelectric layers with sensing and actuating energy are widely used in many industrial fields. For example, in the micro-positioning platform, the flexible chain is driven by piezoelectric brake to achieve micron-precision positioning of the structure. In the aerospace field, aircraft wings, aircraft cabins, satellite solar windsurfing and other thin-walled structures are extremely prone to large-scale vibration and deformation. Piezoelectric smart structure can restrain the vibration, noise and deformation of this kind of structural parts and realize lightweight design.

Based on the limit and shakedown theory, the multi-scale analysis of reinforced Metal Matrix Composites (MMCs) is carried out at the representative element and structural level, and the main problems solved are as follows: Shakedown modeling of representative elements of composite materials and prediction of strength; research on large-scale nonlinear optimization algorithm for shakedown problem; and shakedown modeling and optimization design of macroscopic piezoelectric smart structure coupled with multiple physical fields.

The research achievements of this project will provide more accurate theoretical algorithms and effective numerical analysis methods for predicting the bearing domain of various composite materials and modeling coupled piezoelectric materials, and make it possible to integrate plastic optimization of materials and structures in engineering smart structures of composite materials.

Key issues solved:

1. The composite materials were analyzed by dual-scale method. At the meso-scale, the local stress and strain of representative volume elements were researched. At the macro-scale, the global response of composites was analyzed. The relationship between the two scales was given by homogenization theory.

2. The limit and shakedown analysis of composite materials was carried out by using three-dimensional non-conforming and other isoparametric element. The lower bound scheme for limit and shakedown analysis of composite materials is a large-scale nonlinear programming problem. The application of non-conforming and other isoparametric element can not only achieve the same accuracy as the second-order element calculation, but also greatly reduce the planning scale and calculation cost.

3. Combined with large-scale nonlinear optimization open source software package, a calculation platform for limit and shakedown analysis of composite materials was developed. IPOPT, an open source software package based on interior point method, was used to solve the limit and shakedown programming problems of composite materials. The efficiency of interior point method is much higher than that of LANCELOT based on enhanced Lagrange method, and the interface program is more convenient and easy to write, which makes it possible to apply limit and shakedown analysis in practical engineering.

4. Large deformation modeling of thin-walled structures. The application and development of various thin-walled structures often require large deformation and large rotation angle. At this point, the restricted geometric nonlinear model will not be suitable for this situation any more. In addition, for piezoelectric materials, geometric nonlinearity and electroinduced material nonlinearity of piezoelectric materials are considered simultaneously.

The above theory is used to analyze the mechanical properties of carbon nanotubes, metal matrix composites and representative composites with locking lattice, which provides valuable design basis for the design of actual materials and structures.

The research results of this project will provide more accurate theoretical algorithms and effective numerical analysis methods for predicting the bearing domain of various composite materials and modeling coupled piezoelectric materials, and make it possible to integrate plastic optimization of materials and structures in engineering smart structures of composite materials.

Research achievements:

1) Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	基于曲线柔性单元的晶格结构柔性铰链	CN201810020947.7	ZL201810020947.7	陈敏，温欣，张顺琦，王翔
(2)	发明	实审	一种空间六自由度微动平台	CN201811589821.8		陈敏，王忆如，张顺琦，吴斌，朱林
(3)	发明	实审	一种法向二自由度微动平台	CN201811589810.X		陈敏，王忆如，张顺琦，吴斌，朱林
(4)	实用新型专利	授权	一种空间六自由度微动平台	CN201822185058.4	ZL201822185058.4	陈敏，王忆如，张顺琦，吴斌，朱林
(5)	实用新型专利	授权	一种法向二自由度微动平台	CN201822186108.0	ZL201822186108.0	陈敏，王忆如，张顺琦，吴斌，朱林

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Numerical investigation on hydraulic and thermal characteristics of micro latticed pin fin in the heat sink	X. Wang, M. Chen*, D. Tate, H. Rahimi, and SQ. Zhang	International Journal of Heat and Mass Transfer	2020
(2)	EI	Shakedown loading capacity prediction of metal-based nanocomposites	S. Soleimanina, M. Chen*, D. Tate and SQ. Zhang	Journal of Physics: Conf. Series	2019
(3)	EI	基于数据驱动和贝叶斯理论非齐次泊松过程的结构损伤评估方法	朱林，陈敏，贾民平等	振动工程学报	2019

Project 2: Numerical Study of Micromechanics of the Impact Attrition of Elasto-Plastic Granular Materials

| Lianfeng Liu

Technical field: Computational Mechanics

Programme category: Jiangsu Science and Technology Programme - Basic Research Plan (Natural Science Foundation) - General Programme

Introduction: In this research, the complex micromechanics behavior of 'Real' granular materials in the impact process was revealed by computer simulation of the impact boundary wall of granular materials. The effects of viscoplastic deformation between particles on collision breakage, energy consumption, splitting (fracture) mode and mass distribution of sub-particles after collision were researched. A more scientific theory of internal damage rate of particle materials in collision was also established. In this project, the development of micromechanics of granular materials collision was promoted, and the research results could be used as reference for various processing industries.

Keywords: Discrete Element Method, Granulosity, Elaso-Plastic Contact Model

Key issues solved: First issue: We successfully combined THORNTON's improved viscoelastic-plastic model with the existing JKR contact calculation model, and successfully applied it to granulosity collision simulation. The effects of granules surface energy, material plasticity and other factors on granulosity collision were investigated. In addition, we solved another key problem, that is, the generation of discrete element computational model for granulosity.

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Discrete Element Modelling of agglomerate impact using autoadhesive elastic-plastic particles	L. Liu, C. Thornton, S. J. Shaw, E. M. Tadjouddine	Powder Technology	2016
(2)	A&HCI	Energy dissipation during impact of an agglomerate composed of autoadhesive elastic-plastic particles	L. Liu, C. Thornton, S. J. Shaw	Proceedings of the 7th International Conference on Discrete Element Methods	2017
(3)	A&HCI	Simulations of agglomerate impact using autoadhesive elastic-plastic particles	L. Liu, C. Thornton, S. J. Shaw	The 7th International Conference on Discrete Element Methods (DEM7)	2016.8.1-2016.8.4
(4)	EI	Discrete Element Modelling of impact attritions of agglomerates of autoadhesive elasto-plastic particles	Lianfeng Liu, Shufang Liao	Chinese Journal of Applied Mechanics	2015
(5)	A&HCI	Discrete element modelling of impact attritions of agglomerates of fine particles	Lianfeng Liu, Stephen James Shaw; Emmanuel Tadjouddine, Shufang Liao, Colin Thornton	Conference of Computational Mechanics of Granular Materials (CMGM-2014)	2014.8.22-2014.8.24

Project 3: New Methods for the Asymmetric Trifluoromethylation of Organic Molecules

| Yi Li

Programme category: Jiangsu Science and Technology Programme – Basic Research Plan (Natural Science Foundation) - General Programme

Introduction: Fluorinated organic compounds have a broad prospect in developing novel drugs and advanced materials because of their special physicochemical properties, and the research in this field has been in the ascendant. Trifluoromethyl (CF3) functional group has strong electron withdrawing property. The introduction of trifluoromethyl can significantly change the physical, chemical and biological properties of compounds. Compared with ordinary organic molecules, because of the changes in solubility and lipophilicity, compounds with trifluoromethyl will increase metabolic stability, better membrane permeability and bioavailability, and also made them widely used in medicine, pesticides and other fields.

Trifluoromethylation of organic compounds has gradually become a hot research direction in organic synthesis. Although great progress has been made in this field, there is still much room for development, especially in asymmetric Trifluoromethylation reactions. The primary objective of this research is to explore the feasibility of a series of new asymmetric reactions. These reactions can be used to synthesize chiral alkyl alcohols containing trifluoromethyl and perfluoroalkyl groups with important industrial and pharmaceutical value in the future. The focus of the research is to explore an effective way to introduce trifluoromethyl functional groups asymmetrically. Currently, there are still many gaps in the research in this field, which are pioneering, innovative and quite difficult.

Keywords: Asymmetric Reaction, Trifluoromethylation Reaction, Organic Zinc Reagent

Key issues solved: In this research, three kinds of asymmetric trifluoromethyl reactions have been researched, and some achievements have been made, which will increase the further understanding of these reactions and lay a foundation for further exploration in this field in the future.

The achievements of the work are reflected in the following aspects:

1. Trifluoromethyl zinc reagent was synthesized and its application in asymmetric nucleophilic addition reaction was researched.
2. The transition metal palladium catalyzed preparation of dialkene zinc reagent and asymmetric addition reaction of aldehydes were realized, and the results indicated that this kind of reaction had good stereochemical selectivity.
3. The ring-opening reaction of chiral 2, 3-epoxy alcohols with Ruppert reagent was researched, and various reaction conditions were explored, which provided valuable reference results for the development of this type of reaction in the future. In addition, focusing on the development of organic fluorine chemistry in the future, we have also made active explorations in related fields, and achieved certain progress and results.

Research achievements:

1） Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	香豆素类化合物的合成方法	CN201611168346.8	ZL201611168346.8	李毅，湛坤

2） Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Microwave-Assisted Silver-Catalyzed Protodecarboxylation and Decarboxylative Iodination of Aromatic Carboxylic Acids	湛坤，李毅	Catalysts	2017.10.26
(2)	SCI	Synthesis of Isoquinolinones via Regioselective Palladium-Catalyzed C-H Activation/Annulation	李毅，戚文科，武一玫，韩永旭	Catalysts	2017.10.30
(3)	SCI	Visible-Light Photocatalytic E to Z Isomerization of Activated Olefins and Its Application for the Syntheses of Coumarins	湛坤，李毅	Catalysts	2017.11.9

3. Municipal Projects

Project 1: Radiation Hardness of Lanthanide Doped HfO2 and Ultrathin HfO2 Gate Dielectrics

| Cezhou Zhao

Programme category: Suzhou Science and Technology Development Planning Programme – Others

Introduction: In this research, the medium of La-based high dielectric constant (high-k dielectric) was focused. Their radiation response mechanism under X-ray or gamma-ray radiation environment and their radiation resistance reinforcement technology were researched so as to improve their radiation resistance.

In this project, the main objective was to research the X-ray and gamma-ray radiation response and radiation reliability of CeHfOi, CeZr02, LaHf02, LaZr02, NdAl and other grown MOS capacitors so as to understand the working life of these high-k dielectric MOS devices in nuclear technology and radiomedical technology applications.

The results of this project are as follows: Pulsed capacitor voltage and pulsed current voltage techniques were used to characterize the traps and charges induced by X-ray and gamma-ray radiation in La-based ternary media; the radiation hardening technology of them was studied by optimizing the growth conditions and annealing conditions of copper family elements doped ternary gate dielectrics; the effects of grain sizes of monoclinic, cubic and tetrahedral phases in La-based ternary media on radiation-induced inrush current, hole collapse and de-collapse, hydrogen release and transport were researched; and the effects of radiation-induced neutral traps on inrush current soft breakdown and time-dependent dielectric breakdown in ultra-thin pot element-doped ternary gate dielectrics were researched.

Key issues solved:

1. A real-time pulse measurement technique for LaHf02, CeHf02 and other high-k media during and after the irradiation was established.
2. Generation mechanism of La-based Hf02 high-k dielectrics during radiation.
3. Generation mechanism of La-based Hf02 high-k dielectrics after radiation.
4. Radiation induced leakage current and reliability of ultra-thin La-based Hf02 high-k dielectrics.
5. Radiation-resistant hardening process and annealing conditions of La-based Hf02 new high-k dielectrics.

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	实用新型	授权	一种 PN 结瞬时电容能谱测量系统	CN201520179615.5	ZL201520179615.5	吴京锦，赵策洲，刘晨光
(2)	实用新型	授权	一种半导体器件瞬态电容的测试系统	CN201520179612.1	ZL201520179612.1	吴京锦，赵策洲，刘晨光
(3)	发明	授权	一种 PN 结瞬时电容能谱测量方法和系统	CN201510140554.6	ZL201510140554.6	吴京锦，赵策洲，刘晨光

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Real-time and on-site r-ray radiation response testing system for semiconductor devices and its applications	Yifei Mu, Ce Zhou Zhao, Chun Zhao, Yanfei Qi, Yutao Cai, Ivona Z. Mitrovic, Stephen Taylor, Paul R. Chalker	Nuclear Inst. and Methods in Physics Research, B	2016
(2)	SCI	Electrical property and interfacial study of [Equation] high permittivity gate insulators deposited on germanium substrates	Chun Zhao, Ce Zhou Zhao, Stephen Taylor and Paul R. Chalker	Materials	2015
(3)	SCI	Review on Non-Volatile Memory with High-k Dielectrics: Flash for Generation Beyond 32 nm	Chun Zhao, Ce Zhou Zhao, Stephen Taylor and Paul R. Chalker	Materials	2014
(4)	SCI	Hysteresis in Lanthanide Aluminate Oxides Observed by Fast Pulse CV Measurement	Chun Zhao, Ce Zhou Zhao, Qifeng Lu, Xiaoyi Yan, Stephen Taylor and Paul R. Chalker	Materials	2014
(5)	SCI	Hysteresis in Lanthanide Zirconium Oxides Observed Using a Pulse CV Technique and including the Effect of High Temperature Annealing	Qifeng Lu, Chun Zhao, Yifei Mu, Ce Zhou Zhao, Stephen Taylor and Paul R. Chalker	Materials	2015
(6)	SCI	Dielectric relaxation of high-k oxides	Chun Zhao, Ce Zhou Zhao, Matthew Werner, Steve Taylor and Paul Chalker	Nanoscale Research Letters	2013
(7)	EI	Dielectric Relaxation in Lanthanide Doped/Based Oxides Used for High-k Layers	Ce Zhou Zhao, Stephen Taylor, Chun Zhao, and Paul R. Chalker	Advanced Materials Research Vol. 1024	2014

3）Others

1. 建立辐射实验开放实验室 1 个

Project 2: Characterization and Reliability of HfO2 Doped by Lanthanide Elements

| Cezhou Zhao

Programme category: Suzhou Science and Technology Development Planning Programme – Others

Introduction: To overcome the problem of increasing power consumption caused by MOSFET size reduction, the traditional SiO2 or SiON gate dielectrics are being replaced by the gate dielectrics with high dielectric constant (such as hafnium oxide: HfO2). Currently, the integrated circuit manufacturing technology is developing rapidly. Intel used HfO2 (the dielectric constant is about 20) in 45nm process in 2007. To develop the 22nm process, Intel invested $11 billion. These investments include the R&D of gate dielectrics with higher dielectric constant (the dielectric constant is >25). In recent years, a large number of research results have been published at home and abroad for the research of gate dielectrics with high dielectric constant (referred to as high-k dielectrics for short). Applicants were impressed by the achievements of their domestic counterparts, who researched high-k dielectrics from different perspectives (such as growth, characterization, reliability and application). In this research, the high-k dielectrics in the next generation (22 nm technology) MOSFET was systematically researched, that is, lanthanide doped ZrO2 and HfO2 dielectrics, that is, high-k dielectrics with dielectric constant greater than 32.

Key issues solved:

1. The selection of annealing temperature (>800℃) and annealing time is one of the key technical problems to be solved.

2. The way to establish a practical pulse test system to characterize electron traps correctly by measuring dielectric capacitance is another key technical problem we intend to solve.

3. The reliability of dielectric film is also a research content.

Research achievements:

1) Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	实用新型专利	授权	一种可程控智能微电流测量显示系统	CN201120545871.3	ZL201120545871.3	桑迟，魏小莽，赵策洲
(2)	发明	申请	一种可程控智能微电流测量显示系统	CN201110436991.4		桑迟，魏小莽，赵策洲
(3)	实用新型专利	授权	脉冲 I-V 与脉冲 C-V 半导体参数自动测量装置	CN201020676494.2	ZL201020676494.2	魏小莽，赵策洲，周云龙
(4)	发明	授权	脉冲 I-V 与脉冲 C-V 半导体参数自动测量装置	CN201010602838.X	ZL201010602838.X	魏小莽，赵策洲，周云龙
(5)	实用新型专利	授权	脉冲实时场效应管阈值电压参数自动测量装置	CN201120536047.1	ZL201120536047.1	赵策洲；黄鼎；魏小莽
(6)	发明	授权	脉冲实时场效应管阈值电压参数自动测量装置	CN201110429047.6	ZL201110429047.6	赵策洲；黄鼎；魏小莽

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Dielectric relaxation of La-doped zirconia caused by annealing ambient	C. Z. Zhao, M. Werner, S. Taylor, P. R. Chalker, A. C. Jones, and Chun Zhao	Nanoscale Research Letters	2011
(2)	SCI	Extrinsic and intrinsic frequency dispersion of high-k materials in capacitance-voltage measurements	Jing Tao, Ce Zhou Zhao, Chun Zhao, P.Taechakumput, M. Werner, S. Taylor, P.R. Chalker	Materials	2012
(3)	SCI	Thermal Stability of Neodymium Aluminates high-k dielectric deposited by Liquid Injection MOCVD using single source Heterometallic Alkoxide precursors	P. Taechakumput, C. Z. Zhao, S. Taylor, M. Werner, P. R. Chalker, J. M. Gaskell, H. C. Aspinall, A. C. Jones, and Susu Chen	Journal of Nanomaterials	2012
(4)	SCI	Dielectric Relaxation of Lanthanide-based Ternary Oxides: Physical and Mathematical Models	Chun Zhao, Ce ZhouZhao, Jing Tao, Matthew Werner, Steve Taylor and Paul R. Chalker	Journal of Nanomaterials	2012
(5)	SCI	Advanced CMOS Gate Stack: Present Research Progress	Chun Zhao, Ce Zhou Zhao, Matthew Werner, Steve Taylor And Paul R. Chalker	ISRN Nanotechnology	2012
(6)	SCI	Grain size dependence of dielectric relaxation in cerium oxide as high-k layer	Chun Zhao, Ce Zhou Zhao, Matthew Werner, Steve Taylor And Paul R. Chalker	Nanoscale Research Letters	2013

Project 3: Performance Investigation on Prefabricated Ultra High Performance Concrete- Steel Buckling Restrained Shear Wall

| Jun Xia

Technical field: Prefabricated Building Components

Programme category: Suzhou Construction System Scientific Research Project

Introduction: Buckling Restrained Shear Wall (BRSW) is an efficient anti-seismic device which has been researched by many scholars. Of which, the two main forms are Steel Plate Shear Wall (SPSW) and Steel Plate Composite Shear Wall (SPCSW). Generally, the SPSW is embedded in the frame by a thin steel plate, which is connected with beams and columns around. It can effectively resist horizontal loads caused by wind or earthquake. However, it has the weakness of easy buckling. For this purpose, many scholars have researched and invented SPCSW to prevent premature buckling of steel plate in use. Zhao Angjun believes that SPCSW is an innovative form of SPSW, which consists of steel plate and concrete cover plates on both sides. The steel plate shall be the steel with low yield point and high ductility or the steel with high strength and high ductility. Embedded steel plates are connected with beams and columns by bolts or welding. There are certain gaps between the concrete cover plate and the edges of columns and beams so as to avoid the crushing damage of the concrete cover plate when the composite wall works. The bolt connects the embedded steel plate with the concrete slab by opening an elliptical hole so that the bolt has enough sliding space. The location and distribution of connecting bolts are determined according to the in-plane deformation of the embedded steel plate and the constraint stiffness of the concrete cover plate, which ensures that the embedded steel plate will not suffer from out-of-plane local instability and overall instability under the out-of-plane constraint of the concrete cover plate. The concrete cover plate provides out-of-plane restraint to the steel plate and the embedded steel plate provides in-plane stiffness, which play an energy dissipation role under large earthquakes. The greatest advantage of buckling-restrained energy dissipation steel plate shear wall is its buckling-restrained function. The steel plate has large stiffness in the plane, and it also has very full hysteretic behavior under the action of large earthquake.

Keywords: Composite Shear Wall, Bolted Connection, Seismic Design

Key issues solved:

The main design points of common steel plate-concrete composite slab are as follows:
1. Shear resistance of thin steel plate.
2. High-order buckling of thin steel plate.
3. Entry plasticity and energy consumption of tensile band of thin steel plate.

Concrete does not participate in shear resistance, but only provides out-of-plane support of steel plates. In design, ensure that the elastic buckling load of composite plate is higher than the plastic load of steel plate. Generally, it presents a trilinear model.

The ideal design assumptions of steel plate-concrete composite slab are as follows:
1. Shear resistance of thin steel plate.
2. Shear resistance and cracking resistance of concrete, entry plasticity of steel bar, energy dissipation through dispersion cracking, fiber pull-out and plasticity of steel bar.
3. High-order elastic buckling of thin steel plate.
4. After unloading, the elasticity of the core steel plate recovers and plays the role of self-reduction.

The purpose of this research is to try to achieve the ideal design goal of steel plate-concrete composite slab by using high performance concrete and steel, and to analyze and optimize the parameters by finite element model. For the high-performance materials used, the research on their properties detection and quality control was also carried out.

Research achievements:

1) Patent

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	实用新型	授权	钢板剪力墙组件	CN201922373583.3	ZL201922373583.3	夏骏，沈晓明，验俊海

2) Publication（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	Fibre Distribution Characterization of Ultra-High Performance Fibre-Reinforced Concrete (UHPFRC) Plates Using Magnetic Probes	Lufan Li, Jun Xia Chee Chin and Steve Jones	Materials	2020

Biomedical Engineering

Biomedical Engineering has become a new growth point for the national economy. The Ministry of Science and Technology of China has formulated the 'Tenth Five-Year Plan' and put forward the strategic development objectives to form this field into an emerging field. Biomedicine is one of the focused research areas of XJTLU. Our academic staff were recruited from top universities and institutes around the world, and the department has custom-designed laboratories that are very well-equipped for research. By the end of 2020, XJTLU has successfully completed 20 government research projects in the field of biomedical engineering, including 8 national projects, 7 provincial projects and 5 municipal projects.

1.National Projects

Project 1: Bioinformatics Approaches for RNA Methylation-Related High-Throughput Sequencing Data and RNA Methylome Regulatory Network Reconstruction

| Jia Meng

Application code: C0608 (Department of Life Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - General Programme

Introduction:

Project Background: With the development of high-throughput sequencing technology, especially the advent of MeRIP-Seq technology, RNA epigenetics has gained more attentions. Recent research has indicated that 6-methyladenine modified m6A of RNA is involved in regulating cell differentiation, RNA cleavage, protein translation and other important functions.

Primary research contents: In this project, the bioinformatics methods and tools for RNA methylation sequencing omics data was further improved, including: quality control and error correction of MeRIP-Seq and RNA BS-Seq data, more statistically effective differential methylation analysis model, visualization method of RNA modification and combination mode of different modifications. The core contents of this project focused on the regulation means of RNA methylation spectrum. The nonparametric Bayesian network generation model system was used to reconstruct the network mechanism that RNA methylation modification sites were regulated by related enzyme genes, and the possible application of the system regulation mechanism in the treatment of hepatitis and other diseases and drug target screening was further explored.

Important results: The research group published 28 scientific research papers, including 23 SCI papers and 5 EI papers, including 6 Q1 papers. Several RNA modification omics databases and analysis tools were developed.

Key data: The research project focuses on methodological content, mostly using publicly available data from the NCBI.

Scientific significance: This project provided key epitranscriptome gene regulatory network information and a series of effective tools for RNA modification omics data for research projects in RNA methylation related fields.

Keywords: RNA odification, Epitranscriptome, RNA Methylation, Bioinformatics, Modification

Key issues solved:

1. Mathematical description of RNA methylation co-regulation module
2. Prediction of targeting sites of RNA methylation and demethylase
3. Identification method of systematic deviation of high-throughput technology of RNA methylation omics

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	WHISTLE: a high-accuracy map of the human N-6-methyladenosine (m(6)A) epitranscriptome predicted using a machine learning approach	Chen, Kunqi; Wei, Zhen; Zhang, Qing; Wu, Xiangyu; Rong, Rong; Lu, Zhiliang; Su, Jionglong; de Magalhaes, Joao Pedro; Rigden, Daniel J; Meng, Jia*	Nucleic Acids Research	2019
(2)	SCIE	DRUM: Inference of Disease-Associated m(6)A RNA Methylation Sites From a Multi-Layer Heterogeneous Network	Tang, Yujiao; Chen, Kunqi; Wu, Xiangyu; Wei, Zhen; Zhang, Song Yao; Song, Bowen; Zhang, Shao Wu; Huang, Yufei; Meng, Jia*	Frontiers in Genetics	2019
(3)	SCIE	m6A comet: large-scale functional prediction of individual m(6)A RNA methylation sites from an RNA co-methylation network	Wu, Xiangyu; Wei, Zhen; Chen, Kunqi; Zhang, Qing; Su, Jionglong; Liu, Hui; Zhang, Lin*; Meng, Jia*	BMC Bioinformatics	2019
(4)	SCIE	Predict Epitranscriptome Targets and Regulatory Functions of N-6-Methyladenosine (m(6)A) Writers and Erasers	Song, Yiyou; Xu, Qingru; Wei, Zhen; Zhen, Di; Su, Jionglong; Chen, Kunqi*; Meng, Jia*	Evolutionary Bioinformatics	2019
(5)	SCIE	MeT-DB V2.0: elucidating context-specific functions of N-6-methyl-adenosine methyltranscriptome	Liu Hui#; Wang Huaizhi#; Wei Zhen#; Zhang Songyao; Hua Gang; Zhang Shao Wu; Zhang Lin; Gao Shou Jiang; Meng Jia*; Chen Xing*; Huang Yufei*	Nucleic Acids Research	2018
(6)	SCIE	Enhancing Epitranscriptome Module Detection from m(6) A-Seq Data Using Threshold-Based Measurement Weighting Strategy	Chen Kunqi; Wei Zhen; Liu Hui; de Magalhaes Joao Pedro; Rong Rong; Lu Zhiliang; Meng Jia*	Biomed Research International	2018
(7)	SCIE	QNB: differential RNA methylation analysis for count-based small-sample sequencing data with a quad-negative binomial model	Lian Liu; Shao-Wu Zhang*; Yufei Huang; Jia Meng*	BMC Bioinformatics	2017
(8)	SCIE	trumpet: transcriptome-guided quality assessment of m (6) A-seq data	Zhang, Teng; Zhang, Shao Wu*; Zhang, Lin; Meng, Jia*	BMC Bioinformatics	2018
(9)	SCIE	Topological Characterization of Human and Mouse m(5)C Epitranscriptome Revealed by Bisulfite Sequencing	Wei Zhen; Panneerdoss Subbarayalu; Timilsina Santosh; Zhu Jingting; Mohammad Tabrez A; Lu Zhi Liang; de Magalhaes Joao Pedro; Chen Yidong; Rong Rong; Huang Yufei*; Rao Manjeet K*; Meng Jia*	International Journal of Genomics	2018
(10)	SCIE	RMDisease: a database of genetic variants that affect RNA modifications, with implications for epitranscriptome pathogenesis.	Chen, Kunqi#; Song, Bowen#; Tang, Yujiao#; Wei, Zhen*; Xu, Qingru; Su, Jionglong; de Magalhães, João Pedro; Rigden, Daniel J; Meng, Jia*	Nucleic Acids Research	2020

(11)	SCIE	MetaTX: deciphering the distribution of mRNA-related features in the presence of isoform ambiguity, with applications in epitranscriptome analysis	Wang, Yue; Chen, Kunqi; Wei, Zhen; Coenen, Frans; Su, Jionglong; Meng, Jia*	Bioinformatics	2020
(12)	SCIE	Bioinformatics approaches for deciphering the epitranscriptome: Recent progress and emerging topics	Liu, Lian#; Song, Bowen#; Ma, Jiani#; Song, Yi; Zhang, Song-Yao; Tang, Yujiao; Wu, Xiangyu; Wei, Zhen; Chen, Kunqi; Su, Jionglong; Rong, Rong; Lu, Zhiliang; de Magalhães, João Pedro; Rigden, Daniel J; Zhang, Lin; Zhang, Shao-Wu; Huang, Yufei; Lei, Xiujuan*; Liu, Hui*; Meng, Jia*;	Comput Struct Biotechnol J	2020
(13)	SCIE	Global analysis of N6-methyladenosine functions and its disease association using deep learning and network-based methods	Zhang, Song Yao; Zhang, Shao Wu*; Fan, Xiao Nan; Meng, Jia; Chen, Yidong; Gao, Shou Jiang; Huang, Yufei*	PLoS Computational Biology	2019
(14)	SCIE, ISTP	FunDMDeep-m (6) A: identification and prioritization of functional differential m (6) A methylation genes	Zhang, Song Yao; Zhang, Shao Wu*; Fan, Xiao Nan; Zhang, Teng; Meng, Jia; Huang, Yufei*	Bioinformatics	2019
(15)	SCIE	m7GHub: deciphering the location, regulation and pathogenesis of internal mRNA N7-methylguanosine (m(7)G) sites in human	Song, Bowen; Tang, Yujiao; Chen, Kunqi; Wei, Zhen; Rong, Rong; Lu, Zhiliang; Su, Jionglong; de Magalhaes, Joao Pedro; Rigden, Daniel J.; Meng, Jia	Bioinformatics	2020
(16)	SCIE	m6A-Atlas: a comprehensive knowledgebase for unraveling the N6-methyladenosine (m6A) epitranscriptome	Yujiao, Tang; Kunqi, Chen; Bowen, Song; Jiongming, Ma; Xiangyu, Wu; Qingru, Xu; Zhen, Wei; Jionglong, Su; Gang, Liu; Rong, Zhiliang, Lu; João Pedro, de Magalhães; Daniel J, Rigden; Jia, Meng	Nucleic Acids Research	2020
(17)	SCIE	PSI-MOUSE: Predicting Mouse Pseudouridine Sites From Sequence and Genome-Derived Features	Song, Bowen; Chen, Kunqi; Tang, Yujiao; Ma, Jialin; Meng, Jia; Wei, Zhen	Evolutionary Bioinformatics	2020
(18)	SCIE	Prediction of RNA Methylation Status From Gene Expression Data Using Classification and Regression Methods	Xue, Hao; Wei, Zhen; Chen, Kunqi; Tang, Yujiao; Wu, Xiangyu; Su, Jionglong; Meng, Jia	Evolutionary Bioinformatics	2020
(19)	SCIE	PIANO: A Web Server for Pseudouridine-Site (psi) Identification and Functional Annotation	Song, Bowen; Tang, Yujiao; Wei, Zhen; Liu, Gang; Su, Jionglong; Meng, Jia; Chen, Kunqi	Frontiers in Genetics	2020
(20)	SCIE	ISGm1A: Integration of Sequence Features and Genomic Features to Improve the Prediction of Human m 1 A RNA Methylation Sites	Liu, Lian; Lei, Xiujuan; Meng, Jia; Wei, Zhen	IEEE Access	2020
(21)	SCIE	m5UPred: A Web Server for the Prediction of RNA 5-Methyluridine Sites from Sequences.	Jiang, Jie; Song, Bowen; Tang, Yujiao; Chen, Kunqi; Wei, Zhen; Meng, Jia	Molecular Therapy - Nucleic Acids	2020
(22)	SCIE	LITHOPHONE: Improving lncRNA Methylation Site Prediction Using an Ensemble Predictor	Liu, Lian; Lei, Xiujuan; Fang, Zengqiang; Tang, Yujiao; Meng, Jia; Wei, Zhen	Frontiers in Genetics	2020
(23)	SCIE	m(6)A Reader: Epitranscriptome Target Prediction and Functional Characterization of N (6)-Methyladenosine (m(6)A) Readers	Zhen, Di; Wu, Yuxuan; Zhang, Yuxin; Chen, Kunqi; Song, Bowen; Xu, Haiqi; Tang, Yujiao; Wei, Zhen; Meng, Jia	Front Cell Dev Biol	2020
(24)	SCIE	Weakly supervised learning of RNA modifications from low-resolution epitranscriptome data	Huang, Daiyun; Song, Bowen; Wei, Jiangjue; Su, Jionglong; Coenen, Francis; Meng, Jia	Bioinformatics	2021
(25)	SCIE	ConsRM: a centralized platform for conservation analysis and functional prioritization of individual RNA methylation sites	Song, Bowen; Chen, Kunqi; Tang, Yujiao; Wei, Zhen; Su, Jionglong; De Magalhães; Rigden, Daniel; Meng, Jia	Briefings in Bioinformatics	2021

Project 2: Convolutional Neural Network-based Automatic Recognition System

| **Jionglong Su**

Technical Field: Precision Medicine

Programme Category: National Key Laboratory of Software Architecture – Open Project

Introduction: Deep Learning, as the hottest topic in the discipline of machine learning, has attracted extensive attention from various industries. The personalization of the US medical industry, Microsoft's automatic simultaneous interpretation system, and the design of Alpha Go cannot be developed without the support of deep learning technology. As the era of big data progressed, more and more people are also focusing on the development of deep learning, and the image recognition technology is the main point that can realize the value of deep learning. As the people has higher and higher requirements for the image recognition technology, the original multi-layer neural network is limited to the lack of spatial structure information and difficult training, so that it can not satisfy with the people, while the convolutional neural network, as an effective recognition algorithm developed on the basis of artificial neural networks, comes into our sight. But when running the CNN algorithm, the image must be converted into an array or matrix firstly, and the appropriate parameters must be adjusted accordingly. Therefore, we are now focusing on study how to effectively, conveniently and accurately use CNN in the image recognition and how to put it into application on a large scale.

Keywords: Medical Images, Medical Robots

Key issues solved:

1. Cutting and classification of medical images.
2. Human-machine interaction of medical robots.

Research achievements:

1） Patents

No.	Category	Status	Patents Title	Application no.	Inventor(s)
(1)	发明	审查	医疗图像分类模型的训练方法、系统、存储介质及医疗图像处理装置	CN202011178984.4	苏炯龙、孟佳、胡华峰
(2)	发明	审查	Compact SegUnet 自学习模型、构建方法及应用	CN201910151252.7	苏炯龙、马飞、孟佳、宋思凡、黄戴赟、时长军、肖晟、杨春潇
(3)	发明	审查	基于 Compact SegUnet 自学习模型的双染色体图像切割方法	CN201910152076.9	苏炯龙、马飞、孟佳、宋思凡、黄戴赟、时长军、肖晟、杨春潇
(4)	发明	审查	基于 BagPix2Pix 自学习模型的弯曲染色体图像拉直方法、系统、可读存储介质及图像处理装置	CN202010360518.1	苏炯龙、马飞、孟佳、宋思凡、黄戴赟、时长军、肖晟、杨春潇
(5)	发明	审查	弯曲染色体图像拉直模型生成方法、模型的应用、系统、可读存储介质及计算机设备	CN202010360505.4	苏炯龙、马飞、孟佳、宋思凡、黄戴赟、时长军、肖晟、杨春潇

2） Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI	LOCATION-AWARE CONVOLUTIONAL NEURAL NETWORKS BASED BREAST TUMOR DETECTION	Huafeng Hu , Frans Coenen , Fei Ma , Jeyarajan Thiyagalingam, Jionglong Su	BRAIN 2018	2018
(2)	SCI	Research on Social Robot's Whole Body LowCost Tactile Perception System Based on Event-trigger for Natural Interaction Scenarios	Shengzhao Lin, Jionglong Su, Sifan Song, Jiaming Zhang	IEEE Access	2021
(3)	EI	Learning Bionic Motions by Imitating Animals	Da ZHAO; Sifan SONG; Jionglong Su; Zijian JIANG; Jiaming ZHANG	ICMA, 2020	2020
(4)	SCI	Intention Understanding in Human-robot Interaction Based on Visual-NLP Semantics	Zhihao Li, Yishan Mu, Zhenglong Sun, Sifan Song, Jionglong Su, and Jiaming Zhang	Frontiers in Neurorobotics	2021
(5)	EI	Chromosome Classification with Convolutional Neural Network based Deep Learning	Wenbo Zhang, Sifan Song, Tianming Bai, Yanxin Zhao, Fei Ma, Jionglong Su, Limin Yu	CISP-BMEI 2018	2018

Project 3: Studying Gene Regulation Responses to Coaggregation between Oral Bacteria using RNA-Seq and Bioinformatics Approaches

| Choo Siew Woh

Application code: C060701 (Department of Life Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - International Young Scientists Programme

Introduction: Cell-cell interactions between genetically distinct bacteria, known as coaggregation, are important for the formation of mixed-species biofilms such as dental plaque. Interactions lead to gene regulation in the partner organisms that may be critical for adaptation and survival in mixed-species biofilms. Here, gene regulation responses to coaggregation between Streptococcus gordonii and Fusobacterium nucleatum were studied using dual RNA-Seq. Initially, S. gordonii DL1 was shown to coaggregate strongly with F. nucleatum in buffer or human saliva. Using confocal laser scanning microscopy and transmission electron microscopy, cells of different species were shown to be evenly distributed throughout the coaggregate and were closely associated with one another. This distribution was confirmed by serial block face sectioning scanning electron microscopy, which provided high resolution three-dimensional images of coaggregates. Cell-cell sensing responses were analysed 30 minutes after inducing coaggregation in human saliva. By comparison with monocultures, 16 genes were regulated following coaggregation in F. nucleatum whereas 119 genes were regulated in S. gordonii. In both species, genes involved in amino acid and carbohydrate metabolism were strongly affected by coaggregation. In particular, one 8-gene operon in F. nucleatum encoding sialic acid uptake and catabolism was up-regulated 2- to 5-fold following coaggregation. In S. gordonii, a gene cluster encoding functions for phosphotransferase system-mediated uptake of lactose and galactose was down-regulated up to 3-fold in response to coaggregation. The genes identified in this study may play key roles in the development of mixed-species communities and represent potential targets for approaches to control dental plaque accumulation.

Keywords: Biofilm, RNA-Seq, Streptococcus Gordonii, Fusobacterium Nucleatum, Coaggregation

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	Transcriptional responses of Streptococcus gordonii and Fusobacterium nucleatum to coaggregation	Mutha NVR, Mohammed WK, Krasnogor N, Tan GYA, Jakubovics NS and Choo SW	Mol Oral Microbiol	2018 Dec
(2)	SCI	Transcriptional profiling of coaggregation interactions between Streptococcus gordonii and Veillonella parvula by Dual RNA-Seq	Naresh V.R. Mutha, Waleed K. Mohammed, Natalio Krasnogor, Geok Y. A. Tan, Wei Yee Wee, Yongming Li, Nicholas S. Jakubovics and Siew W. Choo	Scientific Reports	2019

Project 4: Regulation of T cell Receptor (TCR) Signaling by SUMOylation of Immune Adaptor SLP-76 in T Cells

| Hebin Liu

Application code: C0801 (Department of Life Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - General Programme

Introduction: SUMOylation are widely involved in many important physiological and pathological processes of cells, including immune diseases and viral infections. However, the role and mechanism of SUMOylation pathway in TCR signal transduction is still unclear. The project was implemented by focusing on the core scientific problem that the cross dialogue between SUMO pathway and immune adaptor proteins such as SLP-76 and ADAP regulates T cell function. We reported for the first time that Ubc9, a key E2 conjugate enzyme in ubiquitinized SUMO pathway, interacts with SLP-76 to regulate T cell activation. For the difficulty of low SUMO level of SLP-76 in vivo and in vitro, we improved and established an efficient and stable SUMO analysis and identification method of SLP-76 in vitro. We elucidated that SLP-76 was modified by SUMOylation through functional interaction between its C-terminal and Ubc9, and successfully identified two important SUMO sites of proline enrichment of SLP-76 by mass spectrometry. Functionally, depending on the level of SLP-76 SUMO, Ubc9 and SLP-76 synergistically & specifically enhance TCR-mediated IL-2 transcription, and SLP-76 SUMO is necessary for the formation of IL-2 transcription-dependent functional complexes in T cell activation. In the research of the project, we also found that Ubc9 can also interact with the nuclear localization sequence of ADAP, an adaptor protein related to SLP-76 function, and regulate the immune adhesion function of T cells. We confirmed that Ubc9-ADAP interaction can regulate the localization of Rap1-RapL, a downstream effector molecule of ADAP, which plays an important role in integrin-mediated T cell adhesion, on cell membrane and selectively activate Rac1. In addition, based on the fact that Ubc9 mediates SUMO-modified MDA5 to regulate the infection and replication of various RNA viruses, including HIV, we further explored the potential application of the interaction between Ubc9 and immune adaptor protein in antiviral infection. In the process of establishing the dsRNA virus infection model, we found for the first time that STAU1 can compete with MDA5 to recognize and bind to IBDV virus dsRNA and win, thus inhibiting IFN-β gene transcription mediated by MDA5 in this virus infection. This is an important strategy and mechanism model for IBDV to evade immune suppression caused by the host IFN antiviral response. In a word, the research clarified for the first time that the SUMO modification pathway selectively interacts with SLP-76 and ADAP through key conjugase Ubc9, and participates in TCR-mediated T cell activation signal transduction and integrin-mediated T cell immune adhesion regulation, respectively. Further, it provides new strategies and drug targets for controlling and correcting immune diseases and viral infectious diseases caused by T cell activation or adhesion disorder. Published 3 high-level SCI papers as correspondent authors, with 2 papers to be published; applied for 2 national invention patents; trained 2 doctoral students, of which one has graduated and one is studying.

Keywords: Immune Adaptor Proteins, SUMO, T Cell Receptor, Signal Transduction

Research achievements:

1） Patents

No.	Category	Status	Patents Title	Application no.	Inventor(s)
(1)	发明	审查	T 细胞特异接头蛋白 SLP-76 类泛素化的方法及相应体外鉴定	CN2019101094047	刘合宾，熊伊韦
(2)	发明	审查	一种非 (TCR/CD3) 刺激依赖的的体外特异激活鼠 T 细胞的方法	CN201711015876.3	刘合宾，熊伊韦，杨乃琦

Project 5: Small Sample Based High-Resolution Differential Analysis of RNA Methylation Sequencing Data

| Jia Meng

Application code: F012405 (Department of Information Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - Young Scientists Fund

Introduction: Project background: As one of the most basic gene expression regulation mechanisms in organisms, RNA modification widely exists in three biological kingdoms. The latest edition of RNA modification database Modics in 2017 contains 168 RNA modification forms, of which methylation modification accounts for about 80%. Currently, the research on RNA modification focuses on 6-methyladenosime (M6A), 5-methylcytosine (M5C), pseudouridine (A), hydroxymethylcytosine (hm5C) and 1-methyladenosime (mlA). Apart from the above modifications, people still know little about the distribution characteristics, biological functions and regulatory pathways of most other kinds of RNA modifications. It can be said that what we have known is only the tip of the iceberg in the world of RNA modification, and there are still a lot of unknowns waiting for people to explore in the field of RNA modification.

Main research contents: For this project, the statistical methods for the processing of biological information data based on high-throughput data of RNA methylation modification were developed, including:

1. Based on a small sample, the'Over-dispersion' phenomenon in MeRIP-Seq was statistically modeled, and the significance of difference analysis was corrected by estimating the 'Intraclass Variability'.

2. Based on the spatial information of alignment sequences in transcriptome and Hidden Markov Model, the spatial resolution and accuracy of difference analysis algorithm based on MeRIP-Seq were further improved.

Important results: The research group published 13 scientific research papers, including 9 SCI papers and 4 EI papers. Among them, there are two SCI papers directly aiming at the main research contents of the project. In addition, the research group pointed out that there is a histological regulation law of co-methylation regulation module in RNA methylation spectrum, which was quoted by Nature.

Key data: For the research project, the methodological contents were focused on, and the public data from NCBI were used in most cases

Scientific significance: These work provided more effective statistical methods, more practical software tools and more convenient biological information databases for the processing of high-throughput data of RNA methylation modification.

Keywords: RNA Methylation, Epitranscriptomics, 6-Methyladenine, Epigenetics, Bioinformatics

Key issues solved:

1. Based on a small sample, the'Over-dispersion' phenomenon in MeRIP-Seq was statistically modeled, and the significance of difference analysis was corrected by estimating the 'Intraclass Variability'. Estimating variability using biological duplicate samples has become an essential part of sequencing data analysis. Since the difference analysis of MeRIP-Seq involved four groups of 2X2 samples (research group/control group, immunoprecipitation sample/input control sample) instead of two groups of samples in the usual model, the existing methods can not be directly applied to the difference analysis of MeRIP-Seq.

2. Based on the spatial information of alignment sequences in transcriptome and Hidden Markov Model, the spatial resolution and accuracy of difference analysis algorithm based on MeRIP-Seq were further improved. The existing methods follow the basic process of 'Feature Extraction - Difference Analysis'. Since the deviation of feature extraction process will automatically accumulate in the process of difference analysis, resulting in failure or deviation of difference feature extraction.

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	MeT-DB: a database of transcriptome methylation in mammalian cells	H. Liu; M. A. Flores; J. Meng; L. Zhang; X. Zhao; M. K. Rao; Y. Chen; Y. Huang	Nucleic Acids Res	2014.10.9
(2)	SCIE	Decomposition of RNA methylome reveals co-methylation patterns induced by latent enzymatic regulators of the epi transcriptome	Lian Liu; Shao-Wu Zhang; Yu-Chen Zhang; Hui Liu; Lin Zhang; Runsheng Chen; Yufei Huang; Jia Meng	Molecular Biosystems	2015.01.01
(3)	SCIE	Spatially Enhanced Differential RNA Methylation Analysis from Affinity-Based Sequencing Data with Hidden Markov Model	Yu-Chen Zhang; Shao-Wu Zhang; Lian Liu; Hui Liu; Lin Zhang; Xiaodong Cui; Yufei Huang; Jia Meng	Biomed Research International	2015.01.01
(4)	SCIE	DRME: count-based differential RNAmethylation analysis at small sample size scenario	Lian Liu; Shao-Wu Zhang; Fan Gao; Yixin Zhang; Yufei Huang; Runsheng Chen; Jia Meng	Analytical Biochemistry	2016.2.2
(5)	SCI	高通量 rna 甲基化测序数据处理与分析研究进展	Lian Liu; Shao-Wu Zhang; Jia Meng; Runsheng Chen	Progress in Biochemistry and Biophysics	2015. 1. 1
(6)	EI	Differential analysis of RNA methylome with improved spatial resolution	Yu-Chen Zhang; Shao-Wu Zhang; Lian Liu; Lin Zhang; Hui Liu; Xiaodong Cui; Yufei Huang; Jia Meng	2014 IEEE Global Conference on Signal and Information Processing (GlobalSIP)	2014. 12. 1
(7)	EI	Detecting differentially methylated mRNA from MeRIP-Seq with likelihood ratio test	Lin Zhang; Jia Meng; Hui Liu; Xiaodong Cui; Shao-Wu Zhang; Yidong Chen; Yufei Huang	2014 IEEE Global Conference on Signal and Information Processing (GlobalSIP)	2014. 12. 1

Project 6: Designing Tissue Inhibitors of Metalloproteinases (TIMPs) for Specific Inhibition against Membrane-Type1 Matrix Metalloproteinase (MT1-MMP) Involved in Cancer Metastasis

| Meng Huee Lee

Application code: C050203 (Department of Life Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - General Programme

Introduction: Background: Membrane type 1 matrix metalloproteinase (MT1-MMP) is a membrane-anchored zinc-dependent matrix metalloproteinase (MMP) involved in cancer cell metastasis and tumor proliferation. The physiological activity of MT1-MMP is regulated by endogenous inhibitor, tissue inhibitor of matrix metalloproteinases (TIMP)-2.

Research purpose: The objective of this NSFC project is to enhance the effect of TIMP-2 on MT1-MMP by using a set of different transmembrane anchors to transfer TIMP to the cell surface. The transmembrane anchors mentioned include the heme protein +/-transmembrane domain of MT1-MMP and other transmembrane proteins anchored by glycosyl phosphatidylinositol (GPI) such as RECK and prion proteins.

Important results: We have successfully designed a group of modified TIMP-2, which can form complexes with MT1-MMP in cells and on cell surface. We achieved this by fusing TIMP-2 to the heme + +/-transmembrane domain of the target enzyme MT1-MMP. So far, we have created two modifications TIMP-2 (named 'T2: PEX + TM' and 'T2: PEX') which can associate with MT1-MMP and significantly reduce the enzyme activity of MMP compared with wild-type TIMP-2.

Key data: Cervical cancer cells expressing modified TIMP (HeLa) indicated significantly lower gelatinolytic activity (<90%) and mobility (<50%) than control cells. In mouse xenotransplantation, compared with the control group, the volume and weight of cervical tumor tissue in TIMP group decreased by as much as 85%.

Significance of findings:

1. The fusion method is innovative. This is the first example of TIMP designed specifically to suppress MMP in this way.
2. The pattern of MT1-MMP inhibition is highly specific. Since the intrinsic affinity of heme binding protein domain to MT1-MMP, our modified TIMP 'T2: PEX + TM' and 'T2: PEX' can selectively recognize MT1-MMP instead of other MMPs.
3. So far, we have indicated that our modified TIMP is highly effective in tumor suppression in mouse xenografts. We believe that TIMP can be further developed as a biological agent in the treatment of human cancer.

Keywords: Matrix Metalloproteinases, Tissue Inhibitor of Matrix Metalloproteinases, Protein Engineering, Membrane Type 1 Matrix Metalloproteinase, Tumor

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI,SSCI	确定膜型 1 基质金属蛋白酶（MT1-MMP）与金属蛋白酶（TIMP）-2 组织抑制剂使用 血红素结合蛋白酶作为载体：靶向方法	BingJie Jiang , Yan Zhang, Jian Liu, Anastasia Tsigkou, Magdalini Rapti, Meng Huee Lee	Oncotarget	2017.02.14
(2)	SCI,SSCI	扩大金属蛋白酶（TIMP）-1 组织抑制剂的表面锚定的金属蛋白酶通过替代其 C 终端域的活性：对抗癌作用的影响	Duan JX , Rapti M, Tsigkou A, Lee MH	pLOS ONE	2015.08.26
(3)	SCI,SSCI	ADAMTS13 和 15 不受 TIMP-1, -2, -3 和 -4 的全长和 N 端结构域形式调节	Guo C , Tsigkou A, Lee MH	Biomed Rep	2016.01.04
(4)	SCI,SSCI	子宫平滑肌瘤中孕激素受体表达增加：与年龄，平滑肌瘤数目和临床症状相关	Tsigkou A , Reis FM, Lee MH, Jiang B, Tosti C, Centini G, Shen FR, Chen YG, Petraglia F	Fertil Steril	2015.05.23
(5)	SCI,SSCI	肌球蛋白和基质金属蛋白酶 14 mRNA 在子宫肌瘤中的表达水平与痛经相关	Tsigkou A , Reis FM, Ciarmela P, Lee MH, Jiang B, Tosti C, Shen FR, Chen YG, Petraglia F	Reprod Sci	2015.12.22
(6)	SCIE	A Novel 3D Model for Visualization and Tracking of Fibroblast-Guided Directional Cancer Cell Migration	Zhang, Y., Jiang, B.J., Lee, M.	Biology	2020
(7)	SCIE	Translocating a High-Affinity Designer TIMP-1 to the Cell Membrane for Total Renal Carcinoma Inhibition: Putting the Prion Protein to Good Use.	Jiang, B.J., Xu, Y.W., Zhang, Y.H., Lee. M.	Mol Cell Biol	2019
(8)	SCIE	Targeting a Designer TIMP-1 to the Cell Surface for Effective MT1-MMP Inhibition: A Potential Role for the Prion Protein in Renal Carcinoma Therapy	Jiang, B.J., Liu, J., Lee, M.	Molecules	2019

Project 7: Detection of Tuberculosis-Specific Antibodies in Patient Sera by Using Glycan Gold Nanoparticles

| Boris Tefsen

Application code: H1911 (Department of Health Sciences)

Programme category: National Natural Science Foundation of China (NSFC) – International Young Scientists Programme

Introduction: Tuberculosis is a devastating disease that is still affecting millions of people globally, including in China, despite the existence of several drugs. Mainly in developing countries, adequate treatment is hindered by several factors; one of which is that the currently used diagnosis methods are slow and expensive. In this project, a potential serodiagnosis tool was tested that could help to combat the disease early and properly in tuberculosis patients. The main aim of this research proposal was to investigate the potential use of the typical non-mammalian carbohydrates galactofuranose (Galf) and rhamnose (Rham) that are present in the cell envelope of Mycobacterium tuberculosis for diagnostic purposes of tuberculosis. A secondary goal of the project was to gain insights in the immunomodulatory capacity of these two carbohydrates. The results of the project show differential responses in different patients groups compared to control groups in the ELISA assay; however, these cannot predict whether the serum donor is suffering from tuberculosis at this stage. The second part of this project showed it is possible to study the immunomodulatory potential of mycobacterial glycans by using GNPs.

Keywords: Glyconanoparticles, Carbohydrates, Immunomodulation, Serodiagnosis, Tuberculosis

Project 8: Investigation of the Role Carbonic Anhydrase Plays in ALS Pathology

| Jian Liu

Application code: H0912 (Department of Health Sciences)

Programme category: National Natural Science Foundation of China (NSFC) – General Programme

Introduction: The objective of this project is to research the role of Carbonic Anhydrase I (CA1) in the pathology of Amyotrophic Lateral Sclerosis (ALS). We found that the content of CA1 protein increased in spinal cord of ALS patients. Up to now, the function of CA1 protein in spinal cord is still unclear. First, we determined the expression of CA1 in human motor neurons and the biochemical pathological changes in ALS. Second, we used in vitro cells and Drosophila models to research the mechanism of CA1 in ALS pathology. Our results indicated that CA1 was expressed in human motor neurons, and that a portion of CA1 protein was not free in cytoplasm as predicted, but bound to endoplasmic reticulum (ER) markers. Moreover, ER-bound CA1 increased more in ALS patients than free CA1 in cytoplasm. Since endoplasmic reticulum stress is a definite fact in the pathological mechanism of ALS, we speculated or hypothesized that CA1 may play a role in the pathological mechanism of ALS through the information channel of endoplasmic reticulum stress. In N2 cells, the expression of CA1 indicated that it can alleviate the endoplasmic reticulum stress response caused by mutant SOD1. In COS7 cells, however, the expression of CA1 can lead to toxicity. In the Drosophila model, the expression of CA1 in neuromotor cells had no effect on the development process of Drosophila and the locomotion of larvae. But in the test of negative geotaxis behavior of mature Drosophila melanogaster, the expression of CA1 reduced this test index and shortened the life span of Drosophila melanogaster. These results indicated that CA1 can cause degeneration of neuromotor cells in Drosophila melanogaster, which is another new model to research the pathological mechanism of ALS and explore drug targets. It plays an important role and significance in ALS research field.

Keywords: Amyotrophic Lateral Sclerosis (ALS), Carbonic Anhydrase I, Endoplasmic Reticulum Stress, Motor Neuron, Drosophila Model

2. Provincial Projects

Project 1: Methods for the Differential Analysis of RNA Methylation Sequencing Data with Small Sample

| Jia Meng

Technical fields: Electronic Information - Software - Application Software

Programme category: Jiangsu Science and Technology Programme - Basic Research Plan (Natural Science Foundation) - Young-Scholar Programme

Introduction: Recently, RNA methylation has been found to participate in biological clock, RNA decomposition and other important biochemical functions. Due to the poor stability of RNA molecules, gene subtypes and differential expression of RNA, the existing tools cannot effectively meet the needs of data difference analysis of the emerging RNA methylation sequencing (MeRIP-Seq).

In this project, the construction of a set of software platform for MeRIP-Seq data difference analysis has actually been completed: Its core is the statistical model based on small samples (or over-dispersion) RNA methylation difference analysis. The key research contents also cover the removal of local anomalies, high-resolution difference analysis based on Hidden Markov Model, visualization of methylation sites, fusion of various omics data and RNA methylation data, algorithm optimization of omics data, parallel computing, open source cross-platform software implementation and other aspects.

The developed software and method have been directly applied to the MeRIP-Seq data of breast cancer to research the abnormal RNA methylation in cancer. In the previous research, it was found that the software prediction results were highly consistent with the experimental conditions. Moreover, the anti-cancer pathway P53 was significantly enriched with RNA differential methylation genes in breast cancer cells, which indicated the relationship between RNA methylation and cancer mechanism and its future application prospect in cancer treatment.

Keywords: RNA Modification, Epitranscriptome, MeRIP-Seq

Key issues solved:

1. Based on a small sample, the 'over-dispersion' phenomenon in MeRIP-Seq was statistically modeled, and the significance of difference analysis was corrected by estimating the 'Intraclass Variability'. Estimating variability using biological duplicate samples has become an essential part of sequencing data analysis. Due to the limitation of cost and materials, most of the existing sequencing data only have a few biological duplicate samples. Therefore, most of the existing methods borrowed genes with similar expression levels (or other characteristics). The expression quantity was modeled as smooth in a certain region by 'over-dispersion' assumption of 'Variability', and the variability within the group was estimated by local fit. Since the difference analysis of MeRIP-Seq involved four groups of 2X2 samples (research group/control group, immunoprecipitation sample/input control sample) instead of two groups of samples in the usual model, the existing methods cannot be directly applied to the difference analysis of MeRIP-Seq.

2. Based on the spatial information of alignment sequences in transcriptome and Hidden Markov Model, the spatial resolution and accuracy of difference analysis algorithm based on MeRIP-Seq were further improved. The existing methods follow the basic process of 'Feature Extraction - Difference Analysis'. Since the deviation of feature extraction process will automatically accumulate in the process of difference analysis, resulting in failure or deviation of difference feature extraction.

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	MeT-DB: a database of transcriptome methylation in mammalian cells	H. Liu#, M. A. Flores#, J. Meng#, L. Zhang, X. Zhao, M. K. Rao, Y. Chen*, and Y. Huang*	Nucleic Acids Research	2014.11.06
(2)	SCI	Spatially enhanced differential RNA methylation analysis from affinity-based sequencing data with hidden Markov mode	Y.C. Zhang, S. W. Zhang*, L. Liu, L. Zhang, H. Liu, X. Cui, Y. Huang and J. Meng*	Biomedical Research International	2015
(3)	EI	Sketching the distribution of transcriptomic features on RNA transcripts with Travis coordinates	X. Cui#, W. Zhen#, L. Zhang, H. Liu, S. Lei, S.-W. Zhang, Y Huang and J. Meng*	6th Workshop on Integrative Data Analysis in System Biology (IDASB) in conjunction with BIBM2015	2015.11.9-2015.11.12
(4)	SCI	DRME: count-based differential RNA methylation analysis at small sample size scenario	L. Liu, S.W. Zhang*, F. Gao, Y. Zhang, Y. Huang, R. Chen and J. Meng*	Analytical Biochemistry	2016
(5)	SCI	Guitar: An R/Bioconductor Package for Gene Annotation Guided Transcriptomic Analysis of RNA-Related Genomic Features	X. Cui#, Z. Wei#, L. Zhang, H. Liu, L. Sun, S.-W. Zhang, Y. Huang and J. Meng*	BioMed Research International	2016
(6)	SCI	QNB: differential RNA methylation analysis for count-based small-sample sequencing data with a quad-negative binomial model	L. Liu, S.W. Zhang*, Y. Huang and J. Meng*	BMC Bioinformatics	2017

2）Others

建成 MeRIP-Seq 分析平台，完成多个 RNA 修饰组学数据分析软件工具，包括：

1. MetDB: http: //compgenomics.utsa.edu/methylation/
2. RHHMM: https: //github.com/lzcyzm/RHHMM
3. exomePeak: http: //bioconductor.org/packages/release/bioc/html/exomePeak.html
4. Guitar: http: //bioconductor.org/packages/release/bioc/html/Guitar.html
5. QNB: https: //cran.r-project.org/web/packages/QNB/index.html

Project 2: Characteristics of Wireless Capsule Endoscopy Antennas in the Human Body

| Eng Gee Lim

Technical field: Microwave RF

Programme category: Jiangsu Science and Technology Programme – Basic Research Plan (Natural Science Foundation) – General Programme

Introduction: In this project, a pair of small-sized Ultra Wide Band transmitting and receiving antennas working in the band from 350MHz to 600MHz are designed and developed, which are suitable for human small intestine. On the basis of designing antenna by miniaturization technology, considering the multipath loss caused by human tissues and organs and the influence of human biological tissues on antenna radiation, the electromagnetic wave radiation propagation characteristics of wireless capsule endoscopy transmission antenna in human body were deeply researched. The results of modeling and simulation can be used to guide the design of wireless communication module in the system, and provide reliable reference information for capsule communication channel, precise positioning and wireless power supply, thus improving the accuracy of pathological diagnosis and measurement. It is reported that the 'Capsule Endoscopy' has not been included in the scope of medical insurance payment now, and the price of imported capsules is over RMB 7,000. It can be predicted that the research results of capsule endoscopy in this project have a wide application prospect in the field of digestion, especially in the research of physiological function of small intestine and pathogenesis of diseases.

Keywords: Antenna Radiation, Electromagnetic, Human Biological Tissue

Key issues solved: The current capsule endoscopy still has some problems, such as low image resolution, inability to accurately locate and control motion, which greatly restricts the clinical application of capsule endoscopy technology. After entering the human body, the wireless capsule endoscopy converts the gastrointestinal information detected by its sensors into electrical signals. In the process of propagation from inside human body to outside human body, electromagnetic wave signals containing such information will have energy exchange with biological issues. Then the biological issues absorb electromagnetic wave energy to attenuate it. To provide reliable reference information for capsule communication channel, precise positioning and wireless power supply, in this project, the electromagnetic radiation propagation characteristics and reliability of wireless signals have been deeply researched, especially Ultra Wide Band signals in human body. For this purpose, a new type of small-size and high-gain Ultra Wide Band micro antenna suitable for human small intestine has been developed in this project. Then, based on this Ultra Wide Band antenna and human dielectric characteristics, the transmission attenuation of communication and positioning signals was researched, which provided reliable reference information for capsule communication channel, precise positioning and wireless power supply.

Research achievements:

1） Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	实用新型	授权	无线胶囊内窥镜的双频微带天线	CN201420043168.6	ZL201420043168.6	林永义，王焸，杨民助，王璟琛
(2)	实用新型	授权	应用于无线胶囊内窥镜的的双频微带天线	CN201420041748.1	ZL201420041748.1	林永义，王焸，杨民助，王璟琛

2） Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI	Review of Wearable Antennas for WBAN Applications	J.C. Wang, E.G. Lim, M. Leach, Z. Wang, and K. L. Man	IAENG International Journal of Computer Science	2016
(2)	SCI	RF characteristics of wireless capsule endoscopy in human body	J. Chen, Z. Wang, M. Leach, S. Lee, E.G. Lim, Y. Huang	Journal of Central South University of Technology	2016
(3)	EI	Review of SAR Measurement Methods in Relation to Wearable Devices	J.C. Wang, E. G. Lim, M. Leach, Z. Wang, and K. L. Man	Engineering Letters	2016
(4)	SCI	Medical Applications of Microwave Imaging	W. Zhao, E.G. Lim, Y. Tang, and M. Leach	The Scientific World Journal	2014
(5)	SCI	Study on the electromagnetic wave propagation of Wireless Capsule Endoscopy in human body	E.G. Lim, Z. Wang, J. Chen, T. Tillo, K.L. Man	Journal of Central South University of Technology	2013.10
(6)	EI	Two methods of SAR measurement for wearable electronic devices	J. C. Wang, E. G. Lim, M. Leach, Z. Wang, K. L. Man and Y. Huang	International MultiConference of Engineers and Computer Scientists (IMECS'16)	2016.3
(7)	EI	Conformal Wearable Antennas for WBAN Applications	J. C. Wang, E.G. Lim, M. Leach, Z. Wang, K. L. Man and Y. Huang	International MultiConference of Engineers and Computer Scientists (IMECS'16)	2016.3
(8)	EI	Wireless Body Area Network and its Applications	Jing Chen Wang, Mark Leach, Zhao Wang, Eng Gee Lim, Ka Lok Ma, Yi huang	IEEE Proceedings of the 12th International SoC Design Conference (ISOCC 2015)	2015.11
(9)	EI	The New Wrappable Wireless Capsule Antennas	Eng Gee Lim, Zhao Wang, Tianqi Xia, Mark Leach, Ka Lok Man	IEEE Proceedings of the 11th International SoC Design Conference (ISOCC 2014)	2014.11
(10)	EI	Determine the Permittivity of the Plastic Materials	Eng Gee Lim, Zhao Wang, Mark Leach, Derek Gray, Ka Lok Man and Nan Zhang	IEEE International Symposium on Computer, Consumer and Control (IS3C2014)	2014.6
(11)	EI	Electromagnetic Wave Propagation of Wireless Capsule Antennas in the Human Body	Zhao Wang, Eng Gee Lim, Meng Zhang, Jingchen Wang, Tammam Tillo, and Jinhui Chen	International Symposium on Antennas and Propagation (ISAP2013)	2013.10
(12)	EI	Moveable Wireless Capsule Endoscopy	Eng Gee Lim, Zhao Wang, Sen Nie, Tanunam Tillo, K.L. Man, and Nan Zhang	IEEE Proceedings of the 10th International SoC Design Conference (ISOCC 2013)	2013.10
(13)	EI	RF Characteristics of Wireless Capsule Endoscopy in Human Body	Meng Zhang, Eng Gee Lim, Zhao Wang, Tammaro Tillo, Ka Lok Man, Jing Chen Wang	the 8th International Conference on Grid and Pervasive Computing (GPC 2013)	2013.5

Project 3: High Resolution Image Acquisition with Wireless Capsule Endoscopy and Video Endoscopy

**Tammam Tillo &
Eng Gee Lim**

Technical field: Image Processing

**Programme category: Jiangsu Science and Technology Programme – Basic Research Plan
(Natural Science Foundation) – General Programme**

Introduction: The biggest limitation of Wireless Capsule Endoscopy (WCE) diagnosis is that it requires experienced people to visually detect a large number of images obtained and determine any anomalies from them. Typically, the doctors spend 45min to 180min analyzing all the images taken by the wireless capsule endoscopy. In addition, due to the relatively low image resolution and limited lighting conditions, some diseases in more hidden places may be missed. Thus, it is clear that there is a very important challenge in WCE diagnosis, which is to research the way to reduce the time required for doctors to carry out the analysis. For this topic, the following two different methods were used as the key technologies to research the way to reduce the time and huge amount of cost of image analysis.

1. The first method is to improve the ability to automatically detect hidden bleeding and clearly mark the symptoms on the image. With this technology, the specialists only need to focus on the marked images. This will greatly reduce the time required for the analysis. In fact, the capsule manufacturers also provide some software with automatic image analysis function. However, the performance of these analysis software is not satisfactory, especially their high error rates, which limit their practical usability.

2. The second method is to show better visual effect on the captured image. This will enable experienced personnel to detect the collected images more quickly. Post-image processing technology can make up for many limitations of WCE hardware, and can enhance the captured image. In this project, post-image processing technology will also be developed to reduce overlapping information captured by WCE. It is worth emphasizing that the above techniques will also make full use of the information of these overlapping images to enhance the final image resolution. Thus, this will greatly improve the resolution of WCE images.

The purpose of this project is to research and develop a new 2D to 3D mapping technology for wireless capsule endoscopy (WCE) images. Although 2D to 3D conversion research has been widely used in the field of graphic design image synthesis, so far this research has not been applied in the field of video endoscopy and wireless capsule endoscopy. This mapping technology will greatly reduce the time required (two hours per patient on average) so that doctors can analyze all the images obtained more quickly. Thus, it will make up for a major defect in WCE technology. It is worth emphasizing that this technology can be used for similar applications that need to extract information from a series of images taken along motion curves, so it has a wide application prospect.

Keywords: Image Resolution, Resolution, Automatic Detection

Key issues solved: In fact, WCE technology will also capture a lot of overlapping information. Thus, in this project, the information of these overlapping images will be completely used to enhance the final image resolution. Thus, this will greatly improve the resolution in WCE images. It is worth noting that the increase in image resolution is not due to the use of higher resolution video sensors (which requires a larger battery), but to the processing of captured images through post-image processing technology. This will help improve the performance of WCE, and also solve the limitation of WCE hardware.

Another innovation point of this project is to use all the captured images to reproduce the whole inner wall of the small intestine without ignoring any original parts. This will allow doctors to make a diagnosis for any pathology. This technique can overcome the main technical shortcomings based on 'Improving Automatic Detection of Fuzzy Bleeding and Pathology'. Usually, these existing technologies are targeted at very specific targets. Thus, they cannot be used to detect other diseases. For example, the technology of automatically detecting bleeding sites cannot be used to detect other diseases.

Research achievements:

1) Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	基于无线胶囊内视镜或视频内窥镜体内摄像的图像处理方法及其系统	CN200910186622.7	ZL200910186622.7	罗天明，林永义
(2)	实用新型	授权	带反射镜的无线胶囊内窥镜系统	CN201120219259.7	ZL201120219259.7	林永义，王焰，罗天明
(3)	实用新型	授权	带环形透镜的无线胶囊内窥镜	CN201120415583.6	ZL201120415583.6	王焰，罗天明，林永义，陈瑾慧
(4)	实用新型	授权	基于图像识别技术的可调节拍摄速率的无线胶囊内窥镜系统及方法	CN201120488509.7	ZL201120488509.7	罗天明，林永义，王焰，陈瑾慧

2）Copyright

No.	Category	Title	Author(s)
(1)	Book Chapter	Review of the Wireless capsule transmitting and receiving antennasBook title: Wireless Communications and Networks - Recent Advances	Zhao Wang, Eng Gee Lim, Tammam Tillo, Fang Zhou Yu

3）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI	Inverse projection of the wireless capsule endoscopy images	T. Tillo, E. G. Lim, Z. Wang, J.W. Hang, R. Q. Qian	IEEE International Conference on Biomedical Engineering and Computer Science (ICBECS 2010)	2010.4
(2)	EI	2D to Cylindrical Inverse Projection of the Wireless Capsule Endoscopy Images	Tammam Tillo, Yinan Liu, Eng Gee Lim, Zhao Wang	The 4th International Conference on Image and Signal Processing (CISP'11)	2011.10
(3)	EI	A Novel Radio Propagation and Radiation Model of the Wireless Capsule Endoscopy in Human Gastro-Intestine (GI) Tract	Eng Gee Lim, Zhao Wang, Tammam Tillo, Ka Lok Man, Tuck Seng Wong, Khin Wee Lai	IEEE International System on Chip Design Conference (ISOCC 2011)	2011.11
(4)	EI	Investigation of in Body Wireless Capsule Endoscopy	Eng Gee Lim, Zhao Wang, Jin Hui Chen, Tammam Tillo and Ka Lok Man	The 2nd International Conference on Convergence Technology (ICCT 2012)	2012.7
(5)	EI	Investigation of EM Wave Propagation of the Wireless Capsule in Human Body	Eng Gee Lim, Zhao Wang, Jin Hui Chen, Tammam Tillo and Ka Lok Man	IEEE Proceedings of the 10th East-West Design and Test International Symposium (EWDTS'12)	2012.9

| (6) | EI | Transmitter Antennas for Wireless Capsule Endoscopy | Eng Gee Lim, Zhao Wang, Fang Zhou Yu, Tammam Tillo and K.L. Man | IEEE Proceedings of the 9th International SoC Design Conference (ISOCC 2012) | 2012.11 |
| (7) | EI | A Training Based Support Vector Machines Technique for Blood Detection in Wireless Capsule Endoscopy Images | Jie Li, Tammam Tillo, Bailing Zhang, Eng Gee Lim, Yu Zheng Chong | IEEE-EMBS International Conference on Biomedical Engineering and Sciences (IECBES 2012) | 2012.12 |

Project 4: An Investigation on the Regulation of T Cell Activation by SUMOylation of Immune Adaptor SLP-76

| Hebin Liu

Programme category: Jiangsu Science and Technology Programme – Basic Research Plan (Natural Science Foundation) - General Programme

Introduction: T cell activation is initiated by the specific recognition of T cell antigen receptor (TCR) and MHC polypeptide (MHCp) on the surface of antigen presenting cell (APC). At the contact interface between T cells and APC cells, a specific and stable viscous region, namely immune synapse (IS), will be formed. The activation signal is transmitted to the lower link, triggering a series of important signal cascade reactions in the process of immune response, such as T cell activation, migration, differentiation and apoptosis. Integrin mediates the adhesion between T cells and APC cells, and enhances the binding between T cells and APC cells, which is the premise of forming stable immune synapses. The existing research have found that inside-out signaling pathway regulates the molecular mechanism of T cell adhesion. The key signaling molecules include integrin and a series of adaptive proteins such as ADAP (adhesion and degranulation-promoting adapter protein) and SKAP1 (Src-kinase-associated phosphoprotein of 55 kDa). As an important post-translational protein modification, Protein SUMOylation or SUMO (small ubiquitin-related modifier) modification is widely involved in various aspects of cell physiological activities, such as DNA replication/repair, cell differentiation, movement, nuclear-cytoplasmic transport and transcription. However, the role of SUMO-modified pathway in T cell function has not been reported. The purpose of this research is to explore the role of SUMO-modified pathway, especially E2 ligase UBC9 in T cell adhesion. We found that UBC9 deletion damaged integrin-mediated T cell adhesion and integrin cluster. The further research indicated that UBC9 specifically bound to ADAP protein, and the interaction between UBC9 and ADAP protein did not affect the proximal signal pathway and distal interleukin-2 transcription of TCR. UBC9-ADAP regulates immune adhesion by affecting LFA-1-mediated localization of ADAP-SKAP1-Rap1-RIAM and fibronectin-mediated activation of Rac1. In this research, the cross-dialogue mechanism between SUMO modification pathway and T cell adhesion function was first discovered, which was realized by the interaction between E2 ligase UBC9 and key adaptor protein ADAP. The interaction between UBC9 and ADAP is an indispensable link for T cells to perform normal adhesion function. However, the discovery that UBC9 is the interaction partner of ADAP is helpful for us to further understand and explore the diversity of ADAP protein functions and domains. More importantly, this research provides a new vision for the regulation mechanism of T cell adhesion, and creatively reveals that SUMO modification pathway forms a new level of T cell adhesion regulation through functional association with immune adaptor protein. It provides a new direction and potential target for the treatment of immune-related diseases and drug R&D, and has a great impact on the field of immunology.

Keywords: Immune Adaptor Protein, SUMO, T Cell Signal Transduction

Key issues solved:
1. It is the first time to research the new mechanism of T cell signal transduction regulation from the perspective of cross dialogue between ADAP, a key immune adaptor protein of T cells, and SUMO modification pathway, which is innovative and advanced in theory at home and abroad.
2. It is the first time that the unique SUMO ligase Ubc9, an important protein, is linked to the regulation of T cell signal transduction through the dynamic regulation of immune adaptor protein ADAP. It is of great significance to establish and further improve the multi-level system of T cell signaling regulation, and realize theoretical innovation in the research of T cell signaling regulation.
3. Adhesion function was first discovered, which was realized by the interaction between E2 ligase UBC9 and key adaptor protein SLP-76/ADAP. The interaction between UBC9 and ADAP is an indispensable link for T cells to perform normal adhesion function. However, the discovery that UBC9 is the interaction partner of ADAP is helpful for us to further understand and explore the diversity of ADAP protein functions and domains. More importantly, this research provides a new vision for the regulation mechanism of T cell adhesion, and creatively reveals that SUMO modification pathway forms a new level of T cell adhesion regulation through functional association with immune adaptor protein.

4. The interaction mode between SUMO and immune target protein molecules and its biological significance were clarified for the first time. T cell regulatory network was improved and the important role of SUMO pathway in T cell activation mediated by key linker protein and immune response regulation was clarified.

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Ubc9 Binds to ADAP and is required for Rap1 membrane recruitment, Rac1 activation, and integrin-mediated T-cell adhesion	Yiwei Xiong, Chengjin Ye, Naiqi Yang, Madanqi Li and Hebin Liu*	Journal of Immunology	2017
(2)	SCI	Transcriptional analysis of impacts of glycerol transporter 1 on methanol and glycerol metabolism in Pichia pastoris	Li, Xiang; yang, yankun; zhan, chunjun; Zhang, Zhenyang; Liu, Xiuxia; Liu, Hebin; Bai, Zhonghu	FEMS Yeast Research	2016

Project 5: Electromagnetic Wave Propagation and the Real-time Localization of Wireless Capsule in Human Body

Zhao Wang & Eng Gee Lim

Programme category: Jiangsu Science and Technology Programme – Basic Research Plan (Natural Science Foundation) – General Programme

Introduction: Digestive tract diseases are very common and vary greatly in extent. Early detection and treatment are very meaningful for healing of patients, and digestive tract diagnosis is an extremely significant part. However, the length of adult digestive tract is extremely long (about 10m), in which the upper digestive tract (about 1m for esophagus and stomach) is generally diagnosed by gastroscopy, and the lower digestive tract (about 2m for colon and rectum) is usually diagnosed by colonoscopy. Gastroscopy and colonoscopy are endoscopies, which need to be extended into the subject when used, and the movement of their connecting tubes in human body will cause discomfort to a certain extent. More importantly, the long and curved small intestine between the upper and lower digestive tract is seriously beyond the detection range of traditional endoscopic technology. Thus, wireless capsule endoscopy technology has been proposed to achieve the purpose of observing and diagnosing small intestinal mucosa.

Wireless capsule endoscopy is a non-invasive technology, with a color camera and a radio frequency transmitter inside. During the 8-hour digestive tract journey, the wireless capsule endoscopy will continuously take color pictures and transmit them to the outside of the body. The size of the wireless capsule is equivalent to the largest vitamin pill (usually, the size is not more than 11mm x 26mm). It is sealed with special biomaterials, which can resist gastric acid and powerful digestive enzymes. Once the wireless capsule endoscopy is swallowed by the patient, it will be slowly pushed by the digestive tract. Wireless capsule endoscopy is most suitable for observing and diagnosing vague gastrointestinal bleeding. As a new technology, however, the wireless capsule endoscopy still faces many problems now. The first problem is real-time accurate positioning and power supply, and both of these problems inevitably need to be researched and experimented in the complex environment of human body. Thus, the understanding of electromagnetic radiation and its propagation characteristics in human body has become the basic condition to solve the above problems.

In this project, the human body digital model based on visual human project will be used to simulate the working environment of wireless capsule according to the dielectric characteristics of human tissues and organs, to evaluate its channel performance, and to provide reference information for capsule precise positioning and wireless power supply. On the other hand, it is very necessary to use Ultra Wide Band (UWB) radar technology to realize the real-time localization of wireless capsule in human body on the basis of in-depth research of electromagnetic field radiation propagation characteristics of wireless capsule endoscopy transmission antenna in human body and development of a new small-size Ultra Wide Band antenna suitable for human small intestine. The results of modeling and simulation can be used to guide the design of wireless communication module in the system so as to improve the accuracy of pathological diagnosis and measurement.

Keywords: Wireless Capsule Endoscopy, Ultra Wide Band Antenna, Radiation Propagation of Electromagnetic Field

Key issues solved: The application and development of wireless capsule endoscopy involves many technologies, such as the transmission and transmitting of detection signals and the real-time positioning of capsules. After entering the human body, the wireless capsule endoscopy converts the gastrointestinal information detected by its sensor into electrical signals. When the electromagnetic wave signal carrying these information propagates from the inside of body to the outside of body, it will exchange energy with biological tissues, which is reflected in the absorption of electromagnetic wave energy by biological tissues so that it is attenuated. To effectively transmit detection information and locate wireless capsules, it is necessary to research the electromagnetic radiation propagation characteristics of wireless signals, especially Ultra Wide Band signals in human body. For this purpose, we will first develop a new small-size UWB antenna suitable for human small intestine, then research the transmission attenuation of communication and positioning signals based on the characteristics of this antenna and human dielectric, and finally realize the real-time positioning of wireless capsules in human body by using UWB radar technology.

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Authorisation no.	Inventor(s)
(1)	实用新型	授权	带反射镜的无线胶囊内窥镜系统	ZL201120219259.7	林永义，王焬，罗天明
(2)	实用新型	授权	带环形透镜的无线胶囊内窥镜	ZL201120415583.6	王焬，罗天明，林永义，陈瑾慧
(3)	实用新型	授权	基于图像识别技术的可调节拍摄速率的无线胶囊内窥镜系统及方法	ZL201120488509.7	罗天明，林永义，王焬，陈瑾慧

2）Copyright

No.	Status	Category	Title	Author(s)
(1)	出版	著作章节	Review of the Wireless capsule transmitting and receiving antennas; Book title: Wireless Communications and Networks - Recent Advances	Zhao Wang, Eng Gee Lim, Tammam Tillo, Fang Zhou Yu

3）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Study on the Electromagnetic Wave Propagation of Wireless Capsule Endoscopy in Human Body	Eng Gee Lim, Zhao Wang, Jinhui Chen, Tammam Tillo and Ka Lok Man	Journal of Central South University Technology	2013.10
(2)	EI	A Novel Radio Propagation and Radiation Model of the Wireless Capsule Endoscopy in Human Gastro-Intestine (GI) Tract	Eng Gee Lim, Zhao Wang, Tammam Tillo, Ka Lok Man, Tuck Seng Wong,Khin Wee Lai	IEEE InternationalSystem on Chip Design Conference (ISOCC 2011)	2011.11
(3)	EI	Investigation of in Body Wireless Capsule Endoscopy	Eng Gee Lim, Zhao Wang, Jin Hui Chen, Tammam Tillo and Ka Lok Man	The 2nd International Conference on Convergence Technology (ICCT 2012)	2012.7
(4)	EI	Investigation of EM Wave Propagation of the Wireless Capsule in Human Body	Eng Gee Lim, Zhao Wang, Jin Hui Chen, Tammam Tillo and Ka Lok Man	IEEE Proceedings of the 10th East-West Design and Test International Symposium (EWDTS'l2)	2012.9
(5)	EI	Transmitter Antennas for Wireless Capsule Endoscopy	Eng Gee Lim, Zhao Wang, Fang Zhou Yu, Tammam Tillo and K.L. Man	IEEE Proceedings of the 9th International SoC Design Conference (ISOCC 2012)	2012.11
(6)	EI	Novel Wireless Capsule Endoscopy Diagnosis System with Adaptive Image Capturing Rate	Zhi Jin, Tammam Tillo, Eng Gee Lim, Zhao Wang and Jimin Xiao	The 8th International Conference on Computer Vision Theory and Applications (VISAPP 2013)	2013.2
(7)	EI	UWB Planar Antennas for Wireless Capsule Endoscopy	Jing Chen Wang, Eng Gee Lim, Zhao Wang, Yi Hung, Tammam Tillo, Meng Zhang and Rula Alrawashdeh	The 9th International Workshop on An. tenna Technology (iWAT 2013)	2013.3
(8)	EI	Wireless Capsule Antennas	Eng Gee Lim, Jing Chen Wang, Zhao Wang, Geny Juans, Tammam Tillo, Ka Lok Man and Meng Zhang	Proceedings of the IAENG International Multiconference of Engineering and Computer Scientists (IMECS'13)	2013.3
(9)	EI	RF Characteristics of Wireless Capsule Endoscopy in Human Body	Meng Zhang, Eng Gee Lim, Zhao Wang, Tammam Tillo, Ka Lok Man and Jing Chen Wang	Proceedings of the 8th International Conference on Grid and Pervasive Computing (GPC 2013)	2013.5
(10)	EI	Electromagnetic Wave Propagation of Wireless Capsule Antennas in the Human Body	Zhao Wang, Eng Gee Lim, Meng Zhang, Jing Chen Wang, Tammam Tillo and Jinhui Chen	ISAP 2013	2013.10
(11)	EI	Moveable Wireless Capsule Endoscopy	Eng Gee Lim, Zhao Wang, Sen Nie, Tammam Tillo, K.L. Man, and Nan Zhang	IEEE Proceedings of the 10th International S6C Design Conference (ISOCC 2012)	2013.11

Project 6: Reconstruct Gene Regulatory Network at Epitranscriptomic Layer with Non-Parametric Bayesian Approach

| Jia Meng

Programme category: The Natural Science Foundation of the Jiangsu Higher Education Institutions of China - General Programme

Introduction:

The research contents of the topic include:

1. Reconstruct the direct regulatory network of RNA methylation modification in epigenetic transcription layer, and establish a public database to provide query service for RNA methylation-related catalytic enzymes and their target information.
2. Effectively identify abnormal regions of RNA methylation profile in disease state and provide possible repair schemes through omics information.
3. Develop bioinformatics methods and tools for other epitranscriptome high-throughput data.

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	m6Acomet: large-scale functional prediction of individual m 6 A RNA methylation sites from an RNA co-methylation network	Xiangyu Wu, Zhen Wei, Kunqi Chen, Qing Zhang, Jionglong Su, Hui Liu, Lin Zhang, and Jia Meng	BMC Bioinformatics	2019
(2)	SCI	DRUM: Inference of disease-associated m6A RNA methylation sites from a multi-layer heterogeneous network	Yujiao Tang, Kunqi Chen, Xiangyu Wu, Zhen Wei, Song-Yao Zhang, Bowen Song, Shao-Wu Zhang, Yufei Huang and Jia Meng	Frontiers in Genetics	2019
(3)	SCI	WHISTLE: a high-accuracy map of the human N6-methyladenosine (m6A) epitranscriptome predicted using a machine learning approach	Kunqi Chen, Zhen Wei, Qing Zhang, Xiangyu Wu, Rong Rong, Zhi-Liang Lu, Jionglong Su, Joao Pedro de Magalhaes, Daniel J Rigden and Jia Meng	Nucleic Acids Research	2019
(4)	SCI	Trumpet: transcriptome-guided quality assessment of m6A-seq data	Teng Zhang, Shao-Wu Zhang, Lin Zhang and Jia Meng	BMC Bioinformatics	2018
(5)	SCI	Enhancing epitranscriptome module detection from m6A-seq data using threshold-based measurement weighting strategy	Kunqi Chen, Zhen Wei, Hui Liu, Joao Pedro de Magalhaes, Rong Rong, Zhiliang Lu, and Jia Meng	BioMed Research International	2018
(6)	SCI	Topological Characterization of Human and Mouse m5C Epitranscriptome Revealed by Bisulfite Sequencing	Z. Wei, S. Panneerdoss, S. Timilsina, J. Zhu, T. A. Mohammad, Z.-L. Lu, J.C. Pedro de Magalhaes, Yidong, R. Rong, Y. Huang, M. K. Rao and J. Meng	International Journal of Genomics	2018
(7)	SCI	QNB: differential RNA methylation analysis for count-based small-sample sequencing data with a quad-negative binomial model	L Lian, SW Zhang, Y Huang, J Meng	BMC Bioinformatics	2017
(8)	EI	Predict disease-related RNA methylation sites from the methylation-expression association and hypergeometric test	Yujiao Tang, Kunqi Chen, Xiangyu Wu, Zhen Wei, and Jia Meng	BIBE2019	2019

Project 7: Charaterization of Simian Type D Retroviruses from Monkeys in Chinese Breeding Farms

| Rong Rong

Programme category: The Natural Science Foundation of the Jiangsu Higher Education Institutions of China - General Programme

Introduction:

In this project, the monkeys in the main breeding farms in China were taken as the research objects. Through a series of antibody tests and the detection of viral RNA and/or proviral DNA in blood, it was found that SRV/D infected monkeys. The serotype of SRV/D virus prevalent in monkey farms in China was identified and its genetic diversity was determined by sequencing and statistical analysis of the virus genome amplified by molecular biological techniques.

Through the research of this project, it was found that the serotypes of SRV/D virus prevalent in monkey farms in China were SRV4 and SRV5. SRV4 is prevalent in Macaca fascicularis population, and SRV5 is prevalent in Macaca mulatta population. The research group isolated a new virus strain from the blood of Macaca fascicularis, which is quite different from the known SRV/D serotype genome sequence, and named as SRV8/SUZ/2012. Upon the genome comparison and evolutionary analysis, it was found that SRV8/SUZ/2012 was closely related to SRV-4: the nucleotide sequences of gag, prt and pol genes were 82%, 83% and 80% homologous, respectively. By analyzing and comparing the genome sequences of SRV/D virus prevalent in various monkey breeding farms in China, in this project, the prevalence and etiology of SRV/D infection in China was elucidated, and scientific basis for correct diagnosis of SRV/D infection and formulation of prevention and control strategies was provided.

Keywords: Simian Type-D Eetrovirus, Genome Sequence, Phylogenetic Analysis

Key issues solved:
1. Serological type of SRV/D virus in monkey farms in China
2. Gene diversity of virus strain in the same SRV/D serotype

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	A novel simian retrovirus subtype discovered in cynomolgus monkeys (Macaca fascicularis)	Zao, Chih-Ling and Tomanek, Lisa and Cooke, Anthony and Berger, Ron and Yang, Lingyan and Xie, Chen and Chen, Si and Shi, Changjun and Rong, Rong	Journal of General Virology	2016

2）Others

数据库：SRV8/SUZ/2012 基因组全序列及其美国国 家生物技术信息中心基因库入库号（Genbank accession·# KU605777)

Project 1: Research on Medical Record and Robot Creation Based on Speech Recognition and Machine Learning

| Gangmin Li

Technical fields: Medical and Health - Oncology

Programme category: Suzhou Science and Technology Development Planning Programme - Key Industrial Technology Innovation - Prospective Applied Basic Research Project

Introduction: The purpose of this project is to create practical doctor assistants (robots or software). For the voice and text input in the process of doctor's consultation, a formatted medical electronic medical record is formed by using big data analysis, machine learning and artificial intelligence technology, which provides reliable original data for further medical automation and medical quality control.

Except for independent voice input devices (smart audio or recording pen and other products of a third party), the rest of this project was successfully completed according to the original design of the project. The special voice input device is not necessary after being agreed with the user unit. Therefore, it is replaced by a microphone, notebook or other mobile devices such as mobile phones and PDA which with audio input. The core problem of this project is the way to realize text recognition and named entity recognition and automatic extraction after the speech is converted into text, and finally complete the creation and management of electronic medical record.

The core issues have been solved through the hard-working of the team of Xi'an Jiaotong-liverpool University. The template program has been completed and the demonstration system has been constructed. Upon the preliminary inspection by the user unit, it is considered that the medical record establishment system built by students based on the results of theoretical research can be used as a blueprint for developing practical systems. The development of commercial system can be built on the demonstration system of this project and combined with the actual medical record establishment system in the hospital for secondary development so as to make full use of the results of this project, that is, voice to text. Automatic generation of electronic medical records was gradually realized through automatic extraction of written disease names and symptoms combined with machine learning mechanism and integration of doctor feedback. The complicated, tedious and error-prone medical record establishment process for doctors to fill in medical records manually was reduced.

Keywords: Off-Line Speech Recognition, Medical Robot, Big Data Analysis, Machine Learning

Key issues solved: The key issue of this project is extraction of named entity in natural language. It is a way to find the concerned named entities (names, objects, phenomena and representations) and the relationships among entities (timing, inclusion, causality, juxtaposition, isomorphism, semantic similarity or correlation, etc.) in a described natural language. We integrated the existing related technologies and means to establish our own recognition algorithm and achieved international advanced results (published 6 papers and applied for 2 patents), and the disease description recognition was basically solved. Another problem related to this problem, that is, the way to standardize the description of diseases has also been discussed. We can extract the personal feelings of patients and accurate description of possible diseases from the description of patients. Description from patients is far from the description of pathological disease phenomena and representations. Currently, there is no complete solution to transform the patients' description into the closest pathological description. This problem involves the classification of diseases and the medical diagnosis process of different diseases in Medical Departments, and full automation it is not realistic. Thus, a machine life-long learning mechanism is created in this project. For the preliminary medical records generated by the machine, they need to be approved by the doctor before they can be stored. The process of doctor's modification and confirmation is actually an expert feedback process. Our life-long learning mechanism can record any doctor's changes (which will be learned). This continuous learning mechanism makes medical record establishment have an incremental effect, that is, the more you use it, the better it will be.

Research achievements:

1） Patents

No.	Category	Status	Patents Title	Application no.	Inventor(s)
(1)	发明	申请	地址匹配方法及装置	202010462252.1	李刚民，倪蘋，李雨茗
(2)	发明	实审	用于知识图谱中节点和链接的多语言知识匹配方法及装置	202010730143.3	李刚民，倪蘋，李雨茗

2） Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Natural language understanding approaches based on joint task of intent detection and slot filling for IoT voice interaction	P. Ni, Y. Li, Gangmin Li and Victor Chang	Applying Artificial Intelligence to the Internet of Things	2020.3
(2)	SCI	Lifelong Machine Learning and root cause analysis for large-scale cancer patient data	Gautam Pal, Gangmin Li, Katie Atkinson	Journal of Big Data	2019.12
(3)	SCI	A Joint Model of Clinical Domain Classification and Slot Filling Based on RCNN and BiGRU-CRF	Yuming Li, Pin Ni, Junkun Peng, Jiayi Zhu, Zhenjin Dai, Gangmin Li and Xuming Bai	2019 IEEE International Conference on Big Data (Big Data)	2019.12
(4)	SCI	Automatic Generation of Electronic Medical Record Based on GPT2 Model	Junkun Peng, Pin Ni, Jiayi Zhu, Zhenjin Dai, YumingLi, Gangmin Li, and Xuming Bai	2019 IEEE International Conference on Big Data (Big Data)	2019.12
(5)	SCI	A Word2vec Based on Chinese Biomedical Domain Knowledge	Jiayi Zhu, Pin Ni, Yuming Li, Junkun Peng, Zhenjin Dai, Gangmin Li, and Xuming Bai	2019 IEEE International Conference on Big Data (Big Data)	2019.12
(6)	SCI	Disease Diagnosis Prediction of EMR Based on BiGRU-Att-CapsNetwork Model	Pin Ni, Yuming Li, Jiayi Zhu, Junkun Peng, Zhenjin Dai, Gangmin Li, and Xuming Ba	2019 IEEE International Conference on Big Data (Big Data)	2019.12
(7)	EI	Inter-Personal Relation Extraction Model Based on Bidirectional GRU and Attention Mechanism	Yuming Li, Pin Ni, Gangmin Li, Xutao Wang and Zhenjin Dai	2019 IEEE 5th International Conference on Computer and Communications (ICCC)	2019.12
(8)	EI	Using Structured event to represent complaints of patients: a medical assistant for doctors	Haowei Song, Gangmin Li and Xuming Bai	2019 IEEE 5th International Conference on Computer and Communications (ICCC)	2019.12
(9)	EI	Translate and Summarize Complaints of Patient to Electronic Health Record by BiLSTM-CNN Attention model	Haowei song, Gangmin Li, Suzhe Hou, Yuanying Qu, Xuming Bai	2019 12th International Congress on Image and Signal Processing, BioMedical Engineering and Informatics (CISP-BMEI)	2019.10
(10)	EI	Medical diagnosis by of Patients' Complaints and Machine Learning	Gangmin Li, Haowei Song, yuanying qu, Liu Lu, Xuming Bai	2019 12th International Congress on Image and Signal Processing, BioMedical Engineering and Informatics (CISP-BMEI)	2019.10
(11)	EI	Named Entity Recognition based on Language Model and BiLSTM-CRF for Chinese Electronic Health Records	Zhenjin Dai, Xutao Wang, Pin Ni, Yuming Li, Gangmin Li, Xuming Ba	2019 12th International Congress on Image and Signal Processing, BioMedical Engineering and Informatics (CISP-BMEI)	2019.10

3） Others

建立离线语音识别装置（"医生助手"）及病历自动建立系统

Project 2: Applying Image Based Multi-Classification Convolutional Neural Network to Monitor Bioscaffold Fabrication Process

| Jie Sun

Technical fields: Advanced Manufacturing and Automation - Micro-Fabrication System Technology

Programme category: Suzhou Science and Technology Development Planning Programme - Key Industrial Technology Innovation - Prospective Applied Basic Research Project

Introduction: The objective of this project is to manufacture three-dimensional biological scaffolds based on the printing process of electro-hydro jet (hereinafter referred to as 'Electro-hydro Eject'), a method of evaluating the manufacturing process by using real-time monitoring data was proposed, and a prediction model between real-time monitoring data and scaffold performance parameters was established by using artificial intelligence. Finally, the intelligent manufacturing of fiber three-dimensional biological scaffold based on EFI printing technology was realized. Of which, the artificial intelligence technology used is that the neural network technology is used to deeply mine the information of EFI printing status, fiber deposition morphology and other aspects obtained from real-time monitoring data. These processes include classifying, summarizing and further judging the Taylor cone formed in the nozzle, the jet ejected from the Taylor cone, and the morphology of the jet deposited on the receiving bottom plate, so that the adjustment of main process parameters in the process of EFI printing is decided according to the real-time data analysis. Of which, it includes the voltage value between the printing nozzle and the bottom plate, the distance between the printing nozzle and the bottom plate, the speed of the injection pump supplying solution, the moving speed of the moving platform and other parameters that can be adjusted in real time, so as to achieve a stable manufacturing state. The amplitude and direction of adjustment were further optimized and implemented by learning and testing neural network according to the printing process and main process parameters. This technology is applied in the field of tissue engineering, especially in the manufacture of three-dimensional biological scaffolds with micro-nano structures. Such scaffolds are widely used to make biological models in vitro for drug screening, pathological model establishment and renewable medicine.

This project promotes the popularization of micro-nano biological preparation system, reduces the error probability of EFI system, and promotes the development of three-dimensional biological scaffold industry manufacturing. The monitoring system developed in this project has the advantages of low operation cost, fast and simple control response. Especially, it can quickly reflect the problems in the manufacturing process and give corresponding feedback, which helps to improve the manufacturing efficiency of micro-nano biological preparation system. From the perspective of social benefits, the development and use of this monitoring technology will greatly improve the bottleneck of micro-nano fiber scaffold manufacturing in 3D printing and enhance the international competitiveness of 3D bioprinting technology in China.

Keywords: Micro-Nano Fiber Scaffold, EFI Printing, Convolution Neural Network, Hierarchical Dynamic Compensation Control, Characteristic Analysis of Process Parameters

Key issues solved:

1. The problem of obtaining real-time manufacturing image data was solved through the design and assembly of printing monitoring system. The team designed a printing monitoring system with two digital electron microscopes, and selected fixture materials suitable for fixing nozzles to reduce the mutual influence and interference between digital electron microscopes. Secondly, the team adopted the embedded fixing device of high-voltage cable and designed the substrate fixture to improve the insulation performance.

2. The feedback adjustment of EFI printing process was solved by matching the image pattern recognition of EFI jet flight and deposition state. It is necessary to combine the two image recognition results and analyze the bracket manufacturing process layer by layer. Through hierarchical time planning, the team matched the pattern recognition results of electric jet flight image with the pattern recognition results of deposition state image in time so as to make the dynamic compensation.

3. The instability of composite bracket manufacturing process was solved by optimizing composites ink and applying

monitoring system. The electrical conductivity of composites is complex. It is easy to cause discharge when manufactured by open-loop EFI system, and the process is extremely unstable. For the monitoring system developed in this project, the team realized the manufacture of EFI bracket for composites ink.

4. The parameter optimization in the manufacturing of cellular structure bracket was solved by applying the monitoring system to adjust the manufacturing parameters in time. The stability of Taylor cone is poor in the manufacture of complex cellular structure bracket due to the variety of printing path. For the monitoring system developed in this project, the team realized the optimization of printing path and process parameters, and the stable manufacture of cellular structure bracket.

Research achievements:

1） Patents

No.	Category	Status	Patents Title	Application no.	Inventor(s)
(1)	发明	实审	用于电喷微纳生物支架制造装置的监控系统及监控方法	CN202010730143.3	董玉来、孙捷、杨睿
(2)	发明	实审	应用微孔式结构构造三维生物支架的制备方法	CN201910629666.6	孙捷、刘航、敬霖志、德瑞克、洪静远、黄德建

2） Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Electrohydrodynamic Printing Process Monitoring by Microscopic Image Identification	孙捷、敬霖志、Xiaotian Fan、Xueying Ga	International Journal of Bioprinting	2019
(2)	SCI	Microscale scaffolds with diverse morphology via electrohydrodynamic jetting for in vitro cell culture application	王丹丹、敬霖志、刘航、黄德建、孙捷	Biomedical Physics & Engineering Express	2019
(3)	SCI	Creating Nanotopography on Microfiber Surface for Better Cell Scaffold Interactions	敬霖志、孙捷	Procedia Manufacturing	2020
(4)	SCI	Extrusion-Based Multiple Material Mixer Design in Food Printing	孙捷、Daniel Peng Zhuo	International Journal of Food Engineering	2019
(5)	EI	Generating Nanotopography on PCL Microfiber Surface for Better Cell-Scaffold Interactions,	敬霖志、孙捷、刘航、黄德建	48th SME North American Manufacturing Research Conference, NAMRC 48, Ohio, USA, 2020	2020
(6)	EI	Electrohydrodynamic Printing Process Monitoring for Diverse Microstructure Bioscaffold Fabrication,	孙捷、敬霖志、刘航、黄德建	10th International Conference on Biomedical Engineering and Technology, Tokyo, Japan, 2020	2020
(7)	EI	Extrusion-based Multiple Material Mixer Design in Food Printing	孙捷、Daniel Peng Zhuo	10th International Conference on Food Engineering and Biotechnology	2019

Project 3: Investigation of Wireless Capsule Endoscopy

| Eng Gee Lim

Technical field: Microwave RF

Programme category: Suzhou Science and Technology Development Planning Programme – Others

Introduction: The average length of adult digestive tract is about 10m. In recent years, the technology of endoscopy has been expanded, which can load many functions such as lighting, surgery, irrigation and sampling in the same body, and has been widely used in the detection of digestive tract diseases, such as Crohn's disease, gastric ulcer and colon cancer. However, the small intestine in the middle of the digestive tract is seriously beyond the detection range of the previous technology. The result of using special imaging techniques (such as computed X-ray tomography, magnetic resonance imaging) to detect the small intestine is not very effective. For this purpose, the wireless capsule endoscopy was born in 2000 in order to overcome the problems above.

Many diseases that cannot be detected by the traditional endoscopy can also be detected by the wireless capsule endoscopy. The most popular first-generation wireless capsule endoscopy developers and manufacturers were Olympus, Intromedic, GivenImaging and RF System Lab. An upgraded product following the first generation of wireless capsule endoscopy, such as EndoCapsule of Olympus, PillCam of Given Imaging, Norika 3 and Sayaka developed by RFSystem Lab of Japan have made great progress in different directions. The detection procedures of wireless capsule endoscopy was approved by the U.S. Food and Drug Administration in 2001 to detect the gastrointestinal diseases.

The capsule endoscopy independently developed by Chongqing Jinshan Science and Technology Group and accepted by the national '863' expert group was also approved by China SFDA in March 2005 and approved for clinical application. It was the first technological achievement in China. In recent years, Shanghai Jiao Tong University has also begun to explore the control of the advancing speed of capsule endoscopy in human body.

As a new technology, however, the wireless capsule endoscopy still faces many problems now. First, the camera quality of endoscopy shall be improved as much as possible. In fact, the existing optical lens can greatly improve the camera quality, and the bottleneck factor that really restricts the camera quality is the transmission ability of capsules. Thus, it is very important to improve the channel capacity between capsule endoscopy in vivo and image recorder in vitro. Second, it shall be able to locate accurately in real time. Currently, although capsule endoscopy provides a feasible examination scheme for the small intestine that could not be detected in the past, doctors cannot accurately determine the location of the lesions after the patients undergo capsule endoscopy examination and find the lesions because they cannot accurately locate the images taken along the way. Thus, it is imperative for capsule endoscopy to carry out accurate locating. Third, the problem of power supply of wireless capsule shall be solved. Currently, the battery carried by the capsule can only be used for picture shooting and signal transmission with low data volume. In the future, if capsules are to be controlled in vitro and treated in vivo, they will inevitably consume more electric energy while ordinary batteries have been difficult to maintain. Inevitably, all the above three problems need to be researched and experimented in the complex environment of human body. Thus, the research on the propagation characteristics and reliability of electromagnetic wave radiation in human body has become the basic condition to solve the problems above.

Keywords: Wireless Capsule Endoscopy, Digestive Tract Disease Detection, Antenna

Key issues solved: As mentioned above, wireless capsule endoscopy is a noninvasive and painless detection technology, which can achieve the purpose of observing and diagnosing small intestinal mucosa. Capsule endoscopy technology has experienced several years of development, during which many excellent research results have appeared, indicating the profound development potential and great development value. However, the current capsule endoscopy still has some issues, such as low image resolution, inability to accurately locate and control motion, which greatly restricts the clinical application of capsule endoscopy technology. After entering the human body, the wireless capsule endoscopy converts the gastrointestinal information detected by its sensors into electrical signals. In the process of propagation from inside human body to outside human body, electromagnetic wave signals containing such information will have energy exchange with biological issues. Then the biological issues absorb electromagnetic wave energy to attenuate it. To provide reliable reference information for capsule communication

channel, precise positioning and wireless power supply, in this project, the wireless signals are required to be researched, especially the electromagnetic radiation propagation characteristics and reliability of Ultra Wide Band signals in human body. For this purpose, in this project, a new small-size high-gain Ultra Wide Band microstrip antenna suitable for human small intestine is required to be developed first, and then the transmission attenuation of communication and positioning signals based on the characteristics of this Ultra Wide Band antenna and human dielectric is researched. The above two parts clearly indicated the challenges that need to be solved most in this project, and these objectives can be achieved by the following steps:

A pair of Ultra Wide Band micro antennas suitable for human small intestine are developed. The antenna is responsible for radiating the data collected by wireless capsule endoscopy to the outside of the body, and its performance is related to the normal operation of the whole system. Wireless capsule endoscopy works in human gastrointestinal tract, and its space is relatively narrow, which requires a small-sized antenna. Moreover, there are many biological tissues and organs in human body, and their composition is complex. Therefore, it is very difficult to research the radiation efficiency and radiation characteristics of antennas in human body. When designing the antenna of wireless capsule endoscopy, it is necessary to comprehensively consider the multipath loss caused by human tissues and organs, the influence of human biological tissues on antenna radiation, the small size of antenna and other factors. Since the appearance of wireless capsule endoscopy, most of the work is to improve the system performance of capsule, including increasing transmission rate, prolonging working time, reducing capsule size and improving sampling accuracy. However, the research on radiation characteristics of antenna in real human body model is rare. In this project, the first step is to design and develop a pair of new Ultra Wide Band micro transmitting and receiving antennas suitable for human small intestine and working in 350MHz to 700MHz band according to the structural characteristics of wireless capsule endoscopy, and to analyze the signal transmission characteristics of these antennas in free space and human model. Because the position of capsule endoscopy moving through gastrointestinal tract is constantly changing, the position of receiving antenna on human surface is extremely critical. Based on the above-mentioned signal transmission characteristics of transmitting and receiving antenna groups in the human body model, we can effectively select the best position and appropriate number of receiving antennas. The performance and size of the Ultra Wide Band micro antenna designed in this project can fully meet the practical application requirements of wireless capsule endoscopy, and lay a good foundation for the development of a new generation of wireless capsule endoscopy.

Research achievements:

1) Patents

No.	Category	Status	Patents Title	Authorisation no.	Inventor(s)
(1)	实用新型	授权	带环形透镜的无线胶囊内窥镜	ZL201120415583.6	王烙，罗天明，林永义，陈瑾慧
(2)	实用新型	授权	基于图像识别技术的可调节拍摄速率的无线胶囊内窥镜系统及方法	ZL201120488509.7	罗天明，林永义，王焙，陈瑾慧
(3)	发明	授权	基于无线胶囊内视镜或视频内窥镜体内摄像的图像处理方法及其系统	ZL200910186622.7	罗天明，林永义

2) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Study onthe electromagnetic wave propagation of Wireless Capsule Endoscopy in humanbody	Eng Gee Lim, Zhao Wang, Jinhui Chen, Tammam Tillo, Ka Lok Man	Journal of Central South University of Technology	2013

(2)	EI	The UHF Band In-body Antennas for Wireless Capsule Endoscopy	Eng Gee Lim, Jing Chen Wang, Zhao Wang, Tammam Tillo and Ka Lok Man	Engineering Letters	2013
(3)	EI	Determine the Permittivity of the Plastic Materials	Eng Gee Lim, Zhao Wang, Mark Leach, Derek Gray, Ka Lok Man And Nan Zhang	IEEE InternationalSymposium on Computer, Consumer and Control (IS3C2014)	2014
(4)	EI	Electromagnetic Wave Propagation of Wireless Capsule Antennasin the Human Body	Zhao Wang, Eng Gee Lim, Meng Zhang, Jingchen Wang, Tammam Tillo, andJinhui Chen	International Symposium on Antennas and Propagation(ISAP2013)	2013
(5)	EI	Moveable Wireless Capsule Endoscopy	Eng Gee Lim, Zhao Wang, Sen Nie, Tammam Tillo, K.L. Man, and Nan Zhang	IEEE Proceedings of the 10thInternational SoC Design Conference (ISOCC 2013)	2013
(6)	EI	RF Characteristics of Wireless Capsule Endoscopy in HumanBody	Meng Zhang, Eng Gee Lim, Zhao Wang, Tammam Tillo, Ka Lok Man , Jing Chen Wang	Proceedings (Lecture Notes in Computer Science Series Volume) of the8th International Conference on Grid and Pervasive Computing (GPC 2013)	2013
(7)	EI	A New Small ConformalAntenna for Capsule Endoscopy	Rula Alrawashdeh, Yi Huang, Ping Cao, Eng Gee Lim	7th European Conference on Antennas andPropagation (EUCAP 2013)	2013
(8)	EI	UWB planar Antennas for Wireless CapsuleEndoscopy	Jing Chen Wang, Eng Gee Lim, Zhao Wang, Yi Huang, Tammam Tillo, Meng Zhang, Rula Alrawashdeh	The 9th International Workshop on Antenna Technology (iWAT2013)	2013
(9)	EI	Wireless Capsule Antennas	Eng Gee Lim, Jing Chen Wang, Zhao Wang, Gerry Juans, Tammam Tillo, Ka Lok Man and Meng Zhang	Proceedings of theIAENG International MultiConference of Engineers and Computer Scientists(IMECS'l3)	2013
(10)	EI	Wireless capsule endoscopy	Eng Gee Lim, Jing Chen Wang, Zhao Wang, Tammam Tillo, Ka Lok Man and Nan Zhang	Proceedings of the IAENGInternational Multi Conference of Engineers and Computer Scientists(IMECS'13)	2013
(11)	EI	NovelWireless Capsule Endoscopy Diagnosis System with Adaptive Image CapturingRate	Zhi Jin, Tammam Tillo, Eng Gee Lim, Zhao Wang and Jimin Xiao	The 8th International Conference on Computer Vision Theory andApplications (VISAPP 2013)	2013
(12)	EI	Transmitter Antennas for Wireless Capsule Endoscopy	Eng Gee Lim, Zhao Wang, Fang Zhou Yu, Tammam Tillo, K.L. Man, Jing Chen Wang and Meng Zhang	IEEE Proceedings of the 9th International SoC Design Conference (ISOCC2012)	2012
(13)	EI	Investigation of EM Wave Propagation of the Wireless Capsule in HumanBody	Eng Gee Lim, Zhao Wang, Jin Hui Chen, Tammam Tillo and Ka Lok Man	IEEE Proceedings of the 10th East-West Design and Test InternationalSymposium (EWDTS'12)	2012

Project 4: Image Processing in Neuroinformatics: Automated Detection, Tracking and Analysis of Time-Lapse STED Imaging of Dendritic Spines

| Bailing Zhang

Programme category: Suzhou Science and Technology Development Planning Programme - Others

Introduction: In this project, a neural dendritic spine image classification method based on multi-resolution fractal features was proposed, which solved the problems of poor image classification effect and poor classification accuracy in the prior art. For biomicroscope images, a variety of image features were proposed to realize combined row feature extraction, and the feature extraction methods used include curvelet transformation, gray level co-occurrence matrix and local texture features. On the basis of multiple features, an integrated and cascading classification architecture was implemented. On the basis of feature extraction, a feature subspace ensemble classification method based on kernel principal component analysis was proposed. We proposed a model of feature subspace ensemble classifier. A feature subspace was established for each extracted image feature, and the image feature of the image to be classified will be reconstructed by these feature subspace models. The distance between the reconstructed feature and the original feature was calculated and mapped into the classification probability. The classification probability obtained by integrating each feature subspace was used to obtain the final classification confidence for image classification. Experiments indicated that the design system can significantly improve the accuracy of biological microscope image classification.

The primary participants of the project were composed of Professor Zhang Bailing, doctoral students and graduate students. In the process of scheme determination, algorithm testing and software development of the whole project, the work was carried out closely around the contract requirements, and the project was completed on schedule with the joint efforts of the project team and relevant close cooperation.

Key issues solved: The project has obtained a series of research results, including: detected the dendritic spine, integrated dynamic fuzzy clustering algorithm to effectively model the anisotropy of local changes in dendritic spine imaging data, proposed and verified multi-precision typing analysis, curvelet transformation, multi-point geostatistical algorithm and integration of different algorithms to describe the morphological pattern of dendritic spines in dendritic spine shape analysis. An effective integrated classification algorithm can achieve accurate and reliable classification and recognition of high-flow dendritic spine types.

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no./Authorisation no.	Inventor(s)
(1)	发明 Patents	授权	基于集成级联架构的生物显微图像分类方法	201210499577.2	张百灵、张云港

2）Copyright

No.	Status	Category	Title	Author(s)	Application no.
(1)	授权	软著	树突棘的自动检测跟踪和分析软件	李铭盛，朱晓辉等	2014R11L189639

3）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Reliable Image Classification by Combining Features and Random Subspace Support Vector Machine Ensemble	Bailing Zhang	International Journal of Pattern Recognition and Artificial Intelligence	2014
(2)	EI	Random Subspace based ECOC Classifier With Reject Option	Hao Pan, Bailing Zhang	Advanced Materials Research	2014
(3)	EI	Breast cancer diagnosis from biopsy images with highly reliable random subspace classifier ensembles	Yungang Zhang, Bailing Zhang, Frans Coenen, Wenjin Lu	Machine Vision and Applications	2013

Project 5: Innovative Image Processing Technique to Reduce Diagnosis Time of the Video and Wireless Capsulse Endoscopy Images

| Tammam Tillo

Programme category: Suzhou Science and Technology Development Planning Programme - Others

Introduction:

Generally, gastroscopy is recommended for digestive tract diagnosis and treatment. A slender and elastic tube with a camera placed at the end is used on the gastroscopy, which is inserted into the mouth when used. Colon and rectum are examined by colonoscopy. Nowadays, endoscopy technology is being used by gastroenterologists to detect diseases such as Crohn's disease, gastric ulcers and colon cancer. However, most digestive tracts are beyond the detection range of the previous two technologies. The result of using special imaging techniques (such as CT and MRI) to detect the small intestine is not ideal. Some people have tried to increase the length of endoscopy. This technique is also called as "pushing intestinal endoscopy", but the effect is limited.

Wireless Capsule Endoscopy (WCE) is a non-invasive technique, which can achieve the purpose of observing and diagnosing small intestinal mucosa. Sensor devices are provided in WCE, which include a color camera and radio frequency transmitter, and most WCE have 4 LED lights and enough battery power. During the 8-hour digestive tract journey, WCE will take nearly 55,000 color pictures during the inspection, and the quality of these images can meet the standards of traditional endoscopy. The WCE test program was approved by the U.S. Food and Drug Administration in 2001 to detect gastrointestinal diseases. WCE has the size of the largest vitamin pill. It is sealed with special biomaterials, which can resist gastric acid and powerful digestive enzymes. Once WCE is swallowed by patients, it will be slowly pushed by digestive tract. Wireless Capsule Endoscopy is most suitable for observing and diagnosing vague gastrointestinal bleeding. Early research system indicates that this is a very effective diagnostic tool for Crohn's disease. In addition, WCE is expected to improve the survival rate of patient with small intestinal cancer.

Wireless Capsule Endoscopy is an innovative technology, which can be used to observe abnormal gastrointestinal tract and can effectively replace traditional endoscopy in diagnosis and treatment. Its greatest advantage is that it uses wireless technology to effectively observe duodenum and small intestine without the obstruction of other human organs, and also eliminates the discomfort brought by traditional wired endoscopy to patients. However, doctors will spend 45min to 180min analyzing the specific data obtained by wireless capsule endoscopy, which limits the popularization of this technology. Because the whole process will produce a large number of images, it needs a lot of time and money in the process of detection or analysis, which leads to a great cost problem. In addition, the longer diagnosis time means that it will delay the benefits of this diagnostic service and limit the number of patients. Therefore, it is necessary to reduce the time and cost of this technology so that more patients can afford this invention.

Recently, there have been some articles about processing WCE detection images, and technologies for automatic identification of digestive organs, such as esophagus, stomach, small intestine and colon, have been proposed. In fact, complex reality, different human tissue structure and lighting conditions make the false alarm rate very high when using these technologies, so it is difficult to effectively reduce the number of images that need diagnostic analysis. These technologies are usually targeted at very specific targets, so they cannot be used to detect various diseases. For example, the technology of automatically detecting bleeding areas cannot be used to detect other diseases.

Therefore, it is necessary to develop a new image selection method to reduce the analysis time. The purpose of this project is to research and develop a new 2D to 3D mapping technology for Wireless Capsule Endoscopy (WCE) images so as to effectively reduce the number of images that need to be analyzed. It is worth emphasizing that this technology can be used for similar applications that need to extract information from a series of images taken along motion curves, so it has a wide application prospect.

Key issues solved: Recently, there have been some articles on image processing of WCE automatic detection, and the technology of automatic discrimination of digestive organs, such as esophagus, stomach, small intestine and colon, has been proposed. In these articles, systems for identifying normal and abnormal tissues have been described, and in this article, the authors attempted to use the beneficial functions of MPEG-7 to detect various activities, such as bleeding, ulcers and polyps. The problem of automatic detection of bleeding site has been solved. In this paper, the author proposed a method using the highest value cluster and Bayesian information.

Two steps are suggested. The first step is to use the method based on block saturation color to identify bleeding images; and the second step is to refine the classification of the first step by using pixel luminance saturation analysis. Currently, the person in charge of this project is carrying out research activities in the field of anomaly detection. This research activity includes the use of the well-known Reed-Xiaoli (RX) detector, which is used to identify two different data sets and then add it to the WCE abnormality detection framework. It is quite challenging to improve the automatic detection of hidden bleeding and symptoms in the concept of basic technology. In fact, the complex reality, varied human tissue structure and lighting conditions make testing, which seems to be a trivial task, quite difficult even if it costs a lot of money.

These statements further confirm the fact that these techniques present relatively high error rates, thus reducing their effectiveness in reducing image analysis and diagnosis. What's more, these technologies are usually targeted at very specific targets, so they cannot be used to detect various diseases. For example, the technology of automatically detecting bleeding areas cannot be used to detect other diseases.

The purpose of this project is to research and develop a new 2D to 3D mapping technology for Wireless Capsule Endoscopy (WCE) images. This technology will greatly reduce the time required for diagnosis so that doctors can analyze all the images obtained more quickly. Thus, this will fill a major technical defect of WCE. In fact, the above-mentioned technology will also capture a lot of overlapping information. Thus, in this project, the information of these overlapping images will be completely used to enhance the final image resolution. Thus, this will greatly improve the resolution of WCE images.

It is worth noting that for the reverse projection images from 2D to 3D, the problems of non-linear and discontinuous small intestine and capsule endoscopy movement detection should also be solved. In fact, WCE does not move at a uniform speed and may stagnate for a period of time. Also, WCE may rotate around its main axis or other axes. Thus, all these will clearly indicate the challenges that need to be solved most in this project.

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no./Authorisation no.	Inventor(s)
(1)	发明	授权	基于无线胶囊内视镜或视频内窥镜体内摄像的图像处理方法及其系统	ZL200910186622.7	罗天明，林永义
(2)	实用新型	授权	带反射镜的无线胶囊内窥镜系统	ZL201120219259.7	林永义，王焀，罗天明
(3)	实用新型	授权	带环形透镜的无线胶囊内窥镜	ZL201120415583.6	王焀，罗天明，林永义，陈瑾慧
(4)	实用新型	授权	基于图像识别技术的可调节拍摄速率的无线胶囊内窥镜系统及方法	ZL201120488509.7	罗天明，林永义，王焀，陈瑾慧

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	The UHF Band In-body Antennas for Wireless Capsule Endoscopy	Eng Gee Lim, Jing Chen Wang, Zhao Wang, Tammam Tillo and Ka Lok Man	Engineering Letters	2013
(2)	EI	Inverse projection of the wireless capsule endoscopy images	T. Tillo, E.G. Lim, Z. Wang, J.W. Hang, R.Q. Qian	IEEE International Conference on Biomedical Engineering and Computer Science (ICBECS 2010)	2010
(3)	EI	2D to Cylindrical Inverse Projection of the Wireless Capsule Endoscopy Images	Tammam Tillo, Yinan Liu, Eng Gee Lim, Zhao Wang	The 4th International Conference on Image and Signal Processing (CISP'11)	2011
(4)	EI	A Novel Radio Propagation and Radiation Model of the Wireless Capsule Endoscopy in Human Gastro-Intestine (GI) Tract	Eng Gee Lim, Zhao Wang, Tammam Tillo, Ka Lok Man, Tuck Seng Wong, KhinWee Lai	IEEE International System on Chip Design Conference (ISOCC 2011)	2011
(5)	EI	Investigation of EM Wave Propagation of the Wireless Capsule in Human Body	Eng Gee Lim, Zhao Wang, Jin Hui Chen, Tammam Tillo and Ka Lok Man	IEEE Proceedings of the 10th East-West Design and Test International Symposium （EWDTS'12)	2012
(6)	EI	Transmitter Antennas for Wireless Capsule Endoscopy	Eng Gee Lim, Zhao Wang, Fang Zhou Yu, Tammam Tillo, K.L.Man, Jing ChenWang and Meng Zhang	IEEE Proceedings of the 9th International SoC Design Conference (ISOCC 2012)	2012
(7)	EI	A TrainingBased Support Vector Machines Technique for Blood Detection in Wireless Capsule Endoscopy Images	Jie Li, Jinwen Ma, Tammam Tillo, Bailing Zhang, Eng Gee Lim	IEEE-EMBS International Conference on Biomedical Engineering and Sciences (IECBES 2012)	2012
(8)	EI	Novel Wireless Capsule Endoscopy Diagnosis System with Adaptive Image Capturing Rate	Zhi Jin, Tammam Tillo, Eng Gee Lim, Zhao Wang and Jimin Xiao	The 8th International Conference on Computer Vision Theory and Applications （VISAPP 2013)	2013
(9)	EI	Novel Training and Comparison Method for Blood Detection in Wireless Capsule Endoscopy Images	Jinwen Ma, Tammam Tillo, Bailing Zhang, Zhao Wang, Eng Gee Lim	The 7th International Symposium on Medical Information and Communication Technology (ISMICT 2013)	2013
(10)	EI	UWB planar Antennas for Wireless Capsule Endoscopy	Jing Chen Wang, Eng Gee Lim, Zhao Wang, Yi Huang, Tammam Tillo, Meng Zhang, Rula Alrawashdeh	The 9th International Workshop on Antenna Technology (iWAT 2013)	2013
(11)	EI	Wireless Capsule Antennas	Eng Gee Lim, Jing Chen Wang, Zhao Wang, Gerry Juans, Tammam Tillo, Ka Lok Man and Meng Zhang	IAENG International MultiConference of Engineers and Computer Scientists (IMECS'13)	2013
(12)	EI	Wireless capsule endoscopy	Eng Gee Lim, Jing Chen Wang, Zhao Wang, Tammam Tillo, Ka Lok Man And Nan Zhang	IAENG International MultiConference of Engineers and Computer Scientists (IMECS'13)	2013
(13)	EI	RF Characteristics of Wireless Capsule Endoscopy in Human Body	Meng Zhang, Eng Gee Lim, Zhao Wang, Tammam Tillo, Ka Lok Man, JingChen Wang	8th International Conference on Grid and Pervasive Computing (GPC 2013)	2013
(14)	EI	Electromagnetic Wave Propagation of Wireless Capsule Antennas in the Human Body	Zhao Wang, Eng Gee Lim, Meng Zhang, Jingchen Wang, Tammam Tillo And Jinhui Chen	International Symposium on Antennas and Propagation (ISAP2013)	2013
(15)	EI	Moveable Wireless Capsule Endoscopy	Eng Gee Lim, Zhao Wang, Sen Nie, Tammam Tillo, K. L. Man, and Nan Zhang	IEEE Proceedings of the 10thInternational SoC Design Conference (ISOCC 2013)	2013
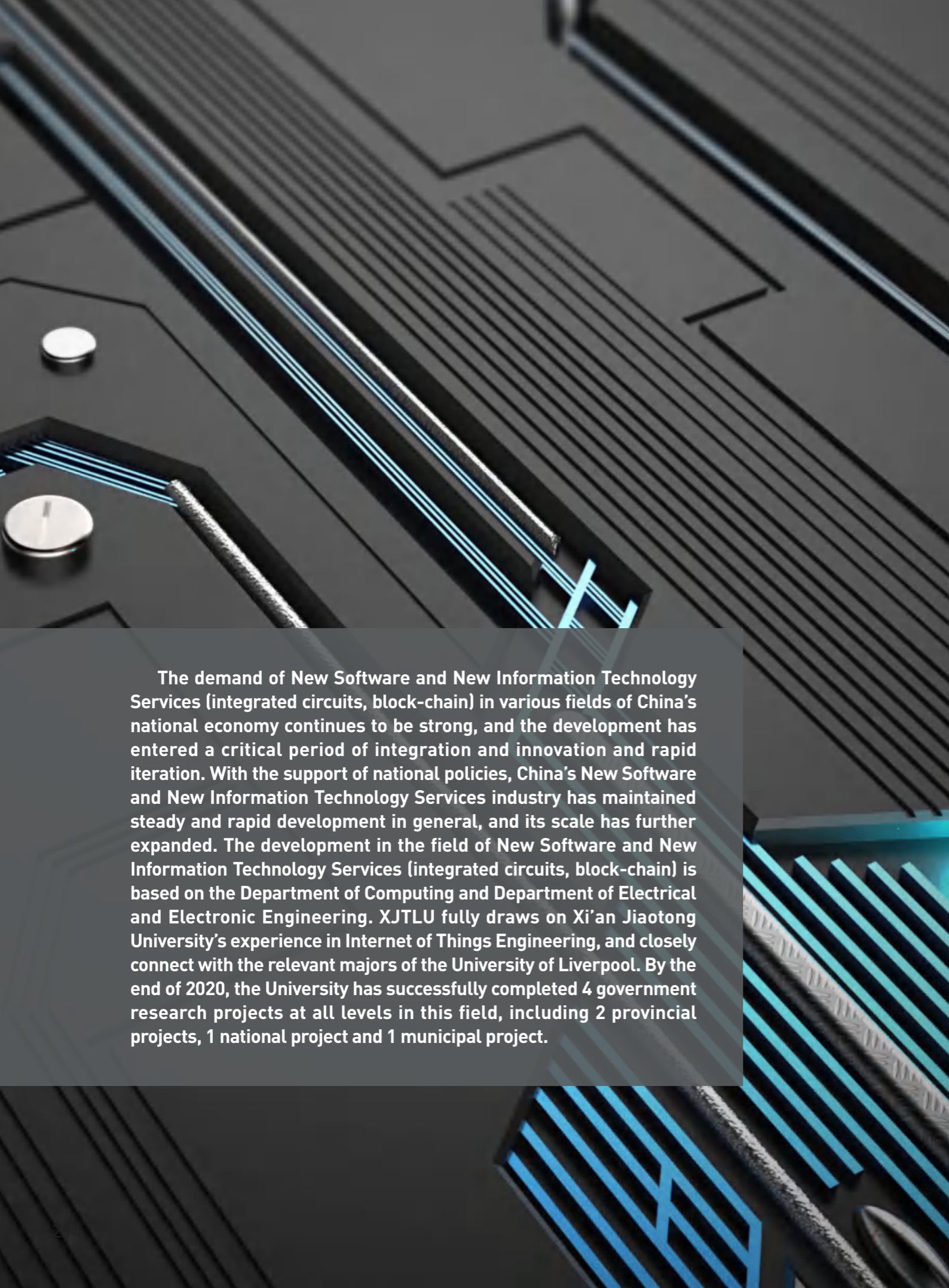
New Software and New Information Technology Services (Integrated Circuit Design, Blockchain)

The demand of New Software and New Information Technology Services (integrated circuits, block-chain) in various fields of China's national economy continues to be strong, and the development has entered a critical period of integration and innovation and rapid iteration. With the support of national policies, China's New Software and New Information Technology Services industry has maintained steady and rapid development in general, and its scale has further expanded. The development in the field of New Software and New Information Technology Services (integrated circuits, block-chain) is based on the Department of Computing and Department of Electrical and Electronic Engineering. XJTLU fully draws on Xi'an Jiaotong University's experience in Internet of Things Engineering, and closely connect with the relevant majors of the University of Liverpool. By the end of 2020, the University has successfully completed 4 government research projects at all levels in this field, including 2 provincial projects, 1 national project and 1 municipal project.

1. National Project

Project 1: Computing Model and Fundamental Mechanisms of Blockchain-Based IoT in IPV6 Environments

| Jie Zhang

Technical field: IPv6 Internet of Things Technology

Programme category: CERNET Innovation Project

Introduction: In the IPv6 environment, the application scale of the Internet of Things is expanding, and the number of networking devices is further increasing, resulting in massive data in the network, which brings great challenges to data management. Although cloud computing plays an important role in the data management of the Internet of Things, there are some issues in data security, reliability and response time in the two main computing models combining cloud computing and the Internet of Things (i.e., centralized computing model emphasizing the role of cloud platform and edge computing model emphasizing the data storage and processing of edge networks). Blockchain provided a new research perspective, which can realize data sharing by building an unalterable distributed ledger, while ensuring data security, and provided the possibility to solve the data management issue of large-scale Internet of Things in IPv6 environment. However, the computing model of the combination of blockchain and Internet of Things is still unclear, and its basic mechanism is that the consensus mechanism and public key cryptography protocol need to be researched. Thus, in this project, we designed and implemented a blockchain Internet of Things computing model with high security, high reliability and low response time, and solved the data management issue of Internet of Things in IPv6 environment.

Key issues solved: In this project, a blockchain Internet of Things computing model was built, and a public key cryptographic protocol suitable for this model was designed and developed, which solved the data management issue of Internet of Things in IPv6 environment. The innovation of the project includes four aspects:

1. Blockchain Internet of Things computing model
2. Consensus mechanism that is applicable to blockchain Internet of Things computing model
3. Public key cryptographic protocol that is suitable for blockchain Internet of Things computing model
4. Published 2 high-level SCI papers, 3 conference papers and applied for 1 invention patent, and the level and quantity of achievements far exceeded the expected indicators

Research achievements:

1) Patents

No.	Category	Status	Patents Title	Application no.	Inventor(s)
(1)	发明	申请	用于分布式能源系统的安全通信方法和装置	CN202010948250.3	张杰，黄鑫

2) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Unbalancing Pairing-Free Identity-Based Authenticated Key Exchange Protocols For Disaster Scenarios	Jie Zhang, Xin Huang, Wei Wang, Yong Yue	IEEE Inte1net of Things Journal	2019
(2)	SCI	Leakage-Resilient Authenticated Key Exchange for Edge Artificial Intelligence	Jie Zhang, Futai Zhang, Xin Huang, Xin Liu	IEEE Transactions on Dependable and Secure Computing	2020

(3)	EI	Formal Verification of Smart Contracts from the Perspective of Concurrency	Meixun Qu, Xin Huang, Xu Chen,Yi Wang, Xiaofeng Ma,Dawei Liu	2018 9th International Conference on Information Technology in Medicine and Education, Hangzhou, China	2018
(4)	EI	Model Checking PBFT Consensus Mechanism in Healthcare Blockchain Network	Kai Zheng, Ying Liu, Chuanyu Dai, Yanli Duan, Xin Huang	2018 9th International Conference on Information Technology in Medicine and Education, Hangzhou, China	2018
(5)	EI	Evaluating the Reliability of Blockchain Based Internet of Things Applications	Ying Liu, Kai Zheng, Paul Craig, Yuexuan Li, Yangkai Luo, Xin Huang	2018 IEEE International Conference on Hot Topics in Information-centric Networking, Shenzhen, China	2018

3）Others

开放源码，完整代码已上传至 IPv6 云服务平台

2. Provincial Projects

Project 1: Cognitive Memes Self-Organization Clustering Algorithm for Data Analysis

| Kam Fung Yuen

Technical fields: Electronic Information – Software - Intelligent Computing and Data Science

Programme category: Jiangsu Science and Technology Programme - Basic Research Plan (Natural Science Foundation) - Young-Scholar Programme

Introduction: This project focuses on the optimization of clustering algorithms, which uses intelligent algorithms to optimize the DBSCAN, and introduces the network fuzzy cognitive method, thereby developing a series of intelligent algorithms and new algorithms for optimization of network cognitive methods, and applies the new algorithm to various examples of data analysis.

This project emphasizes on optimization of current algorithms and extension of application of new algorithms, that is, it extends the research scope from planned "a signal optimization algorithm to improve single clustering algorithm" to "use multiple optimization algorithms and network recommendation systems to optimize different clustering algorithms"; its application is not only limited to financial data, but covers many fields such as decision-making problems, data analysis and system recommendation.

Keywords: Expert System, Machine Learning, Big Data Analysis

Key problems solved: This project selected more new and advanced network cognitive method with respect to traditional hierarchical cognitive method to describe and quantify the experts' and user's opinions. In addition, this project uses the most novel network fuzzy cognition method, which improves the semantic rationality of original method by replacing fuzzy values with signal value.

This project also explored the possibility of optimization of current network cognition method. Swarm Intelligence Algorithm and Genetic Algorithm were used for optimization of network cognition method at the beginning of research, and its research achievements has been applied into the financial data analysis cases such as stock portfolio and fund selection.

This project uses the network fuzzy cognition method to screen the data by characteristics to reduce the dimensionality of high-dimensional data. The network fuzzy cognition method can compare and quantify each dimension of high-dimensional data based on the users and experts to calculate the weight of each dimension so as to delete redundancy and secondary dimension, reduce the dimension of the overall data set and optimize the computing efficiency of subsequent algorithms.

In this project, we made a breakthrough that we made use of network fuzzy cognition method to resolve the difficult quantization of previous category data. The network fuzzy cognition method will compare each attribute of categorical data in the set to be clustered on the basis of users' and experts' opinion, and then calculate the weight of each individual data, and apply such weight into the process of clustering analysis, thereby reflecting the subjective opinions and judgments in the clustering results. This technology can generate the clustering algorithm depending on user preferences so as to make the application of clustering algorithms more user-friendly. The personalized and customized recommendation results can be obtained by application of such technology into recommendation system, so that the user can enjoy with better experience.

The framework established in this project which optimizes the DBSCAN using evolutionary algorithms and cluster intelligence algorithms solves several problems in current DSCAN. First, the optimization algorithm can quickly find the appropriate input parameter to current data for DBSCAN through global search; secondly, the objective function newly proposed in this project can make the users to manually set the required number of cluster in the input stage of DBSCAN; at last, any new swarm intelligence algorithm and DBSCAN, based on the framework, can conveniently and effectively access into this framework to run, so as to further optimize the DBSCAN and enrich the interactive and combined application of evolutionary clustering algorithm and clustering algorithm.

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI/EI	The fuzzy cognitive pairwise comparisons for ranking and grade clustering to build a recommender system: An application of smartphone recommendation	Yuen, K. K. F.	EngineeringApplications of Artificial Intelligence	2017
(2)	EI	Multiple Regression Analyses for Air Quality and Weather in Hong Kong	Yuen, K. K. F.	Journal of Advances in InformationTechnology	2017
(3)	EI	Towards a Canonical Particle Swarm Optimized Direct Least Squares Prioritization Method for Ratio Pairwise Comparison: An Application of Mutual Fund Selection	Yuen K. K. F.	The Ninth International Conference on Developments in e—SystemsEngineering (DeSE2016)	2016
(4)	EI	Towards A Genetic Direct Least Squares Prioritization Method For Pairwise Reciprocal Matrices: Application Of Asset Portfolio Selection	Yuen K. K. F.	International Conference of Machine Learning and Cybernetics (ICMLC) 2016	2016
(5)	EI	Towards A Hybrid Approach of Self-Organizing Map and Density-Based Spatial Clustering of Applications with Noise for Image Segmentation	Chen, V. Q., Yuen K. K. F., and Guan, C.	The 10th International Conference on the Developments in eSystems Engineering	2017
(6)	EI	Towards a recommendation approach for university program selection usingPrimitive Cognitive Network Process	Qingzhi Hu, K. K. F. Yuen and P. Craig	2017 International Conference on Service Systems and Service Management	2017
(7)	EI	Towards A HybridApproach of K—means and Density-Based Spatial Clustering of Applications with Noise for Image Segmentation	Guan C, Yuen K.K.F., and Chen, V.Q.	The 10th IEEEInternational Conference on Cyber, Physical and Social Computing(CPSCom-2017)	2017
(8)	EI	Towards an MCDM-based evaluation framework for regression algorithms	Y. Di, Yuen K. K. F	2017 IEEE InternationalConference on Smart Computing	2017
(9)	EI	Runtime Models Based on Dynamic Decision Networks: Enhancing the Decision-making in the Domain of Ambient Assisted Living Applications	L. H. Garcia Paucar, N. Bencomo. K. K. F. Yuen	Proceedings of the 11th International Workshop on Models@run. time,co—located with ACM/IEEE 19th International Conference on Model Driven Engineering Languages and Systems	2017
(10)	SCI/EI	Particle Swarm Optimized Density-Based Clustering and Classification: Supervised and Unsupervised Learning Approaches	Guan, C, Yuen K. K. F., Coenen F.	Swarm and Evolutionary Computation	2018

Project 2: Usable Multi-Channel Security

| Xin Huang

Technical fields: Electronic Information - Computer and Network - Network Security Equipment

Programme category: Jiangsu Science and Technology Programme - Basic Research Plan (Natural Science Foundation) - Young-Scholar Programme

Introduction: This project has conducted research on the key technologies of security protocols based on the human body channel, and designed a series of security protocols that can be used in the trunk network, including one multi-channel security protocol, two lightweight security protocols and one identity-based security protocol. In the protocol design, considering that the network model in this scenario is often a node with strong computing power and some sensor nodes with weak computing power, we has designed a lightweight key exchange algorithm with asymmetric computing power. During the key establishment process, transferring some computing tasks of devices with weaker computing capabilities to nodes with stronger capabilities can effectively improve the overall efficiency of protocol operation. Moreover, to improve the protocol security, we have carried out security certification and model checking for this type of protocol. In addition, we use such protocols in wearable computing, in smart homes, in photovoltaic networks, and in blockchain applications, and accumulate experience in protocol optimization for different scenarios.

Keywords: Human Body Channel Security Protocol

Solve key issues:

1.Human body channel and its security model

In the body network, the Dolev-Yao channel model is not always applicable. The human body channel has different security models; different security models have different applicable scenarios; to achieve the security model, some auxiliary technologies are often required, for example, the cooperation of users in the protocol implementation.

2.Protocol construction and analysis

Using the special security features of the out-of-band channel, authentication information can be transmitted, which solves the authentication problem in the protocol; The human body channel can simplify the current security protocol based on the public key system.

The multi-channel security protocols in implantable and wearable trunk networks are different; the multi-channel security protocol in the implantable trunk network should be lighter weight and more energy-saving.

Traditional identity-based security protocols can be simplified and optimized using human body channels, etc. In an identity-based authentication system, the private key generation center (PKG) needs to send some secret information to the user securely, while the human body channel can be used as a safe channel to transmit this information.

3.Protocol application

The multi-channel security protocol based on the human body channel can find practical applications, such as medical monitoring and electronic payment. The advantage of this type of protocol is that it can simplify the authentication process and improve security and availability; the challenge is that the device needs to support the human body channel. In various specific applications, the safe channel assumption of the human body channel can generally be established, but a better solution is the cooperation of users.

Research achievements:

1）Patent

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	实用新型	授权	一种支持比特币支付的轨道交通自动售票机	CN201620369250.7	ZL201620369250.7	张杰，黄鑫，徐安迪，李宽，吴斯涵

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI/EI	Unbalancing Pairing-Free Identity—Based Authenticated Key Exchange Protocols For Disaster Scenarios	Jie Zhang, Xin Huang, Wei Wang, Yong Yue	IEEE Internet of Things Journal	2018.08.01
(2)	SCI/EI	A Secure System for Pervasive Social Network-based Healthcare	Jie Zhang, Nian Xue, Xin Huang	IEEE Access	2016
(3)	SCI/EI	An Improved Protocol for the Password Authenticated Association of IEEE 802. 15. 6 Standard That Alleviates Computational Burden on the Node	Jie Zhang, Xin Huang, Paul Craig, Alan Marshall, Dawei Liu	Symmetry	2016
(4)	SCI/EI	A Handshake Protocol with Unbalanced Cost for Wireless Updating	Jiaren Cai, Xin Huang, Jie Zhang.	IEEE Access	2018
(5)	EI	Software defined intelligent building	Ruiyang Xu, Xin Huang, Jie Zhang, Yulin Lu, Ge Wu, Zheng Yan	International Journal of Information Security and Privacy	2015
(6)	EI	S2Net: A Security Framework for Software Defined Intelligent Building Networks	Nian Xue, Xin Huang, Jie Zhang	Trustcom/ BigDataSE/ISPA, IEEE	2016
(7)	EI	POSTER: A Framework for IoT Reprogramming	Nian Xue, Lulu Liang, Jie Zhang, Xin Huang	Proceedings of International Conference on Security and Privacy in Communication Systems	2016
(8)	EI	An Access Control System for Intelligent Buildings	Nian Xue, Lulu Liang, Jie Zhang, Xin Huang	Proceedings of the 9th EAI International Conference on Mobile Multimedia Communications	2016
(9)	EI	Improving Efficiency of Authenticated OpenFlow Handshake using Coprocessors	Andi Xu, Mi Li, Jiaren Cai, Nian Xue, Jie Zhang, Dawei Liu, Paul Craig, Xin Huang	The 8th International Conference on IT in Medicine and Education (ITME 2016)	2016
(10)	EI	An improved IEEE 802. 15. 6 password authenticated association protocol	Xin Huang, Dawei Liu, Jie Zhang	Communications in China (ICCC), 2015 IEEE/CIC International Conference on	2015
(11)	EI	Identity-Based Association Protocols for Wireless Personal Area Networks	Xin Huang, Paul Craig, Qinghua Wang	The 13th IEEE International Conference on Dependable, Autonomic and Secure Computing (DASC-2015)	2015
(12)	SCI/EI	Identification of Location Spoofing in Wireless Sensor Networks in Non-Line-of-Sight Conditions	Dawei Liu, Yuedong Xu, Xin Huang	IEEE Transactions on Industrial Informatics	2017

3）Others

设计了一套协议，包括 1 个多信道安全协议，2 个轻量级安全协议，1 个高效的基于身份的安全协议；并可以在嵌入式设备上测试．测试结果优于国际主流标准协议．

3.Municipal Project

Project 1: Identity-Based Security Protocols Using Out-of-Band Channels

| Xin Huang

Introduction: In this project, the payment protocol in the fare collection system was deeply researched, an embedded module supporting bitcoin transaction was designed, and the rail transit ticketing system supporting bitcoin transaction was constructed by using this module. Two multi-channel security protocols were developed by using the out-of-band channel constructed by the display screen. A key exchange algorithm with asymmetric computation was designed, and a lightweight security protocol and an identity-based security protocol were constructed by using this algorithm. In this project, four security protocols that can be used for mobile payment were designed. All protocols can be tested on embedded devices, and the test results are better than similar protocols in international mainstream standards. Also, the security of the protocol was proved theoretically and verified formally, which ensured that the protocol had satisfying security performance. Currently, one invention patent has been applied for and accepted, and one utility model patent has been obtained. 12 high-level papers, including 5 SCI papers and 7 EI papers, have been published. One doctoral student under this project graduated on July 20, 2018.

Key issues solved:

1. In terms of out-of-band channel, the way to establish feasible out-of-band channel, to establish safe channel model and to improve the availability of out-of-band channel.
2. In terms of lightweight cryptographic protocol, the way to reduce the computing tasks of nodes with weak computing power.
3. In terms of protocol design, the way to apply out-of-band channel and lightweight cryptographic algorithm to protocol construction and the security protocol for mobile payment was designed. The way to apply these security protocols to mobile payment scenarios was designed.
4. In terms of protocol security proof and formal analysis, the way to prove the security of the protocol and the way to establish a formal model of the protocol so as to test whether there are loopholes in the protocol.

Research achievements:

1) Patent

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	实用新型	授权	一种支持比特币支付的轨道交通自动售票机	CN201620369250.7	ZL201620369250.7	张杰，黄鑫，徐安迪，李宽，吴斯涵

2) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI、EI	Unbalancing Pairing-Free Identity-Based Authenticated Key Exchange Protocols For Disaster Scenarios [J]	Jie Zhang, Xin Huang, Wei Wang, Yong Yue	IEEE Internet of Things Journal	2018
(2)	SCI、EI	A Handshake Protocol with Unbalanced Cost for Wireless Updating [J]	Jiaren Cai, Xin Huang, Jie Zhang	IEEE Access	2018
(3)	SCI、EI	Identification of Location Spoofing in Wireless Sensor Networks in Non-Line-of-Sight Conditions [J]	Dawei Liu, Yuedong Xu, Xin Huang	IEEE Transactions on Industrial Informatics [J]	2017
(4)	SCI、EI	A Secure System for Pervasive Social Network-based Healthcare [J]	Jie Zhang, Nian Xue, Xin Huang	IEEE Access	2016
(5)	SCI、EI	An Improved Protocol for the Password Authenticated Association of IEEE 802.15.6 Standard That Alleviates Computational Burden on the Node [J]	Jie Zhang, Xin Huang, Paul Craig, Alan Marshall, Dawei Liu	Symmetry	2016
(6)	EI	Software defined intelligent building [J]	Ruiyang Xu, Xin Huang, Jie Zhang, Yulin Lu, Ge Wu, Zheng Yan	International Journal of Information Security and Privacy	2015
(7)	EI	A Security Framework for Software Defined Intelligent Building Networks [C]	Nian Xue, Xin Huang, Jie Zhang	Trustcom/BigDataSE/ISPA	2016
(8)	EI	POSTER: A Framework for IoT Reprogramming [C]	Nian Xue, Lulu Liang, Jie Zhang, Xin Huang	Proceedings of International Conference on Security and Privacy in Communication Systems	2016
(9)	EI	An Access Control System for Intelligent Buildings [C]	Nian Xue, Lulu Liang, Jie Zhang, Xin Huang	Proceedings of the 9th EAI International Conference on Mobile Multimedia Communications	2016
(10)	EI	Improving Efficiency of Authenticated OpenFlow Handshake using Coprocessors [C]	Andi Xu, Mi Li, Jiaren Cai, Nian Xue, Jie Zhang, Dawei Liu, Paul Craig, Xin Huang	The 8th International Conference on IT in Medicine and Education (ITME 2016)	2016
(11)	EI	An improved IEEE 802.15.6 password authenticated association protocol [C]	Xin Huang, Dawei Liu, Jie Zhang	Communications in China (ICCC), 2015 IEEE/CIC International Conference on, 2015	2015
(12)	EI	Identity-Based Association Protocols for Wireless Personal Area Networks [C]	Xin Huang, Paul Craig, Qinghua Wang	The 13th IEEE International Conference on Dependable, Autonomic and Secure Computing (DASC-2015), Liverpool, England, UK, 2015	2015

Advanced Environmental Protection Technology

The Advanced Environmental Protection Field includes the use of advanced technology to carry out the production and operation of environmental protection equipment, environmental protection products and environmental protection technology integration and related services. Currently, combating climate change, combating environmental pollution and restoring damaged habitats have become important issues related to global ecological security, with green technologies emerging, green business models rapidly iterating and green finance accelerating, the field of Advanced Environmental Technology has become a new investment hotspot. XJTLU has established an Urban and Environmental Studies University Research Centre and the Institute for Sustainable Materials and Environment, and had successfully completed 4 national projects, 7 provincial projects, and 1 municipal project by the end of 2020.

1. National Projects

Project 1: Integrating Spatial Planning and Water Management in Urbanised Deltas - A Comparison of Instruments in the Yangtze (CN) and Scheldt-Meuse-Rhine (EU) River Delta regions

| Christian Nolf

Application code: E0802 (Department of Engineering and Materials Sciences)

Programme category: National Natural Science Foundation of China (NSFC) – International Young Scientists Programme

Introduction: This research compares the Rhine-Meuse-Scheldt Delta in Europe and the Taihu Basin part of the Yangtze River Delta in China from a long-term historical perspective. Urbanized deltas are among the most prosperous and populated regions in the world, but also the most vulnerable. To cope with growing uncertainty, their systematic comparison has become instrumental in building mutual learning on the theory and practice of spatial planning and water resource management in such vulnerable contexts.

Based on a systematic comparative mapping approach of Delta Urbanism with critical review of policies, this research highlights important similarities between these two deltas in terms of physical characteristics, dense occupation, and management history evolving from a decentralized polder-based system to a centralized control model, and a recent adoption of integrated and adaptive water management strategies. On the other hand, the comparison reveals distinct management focuses in current delta plans, as well as contrasting approaches to public participation and historical hydraulic landscapes.

It is found from this comparative study that, beyond the socio-cultural specificities that can explain the distinct management practice of each region, the systematic use of mapping as a visualization and communication tool would facilitate integrative and adaptive delta management.

Keywords: Delta Urbanism, Integrated Water Resource Management, Spatial Planning, Mapping, Visualization, Taihu Basin

Research achievements:

1） Copyrights

No.	Category	Title	Author(s)	Book Title
(1)	章节	Suzhou Waterfront Guidelines	Viganò, P., Qinyi Z., Nolf, C., Pellegrini, P., Pagnacco A.	Urban Waterfront Analysis and Comparative Design _ Beijing, Suzhou and Yinchuan
(2)	章节	Historic Landscape and Water Heritage of Suzhou beyond the Tourist Gaze	Wang, Y. & Nolf, C.	China's Urban Transformation: Suzhou in Transition
(3)	章节	Past, Present and Possible Futures of Jiangnan's Water Villages, Yangtze River Delta (China)	Nolf, C., Vannoorbeeck, F., Pellegrini P.	Sustainable development of Small Settlements in the Southeast Asia Region _ Exemplary Case Studies

2） Publications（SCI、SCIE、SSCI、A&HCI、EI、A Guide to the Core Journal of China only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	A Guide to the Core Journal of China	Cultural Landscape Characterization and Spatial Strategies in the Metropolitan Areas of the Yangtze River Delta	Xie Y., Nolf C.	Chinese Landscape Architecture（中国园林）	2020
(2)	A Guide to the Core Journal of China	Design Research on Landscape-led Rural Revitalization	Chen B., Yao Z., Zhang H., Nolf C.	Chinese Landscape Architecture.（中国园林）	2020
(3)	SSCI, A&HCI	Reframing China's heritage conservation discourse. Learning by testing civic engagement tools in a historic rural village	Verdini, G., Frassoldati, F., Nolf, C.	International Journal of Heritage Studies	2016
(4)	CSSCI	A Consolidated Archipelago. Retrospective of Water Engineering and Urbanization in the Yangtze River Delta	Nolf C., Xie Y., Vannoorbeeck F.	Shanghai Academy of Social Sciences & International Institute for Asian Studies, Special Issue on Water Heritage in Asian Cities	2019

Project 2: The Modulation of Iron Redox Cycling and Arsenic (Im) Mobilization by Implanting Sediment Microbial Fuel Cells in Paddy Soils

| Zheng Chen

Application code: G030702 (Department of Earth Sciences)

Technical field: Environmental Restoration

Programme category: National Natural Science Foundation of China (NSFC) - General Programme

Introduction: Farmland pollution and submerged cultivation of rice can easily lead to the enrichment of toxic heavy elements in rice grains, resulting in excessive heavy metal elements in rice and endangering human health. Thus, it is urgent to inhibit the enrichment of toxic heavy metals in rice grains. For the problem of arsenic pollution in paddy soil, in this project, a new remediation strategy was proposed, that is, microbial fuel cell technology was used to continuously control the release of iron and arsenic in soil pore water, thus reducing the migration and accumulation of arsenic from soil to rice. The research results are divided into four parts.

First, the effects of microbial fuel cell on soil microorganisms and components were investigated. The results indicated that the anode of microbial fuel cell can significantly change the microbial community structure of anode and nearby soil. When the battery load is low, it can promote the growth of anode respiration bacteria. For inorganic components, with the operation of the battery, the anode rapidly consumes organic matter in the soil and leads to acidification.

Second, the effects of microbial fuel cells on the release of iron and arsenic were emphatically investigated. We found that soil soluble organic matter is the key factor to control iron reduction and arsenic release. When the content of organic matter is low, anode microorganisms and soil iron-reducing bacteria compete for organic substrates, inhibit the process of iron reduction and cause arsenic release to slow down. When the content of organic matter is high, the competition mechanism is not dominant. Soil acidification and the increase of iron-reducing bacteria in soil are the main factors causing the accelerated release of iron and arsenic. For soils with excessive organic matter, the available organic matter of soil microorganisms can be rapidly reduced by alternating dry and wet processing so as to obtain the competitive environment of organic substrates again, thus controlling arsenic release.

Third, the whole process of heavy metals from soil to rice under the influence of microbial fuel cells was deeply researched. Microbial fuel cells have no negative effects on rice growth, and can significantly reduce As, Cu, Cr, Ni and Cd in various parts of rice, of which, in the most important grain parts, these harmful heavy metal elements can be reduced by about 40%.

Finally, in the process of researching the electrode and soil-plant system, we realized that the interface process is the key to clarify the migration and transformation mechanism of elements in soil-water-plant system, and the bottleneck of the research on interface process lies in the lack of related technologies. Thus, we developed a new high-precision soil pore water sampling technique, which can be used for in-depth research of soil interface processes.

To sum up, in this project, the influence process and main control factors of microbial fuel cells on the behavior of heavy metals in soil were systematically researched. The results can be used to control moderate and mild arsenic contaminated soil, and provide a new way to solve the arsenic pollution problem in China.

Keywords: Arsenic, Paddy Field, Microbial Fuel Cell, Iron, Heavy Metal

Research achievements:

1) Patent

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	一种原位土壤孔隙水取样器及取样方法和应用	CN201811025505.8	ZL201811025505.8	陈正；袁召锋；刘馥源

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	Tracing the Dynamic Changes of Element Profiles by Novel Soil Porewater Samplers with Ultralow Disturbance to Soil-Water Interface	Zhao-Feng Yuan; Gustave Williamson; Bridge Jonathan; Liang Yi; Sekar Raju; Boyle John; Jin Chen Yu; Pu Tong Yao; Ren Yu Xiang; Zheng Chen*	Environmental Science & Technology	2019
(2)	SCIE	Soil organic matter amount determines the behavior of iron and arsenic in paddy soil with microbial fuel cells	Williamson Gustave; Zhao-Feng Yuan; Raju Sekar; Yu-Xiang Ren; Jinjing-Yuan Liu; Jun Zhang; Zheng Chen*	Chemosphere	2019
(3)	SCIE	Arsenic alleviation in rice by using paddy soil microbial fuel cells	Williamson Gustave; Zhao-Feng Yuan; Yu-Xiang Ren; Raju Sekar; Jun Zhang; Zheng Chen*	Plant and Soil	2019
(4)	SCIE	The change in biotic and abiotic soil components influenced by paddy soil microbial fuel cells loaded with various resistances	Williamson Gustave; Zhao-Feng Yuan; Sekar Raju; Yu-Xiang Ren; Hu-Cheng Chang; Jinjing-Yuan Liu; Zheng Chen*	Journal of Soils and Sediments	2019
(5)	SCIE	Arsenic mitigation in paddy soils by using microbial fuel cells	Williamson Gustave; Zhao-Feng Yuan; Sekar Raju; Hu-Cheng Chang; Jun Zhang; Mona Wells; Yu-Xiang Ren; Zheng Chen*;	Environmental Pollution	2018
(6)	SCIE	Relic DNA does not obscure the microbial community of paddy soil microbial fuel cells	Williamson Gustave; Zhao-Feng Yuan; Raju Sekar; Veronica Toppin; Jinjing-Yuan Liu; Yu-Xiang Ren; Jun Zhang; Zheng Chen*;	Research in Microbiology	2019
(7)	SCIE	Mitigation effects of the microbial fuel cells on heavy metal accumulation in rice (Oryza sativa L.)	Williamson Gustave; Zhao-FengYuan; Xiaojing Li; Yu-Xiang Ren; Wei-Jia Feng; HaiboShen; Zheng Chen*;	Environmental Pollution	2020
(8)	SCIE	Sulfur Redox Cycling Dependent Abiotic Ferrihydrite Reduction by a Desulfitobacterium hafniense	Li Guo-Xiang; Chen Xue-Ping; Wang Xin-Nan; Zheng Chen; Bao Peng*;	ACS EARTH AND SPACE CHEMISTRY	2018

Project 3: Effects of Agricultural Landscape Pattern on Pollinator Insect Diversity and Pollination Services

| Yi Zou

Application code: C0306 (Department of Life Sciences)

Programme category: National Natural Science Foundation of China (NSFC) – Young Scientists Fund

Introduction: Pollination services provided by pollinating insects are very important for agricultural production. Complex farmland landscape can provide habitat for pollinators, which plays an important role in biodiversity conservation in farmland ecosystem. However, in the small-scale agricultural production mode in southern China, how farmland landscape affects biodiversity is not clear. In addition, the pollination efficiency of different pollinating insects needs to be evaluated urgently.

In this project, a series of experimental plots with different agricultural landscape complexity were set up. Through satellite remote sensing combined with UAV shooting, we investigated the land use within 2km radius of these sample plots, and collected pollinating insects and other arthropoda in the sample plots. We evaluated the pollination efficiency of different insects by analyzing the pollination behavior of common flower visiting insects. The results of this project indicate that the increase of semi-natural proportion is beneficial to improve the diversity of pollinating insects, while the standardization of farmland reduces the biodiversity. We further analyzed how large-scale semi-natural habitats can compensate for the loss of biodiversity caused by high-standard farmland construction. In addition, for buckwheat and other crops, we quantified the pollination efficiency of different pollinating insects. During the research of insect diversity, we improved a sampling method of pollinating insects, and put forward a suitable investigation and calculation scheme for insect biodiversity.

The research of this project clarified the importance of semi-natural habitat for pollinating insects diversity protection. In the process of high-standard farmland construction and other land integration, the results of the project can provide theoretical basis for the way to rationally allocate landscapes.

Keywords: Pollinating Insects, Biodiversity, High Standard Farmland, Agricultural Landscape

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	Do diverse landscapes provide for effective natural pest control in subtropical rice?	Zou, Yi; de Kraker, Joop; Bianchi, Felix J. J. A.; Xiao, HaiJun*; Huang, Jikun; Deng, Xiangzheng; Hou, Lingling; Van der Werf, Wopke	Journal of Applied Ecology	2020
(2)	SCIE	Quantifying pollination efficiency of flower-visiting insects and its application in estimating pollination services for common buckwheat	Liu, Ruirui*; Chen, Delai; Luo, Shudong; Xu, Shujuan; Xu, Huanli; Shi, Xiaoyu; Zou, Yi*	Agriculture Ecosystems & Environment	2020
(3)	SCIE	Predictability of species diversity by family diversity across global terrestrial animal taxa	Zou, Yi*; van der Werf, Wopke; Liu, Yunhui*; Axmacher, Jan Christoph	Global Ecology and Biogeography	2020
(4)	SCIE	The Chord-Normalized Expected Species Shared (CNESS)-distance represents a superior measure of species turnover patterns	Zou, Yi*; Axmacher, Jan Christoph	Methods in Ecology and Evolution	2020
(5)	SCIE	Impact of acute oral exposure to thiamethoxam on the homing, flight, learning acquisition and short-term retention of Apis cerana	Ma, Changsheng; Zhang, Yongkui; Sun, Jia; Imran, Muhammad; Yang, Huipeng; Wu, Jie; Zou, Yi*; Li Byarlay, Hongmei; Luo, Shudong*;	Pest Management Science	2019
(6)	SCIE	Estimating the number of species shared by incompletely sampled communities	Zou, Yi*; Axmacher, Jan Christoph	Ecography	2021

Project 4: Environmental Pollution: A New Full Spectrum Approach to Environmental Risk Assessment and Management

| Boris Tefsen

Application code: D071101 (Department of Earth Sciences)

Programme category: National Natural Science Foundation of China (NSFC) – General Programme

Introduction: Unprecedented environmental pollution requires faster and more reliable risk assessment. Objective of the project is to develop innovative methods as a key part of improving environmental risk assessment, thus improving efficiency and reducing costs. The demonstration area is Taihu River Basin, which represents a large area with rapid economic development. Lead is a serious global pollutant. As an experimental case, it is the main focus of attention. The whole-cell biosensor was used to measure the bioavailability of lead, and the results were integrated into a biogeochemical model, which was widely recognized as a risk assessment tool in the United States and the European Union. In addition, the utilization of lake sediments was also researched. During the project, the work was expanded from the original plan to the research on certain metals that can be used as micronutrients as well as toxins. Thus, it is also related to the formation of harmful algal blooms in freshwater.

The results of this project have been verified by the standard method of environmental risk assessment, which proves that this is a successful and rapid risk assessment method. The result is completely consistent with the best possible results from the original project goals and objectives. The risk assessment methodology demonstrated in this project has no obstacles and can be adopted and used more generally. Environmental risk assessments on micronutrients have indicated that very small micronutrient interventions enable less harmful algae to defeat highly toxic harmful algae. This is a safe and meaningful approach and points the way forward for larger-scale field trials. The two methods developed in this project, flow cytometry data-driven analysis and high-throughput screening of copper complex carriers, represent a new method to quickly solve the environmental data requirements and they are complete. Any researcher or environmentalist could use these methods. As far as academic value is concerned, up to now, four journal papers have been published (two of which are divided into one district according to journal citation reports in the journals with the highest impact factors in this discipline). Two other papers are under review, and four others are currently under preparation.

Keywords: Environmental Risk Assessment, Lead, Bioavailability, Micronutrients, Harmful Algal Bloom

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	Effect of micronutrients on algae in different regions of Taihu, a large, spatially diverse, hypereutrophic lake	Zhang, Xiaokai; Li, Boling; Xu, Hai; Wells, Mona*; Tefsen, Boris; Qin, Boqiang	Water Research	2019
(2)	SCIE	Regional-scale investigation of dissolved organic matter and lead binding in a large impacted lake with a focus on environmental risk assessment	Zhang, Xiaokai; Li, Boling; Deng, Jiaming; Qin, Boqiang; Wells, Mona*; Tefsen, Boris;	Water Research	2020
(3)	SCIE	Whole-cell bioreporters and risk assessment of environmental pollution: A proof-of-concept study using lead	Zhang, Xiaokai; Deng, Jianming; Qin, Boqiang; Wells, Mona*;	Environmental Pollution	2017
(4)	EI	Quantitative high-throughput approach to chalkophore screening in freshwaters	Zhang, X., Li, B., Deng, J., Qin, B., Wells, M., Tefsen, B.	Science of the Total Environment	2020.9
(5)	EI	Advances in freshwater risk assessment: improved accuracy of dissolved organic matter-metal speciation prediction and rapid biological validation	Zhang, X., Li, B., Deng, J., Qin, B., Wells, M., Tefsen, B.	Ecotoxicology and Environmental Safety	2020.10
(6)	EI	Whole-cell bioreporters and risk assessment of environmental pollution: A proof-of-concept study using lead	Zhang, X., Li, B., Schillereff, D., Chiverrell, R., Wells, M., Tefsen, B.	Environ Pollut.	2020.2

2.Provincial Projects

Project 1: The Effects of Multiple Stressors on Stream Ecosystem Functioning, Community Structure and Resource Subsidy

| Yixin Zhang

Technical fields: Environmental Protection and Comprehensive Utilization of Resources – Environmental Monitoring and Environmental Ecological Protection

Programme category: Jiangsu Science and Technology Programme – Basic Research Plan (Natural Science Foundation) – General Programme

Introduction: Due to the global changes caused by the rapid development of human society and economy, most freshwater ecosystems were widely affected by various human threats. For example, agricultural development, rapid urbanization and global warming changed the natural runoff and hydrological and hydraulic conditions of natural rivers, promoted the increase of sediment and led to eutrophication of water bodies. Usually, the environmental stress factors interacted with each other, which made it extremely complicated and difficult to predict the effects of different stress factors on biological communities and ecosystem functions. It was far from enough to research the impact of single stress on river ecosystem. In the process of river ecosystem protection, restoration and reconstruction, the effects of multiple stresses on river ecosystem must be considered. To investigate the impacts of multiple land use stresses related to agricultural development and urbanization, a highly repeatable field river microcosmic ecosystem experiment was carried out in the near primitive mountain environment. In this experiment, the Full Factorial Design method was adopted, and four factors were selected: fine sediment, flow rate, nutrients and two different experimental time periods. Subsequently, the linear model was used to analyze the time response mechanism of microbial community and large benthic invertebrate community related to litter decomposition and benthic biofilm. In ecosystems where multiple stresses exist simultaneously, the interaction of different stresses may show superposition, synergy, orange resistance or comparative effects. Microbial community analysis indicated that different stresses between litter decomposition microbial community and biofilm production had different effects on species composition. Nutrient enrichment and flow rate decrease were the most important factors affecting the degradation community of deciduous microorganisms while fine sediment deposition and flow rate decrease were the leading factors for biofilm formation. The deposition of fine sediments and the decrease of flow velocity were also the main factors affecting the community composition of large benthic invertebrate. Two-factor interaction analysis indicated that there was a main interaction between sediment and velocity decrease (sediment X velocity decrease) or between nutrient enrichment and sediment (nutrient enrichment X sediment), and there was also a three-factor interaction between them (nutrient enrichment X sediment X velocity decrease). In addition, the temporal dynamics of community is also very significant. Therefore, the temporal dynamics should be considered as an important factor in the research of multi-factor stress. Changes in abiotic factors often lead to changes in the process of environmental screening and niche selection, and then lead to functional reset of different communities.

During the completion of this project, a total of 10 core papers (including 9 SCI papers) have been published, and another 3 SCI papers are in the process of submission for review. An important revelation of this paper is that it is necessary to research the interaction of multiple environmental stress factors in river system by adopting ecosystem method. In the future research of river ecosystem, we should focus on the energy flow and material circulation among different nutrient levels while considering the temporal and spatial variability factors repeatedly. In addition, the combination of biodiversity index and functional traits is helpful to deeply understand the process and mechanism of ecosystem function. The determination of temporal and spatial dynamics and function will also promote the prediction of stability of freshwater ecosystem under multiple stresses in the future.

Keywords: Exstream System, RNA, Degradation of Organic Matter, Global Change

Key issues solved: Through a series of field simulation experiments, the research indicated that it is necessary to apply the ecosystem method to research the interaction of multiple environmental stress factors in river system. The method definition of solving the research issue of multiple ecological stresses in rivers in the future was defined. In the research of river ecosystem,

we should focus on the energy flow and material circulation among different nutrient levels while considering the temporal and spatial variability factors repeatedly. The combination of biodiversity index and functional traits is helpful to deeply understand the process and mechanism of ecosystem function.

Research achievements:

1）Copyright

No.	Category	Title	Author(s)
(1)	Book Chapter	Multiple Stressors in China's Freshwater Ecoregions.Chapter in: Multiple Stressors in River Ecosystems	Zhang, Y.X.

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Effect of River EcologicalRestoration on BiofilmMicrobial CommunityComposition	Zhang, Yixin	Water	2019
(2)	SCI	Water Bodies' Cooling Effects on Urban Land Daytime Surface Temperature: EcosystemService Reducing Heat Island Effect	Zhang, Yixin	Sustainability	2019
(3)	SCI	Combined effects of watertemperature, grazing snails and terrestrial herbivore on leaf decomposition in urban streams	Zhang, Yixin	PeerJ	2019
(4)	SCI	The Impact of MicroplasticParticles on PopulationDynamics of Predator and Prey: Implication of theLotka-Volterra Model	Zhang, Yixin	Scientific Reports	2020
(5)	SCI	Effects of anthropogenicsubsidy and glyphosate onmacroinvertebrates in streams	Zhang, Yixin	Environmental Science and Pollution Research	2020
(6)	SCI	Anthropogenic stressors affect fungal more than bacterial communities in decaying leaf litter: a stream mesocosm experiment.	Zhang, Yixin	Science of the Total Environment	2020
(7)	SCI	Fine sediment and flow velocity impact bacterial community and functional profile more than nutrient enrichment	Zhang, Yixin	Ecological Applications	2020
(8)	SCI	Evaluating ecosystemfunctioning following riverrestoration: the role ofhydromorphology, bacteria, and macroinvertebrates	Zhang, Yixin	Science of the Total Environment	2020
(9)	SCI	Impacts of multipleanthropogenic stressors onstream macroinvertebratecommunity composition and functional diversity	Zhang, Yixin	Ecology and Evolution	2020

(10)	SCI	Assessment on the Effectiveness of Urban Stormwater Management	Zhang, Yixin	Water	2020

Project 2: Study on Real-Time Monitoring of Nitrogen Dioxide Based on Functionalized Graphene Nano-Sensors

| Sujie Qin

Technical fields: Environmental Protection and Comprehensive Utilization of Resources – Air Pollution Prevention and Control

Programme category: Jiangsu Science and Technology Programme - Basic Research Plan (Natural Science Foundation) – Young-Scholar Programme

Introduction: The purpose of this project is to explore the real-time detection of nitrogen dioxide (NO2) by functionalized graphene nanomaterials and related development work. First, porous tin dioxide modified reduced graphene oxide (SnO2/RGO) nanocomposites were prepared by sol-gel method and supercritical drying technology, and dispersed into sensitive material ink which can be used for printing. After testing, the sensor based on SnO2/RGO has very satisfying selectivity to NO2. It was also found that the device has excellent moisture resistance property, and the response value of degree to NO2 changes less than 5% in dry air and high humidity. To further improve the accuracy of the device, the traditional spectrophotometry was used to calibrate the sensor. On the basis of this work, the range of sensitive materials (Single-Walled Carbon Nanotubes/Silicon (SWNTs/Si), Nickel Oxide (NiO) and SnO2 multilevel nanostructure materials) was further expanded, and new device structures were explored, and low-cost and large-scale sensor preparation technologies were explored to improve the response performance and repeatability of devices.

Research on controllable preparation technology of several nanocomposites:

1. Preparation method of SnO2/RGO: The prepared graphene oxide (GO) was dispersed in N, N-dimethylformamide (DMF) and left overnight. Then, stannic chloride (SnCl4) and epichlorohydrin (PPO) were slowly added with stirring. Finally, porous SnO2/RGO aerogel nanocomposites were obtained by supercritical drying and high temperature carbonization.
2. In-situ growth and controlled preparation of NiO/SnO2 multistage nanostructure: NiO/SnO2 multistage nanostructure materials with controllable morphology were fabricated in-situ by two-step chemical coprecipitation technology.

Research on device fabrication technology: First, large-scale device fabrication was realized by printing or printing SnO2/RGO ink. Second, a combination of micromachining technology (MEMS) ('top-down') and in-situ growth ('down-top') was explored from the perspective of device stability and repeatability.

Calibration technology of devices by traditional methods: A gas mass flow controller (MFC) was used to control the concentration and flow rate of NO2. Then, a high-precision gas sampler was used to collect NO2 samples, and the sampling time was adjusted. Finally, the device was calibrated by measuring the concentration of NO2 sample by spectrophotometry.

Key issues solved:

1. The preparation parameters of porous SnO2/rGO composites was determined.
2. The gas response performance of SnO2/rGO was researched, the influence of humidity and temperature on the device performance was explored, and the moisture resistance and response principle of the device were discussed from the mechanism.
3. The calibration plan of gas sensor by traditional analysis and detection method (GB-T 15435-1995) was established.
4. The in-situ growth scheme of multilevel nano-structured materials was expanded, and the gas sensor with high stability and high response performance was prepared. The mechanism of improving the device performance by heterojunction interface was researched from theoretical calculation.
5. Based on the template-induced dewetting effect, this in-situ growth technology was successfully combined with micromachining technology to realize large-scale and low-cost preparation of gas sensors with uniform performance.
6. A new device structure was designed, which can detect gas molecules by self-driving without external power supply, and the self-driving response mechanism of the new sensor based on p-n heterojunction was explored.

Research achievements:

1）Patent

No.	Category	Status	Patents Title	Application no.	Inventor(s)
(1)	发明	申请	多孔高分子薄膜、气体传感器及其制备方法和应用	CN201910720998.5	秦素洁，刘林，张琎，王颖异

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	A photovoltaic self-powered gas sensor based on a single-walled carbon nanotube/Si heterojunction	Lin Liu, Guanghui Li, Yingyi Wang, Tie Li, Ting Zhang*, Sujie Qin*	Nanoscale	2017
(2)	SCI	Ultrathin free-standing graphene oxide film based flexible touchless sensor	Lin Liu, Yingyi Wang, Guanghui Li, Suiie Qin*, Ting Zhang*	Journal of Semiconductors	2018
(3)	SCIE	Humidity-insensitive NO2 Sensors Based on SnO2/rGO Composites	Yingyi Wang, Lin Liu, Fuqin Sun, Tie Li, Ting Zhang, Sujie Qin*,	Frontiers in Chemistry, section Nanoscience	2021
(4)	SCIE	In-situ Growth of SnO2/NiO Hierarchical Nanostructure for High Performance H2S Sensing	Lin Liu, Guanghui Li, Yanbing Dai, Yingyi Wang, Shuqi Wang, Tie Li, Ting Zhang*, Sujie Qin*	ACS applied Materials & Interfaces	2019
(5)	SCIE	"Top-down" & "Bottom-up" Strategies for Wafer-scaled Miniaturized Gas Sensors Design and Fabrication	Lin Liu, Yingyi Wang, Fuqin Sun, Yanbing Dai, Shuqi Wang, Yuanyuan Bai, Lianhui Li, Tie Li, Ting Zhang*, Sujie Qin*	Microsystems & Nanoengineerings	2020

Project 3: The Application of Biochar Electrode for Pollution Removal in Artificial Wetlands

| Zheng Chen

Technical fields: Environmental Protection and Comprehensive Utilization of Resources – Water Pollution Prevention and Control

Programme category: Jiangsu Science and Technology Programme – Basic Research Plan (Natural Science Foundation) - General Programme

Introduction: Microbial Electrochemical Technology (MET) is a new technology based on extracellular respiration microorganisms widely existing in the environment. As its core part, the extracellular respiratory microorganisms widely live in anaerobic environment. Extracellular respiratory microorganisms, also known as Anode Respiring Bacteria (ARB), can transfer electrons produced by organic oxidation to extracellular solid minerals (such as iron and manganese oxides) or inert electrodes (graphite) through redox proteins, electron intermediaries and conductive fimbriae on cell membranes. Compared with aerobic microorganisms and anaerobic microorganisms dependent on soluble substances (such as nitrate-reducing bacteria), extracellular respiratory microorganisms can continuously transport electrons and obtain energy through electrodes, and their metabolic process was no longer limited by electron acceptor depletion. Therefore, microbial electrochemical technology has great potential in environmental remediation and sustainable energy utilization. In 2015, the iMETland project funded by the European Union was launched, trying to integrate microbial electrochemical cells with constructed wetland technology, thus improving the pollutant treatment efficiency of constructed wetlands by 10 times. With the deepening of basic research, the competition in this field was becoming increasingly fierce, attracting a large number of scientific research and industrial investment.

In recent years, using biochar as an environmental-friendly material to adsorb pollutants in soil and sewage or promote their degradation has been widely concerned by scholars at home and abroad. As a new electrode, biochar began to be introduced into the electrochemical field. Therefore, combining biochar technology with microbial fuel cell technology to strengthen the ability of constructed wetlands to treat pollutants will have broad development prospects. In this project, we proposed to use biochar as electrode material to build a constructed wetland enhanced by microbial electrochemistry, which will greatly increase the removal efficiency of major pollutants in water (such as ammonia nitrogen and organic matter). The constructed wetland technology was called Biochar Electrodes-Artificial Wetland (BEAW) technology in this project. Therefore, as a soil conditioner, biochar is applied in traditional agriculture. With the research of soil pollution, biochar plays an increasingly important role in environmental control, but there is little research on its application in constructed wetlands.

In this project, five representative biochar materials were used to construct BEAW system, and the degradation process of ammonia nitrogen and organic matter was fully researched. Through microscopic observation, elemental analysis, surface functional groups and microbial community sequencing, the microscopic mechanism of pollutants on the surface of biochar electrode was clarified, which provided technical support for further constructing BEAW system with high efficiency and low consumption.

Keywords: Constructed Wetland, Biochar, Microbial Electrochemical Technology

Key issues solved: The large-scale application of constructed wetlands and microbial electrochemical technology requires a large number of cheap electrode materials. Biochar materials have great advantages in this respect. Biochar comes from the pyrolysis of biomass materials, and there is no particularly strict requirement for biomass as raw material. As an electrode, the application of biochar in microbial batteries has been well investigated in the early stage. The preparation temperature of biochar is one of the key factors that determine its surface groups and electrical conductivity. The cracking temperature of conventional biochar is between 200°C and 1000°C. Different cracking temperatures have great influence on the physical and chemical properties of biochar. With the increase of temperature, the higher the graphitization degree of the electrode, the better the conductivity. For biochar used as the electrode, the cracking temperature is above 500°C. With the increase of temperature, the yield of biochar and the content of volatile elements decreased. The ratio of acidic groups to basic groups and

the ratio of oxidizing groups to reducing groups on the surface also changed significantly with temperature, materials and firing time. In this research, we will focus on the interaction mechanism between biochar from different sources as electrodes and microorganisms, and the cracking temperature will be unified at 900℃. In addition, how to integrate biochar electrodes into constructed wetlands is also a key issue to be solved.

Microbial fuel cell is a promising energy conversion technology that uses organic waste to generate electric energy. Electricity-producing bacteria attached to the anode surface of MFC oxidize organic matter to produce electrons and protons. Electrons flow through an external circuit and combine with electron acceptors at the cathode. However, the performance of MFC is limited by cathodic oxygen reduction reaction and high oxygen mass transfer resistance.

To overcome this difficulty, many previous researches have adopted MFC with oxygen as the final electron acceptor and an air cathode configured. However, in these researches, platinum and other expensive catalysts were used to improve the performance of MFC. In addition, PFS and PTFE also required binders for the air cathode in the manufacturing process to immobilize the catalyst powder. However, the commercial application and promotion of this type of MFC was hampered by the high cost of serious catalysts and adhesives. In addition to the need for an ORR catalyst, an air diffusion layer is necessary for the cathode to maintain a continuous oxygen supply from the atmosphere while preventing electrolyte leakage. However, there are two main disadvantages in the formation of air diffusion layer now. First, the manufacturing method of gas diffusion layer is time-consuming and laborious, and it is poor in repeatability. Therefore, it is urgent to optimize the manufacture of air cathode in order to further promote the development of MFC.

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Arsenic mitigation in paddy soils by using microbial fuel cells	Williamson Gustave, Zhao-Feng Yuan, Raju Sekar, Hu-Cheng Chang, Jun Zhang, Mona Wells, Yu-Xiang Ren, Zheng Chen	Environmental Pollution	2018
(2)	SCI	The change in biotic and abiotic soil components influenced by paddy soil microbial fuel cells loaded with various resistances.	Williamson Gustave, Yuan ZF, Sekar R, Ren YX, Chang HC, Jiu JY, Zheng Chen	Journal of Soils and Sediments	2018
(3)	SCI	Relic DNA does not obscure the microbial community of paddy soil microbial fuel cells	Williamson Gustave, Zhao-Feng Yuan, Raju Sekar, Veronica Toppin, Jinjing-Yuan Liu, Yu-Xiang Ren, Jun Zhang, Zheng Chen	Research in microbiology	2018
(4)	SCI	Tracing the Dynamic Changes of Element Profiles by Novel Soil Porewater Samplers with Ultralow Disturbance to Soil–Water Interface	Zhaofeng Yuan, Williamson Gustave, Jonathan Bridge, Yi Liang, Raju Sekar, John Boyle, Chen-Yu Jin, Tong-Yao Pu, Yu-Xiang Ren, Zheng Chen	Environmental Science & Technology	2019
(5)	SCIE, EI	One-step Fabrication of Binder-free Air Cathode for Microbial Fuel Cells by Using Balsa Wood Biochar	Hu-Cheng Chang, Williamson Gustave, Zhao-Feng Yuan, Yong Xiao, Zheng Chen	Environmental Technology & Innovation	2020

Project 4: Application of Microbial Source Tracking to Identify the Fecal Pollution in Taihu Watershed across Tiaoxi River Basin

｜ Sekar Raju

Technical fields: Environmental Protection and Comprehensive Utilization of Resources – Water Pollution Prevention and Control

Programme category: Jiangsu Science and Technology Programme – Basic Research Plan (Natural Science Foundation) – General Programme

Introduction: Fecal pollution threatens Taihu, which serves as a drinking water source for about 30 million residents. Based on the microbial source tracing technology, in this project, the Xiaotiao River Basin was taken as a model to collect stream water, sediment and feces samples along the river. The host-specific microbial molecular marker was used in order to obtain:

1. bacteroides diversity and temporal and spatial changes in feces, water and sediments,
2. the specificity, distribution and richness of qPCR markers of Bacteroides from different hosts,
3. the relationship between the changes of host Bacteroides population and routine fecal bacteria and pathogens. The results can identify fecal pollution sources and be used as a case in lake basin so as to better serve the management.

The physical, chemical and microbial analysis were carried out on the water samples of Xitiao River in three seasons to detect the water quality. The diversity of bacteria in water samples, sediment samples and stool samples was measured by next-generation sequencing technology. The existing host-specific Bacteroides qPCR markers were evaluated to determine their practicability in Xitiao River/Taihu water system research. The presence and abundance of host-specific Bacteroides markers (general markers, human, pig and bird) and five related pathogens in water samples and sediment samples were researched by qPCR technique. We have detected universal Bacteroides markers in all water samples and sediment samples, but the host-specific markers detected are different in different samples. The most frequently detected host-specific tracking marker is human, followed by pigs and then birds. The results of physicochemical and microbial parameters indicated that some sampling sites in Xitiao River were seriously polluted by various pollution sources, which can be related to land use patterns and human activities. The results of microbial community analysis indicated that there was the possibility of human and animal feces pollution in some places of Xitiao River. Overall microbial source tracing results indicated that sites 12 and 16 were the most contaminated areas with human feces, and these results were related to fecal data indicating bacteria and microbial communities. The quantitative results of bacterial pathogens indicated the relationship among pathogens, fecal indicator bacteria and microbial source tracing markers. The results of this research have certain value for better management of Xitiao River and Taihu water system.

Keywords: Microbial Tracer Technique, Fecal Contamination, Xitiao River Basin

Key issues solved:

1. Bacterial communities in water, sediment and fecal samples (from six animal hosts, humans and sewage) were researched by using the next-generation sequencing technology. It was found that there were obviously different bacterial communities in water samples, sediment samples and fecal samples. Certain bacterial genera, such as Bacteroides, Prevotella, Clostridium tenella, Clostridium, Enterococcus and Shigella, were found in some sites, which revealed the possibility of human or animal fecal contamination in those sites.
2. The sensitivity and specificity of 10 microbial source tracing qPCR experiments were evaluated by using DNA samples from feces of 5 hosts (human, bovine, pig, dog and chicken) and DNA samples extracted from sewage. Bac-Uni, HF 183 Taqman, Pig-2-Bac, AV4143 and GFD were used to trace the microbial source in Tiaoxi River. Total Bacteroides markers were detected in all water samples and sediment samples. However, host-specific microbial source tracing markers were different in different samples. The most frequently detected ones are humans, followed by pigs and birds.

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Assessment of water quality and identification of pollution risk locations in Tiaoxi river (Taihu watershed, China)	Kiran Kumar Vadde, Jianjun Wang, Long Cao, Tianma Yuan, Alan J. McCarthy, Raju Sekar	Water	2018
(2)	SCI	Quantification of microbial source tracking and pathogenic bacterial markers in water and sediments of Tiaoxi River (Taihu watershed)	Kiran Kumar Vadde, Alan J. McCarthy, Rong Rong, Raju Sekar	Frontiers in Microbiology	2019
(3)	SCI	Next-generation sequencing reveals fecal contamination and potentially pathogenic bacteria in a major inflow river of Taihu Lake	Kiran Kumar Vadde, Qiaoli Feng, Jianjun Wang, Alan J. McCarthy and Raju Sekar	Environmental Pollution	2019

Project 5: Study on High Performance Environmental Sensors for Formaldehyde, One Typical Indoor Air Pollutant

| Sujie Qin

Technical field: Environmental Monitoring

Programme category: The Natural Science Foundation of the Jiangsu Higher Education Institutions of China - General Programme

Introduction: This project's aim was the rapid, sensitive and real-time monitoring of indoor low-concentration Formaldehyde pollution. New electronic components of nano-gas sensors and portable, highly sensitive, real-time, fast and low-cost nano-sensors were developed to realize the rapid and accurate detection of Formaldehyde, a typical indoor air pollutant, by nano-sensor. This project provides solution for the industrial status quo that indoor Formaldehyde detection in China has always relied on heavy and expensive analytical instruments and imported methyl detectors, and also provides an important basis for controlling and rectifying the serious indoor Formaldehyde pollution issue. The main research contents include designing and optimizing the structure design and micromachining process of chip microelectrodes on p-doped Si/Si02 substrates, then metal nanoparticles were synthesized on the wall of carbon nanotubes by chemical method or electrochemical deposition method, and they were used to functionalize the carbon nanotube sensor. The intermolecular interaction, surface enhancement effect and its influence on electron transport at the interface of nano-composite sensitive materials were optimized and characterized, and the synthesis, preparation and characterization of functionalized carbon nanotube nano-sensor chips were carried out. On this basis, the packaging and integration of nano-sensor module and build a high-precision formaldehyde test system were completed, and the dynamic test of formaldehyde by the sensor was completed and the standard test method was combined for the verification. In this project, we focused on realizing and improving the high sensitivity and satisfying selectivity of nano-sensors for formaldehyde detection.

Key issues solved:

The purpose of this project is to develop a new type of nano-gas sensor electronic components, paper cup portable high sensitive, low-cost nano-sensor to monitor indoor low-concentration formaldehyde pollution quickly and in real time, and provide an important basis for controlling and politically solving the serious indoor formaldehyde pollution issue now. In general, the project was carried out smoothly according to the expected research plan. The project team carried out systematic research on the selection and assembly of suitable nano-sensitive materials, functionalization research, sensor preparation, sensor performance test, realized the nano-composite sensitive material of silver oxide functionalized carbon nanotubes, and explained the sensing mechanism of the composite sensitive material. By further optimizing the aerosol printing assembly technology, the composite sensitive materials were assembled efficiently on the microchip, thus realizing the high sensitivity and high selectivity detection of the new micro-nano gas sensor for trace carbohydrate molecules and related environmental gases. The main technical indexes proposed have been achieved, the resolution of carbohydrate concentration was up to 50ppb, and the detection concentration range can be up to 50ppb-100ppm. Based on the completion of formaldehyde detection, in this project, the extended research was carried out, the detection of nitrogen dioxide and other gases was carried out, and the development and exploration of self-supplied energy sensor were carried out.

According to the important national needs of the detection and control of ambient air quality, facing the international frontier research, the low-cost controllable preparation method of functionalized carbon nanomaterials (carbon nanotubes, graphene) was explored, which provided theoretical basis and new technical methods for researching the application of new high-performance micro-nano sensors in environmental pollutant detection, and had practical significance for real-time monitoring and control methods of serious indoor and indoor air pollution in China. With the support of this project funds, we have published two SCI academic papers and applied for one patent.

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Single CdS Nanorod for High Responsivity UV/Visible Photodetector	Wu Zhao, Lin Liu, Manzhang Xu, et, al.	Advanced Optical Materials	2017
(2)	SCI	Novel SnO2@ZnO hierarchical nanostructures for highly sensitive and selective NO2 gas sensing	Zhiyong Zhang, Manzhang Xu, Lin Liu, et. al	Sensors and Actuators B	2018

Project 6: Application of Microbial Fuel Cells on Arsenic Contamination Mitigation in Rice Fields

| Zheng Chen

Technical field: Environmental Pollution Control

Programme category: The Natural Science Foundation of the Jiangsu Higher Education Institutions of China – General Programme

Introduction: In this project, the application of microbial fuel cell technology in heavy metal contaminated soil was promoted. Microbial fuel cell is a new bioelectrochemical technology. Although it has been developed for decades, most of the previous studies focused on the combination with sewage treatment technology. In this project, we constructed a microbial fuel cell in paddy field, and realized the control of arsenic concentration in pore water of contaminated soil in paddy field. The change of electricity generation capacity of microbial fuel cell in paddy field and the influence of Shen stress on electricity-producing bacteria were investigated in detail under typical dry-wet alternating environment in paddy field. The concrete results are as follows:

Main innovative achievements:

1. The effect of arsenic pollution on microbial community of soil microbial fuel cell anode was clarified. Arsenic is helpful to start microbial fuel cell, and the possible reason is that arsenic stress has a higher effect on aerobic bacteria than anaerobic bacteria.
2. Even in highly polluted paddy soil (arsenic concentration is more than 250ppm), the microbial fuel cell can start normally, but the microbial community structure changed significantly.
3. Our experiments indicated that the release of arsenic from soil solid phase to pore water was significantly slowed down when microbial fuel cells were implanted in paddy soil. The results indicated that the concentration of arsenic in rice grains decreased from 2ppm to about 1ppm in the treatment of microbial fuel cell in paddy soil of Shangyu, Zhejiang Province.

Keywords: Rice Safety, Heavy Metal Pollution, Redox, Electrochemical Technology

Key issues solved:

In the application of microbial fuel cells in remediation of heavy metal pollution, the cost of electrodes was the main limiting factor. Based on the practice of agricultural production, we put forward that biochar materials prepared by high temperature anaerobic can be used as anodes of microbial fuel cells. In addition, we found that the natural pore structure of biomass materials can be used as the air diffusion layer of microbial fuel cell cathode. Biochar air cathodes made from natural biomass (such as balsa wood) did not need to use adhesives that must be used in traditional preparation methods.

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Arsenic modulates the composition of anode-respiring bacterial community during dry-wet cycles in paddy soils	Wang, Ya-Jie and Chen, Zheng and Liu, Pan-Pan and Sun, Guo-Xin and Ding, Long-Jun and Zhu, Yong-Guan	Journal of Soils and Sediments	2016

Project 7: Microbial Diversity-Ecosystem Function in Canals across a Gradient of Urban Intensification in Suzhou, China

| Sekar Raju

Programme category: The Natural Science Foundation of the Jiangsu Higher Education Institutions of China - General Programme

Introduction:

The purpose of this research is to take Suzhou City, Jiangsu Province as an example to obtain the decomposition rate of deciduous layer in canals and how it is affected by microbial diversity and increasing urbanization. The results will be used to assess the relationship between microbial diversity and ecological function of the canal under different urbanization gradients, and how it is affected by the increasing urbanization.

Research content

1. The decomposition rate of organic matter in the canal under the intensive gradient of cities in Suzhou (i.e. high, medium and low urban density) was evaluated. The specific objective is to assess whether the intensification of urbanization affects the decomposition rate of fallen leaves. If yes, how was it being affected? The common way to respond to environmental stressors is the changes in nonlinear ecosystem function. Therefore, we planned to assess the nature of this impact and explore whether there is a linear rise/fall or other relationship between urbanization and ecosystem function. We will achieve this research objective by evaluating the decomposition rate of leaves (willow, willow species) in bags. The experiment will be carried out in nine canals, and it will take two years to repeat seasonally.

2. The diversity of microorganisms propagating in leaves under the gradient of urban intensification in Suzhou was evaluated. In this project, the influence of microbial diversity on different degrees of urban intensification will be evaluated. We expected that with the slowdown of urbanization, there will be more natural growth environments that can enhance microbial diversity. However, we expected that the increase in urban population density will also strengthen the relationship between microbial density and human beings. Thus, we will extract microbial DNA from leaf samples from the above experiments, and analyze microbial diversity in detail through various technical methods.

3. How ecosystem functions respond to changes in biodiversity was evaluated. Specifically, the objective of the project is to evaluate how changing microbial diversity as a result of urbanization affects leaf decomposition processes. We expected that the areas with the highest microbial density have the highest decomposition rate of leaves, and correspond to the most densely populated areas. We will correlate microbial diversity, leaf decomposition rate and urban density for analysis so as to achieve the objective.

4. How seasonal changes affect the relationship between diversity and ecological functions in Suzhou Canal was evaluated. We expected that due to the high temperature, the diversity and density of microorganisms will reach the highest in summer, so the decomposition rate of fallen leaves will also be the highest. We will repeat sample collection and analysis four times in two years to achieve this objective.

Key issues solved:

1. Whether urbanization intensity has changed Suzhou canal and microbial diversity. More specifically, whether microbial diversity will decline as urbanization strengthens.

2. Whether urbanization intensity will change the ecosystem function of Suzhou Canal. More specifically, with the strengthening of urbanization, whether the ecosystem function will decline.

3. In Suzhou Canal, whether there is a direct relationship between microbial diversity and ecosystem function, and whether the acceleration of urbanization will continue to be related to microbial diversity and ecosystem function?

4. Whether the above environmental parameters have seasonal variation trend. More specifically, will the leaf decomposition rate increase with the increase of water temperature in summer, and whether it corresponds to higher microbial diversity?

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Urbanization impacts the physico-chemical characteristics and abundance of fecal markers and bacterial pathogens in surface water	Tianma Yuan, Kiran Kumar Vadde, Jonathan D. Tonkin, Jianjun Wang, Jing Lu, Zimeng Zhang, Yixin Zhang, Alan J. McCarthy and Raju Sekar	International Journal of Environmental Research and Public Health	2019
(2)	SCI	Impact of Temperature, Nutrients and Heavy Metals on Bacterial Diversity and Ecosystem Functioning Studied by Freshwater Microcosms and High Throughput DNA Sequencing	Tianma Yuan, Alan J. McCarthy, Yixin Zhang and Raju Sekar	Current Microbiology	2020
(3)	SCI	Changes in Fungal Community Structure in Freshwater Canals across a Gradient of Urbanization	Tianma Yuan, Haihan Zhang, Qiaoli Feng, Xiangyu Wu, Yixin Zhang, Alan J. McCarthy and Raju Sekar	Water	2020

3. Municipal Project

Project 1: Development of Novel Technology to Control a Major Pest of Apiculture Industry

| Tatsuhiko Kadowaki

Programme category: Suzhou Science and Technology Development Planning Programme – Others

Introduction: In China and around the world, the importance of bees is not only reflected in the production of royal jelly and other bee products, but also reflected in its pollination has an important impact on crop production. China's beekeeping industry has always paid little attention to the health of bees. Recently, however, we have found that many pathogens (viruses and microsporidia) and mites are ubiquitous in many beekeeping farms in China. Thus, like other developing countries, these pathogens and mites may become the main focused targets of beekeeping industry in China. However, the main focus of this research project is the new transient receptor potential channel (TRP1 channel) of varroa destructor, which functions like a sensor and can detect harmful factors (such as high temperature). Activation of TRPA1 channel will cause avoidance behavior of insects. Although honeybees have lost TRPA1 channel, they have acquired a new AmHsTRPA channel with similar function in the process of evolution. Recently, it has been found that the TRPA1 channel of varroa destructor (VdTRPA1) can be activated by high temperature just like the TRPA1 channel of insects. Thus, it is expected that the activation of VdTRPA1 channel can also cause avoidance behavior of mites. On this basis, we will screen out the plant-derived compounds that can activate VdTRPA1 channel but cannot activate AmHsTRPA channel. This natural compound can be used to control mites, but it will not have adverse effects on bees and human beings who consume bee products. The same method can also be applied to research how to control many mites parasitic on humans and other mammals.

Key issues solved: First, the full-length cDNA of TRPA1 channel (VdTRPA1 and TmTRPA1) of Varroa destructor and Tropilaelaps mercedesae was amplified and sequenced, and then expressed in mammalian cell line HEK293.

In the experiment, we found that there are two isomers of VdTRPA1 (VdTRPA1L, VdTRPA1S) and three isomers of TmTRPA1 (TmTRPA1a, TmTRPA1b, TmTRPA1c) according to different translation initiation positions. We tested these isomers at high temperature and compounds respectively. Of which, only VdTRPA1L can be activated by high temperature and chemical substances, while all three TmTRPA1 isomers can be activated by high temperature.

Subsequently, we tested the effects of forty plant-derived compounds on VdTRPA1L and TmTRPA1 channels. Previously, we have identified several compounds that can stimulate TRPA1 channel in mammals by chemical screening. In addition to testing these known compounds, we also screened other plant-derived compounds that can activate VdTRPA1 on a large scale. The first screening was to detect the transient expression of VdTRPA1 in HEK293 cells by using calcium ion imaging technology. However, this method does not describe the characteristics of the channel in detail (for example, the activation degree of the channel). Thus, we also adopted the second screening method: Whole cell patch clamp method. The whole cell patch clamp method recorded the activation effect of the compounds to be screened on VdTRPA1 accurately. The above experiments have helped us to identify compounds that can activate VdTRPA1, of which twenty-four compounds can activate VdTRPA1L, TmTRPA1b and TmTRPA1c. TmTRPA1a was special and could be activated by only six compounds.

On the other hand, the effects of these compounds on bee AmHsTRPA were also recorded by whole cell patch clamp method and then compared. On this basis, we screened a compound that can activate VdTRPA1 but not AmHsTRPA, namely terpineol (α-terpineol).

In the next stage, we tried to make further analysis of the effective concentration.' However, in repellent experiments, we found that varroa destructor did not move well in paper, glass and plastic utensils. To solve this issue, we tried a variety of materials, and finally finished the experiment by covering the filter paper soaked with DMSO or repellent with nylon mesh. In this case, mites should be able to use both smell and taste detection compounds. Under laboratory conditions, terpineol can repel varroa destructor and tropilaelaps mercedesae. When 1μL of 0.3 M terpineol (α-terpineol) was applied to the fifth instar larvae

in the nursery room of honeycomb, the probability of varroa destructor and tropilaelaps mercedesae entering the nest room was significantly reduced.

When the work on bees came to an end, we isolated the cDNA of HsTRPA channel from Solenopsis invicta and expressed it stably in mammalian cell line HEK293. Subsequent researches indicated that SiHsTRPA can be activated at high temperature. In addition, we tested 40 plant-derived natural compounds, of which six kinds of plants can activate SiHsTRPA channel. Then, we selected one of them (amniotic acid) to carry out follow-up experiments on Solenopsis invicta. The results indicated that under laboratory conditions, decanoic acid could repel Solenopsis invicta.

Finally, we used genomic DNA sequences to analyze the evolutionary characteristics of TRP channel in many animals, and found that the evolution of TRP channel has plasticity at different levels (including but not limited to gene acquisition and loss, amino acid substitution, alternative splicing).

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Plant-derived tick repellents activate the honey bee ectoparasitic mite TRPA1	Peng G, Kashio M, Morimoto T, Li T, Zhu J, Tominaga M, and Kadowaki T.	Cell Rep.	2015
(2)	SCI	Evolution of TRP channels inferred by their classification in diverse animal species	Peng G, Shi X, and Kadowaki T.	Mol. Phylogenet. Evol.	2015
(3)	SCI	Evolutionary dynamics of metazoan TRP channels	Kadowaki T.	Pflügers Arch.	2015

Biomedicine

Biomedicine, which provides insights into life processes through genomics, diagnostics and therapeutic drug development, is one of the fastest-growing emerging strategic fields in the world today. XJTLU focuses on the development of biomedical field. In 2008, the Department of Biological Sciences was established, with research focus on molecular biology related to biomedical, agricultural and environmental fields. In 2010, XJTLU established the Suzhou Municipal Key Lab for Metabolic Syndrome Drug Research, and in 2020, XJTLU and Suzhou Industrial Park jointly established the XJTLU Wisdom Lake Academy of Pharmacy. The Academy also has a Pharmaceutical Informatics and Data Science Institute. At present, XJTLU has successfully completed 1 national research project in this field.

1.National Project

Project 1: Molecular Mechanisms of Ligand-Induced Selective Signalling at the Gonadotropin-Releasing Hormone Receptor

| Zhiliang Lv

Application Code: H3109 (Department of Health Sciences)

Technical field: High-Throughput Drug Screening

Programme category: National Natural Science Foundation of China (NSFC) - General Programme

Introduction: The human gonadotropin-releasing hormone (GnRH) receptor is a Gq/11 coupled receptor, which has two endogenous ligands receptors, GnRH I and GnRH II, but only one functional receptor. This project deeply studied the diversity of GnRH receptor signal transduction / coupling and the selectivity of GnRH I and GnRH II signal transduction. We found that GnRH I and GnRH II can activate the G12/13 signal transduction pathway, but both show a differential activation tendency to Gq/11 and G12/13, that is, a certain degree of signal selectivity. The signal transduction pathways jointly participate in the physiological regulation effect of GnRH on the synthesis and secretion of luteinizing hormone. Additionally, human GnRH receptor can directly activate SHP2 phosphorylation (activation) through Src to participate in the regulation of the phosphorylation degree of ERK1/2, beside coupling with the G protein. This signal transduction pathway requires the presence of Gq/11, but is unrelated to its phospholipase-phosphoinositide signal transduction pathway. This signal pathway can illustrate why many Gq/11 Gi-coupled receptors can improve the growth of cancer cell while the GnRH receptors can inhibit the growth. These newly discovered signal pathways constitute a complex GnRH receptor signal communication network with traditional Gq/11 signal pathways to adjust the physiological and pharmacological effects of GnRH. GnRH I and GnRH I and GnRH II can differentially affect different signal transduction pathways so as to adjust various physiological effects.

KPs, as the Kisspeptins secreted by Kiss neurons, participate in the secretion regulation of GnRH, but the peripheral KP plays an important role in inhibition of tumor metastasis. We found that KP receptor can activate calmodulin-dependent protein kinases II and catalyze the phosphorylation of KP receptors, feedback the coupling of tonic inhibition KP receptor and Gq/11, so as to adjust the fluctuation intensity and frequency of intracellular calcium and participate in the regulation of pulse release of KPs to GnRH/LH. Beside, this project also designed and synthesized 2 KP phosphopeptides, one of which (PKPR) can activate KP receptor and selectively inhibit the activity of matrix metalloproteinase 2, so as to provide a lead compound for research and development of KP agonist with double activity or metabolic stability. Furthermore, we also found that C-end cysteine Cys340 of KP receptor is the palmitone acylation site, which is involved in receptor expression, endocytosis and intracellular transport and signal transduction process.

The above-mentioned research is of great significance of deep understanding of effect and mechanism of GnRH and KP receptor in growth and metastasis of reproduction and turmor, and also plays a practical role in design of signal-selective drugs, improvement of clinical drugs and reduction of toxic and side effect.

In this project, we also established RNA BSP clone sequencing (mC5) and MeRIP-Seq (m6A) sequencing and bioinformatics analysis techniques based on its RNA methylation sequencing results, laying a foundation for research on effect of disease research, drugs and signals transduction on RNA methylation.

Keywords: Gonadotropin-Releasing Hormone, Kisspeptin, Gi-Coupled Receptors, Cell Signal Transduction, RNA Methylation

Key problems solved: Construction of NanoBRET or NanoBiT detection technology for the interaction of different G proteins and receptors and their downstream pathways.

Research achievements:

1） Patent

No.	Category	Status	Patents Title	Application no.	Inventor(s)
(1)	发明	申请	基于 Sulfo-Cy5 标记配体的 NanoBRET 受体结合药物筛选系统	CN202011479932	吕志良

2） Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	A protocol for RNA methylation differential analysis with MeRIP-Seq data and exomePeak R/Bioconductor Package	Jia Meng; Zhiliang Lu; Hui Liu; Lin Zhang; Shaowu Zhang; Yidong Chen; Manjeet K. Rao; Yufei Huang	Methods	2014
(2)	SCIE	Functional examination of novel kisspeptin phosphinic peptides	Xiaoyang Zhang, Magdalini Matziari, Yixin Xie, David Fernig, Rong Rong, Jia Meng, Zhi-Liang Lu.	PloS One	2018

Internet and Cloud Computing, Big Data Services

In response to the Suzhou Industrial Park Administrative Committee's economic development strategy with a focus on business analysis, XJTLU has established the Research Institute of Big Data Analysis. The Institute provides an ideal environment for students, academics and industry experts in various fields to conduct research activities. By the end of 2020, XJTLU had successfully completed 9 government research projects at all levels in the field of Internet and Cloud Computing, Big Data Service Field, including 5 national projects, 2 provincial projects, and 2 municipal projects.

1.National Projects

Project 1: Investigation on Context-Based Formal Architecture and Analysis for Cyber Physical System

| Kaiyu Wan

Application code: F020202 (Department of Information Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - Young Scientists Fund

Introduction: In recent years, the United States (PCAST), the European Union (ARTMEIS), KIPA of Korea, Japan and China have all taken CPS as a key project, among which 'Developing a new CPS open architecture' is one of the challenges. Provision of a suitable architecture for CPS software is far more complicated than people's expectation.

In this project, the two basic and critical issues related to CPS software platform will be solved: What kind of architecture is suitable for CPS and how to formally analyze the behavior of CPS? For the first issue, the solution proposed by us was that 'resource-centric, contextual, service-oriented architecture', which can faithfully express CPS elements and features [C16, C20] (referenced in the paper published for this project). To finish this task, we researched Web Services [C2, C3, C4], Context Theory [J1, J4, C14, C22, C28], Service Oriented Architecture [J9, J11]. For the second issue, first, we researched a resource-centric abstract service model, which can dynamically describe the behavior of CPS [J2, C29] and manage resources dynamically [C5, C6]. Second, we provided formal syntax and semantics for each layer of the architecture. These formal syntax can describe service requirements, resource description, resource composition, service provision, service configuration and modification. Finally, we researched a tool to support architecture description and service model, which is user-centered and designed according to semantic rules, and can translate resource information into secure sharing and communication at CPS station, and can support different users to browse, discover, request and allocate resources to related service requirements [C15, C31]. We also analyzed the cases of traffic management [C1], auxiliary medical care [J6, J10], smart grid [J3, C7] and teaching software [J5, J7, C17, C21] to understand the requirements and verify the correctness of the methods.

It is necessary and urgent to provide a suitable architecture for CPS software. In this project, resource management was taken as the center, and the context-related service-oriented architecture and form analysis proposed is innovative to some extent, which has certain research significance for CPS software.

Keywords: CPS, Software Architecture, Formal Analysis, Context Awareness, Resource Management

Key issues solved: In this project, two related and extremely important issues in CPS software platform are to be solved: What kind of architecture is suitable for CPS? How to analyze the behavior of CPS?

Research achievements:

1）Copyright

No.	Category	Title	Author(s)
(1)	Book	Practical Student's Guide: Programming in C and C++	K.L. Man, E.G. Lim, Z.Wang, T. Krilavicius, Kaiyu Wan and M. Mercaldi

2） Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI, ISTP	Dielectric Relaxation in Lanthanide Doped/Based Oxides Used for High-k Layers	A Kanduri、AM Rahmani、P Liljeberg、*K Wan、KL Man	ISOCC2013	2013/11
(2)	EI, ISTP	Review on Non-Volatile Memory with High-k Dielectrics: Flash for Generation Beyond 32 nm	David Afolabi、Kalok Man、Hai Ning Liang、Nan Zhang、Eng Gee Lim、Kaiyu Wan	ISOCC2013	2013/11/17-2013/11/19
(3)	EI	Hysteresis in Lanthanide Aluminum Oxides Observed by Fast Pulse CV Measurement	K Wan、V Alagar、B Wei	6th International Conference of KSEM 2013	2013/8
(4)	EI, ISTP	Developing a Smart Learning Environment in Universities Via Cyber-Physical Systems	CU Lei、*K Wan、KL Man	Information Technology and Quantitative Management (ITQM2013)	2013/5/15-2013/5/17
(5)	EI	A Resource-Centric Architecture for Service-Oriented Cyber Physical System	K Wan、V Alagar	In Proceedings of the 8th International Conference on Grid and Pervasive Computing (GPC)	2013/5/9-2013/5/11
(6)	EI	Parallel Generation of Optimal Mortgage Refinancing Threshold Rates	N Zhang、D Xie、EG Lim、K Wan、KL Man	the 8th International Conference on Grid and Pervasive Computing	2013/5/9-2013/5/11
(7)	EI	Pricing American Options on Dividend-Paying Stocks and Estimating the Greek Letters Using Leisen-Reimer Binomial Trees	N Zhang、*K Wan、EG Lim、KL Man	the 8th International Conference on Grid and Pervasive Computing	2013/5/9-2013/5/11
(8)	EI	Modeling Resource-centric Services in Cyber Physical Systems	K Wan、V Alagar	International Multiconference of Engineers and Computer Scientists 2013	2013/3/13-2013/3/15
(9)	EI	Facilitating Teaching CPS and Technology-based Content with Learning Management Systems	CU Lei、*K Wan、KL Man	International Multiconference of Engineers and Computer Scientists 2013	2013/3/13-2013/3/15
(10)	EI	Integrating Context-Awareness and Trustworthiness in IoT Descriptions	Kaiyu Wan、Alagar, Vangalur	Green Computing and Communications (GreenCom), 2013 IEEE and Internet of Things (iThings/CPSCom), IEEE International Conference on and IEEE Cyber, Physical and Social Computing	2013/8/20-2013/8/23
(11)	EI	Responsive, Dynamic Architectural Surfaces: From Conceptualization to Implementation	HN Liang、N Diniz、KL Man、K Wan	IAENG International Journal of Computer Science	2013
(12)	EI	Development of a reliability course for emerging circuits and systems	Lei, Chi-Un、Man, K.L.、Lim, Enggee、Zhang, Nan、Kaiyu Wan	Advanced Materials Research	2013
(13)	EI	Context-aware Security Solutions for Cyber Physical Systems	Kaiyu Wan、Vangalur Alagar	International Conference on Context-Aware Systems and Applications	2012/11/26-2012/11/27

(14)	EI	A Context-aware Multi-agent Systems Architecture for Adaptation of Autonomic Systems	K.Wan、Vangalur Alagar	the 7th International Conference on Intelligent Information Processing	2012/10/12-2012/10/15
(15)	EI	Space Exploration of Multi-Agent Robotics via Genetic Algorithm	T.O. Ting、*K. Wan、K.L. Man、Sanghyuk Lee	The 9th IFIP International Conference on Network and Parallel Computing	2012/9/6-2012/9/8
(16)	EI	Weightless Swarm Algorithm (WSA) for Dynamic Optimization Problems	T. O. Ting、K. L. Man、Sheng-Uei Guan、Mohamed Nayel、*K.Wan	The 9th IFIP International Conference on Network and Parallel Computing	2012/9/6-2012/9/8
(17)	EI	Design of a reliable XOR-XNOR Circuit for Arithmetic Logic Units	Mouna Karmani、Chiraz Khedhiri、Belgacem Hamdi、Amir-Mohammad Rahmani、Ka Lok Man、*K.Wan	The 9th IFIP International Conference on Network and Parallel Computing	2012/9/6-2012/9/8
(18)	EI	Development of a Reliability Course for Emerging Circuits and Systems	Chi-Un Lei、K. L. Man、Enggee Lim、Nan Zhang、*K.Wan	ICMCE 2012	2012/8/25-2012/8/26
(19)	EI	Resource Modeling for Cyber Physical Systems	K.Wan、Vangalur Alagar	The 2012 International Conference on Systems and Informatics	2012/5/19-2012/5/21
(20)	EI	Toward a Hybrid Approach to SoC Estimation for a Smart Battery Management System (BMS) and Battery Supported Cyber-Physical Systems (CPS)	K.L. Man、T.O. Ting、T. Krilavicius、*K.Wan	2nd Baltic Conference on Future Internet Communications	2012/4/25-2012/4/27
(21)	EI	Using Web 2.0 Tools to Enhance Learning in Higher Education: A Case Study in Technological Education	Chi-Un Lei、Tomas Krilavicius、Nan Zhang、*K.Wan、Ka Lok Man	The 2012 IAENG International Conference on Electrical Engineering Special Session: Design, Analysis and Tools for Integrated Circuits and Systems	2012/3/14-2012/3/16
(22)	EI	Specifying Resource-Centric Services in Cyber Physical Systems	Kaiyu Wan、Vasu Alagar、Yuji Dong	Transactions on Engineering Technologies	
(23)	EI	An Approach to Designing an Autonomic Network of Tracffic Managers	Vangalur Alagar、Kaiyu Wan	The 3rd International Conference on Connected Vehicles and Expo	2014/11/3
(24)	EI	Integrating Trust and Economic Theories with Knowledge Science for Dependable Service Automation	Vangalur Alagar、*Kaiyu Wan	10th International Workshop on Security and Trust Management - STM'14	2014/9/10
(25)	EI	Achieving Dependability of Cyber-physical Systems with Autonomic Covering	Kaiyu Wan、Vangalur Alagar	The 12th IEEE International Conference on Dependable, Autonomic and Secure Computing (DASC 2014)	2014/8/24
(26)	EI	Synthesizing Data-to-Wisdom Hierarchy for Developing Smart Systems	Kaiyu Wan、Vangalur Alagar	the 2014 11th International Conference on Fuzzy Systems and Knowledge Discovery	2014/8/19

(27)	EI	Analyzing Item Features for Cold-Start Problems in Recommendation Systems	Soryoung Kim、Sang-Min Choi、Yo-Sub Han、Man Ka Lok、Kaiyu Wan	The Tenth International Conference on Intelligent Information Hiding and Multimedia Signal Processing	2014/8/27-2014/8/29
(28)	EI	Bandwidth Enhancement for Planar Inverted F Antenna	Eng Gee Lim、Zhao Wang、Xiang Li、Ka Lok Man、Nan Zhang、Kaiyu Wan	Mechatronics and Automatic Control Systems	2014
(29)	EI, SCI	Building an Intelligent Laboratory Environment via a Cyber-Physical System	Lei, Chi-Un、Man, Ka Lok、Liang, Hai-Ning、Lim, Eng Gee、Wan, Kaiyu	International Journal of Distributed Sensor Networks	2013
(30)	EI	Applying A Dynamic Resource Supply Model in Smart Grid	Kaiyu Wan、Yuji Dong、Qian Chang、Tengfei Qian	Algorithms	2014/9
(31)	EI	A Dynamic Resource Supply Model towards Cyber Physical System (CPS)	Yuji Dong、*Kaiyu Wan、Yong Yue	IEEE IS3C2014	2014/6/10-2014/6/12
(32)	EI, SCI, ISTP	Context-Aware Security Solutions for Cyber-Physical Systems	Wan, Kaiyu、*Alagar, Vangalur	Mobile Networks and Applications	2014/4
(33)	EI	Unified Dynamic Resource Supply Model to Support Cyber Physical System	Yuji Dong、*Kaiyu Wan、Yong Yue	International MultiConference of Engineers and Computer Scientists	2014/3/12-2014/3/14
(34)	EI	Design and Implementation of Resource-Centric Web Services in Smart Grid Cyber-Physical Systems	Qian Chang、*Kaiyu Wan、Yuji Dong	International Multi-Conference of Engineers and Computer Scientists 2014	2014/3/12-2014/3/16
(35)	EI	Modeling and Verification of Compensating Transactions using the Spin Tool	K.Wan、Hemangee K. Kapoor、Shirshendu Das、B. Raju、Tomas Krilavicius、Ka Lok, Man	IMECS2012	2012/3/14-2012/3/16

Project 2: Rational Orthogonal Wavelet Theory Applied to Multipath Resolving and Underwater Acoustic Networking

| Limin Yu

Application code: F010701 (Department of Information Sciences)

Technical fields: Radar/Sonar System Design, Fine Signal Time-Frequency Analysis, Feature Extraction and Classification, Data Fusion, Weak Signal Detection, Multi-Target Detection and Tracking, Wavelet-Based Neural Network

Programme category: National Natural Science Foundation of China (NSFC) - Young Scientists Fund

Introduction: The analysis of multi-path effects and multi-path signals is a problem that plagues the design of broadband underwater acoustic systems. There is no very good solution yet. This subject explores the new wavelet theory, uses the inherent relationship between the Doppler effect and the time scale of multipath signals, applies high-precision wavelet and filter bank algorithms to the design of active and passive sonar systems, and achieves good detection results. For active sonar systems, the subject demonstrated the special advantages of adopting high-resolution rational orthogonal wavelet theory for waveform and receiver design to improve Doppler robustness and noise suppression. A design framework for a new type of broadband sonar pulse signal CROW-S is proposed. And adopt the orthogonal wavelet filter bank to carry on the corresponding detector design. The designed broadband pulse family is based on the combination of multiple basis functions of complex rational orthogonal wavelets. This broadband CROW-S signal has minimal PAPR characteristics, orthogonality, good time-frequency characteristics and high design flexibility. In different mobile scenes, it has good noise suppression, Doppler robustness and detection performance.

The project first used the geometric underwater acoustic channel model to simulate and analyze the performance against Doppler, noise and multipath interference, and systematically compares the performance of the wavelet-based active sonar system and the traditional chirp LFM sonar system. Through the receiver operating characteristic curve (ROC Curve), it is confirmed that the designed system can resist severe multipath, high environmental noise and severe Doppler dispersion. This design framework provides possible solutions for underwater acoustic applications under low signal-to-noise ratio and moving target/platform conditions. The project also further demonstrates the performance advantages of the CROW-S active sonar pulse and detection system through pool experiments. For passive sonar systems, the subject demonstrates the special advantages of detector design based on rational wavelet filter bank (FB) in passive sonar detection, especially in complex shallow sea environments and low signal-to-noise ratio detection scenarios. It studies the threshold algorithm design theory of passive detection based on FB in radar and sonar systems. It derives the calculation formula of detection performance under different threshold strategies. Under the FB-based detection framework, it derives the implementation principles of system design. To verify the validity of the theory, it carries out system design and simulation, demonstrates the performance of the rational wavelet FB detector by using the geometric ocean channel model based on ray tracing. The simulation results prove the correctness of the theory and design principles. The project also proposes design schemes for multiple types of wavelet-based broadband detectors, and compares with the performance of the narrow-band detector to demonstrate the advantages of the wide-band detector. The subject uses different wavelet scale factors to design passive detectors, and demonstrates the special advantages of the proposed threshold strategy and the design of passive sonar systems based on high-resolution wavelets compared with low-resolution wavelets in multipath signal analysis and fusion, which has achieved good detection performance in passive sonar simulation.

Keywords: Rational Orthogonal Wavelet, Active Sonar Detection, Passive Sonar Detection

Key issues solved: It proposes CROW wavelet theory and high-precision time-frequency/scale analysis and detection algorithms based on CROW filter banks. By effectively decomposing the signal in a multi-dimensional orthogonal subspace, it uses a fusion algorithm to achieve a solution for weak signal processing under high noise and multipath/Doppler dispersion.

Research achievements:

1) Patents

No.	Category	Status	Patents Title	Application no.	Inventor(s)
(1)	发明	申请	AGV 控制方法及装置	CN202010114197.7	余丽敏；张桐坡；马飞；马波力
(2)	发明	申请	AGV 控制方法及装置	CN202010511721.4	余丽敏；张桐坡；聂小凯；马飞；马波力

2) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE, EI	Rational Orthogonal Wavelet-based Active Sonar	L. Yu; F. Ma; E. Lim; E. Cheng ; L. B. White	IEEE Journal of Oceanic Engineering	2018.2.27
(2)	SCIE, EI	Length-of-Stay Prediction for Pediatric Patients with Respiratory Diseases Using Decision Tree Methods	F. Ma, L. Yu, L. Ye, D. D. Yao and W. Zhuang	IEEE Journal of Biomedical and Health Informatics	2020.2.24
(3)	SCIE, EI	Extended ResNet and Label Feature Vector based Chromosome Classification	C. Wang, L. Yu, X. Zhu, J. Su and F. Ma	IEEE Access	2020.10.29
(4)	EI	Broadband sonar waveform design with rational orthogonal wavelet	L. Yu, F. Ma, E. Lim, E. Cheng and L. B. White	The 14th International Computer Conference on Wavelet Active Media Technology and Information Processing (ICCWAMTIP)	2017.12.15-2017.12.17
(5)	EI, ISTP	Prediction of days in hospital for children using random forest	C. Wang, X. Dong, L. Yu, L. Ye, W. Zhuang and F. Ma	10th International Congress on Image and Signal Processing, BioMedical Engineering and Informatics (CISP-BMEI)	2017.10.14-2017.10.16
(6)	EI, ISTP	Chromosome Classification with Convolutional Neural Network based Deep Learning	W. Zhang, S. Song, T. Bai, Y. Zhao, F. Ma, J. Su, L. Yu	11th International Congress on Image and Signal Processing, BioMedical Engineering and Informatics (CISP-BMEI)	2018.10.23-2018.10.25
(7)	EI	ECG signal classification with deep learning for heart disease identification	W. Zhang; L. Yu; L. Ye; W. Zhuang; Fei Ma	International Conference on Big Data and Artificial Intelligence (BDAI)	2018.6.22-2018.6.24

Project 3: Diversity-Based Adaptive Particle Swarm Optimization Algorithm with Applications to Web Classification

| Yuhui Shi

Application code: F030707 (Department of Information Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - General Programme

Introduction: In this project, the definition, monitoring and control of population diversity based on particle swarm optimization (PSO) were focused. First, the definitions of diversity of different groups were discussed. Each definition has its own characteristics and applicability, which can be used to monitor population diversity in PSO for solving different types of problems. To make the definition of population diversity more universal, the normalized population diversity was discussed and defined, and the propagation mode and propagation speed of PSO search information under different domain structures were discussed and analyzed. Simulation experiments proved that different PSO domain structures should be adopted to obtain more suitable search information dissemination mode and speed, or to obtain different dynamic changes of group diversity when solving different types of problems. Simulation experiments were carried out to study the influence of PSO domain structure and parameters on population diversity. Different boundary constraints of PSO and their influence on population diversity were researched and discussed, and the population diversity of multi-objective particle swarm optimization (MOPSO) was analyzed and defined. On the basis of population diversity of single objective PSO, population diversity of all individuals in archive set and Pareto set should also be considered in MOPSO, so that population diversity of MOPSO can provide more abundant dynamic search information. Second, on the basis of observing and analyzing the population diversity of PSO, several methods of controlling population diversity were discussed and researched to improve the performance of PSO. The method of adaptive control of algorithm diversity by adding average speed to each dimension was researched. PSO velocity distribution information (similar to the definition of velocity diversity) and position distribution information (similar to the definition of position diversity) were used dynamically to adaptively adjust PSO inertia parameters; and a method of dynamically reducing the search area was designed. After a certain number of iterations, in each dimension, the areas where particle groups rarely appear were eliminated. Through continuous iteration, the search area of PSO can be reduced to a smaller range, thus improving the search efficiency. Specially, this method is suitable for solving large-scale optimization problems with PSO. Finally, POD was applied to Chinese web page classification. By applying PSO to the selection of classified samples, to the parameter optimization of nearest neighbor algorithm or to the initialization of classified samples to improve the classification accuracy or precision rate of Chinese web pages. In addition, a variety of new swarm optimization algorithms were proposed and researched, such as brainstorming optimization algorithm. These algorithms directly or indirectly change population diversity through various operations so as to achieve better optimization performance.

During the project, the research was carried out according to the plan proposed in the Natural Science Foundation application, and all the objectives proposed in the Natural Science Foundation application have been completed. Of which, 27 papers were published (marked with fund support), 2 books were edited (marked with fund support), 2 Chinese invention patents were applied for, many students were supervised, and 10 international conferences were held.

Keywords: Particle Swarm Optimization, Diversity, Adaptive, Optimal Design, Web Page Classification

Research achievements:

1) Patent

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	采用演化算法进行基因芯片图像基因点自动定位方法	CN201110198107.8	ZL201110198107.8	史玉回

2) Copyrights

No.	Category	Title	Author(s)
(1)	Book	Recent Algorithms and Applications in Swarm Intelligence Research	Shi, Yuhui
(2)	Book	Innovations and Developments of Swarm Intelligence Applications	Shi, Yuhui

3) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI	Experimental study on PSO diversity	Zhan, Zhihui、Zhang, Jun、Shi, Yuhui	2010 International Workshop on Advanced Computational Intelligence	2010/08/25-2010/08/27
(2)	SCI	Hybrid Genetic Algorithm Using a Forward Encoding Scheme for Lifetime Maximization of Wireless Sensor Networks	Hu, Xiao-Min、*Zhang, Jun、Yu, Yan、Chung, Henry Shu-Hung、Li, Yuan-Long、Shi, Yu-Hui、Luo, Xiao-Nan	Ieee Transactions On Evolutionary Computation	2010/10
(3)	EI	A Differential Evolution based on individual-sorting and individual-sampling strategies	Lou, Yang、Shi, Yuhui、Li, Junli	2011 IEEE Symposium on Swarm Intelligence	2011/04/11-2011/04/15
(4)	EI	Diversity Control in Particle Swarm Optimization	Cheng, Shi、Shi, Yuhui	2011 IEEE Symposium on Swarm Intelligence	2011/04/11-2011/04/15
(5)	EI	A Novel Search Interval Forecasting Optimization Algorithm	Lou, Yang、Li, Junli、Shi, Yuhui、Jin, Linpeng	2011 International Conference on Swarm Intelligence	2011/06/11-2011/06/15
(6)	EI	Inertia Weight Adaption in Particle Swarm Optimization Algorithm	Zhou, Zheng、Shi, Yuhui	2011 International Conference on Swarm Intelligence	2011/06/12-2011/06/15
(7)	EI	Normalized Population Diversity in Particle Swarm Optimization	Cheng, Shi、Shi, Yuhui	2011 International Conference on Swarm Intelligence	2011/06/12-2011/06/15
(8)	EI	Brain Storm Optimization Algorithm	Shi, Yuhui	2011 International Conference on Swarm Intelligence	2011/06/12-2011/06/15
(9)	EI	Promoting Diversity in Particle Swarm Optimization to Solve Multimodal Problems	Cheng, Shi、Shi, Yuhui、Qin, Quande	2011 International Conference on Neural Information ProcessingC	2011/11/14-2011/11/17
(10)	SCI	DNA Sequence Compression Using Adaptive Particle Swarm Optimization-Based Memetic Algorithm	Zhu, Zexuan、Zhou, Jiarui、Ji, Zhen、Shi, Yu-Hui	Ieee Transactions On Evolutionary Computation	2011/10
(11)	EI	Particle swarm optimization based semi-supervised learning on Chinese text categorization	Cheng, Shi、Shi, Yuhui、Qin, Quande	2012 IEEE Congress on Evolutioanry Computation	2012/06/10-2012/06/15
(12)	EI	Dynamical exploitation space reduction in particle swarm optimization for solving large scale problems	Cheng, Shi、Shi, Yuhui、Qin, Quande	2012 IEEE Congress on Evolutioanry Computation	2012/06/10-2012/06/15

Project 4: Research on Intelligent Evaluation and Online Teaching System of Computer Programming Course Based on IPv6

| Jieming Ma

Technical field: IPv6 Network Education Service

Programme category: CERNET Innovation Project

Introduction: Programming ability is the basic ability that computer majors should possess. The previous research have proved that practical experience is more helpful for thousands of students to form computational thinking, so that a certain amount of programming exercises is significant in programming learning. Online evaluation system is a kind of online system that can evaluate uploaded programs by compiling and executing program codes. It is often used in programming competitions and plays an active role in cultivating the programming abilities of students. However, with the rapid increase of user data and business data, the existing online assisted instruction system often leads to the decline of service quality due to the lack of network resources. On the other hand, limited by IPv4 network bandwidth, the multimedia information for teaching cannot be quickly transmitted and downloaded, which is difficult to meet the current teaching needs. In view of the current situation and problems of the above-mentioned online teaching assistant system, in this project, the research on intelligent evaluation of computer programming course and online teaching system based on IPv6 was carried out, and the specific research objectives include:

1. Based on 1Pv6, an online teaching auxiliary platform integrating audio, video and animation was developed to realize efficient transmission of multimedia information, enhance the interactivity of teaching system, improve the experience of using online teaching system of students and enhance the security of data transmission;

2. The program evaluation system was reconstructed to realize multi-dimensional evaluation of execution efficiency, occupied space, correctness, readability and extensibility, and also improve the reliability and accuracy of system verification;

3. Analyzed the data generated by learning process of students and perceived learning state of students through artificial intelligence method to realize dynamic prediction of knowledge level of students.

Keywords: IPv6, Online Assisted Instruction, Intelligent Evaluation

Key issues solved: In this project, combine the teaching needs of computer programming courses in the new era closely and focus on the intelligent evaluation and online teaching system, the following three aspects of research are planned to be conducted:

1. The IPv6 online teaching system for modern teaching methods is designed to integrate audio, video, animation and other multimedia information from the perspectives of visitors, students, teachers and administrators, and realize a complete set of online classroom, online practice, course discussion, homework after class, program competition, industrial projects and other teaching auxiliary functions.Based on IPv6 technology, it realizes network real-time teaching, real-time synchronous teaching and learning auxiliary functions. Based on IPv6 technology, it realizes network real-time teaching, real-time synchronous teaching and asynchronous teaching, improves data transmission speed, enriches network resources, enhances system interactivity and security and thus improves the service quality of online teaching system as a whole.

2. Build a safe, extensible and intelligent evaluation system, develop a multilingual evaluation system for C, C++, JAVA, and establish a multidimensional evaluation system such as execution efficiency, occupied space, correctness, readability and extensibility. The front-end separation is adopted to enhance the scalability of the system, and the first-in-first-out task queue and load balancing method are adopted to improve the accuracy of the evaluation program efficiency.

3. Research the educational data analysis model supporting process-oriented learning to collect characteristic data generated in students' learning process (including learning time, completion rate of their exercises, homework scores and test scores), construct a data-driven analysis model to evaluate students' learning situation, guide students' next learning and put forward appropriate teaching strategies.

Research achievements:

1） Copyrights

No.	Status	Category	Title	Author(s)	登记号 /Application no.
(1)	授权	软著	编程能力即时在线评测系统软件 V1.0	马洁明	软著登字第 6751562 号
(2)	授权	软著	CPT 在线判题系统 V1.0	马洁明	软著登字第 6604401 号

2） Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Intelligent design and implementation of blockchain and Internet of things - based traffic system	Qilei Ren, Ka Lok Man, Muqing Li, Bingjie Gao	IJDSN	2019.05.26

Project 5: Research on Safety Navigation Technology Based on Internet of Vehicles

| Dawei Liu

Technical field: IPv6 Internet of Vehicles

Programme category: CERNET Next Generation Internet Technology Innovation Project

Introduction: Wireless positioning is considered as the most promising development direction in the mobile Internet era. From the early OBU navigation to the electronic map, intelligent transportation, dangerous goods detection and other applications, wireless positioning services have been widely used in all aspects of society. However, wireless positioning technology also has its inherent defects. The commonly used wireless positioning systems, such as mobile phone network or GPS, are generally weak in signal strength and easily interfered. For example, high-rise buildings will cause NLOS propagation of positioning signals, which is considered as the most important error source of wireless positioning system. In addition, another big challenge faced by wireless positioning system comes from positioning spoofing by malicious users. In 2003, the US Department of Transportation initially reported that civil GPS signals were at risk of being forged. False GPS signals may lead to positioning errors of users, and even paralyze the positioning functions. With the emergence of pseudo base stations, mobile phone network positioning is also facing the risk of being misled. Thus, the way to solve the security problem in wireless positioning has become a research hotspot. In this project, we will design a special verification scheme for the special environment of onboard application. The research contents include remote verification of onboard GPS signal and real-time correction of position information. Our goal is to achieve safe and reliable onboard positioning through wireless network and PV6.

Key issues solved:

1. The way to design a reliable signal identification method to achieve the purpose that not a single good person will be wronged, and not a single bad person could escape.

2. The way to design an accurate motion-assisted location algorithm. New measurement errors are inevitably brought while using motion information. They way to make full use of a few positioning nodes to solve this problem is the key.

In this project, a complete positioning security scheme for onboard network was proposed, which has the following innovations:

1. We systematically used the physical characteristics of positioning signals to detect and identify signal interference. Compared with the traditional detection and identification methods based on positioning results, the analysis based on positioning signals is more transparent and secure.

2. We proposed a motion-assisted positioning scheme based on virtual nodes, which has less overhead than traditional inertial positioning and reckoning positioning.

3. With the unique geology of IPV6 Internet of Vehicles device, we will be able to verify the feasibility of signal sources more effectively and greatly reduce the possibility of signal deception.

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	A Handshake Protocol with Unbalanced Cost for Wireless Updating	Jiaren Cai, Xin Huang, Jie Zhang, Jiawei Zhao, Yaxi Lei, Dawei Liu, Xiaofeng Ma	IEEE Access	2018
(2)	SCI	Experimental Analysis on Weight K-Nearest	Jiusong Hu, Dawei Liu, Zhi Yan, Hongli Liu	IEEE INTERNET OF THINGS JOURNAL	2018
(3)	SCI	Identification of Location Spoofing in Wireless Sensor Networks in Non-Line-of-Sight Conditions	Dawei Liu, Yuedong Xu, Xin Huang	IEEE Transactions on Industrial Informatics	2018
(4)	EI	Toward A Dynamic Kin K-Nearest Neighbor Fingerprint Indoor Positioning	Hu, Jiusong, Hongli Liu, and Dawei Liu	2018 IEEE International Conference on Information Reuse and Integration for Data Science	2018
(5)	EI	Lifelong Machine Learning: Outlook and Direction	Xianbin Hong, Prudence W. H. Wong, Sheng-Uei Guan	The 2nd International Conference on Big Data Research	2018
(6)	EI	Semi-Unsupervised Lifelong Learning for Sentiment Classification: Less Manual Data Annotation and More Self-Studying	Xianbin Hong, Gautam Pal, Sheng-Uei Guan, Prudence Wong, Dawei Liu, Ka Lok Man, Xin Huang	The 2nd International Conference on Big Data and Artificial Intelligence	2019

2）Others

i.   Arduino 终端软件或移动设备 APP 以及安全定位的服务程序．

ii.   用于收集车辆运动传感器数据的 Arduino 终端或移动设备，以及用于安全定位的服务器．

2.Provincial Projects

Project 1: A Context-Based Formal Framework for Cyber Physical Systems

| Kaiyu Wan

Programme category: Jiangsu Science and Technology Programme – Basic Research Plan (Natural Science Foundation) – General programme

Introduction: Cyber Physical Systems (CPS), as a unity of computing process and physical process, is the next generation intelligent system integrating computing, communication and control. CPS realizes the interaction with physical processes through human-computer interaction interface, and controls a physical entity in a reliable, real-time, safe and cooperative way by using networked space with complex calculation and remote communication. CPS includes environment awareness, embedded computing, network communication, network control and the ubiquitous systems engineering in the future, which makes the physical system have the functions of calculation, communication, precise control, remote cooperation and autonomy. It focuses on the close combination and coordination of computing resources and physical resources, and is used for high-reliability medical equipment and systems, traffic control, safe and advanced automobile systems, environmental control, aviation, core infrastructure control and defense systems. CPS will have a profound impact on people's daily life and bring many benefits. For this reason, in July 2007, the President's Council of Advisors on Science and Technology (PCAST) listed eight key information technologies in its report entitled Leading under Challenges - Information Technology Research and Development in a Competing World, of which CPS ranked first. In Europe, the European Union plans to invest 5.4 billion euros (more than $7 billion) in research and technology for embedded intelligence and systems (ARTMEIS) from 2007 to 2013 to become the world leader in intelligent electronic systems in 2016. Korean IT Industry Promotion Agency (KIPA) also listed CPS as an important research project. In 2008, the largest conference on embedded systems and technologies attended by 10,000 researchers was held in Japan, which also reflected the importance attached by Japan to CPS. In China, the National Natural Science Foundation of China, '973 Plan' and '863 Plan' have also taken CPS as a key project.

These research groups gradually realized the importance of CPS research and also reached a consensus: To meet the idea of CPS integrating computing, communication, control and physical equipment, it is necessary to evolve the existing science and technology related to physical and information systems and establish the infrastructure related to science and technology to meet the needs of CPS. In the process of establishing infrastructure, however, 'developing a new CPS open architecture' is one of the challenges. Therefore, it is necessary and urgent to provide a suitable architecture for CPS software, but it is far more complex than people expected. The complexity is determined by the heterogeneity of CPS system, the close coupling with the environment and the fluidity.

Based on the above research significance and challenges, in this project, two related and extremely important problems in CPS software platform are to be solved: "What kind of architecture is suitable for CPS? How to analyze the behavior of CPS?"

Keywords: Architecture, Formal Analysis, Context

Key issues solved: In this project, the two basic and critical questions related to CPS software platform will be solved:
1. What kind of architecture is suitable for CPS?
2. The way to formally analyze the behavior of CPS?

For the first issue: The solution proposed by us was that 'resource-centric, contextual, service-oriented architecture', which can faithfully express CPS elements and features.

For the second question: first, we researched a resource-centric abstract service model, which can dynamically describe the behavior of CPS. Second, we provided formal syntax and semantics for each layer of the architecture. These formal syntax can describe service requirements, resource description, resource composition, service provision, service configuration and modification. Finally, we researched a tool to support architecture description and service model, which is user-centered and

designed according to semantic rules, and can translate resource information into secure sharing and communication at CPS station, and can support different users to browse, discover, request and allocate resources to related service requirements. We also carried out case researches of traffic management and paramedical care to understand the needs and verify the correctness of our methods.

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI	Integrating Context-awareness and Trustworthiness in IoT Descriptions	Kaiyu Wan, Vasu Alagar	The 2013 IEEE International Conference on Internet of Things	2013.8
(2)	EI	Intelligent Graphical User Interface for Managing Resource Knowledge in Cyber Physical Systems	Kaiyu Wan, Vasu Alagar, Bai Wei	KSEM 2013	2013.8
(3)	EI	A Resource-centric Architecture for Service-oriented Cyber Physical System	Kaiyu Wan, Vangalur Alagar	the 8th International Conference on Grid and Pervasive Computing (GPC 2013)	2013.5.9-2013.5.11
(4)	EI	Modeling Resource-centric Services in Cyber Physical Systems	Wan, Vangalur Alagar	International Multiconference of Engineers and Computer Scientists 2013 (IMECS 2013)	2013.3.13-2013.3.15
(5)	EI	Context-aware Security Solutions for Cyber Physical Systems	Kaiyu Wan, Vangalur Alagar	International Conference on Context-Aware Systems and Applications	2012.11.26-2012.11.27
(6)	EI	A Context-aware Multi-agent Systems Architecture for Adaptation of Autonomic Systems	Kaiyu Wan, Vangalur Alagar	the 7th International Conference on Intelligent Information Processing	2012.10.12-2012.10.15
(7)	EI	Resource Modeling for Cyber Physical Systems	Kaiyu Wan, Vangalur Alagar	The 2012 International Conference on Systems and Informatics	2012.5.19-2012.5.21

Project 2: Detect Positioning Error in Wireless Networks

| **Dawei Liu**

Technical fields: Electronic Information - Sensor Networks - Intelligent Sensing and Processing

Programme category: Jiangsu Science and Technology Programme - Basic Research Plan (Natural Science Foundation) – Young Scientists Fund

Introduction: With the wide application of wireless positioning technology, the security of wireless positioning system has attracted more and more attention. The main security threat faced by wireless positioning system comes from positioning spoofing by malicious users. In 2003, the US Department of Transportation reported that GPS civil signals can be forged, and the forged GPS signals may lead to abnormal positioning results, and even cause complete paralysis of GPS functions in a certain area. In recent years, more and more researches have begun to focus on the security issues in wireless positioning, and the main research directions include the ways to find abnormal positioning results caused by malicious users and to eliminate such anomalies.

Another reason for abnormal positioning results is the NLOS propagation of wireless signals. The positioning error of CDMA System can reach 589m in NLOS environment, while the general error is only tens of meters. There are similar problems in other positioning system, such as the wireless sensor network positioning and wireless local area network positioning. Thus, the way to detect NLOS propagation and to eliminate its influence has always been one of the hot spots in research of Wireless Positioning System.

In this project, a set of abnormal error detection mechanism is designed through the research of positioning spoofing signal and NLOS signal, which solves the issue of positioning spoofing identification in NLOS environment. The project was carried out strictly according to the plan, with 10 papers published, 1 invention patent applied, 4 graduate students trained and all technical indicators completed. The research results provided theoretical basis and technical support for abnormal error detection and identification of wireless positioning, and provided a basis for relevant Departments to develop the industry standards, regulations and policies.

Keywords: Wireless Positioning, Location Security, NLOS Propagation

Key issues solved:

1. The problems were found out by detecting the positioning error on the periphery of convex hull. Traditional consistency analysis cannot effectively act on the convex hull of wireless positioning nodes. It means that the alternatives must be found. On the one hand, the alternatives designed by us can find any positioning errors on the periphery of convex hull, on the other hand, it will not introduce new failure problems.

2. Fingerprint acquisition method based on user data. It is the basis of establishing a perfect fingerprint database to discover those safe and reliable users in unknown areas, measure their wireless signals and calculate the degree of NLOS propagation. By analyzing the similarity of adjacent users, we solved the problem of the way to find those safe users from a small number of users.

3. Implementation of distributed authentication technology for positioning spoofing. We focused on solving the security problem of distributed protocols. On the basis of traditional research, combined with the unique geometric constraints of wireless location, we designed a set of secure and reliable authentication methods.

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI	An Improved IEEE 802.15.6 Password Authenticated Association Protocol	X. Huang, D. Liu, et al	IEEE/CIC I CCC 2015 Symposium on Selected Topics in Communications	2015
(2)	EI	Analysis of Location Spoofing Identification in Cellular Networks	Wei Y, Liu D.	International Conference on Mobile, Secure and Programmable Networking	2015
(3)	EI	Identifying malicious attacks to wireless localization in bad channel conditions	Liu D.	2014 IEEE MiSeNet	2014
(4)	EI	Linear programming algorithms for sensor networks node localization	Xu K, Liu H, Liu D, et al.	2016 IEEE International Conference on Consumer Electronics (ICCE)	2016
(5)	EI	Dynamic Sensor Selection in Heterogeneous Sensor Network	Ma Y, Hou F, Ma S, and D. Liu.	IEEE Vehicular Technology Conference (VTC Spring)	2016
(6)	EI	Wi-Fi Access Point Roaming: Challenges and Potential Solutions	L. Wang, Y. Zhao, D. Afolabi, D, Liu.	18th IEEE International Conference on Network-Based Information Systems (NBiS)	2015
(7)	EI	A Role-Based Access Control System for Intelligent Buildings	N. Xue, C. Jiang, X.Huang and D. Liu	International Conference on Network and System Security	2017
(8)	EI	MuVi: Multi-view Video Aware Transmission over MI MO Wireless Systems	Z. Chen, X. Zhang, et al	IEEE Transactions on Multimedia, accepted to appear	2017
(9)	EI	Temporal Coherence-Based Deblurring Using Non-Uniform Motion Optimization	C. Qiao, RWH. Lau, et al	IEEE Transactions on Image Processing	2017
(10)	EI	Identification of Location Spoofing in Wireless Sensor Networks in Non-Line-of-Sight Conditions	Dawei Liu	IEEE Transactions on Industrial Informatics	2017

3. Municipal Projects

Project 1: A Platform for Monitoring and Risk Assessment of Dangerous Goods Logistics Based on IoT Technology

Hossam Ismail &
Zhiqin Ni

Programme category: Key Programme Special Fund (KSF) – Applied Technology Research Programme

Introduction: The R&D of this project was divided into three phases: Phase I: Demand collection and initial design of the project (June 2018 to December 2018). Phase II: Hardware selection and software design (January 2019 to December 2019). Phase III: Project testing and marketing (January 2020 to September 2020).

Phase I of the project: Investigation and demand analysis were carried out on the transportation and logistics process of dangerous goods, and the initial objective was the transportation scenario of lithium battery. Dongguan Chuangming Battery Co., Ltd. (consignor), Suzhou Industrial Park Samsung Display Technology Co., Ltd. (consignor), Suzhou Jianshuo Electronics Co., Ltd. (consignor), Suzhou Industrial Park Tiantian Supply Chain Co., Ltd. (carrier) and many other enterprises were investigated respectively, and parameters on the transportation requirements of lithium batteries and display panels, as well as the actual dangerous goods transportation process were visited and collected. Generally, the environment was monitored in the industry, and the strategy of monitoring goods by the logistics monitoring risk platform of this project was determined, which is characterized by innovation and differentiation.

Phase II of the project: The software of the platform was developed, the Internet of Things sensors was selected, and the software platform was connected and tested. Based on the design of the previous scene and the combing of the process, after about half a year's development, the platform functions corresponding to PC and WeChat applet were formed. Bosch TDL110, a sensor with super endurance that can monitor temperature, humidity, impact and tilt at the same time, was selected, which makes the Internet of Things data communicate and connect with the platform. Field test and simulation were also carried out for dynamic and static scenes, and early warning mechanism and control program were added. Based on the flexibility of the actual scene, the rule chain setting was introduced. For different roles of consignors, carriers, consignees, governments and other third-party organizations, the customized query and analysis interfaces of different processes can also adapt to the matching and traceability functions of different sales contracts, purchase contracts, waybills and other information.

Phase III of the project: Market-oriented development and application. In the developed scheme, the solutions of Suzhou Transportation Bureau, Suzhou Road Dangerous Goods Transport Association, Sinotrans Suzhou Logistics Co., Ltd., Youlesai Supply Chain Co., Ltd., Jiangsu Chuanghong Logistics, Suzhou Leitong, Wuhan Jishun and other enterprises were displayed and promoted. Memorandums of cooperation were signed with the above six companies to jointly promote the landing and commercialization of the dangerous goods monitoring and risk assessment platform project based on the Internet of Things and certain social impact was achieved. Many field tests and experiments have been carried out in Tiantian Supply Chain of Suzhou Industrial Park and Jiangsu Chuanghong Logistics Co., Ltd. As the secondary development of platform application, the project of 'Standardized Storage Unit Asset Management' of Youlesai Supply Chain Co., Ltd. in the park has been further researched and optimized. Currently, in the process of active promotion, it helped them solve the issues of asset management and the way to to optimize traffic.

Key issues solved:

Based on Internet of Things technology, through binding goods and sensors of Internet of Things, the dangerous goods logistics monitoring and risk assessment platform could collect dangerous goods parameters in real time, and could monitor the environmental parameters of goods in real time through communication with background software and the mobile network. Based on the parameters and attributes of dangerous goods, environmental thresholds can also be set freely. When the status

parameters of goods exceed the environmental threshold of early warning in the scene of transportation or warehousing, that is, before the loss caused by actual dangerous goods occurs, inform the stakeholders, including carriers, freight drivers or warehouse managers, and report and dispose quickly to achieve the purpose of controlling the risks in the process of dangerous goods logistics. A shared information platform was also provided. The consignee, consignor and carrier can query the real-time position and status of the goods through the senior rule chain, which makes the whole process visible and transparent and greatly facilitates all stakeholders. Data were also provided for the government or other insurance companies to support their decision-making.

Research achievements:

1） Patents

No.	Category	Status	Patents Title	Application no.	Inventor(s)
(1)	发明	实审	危险品物流监测方法、装置和系统	202010098014.7	刘国权、倪志勤
(2)	发明	实审	一种支持万级接入点的智能标签资产管理系统	202010613571.8	刘国权、倪志勤
(3)	发明	实审	一种应用在物流存储单元上的智能标签	202010612180.4	倪志勤、刘国权
(4)	发明	实审	复杂环境下自适应节能算法和装置	202010940719.9	倪志勤、刘国权

2） Copyright

No.	Status	Category	Title	Author(s)	Application no.	Certificate no.
(1)	授权	软件著作	西交利物浦大学危险品物流检测与风控系统 V1.0	刘国权、倪志勤	2020SR0425577	5304273

3） Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Sustainable supply chain finance: Toward a research agenda	陈露洁	Journal of Cleaner Production	2019 年 9 月
(2)	SCI	The circular economy in the textile and apparel industry: A systematic literature review.	陈露洁	Journal of Cleaner Production	2020 年 2 月

与苏州交通局、苏州危险品运输协会的专家一起，形成了锂电池、有机过氧化物、氢气等三类危险品运输的知识库，将为未来运输过程的控制、风险管理提供技术基础性文件．

锂电池运输和包装
知识库

有机过氧化物运输和包装
知识库

氢气运输和包装
知识库

Project 2: Research on Building Photovoltaic Power Control Method Based on Edge Computing

| Jieming Ma

Technical field: Computer Application

Programme category: Suzhou Smart City Research Institute – Open project

Introduction: Building photovoltaic system has nonlinear multi-peak electrical output characteristics in changeable climate environment, especially under local shadow shading condition. The way to improve energy-saving efficiency has always been a research hotspot and difficulty in the field of building photovoltaic application. Maximum Power Point Tracking (MPPT) is an effective way to improve photovoltaic output and is widely used in photovoltaic controllers. However, the current building photovoltaic controller lacks an environment-aware model to provide key information for MPPT by identifying the working state.

In this project, it was planned to develop the photovoltaic controller based on environmental awareness model by focusing on the environmental awareness technology of photovoltaic system based on the analysis of the electrical characteristics of building photovoltaic system. The intelligent controller researched has the following characteristics:

1. Shadow detection technology and quantitative analysis method of output characteristics for local shadow occlusion conditions.
2. An environmental perception model to identify shadow patterns, and accurately predict the maximum power point position of building photovoltaic systems in complex environments.
3. The MPPT method with model algorithm control to improve the output power of building photovoltaic system efficiently and in real time.

This project can reveal the internal relationship between environmental factors and maximum power points. It can also clarify the feasibility of photovoltaic power control based on environment awareness, which is expected to further improve the energy-saving efficiency of building photovoltaic systems and provide data accumulation and technical support for promoting the development of distributed photovoltaic systems.

Keywords: Photovoltaic Cell, Edge Computing, Power Control

Key issues solved:

1) The way to build a shadow recognition model for SoC FPGA in the edge layer.

Edge layer is the core of the three-tier architecture of edge computing. On the basis of receiving and processing field layer data stream, the way to build a shadow recognition model, the way to optimize the model and encapsulate it into the edge layer with SoC FPGA as the main edge controller, and the way to improve the data processing ability of the edge layer are the key issues to realize intelligent edge sensing.

2) The way to mine the technical parameters of subsystems under different working conditions in the cloud computing layer and accurately predict the system power.

The aging degree of photovoltaic cells and semiconductor materials directly affect their power generation output.

The technical parameters of photovoltaic cells can provide necessary basis for system modeling and control, and are the premise and basic conditions for accurate energy management. In the cloud computing layer, the way to deeply mine multi-source data, estimate technical parameters and predict system output power is the key issue to achieve accurate photovoltaic control.

3) The way to establish edge computing with flexible management, collaborative execution and heterogeneous environment and its distributed predictive control strategy to enhance the dynamic adaptability of edge computing.

Shadow occlusion can be considered as a kind of fault in photovoltaic applications, and its occurrence is obviously intermittent and random. When multiple photovoltaic cell strings are occluded at the same time, the computational complexity of shadow recognition will increase. This requires that the edge computing model should be segmented, that is, the intelligent

recognition task can be divided into several subtasks and migrated to multiple edge ends for computing. In real-time control, the way to establish distributed computing with flexible management, collaborative execution and heterogeneous environment and its distributed predictive control strategy is the key to realize the dynamic adaptability of edge computing.

Research achievements:

1）Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	一种串联型光伏电板遮挡自动检测系统	CN201821753690.8	ZL201821753690.8	马洁明，毕自强
(2)	发明	申请	一种特性失配光伏组串的功率峰数测量方法	CN202010363393.8		马洁明，王康石，文家乐
(3)	发明	申请	一种串联型光伏电板遮挡自动检测系统及方法	CN201811264554.7		马洁明，毕自强
(4)	发明	申请	一种光伏串联的阴影遮挡检测方法、装置和设备	CN202010010649.7		马洁明
(5)	发明	申请	光伏串列阴影信息检测方法、最大功率点追踪方法及系统	CN202010321887.X		毕自强，马洁明，文家乐

2）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	Intelligent design and implementation of blockchain and Internet of things–based traffic system	Q. Ren, K.L. Man, M. Li, B. Gao, and J. Ma	International Journal of Distributed Sensor Networks	2019.7
(2)	SCIE	Identification of Partial Shading Conditions for Photovoltaic Strings	Z. Bi, J. Ma, K. Wang, K.L. Man, Y. Yue and J.S. Smith	IEEE Access	2020.5
(3)	SCIE	An Enhanced 0.8Voc-Model-Based Global Maximum Power Point Tracking Method for Photovoltaic Systems	Z. Bi, J. Ma, K.L. Man, J.S. Smith, Y. Yue and H. Wen	IEEE Transactions on Industry Applications	2020.8
(4)	EI	Global MPPT Method for Photovoltaic Systems Operating under Partial Shading Conditions using the 0.8VOC Model	Z. Bi, J. Ma, K. L. Man, J. S. Smith, Y. Yue and H. Wen	2019 IEEEInternational Conference on Environment and Electrical Engineering and 2019 IEEEIndustrial and Commercial Power Systems Europe (EEEIC/ I&CPSEurope)	2019.6
(5)	EI	Predicting the Global Maximum Power Point Locus using Shading Information	J. Ma, Z. Bi, K. L. Man, H. Liang and J. S. Smith	2019 IEEEInternational Conference on Environment and Electrical Engineering and 2019 IEEEIndustrial and Commercial Power Systems Europe (EEEIC/ I&CPS Europe)	2019.6
(6)	EI	A Novel Global Maximum Power Point Tracking Method based on Shading Detection	J. Ma, Z. Bi, K. L. Man, Y. Yue and J. S. Smith	2019 International SoC Design Conference (ISOCC)	2019.11

No.	Category	Title	Author(s)	Journal Title	Publication Date
(7)	EI	An Analytical Model for a Photovoltaic Module Under Partial Shading Conditions	J. Ma, K. Wang, K. L. Man, H-N. Liang, X. Pan	2020 IEEEInternational Conference on Environment and Electrical Engineering and 2019 IEEEIndustrial and Commercial Power Systems Europe (EEEIC/ I&CPS Europe)	2020.6
(8)	EI	Maximum Power Point Tracking of Photovoltaic Systems Using Deep Q-networks	K. Wang, D. Hong, J. Ma, K. L. Man, K. Huang and X. Huang	2020 IEEE International Conference on Industrial Informatics	2020.6
(9)	EI	A Novel Global Maximum Power Point Tracking Technique based on Shading Detection for Photovoltaic Strings	Z. Bi, J. Ma, K.L. Man, Y. Yue and J.S. Smith	2020 International SoC Design Conference (ISOCC)	2020.10

3）Others

在理论和算法方面，提出基于电气特征的阴影识别方法及控制策略；在应用方面，构建预测控制系统，解决建筑发电系统在复杂环境条件下能源转换效率低下的问题．

Mathematics

As a fundamental tool essential to the study and research of modern science and technology, mathematics has played an irreplaceable role in our historical development and social life. XJTLU has now developed a sound and mature system of modern mathematics education, established an extensive network of international research cooperation, and maintained close academic exchanges with top scholars at home and abroad to jointly conduct cutting-edge research in mathematics-related fields. By the end of 2020, XJTLU has established three research units in the field of mathematics, namely Intelligent Computing and Financial Technology Laboratory, Research Institute of FinTech, and the Research Institute of Quantitative Finance, and has successfully completed 17 governmental research projects at all levels, including 8 national projects, 7 provincial projects, and 2 municipal projects.

1.National Projects

Project 1: Geometry of Submanifolds in Complex Grassmann Manifolds

| Jieming Ma

Application code: A010301 (Department of Mathematical and Physical Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - Young Scientists Fund

   Introduction: Homogeneity and rigidity of submanifolds are classical projects in submanifold geometry. Complex Grassmann manifold is a generalization of complex projective space, and its geometric structure is much more complex than that of complex projective space. In this project, the geometry and rigidity of minimal surfaces in complex Grassmann manifolds were researched. First, we proved the homogeneity preserving property of harmonic sequences in complex Grassmann manifolds. We completely classified the homogeneous minimal 2D spheres in the quaternion projective space HPn. Ohnita's conjecture was solved when n is an odd, where HPn was regarded as a total geodesic submanifold in complex Grassmann manifold G (2, 2n +2). Second, we proved the local rigidity theorem of holomorphic curves in G (2, 6), which generalized P. Griffiths' local rigidity theorem of holomorphic curves in G (2, 4). We gave the complete classification of homogeneous holomorphic 2D spheres in complex Grassmann manifolds G (2, n) and G (3, n) by using the theory of Lie groups and the complex irreducible representation of SU (2). These results provided us with a large number of examples of holomorphic 2D spheres with constant curvature in complex Grassmann manifolds, which is helpful for us to further research the classification of holomorphic 2D spheres with constant curvature in complex Grassmann manifolds.

   Keywords: Complex Grassmann Manifold, Minimal Surface, Rigidity, Homogeneity, Constant Curvature

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Homogeneity-preserving property of harmonic sequences from surfaces into complex Grassmann: manifolds	Jie Fei; Wenjuan Zhang	Frontiers of Mathematics in China	2017.3
(2)	SCI	Classification of homogeneous minimal immersions from S2 to HPn	Jie Fei; Ling He	Annali di Matematica Pura ed Applicata	2017.4
(3)	SCI	Local rigidity of holomorphic curves in the complex Grassmann manifold G(2,6)	Jie Fei; Xiaowei Xu	Journal of Geometry and Physics	2017.8
(4)	SCI	Local rigidity of minimal surfaces in Q2	Jie Fei; Jun Wang	Journal of Geometry and Physics	2018.11
(5)	SCI	Classification of homogeneous holomorphic two-spheres in complex Grassmann manifolds	Jie Fei	Differential Geometry and its Applications	2019.1
(6)	SCI	Rigidity of holomorphic curves in a hyperquadric Q4	Jie Fei; Jun Wang	Differential Geometry and its Applications	2019.8
(7)	SCI	Classification of homogeneous two-spheres in G(2,5,C)	Wenjuan Zhang; Jie Fei; Xiaoxiang Jiao	Acta Math. Sci. Ser. B	2019.1
(8)	SCI	Minimal two-spheres with constant curvature in the quaternionic projective space	Jie Fei; Chiakuei; Xiaowei Xu	Science China Mathematics	2020.5
(9)	SCI	Superminimal surfaces in hyperquadric Q2	Jun Wang; Jie Fei	Frontiers of Mathematics in China	2020.10
(10)	SCI	A characterization of homogeneous holomorphic two-spheres in Qn	Jie Fei; Jun Wang	Journal of Geometric Analysis	2019.8

Project 2: Two-Parameter Fleming-Viot Process and Its Related Problems

| Youzhou Zhou

Application code: A0209 (Department of Mathematical and Physical Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - Young Scientists Fund

Introduction: In this project, the construction of two-parameter Fleming-Viot process was researched, which is a natural extension of one-parameter Fleming-Viot process. One-parameter Fleming-Viot process is an important model in population genetics and has important applications in statistics and other related fields. In this project, based on the interactive particle system, a two-parameter interactive particle system was obtained by extending the Donnelly-Kurtz interactive particle model, and then it was proved that the empirical measure of the particle system converges to a measure-valued process, which is a two-parameter Fleming-Viot process. It was noted that the Blackwell-MacQueen model was nested in the particle system, and then the explicit expression of the transition function of the two-parameter Fleming-Viot process was obtained. Finally, we also noticed that the ancestor number of one-parameter Fleming-Viot process and two-parameter Fleming-Viot process was the same process. Thus, we researched the asymptotic properties of Kingman's ancestral tracing process in detail. The research results in this project will promote some problems in statistics.

Keywords: Two-Parameter Fleming-Viot Process, Kingman Ancestral Process, Blackwell-MacQueen Model, Donnelly-Kurtz Interactive Particle System

Key issues solved: We found that Kingman ancestral process is a dual process of a large class of processes.

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	Integral Representation of Probabilities in Kingman Coalescent	Zhou,Youzhou	Science China (Math)	2020
(2)	SCIE	Cramer-type moderate deviations for the parameter estimation in Ornstein-Uhlenbeck Process with discrete observation	Hui Jiang, Hui Liu and Youzhou Zhou	Electronic Journal of Statistics	2019
(3)	SCIE	Asymptotic expansions and precise deviations in Kingman's coalescent	Gao,Fuqing, Wang, Yujing and Zhou,Youzhou	Electronic Communications in Probability	2020

Project 3: Some Questions on Actions of Non-Linear Algebraic Groups

| Jinsong Xu

Application code: A0107 (Department of Mathematical and Physical Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - Young Scientists Fund

Introduction: Nonlinear algebraic groups, that is, algebraic groups that are not linear. Owing to the great progress of birational geometry in recent 40 years, in this project, the principle investigator continued his postdoctoral research work, and devoted himself to exploring the role of nonlinear algebraic groups in algebraic varieties by applying birational geometry technology. Its primary research contents are as follows:

1. The role of Abel clusters in irregular logarithmic Calabi-Hill spaces was discussed.
2. From the perspective of nonlinear algebraic group action, the Jordan property of double rational automorphism group and its application to rational problem of algebraic variety were researched.
3. The structure of rational connected clusters with large order finite group interaction.

According to the actual research implementation, the project investigator has achieved the following important results:

1. The existence of the interaction of Abelian clusters on irregular logarithmic Calabi-Hill spaces was proved and a finer structure theorem of such algebraic clusters was obtained. The paper has been published in Manuscripta Mathematica.
2. Part of the research of Caucher Birkar, winner of Fields Prize in 2018, on the boundedness of Fano cluster was expounded in the paper, which has been accepted by the Continental Mathematics series of American Mathematical Society.
3. Based on the research of Caucher Birkar on the boundedness of Fano clusters, a complete characterization of three-dimensional algebraic clusters with double rational automorphism groups that do not satisfy Jordan property was given by using the action of nonlinear algebraic groups, and an extension and conjecture of higher dimensions were put forward. A rational discriminant method of rational connected clusters was also obtained, and a question raised by C. Shramov and Yu. Prokhorov was solved. The paper has been delivered.
4. The results of the research by C. Shramov and Yu Prokhorov on the rank of finite p subgroups of bi-rational automorphism groups of rational connected clusters were improved, and an almost optimal answer was given. The paper has been published in Comptes Rendus Mathematicque.

In this project, a new method for the research of Jordan properties of bi-rational automorphism groups was recommended, and a more reasonable high-dimensional conjecture was put forward. These works play an important role in our understanding of bi-rational automorphism groups of algebraic varieties.

Keywords: Non-Linear Algebraic Group, Birational Geometry, Jordan Property

Key issues solved: An issue proposed by C. Shramov and Yu. Prokhorov was solved by using the boundedness theory of Fano clusters, and a criterion of rationality of algebraic clusters was obtained.

Project 4: Structure of Pieri Algebras for Symplectic Groups and Orthogonal Groups

| Yi Wang

Application code: A010202 (Department of Mathematical and Physical Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - Young Scientists Fund

Introduction: For typical groups, each irreducible representation uniquely corresponds to a Young's Diagram according to the Highest Weight Theory. The decomposition of tensor product of two irreducible representations was described by the Littlewood-Richardson Rule. When one of the corresponding Young's Diagram only has one row, the tensor integral solution of this special case obeys the Skew Pieri Rule. When one of the corresponding Young's Diagram only has one column, the tensor integral solution of this special case obeys the Skew Pieri Rule. Algebras whose structures contain information about the corresponding the Pieri Rule are called Pieri algebras or skew Pieri algebras respectively. In this project, the structure of skew Pieri algebra of general linear groups was clearly described.

In this project, the structure of Pieri algebras of symplectic groups and orthogonal groups were researched. After the explicit expressions of a set of generators were obtained, the proper signed diurnal ratio cone was constructed by the Pieri Rule, and then the explicit expressions of a set of bases of Pierry algebra were obtained by standard monomial basis theory. Each vector in this set of bases is an irreducible representation of the highest weight vector. In this project, through the research of the Pieri Rule for symplectic groups and orthogonal groups, the Pieri algebra for symplectic and orthogonal groups in polynomial algebra and exterior algebra were realized, and the corresponding signed diurnal ratio cones were obtained. In the process of constructing generator, the explicit construction of most generator has been completed, and the explicit construction of a special kind of generator is also in progress.

At present, the results have been compiled into two articles, one of which has been published. The project was presented in four international conferences, including one conference report. For this project, 180,000 RMB was invested, and 110,756 RMB were spent, all of which did not exceed the budget. The remaining funds of 69,244 RMB will be used for the follow-up research expenditure of this project.

Keywords: Skew Pieri Algebra, Lowest Weight Module, Symbolized Diurnal Ratio Cone, Highest Weight Vector, Typical Group

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	Skew Pieri Algebras of the General Linear Group	Sangjib Kim, Soo Teck Lee, Yi Wang	Journal of Mathematical Physics	2018.12.11

Project 5: Cohomologicaly Dimension and Quillen's Plus Construction

| Shengkui Ye

Application code: A010401 (Department of Mathematical and Physical Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - Young Scientists Fund

Introduction: In this project, Quillen addition construction was used to research the relationship between cohomology dimension and geometric dimension of cell complex. We considered the following D (2) issue: Let X be a finite 3D cell complex and the cohomology dimension is 2. Is X homotopy equivalent to a 2D cell complex? This issue was closely related to the Eilenberg-Ganea conjecture and Whitehead conjecture in topology. We used Quillen addition operation to research this issue, and the research results were abundant.

Keyword: Low-Dimensional Topology

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	Euler characteristics and actions of automorphism groups of free groups	Ye Shengkui	Algebraic and Geometric Topology	2018
(2)	SCIE	The action of matrix groups on aspherical manifolds	Shengkui Ye	Algebraic & Geometric Topology	2018.06.01
(3)	SCIE	Vanishing of L-2-Betti numbers and failure of acylindrical hyperbolicity of matrix groups over rings	Ji Feng; Ye Shengkui	Algebraic and Geometric Topology	2017
(4)	SCIE	PARTIAL EULER CHARACTERISTIC, NORMAL GENERATIONS AND THE STABLE D(2) PROBLEM	Ji Feng; Ye Shengkui	Homology, Homotopy and Applications	2018

Project 6: Some Filtering Decomposition Type Preconditioners for Numerical Solution of Incompressible Navier-Stokes Equations

| Qiang Niu

Application code: A011705 (Department of Mathematical and Physical Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - Young Scientists Fund

Introduction: Incompressible Navier-Stokes equations had important applications in numerical simulation of many fluid issues. In this project, the preprocessing techniques of large-scale structured linear equations generated in the numerical solution of incompressible Navier-Stokes equations was focused on. With the help of Fourier analysis and other tools, we developed dimension splitting preconditioner, displacement splitting preconditioner and two-parameter preconditioner with asymptotic optimal convergence property. On this basis, several efficient combined pretreatment technologies have also been developed. In this project, a scheme was also given to optimize the traditional split iterative preprocessor, which solved the problem of parameter selection involved in the traditional preprocessing method. The optimal parameter selection, the optimal combination of several preconditioners and other issues were solved by taking the optimal condition number of the preconditioned matrix as the objective. The research results of this project would lay a foundation for further development of high-performance pretreatment technologies such as parallel and multi-core, and were of great significance for improving the numerical simulation efficiency of complex viscous fluids.

Keywords: Navier-Stokes Equalization, Preconditioner, Iterative Method, Fourier Analysis

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	一类组合预处理子的数值研究	Qiang Niu, Michael Ng	Journal of computational mathematics	2014.01.15
(2)	SCI	解鞍点问题的一类矩阵分裂预处理子的谱性质	Rui-Rui Wang, Qiang Niu, Fei Ma, Linzhang Lu	Journal of Computational and Applied Mathematics	2016.05.15
(3)	SCI	求解鞍点问题的一类新的松弛维数方式分裂迭代及其理论分析	Martin Gander, Qiang Niu, Yingxiang Xu	BIT	2016.06.16
(4)	SCI	包含模糊空间信息的乳腺 x 图像配准	Fei Ma, Limin Yu, Mariusz Bajger, Murk J. Bottema	Fuzzy Sets and Systems	2015.11.15
(5)	SCI	轴对称物体 X 射线层析成像的高阶全变分正则化方法	Raymond H. Chan, Haixia Liang, Suhua Wei, Mila Nikolova, Xue-Cheng Tai	Inverse Problems and Imaging	2015.01.16
(6)	SCI	松弛套嵌分解以及组合预处理	Pawan Kumar, Laura Grigori, Frederic Nataf, Qiang Niu	International Journal of Computer Mathematics	2015.01.23
(7)	SCI	求解鞍点问题的位移分裂预处理子	Yang Cao, Jun Du, Qiang Niu	Journal of Computational and Applied Mathematics	2014.12.15
(8)	SCI	计算机辅助的乳腺肿瘤随时空变化检测	Fei Ma, Limin Yu, Gang Liu, Qiang Niu	Computer Science and Information Systems	2015
(9)	SCI	广义位移分裂预处理鞍点问题的谱分析	Zhi-Ru Ren, Yang Cao, Qiang Niu	Journal of Computational and applied mathematics	2017.01.01
(10)	SCI	图关联项目集的简明模式识别技术	Di Zhang, Yunquan Zhang, Qiang Niu, Xingbao Qiu	NeuroComputing	2018.11.02
(11)	SCI	均衡本质无振荡 WENO 方法在浅水泥沙模型中的应用	Shouguo Qian, Gang Li, Fengjing Shao and Qiang Niu	Computational Geosciences	2018.02.01
(12)	SCI	解位移线性方程组的带增广误差项的广义极小残量法	Rui-Rui Wang,Qiang Niu, , Xiang Wang	Computers & Mathematics with Applications	2019.09.15

Project 7: Two-Echelon Multi-Depot Heterogeneous Vehicle Routing with Time Windows

| Min Wen

Application Code: A011202 (Department of Mathematical and Physical Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - Young Scientists Fund

Introduction: The vehicle routing problem is a classic problem in combinatorial optimization. As people has presented higher and higher requirements for transportation and distribution, the vehicle routing problems also faces new challenges, and the theoretical research on new problems is needed. In this project, we studied the 2E-VRP with time windows, and established hybrid shaping planning model that is programmed in CPLEX software for experiments design, data generation and correctness and validity evaluation. Meanwhile, we also studied the heuristic large-field search algorithm with respect to this problem. Additionally, we took heuristic algorithm as the core and followed up with the various trends in VRP in recent years to research the theory and design of the large-scale heuristic algorithms in several key issues, which obtained excellent effect. These issues contain cooperative vehicle routing problems, dynamic cooperative vehicle routing problems, multi-objective routing optimization problems and mobile production vehicle routing problems with time windows. This research has good application future since many problems are directly from actual data and cases. The transportation modes targeted by some problems is still in conceptual stage because they are on the quite cutting edge, but they will be developed well in the future as people has paid more and more attention to them.

Keywords: Vehicle Routing Problem, Traffic Logistics, Mathematical Model, Heuristic Algorithm

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE, SSCI	A multiple ship routing and speed optimization problem under time, cost and environmental objectives	Wen, M; Pacino, D*; Kontovas, C A; Psaraftis, H N	Transportation Research Part D: Transport and Environment	2017
(2)	SCIE, SSCI	Centralised horizontal cooperation and profit sharing in a shipping pool	Wen, Min*; Larsen, Rune; Ropke, Stefan; Petersen, Hanne L; Madsen, Oli B G	Journal of the Operational Research Society	2019
(3)	SCIE	Weakly sharp solutions and finite convergence of algorithms for a variational inequality problem	Liu Yina*	Optimization	2018

Project 8: Fast Iterative Solvers for Algebraic Systems Arising from Radiative Transfer Problems

| Shengxin Zhu

Programme category: Key Laboratory - Open Project

Introduction: With the strong demand of radiative transport issues for computational science, this advanced research project researched the fast calculation method of alternative sparse algebraic equations caused by discrete radiative transport equations, and focused on all potential issues in the calculation of radiative transport equations. The advanced researched project did not hope to solve all the issues directly, but focused on the in-depth investigation of radiation transport issues, and provided potential feasible technical routes and solutions for relevant technicians based on the latest research literature. Through the in-depth research, more general frontier basic scientific issues that may help accelerate the solution of radiation transport issues were compacted, more original issues were explored, and the scientific original research projects for related research projects were provided.

Main research contents of this project are as follows: Algebraic structure and properties of multi-group radiation diffusion equations, discrete structure and properties of multi-group radiation transport equations for simple issues.

Key issues solved: With the strong demand of radiative transport issues for computational science, this advanced research project researched the fast calculation method of alternative sparse algebraic equations caused by discrete radiative transport equations, and focused on all potential issues in the calculation of radiative transport equations. The advanced researched project did not hope to solve all the issues directly, but focused on the in-depth investigation of radiation transport issues, and provided potential feasible technical routes and solutions for relevant technicians based on the latest research literature. Through the in-depth research, more general frontier basic scientific issues that may help accelerate the solution of radiation transport issues were compacted, more original issues were explored, and the scientific original research projects for related research projects were provided.

2. Provincial Projects

Project 1: Stochastic Modelling of Natural Gas Consumption

| Ahmet Goncu

Programme category: The Natural Science Foundation of the Jiangsu Higher Education Institutions of China - General Programme

Introduction:

This research focuses on stochastic modeling of natural gas consumption and energy prices.

We completed the required research of the entire project and published the results in four journal articles. The main research results are described below.

The first part of the research is the article entitled A New Logistic Model to Estimate the Seasonal And Annual Consumption of Natural Gas, published in the journal Research in Applied Economics. In this article, we analyze and compare different natural gas consumption estimation methods. The second article is Effective Simulation of Multi-factor Dynamic Volatility Models. We have improved the way that the model Carlo model method is applied to simulate dynamic fluctuation models. Although this paper does not analyze the data of stochastic modeling of natural gas consumption, this method can be applied to stochastic modeling of natural gas consumption. The third article is entitled Modeling the Long-term Seasonal Volatility of Electricity Prices in Turkey. This article analyzes the fluctuations of electricity prices. Practice has shown that: electricity prices are subject to strong volatility. Therefore, we apply different stochastic modeling methods to explain the characteristics of the data. Finally, the fourth article is entitled Estimating the Temperature Sensitivity of Weather Derivatives. We derive an estimate of the sensitivity of the Monte Carlo simulation of weather option contracts. In fact, these complete contracts have similar characteristics to futures contracts based on natural gas consumption and other energy derivatives.

In summary, the preceding four papers demonstrates the feasibility of using stochastic modeling to estimate natural gas consumption. Moreover, Monte Carlo simulation is a very important part of the stochastic modeling of natural gas consumption. In terms of method improvement, we show that Monte Carlo simulation can be effectively used to price derivatives based on non-tradable indexes. For example, weather derivatives can be priced using Monte Carlo simulation. At the same time, we have also derived the sensitivity of energy derivatives, which is very important for risk management in energy derivatives. We believe that these results have far-reaching implications for academic research.

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
[1]	SCI	Efficient Simulation of a Multi-factor Stochastic Volatility Model	Göncü, Ahmet, and Giray Ökten	Journal of Computational and Applied Mathematics	2013
[2]	SSCI	Estimating Sensitivities of Temperature-Based Weather Derivatives	Yuan, Wei, Ahmet Göncü, and Giray Ökten	Applied Economics	2015

Project 2: Fast Modeling and Calculation for Heterogeneous Big Data Based on Incomplete Information Splitting

| Shengxin Zhu

Technical fields: Fundamental Discipline - Mathematics

Programme category: Jiangsu Science and Technology Programme - Basic Research Plan (Natural Science Foundation) - General Programme

Introduction: With the proliferation of data in biological breeding, medical experiments, ecological evolution, multi-source perception, search engines, social networks, credit risk control, advertising recommendation and other applications, the bottleneck of computational efficiency in analyzing massive data of traditional statistical models was highlighted, and the demand for scalable algorithms for correlation analysis was increasing day by day. These new application scenarios and the accumulation of massive data brought new challenges and broad research opportunities to association analysis. Unstructured data analysis has become one of the important problems to be solved in the development of emerging industries in the 13th Five-Year Plan strategy of our country. Therefore, we put forward this frontier applied basic research project. Through the in-depth research of this project, we hope to establish a new model of association analysis of the most heterogeneous data in the sea, develop the theoretical basis of corresponding mathematical statistical analysis, and design efficient and fast algorithms so as to develop an algorithm platform that can support the association analysis of massive heterogeneous data. Through this project, a large number of heterogeneous data analysis talents will be trained to meet the market demand, and enhance the research level and international influence of our school team in this frontier project.

In this project, several efficient modeling and calculation methods for unstructured data analysis were researched. We combined the linear hybrid model, knowledge map and heterogeneous network, and researched some algorithms that can be applied to intelligent recommendation system. These results can be used for user portrait analysis and accurate advertisement recommendation. In addition, we also researched some unstructured analysis methods based on graph matching, which have potential application value.

Key issues solved:

We gave important core mathematical formulas for linear mixed model calculation, and formed a summary scientific and technological report. In particular, we solved two key computational issues.

1. Calculation of the first information matrix. The computation of information matrix is huge, and the scalability of this kind of method is seriously limited by using information matrix directly. We proposed a computational method based on average information splitting, which can reduce the computational complexity of information matrix elements from multiple matrices to the product of a few matrix vectors. The calculation amount was effectively reduced and the calculation performance was improved. The results have been published in Mathematical Foundations of Computing.

2. We gave a fast calculation method for calculating the logarithm of matrix determinant. The logarithm of matrix determinant appeared in the maximum likelihood objective function. For the high latitude issue, the calculation amount of this term was particularly large. By using the technique of sparse matrix and the technique of changing equivalent matrix, we skillfully transformed the high-dimensional computation issue into a lower-dimensional computation, which greatly improved the computational performance of sparse matrix determinant logarithm. We have formed a high-quality manuscript with this achievement.

In terms of application framework level:

1. We proposed a hybrid framework of linear hybrid model, knowledge map and heterogeneous neural network, which solved the effective coupling problem between parametric model learning and nonparametric model learning. The achievements in this direction have been published in IEEE ACCESS, ACMICMLC2019 and IEEE-ICBDA2019.

2. The first basic step in the promotion and precision marketing of modern online advertising was to understand preferences of customers. In the data-centric era, user portrait recommendation relies more and more on mining and accumulating more and more and often anonymous (protected) data. Personalized profiles (preferences) for

anonymous users can even be recovered through certain data technologies. The purpose of this research is to introduce some commonly used information retrieval technologies in recommendation systems and introduce the new trends of methods based on heterogeneous information networks and knowledge graphs. Business developers can gain insight into what type of data to collect and how to store and manage it so that they can make better decisions after analyzing the data and extracting the required information. We published the modeling and analysis methods of common user portrait features in a chapter of the book series of Springer Nature.

3. The purpose of popular application of personalized recommendation model is to seek targeted advertising strategies for business development and providing personalized suggestions about products or services to customers according to their personal experience. Conventional methods of recommendation systems, such as collaborative filtering (CF), use direct user ratings without considering potential functionality. To overcome this limitation, we developed a recommendation strategy based on the so-called heterogeneous information network. This approach can merge two or more source data sets, revealing more potential associations/functionality between projects. Compared with the well-known 'k nearest neighbor' model and 'singular value decomposition' method, this new method produced higher accuracy under the commonly used measured values (average absolute deviation). The results were published in a chapter in the book series of Springer Nature.

4. For some defects of linear mixed model, we combined singular value decomposition model. We compared the average absolute errors of LMM and SVD given different numbers of historical ratings. Then, a hybrid recommendation system was developed to combine these two models. Facts have proved that this system has higher accuracy than single LMM and SVD models. It may have practical value in different fields in the future. The results were published in a chapter in the book series of Springer Nature.

5. Many heterogeneous information networks can be represented by graphs. Project sets are the basic and common form of data. People can find hidden laws through pattern mining so as to obtain new insights about their business. In some practical applications, such as network alert associations, typically the project sets have the following two characteristics: (1) The observed samples come from different entities, and their inherent characteristics imply the inherent structural relationship. (2) Samples are scarce, which may lead to incomplete pattern extraction. In this paper, how to find a concise pattern for this kind of data effectively was considered. First, we used graphs to represent entities and their interconnections, and propagated the nodes with weights for each sample to each node. The weight was determined by a predefined combination of kernel functions based on node and schema similarity. Next, the weight values can naturally be imported into the MDL-based filtering process, bringing a different set of patterns for each node. Experiments indicate that the performance of this solution is better than that of global solution (all nodes are regarded as one node) and isolated solution (all edges are removed) on simulated and real data, and its effectiveness and scalability can be further verified and maintained in large-scale network operations and applications. The results were published in the top journal Neurocomputing.

6. Reusing and modifying experimental pictures in scientific and technological publications is a serious academic misconduct, which should be better discovered in the review process. However, due to the large number of submissions, it is laborious for reviewers to detect whether images are forged or reused, and sometimes it is impossible for human eyes to recognize them. Tools for detecting similarities between images may help alleviate this issue. Some methods based on local feature point matching play a role in most of the time. However, these methods may lead to confusion in matching due to insufficient understanding of the global relationship between features. We provided a framework for using graph matching technology to detect similar or forged pictures. A new iterative method was proposed. Experiments indicated that in some cases, this graph matching technique was superior to the graph matching technique based only on local features. The work has been published. The results have been published at the IEEE-APIT2020 conference.

Research achievements:

1) Patents

No.	Category	Status	Patents Title	Application no.	Inventor(s)
(1)	发明	申请	基于图匹配的图像匹配方法、系统及存储介质	CN202010036611.7	申槟瑞，朱圣鑫，牛强，马飞

2) Copyright

No.	Category	Title	Author(s)
(1)	Book Chapter	Personalized Recommender Systems with Multi-source Data	Y. Wang, T. Wu, F. Ma, S. Zhu

3) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Knowledge discovery and recommendation with linear mixed model	Z Chen, 朱圣鑫，牛强，T Zuo	IEEE Access	2020
(2)	SCI	Mining concise patterns on graph-connected itemsets	Di Zhang, Yunquan Zhang, 牛强，Xingbao Qiu	Neurocomputing	2019
(3)	SCI	Stabilized dimensional factorization preconditioner for solving incompressible Navier–Stokes equations	Laura Grigori, Qiang Niu, Yingxiang Xu	Applied Numerical Mathematics	2019
(4)	EI	A hybrid recommender system combing singular value decomposition and linear mixed model	T. Zuo, S. Zhu, J. Lu	Intelligent Computing	2020
(5)	EI	Profile Inference from Heterogeneous Data – Fundamental and New Trends	Xin Lu, Shengxin Zhu, Qiang Niu, Zhiyi Chen	BIS	2019
(6)	EI	Modeling the Cashflow Management of Bike Sharing Industry	Binrui Shen, Yu Shan, Yunyu Jia, Dejun Xie, Shengxin Zhu	BIS	2019
(7)	EI	Detecting Anomalies in Communication Packet Streams	Di Zhang, Qiang Niu, and Xingbao Qiu	14th WASA	2019
(8)	EI	Symmetric Sweeping Algorithms for Overlaps of Quadrilateral Meshes of the Same Connectivity	Xihua Xu, Shengxin Zhu	ICCS (3) 2018	2018
(9)	EI	Fabricated Pictures Detection with Graph Matching	B. Shen, Q. Niu and S. Zhu	ACM, APIT 2020	2020
(10)	EI	Fast Sparse Kernel Summation on Cartesian Grids: an on-chip algorithm for 3D implicit surface visualization	S. Zhu, A. Wathen	ACM2019	2019

[11]	EI	Censorious Young: Knowledge Discovery from high-throughput movie rating data with LME4	Zhiyu Chen, Shengxin Zhu, Qiang Niu and Xin Lu	IEEE ICBDA2019	2019
[12]	EI	Learning with linear mixed model for group recommendation systems	Baode Gao, Guangpeng Zhan, Hanzhang Wang, Yiming Wang, and Shengxin Zhu	ICMLC2019	2019

Project 3: Modeling Real Estate Bubbles/Anti-Bubbles in China: Multi-Dimensional Log-Periodic Power Law Model

| Lu Zong

Technical fields: Fundamental Discipline - Mathematics

Programme category: Jiangsu Science and Technology Programme - Basic Research Plan (Natural Science Foundation) – Young-Scholar Programme

Introduction: The purpose of this project is to research the current situation of bubble in China's real estate market, build a multi-factor dynamic model based on multi-dimensional logarithmic periodic offering law for housing prices in various cities in China, and achieve the purpose of predicting the critical point of bubble and anti-bubble in China's real estate market through model revision and teaching research supported by data. Learning and early warning of bubbles and anti-bubbles in China's real estate market can assist the decision-making process of participants in the real estate market and even financial market, and they also provided reference for developing the normative policies to maintain the stability and effectiveness of China's financial market.

The implementation of the project started from macro and micro perspectives. First, through the micro-big data modeling of urban spatial housing prices represented by Beijing, the purpose of this research is to mine and interpret the regional spatial dynamics, and determine a reliable regional housing price trend prediction mechanism through model comparison so as to better understand the evolution of domestic real estate market. Second, this research constructed a hybrid model of risk triggering and transmission mechanism between real estate market and other markets including stock market, bond market and foreign exchange market from a macro perspective, and compared it with the risk mechanism of related markets in the United States. Through the research, it was found that the U.S. financial markets seem to be facing greater systemic risks because of their contagious system. While the boom in China's property market over the past decade seems to have provided a safeguard for Chinese investors, the exchange rate risk appears to have played a more prominent role in the evolution of the Chinese market and cross-industry cooperation is larger, which is an important link between China's financial system and the global market.

Keywords: Multi-Dimensional Log-Periodic Power law, Critical Time of Real Estate Bubbles

Key issues solved:

1. Modeling the big data of second-hand houses in Beijing in time and space through various deep learning (integration) models, and mining the leading factors of urban housing prices.
2. Through SWARCH model, EVT model and R-vine copulas model, the crisis transmission effect between the four major markets of stock and debt exchange housing in China and the United States was analyzed.
3. A financial market early warning system based on SWARCH model and deep learning was constructed, which can not only be used to predict the crisis of the single market of stocks and bonds, but also infer the fragility of the financial system.

Research achievements:

1) Patents

No.	Category	Status	Patents Title	Application no.	Inventor(s)
[1]	发明	申请	一种新闻特征向量的构建方法及应用	CN201910397143.3	宗璐，马晔
[2]	发明	申请	基于注意力分布已知的抽象式神经网络生成摘要的方法	CN2020010610681.9	马晔，宗璐
[3]	发明	申请	基于多文本利用分阶层 Transformer 生成摘要的方法及系统	CN201910609274.6	马晔，宗璐

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SSCI	Contagion effects and risk transmission channels in the housing, stock, interest rate and currency markets: An Empirical Study in China and the US	王珮琬，宗璐	The North American Journal of Economics and Finance	2019
(2)	SCI	An integrated early warning system for stock market turbulence	王珮琬，宗璐，马晔	Expert Systems with Applications	2020
(3)	EI	Predicting Chinese Bond Market Turbulences: Attention-BiLSTM based Early Warning System	王珮琬，宗璐，杨雨润	2nd conference on Big Data Engineering 2020	2020.5.29-2020.5.31
(4)	EI	Spatial Prediction of Housing Prices in Beijing Using Machine Learning Algorithms	闫梓越，宗璐	3rd International Conference on Big Data and Artificial Intelligence(BDAI 2020)	2020.7.3-2020.7.6
(5)	EI	News2vec: News network embedding with subnode information	马晔，宗璐，杨奕康，苏炯龙	Proceedings of the 2019 Conference on Empirical Methods in Natural Language Processing and the 9th International Joint Conference on Natural Language Processing (EMNLP-IJCNLP)	2019.11

Project 4: Regularization Method for Image Restoration

| **Haixia Liang**

Technical fields: Fundamental Discipline - Mathematics

Programme category: Jiangsu Science and Technology Programme - Basic Research Plan (Natural Science Foundation) – Young-Scholar Programme

Introduction: The purpose of this project is to research the application of variational model based on fractional derivative in image processing, and to improve the regularity term of variational model in order to improve the accuracy of reconstructed image as much as possible. The objective product of this project is to construct three variational model solving methods based on fractional derivative. First, the truncation method of fractional derivative operator was researched, and a truncated fractional variational model was proposed and applied to image reconstruction. Second, the dual algorithm of truncated fractional variational model was research, the convergence of the method was explored and the convergence conditions were given. Third, a non-local fractional variational model was constructed and applied to high texture image reconstruction to improve the accuracy of high texture image reconstruction. The application of variational model in other image issues was explored, such as CT image reconstruction and MRI image reconstruction.

Under the support of this project, four related tasks have been completed:

1. The truncated fractional variational model was successfully constructed to deal with image reconstruction, complete related work and publish an article.
2. The dual algorithm of truncated fractional variational model was deduced and applied to the problem of image desiccation, the convergence of the algorithm was analyzed, the convergence conditions were given, the related work was completed and received and published online.
3. The truncated fractional derivative was combined with LLT model, and a nonlocal variational model was constructed, which has been completed and is being revised.
4. The adaptive variational model was completed and applied to CT reconstruction, and the article has been published.

Keywords: Reize Fractional Derivative Regularization Method, Image Restroation

Key issues solved:

1. The correction test of fractional derivative operator and a suitable truncated correction method was proposed, and a truncated fractional variational model was proposed. The ADMM algorithm and dual algorithm of the model were researched, the convergence of the algorithms was analyzed, and the effectiveness of the algorithms was tested.
2. The construction of nonlocal fractional variational model combined fractional derivative and LLT model effectively to construct nonlocal fractional variational model.
3. A fast solution algorithm was proposed to derive the ADMM algorithm for solving nonlocal fractional variational model, which was numerically implemented in MATLAB. The core and most difficult point of this issue is to construct the kernel of the coefficient matrix of the core linear equation so that the equations can be solved directly by fast Fourier transform.

Research achievements:

1） Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Dual Algorithm for Truncated Fractional Variation Based Image Denoising	Haixia Liang, Juli Zhang	International Journal of Computer Mathematics	2019

Project 5: Matrix Group Actions on Manifolds

｜ Shengkui Ye

Technical fields: Fundamental Discipline - Mathematics

Programme category: Jiangsu Science and Technology Programme - Basic Research Plan (Natural Science Foundation) – Young-Scholar Programme

Introduction: Matrix and manifold are the basic research objects of mathematics. In this project, the homeomorphism of matrix groups on manifolds was researched. By characterizing the convective symmetry, we got a series of results: When a manifold is a product of spheres, a flat manifold (a manifold with a curvature of 0), and an orientable manifold whose Euler indicative number is not divisible by 6, we proved that the function of a matrix group on a low-dimensional manifold can only be trivial. For general sphereless manifolds, we gave a sufficient condition that group actions were trivial actions. By using this condition, we proved that when holonomy groups were special, the action of matrix groups on low-dimensional almost flat manifolds can only be trivial. This proved the Zimmer conjecture of these manifolds.

Keywords: Group Actions, Matrix Group, Low Dimensional Manifold

Key issues solved: Zimmer's conjecture was proved for the following cases (below, we always assumed that the dimension of manifold M was less than n-1):

1. When the manifold M is the product of spheres, the special linear group G=SL (n, Z) was trivial.
2. When the manifold M was a flat manifold, all the group G=SL (n, Z) actions were trivial.
3. When M was a spherical manifold, we gave a sufficient condition for trivial G action. By using this condition, we proved Zimmer's conjecture for manifold M whose basic group was nilpotent group and almost flat manifold M with special basic group.
4. When the Euler indicative number of orientable manifold M cannot be divisible by 6, we proved Zimmer's conjecture.

Research achievements:

1） Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Vanishing of L2-Betti numbers and failure of acylindrical hyperbolicity of matrix groups over rings	Feng Ji and Shengkui Ye	Algebraic & Geometric Topology	2017
(2)	SCI	Euler characteristics and actions of automorphism groups of free groups	Shengkui Ye	Algebraic & Geometric Topology	2017

Project 6: Weakly Sharp Solutions of Variational Inequalities

｜ Yina Liu

Technical fields: Mathematical Optimization and Its Application in Engineering

Programme category: The Natural Science Foundation of the Jiangsu Higher Education Institutions of China - General Programme

Introduction: In this project, two kinds of gap functions were used as research tools to solve the weak sharp solutions of variational inequalities, and the iterative algorithms with finite step convergence were also discussed. In addition, the application research of mathematical optimization issues in energy engineering has also been launched.

Keywords: Variational Inequality, Gap Function, Convergence Algorithm, Mathematical Optimization, Energy Collection

Key issues solved:

In this project, the primitive gap function G and the dual gap function G were used to research the weakly sharp solutions of variational inequalities under more general conditions, and an iterative algorithm with finite step convergence was introduced. The differentiability and continuity of primitive gap function and dual gap function were discussed, and the special properties of thousand functions on some special sets were also discussed accordingly.

This project focused on the important properties of the original clearance function and the dual clearance function and the profound relationship between the two functions, and on this basis, a new clearance function with better quality was researched. Under certain conditions, the existence of error bounds of primitive gap function and dual gap function was equivalent to the weak sharpness of solutions of variational inequalities. Under similar conditions, the equivalence between the existence of error bounds of the new gap function with better quality and the weak sharpness of variational inequalities was also verified. In addition, the advantages of different gap functions in solving issues was also described in detail. Under the condition that the variational inequalities have weakly sharp solutions, the iterative algorithms with finite step convergence were also discussed. This kind of algorithm has important application value in finance, engineering and other many disciplines. On the basis of the above theoretical conclusions, an important application of a class of optimization issue was put forward in this project. For example, on the basis of the optimization algorithm, a series of engineering application issue have been carried out, including the energy collection of nano-generators, which effectively realized the application of the algorithm in efficiently collecting blue energy such as sea wave energy, wearable devices of nano-generators, self-driven sensors and self-powered systems.

Research achievements:

1） Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Weakly sharp solutions and finite convergence of algorithms for a variational inequality, problem	Y. Liu	Optimization	2018.2.1
(2)	SCI	Atmospheric Pressure Difference Driven Triboelectric Nanogenerator for Efficiently Harvesting Ocean Wave Energy	P. Cheng, Y. Liu, Z. Wen, H. Shao, A. Wei, X. Xie, C. Chen, Y. Yang, M. Peng, Q. Zhuo and X. Sun	Nano Energy	2018.10.11

[3]	SCI	Triboelectric-Electromagnetic Hybrid Generator for Harvesting Blue Energy	H. Shao, P. Cheng, R. Chen, L. Xie, N. Sun, Q. Shen, X. Chen, Q. Zhu, Y. Zhang, Y. Liu, Z. Wen and X. Sun	Nano-micro Letters	2018.5.29
[4]	SCI	A Wrinkled PEDOT: PSS Film Based Stretchable and Transparent Triboelectric Nanogenerator for Wearable Energy Harvesters and Active Motion Sensors	Z. Wen, Y. Yang, N. Sun, G. Li, Y. Liu, C. Chen, J. Shi, L. Xie, H. Jiang, D. Bao, Q. Zhuo and X. Sun	Advanced Functional Materials	2018.7.27
[5]	SCI	Atmospheric Pressure Difference Driven Triboelectric Nanogenerator for Efficiently Harvesting Ocean Wave Energy	P. Cheng, Y. Liu, Z. Wen, H. Shao, A. Wei, X. Xie, C. Chen, Y. Yang, M. Peng, Q. Zhuo amd X. Sun	Nano Energy	2018.2.3

Project 7: Complex Analysis and Integrable Hamiltonian Systems

| Konstantinos Efstathiou

Programme category: The Natural Science Foundation of the Jiangsu Higher Education Institutions of China - General Programme

Key issues solved:

The main contribution of this project was that we have successfully summed up a unified method for dealing with various single-valued integrable Hamiltonian systems. Moreover, we proved a very direct method for calculating the monodromy of this kind of system. Under the action of a circle, the points with nontrivial stable subgroups were all isolated fixed points. We proved that the monodromy was determined by the Chern class of the main circle bundle around these fixed points. Because in this case, the circle is the Hopf fibration, we can effectively calculate its influence on the monodromy. This conclusion can also be applied to the case of 'island monodromy' which cannot be dealt with directly before: In this case, the monodromy can also be determined by the fixed point under the action of the circle. This result is significant because it indicates that the circle action in integrable Hamiltonian system is the key to the monodromy, and it also indicates that it is not necessary to focus on all kinds of details of the whole system when determining the monodromy of integrable Hamiltonian system in the future. The research results, titled 'Monodromy of Hamiltonian Systems with Complexity 1 Torus Actions' (in cooperation with N. Martynchuk), were published by SCI journal Geometry and Physics in May 2017. This idea was also applied to single-valued Hamiltonian functions such as 'fractional monodromy' and 'bidromy', and can be applied to more general types that could not be handled by previous methods. The main improvement here was to consider the parallel movement of homological circumference along Seifert manifold. This enabled us to give a unified geometric definition to the monodromy of general Hamiltonian function, and verified that it only depends on the fixed point under the action of circle. Different from the previous article, we also considered the existence of points with nontrivial stable subgroups. Additionally, instead of considering torus as a structural group for standard single-valued problems or island monodromy issues, we considered more general fibrosis: fibers may not even be connected as in bidromy and some fractional monodromy cases, and the related results of this study are being compiled. The last result was about the influence of the number of rotations on the calculation of monodromy near focus-focus singular points in integrable Hamiltonian systems. In this case, we found that the best way to solve this issue is to define a 'rotation 1-form', that is, the rotation number can be obtained by integrating along the trajectory of Hamiltonian vector field. That is, 'rotation 1-form' must be isolated within the pole set. In some specific applications, this pole set is a two-dimensional manifold. Next, we found that for a given monodromy near focus-focus point, the change of rotation number can be calculated by integrating rotation 1-form near the pole. This is very similar to the situation used to calculate the change of rotation number in complex analysis: The change of rotation number was given by the residue of meromorphic function at pole. This established a close relationship between the standard method and the method of calculating monodromy by rotation number and related complex analysis knowledge. The related results of this research, titled 'Rotation Forms and Local Hamiltonian Monodromy' (in cooperation with A. Giacobbe, P. Mardesic, D. Sugny), were published in the Journal of Mathematical Physics in February 2017.

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
[1]	SCI	Monodromy of Hamiltonian Systems with Complexity 1 Torus Actions	Efstathiou, Konstantinos and Martynchuk, Nikolay	Journal of Geometry and Physics	2017.5
[2]	SCI	Rotation Forms and Local Hamiltonian Monodromy	Efstathiou, K., Giacobbe, A., Mardešić, P., & Sugny, D.	Journal of Mathematical Physics	2017.2

3. Municipal Projects

Project 1: The Building of Financial Computing Service Public Platform

| Lianfeng Liu

Technical field: Computational Mathematics

Introduction: Mathematical financial computing service platform is an exploratory scientific research and practice work completed under the support of Suzhou Industrial Park Guiding Funds. Mathematical financial computing includes securities, futures, options and other computing of derivatives, financial time series data analysis, computing of fixed income securities, portfolio computing, research on financial data visualization, and research on financial mathematics and financial computing theory. The Mathematical Financial Computing Service Platform Project laid the foundation for the establishment of the Financial Mathematical Financial Computing Center.

Keywords: Computational Mathematics, Financial Mathematics, Financial Computing, Financial Derivatives

Key issues solved:

1. Financial derivative asset pricing (option futures) BLACK-SCHOLES pricing theory and application, research on pricing of various financial option futures, and asset model development.
2. Application and development of financial software products. Matlab, SAS, and EXCEL/VBA, SPSS, STATA, EViews, Matlab Financial Toolbox.
3. Enterprise financial strategy and capital analysis. Comprehensive risk analysis of assets (diversifiable risk and non-diversifiable risk); capital structure analysis; capital budget and dividend policy. Capital market analysis: market indicators and formation principles; analysis of the trend of domestic and international financial markets and Portfolio analysis. Financial statements and data analysis: financial analysis; operational efficiency analysis; cash flow analysis; financial analysis, and fixed income investment.
4. Financial and statistical data analysis. Matlab, SAS, and EXCEL/VBA were used to deal with financial statistics, investment management analysis, and risk management.
5. Short-term training for financial enterprises. Mathematical theory of financial option futures; training in software use in financial field.

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI	Volatility Analysis for Chinese Stock Market Using GARCH Type Models	Zehua Yin, Lei Zhang, and David Liu	International Institute of Statistics & Management Engineering Symposium	2010
(2)	EI	China Stock Market Regimes Prediction with Artificial Neural Network and Markov Regime Switching	David Liu, Lei Zhang	2010 World Congress on Financial Engineering,	2010
(3)	EI	Option Pricing by Using Markov Regime Switching and Artificial Neural Network	Lei Zhang, David Liu	Quantitative Methods in Finance (QMF) Conference	2010
(4)	EI	Improved Prediction of Financial Market Cycles with Artificial Neural Network and Markov Regime Switching	David Liu, Lei Zhang	Electrical Engineering and Applied Computing, edited by Sio-Iong Ao and Len Gelman. Springer Publisher, London	2010
(5)	EI	Volatility Analysis for Chinese Stock Market Using GARCH Type Models	Zehua Yin, Lei Zhang, and David Liu	Data Processing and Quantitative Economy Modelling, edited by Konglai Zhu and Henry Zhang. Aussino Academic Publishing House, Australia	2010
(6)	EI	Calibration of Heston Volatility Model using Simulated Annealing Algorithm	Lin Wang, Lei Zhang, David Liu	Quantitative & Technical Economics Research	2011
(7)	EI	Pricing Chinese warrants using artificial neural networks coupled with Markov regime switching model	David Liu and Lei Zhang	Int. J. Financial Markets and Derivatives	2011
(8)	EI	Study on Model Free Implied Volatility of Hang Seng Index Options	David Liu, Lin Ran, and Lei Zhang	International Journal of Mathematics in Operational Research	2012
(9)	EI	Study on Hybrid Artificial Neural Network Models for HK Index Options during Financial Crisis	David Liu and Siyuan Huang	The 3rd International Conference on Operations Research and Statistics	2013
(10)	EI	Real options valuation of international railway construction projects: a case study	David Liu, Xiao Chen	Int. J. Business Continuity and Risk Management	2014
(11)	SCI	Particle-scale modelling of financial price dynamics	David Liu	Communication in Nonlinear Science and Numerical Simulation	2017

Project 2: AI (Artificial-Intelligence)-Oriented Trading, Risk Management and Fund Allocation (FoF) in China's Futures/Options Markets

| Qiuyu Chen

Programme category: Key Programme Special Fund (KSF) – Applied Technology Research Programme

Introduction:

Although China's futures and options market is an emerging market, it is in a period of rapid development. The number of listed varieties on the four major exchanges is growing rapidly, and its expansion trend is expected to continue in the future, and the number and volume of investors in the market are also growing rapidly. Thus, it is extremely important to research futures and options trading strategies and risk control technologies and further provide investors with more systematic allocation tools at the asset allocation level. On this basis, our research objective is to use artificial intelligence method to predict the returns and risks of China's futures/options market and build a portfolio, and to develop intelligent allocation of funds in funds. As a result of this project, we provided integrated solutions based on artificial intelligence for asset management and financial services companies to answer what is the optimal trading strategy, what is the best method to quantify risk control, and how to make optimal fund allocation in different markets.

First, we used XGboost method in machine learning to rank the importance of many features of the research object, so as to know which features have important influence on the research purpose. Second, we used the machine learning method support vector machine (SVM) to select the best investment varieties, so as to construct the buying and selling portfolio and evaluate the performance of the portfolio. The results indicated that the training accuracy was very high and the benefits are considerable. Third, in order to consider the time dependence of financial time series, we used the Long Short-term Memory Networks (LSTM) model for further training and prediction. The training results indicated that the multi-layer stack LSTM has great effect, and the prediction results indicated that its results have strong ability to generalize to new data. On the basis of this prediction, we used the co-integration method to construct the portfolio of paired transactions, and the results indicated that the returns were stable and the risks were within a reasonable range. On the basis of futures/options products mentioned above, the strategic allocation of trading such products (funds), that is, the allocation of funds in funds (FoF) was further researched. This part covers two aspects. First, the efficiency of fund allocation depends on the basic work of the fund, including fund performance and risk evaluation, fund trading strategy identification, fund performance and strategy indexation. This part focused on the artificial intelligence algorithm implementation system of fund evaluation, screening and combination construction. Second, according to the strategic characteristics of fund portfolio, the performance optimization and risk management of portfolio were carried out. This part focused on the performance optimization and risk control of FoF fund portfolio artificial intelligence algorithm and its implementation. Through the above research, the strategy types of CTA funds were identified, the CTA fund strategy index was put forward, and different types of CTA hedge funds were allocated at the strategic level, which further enriched the investment targets of investors and optimized the performance of CTA portfolio funds to the greatest extent.

Keywords: Futures, Option, Artificial Intelligence, Risk Control, FoF

Key issues solved:

The key issues solved in this project are as follows:

1. The data structure of futures/options is significantly different from that of stocks. Thus, how to construct continuous big data time series of futures/options has become a key. In this process, we did not directly use the data provided by the data provider, but prepared our own program to clean and process the data.

2. How to give the optimal weight distribution to the data predicted by artificial intelligence is a key technical issue. To solve this issue, we used multi-layer fully connected neural network and multi-layer stack SLTM to deepen the depth of network learning, so as to obtain the optimal weight parameter estimation.

3. Due to the poor quality of information disclosure of related (option/futures) fund products in China, how to obtain high-

quality fund data is the key to this research. To solve this issue, we adopted the basic strategy of cross-calibration through the basic information level of the original fund data, and then revised the original fund net value data provided by various data service providers.

4. As this part of the research focused on the allocation of funds at the strategic level, how to obtain complete and consistent trading strategy information of funds was also the key issue of this project. Currently, many fund information provided by data service providers is lack of strategic information, and there are inconsistent issues. For this part of the issue, in the research process, we used cross-validation and research and development based on queuing matching algorithm to solve the issue.

The difficulty of this research lies in the selection of performance evaluation index and algorithm framework of combination configuration. Based on the unified evaluation index, the research on the optimal allocation algorithm of fund portfolio will be the main objective of this research. In view of this issue, first we used the relative alpha as a single strategy to measure the performance of each fund indicators. On this basis, the objective programming algorithm with polynomial based on the fourth-order moment method was further developed to realize the optimal allocation of portfolio funds, and the setting of fund rates was discussed.

Research achievements:

10 research reports were formulated.

Architecture

China's construction industry has a huge output value. In 2020, the annual revenue of the Chinese construction industry has reached 721,959 million dollars and Chinese construction companies have undertaken top 5 of the global Top 100 construction companies. The research achievements of XJTLU in the field of Construction mainly come from the experts and scholars of the School of Design, among which the research expertise of architecture, architectural engineering, civil engineering and industrial design have gained international validations and accreditations by leading professional institutions. By the end of 2020, XJTLU had successfully completed 6 government research projects at all levels in this field, including 3 national, and 3 provincial projects.

1.National Projects

Project 1: Effects of Permeability Properties of the Repair Material on the Formation of Macro-Cell Corrosion in Repaired Concrete Members

| Ominda Prasad Nanayakkara Wasam Mayakaduwage

Application code: E080511 (Department of Engineering and Materials Sciences)

Programme category: National Natural Science Foundation of China (NSFC) -International Young Scientists Programme

Introduction: The repairing in reinforced concrete itself creates a non-uniform environmental condition around the steel bar induced by the substrate material and new repair material. Therefore, an electrochemical instability is generated on the steel bar. The mechanism of prevailing corrosion process after patch repairing depends on the physical, chemical and electrochemical properties of the repair material. It has been understood that a denser and less permeable repair material is highly effective in reducing further corrosion. However, its theoretical understanding in relation to the difference of permeability properties between the concrete and repair, which is equally important to develop more effective methods and to monitor the after-repair corrosion, is not well established. The aim of this research study is to investigate the prevailing mechanism of reinforcement corrosion after the repair is carried out considering only the permeability properties of repair material.

The aim is initially achieved by a modelling approach using commercially available finite element analysis software, COMSOL Multiphysics. A preliminary laboratory experimental work has been carried out to investigate the macro-cell current flow between original concrete and the repair material and the concrete specimen size of 150mm x 150mm x 150mm were used. This experimental work has been set to pre-verify the modelling work carried out by finite element analysis method. The modelling work is to be further improved and enhanced by introducing concrete permeability properties which are to be measured using the commercially available AUTOCLAM permeation system which can measure the air and water permeability and water absorption by the surface concrete of specimens. These experimental data are used as input to the modelling work and further verified by measuring macro-cell corrosion current. A specimen size of 75mm x 75mm x 250mm is to be used for the purpose of measuring macro-cell corrosion current together with half-cell potential. These specimens are also to be used for visual observations to investigate the actual corrosion deposits, actively corroded locations and hence to compare with externally measured macro-cell corrosion currents and half-cell potentials.

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI	Macrocell Corrosion Formation in Concrete Patch Repairs - A Laboratory Study	Eldho C.A.; Nanayakkara, O.; Xia, J.; Jones, S.W.;	Key Engineering Materials	2016
(2)	EI	Performance of concrete patch repairs – From a durability point of view	Eldho C.A.; Jones S.; Xia, J.; Nanayakkara, O.;	5th International Conference on Durability of Concrete Structures	2016

Project 2: Influence of Semi-Rigid Connections on the Overall Structural Stability of Precast Concrete Frame Structures

| Charles Kwet Shin LOO CHIN MOY

Application code: E080501 (Department of Engineering and Materials Sciences)

Technical field: Design Consideration of Precast Reinforced Concrete Structures

Programme category: National Natural Science Foundation of China (NSFC)-International Young Scientists Programme

Introduction: Precast concrete connections are crucial when analysing the overall stability of the structure. More precisely, the beam to column connection is the determining factor to ensure proper analysis of the frame structure. These are often defined as semi-rigid since they provide some rigidity but not enough to be considered rigid. To be on the safe side, designers often considers the joints as either pinned or utilise steel connections principle to design the connections. The aim of this work was to provide a benchmark based on full-scale experiments with which designers can refer to judge the principle to be adopted when designing precast concrete connections.

Hence, a set of full scale experiment were designed and tested under cyclic loading following recommendations from ACI-ASCE 352 (2002). The joint type selected was a traditional bolted beam to column supported vertically on a rectangular hollow section embedded inside the column. The variants for the test samples were the strengthening of the joints with basalt fibre reinforced polymer, steel angle cleats, continuous main reinforcement inside the column and the presence of concrete slabs. The results gave a good understanding of the influence of the different variants on the stiffness, rigidity and ductility of the joints. A deeper understanding of localised effects of the connection was investigated using finite element modelling. A good comparison could be made between the experiment results and the numerical results.

Keywords: Precast Concrete, Semi-Rigid Connection, Stability, Moment-Rotation, Stiffness

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	Performance of corroded reinforced concrete beams in flexure strengthened using different basalt fiber textile-reinforced mortar schemes	S. Oluwadahunsi, C.K.S. Moy	Journal of Composites for Construction	2020

Project 3: Western Origins of Chinese Modern Industrial Buildings and the Localization Process-Case study of Textile Mills in Jiangsu and Shanghai Area

| Yiping Dong

Application code: E080102 (Department of Engineering and Materials Sciences)

Technical fields: Architectural History Theory, Architectural Heritage Protection

Programme category: National Natural Science Foundation of China (NSFC) - Young Scientists Fund

Introduction: With the emphasis on the protection of industrial heritage, a large number of modern industrial buildings have been listed as protection objects by Government Departments at all levels in recent years. In view of the limited research on the construction and development history of production space involved in the current industrial heritage research, in the protection practice with 'Adaptive Reuse' as the core in China, misreading of value elements often occurs, and the indifference or even damage of 'Inappropriate Reuse' to value elements is an urgent problem to be solved in industrial heritage research.

Industrial architecture research is the basis of scientific evaluation of the historical value and proper reuse of industrial architecture heritage, and it also needs interdisciplinary vision and methods and solid, in-depth historical data support. From the perspective of technical history of industrial architectural heritage, this research studies the construction practice and development process of modern textile buildings by combining archival historical materials with empirical evidence, and makes up for the missing part in historical value evaluation.

By focusing on the historical source of modern Chinese industrial buildings and the process of technology transfer, taking the remains of cotton spinning buildings in Jiangsu and Shanghai as research samples and referring to the examples of early textile architecture heritage in Europe, America and Japan, in this research, the specific technical development path of textile architecture construction and design was analyzed, and the process and path of technology transfer of modern civil industrial buildings represented by textile architecture from the West to China were clarified.

The primary findings are as follows:

1. Textile industrial buildings in modern China began in Shanghai. With the entry of foreign capital and the development of national industry and commerce, textile industry gradually penetrated into cities along the Grand Canal or the Yangtze River.
2. Due to the transportation demand of raw materials and finished products, the selection of early factory were close to the bank.
3. The sources of textile architecture in modern China were diverse, and the construction of specific buildings was related to the capital sources of factories.
4. The design of modern textile architecture has experienced the gradual localization process from Western craftsmen to proofing design and to architectural firms. However, the layout of all kinds of textile machinery was provided by overseas machinery suppliers in the early stage and trained by local professional engineers in the later stage. The construction was bid by the local "Shui Mu Zuo" craftsman in the early days, and gradually developed into a professional construction factory bidding.
5. From the perspective of the development of building technology, the textile industrial buildings in modern China have experienced a process from the early multi-storey brick-wood structure to the single-storey factory building with brick-concrete structure, steel structure frame analysis and reinforced concrete structure, and then to the mixing of reinforced concrete multi-storey factory building and single-storey factory building, of which, zigzag single-storey factory building was the most important structural form.

Compared with the development process in the West, the development of industrial buildings in China has skipped the historical stage of fireproof structures with cast iron and brick vouchers.

Keywords: Industrial Architectural Heritage, Textile Architecture, History of Architectural Technology, Technology Transfer, Localization

Key issues solved:

The key issues solved in this research are as follows:

The international and domestic development of early textile industrial buildings presented space and path characteristics, and the introduction and localization course of modern Chinese textile buildings:

The construction of textile buildings in China between 1840 and 1949 indicated that the process of technology transfer presented the characteristics of multi-country. In this research, the spatial distribution characteristics of modern Chinese textile industry was marked through the visualization of data collation. The key time nodes and era context of the development of modern Chinese industrial buildings were clarified and their reasons were analyzed. Through the analysis of the elements of the historical value evaluation of modern textile buildings, it was clearly pointed out that the roof truss structure form is an important element to understand the development and rheology of textile buildings, and the selection of building materials and the way of material handover between truss and column are also recognizable and remarkable features of the changes of the times.

Research achievements:

1) Patents

No.	Category	Title	Author(s)
(1)	专著	工业建筑遗产的价值与观念演进	董一平
(2)	合著	中国工业遗产丛书 - 江苏卷	蒋楠、董一平等
(3)	译著	工业遗产的重组 : TICCIH 工业遗产保护指南	刘伯英、董一平

2) Publications（SCI、SCIE、SSCI、A&HCI、EI、CSSCI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	CSSCI	从技术奇观到工业遗产——略论博物馆对机械时代认知观念转变的意义	董一平，侯斌超	建筑遗产	2017
(2)	行业顶刊	Growing Industrial Heritage Conservation and Research Community	Dong, Y.	TICCIH Bulletin	2016

2. Provincial Projects

Project 1: Information Modelling and Real-time Monitoring System for Smart Construction

| Cheng Zhang

Technical fields: Construction Information Technology

Programme category: The Natural Science Foundation of the Jiangsu Higher Education Institutions of China - General Programme

Introduction: In view of the current situation of construction industry, the purpose of this research project is to establish a dynamic and accurate model in the construction process. Then, on the basis of this dynamic model, combined with real-time positioning system, and using intelligent algorithm to effectively control and coordinate manpower, machines and materials on site, so as to improve production efficiency and reduce potential safety hazards.

Based on the dynamics and complexity of construction site, first, we need a new method to carry out modeling quickly and accurately. The basic materials of most building structures are steel bars and concrete. There is a significant difference in thermal sensitivity between the two materials, which cannot be reflected in ordinary photos, but there is a significant color difference in the images under infrared cameras. What is more worth mentioning is the heat released by cement in the hardening process, which makes the concrete members that have just been poured have significant temperature differences. Considering the characteristics of concrete materials, a modeling method based on thermal image processing technology will be applied to the construction site. In the research process of this project, we will use several infrared cameras to shoot. On this basis, image processing and synthesis were carried out to comprehensively describe building components. By comparing with the original model, the deviation and quality problems in construction can also be found in time, and the BIM model can be solved and updated in time. The second key technology of this project is intelligent algorithm, how to solve conflicts in dynamic environment, including space and time conflicts. The simplest example is the coordination of various types of work, how to allocate time and space reasonably, and solve conflicts in time, which will greatly improve efficiency and reduce costs. In addition, large-scale machinery workspace and construction site often have a large number of different construction machinery working in adjacent areas, which not only brings hidden dangers to site safety, but also brings difficulties to reasonable arrangement of workspace. Many factors need to be considered, especially the space limitation of the scene. Using the dynamic model of the scene and intelligent algorithm, these conflicts between time and space can be solved in time. Setting priority reasonably is a good solution. Based on the author's previous research results, and by adjusting the existing intelligent algorithms, it can cover other construction machinery, transportation tools and teams working in different processes, thus forming an intelligent control network covering the whole construction site.

Keywords: Building Information Model, Scan-to-BIM, Computer Vision, Intelligent Control

Key issues solved:

The main innovation of this project lies in using thermal imaging photo processing technology to update the construction BIM model in real time and build a dynamic model. Combined with the real-time positioning system, through the real-time tracking of manpower, machines and materials on the construction site, the construction progress can be estimated, which can provide real-time data for improving production efficiency and reducing potential safety hazards.

The main innovation of this project is to improve the dynamic of building information model by applying thermal imaging photo processing technology, and provide a new idea of Scan-to-BIM. Traditional construction progress assessment methods need to collect data manually and extract a large amount of data from drawings and schedules. In addition, the professionals are needed to collect and analyze such information. Automated construction progress monitoring can significantly affect project management and improve the efficiency and accuracy of the process. Ideal automatic construction progress monitoring needs to record the construction status regularly, compare it with the target status, and detect the deviation between them. Relevant scholars have been trying to develop automatic monitoring tools by combining image processing and 3D scanning to improve the

efficiency of construction inspection. However, image processing depends heavily on image quality. Ambient lighting conditions, image noise, shadow, occlusion, low detection of object edges and other features will significantly affect the accuracy of the results, so it is difficult to fit the model to the actual object. However, 3D scanners and other methods that can obtain high-precision data are difficult to be popularized on a large scale under the existing conditions due to the long data processing time, expensive equipment and long training period of related talents. In this research, we proposed an innovative 3D reconstruction method based on thermal imaging graphics processing technology to solve the above issues. By comparing with the design BIM model, the construction progress was controlled and effective site management was carried out.

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
[1]	SCI	BIM-based investigation of total energy consumption in delivering building products	C. Zhang, R. S. Nizam, and L. Tian	Adv. Eng. Informatics	2018.8

Project 2: The Role of Materiality in the Work of Japanese Architects SANAA

| Jing Yang

Programme category: The Natural Science Foundation of the Jiangsu Higher Education Institutions of China - General Programme

Introduction: In this research, we discussed the trend of non-materialization of architecture in the information age due to the development of science and technology and proposed the demand of new life style and its de-materialization material property has a profound impact on users' physical perception and behavior activities. Its special material property can also make architecture a carrier of mixed reality. Specifically, it includes the following two aspects:

1. Dematerialized materials will have an impact on people's visual perception, including visual fuzziness. Based on Margaret's theory of visual system and Merleau Ponty's theory of the relationship between vision and motion, in this research, the concrete cases were used to verify how visual fuzziness caused by material properties affects people's behavior and use of public space in architectural space. The blurred depth and outline of space caused by special materials will stimulate the body to explore space, thus strengthening the touch between the body and the world. A dynamic way for the body to experience space and interact with the world was provided.

2. The special material space created by dematerialized materials can be used as the carrier of virtual space or digital media. As a place to provide shelter and activities for the body, architecture not only provides space for the real body's life, but also provides a place for the body in the digital space to communicate. For architecture in the information age, the superposition of physical space and virtual space shall also be considered. Compared with the increasing feeling of being divorced from the real world brought by virtual reality, on the one hand, architecture should strengthen people's perception of reality and self, so that people can interact with the world in which it exists more deeply; on the other hand, architecture also has the potential to play the intermediate of real and virtual world, and become a carrier of mixed reality.

Keywords: Weak Construction, Material Properties, Embodied Experience, Perception, SANAA

Key issues solved: In this project, the research took the works and design techniques of Japanese architect SANAA as the object. The space, materials and technical techniques of 'Weakening' materiality was analyzed, a very important theoretical project in contemporary architectural practice - the interactive relationship among architectural visual perception, material expression and physical experience was discussed, including image media presentation and on-site space feeling, and a new possibility of enriching each other between virtual and reality was explained.

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI、CSSCI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	CSSCI	SANAA 图解建筑的材料性—以卢浮宫朗斯分馆为例	杨璟	建筑学报	2018.11
(2)	CSSCI	一个建造的"虚拟现实"	杨璟	建筑学报	2020.12
(3)	A&HCI	How do Buildings Talk? Embodied Experience in the Rolex Learning Centre	Jing Yang, Jonathan Hale & Toby Blackman	arq: Architectural Research Quarterly	2021.6

Project 3: Composite Deck System Made of Ultra-High Performance Concrete and High Strength Steel

| Jun Xia

Programme category: The Natural Science Foundation of the Jiangsu Higher Education Institutions of China - General Programme

Introduction: In this research project, the shear connection and flexural properties of ultra-high performance concrete-high strength steel composite beams were researched. The compressive strength of ultra-high performance concrete materials used in the test was up to 140MPa, and the strength of welded I-shaped high-strength steel beams was up to Q690 level. The mechanical behavior of six shear connections, such as channel steel, angle steel, bent-up steel bar and perforated plate, was verified by small-scale push-out test. Except for the bent-up steel bar connection, the other shear connections are brittle and have limited relative slip due to shear failure. Under the double action of shear force and tension force, the bent-up steel bar connection has better ductility and simpler structure than other connection forms. With the help of the perforated plate connected by steel bars, the force transmission path was clear, and the shear connector was suitable for matching high performance concrete and steel, which provided a feasible choice for the overall prefabrication of composite floor system and the integrated design, production and construction of structure decoration in the future. The related technology has submitted the patent application.

Two groups of 10 composite beams and two composite beams under negative bending moment were tested based on the traditional stud connection and perforated plate connection. The test results indicated that the performance of the component can be further improved by the combination of two high-performance materials. The flexural behavior of composite beams was close to the results predicted by theoretical formulas and simplified finite element analysis model, thus achieving the objective of predicting the structural performance of composite beams by formulas and finite element analysis.

Based on the performance of ultra-high performance concrete-high strength steel composite beam members, the mechanical performance of different UHPFRC materials, such as concrete materials containing reclaimed rubber particles and perforated UHPFRC reinforced plates, was researched, and the application prospect of new materials and member forms in composite beam system was analyzed.

Research achievements:

1) Patent

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	通过开孔板连接的超高性能混凝土高强钢组合楼板 构件	CN201721855867.0	ZL201721855867.0	夏骏陆金钰李路帆

2) Publication（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	Properties of high-performance cementitious composites containing recycled rubber crumb	Wang, Xiang and Xia, Jun and Nanayakkara, Ominda and Li, Yishen	Construction and Building Materials	2017.9

Others

XJTLU has been building its international research strength by establishing subjective learning and innovation centres in fields not mentioned above. We actively build and share global knowledge networks and resources, promote the development of university research and innovation platforms such as industry-university cooperation academy, select and recruit more professors as research leaders, and explore effective research boosting measures in cooperation with foreign institutions. By the end of 2020, XJTLU had completed 4 government research projects at all levels areas other than those demonstrated above, including 3 national projects, and 1 provincial project.

1.National Projects

Project 1: The Evolution of Planetary Systems: From Their Birth in Dense Stellar Environments to Their Observable Properties Today

| Mattheus Bartholomeus Nicolaas Kouwenhoven

Application code: A030404 (Department of Mathematical and Physical Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - General Programme

Introduction:

There are two main problems in the research of planetary astronomy: (1)the formation and early evolution of planetary systems are still a mystery, and (2) the way of the observed planetary systems reach their orbital structure is unclear. It is important to quantify the way of the structure of planetary systems and their fragments is shaped by the environment in which they were born and lived. The objective of this research project is to answer the following questions:

1. How is the formation process of planets affected by their birth environment?
2. How long will the planetary system be affected by its gravitational interaction with other stars, and which interaction is the most important?
3. What is the influence of external disturbance on the evolution of planetary system?
4. What are the differences between planetary systems born from different environments, and what exactly caused these differences?
5. What is the fate of free floating planets and what are their properties?
6. How different are known planetary systems from the structures of their birth, and what causes these possible differences?
7. How does the dynamic evolution of planetary systems affect their stability and habitability?

These problems will be dealt with by numerical experiments. These results will profoundly affect our understanding of the formation, evolution and habitability of exoplanets.

Keywords: Exoplanet Dynamics, Planetary Formation, Cluster Dynamics, Comet Dynamics, Evolution of Binary Stars

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	On the survival of resonant and non-resonant planetary systems in star clusters	Reichert, K.; Cai, Maxwell X.; Spurzem, R.*; Kouwenhoven, M.B.N.; Portegies Zwart, S.F.	Monthly Notices of the Royal Astronomical Society	2020
(2)	SCIE	Linking the formation and fate of exo-Kuiper belts within Solar system analogues	Veras, D.*; Reichert, K.; Flammini Dotti, F.; Cai, M.X.; Mustill, A.J.; Shannon, A.; McDonald, C.H.; Portegies Zwart, S.F.; Kouwenhoven, M.B.N.; Spurzem, R.;	Monthly Notices of the Royal Astronomical Society	2020
(3)	SCIE	On the survivability of planets in young massive clusters and its implication of planet orbital architectures in globular clusters	Cai, M.X.*; Portegies Zwart, S.F.; Kouwenhoven, M.B.N.; Spurzem, R.;	Monthly Notices of the Royal Astronomical Society	2019
(4)	SCIE	Planetary systems in a star cluster I: the Solar system scenario	Flammin Dotti, F.; Kouwenhoven, M.B.N.; Cai. M.X.; Spurzem, R.;	Monthly Notices of the Royal Astronomical Society	2019
(5)	SCIE	Substructure and halo population of Double Cluster h and χ Persei	Zhong, J.*; Chen, L.; Kouwenhoven, M.B.N.; Li, L.; Shao, Z.; Hou, J.;	Astronomy & Astrophysics	2019
(6)	SCIE	Kouwenhoven, M.B.N.; Kepler-411: a four-planet system with an active host star	Sun, L.*; Ioannidis, P.; Gu, s.; Schmitt, J.H.M.M.; Wang, X.*;	Astronomy & Astrophysics	2019
(7)	SCIE	The dynamical origin of multiple populations in intermediate-age clusters in the Magellanic Clouds	Hong Jongsuk*; de Grijs Richard; Askar Abbas; Berczik Peter; Li Chengyuan; Wang Long; Deng Licai; Kouwenhoven M B N; Giersz Mirek; Spurzem Rainer	Monthly Notices of the Royal Astronomical Society	2017
(8)	SCIE	Clearing Residual Planetesimals by Sweeping Secular Resonances in Transitional Disks: A Lone-planet Scenario for the Wide Gaps in Debris Disks around Vega and Fomalhaut	Zheng Xiaochen*; Lin Douglas N C; Kouwenhoven M B N; Mao Shude; Zhang Xiaojia	Astrophysical Journal	2017
(9)	SCIE	Stability of multiplanetary systems in star clusters	Cai Maxwell Xu; Kouwenhoven M B N; Zwart Simon F Portegies; Spurzem Rainer;	Monthly Notices of the Royal Astronomical Society	2017
(10)	SCIE	Planetesimal Clearing and Size-dependent Asteroid Retention by Secular Resonance Sweeping during the Depletion of the Solar Nebula	Zheng Xiaochen*; Lin Douglas N C; Kouwenhoven M B N;	Astrophysical Journal	2017
(11)	SCIE	The long-term dynamical evolution of disk-fragmented multiple systems in the solar neighbourhood	Li Yun; Kouwenhoven M B N; Stamatellos D; Goodwin Simon P;	Astrophysical Journal	2016
(12)	SCIE	The dragon simulations: globular cluster evolution with a million stars	Wang, Long*; Spurzem, Rainer*; Aarseth, Sverre; Giersz, Mirek; Askar, Abbas; Berczik, Peter; Naab, Thorsten; Schadow, Riko; Kouwenhoven, M. B. N.;	Monthly Notices of the Royal Astronomical Society	2016
(13)	SCIE	The dynamical fate of binary star clusters in the Galactic tidal field	R Priyatikanto; M B N Kouwenhoven; M I Arifyanto; H R T Wulandari; S Siregar;	Monthly Notices of the Royal Astronomical Society	2016

Project 2: An Emergent Topological Model of Particle Physics and Its Implications to Non-Commutativity in Quantum Spacetime

| Niels Gijsbertus Gresnigt

Application code: A050201 (Department of Mathematical and Physical Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - Young Scientists Fund

Introduction: Describing the physical properties of elementary particles and the possibility of interaction by quantities carrying topological information was involved in this project. In particular, this project focused on the topological description of basic materials according to a certain kind of frame braid. Helon braid model is compatible with LQG and can provide a possible method to unify SM with quantum space-time.

This project has been published on three internationally renowned and peer-reviewed journals, and another one is still under review. The research was further presented at numerous international conferences, generating four conference minutes and documents, and the fifth one were accepted and quickly appeared on the Internet. Finally, the research has spawned numerous new collaborative and research ideas on topics ranging from divisible algebra and reduced contemporary numbers to loop quantum cosmology.

Some people proposed to research the quantized flux tubes and frame braids, hoping to confirm these two points. In the preceding description, when elementary particles were identified with a knot quantization flux tube, the concept of charge is not important any more, and theoretical derivation must be found from the electromagnetic field. In the early stage of this project, the research indicated that the electromagnetic interaction of magnetic field alone may not explicitly introduce charge. Thus, these fields are the only basic entities.

In the second paper, new charge-specific Octonion and decimet baryon mass formulas based on the flavor symmetry of a quantum group $SU_q(3)$ were derived. For the Octonion and decimet baryon mass, the errors of the derived mass relations were only 0.02% and 0.08%. Quantum groups generalized the familiar concept of symmetry and were closely related to knots and braids. In addition, the same quantum group was also used to research the magnetic moment of baryons.

The unexpected structural similarities between the Fermion topological model as framed braids and the divisible algebraic description of symmetry of the standard model have been found. Non-ordinary braid groups represented by complex numbers and quaternions are exactly those that can construct single-generation braid fermions. In turn, this makes the braided matter state of Helon model correlated with Octonion algebra. The braid model is extended from one generation to three generations by using special approximate contemporary numbers, so some progress has also been made.

Keywords: Standard Model Symmetry, Braid, Knot, Octonion, Fermion

Research achievements:

1) Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE, SSCI, EI	Braids, normed division algebras, and Standard Model symmetries	Niels G Gresnigt	Physics Letters B	2018.8
(2)	SCIE	Symmetric but non-local pure-field expression of EM interactions	Butler Philip H; Gresnigt Niels G	Journal of Electromagnetic Waves and Applications	2016

Project 3: Stabilization of Higher Order Theories of Gravity and Cosmology

| Tai-Jun Chen

Application code: A050106 (Department of Mathematical and Physical Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - Special Programme

Introduction: In this project, the stability of Higher-Order Gravity Theory and its cosmological prediction of dark energy was researched.

The original plan of this project was to improve the scalar-tensor field theory including higher-order differential terms and the vector-tensor field theory including higher-order differential terms under the observation constraints. In the process of project implementation, since the model established in this project will degenerate into the original DHOST model under the requirements of gravitational wave velocity observation and Lorentz symmetry, the project investigator consulted the Physics Department of King's College London and Associate Professor Eugene A. Lim of the Institute, discussing the differences between the model established in this project and general relativity and DHOST under strong action from the perspective of numerical relativity.

The results of this project are as follows

1. In this project, an extended theory based on degenerate higher-order differential scalar-tensor field theory was established. However, if it is required to conform to the theoretical observation, this model will degenerate into the original DHOST model.
2. In this project, an unstable vector-tensor field model including second-order differential terms was proposed.
3. In this project, GRChombo code was used with numerical relativity to deal with the problem of black hole fusion under general relativity, DHOST and scalar-tensor field theory including higher-order differential terms.

Keywords: Gravity, Modify Gravity, Higher-Order Derivative Theory, Dark Energy, Cosmology

Key issues solved: A scalar-tensor field theory was established, which may be used as a model of dark energy in cosmology.

2. Provincial Project

Project 1: Uncertainty in Point Cloud Data of Terrestrial Laser Scanning in Geomorphology Applications

| Lei Fan

Technical fields: Fundamental Discipline - Geoscience - Geography

Programme category: Jiangsu Science and Technology Programme - Basic Research Plan (Natural Science Foundation) – Young-Scholar Programme

Introduction: When 3D laser scanning point cloud data is applied to the field of physical geography, to facilitate further data processing and analysis, it is usually necessary to establish digital elevation model (DEM). This is because DEM is the basic data for GIS tasks (such as geoscience analysis). There will be errors in the production of DEM. Although scholars at home and abroad have done a lot of research and discussion on various aspects of DEM errors, the research on related errors based on 3D laser scanning point cloud data on the ground is relatively few. In the research of this technology, the further work in this field includes the influence of point cloud data measurement error and terrain complexity on DEM error model, and through point cloud data reduction, the obtained point cloud data have similar model accuracy in space when building terrain model. The research results have certain reference value for the application of 3D laser scanning point cloud data in geoscience.

In this research, the main factors affecting DEM errors are quantitatively compared and analyzed by using the measured point cloud data and computer simulation experiments. In this research, a new multi-scale method for calculating local terrain complexity was proposed, and simulation experiments indicated that the local terrain complexity calculated by this method can effectively reflect the local DEM error. In this research, we proposed a data filtering method, which removed some redundant data points and made the terrain model based on reduced point cloud data have more similar errors in space. The overall completion of this project is desirable, and new insights and solutions were put forward in the main key issues. However, some technical issues found in the research process still need further in-depth research.

In addition to the above-mentioned research work, a small amount of surplus funds from the project were also used to support the research work of the same type of projects.

Keywords: 3D Laser Scanning, Point Cloud Data, Elevation Model, Geometric Model, Terrain Complexity, Error

Key issues solved: In this research, we proposed a new multi-scale method for calculating local terrain complexity. Experimental results indicated that the local terrain complexity calculated by this method can effectively reflect the local DEM error. In addition, we proposed a new data filtering method in this research, which made the filtered data density match the terrain complexity in space so that the DEM errors were more consistent in space.

Research achievements:

1）Publications（SCI、SCIE、SSCI、A&HCI、EI only）

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCI	A new multi-resolution based method for estimating local surface roughness from point clouds	范磊	ISPRS Journal of Photogrammetry and Remote Sensing	2018
(2)	SCI	An Iterative Coarse-to-Fine Sub-Sampling Method for Density Reduction of Terrain Point Clouds	范磊	Remote Sensing	2019
(3)	EI	Effects of random measurement errors on a linear DEM error model: a case study using TLS point clouds	范磊	2nd International Conference on Sustainable Buildings and Structures	2019
(4)	SCI	The influence of particle elongations on direct shear behaviour of granular materials using DEM	Shiva Kodicherla	Granular Matter	2019
(5)	EI	Big visual data analysis for built environment information modeling	Cheng Zhang	CSCE Annual Conference	2019
(6)	EI	A comparison between structure-from-motion and terrestrial laser scanning for deriving surface roughness: A case study on A sandy terrain surface	范磊	The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences	2020
(7)	SCI	Investigations of the effects of particle morphology on granular material behaviors using a multi-sphere approach	Shiva Kodicherla	Journal of Rock Mechanics and Geotechnical Engineering	2020
(8)	SCI	An Efficient Approach to Automatic Construction of 3D Watertight Geometry of Buildings Using Point Clouds	范磊	Remote Sensing	2021

Part B:
Humanities and
Social Sciences

XJTLU's research in Humanities and Social Sciences covers a diverse range of disciplines, including Economics, Finance, Accounting, China Studies, International Studies, Media and Communication, Applied Linguistics, Literature, Translation and Interpreting and so on. XJTLU has successfully applied for many national, provincial, and municipal projects in the field of Humanities and Social Sciences, actively promoting interaction and dialogue between China and the rest of the world. By the end of 2020, XJTLU had successfully completed 53 government research projects at all levels, including 10 national projects, 15 provincial projects, and 28 municipal projects in the field of Humanities and Social Sciences.

1.National Projects

Project 1: Enterprise and the Non-Profit Organization Social Union Strategy Research

| Juelin Yin

Application code: G020103 (Department of Management Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - Young Scientists Fund

    Introduction: Starting from defining the constituent dimensions and structural characteristics of corporate social alliances, this project considered the initial formation conditions and performance consequences of social alliances, analyzed the micro-process of formulating and implementing corporate social alliances, and revealed the mechanism of this process acting on alliance performance. Based on the knowledge framework of corporate social responsibility literature, resource dependence theory, organizational learning theory and institutional theory, this project tried to achieve the following research objectives:

1. Refine the dimensions and types of corporate social alliance in China, and clarify the basic starting point of corporate social alliance research.
2. Identify the basis, influencing factors and logical relationship of strategic decision-making of enterprise social alliance, and provide theoretical basis for scientific formation of social alliance between enterprises and non-profit organizations.
3. Investigate the influence mechanism of the initial conditions and governance process of social alliance strategy on alliance performance, and reveal the deep-seated reasons of the source of social alliance performance.

    In three and a half years, the research group has completed in-depth interviews, case studies and large-scale questionnaire data collection of many sample enterprises and non-profit organizations. Specifically, the research group interviewed 11 typical foreign-funded enterprises and their non-profit partners in depth, and collected more than 300 questionnaires of non-profit organizations randomly in Zhejiang Province through cooperation with Zhejiang University and Zhejiang League College. The research group has fully analyzed the data and published 12 empirical papers in mainstream Chinese and English journals. Most of the papers published by the research group were published in high-level English SSCI journals or key journals of NSFC, such as Long Range Planning, Business & Society, Total Quality Management & Business Excellence, Journal of Management, Science Studies and Management of Science and Technology. Of which, the first author or correspondent author of 8 articles is the subject applicant, which indicates the high level and high quality of the research results produced by this project. On this basis, the research group has also completed a number of working papers to be submitted one after another in 2016. In the process of project research, the research group also reported and exchanged the project results at many international and domestic mainstream conferences, such as American Management Annual Meeting, International Association for Chinese Management Research Biennial Meeting and China Management Annual Meeting.

    The main theoretical contribution of this project lies in enriching the research on the strategic process of corporate social responsibility. Alliance with non-profit organizations is one of the important implementation methods of corporate social responsibility strategy, and it has also become an important development direction of corporate social responsibility strategy research. However, the issues closely related to competitive advantage, such as what kind of alliance form should be established and how to implement the alliance agenda still cannot constitute the theoretical shortcomings in the research of social responsibility strategy (especially the related direction of social alliance). Based on this theoretical vacancy, the purpose of this project is to strengthen the theoretical investigation of social alliance, hoping to promote the scientific understanding of the internal mechanism of corporate social responsibility strategy implementation, especially enrich the Chinese experience research of corporate social responsibility strategy in China.

    Keywords: Social Alliance, Corporate Social Responsibility, Non-Profit Organizations, Chinese Situation

Research achievements:

1) Publications (SCI、SCIE、SSCI、A&HCI、EI、CSSCI and A Guide to the Core Journal of China only)

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SSCI	Strategic Corporate Social Responsibility of Multinational Companies Subsidiaries in Emerging Markets: Evidence from China	Juelin Yin、Dima Jamali	Long Range Planning	18/1/2016
(2)	SSCI	Institutional Drivers for Corporate Social Responsibility in an Emerging Economy A Mixed-Method Study of Chinese Business Executives	Juelin Yin	Business & Society	30/6/2015
(3)	SSCI	Social Media and Multinational Corporations' Corporate Social Responsibility in China: The Case of ConocoPhillips Oil Spill Incident	Yin, Juelin、Feng, Jieyun、Wang, Yuyan	IEEE Transactions on Professional Communication	6/2015
(4)	SSCI	How innovativeness and institution affect ISO 9000 adoption and its effectiveness: evidence from small and medium enterprises in China	Yunzhou Du、Juelin Yin、Yuli Zhang	Total Quality Management & Business Excellence	18/8/2015
(5)	SSCI	All Roads Lead to Rome: Autonomy, political connections and organisational strategies of NGOs in China	Song Chengcheng、Wang Shizong、Parris Kristen	China: An International Journal	1/12/2015

Project 2: The Social Construction of Sense of Place: Place-Making in Cross-Border Communities in Shenzhen and Hong Kong

| Werner Breitung

Application code: D010202 (Department of Earth Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - General Programme

   Introduction: The purpose of this research is to analyze the local construction in Shenzhen and Hong Kong, especially the practice of home construction. The research focused on the social construction of place and home - Local identity and sense of belonging created by local interaction and human interaction. This project was carried out from two levels: community and city. At these two levels, we focused the existence of borders, especially the border between Shenzhen and Hong Kong and the experience of frequent cross-border people. This research is based on two assumptions: First, boundary acts on local construction and home construction and distinguish places from people through boundaries. Second, the sense of place and the cognition of home have an impact on border-related attitudes and mobility. These views were applied to the boundary between Shenzhen and Hong Kong, but they can also point to the boundary between communities (such as access control communities). It was also very important to focus on the relationship and parallelism between these two levels.

   The combination of qualitative and quantitative was the primary research method of this project. Generally speaking, the research results of this project were reflected in the following three aspects: First, the cross-border liquidity was mapped and analyzed based on second-hand data supported by questionnaire survey data. The primary findings were a large increase in leisure-related cross-border, short-distance cross-border (limited to those between Shenzhen and Hong Kong) and cross-border mainlanders rather than Hong Kong people. These findings were consistent with field observations and media reports about the dramatic increase in mainland tourists to Hong Kong and the resulting conflicts. The theoretical hypothesis was that increased host-object contact led to better mutual understanding and a smoother integration process. Second, the research on community level in this project was only carried out in Shenzhen. Through preliminary investigation, we found that the frequent cross-border people living in Shenzhen and Hong Kong did not gather as originally thought, and the connection between community and city cannot be connected through the so-called community. Therefore, we decided to conduct community-level research in Guangzhou. We have better entry, and there are also a large number of Hong Kong people living in such communities. We analyzed the process of delimitation, deterritorialization and reconstruction of these communities, as well as the process of home building and defense in communities and their surrounding neighborhoods. It was found that boundaries play a key role in both internal and external populations. Finally, we investigated the practice of local construction at the city level in Shenzhen and Hong Kong, especially the practice of home construction. A large-scale questionnaire survey and interview were conducted. The main finding of this paper is that social contact has a great influence on home building. The main finding of this paper is that social contact has a great influence on home building. There are also great differences between Hong Kong and Shenzhen residents, which reflects that the construction of home is flexible and not based on fixed factors. On the contrary, people create the concept of home around the different resources they have (such as property rights, childhood memories and ancestral home).

   The theoretical contribution of this project is reflected in the field of boundary research:

1. Better understand the connection between boundary and local construction.
2. The comparability of demarcation, deterritorialization and boundary reconstruction processes at different scales (especially urban boundaries within community and national boundaries) was emphasized. In the field of cultural geography, a more systematic factor analysis of the construction and reconstruction of home was proposed.

This project is the first research on cross-border situation.

Keywords: Local Construction, Cross-Border Movement, Integration, Shenzhen, Hong Kong

Research achievements:

1) Publications (SCI、SCIE、SSCI、A&HCI、EI、CSSCI and A Guide to the Core Journal of China only)

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SSCI	Creating and defending concepts of home in suburban Guangzhou	FENG Dan、Werner BREITUNG、ZHU Hong	Eurasian Geography and Economics	2014

Project 3: The Study of the Relations between University Management System and Scientific Innovation Capacity

| Youmin Xi

Application code: G03 (Department of Management Sciences)

Programme category: National Natural Science Foundation of China (NSFC) – Special Programme

Introduction: The scientific research level of colleges and universities has increasingly become the core element of national innovation ability and even national competitiveness. However, the current situation of scientific research in colleges and universities in China is not optimistic, for example, the number of published articles is large but the contribution is small; scientific research funds are increasing but original achievements are scarce; academic misconduct has been repeatedly prohibited; the utilitarianism of researchers prevails; the phenomenon of 'running to ministries to get money' is widespread; and the ability of top returnees to innovate talents has been obliterated. As a direct institution serving scientific research, the scientific research management system of colleges and universities is the direct factor causing the above issues. Restricted by traditional culture, national system and other factors, there are serious issues in the scientific research management system of colleges and universities in China now. Including the administration of scientific research management system; government-led mode in resource allocation; unreasonable evaluation system and incentive mechanism of scientific research achievements; bureaucratic internal organizational structure; academic culture is not conducive to innovative activities; and researchers are lack of enough freedom.

The root causes of these issues come from four aspects. 1. The university governance structure is single, the government alone leads the allocation of resources and lacks the participation of social and academic groups; 2. The internal organizational structure of colleges and universities is not conducive to the cooperation and exchange of researchers; 3. Academic encouragement and evaluation deviate from the characteristics of scientific research; and 4. Academic culture is seriously eroded by administration, which hinders researchers from carrying out pioneering research. Based on the above analysis, in view of the present situation of scientific research management in colleges and universities in China, we put forward five suggestions to reform the scientific research management system in colleges and universities.

1. Universities should reform their governance structures, increase social and academic power in resource distribution, and improve the effectiveness of the principal responsibility system under the leadership of the Party Committee.
2. According to the working mode of scientific research, a flat and networked organizational structure should be established to provide conditions and opportunities for interdisciplinary and inter-departmental exchanges and cooperation of researchers.
3. Change the current short-term and over-materialized incentive mechanism and establish a diversified incentive model with equal emphasis on material and spiritual incentives.
4. Establish a new academic evaluation system, change the current administrative evaluation into social evaluation and strive to build an academic credit system.
5. Construct an academic culture that breeds innovation and establish academic freedom as the most fundamental cultural essence of universities.

Keywords: Scientific Research, Innovation Ability, Resource Allocation, Governance Structure, Academic Culture

Research achievements:

1） Copyright

No.	Category	Title	Author(s)
(1)	著作章节	提升中国科学创新能力若干关键问题研究	李正风 , 席酉民

2）Others

席酉民，国家中长期教育改革和发展规划纲要 (2010-2020) 实施建议，陕西省教育厅，陕西省人文社科优秀成果，（二等奖），1/12/2011，已标注

Project 4: The Impact of Discrimination on the Job Search Behavior of Disadvantaged Workers: Experimental Investigation and Policy Recommendations

| Gergely Horvath

Application code: G0302 (Department of Management Sciences)

Programme category: National Natural Science Foundation of China (NSFC) – International Young Scientists Programme

Introduction: This report details the research results of the project "The impact of discrimination on the job search behavior of disadvantaged workers: Experimental investigation and policy recommendations" awarded under the 2019 Research Fund for International Young Scientists program, grant no. 71950410622. I describe the research questions, methodology and results from two online economic experiments that were accomplished by the support of this research grant. The first experiment studies the impact of discrimination and pay transparency on the search behavior of discriminated workers. My main results show that search models may overstate the impact of taste-based discrimination on labor market outcomes of discriminated workers because job seekers deviate from the optimal search strategy. Pay transparency allows discriminated workers to avoid discriminating employers and, hence, increases the wages obtained by these workers. However, it also increases the search duration, thus creates trade-offs between wages and search duration. The second experiment aims to correct the observed deviations of job seekers from the optimal search behavior by introducing policy interventions. The main results show that reducing search costs and nudging messages can partially correct the deviations from the optimal search behavior by job seekers. Based on these results, I propose that nudging messages should be added to the existing active labor market policies.

Keywords: Job Search, Discrimination, Laboratory Experiments, Labor Market Policy, Nudges

Research achievements:

1) Publications (SCI、SCIE、SSCI、A&HCI、EI、CSSCI and A Guide to the Core Journal of China only)

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	The impact of taste-based discrimination and pay transparency on job search behavior: An experimental analysis	G Horvath	Scandinavian Journal of Economics	2020.12
(2)	SCIE	Alleviating behavioral biases at job search: Do nudges work?	G Horvath	Experimental Economics	2020.12

Project 5: E-marketing Services and E-marketing Performance: The Roles of Innovation, Knowledge Complexity and Environmental Turbulence in Influencing the Relationship

| Chong Woon Kian

Application code: G020703 (Department of Management Sciences)

Programme category: National Natural Science Foundation of China (NSFC) – Young Scientists Fund

Introduction: B2B Electronic Marketplace is an internet-based business platform that allows multiple buyers/sellers to share information products/services instantly. However, Chinese B2B small and medium-sized enterprises, who are keen to participate in the electronic market competition, are very concerned about their own benefits in the B2B electronic market. Chinese small and medium-sized enterprises need to understand which e-marketing services determine their e-marketing performance, and how innovation, knowledge complexity and environmental changes affect the relationship between e-marketing services and e-marketing performance. The research will fill this research gap through the following aspects:

1. Which e-marketing services are positively related to e-marketing performance, and how these services help improve performance?
2. How innovation, knowledge complexity and environmental change affect e-marketing performance?

In this research, quantitative and computer simulation methods were used to solve the issues above. Through an empirical survey of 176 small and medium-sized enterprises, in this research, the e-marketing services that have a significant impact on e-marketing performance and the way to of different e-marketing services affecting e-marketing performance together were evaluated. The way to of innovation, knowledge complexity and environmental change mediating/regulating business relationships through a calibrated NK model was investigated. In this research, it was found that electronic customer relationship management, electronic supply chain management, the degree of competition of e-commerce enterprises, the integration of international standardization organizations and information transparency will have an impact on e-marketing performance. Innovation mediated the relationship between e-marketing service and e-marketing performance, while knowledge complexity and environmental change moderate the relationship.

The significance of this research is as follows. First, e-marketing services was comprehensively researched, and which e-marketing services investment will greatly affect the e-marketing performance of enterprises was evaluated. We also built a theoretical framework of e-marketing services for scholars and managers. This framework is helpful for scholars to have a comprehensive understanding of the research issue of 'e-marketing services that can significantly improve e-marketing performance'. It is of great academic significance to research the influence of single e-marketing service on e-marketing performance. However, because enterprises often need to invest in different kinds of e-marketing services, and these services may be interrelated, the research on how these services together change the performance of e-marketing can promote the research in this field. Second, there are few researches on organizational capabilities (such as innovation) and institutional characteristics (such as knowledge complexity and environmental changes), and how these factors affect the relationship between e-marketing services and e-marketing performance. This research filled the deficiency of previous research.

Keywords: E-Marketing Service, E-Marketing Performance, Innovation, Complexity of Knowledge, Environmental Turbulence

Research achievements:

1) Copyright

No.	Category	Title	Author(s)
(1)	著作章节	Analyzing the Relationship Between B2B E-Marketplace Adoption and E-Business Performance Using NK Simulation Method in Lecture Notes in Electrical Engineering	Woon Kian Chong; Yan Sun; Nan Zhang; Ka Lok Man

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE	The impact of e-marketing orientation on performance in Asian SMEs: a B2B perspective	Woon Kian Chong; Ka Lok Man; Mucheol Kim	Enterprise Information Systems	2018.01.02
(2)	SCIE	A Recommendation Model Using the Bandwagon Effect for E-Marketing Purposes in IoT	Sang-Min Choi; Hyein Lee; Yo-Sub Han; Ka Lok Man; Woon Kian Chong	International Journal of Distributed Sensor Networks	2015.07.07
(3)	EI	Examining E-marketing Services and E-marketing Performance with NK Model	Woon Kian Chong; Ka Lok Man	The International MultiConference of Engineers and Computer Scientists	2017.3.15-2017.3.17

Project 6: Strategy Study on Innovation of Environment Technology

｜ **Xuanwei Cao**

Application code: G020101 (Department of Management Sciences)

Programme category: National Natural Science Foundation of China (NSFC) – Young Scientists Fund

Introduction: With the increasing concern of management research on important issues in reality, an increasingly important issue in strategic management practice was the concern about the relationship between environmental issues and enterprise strategy. From the perspective of realizing the relationship between microcosmic and macrocosmic in the theoretical research and practice of strategic management, and from the perspective of management cognition and strategic choice, the research focused on the in-depth research of the time strategy of environmental technology innovation. The research was carried out from four aspects:

1. The time research in strategic management was thoroughly and systematically combed. Based on strategic process analysis, the interactive relationship between management cognition and strategic action based on time dependence was explored, the mechanism of individual actors' influence on organizational strategic action in different time cognitive states was explained, and the interaction between micro-actors and organizational action process at meso and macro levels in the process of organizational strategy formation, implementation and innovation was analyzed.

2. The relationship among management cognition, strategic action and path dependence was researched. Based on the discussion of the micro-mechanism of strategy origin and strategy formation, the transformation mechanism between management cognition and organizational strategic choice and action in an organization from the perspective of 'inside-out' (the influence of cognitive changes of internal actors on external structure) was reviewed, and the path dependence from the perspective of micro-cognition was researched.

3. The relationship between entrepreneurs and opportunities from the perspective of time strategy was researched. Based on the understanding of time strategy as a key (core) capability of an organization, how entrepreneurs' cognition and strategic response when dealing with strategic ambiguity issues such as environmental technology innovation have an impact on the application and innovation of new technologies was discussed, and the process of opportunity formation mechanism from a new perspective by incorporating time factor into the analysis of opportunity formation mechanism was analyzed.

4. The relationship among environmental technology innovation, path dependence and time strategy was researched. Based on the perspective of co-evolution, the strategic choice of enterprises and the formation and evolution of time strategy as a whole part of enterprise strategy were analyzed, the path dependence in environmental technology innovation based on time strategy breakthrough was discussed, and a dynamic evolution model of management cognition, strategic choice, path dependence and path breakthrough through the time dimension of strategic management was constructed. Through in-depth case research and empirical research, the factors that affect the environmental strategy of enterprises was analyzed, and the way to the micro-level factors affecting the environmental strategy of organizations was discussed.

Keywords: Management Cognition, Strategic Selection, Path Dependence, Environmental Technology Innovation, Enterprise Environmental Strategy

1） Copyrights

No.	Category	Title	Author(s)
(1)	Book Chapter	A Tale of Two Cities on Regional Entrepreneurship Policymaking: A Comparative Study on Suzhou and Wuxi from Path Dependence Perspective in Self-Reinforcing Processes in and among Organizations	Yipeng Liu、Xuanwei Cao、Yijun Xing
(2)	Book Chapter	Incorporating Technological Innovation and Environmental Strategy: an Integrated View of Cognition and Action in Management of Technological Innovation in Developing and Developed Countries	Xuanwei Cao

2） Publications (SCI、SCIE、SSCI、A&HCI、EI、CSSCI and A Guide to the Core Journal of China only)

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SSCI, SCI	Ambidextrous Organization in Harmony: A Multi-Case Exploration of the Value of HXMT	Youmin Xi、*Xuanwei Cao、Liuxu Xiangli	Chinese Management Studies	2011
(2)	SSCI, SCI	A Chinese View on Rebuilding the Integrity of Management Research: The Evolving HeXie Management Theory	Xuanwei Cao	Chinese Management Studies	2010
(3)	EI	Time Strategy for Environmental Technology Innovation: An Integrated View of Cognition and Action.	Xuanwei Cao	2010 IEEE International Conference on Advanced Management Science (IEEE ICAMS 2010)	2010/7/9-2010/7/11
(4)	SSCI	Does an institutional factor influence corporate environmental strategy? Looking through the Guanxi lens	Xuanwei Cao	Sustainability Accounting, Management and Policy Journal	2017

Project 7: Operationalizing Culture as a Variable in Cross-Cultural Management Modeling. An Application to Innovation Adoption within Cultural Groups

| Shihao Eddy Fang

Application code: G0405 (Department of Management Sciences)

Programme category: National Natural Science Foundation of China (NSFC) - International Young Scientists Programme

   Introduction: The present project aims at studying the behaviors, preferences, and attitudes of Chinese economic agents, in the perspective of refining cross-cultural agent-centered modelling on topics within and around the question of innovation adoption. After a general methodological framework was developed, the funds provided by NSFC was used to conduct empirical work on innovation adoption within this framework and focused on various areas of studies (Chinese consumers and food safety, Chinese consumers and tourism, education decision in the Chinese market, etc.). All goals set for this project are now fulfilled, including, among others, 3 papers under review in SSCI journals and presentations in international conferences. The research made possible by this NSFC fund was received beyond expectations by the scientific community, which resulted in several collaboration requests from academics from both within and outside of China (Australia, New Zealand and France).

   Research achievements:

   1） Publications (SCI、SCIE、SSCI、A&HCI、EI、CSSCI and A Guide to the Core Journal of China only)

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SSCI	Money or in-kind gift? Evidence from red packets in China	Hudik, M., & Fang, E.	Journal of Institutional Economics	2020
(2)	SSCI	Preference reversals in decisions that matter: Education choices in China	Benoit Desmarchelier, Lixian Qian, Eddy S. Fang	Journal of Behavioral and Experimental Economics	2018
(3)	SSCI	Why do employees engage in counterproductive work behaviors? The role of cultural values among white-collar employees in China	Yuliani Suseno, Chiachi Chang, Marek Hudik, Eddy Fang & Na Liu	Motivation and Emotion	2021

Project 8: Games and Goal-Oriented Behavior

| **Marek Hudik**

Application code: G0105 (Department of Management Sciences)

Programme category: National Natural Science Foundation of China (NSFC) – International Young Scientists Programme

Introduction: In this project, I studied strategic interactions of players who make choices with a set of goals in mind. These goals may or may not be mutually compatible across players. Based on this compatibility, I define a new solution concept - Hayek equilibrium. In this equilibrium, all players are successful in achieving their goals. Hayek equilibrium may differ from Nash equilibrium and hence players may face a dilemma between the two. Nash equilibrium is appealing to players because they choose mutually best responses; however, they may fail to realize their goals. In Hayek equilibrium players realize their goals; however, there may be a better strategy available to them, given the strategies of others. The model is applied to account for cooperative behavior in Prisoners' Dilemma and stability of social norms. It is argued that the games with the Nash equilibria that are Hayek equilibria are unstable, as players have incentives to modify the rules of play. It is shown that the model has testable implications that cannot be derived from the conventional model. Several other extensions of the goal-based approach are considered in both strategic situations and one-person decision problems. The outcomes of this project include four conference presentations (three international and one domestic), two paper submissions in international journals and a completion of one additional manuscript. During this project, an international cooperation was established which resulted in a new research grant.

Keywords: Non-Cooperative Games, Goal-Directedness, Procedural Rationality, Rational Choice, Classification of Games

Research achievements:

1) Publications (SCI、SCIE、SSCI、A&HCI、EI、CSSCI and A Guide to the Core Journal of China only)

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE, SSCI	A preference change or a perception change? A comment on Dietrich and List	M. Hudik	International Journal of Game Theory	2017
(2)	SSCI	Push factors of endogenous institutional change	M. Hudik	Journal of Economic Behavior and Organization	2021

Project 9: Nonparametric Efficiency Analysis for Multi-Output Producers

| **Barnabe Frederic P. Walheer**

Application code: G0103 (Department of Management Sciences)

Research field: Mathematical Analysis

Programme category: National Natural Science Foundation of China (NSFC) – International Young Scientists Programme

Introduction: The aim of my project was to develop benchmarking tools for analyzing the efficiency of Decision Making Units that produce multiple outputs. The distinguished features of the proposed methodology are twofold. On the one hand, the benchmarking tools do not require strong assumptions for any aspects of the production process (i.e. nonparametric spirit) and try to stay as close as possible to the reality (i.e. high discriminatory power). On the other hand, the benchmarking tools are motivated by empirical questions and are therefore specially designed to tackle specific research questions. The panel of covered research questions is important: from microeconomics to macroeconomics, from private to public producers, from the manager point of view to the regulator/policy maker points of view. As such, my models could be applied to any countries, but I will consider first the case of China for two main reasons. On the one hand, there are not a lot of works that have been done before on analyzing the efficiency of China. On the other hand, the applications I will consider are particularly relevant for that country. All in all, it means that the project is interesting for both a (theoretically oriented) economics audience and also for a (practically oriented) operations research/management audience.

Keywords: Benchmarking, Production, Data Envelopment Analysis, Energy, Economic Growth

Research achievements:

1) Publications (SCI、SCIE、SSCI、A&HCI、EI、CSSCI and A Guide to the Core Journal of China only)

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SSCI	Scale, congestion, and technical efficiency of European countries: a sectorbased nonparametric approach	Walheer B.	Empirical Economics	2019
(2)	SSCI	How foreign investments contribute to economic growth of industrial parks in China: a production-frontier decomposition approach	Walheer B.	Applied Economics Letters 26	2019
(3)	SCIE, SSCI	Malmquist productivity index for multi-output producers: an application to electricity generation plants	Walheer B.	Socio-Economic Planning Sciences 65	2019
(4)	SSCI	Economic growth and greenhouse gases in Europe: a non-radial multi-sector nonparametric production-frontier analysis	Walheer B.	Energy Economics 74	2018
(5)	SSCI	Profit Luenberger and Malmquist-Luenberger indexes for multiactivity decision making units: the case of the star-rated hotel industry in China.	Walheer B., Zhang L.	Tourism Management 69	2018
(6)	SCIE	Labour productivity growth and energy in Europe: a production-frontier approach	Walheer B.	Energy 152	2018

(7)	SCIE	Aggregation of metafrontier technology gap ratios: the case of European sectors in 1995-2015	Walheer B.	European Journal of Operational Research 269	2018
(8)	SSCI	Scale efficiency for multi-output cost minimizing producers: the case of the US electricity plants	Walheer B.	Energy Economics 70	2018
(9)	SSCI	Decomposing the Europe 2020 index.	Walheer B.	Social Indicators Research 140	2018
(10)	SSCI	Cost Malmquist Productivity Index: an output-specific approach for group comparison	Walheer B.	Journal of Productivity Analysis 49	2018

2）Others

i. Walheer B., "Energy and economic growth in China", SURF Project, Xi'an Jiaotong－Liverpool University, 2018.

ii. Walheer B., Research Excellence, SEID Key Educator Program, Suzhou, China, 2018.

iii. Walheer B., Research Excellence, International Business School Suzhou, Xi'an Jiaotong－Liverpool University, 2017.

Project 10: Theoretical and Empirical Studies on the Dynamic Diffusion of Low Carbon Innovations: The Perspective of Socio-technical System Evolution

| **Lixian Qian**

Introduction: Starting from the urgent needs of sustainable development of Chinese society and based on the multi-level perspective of complex social technology system, in this project, the heterogeneity of consumers' adoption preference for low-carbon innovation, the dynamic diffusion mechanism of low-carbon innovation and its key influencing factors were deeply explores. Through rational application of multidisciplinary theories and methods, this project tried to achieve the following research objectives:

1. Create a complex social technology system of low-carbon innovation and identify potential influencing factors in the process of low-carbon innovation diffusion.
2. Develop a multi-intensity low-carbon innovation diffusion analysis model based on market segmentation preference by analyzing the heterogeneity of market adoption preference for low-carbon innovation.
3. Carry out the empirical research in China's low-carbon innovation market to analyze the far-reaching impact of key factors in complex social technology system on low-carbon innovation diffusion.

During the four-year project implementation period, the project team deeply explored various influencing factors of low-carbon innovation diffusion, including products/services, government policies, macro values, micro-population and personal consumption psychology and meso-urban characteristics, thus greatly enriching the social and technological system of low-carbon innovation. The project team conducted three rounds of self-reported preference experiments in 500 household panels across the country, and on this basis, it constructed a multi-intensity low-carbon innovation diffusion model based on heterogeneity of market segment preferences. Based on the multi-angle and multi-cycle research of China's new energy vehicle market and low-carbon travel market, the role of innovative business models was incorporated into the project research, thus enriching the connotation of research and improving the universality of relevant conclusions. Up to now, the project team has published 10 high-level international SSCI/SCI papers and 1 academic monograph, of which 1 paper was selected as an ESI highly cited paper in 2019, and there are still many papers under review and waiting to be submitted. The project team also reported and exchanged research results at more than 10 international and domestic mainstream academic conferences.

The main theoretical contribution of this project lies in fully identifying the key factors affecting the diffusion of low-carbon innovation in the social technology system and exploring their important mechanisms, thus pointing out the diffusion ways of low-carbon innovation in China. Based on the multi-angle analysis of new energy vehicles, public bicycles, bike-sharing and car-sharing, this project revealed the heterogeneity and dynamics of Chinese consumers' preference for adopting low-carbon innovation, as well as the important role of innovative business models in promoting the adoption of low-carbon innovation. As a result, this project provided important management significance for enterprises to develop low-carbon innovative products suitable for market demand and target market customers, and valuable suggestions for Chinese government agencies to formulate effective public policies.

Keywords: Low-Carbon Innovation, Social Technology System, Consumer Adoption and Diffusion, New Energy Vehicles, Green Travel

Key issues solved: Identify the key influencing factors of low-carbon innovation diffusion in complex social technology system; Real-time analysis of the heterogeneity and dynamics of market preference in the process of low-carbon innovation diffusion; Study the role of innovative business model in low-carbon innovation diffusion.

Research achievements:

1） Publications (SCI、SCIE、SSCI、A&HCI、EI、CSSCI and A Guide to the Core Journal of China only)

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SCIE, SSCI	Consumer Adoption of Electric Vehicles in Alternative Business Models	Youlin Huang; Lixian Qian	Energy Policy	2021
(2)	SSCI	On the heterogeneity in consumer preferences across generations and cities towards electric vehicles in China	Youlin Huang; Lixian Qian	Technological Forecasting and Social Change	2021
(3)	SSCI	Buy, Lease or Share? Consumer Preferences for Innovative Business Models in the Market of Electric Vehicles	Youlin Huang; Lixian Qian	Technological Forecasting and Social Change	2021
(4)	SSCI	Understanding the Potential Adoption of Autonomous Vehicles: The Perspective of Behavioural Reasoning Theory	Youlin Huang; Lixian Qian	Psychology & Marketing	2021
(5)	SCIE, SSCI	The impact of service and government-policy attributes on consumer preferences for electric vehicles in China	Lixian Qian; Jose M. Grisolía*; Didier Soopramanien	Transportation Research Part A: Policy and Practice	2019
(6)	SCIE, SSCI	Linking Chinese cultural values and the adoption of electric vehicles: The mediating role of ethical evaluation	Lixian Qian; Juelin Yin	Transportation Research Part D: Transport and Environment	2017
(7)	SSCI	First-Time Buyers' Subjective Knowledge and the Attribute Preferences of Chinese Car Buyers	Lixian Qian; Didier Soopramanien*; Ahmad DaryAnto	Journal of Retailing and Consumer Services	2017
(8)	SSCI	Consumer preferences for electric vehicles in lower tier cities of China: Evidences from south Jiangsu region	Youlin Huang; Lixian Qian	Transportation Research Part D: Transport and Environment	2018
(9)	SCIE, SSCI	From Value Co-creation to Value Co-destruction? The Case of Dockless Bike Sharing in China	Juelin Yin; Lixian Qian*; Junjie Shen	Transportation Research Part D: Transport & Environment	2019
(10)	SSCI	Sharing sustainability: how values and ethics matter in consumers' adoption of public bicycle-sharing scheme	Juelin Yin; Lixian Qian; Anusorn Singhapakdi	Journal of Business Ethics	2018
(11)	SSCI	Preference Reversals in Decisions that Matter: Education Choices in China	Benoit Desmarchelier*; Lixian Qian; Eddy S. Fang	Journal of Behavioral and Experimental Economics	2018
(12)	SSCI	The Effects of Corporate Social Responsibility on Real and Accrual-based Earnings Management: Evidence from China	Kim, Sang Ho*; Udawatte, Prabhu; Yin, Juelin	Australian Accounting Review	2019
(13)	SSCI	Business Ethics in the Greater China Region: Past, Present, and Future Research	Yin, Juelin*; Quazi, Ali	Journal of Business Ethics	2018
(14)	SCIE, SSCI	Strategic Corporate Social Responsibility of Multinational Companies Subsidiaries in Emerging Markets: Evidence from China	Yin, Juelin*; Jamali, Dima	Long Range Planning	2016

2）Others

Awards:

i.　Lixian Qian(1/1); Outstanding Reviewer for Journal of Retailing and Consumer Services, Elsevier, 杰出审稿人，国际学术奖，2018（Lixian Qian）.

ii.　Lixian Qian(2/3); Sharing Sustainability: How Values and Ethics Matter in Consumers' Adoption of Public Bicycle-Sharing Scheme, 科睿唯安（Clarivate Analytics），ESI 高被引论文，国际学术奖，2019（Juelin Yin; Lixian Qian; Anusorn Singhapakdi*）.

iii.　Lixian Qian(1/1); 2018/2019 Research Excellence Award, 西交利物浦大学西浦国际商学院，卓越科研奖，其他，2019（Lixian Qian）.

Report:

基于社会技术体系演进的低碳创新扩散研究：2017-2019 年消费者对电动汽车的纵向分析

2. Provincial and Ministry-Level Projects

Project 1: Exploring the Spatial Implications of Integrated Water Management in the Suzhou Metropolitan Area

| Christian Nolf

Research fields: Social Undertakings - Human Settlements - Town Planning

Programme category: Jiangsu Science and Technology Programme - Basic Research Plan (Natural Science Foundation) - General Programme

Introduction: Like many other developed countries, China has recently adopted an Integrated Water Resources Management (IWRM) system to address emerging water quantity and quality challenges and address environmental and climate change issues. However, facing the physical and institutional realities of the Territory, its practical implementation remains extremely challenging. The purpose of this research is to discuss the integrated water resources management under the specific background of Suzhou city. Located in the heart of the Yangtze River Delta, Suzhou has developed from a medium-sized city to one of the urban areas with the highest population density and productivity in the world at an alarming rate.

The purpose of this research is to explore in depth how the implementation of integrated water resources management systems can simultaneously address spatial planning and environmental challenges, such as recertification of urban areas, definition and certification of urban-rural fringes, and ecological enhancement of natural and agricultural delta landscapes. To achieve this objective, the research combined two main methods:

1. In the analysis, a review of spatial planning and water management policies and challenges on a regional scale was included. Supported by a set of original maps and composite tables in the form of atlases (see Appendix 1), the indicators for the integration approach were defined and discussed in this section.

2. In the exploration, how to solve specific issues in an integrated way through pilot projects was investigated. The main case study for Wujiang (south of Suzhou) was complemented by other design explorations. Developed jointly by local stakeholders and with the participation of international students and experts, this design exploration proposed innovative, concrete and environmentally integrated strategies to apply an integrated approach to water and space issues.

For the analysis part, further cross-sectoral integrated water resources management is still required to prove, and the design exploration also outlines the possible approaches. In particular, a scale strategy with a physical regional background was researched and developed, and the potential of restarting traditional landscapes was considered to deal with new issues.

Keywords: Urban Spatial Planning, Urban Design, Water Resources Management

Key issues solved: In this research, we discussed the relationship between spatial planning and the implementation of integrated water resources management system in Suzhou, China.

Research achievements:

1） Copyright

No.	Category	Title	Author(s)
(1)	书籍章节	Historic Landscape and Water Heritage of Suzhou beyond the Tourist Gaze, in book: Suzhou in Transition.	Wang, Y., Nolf, C.

2） Publications (SCI、SCIE、SSCI、A&HCI、EI、CSSCI and A Guide to the Core Journal of China only)

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	CSSCI	A Consolidated Archipelago: Retrospective of Water Engineering and Urbanization of the Yangtze River Delta.	Nolf, C., Xie Y., Vannoorbeeck F.	上海社会科学院	2019.6
(2)	A Guide to the Core Journal of China	Design Research on Landscape – led Rural Revitalization	Chen B., Yao Z., Zhang H. and Nolf C.	中国园林	2020

Project 2: New Urban Spare in the Era of Globalisation: The Case of Suzhou

| Kim Hyungmin

Programme category: The Natural Science Foundation of the Jiangsu Higher Education Institutions of China - General Programme

Introduction: In this research, the impact of foreign direct investment on local cities was focused on. The previous studies focused on the reasons for foreign investment and the choice of investment location, but the changes of the invested cities after obtaining foreign investment were not researched. Thus, Suzhou was taken as an example to explore the influence of foreign capital on urban spatial change, try to solve the relationship between foreign capital and urbanization, and improve the understanding of China's urbanization process.

In this research, the following three aspects were included: First, in this research, the spatial layout of Suzhou's foreign investment was focused on, and the influence of foreign enterprises was understood through the location choice and size of investment by foreign-invested enterprises. Second, the migration of population in China was explored from the perspective of population mobility. Foreign-invested enterprises play an important role in the migration of population in China's metropolitan areas. The primary reasons for regional population migration are to obtain better economic opportunities provided by foreign-invested enterprises. Third, in this research, the formation of foreign population supplement areas will also be focused on. Because of the entry of foreign-invested enterprises, the population of foreign nationality forms a compact community, and gradually affects the regional differentiation within cities.

Research achievements:

1） Copyright

No.	Category	Title	Author(s)
(1)	书籍章节	Manufacturing and Logistics Networks of Korean Firms in China: A Case Study of Suzhou Incluslrial Park	Zheng Liu, Hyung Min Kim, Kaifeng Zhang

2） Publications (SCI、SCIE、SSCI、A&HCI、EI、CSSCI and A Guide to the Core Journal of China only)

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SSCI	The role of Quality of Place factors in expatriate international relocation decisions: A case study of Suzhou, a globally-focused Chinese city	Kim, Hyung Min and Cocks, Matthew	Geoforum	2017
(2)	SSCI	The influx of high-income foreign nationals and the housing market in a developing country: a case study of Suzhou Industrial Park, China	Kim, Hyung Min	Journal of Housing and the Built Environment	2018

Project 3: Study on Building up Innovation Ecosystem and Improving Innovation Intensity in Jiangsu Province

| Xuanwei Cao

Research fields: Management Sciences

Programme category: Applied Research of Jiangsu Social Science Boutique Project - Self-funded Programme

Introduction: For this project, it was carried out by focusing on the connotation of innovation ecosystem. Based on the international research progress and practice summary of innovation ecosystem, the main policies and practices of promoting innovation ecosystem construction in Jiangsu under the background of 'strategic drive' were sorted out. Through the field investigation and visit of Nano City and Science and Education Innovation Zone in Suzhou Industrial Park, the bottleneck factors restricting the construction of innovation ecosystem now were found, and the development ideas and countermeasures for Jiangsu to build and optimize an open and inclusive innovation ecosystem were proposed based on the practice of innovative areas at home and abroad. Based on field visits and investigations, we listened to the achievements and opinions of front-line scientific and technological workers and government workers on the construction of innovation ecosystem, obtained a lot of real materials and understood some issues that still exist in the process of innovation ecosystem construction. On the basis of investigation, in this project, the construction of innovation ecosystem in the whole province based on the spirit of openness and inclusiveness was proposed, and different innovation subjects such as enterprises, universities and research institutions, government departments and social organizations (the public) was promoted to participate in the process of building an open and inclusive innovation ecosystem, promote social innovation, and guide the integration of scientific and technological innovation and social innovation. For this purpose, eleven suggestions were put forward, including:

1. Encourage local government to conduct innovation.
2. Construct an innovation-friendly environment as a soil to nourish an open and inclusive innovation ecosystem.
3. Strengthen the main position of technological innovation of enterprises.
4. Improve the training and using mechanism of innovative talents.
5. Promote the formation of an open innovation pattern.
6. Develop the digital economy and build an innovative ecosystem based on the big data platform.
7. Scientific and technological innovation and social innovation should be carried out simultaneously, focus on the unique role of inclusive innovation in solving social problems.
8. Improve the management system of science and technology and explore the road map of open science and research.
9. Play the role of innovation intermediary.
10. Improve the governance structure of innovation ecosystem.
11. Establish a cross-disciplinary innovation think tank close to the needs of the industry.

Keywords: Innovation Ecosystem, Innovation Concentration

Key issues solved: It was proposed that we should look at the connotation of innovation ecosystem from a more urgent, pragmatic, systematic and organic point of view, and solve the 'unbalanced and insufficient development' based on the national conditions and provincial conditions. In this project, it was pointed out that the innovation ecosystem cannot only consider the innovation of science and technology and the growth of economic system, but ignore the ecological security and sustainable development of other subsystems. An open and inclusive innovation ecosystem is dedicated to integrating scientific and technological innovation with social issues solving, and solving the unsustainable issues of business, society and ecological environment in the process of economic development. In this project, it was proposed that Jiangsu should build an open, inclusive and innovative ecosystem. In addition to continuing to deepen the drive of scientific and technological innovation, create a new highland by occupying the commanding heights of strategic industries and technologies, it is also necessary to provide equal opportunities and accessible innovative technologies and services for different social groups through inclusive innovation, combine scientific and technological innovation with improving people's livelihood and well-being, and give full play

to the important role of scientific and technological innovation in improving people's living standards, enhancing the scientific and cultural quality and health quality of the whole people, promoting high-quality employment and entrepreneurship, helping the poor and getting rid of poverty, and building a resource-saving and environment-friendly society, so that more innovative achievements can be shared by the people and the people's sense of gain can be enhanced.

Research achievements:

Research Report:
Study on Building up Innovation Ecosystem and Improving Innovation Intensity in Jiangsu Province

Project 4: Research on Information Clue and Digital Library Website Service Improvement

| Xiaopu Jin

Programme category: Philosophy and Social Science Research Programme of the Jiangsu Higher Education Institutions of China

Introduction: Because it can basically achieve the objective of 'any user can access any resources of the library at any time and any place', the concept of digital library has been widely welcomed by libraries and users since it was put forward. After more than 20 years of development, the theory and practice of digital library have made rich achievements. Currently, every university in China has basically built its own digital library website, which includes the full-text database purchased at home and abroad, abstract database, self-built characteristic database and open access network information resources. Literature survey indicates that although there are many researches on the current situation of digital library, most of the existing researches are conducted from the perspective of the current situation of digital library website construction. The status quo of users' satisfaction with digital library experience \is still very little.

Keywords: Information Clue, Digital Library, Website Service Improvement

Key issues solved: By checking the status quo of information clues of digital library websites at home and abroad, we found the characteristics, types and existing issues of information clues of digital library websites now. Then, a digital library website optimization model based on information clues was constructed and case studies was conducted to test its validity. Finally, the optimization strategy of digital library website was put forward.

Research achievements:

1）Publications (SCI、SCIE、SSCI、A&HCI、EI、CSSCI and A Guide to the Core Journal of China only)

No.	Category	Title	Author(s)	Journal Title	Publication Date
（1）	CSSCI	基于用户体验的数字图书馆网站现状调查与分析	金小璞	现代情报	2018.11
（2）	CSSCI	基于结构方程的移动图书馆用户体验满意度模型研究	金小璞、毕新	情报科学	2017.11
（3）	CSSCI	基于用户体验的移动图书馆服务质量提升机制构建	金小璞	现代情报	2017.11

2）Others

Research report:

Research on Information Clue and Digital Library Website Service Improvement

Project 5: On the Standard Framework for Chinese Undergraduates' English Academic Literacy Skills

| Zhoulin Ruan

Research fields: Linguistics and Applied Linguistics

Programme category: Philosophy and Social Science Research Programme of the Jiangsu Higher Education Institutions of China

Introduction: Since the Ministry of Education initiated the implementation of bilingual teaching in colleges and universities in 2001, bilingual teaching has become an important means to improve the quality of personnel training in colleges and universities and the internationalization of higher education in China. Bilingual teaching in domestic universities is similar to English as the Medium of Instruction (EMI) and Content-Integrated Language Learning (CLIL) (Coyle, et al., 2010; Cenoz, et al., 2014; Dalton-Puffer, 2011; Wannagat, 2007), and the main feature is to take the subject content as the curriculum arrangement and classroom teaching framework, and use English as the language tool to teach subject knowledge, so as to achieve the teaching goal of dual-focused approach of foreign language ability and subject knowledge.

Keywords: Academic English, Writing Academic Papers, English-Chinese Bilingual Research

Key issues solved:

1. The current situation of bilingual teaching with English as the teaching language in domestic universities and the demand for academic English was investigated.
2. The language barriers encountered by students in learning professional knowledge in English was investigated.
3. Based on the above research, the author hopes to lay a good foundation for the theoretical framework of academic English literacy in the future, and to fill the gaps in the research in this field in China.

Research achievements:

1）Publications (SCI、SCIE、SSCI、A&HCI、EI、CSSCI and A Guide to the Core Journal of China only)

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SSCI	Structural compression in academic writing: An English-Chinese comparison study of complex noun phrases in research article abstracts	阮周林	Journal of English for Academic Purposes	2018

Project 6: Discursive Mediation in Journalism Translation

| Hui Wang

Research field: Linguistics

Programme category: Philosophy and Social Science Research Programme of the Jiangsu Higher Education Institutions of China

Introduction: The concept of mediation has been widely discussed in the field of translation since it was first proposed by de Beaugrande and Dressler (1981), the Linguists. However, no relevant literature has been found on mediation in translation so far, and this researched aimed to fill this gap. Under the guidance of CDA, Text Linguistics and Systemic Functional Grammar, the research framework of mediation theory was constructed. This framework includes a micro-analysis model and a macro-analysis model. The micro-analysis model focused on the realization of mediation in the translation process (information selection and information expression stage) to reproduce the text world presented by the original text, while the macro model put mediation in a certain social environment and discussed the relationship between mediation and rights, ideology and norms.

Keywords: Discourse Mediation, News Translation, Information Selection and Structure, Information Presentation

Key issues solved: The short-term purpose of the project is to reveal the realization of discourse mediation in the process of news translation and the interactive relationship between mediation and ideology, power, economy and culture in the process of translation. Considering the universality of mediation in translation, the long-term objective of this research is to fully demonstrate the important role of mediation research in highlighting the interaction between translation and social structure, so as to deepen professional translators' understanding of mediation in translation and hope to be a useful supplement to translation teaching.

Research achievements:

1）Copyright

No.	Category	Title	Author(s)
(1)	书籍章节	《翻译中的语篇斡旋》（Investing Mediation in Translation），Said Faiq［编］, Discourse in Translation, Routledge: 67-90 页 .	田璐、王惠

2）Others

i. 研究报告《新闻翻译中的语篇斡旋》

ii. 邝献文，2019，"对苏州城市形象传播工作的策略性建议"，《西浦智库报告》.

Project 7: Consumer Adoption of Multi-Level Low-Carbon Innovations: Empirical Study in South Jiangsu Area

| Lixian Qian

Research fields: Business and Economy, Transportation Science, Environmental Research

Programme category: Philosophy and Social Science Research Programme of the Jiangsu Higher Education Institutions of China

Introduction: In the process of promoting low-carbon transformation, how to achieve 'sustainable transportation' is the most difficult issue now (Banister, 2008). In southern Jiangsu, encouraging the use of clean transportation tools and vigorously promoting advanced and efficient green transportation modes are one of the important means to achieve energy-saving and emission reduction and accelerate green and low-carbon development. However, most of the existing research on China's new energy vehicle market focused on the perspective of industrial policy analysis (e.g. Fu Guixing, 2013; Jiang Li, Yang Yaping, 2012; Zhang Yong et al., 2014). A small amount of research from the individual level of consumers failed to consider the coexistence of multi-intensity innovative products (such as non-plug-in hybrid vehicles, plug-in hybrid vehicles, and pure electric vehicles) in the new energy vehicle market (such as Zhang et al, 2011; Xiang Shijian, Ma Tieju, 2014) or lack of systematic support for low-carbon innovation theory (such as Qian & Soopramanien, 2011). Thus, the research on China's new energy vehicle market needs an in-depth analysis of the individual preferences and behaviors of consumers, and a systematic research on the adoption mechanism of low-carbon innovation.

Keywords: Low-Carbon Innovation Adoption, Joint Analysis, Discrete Choice Model (DCM), New Energy Vehicles

Key issues solved: By constructing a social technology system of multi-intensity low-carbon innovation, the adoption mechanism of low-carbon innovation was deeply explored. Based on the actual needs of modernization development in southern Jiangsu, an empirical research on the adoption of new energy vehicles in southern Jiangsu was carried out, thus forming the theoretical contribution and practical application value of this project.

Research achievements:

1) Publications (SCI、SCIE、SSCI、A&HCI、EI、CSSCI and A Guide to the Core Journal of China only)

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SSCI & SCIE	Linking Chinese Cultural Values and the Adoption of Electric Vehicles: The Mediating Role of Ethical Evaluation	钱力显、尹珏林（共同第一作者）	Transportation Research Part D: Transport and Environment	2017.10
(2)	SSCI & SCIE	Consumer preferences for electric vehicles in lower tier cities of China: evidences from south Jiangsu region	黄幼麟、钱力显（通讯作者）	Transportation Research Part D: Transport and Environment	2018.8
(3)	SSCI & SCIE	The impact of service and government-policy attributes on consumer preferences for electric vehicles in China	钱力显、Jose M. Grisolia, Didier Soopramanien（第一作者）	TRANSPORTATION RESEARCH PART A-POLICY AND PRACTICE	2019.4

2）Others

Research Report:

Consumer Adoption of Multi-Level Low-Carbon Innovations: Empirical Study in South Jiangsu Area

Project 8: Research on Green Consumption Behavior Pattern and Its Influencing Factors of Suzhou Residents

| Juelin Yin

Programme category: Philosophy and Social Science Research Programme of the Jiangsu Higher Education Institutions of China

Introduction: Developing green economy is the only way to implement the scientific concept of development and the inevitable choice of national resources and environmental conditions and the requirements of the times. Green economy is a new economic development model with 'reduction, reuse and recycling' as the core; while green consumption pattern is a new consumption behavior and process characterized by moderately controlling consumption, avoiding or reducing environmental damage, advocating nature and protecting ecology. In the process of building a green economic development model, the role of green consumption cannot be ignored.

Keywords: Green Consumption, Behavior Pattern, Influencing Factors, Suzhou City

Key issues solved:

1. Identify the green consumption attitude and behavior characteristics of Suzhou residents.
2. Explore the psychological consciousness factors, situational factors and personal factors that influence the transformation of consumers' green attitude into green purchasing behavior.

Research achievements:

1) Publications (SCI、SCIE、SSCI、A&HCI、EI、CSSCI and A Guide to the Core Journal of China only)

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SSCI	Sharing Sustainability: How Values and Ethics Matter in Consumers'Adoption of Public Bicycle-Sharing Scheme	尹珏林	Journal of Business Ethics	2016
(2)	SSCI	Linking Chinese cultural values and the adoption of electric vehicles: The mediating role of ethical evaluation	尹珏林、钱力显	Transportation Research Part D: Transport and Environment	2017
(3)	SSCI	Business Ethics in the Greater China Region: Past, Present,and Future Research	尹珏林	Journal of Business Ethics	2016

2）Others

Research Report:

Research on Green Consumption Behavior Pattern and Its Influencing Factors of Suzhou Residents

Project 9: How to Achieve Innovation Catch-up for Late-Developing Enterprises: Research on How Do Latecomers Catch up: Internationalization, Institutions and Innovation of Firms in Emerging Economies

| Fangrong Li

Research fields: Strategic Management, International Business, Innovation Management

Programme category: Philosophy and Social Science Research Programme of the Jiangsu Higher Education Institutions of China

Introduction: In this project, the relationship between internationalization behavior and innovation ability of enterprises in emerging economies was researched. From the perspective of 'latecomer' theory, internationalization is an important way for enterprises in emerging economies to seek foreign high-quality strategic resources, learn and absorb them, and improve their capabilities and performance. However, there are relatively few researches on how the internationalization of enterprises contributes to the promotion of innovation ability. For this deficiency, the influence relationship and mechanism of internationalization of Chinese enterprises on enterprise innovation was discussed in this project. Using corporate learning and institutional perspectives for reference, how the internationalization activities of Chinese enterprises, especially cross-border mergers and acquisitions, affect the innovation ability of enterprises, was researched in this project. The research results revealed that the characteristics of enterprises (such as acquisition scale, performance before acquisition, absorptive capacity) and the institutional differences between home country and host country (including regulatory environment differences and cultural differences) jointly affect the extent to which enterprises can bring innovation ability and performance improvement through cross-border mergers and acquisitions.

Keywords: Emerging Economies, Internationalization of Enterprises, Institutional Environment, Innovation

Key issues solved:

The influence of enterprise internationalization on enterprise innovation.
The mechanism of enterprise internationalization for enterprise innovation.
The influence of institutional environment on enterprise innovation.
The interactive influence of institutional environment and enterprise internationalization on enterprise innovation.

Research achievements:

Research Report:
How to Achieve Innovation Catch-up for Late-Developing Enterprises: Research on How Do Latecomers Catch up: Internationalization, Institutions and Innovation of Firms in Emerging Economies

Project 10: The Role of Students in University's Quality Assurance System

| Xiaojun Zhang

Programme category: Philosophy and Social Science Research Programme of the Jiangsu Higher Education Institutions of China

Introduction: Based on the case of Xi'an Jiaotong-Liverpool University, we proposed the four key characteristics of student-centered, result-oriented and continuous improvement quality assurance system in this research:
1. Student-centered teaching philosophy
2. A systematic quality management system is established
3. The student group is extensive and highly involved to ensure the best learning experience for students
4. The quality assurance system is guided by continuous improvement and perfection

Keywords: Students, Teaching Quality Assurance System in Colleges and Universities, Student-Centered

Key issues solved: The first research content of this research is to identify the key elements of university teaching quality assurance system from the perspective of 'student-centered', that is, the key components of students' learning process and learning experience. The second content is the role that students can play in ensuring their own learning experience and the third research content is how the university quality assurance system guarantees students' role in quality construction.

Research achievements:

Research Report:
The Role of Students in University's Quality Assurance System

Project 11: Research on the Cultivation Mode of College Students' Comprehensive Quality under the Background of Ecological Civilization Construction

| Bing Chen

Programme category: Philosophy and Social Science Research Programme of the Jiangsu Higher Education Institutions of China

Introduction: The purpose of this project is to explore the feasibility of combining scientific research with personnel training in higher education by taking architectural environment related disciplines (including urban planning, civil engineering, architecture and landscape) as examples. Taking the construction of ecological civilization as the breakthrough point of connecting with international sustainable education and by comparing and analyzing the characteristics of different quality education under the three modes of Chinese, Western and Chinese-Western cooperation in running schools as well as the influence of different teaching modes on students related knowledge, initiative and values, especially the cultivation of social responsibility, innovative spirit and practical ability required by ecological civilization construction, we took the lead in putting forward a new education mode of cultivating students' sustainable comprehensive quality by using research-oriented teaching mode. By emphasizing the importance of ecological civilization construction, the project team pointed out that it is urgent to combine 'scientific research' with 'personnel were training' in higher education now, and take 'cultivating people by virtue' as its fundamental task. Through establishing and popularizing the correct concept of sustainable development education, the research and practice of 'orientation of education objective, construction of curriculum and teaching materials, innovation of education mode and construction of school campus' have been carried out. By deepening the research-oriented teaching reform and actively exploring the concrete methods of improving the quality of education and implementing quality education, the purpose is to cultivate the comprehensive quality of contemporary college students, which integrates 'social responsibility, innovative spirit and practical ability'.

Keywords: Higher Education, Education for Sustainable Development, Research Orientation, Teaching Reform, Comprehensive Quality

Key issues solved: The purpose of this project is to explore how to strengthen the comprehensive quality training of talents under the background of ecological civilization construction through research-oriented teaching reform, taking architectural environment related majors as an example. Based on the principle of 'looking at the sky from the pipe, prick the earth with an awl - see big things but the visible part is very small and prick big things but the piercing part is very small', I hope this project can play a reference role for the further integration of scientific research and personnel training based on the scientific concept of development.

Research achievements:

1） Copyrights

No.	Category	Title	Author(s)
(1)	著作章节	研究导向型教学模式的应用探索，《研究导向型教育：以学生为中心的教学创新及案例》	陈冰
(2)	著作章节	"A Pedagogical Approach to Designing the Future of China＇s Urban Fringe 从教学法出发探讨如何设计未来中国的城市边缘" in "Urban China's Rural Fringe: Actors, dimensions and management challenges.《城市化中国的城乡边缘：参与者，规模及管理挑战》	Rebecca Kiddle, Joon Kim, 陈冰

2） Publications (SCI、SCIE、SSCI、A&HCI、EI、CSSCI and A Guide to the Core Journal of China only)

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	A Guide to the Core Journal of China	研究导向＋混合"教学模式的应用探索	陈冰	中国成人教育	2018

3） Others

Research Report:

Research on the Cultivation Mode of College Students' Comprehensive Quality under the Background of Ecological Civilization Construction

Project 12: Research and Practice of Enhancing Tertiary EFL Students' Collaborative Learning in an Wiki-Based Context

| Bin Zou

Research fields: Web 2.0, Foreign Language Learning

Programme category: Higher Education Reform Research Programme in Jiangsu Province

Introduction: In this research, two universities in the UK set up a Web site on Wiki to provide a platform for English and Chinese learners to communicate and cooperate with each other. Some activities are designed to guide students from both sides to communicate with each other on Wiki and promote their foreign language learning, so as to improve their communicative competence and collaborative learning skills. Questionnaires and interviews were given to the students participating in the research, and then analysis was carried out to write the project research report. Our research objective is to research which activity design can promote students' cooperative learning more effectively through the communication between Chinese and foreign students on Wiki. The results indicates that Chinese and English students actively engage in collaborative learning on Wiki websites, which promotes foreign language learning of students from the Parties. For the research results, two SSCI articles in international journals and one Scopus journal article were published.

Keywords: Web 2.0, Wiki, English, Chinese, Collaborative Learning

Key issues solved:

What kind of activities can be designed on Wiki network platform to promote students' collaborative learning?

How effective is Wiki in promoting students' collaborative learning of foreign languages?

Research achievements:

1) **Publications (SCI、SCIE、SSCI、A&HCI、EI、CSSCI and A Guide to the Core Journal of China only)**

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SSCI	Collaborative tasks in Wiki-basedenvironment in EFL learning.	Zou, B., Wang D.S., Xing, M, J.	Computer Assisted Language Learning	2016
(2)	SSCI	Students' Perception of a Wiki Platform and the Impact of Wiki Engagement on Intercultural Communication.	Wang, J.H., Zou, B., Wang D.S., Xing, M, J	System	2013

Project 13: The Innovation and Investigation of the Undergraduate Mathematical Teaching under the Frame of Sino-Western Cooperation

| Gang Liu&Jingming Guo (PI)

Research field: Mathematics

Programme category: Higher Education Reform Research Programme in Jiangsu Province

Introduction: After long-term teaching practice and accumulation, calculus and linear algebra courses in Chinese universities have formed extremely rich teaching resources. Especially, through the teaching reform since 1990s, a large number of new achievements have been added, which not only cover a wide range of contents, but also have more diverse forms, and play an important role in improving teaching quality. Meanwhile, in order to meet the needs of scientific and technological development and personnel training, western developed countries, represented by the United States, have also done a lot of work in the construction of teaching resources for basic mathematics courses, forming a large number of new resources with obvious application characteristics and close combination with modern technical means. The objective of the project is to find out the teaching resources (or methods) that are needed in China from the teaching reality and to independently develop new characteristic resources based on foreign excellent teaching cases (resources) - the ultimate objective is not only to integrate the strengths of each family, but to meet the teaching needs in China. Relevant teaching resources at home and abroad were analyzed comprehensively, their advantages were explored in depth, and the integration and improvement of teaching resources between the two sides was promoted. We strove to make our resources more international and the sinicization of international resources to meet the needs of domestic teaching development, and also build new resources that can reflect the advantages of Chinese and American teaching and make them a distinctive part of China's mathematics teaching resources library. Two monographs and several papers were completed during the implementation of the project, which formed a set of teaching contents of basic mathematics courses suitable for Sino-foreign cooperation in running universities.

Keywords: Basic Mathematics Teaching, Calculus, Linear Algebra, Sino-Foreign Cooperation in Running Universities

Key issues solved: Basic Mathematics Course Teaching Suitable for Sino-foreign Cooperation in Running Universities

Research achievements:

1) **Copyrights**

No.	Category	Title	Author(s)	Publisher	Publication Date
(1)	教材	美国微积分精粹摘评	郭镜明，韩云瑞，章栋恩，刘刚等	高等教育出版社	2011 年
(2)	教材	线性代数	谢国瑞，刘刚等	高等教育出版社	2013 年

Project 14: Study on Mobile Library Service Quality Improving Mechanism based on User Experience

│ **Xiaopu Jin**

Programme category: Humanities and Social Science Program of Ministry of Education of PRC (MoE) - Young Scientists Fund

Introduction: First, on the basis of using the existing results for reference, a questionnaire on the status quo of digital library websites based on user experience was designed. Second, the users of digital library was investigated by means of convenient sampling, and the survey data was systematically analyzed from the aspects of interface design, system function, user service and information security. Finally, the optimization strategies of digital library website was proposed, such as interface design optimization, system function optimization, user service optimization and information security optimization.

Keywords: User Experience, Digital Library, User Satisfaction, Website Optimization

Key issues solved: From the perspective of user experience, the users' satisfaction with digital libraries in China was investigated, the issues existing in the construction of digital libraries in China was found from a new perspective, and the corresponding countermeasures were provided to solve these issues in order to provide support for the service improvement of digital libraries in China.

Research achievements:

1） Publications (SCI、SCIE、SSCI、A&HCI、EI、CSSCI and A Guide to the Core Journal of China only)

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	CSSCI	基于结构方程的移动图书馆用户体验满意度模型研究	金小璞、毕新	情报科学	2017.11
(2)	CSSCI	基于用户体验的移动图书馆服务质量影响因素分析	金小璞、毕新	情报理论与实践	2016.6

2） Others

Research Report:

Study on Mobile Library Service Quality Improving Mechanism based on User Experience

Project 15: The Antecedent and Competitive Advantages of Corporate Social Responsibility Strategy: Evidence from China

│ **Juelin Yin**

Programme category: Humanities and Social Science Program of Ministry of Education of PRC (MoE) - Young Scientists Fund

Introduction: Under the background of accelerating economic globalization and intensifying social changes, China, as the largest transitional country in the world, is undergoing tremendous turbulence and changes in its economic and social outlook. With the deepening of reform and opening up, although China's traditional industrialization road has achieved rapid economic growth, it has also brought about the aggravation of environmental pollution, natural ecological deterioration, social injustice and other issues. Promoting corporate social responsibility has increasingly become a hot project related to the national economy and people's livelihood.

Keywords: Corporate Social Responsibility, Motivation Mechanism, Legitimacy, Resources, Institutional Theory

Key issues solved:

1. Only the mechanism of transforming corporate social responsibility into competitive advantage can be explored by identifying the pre-factors of corporate social responsibility strategy and analyzing the process of formulating and implementing corporate social responsibility strategy.
2. Corporate social responsibility is context-dependent, and the strategic choice of corporate social responsibility is the result of the interaction between market orientation, social responsibility orientation and external institutional environment and industry environment.

Research achievements:

Research Report:
The Antecedent and Competitive Advantages of Corporate Social Responsibility Strategy: Evidence from China

3. Municipal Projects

Project 1: Firm Price-Setting Behavior Analysis in the Background of Consumption Upgrade: Based on Big Data from E-commerce

| Kun Tian

Programme category: Soft Science Research Programme of Suzhou Association for Science and Technology

Introduction: A unified analysis framework of micro-price adjustment frequency measurement was established in this research. First, chart method was used to analyze the weight of each main component of consumer price index, to analyze the monthly frequency of price changes of various kinds of goods and services, to decompose the price adjustment into price increase and price decrease, to focus on the specific changes of price adjustment in each month, and to explore the seasonal characteristics of price adjustment. Second, the different attributes of price adjustment was analyzed, and the conventional price adjustment, promotional discount price adjustment and price adjustment brought by the emergence of substitutes were emphatically distinguished. Finally, the characteristics of micro-price adjustment from three aspects: form, path and effect were summarized. In the research, it was found that after using the micro-price data that constitute the consumer price index, excluding the influence of promotional discount price adjustment and substitute price adjustment, the frequency of conventional price adjustment decreased, indicating obvious seasonal characteristics, and there are great differences among different categories of goods and services. The difference between the frequency of price increase and price decrease also persisted. The survival analysis model of micro-price adjustment in time series dimension was improved.

Key issues solved: The relevant important factors affecting manufacturers' price adjustment was analyzed and the impact mechanism of global economic crisis on manufacturers' pricing was investigated. From the perspective of consumers, the differences of consumers' purchasing behavior characteristics among different age groups and the resulting differences in actual payment prices were analyzed.

Research achievements:

Research Report:
Firm Price-Setting Behavior Analysis in the Background of Consumption Upgrade: Based on Big Data from E-commerce

Project 2: Investigate the Verbal Communication in Multilingual Context and Strengthen the External Service of Taxis in Suzhou

| Marina Dodigovvic

Programme category: Suzhou social science planning programme - applied strategy

Introduction: Suzhou's transportation and taxis are convenient and fast, and the service is very satisfying. However, with the development of vibrant multiculturalism in Suzhou and the progress of tourism, foreigners from all over the world come to Suzhou with different languages. As a result, a new issue arises: In the absence of an interpreter, it is often difficult for foreigners to communicate effectively with service providers. Admittedly, taxi reservations can be made through the Internet. However, even the last step of booking by mobile phone or Internet still requires to be confirmed by the taxi driver by calling, which requires foreigners to communicate in Chinese. Although many foreigners try hard to learn Chinese, as the only listening channel, calling is still very limited for foreigners (Yule, 2009). Thus, foreigners trying to speak Chinese are often misunderstood, and so are local drivers, especially when they speak dialects, which will also cause obstacles in language communication. The consequences of this communication barrier are often very serious, which can lead the service provider to blacken or block this number, so that the caller has no choice for customized transportation services in the city. On the other hand, for the taxi industry and drivers, this means losing customers. From a macro point of view, this will directly affect the life and tourism of foreigners in Suzhou and indirectly affect the development of multiculturalism in Suzhou. In this case, technical solutions or additional training can help service recipients and providers (Yuan, Moore & Grierson, 2008).

Key issues solved: Investigated the language-level causes of language communication barriers or communication failures between taxi drivers and foreigners in Suzhou taxi service industry, and gave the practical technical solutions or training programs.

Research achievements:

Research Report:
Investigate the Verbal Communication in Multilingual Context and Strengthen the External Service of Taxis in Suzhou

Project 3: Extending Suzhou's Cultural Heritage Tourism into the Future

| **Holger Briel**

Programme category: Suzhou social science planning programme-applied strategy

Introduction: The project of 'Community-led Cultural Heritage Development: Making Suzhou's cultural heritage tourism further successful in the future' was conceived in the first half of 2014, and then applied for project establishment and implemented in Suzhou in August, September and October 2014. The original reason for this project is that Suzhou is a cultural capital, and the cultural industry is also an important source of income for the local economy. However, currently apart from Tiger Hill, Suzhou Gardens or Pingjiang Road and other traditional tourist attractions, Suzhou's popularity in the fields of art and tourism is relatively limited. The proposed project will improve this situation by reaching out to various artists and seeking their views on themselves, their works of art and the relationship between Suzhou. After the recent introduction of 'Community-led tourism theory' into tourism research technology, we hoped that artists' insights can help implement wider and more targeted promotion activities, and improve the popularity of Suzhou's current cultural attractions among domestic and foreign tourists.

Key issues solved: Collected and focused on the views of cultural practitioners on how to promote cultural tourism so that Suzhou officials can have an in-depth understanding of how to use these cultural practitioners in their tourism promotion activities. Use these videos in the future Suzhou cultural heritage tourism promotion activities to provide cultural practitioners with opportunities to introduce their works so as to describe Suzhou cultural practitioners in more detail. These meticulous customers can be expanded in the future, and relevant interviews and project records will be provided to researchers, government officials and students in the future to further analyze current and future cultural tourism needs, highlighting the importance of these artists and their access to more sources of income for cultural heritage tourism.

Research achievements:

Research Report:
Extending Suzhou's Cultural Heritage Tourism into the Future

Project 4: Establishing a Community based Mechanism to Foster New Urban Citizens

| **Xiaonan Zhang**

Programme category: Suzhou social science planning programme-applied strategy

Introduction: One of the humanistic connotations of new urbanization is to emphasize the transformation of urbanization level from quantitative growth to quality growth. Its core is not the high-rise building of the city, but the citizenization of people. The National New Urbanization Plan (2014-2020) issued by Xinhua News Agency in March this year pointed out that 'a large number of agricultural transfer population is difficult to integrate into urban society, and the process of citizenization lags behind. Currently, the migrant workers have become the main body of industrial workers in China. Affected by the household registration system of urban-rural division, 234 million migrant workers and their accompanying families, who are counted as urban population, fail to enjoy the basic public services of urban residents in education, employment, medical care, old-age care and affordable housing. The integration of production and city is not close, industrial agglomeration and population agglomerations are out of sync, and urbanization lags behind industrialization. New dualistic contradictions appear in cities and towns, and the issues of left-behind children, women and the elderly in rural areas have become increasingly prominent, bringing many potential risks to economic and social development. The way to solve this issue is to 'promote migrant workers' integration into enterprises, children's integration into schools, families' integration into communities, and groups' integration into society and build inclusive cities'.

Key issues solved:

1. The living and working status of relocated residents and migrant workers are the main issues faced by their social integration and role transformation
2. The strategies and measures that the government and relevant enterprises and institutions may adopt to 'recruit new members' and 'cultivate new members'
3. Develop the working mechanism of cultivating new citizens based on community

Research achievements:

Research Report:
Establishing a Community based Mechanism to Foster New Urban Citizens

Project 5: Innovation Ecosystem in Suzhou: Status and Suggestions

| **Xuanwei Cao**

Research field: Regional Development

Programme category: Suzhou social science planning programme-applied strategy

Introduction: Combining closely with Suzhou's economic and social development goals during the 13th Five-Year Plan and the opinions of the municipal government on building a first-class innovation ecology and building a famous city of innovation and entrepreneurship, the constituent elements, system structure and function of Suzhou's innovation ecosystem under the basic guidance of system theory were analyzed in this research. Based on the system perspective, the subsystems and innovation elements of Suzhou innovation ecosystem was analyzed, the shortcomings in the development of Suzhou's innovation ecosystem were found out, the specific suggestions from the aspects of institutional innovation, knowledge innovation, organizational innovation, entrepreneur innovation, social innovation, integration innovation of 'production and education' and 'science and education' were analyzed and put forward. It was proposed to introduce the idea of 'Social Innovation' into the policy formulation and construction process of innovation ecosystem, strengthen Suzhou's 'source innovation', and continuously promotes Suzhou to become the 'source' of innovation through institutional innovation.

Keywords: Innovation Ecology, Source Innovation, Institutional Innovation, Knowledge Innovation, Organizational Innovation and Social Innovation

Key issues solved: How to promote the flow of creative ideas in a wider range of subjects, to improve the cross-border flow and integration of creativity, talents, knowledge, technology, capital and other innovative resources, how to build an innovation platform, to promote the interaction and competition among innovation subjects in the whole process from creative generation, to research and develop to market-oriented innovation, to improve the ecological efficiency of the whole open innovation system and achieve rapid growth, and to explore the operation mechanism of the open innovation ecosystem has become an important topic concerned by scholars and policy departments.

Research achievements:

Research Report:
Innovation Ecosystem in Suzhou: Status and Suggestions

Project 6: Revitalising Suzhou Countryside through the Regeneration of Township-Village Enterprises

| **Yiwen Wang**

Research fields: Urban and Rural Planning, Urban and Rural Planning Management

Programme category: Suzhou Science and Technology Development Planning Programme

Introduction: Under the background that the country vigorously promotes the rural revitalization strategy now and under the current situation of Suzhou rural tourism, which emphasizes material and neglects culture, in this research, it is hoped to realize rural revitalization by guiding diversified social capital to participate in rural construction. Starting from the domestic and foreign case studies of social capital participating in the construction of rural tourism projects, we analyzed and summarized the advantages and disadvantages of various types of social capital investing in rural areas, explored the rural cultural resources to be developed in Suzhou, cultivated rural cultural and creative industries, and promoted the integration and development of rural primary, secondary and tertiary industries. It is expected to provide new ideas and feasible ways for rural revitalization in Suzhou by attracting social capital from all sides to develop rural cultural tourism in Suzhou.

Keywords: Diversified Social Capital, Cultural Resources, Rural Cultural and Creative Industries, and Integration and Development of Primary, Secondary and Tertiary Industries

Key issues solved: How to guide diversified social capital to participate in Suzhou rural cultural tourism. How to use existing cultural resources to develop rural cultural tourism and cultural creative industries?

Research achievements:

Research Report:
Revitalising Suzhou Countryside through the Regeneration of Township-Village Enterprises

Project 7: Research on Building up Green, Low-Carbon, and Circular Economy System in Suzhou

| Xuanwei Cao

Research field: Regional Sustainable Development

Programme category: Suzhou social science planning programme - applied strategy

Introduction: Exploring the establishment and improvement of a green, low-carbon and circular economic system actively is a strategic choice for Suzhou to break through resource and energy constraints and achieve sustainable development, and it is also an important fulcrum for Suzhou to consolidate and enhance its regional competitiveness and international core competitiveness. Suzhou should uphold the system view based on social-economic-technical system in the process of establishing a green and low-carbon circular economy development system, carry out positioning of future urban development of Suzhou from a higher level, a longer-term and a more international perspective. Compared with the relevant policy tools of countries and cities with better green and low-carbon circular economy construction at home and abroad, combined with the social, economic and technological development of Suzhou, we should strengthen institutional coordination, build a green and low-carbon circular economy at a higher level, and pursue high-quality development and sustainable development, so as to promote the perfection of each subsystem and sub-goal in the construction of a green and low-carbon circular economy system. Based on combing the existing policy tools, the guiding opinions of Suzhou's construction of green and low-carbon circular economy system were put forward from eight aspects in this report, and then the implementation path and safeguard measures were put forward from six aspects, which pointed out the direction for Suzhou to further improve the construction of green and low-carbon circular economy system in a more complete and forward-looking way.

Keywords: Green and Low-Carbon Cycle, Economic System, Social-Economic-Technical System, Urban Positioning, Institutional Coordination

Key issues solved: Building a green and low-carbon circular economic system is a socio-economic and technological system involving economy, society, environment, science and technology and other aspects, which is related to major changes in production mode, consumption mode, circulation mode, lifestyle, innovation mode and values. At a time when Suzhou's social and economic development is changing towards a higher quality development model, it is of great practical guiding significance to sort out and summarize Suzhou's practice and achievements in building a green and low-carbon circular economy system, discuss the mechanism and path of further improving Suzhou's green and low-carbon circular development economy system, and discuss and analyze the effective operation of the green and low-carbon circular development system.

Research achievements:

Research Report:
Research on Building up Green, Low-Carbon, and Circular Economy System in Suzhou

Project 8: Big Data Analysis on Suzhou House Price

| Hao Lan

Research fields: Econometrics, Micro Pricing Analysis, Real Estate Economics

Programme category: Suzhou social science planning programme - applied strategy

Introduction: In China, the housing price level can reflect the development level of a city and affect the competitiveness of sustainable development of a city to some extent. As an important livelihood issue, 'housing price' has always been the focus of Government Departments. In this project, micro-transaction data were used to select variables as characteristics. Finally, the hedonic price model was used to estimate the linear relationship between these variables and housing prices, and five conclusions were drawn in order to provide decision-making reference for the government to better control housing prices.

Keywords: Suzhou, House Prices, Big Data, Hedonic Price Model

Key issues solved: Under the background of big data, the micro-influencing factors and degree of housing prices from the market perspective were explored in order to provide decision-making reference for the government to better control housing prices.

Research achievements:

Research Report:
Big Data Analysis on Suzhou House Price

Project 9: Impact of Low Birth Rate on the Future Social Economic Development in Suzhou

| M.B.N (Thijs) Kouwenhoven

Programme category: Suzhou Science and Technology Development Planning Programme

Introduction: Suzhou is facing the issues of aging population and persistently low fertility rate. Although Suzhou has taken a series of measures to increase the birth rate in recent years, there is no obvious improvement. If more effective action is not taken, Suzhou will bear a series of financial, social and economic consequences caused by population aging. In this research, we provided comprehensive population projections so that we are able to predict the impact of various population-related policy decisions. We found that the effects of ageing can be mitigated by increasing the total fertility rate and the continuous influx of young immigrants and the employment of temporary migrant workers. Based on our research results, we provided a series of suggestions to maintain Suzhou's sustained economic growth and satisfying citizens' welfare. In terms of population, we recommended raising the fertility level in Suzhou and strongly recommended a net inflow of 80,000-100,000 new Suzhou immigrants every year. In addition, by attracting high-level employees, improving the education level of the local population, and shifting the focus from industry to diversified and innovative economy, we can achieve sustained GDP growth. The most important point is that the retirement age limit should be raised to about 70 years in the next 10 to 20 years, the mandatory age limit for retirement should be abolished and the minimum age for retirement should be extended. Finally, our model projections indicate that sustained economic growth and prosperity are closely related to population growth, economic diversification and population ageing. With the growth of population, local governments should prepare to cope with the resulting increase in demand for public services, social services and infrastructure, and also provide people with a green and healthy living environment to cultivate and attract highly skilled workers and investment.

Keywords: Socio-Economic Impact, Population Dynamics, Forecast, Speculate, Labor Availability, Policy Recommendations

Key issues solved:
1. What is the impact of the current low birth rate on the future development of population in Suzhou? What impact will the local government's policies on population have?
2. How does the changing population in Suzhou affect the labor market? How can education, immigration, diversity and adjustment of retirement age be used to solve these issues?
3. With the development of population, how can the local government improve the volume and efficiency of public services, and what actions should be taken to maintain a clean and healthy living environment?

Research achievements:

Research Report:
Impact of Low Birth Rate on the Future Social Economic Development in Suzhou

Project 10: Exploring Slow Tourism Strategies for the Sustainable Redevelopment of Historic Suzhou

| Christian Nolf

Programme category: Suzhou Science and Technology Development Planning Programme

Introduction: The vigorous development of tourism has had a great impact on China's historical environment. The opportunity of urban renewal and the threat to real urban life and local culture coexist. Thus, it is necessary to construct the development of tourism in an all-round way. In this term, the ancient city of Suzhou can be regarded as an illustrative case. The ancient city of Suzhou is polarized between over-commercialized scenic spots and declining communities. Taking the emerging concept of 'slow tourism' as a framework and drawing lessons from international advanced case studies, in this project, how alternative, bottom-up, spatially distributed and locally integrated tourism forms in ancient city of Suzhou can contribute to the long-term development and sustainable regeneration of historical and cultural cities and their communities was discussed.

Keywords: Slow Tourism, Sustainable Cities, Historic City, Legacy, Livable

Key issue solved: How did slow tourism promote the sustainable renewal and development of famous historical cities in China?

Research achievements:

Research Report:

Exploring Slow Tourism Strategies for the Sustainable Redevelopment of Historic Suzhou

Awards: October 2019: "Heritage and Innovation Award" for the exhibition 'Reinventing Suzhou' at the Suzhou Design Week 2019. Curatorial team: Nolf, C., with Attuyer K., Pellegrini P., Vannoorbeeck F. and Vardy D. https://www.xjtlu.edu.cn/en/news/2019/11/xjtlu-shines-at-suzhou-design-week

Project 11: Studies on Building up Open and Inclusive Innovation Ecosystem in Suzhou

| Xuanwei Cao

Research fields: Regional Innovation Ecosystem

Programme category: Suzhou Social Science Planning Programme

Introduction: The "Four Questions on Innovation" and asking how the innovation path and innovation ecosystem of innovative countries and regions evolved and developed can not be separated from asking and pondering the 'Social Innovation'. Looking at the innovation ecosystems of major innovative countries and regions, their evolution and development always emphasize the application of open and inclusive principles to build innovation ecosystems. Applying the logic of open and inclusive innovation in the fields of science and technology and knowledge innovation, emphasizing improving the effective supply of systems and policies and paying more attention to promoting the integration of technology and social innovation means to provide innovative solutions to solve social issues.

Keywords: Innovation Ecosystem, Social Innovation, Institutional Innovation

Key issues solved: How to further build Suzhou into an innovative highland facing the forefront of world science and technology, the main battlefield of national economy and the major strategic needs of the country, and explore the development path of innovative ecosystem with Suzhou characteristics.

Research achievements:

Research Report:
Research on the Countermeasures of Constructing an Open, Inclusive and Innovative Ecosystem in Suzhou

Project 12: Research on Existing Key Problems and Measures in the Ecological Civilization Construction in Suzhou

| Xuanwei Cao

Research fields: Ecological Civilization, Sustainable Development and Environmental Governance

Programme category: Suzhou Social Science Planning Programme - Applied Strategy

Introduction: Ecological civilization construction has become an important strategic part of the overall layout of socialism with Chinese characteristics. As an important part of national governance, ecological governance system and governance capacity have become shortcomings that hinder the transformation of social and economic development. Building a modern ecological governance system and promoting the modernization of ecological governance are the only way to build a highly developed ecological civilization. A prominent paradox in the current ecological civilization construction is that on the one hand, the central government has shown great concern for environmental issues, formulated a large number of laws and regulations at the central government level, established a top-down environmental administrative system, and actively participated in international cooperation in environmental affairs. On the other hand, many local governments have made unsatisfactory improvement in environmental performance after investing heavily in environmental remediation and governance, the situation of 'partial improvement and overall deterioration' is still a reality, and the environmental quality of atmosphere, water and soil continues to deteriorate. In view of this situation, one of the key points of ecological civilization construction should be to strengthen policy and institutional innovation in dealing with economic development and environmental pollution and seeking more effective environmental management and resource management to realize the transformation of environmental management means from traditional government management to governance, and from hierarchical management to various forms of cooperative governance structure. The main position of ecological civilization construction is the environmental governance. Establishing an effective environmental governance system, giving full play to the governance function of environmental system, promoting the ability of environmental governance subjects, including strengthening the cultivation of social organizations, supporting residents' community autonomy by government departments, citizens' participation in public decision-making on environmental affairs, and stimulating the subjective initiative of enterprises to fulfill their environmental and social responsibilities are the key points that need to be deepened and broken through in the future construction of local ecological civilization.

Keywords: Ecological Civilization, Governance Mechanism, Environmental Governance and Sustainable Development

Key issues solved: The main position of ecological civilization construction is the environmental governance. To build ecological civilization, we need to improve the environmental governance system and improve the environmental governance capacity, break through the traditional outdated ideological understanding that 'economic development depends on the market and environmental protection depends on the government', build an environmental governance system of 'pluralism, coordination and co-governance', solve the dilemma of environmental protection, control environmental pollution, improve environmental quality, and realize the green transformation of economic growth mode. By promoting the modernization of environmental governance, we can solve outstanding issues in the field of ecological environment, ensure national ecological security, improve resource utilization efficiency and promote the formation of a new pattern of modernization with harmonious development between man and nature.

Research achievements:

Research Report:
Research on Existing Key Problems and Measures in the Ecological Civilization Construction in Suzhou

Project 13: Research on the Path of Implementing the 'Open Concept' in Suzhou

| Xuanwei Cao

Programme category: Suzhou Social Science Planning Programme - Advice for Policy Making

Introduction: Implementing the five development concepts, keeping pace with the times, enriching and perfecting the development strategy, leading the transformation of development mode with the transformation of development concept, promoting the improvement of development quality and efficiency with the transformation of development mode and striving to achieve higher quality, more efficient, fairer and more sustainable development are the important policy objectives of Suzhou to be the vanguard of building a 'strong, rich, beautiful and high' new Jiangsu. Implementing the concept of open development is not only an objective requirement for realizing the qualitative improvement of economic development, but also requires us to use the methodology, strategic thinking and innovative thinking contained in the concept of open development to interpret the concept of open development from a full perspective from the perspective of promoting governance modernization and improving governance capacity. Based on the core gist of the open concept, we expounded from four dimensions: government opening, economic opening, education and scientific research opening and cultural opening, and put forward specific paths and policy suggestions for Suzhou to implement the open concept.

Keywords: Open Concept, Government Opening, Economy Opening, Education and Scientific Research Opening, Culture Opening

Key issues solved: We expounded from four dimensions: government opening, economic opening, education and scientific research opening and cultural opening, and put forward specific paths and policy suggestions for Suzhou to implement the concept of opening.

Research achievements:

Research Report:
Research on the Path of Implementing the 'Open Concept' in Suzhou

Project 14: Social Media Information Identified Suzhou Tourism Characteristics and Tourists' Tourism Identity - Draw the Tourism Characteristic Catalogue and Prepare for International Tourism Strategy with Intelligent Tourism Research Method

| Joon Sik Kim

Research field: Urban planning

Programme category: Suzhou Social Science Planning Project (Applied Countermeasures)

Introduction: With the advent of the global tourism era, people's demand for tourism has been continuously released, and 'local identity' has become increasingly prominent in the development of urban tourism. 'Local Identity' is an individual's attachment and sense of belonging to a certain place on the psychological and emotional level, which is a subjective feeling that is difficult to define. Tourist identity is a subjective feeling that is difficult to be collected, researched, evaluated and defined through questionnaires and interviews. The organization form and product form of tourism industry determine the high dependence of tourism industry on information. The particularity of todays tourists lies in the extensive use of various mobile electronic networks. This phenomenon provides a brand-new platform for shaping the characteristics of urban tourism - Digital platform for tourists' feedback information interaction in modern society. Social platform can help planners collect rich, real and effective data because of its timeliness, spontaneity and universality. Through the collection and qualitative research of people's spontaneous feelings, the abstract subjective feelings were quantified and the evaluation from quality to quantity was realized so as to provide more humane reference opinions for the planning practice of future tourism identity. Thus, this project innovatively proposed to take social platform as the research carrier to analyze local identity, to collect tourists' somatosensory feedback, to keep up with the changing trend of tourism identity, to realize the sustainability of commercial value, to improve the quality of tourism globalization in Suzhou and to provide reference guidance for tourism planning practice.

Keywords: Tourism Identity, Digitalization, Information Interaction, Smart Tourism, Social Media, Somatosensory Feedback, International Tourism Strategy

Key issues solved:
1. What experiences and activities about Suzhou tourist attractions have tourists posted on social media?
2. How to analyze Suzhou's tourism identity through digital platform?
3. How to link the digital characteristics of urban tourism with the practice of tourism planning?

Research achievements:

Research Report:

Social Media Information Identified Suzhou Tourism Characteristics and Tourists' Tourism Identity - Draw the Tourism Characteristic Catalogue and Prepare for International Tourism Strategy with Intelligent Tourism Research Method

Project 15: Research on the Relationship Mechanism of Social Entrepreneurship Orientation, Process and Performance of Social Organizations in Suzhou

| **Juelin Yin**

Programme category: Suzhou Social Science Planning Programme - Applied Strategy

Introduction: In recent years, social entrepreneurship has flourished in the world relying on its innovative ways to solve social issues, and has become an effective way and innovative way to break through market externalities, government failures and social development difficulties. Based on the practice of social entrepreneurship in Suzhou, the purpose of this project is to explore the transformation path of 'social entrepreneurship orientation - social entrepreneurship process - social entrepreneurship performance' of social organizations. Through in-depth interviews and multi-case researches, the following main research findings were drawing in this research:

1. Entrepreneurs' sense of mission and concern for social issues make them better at observing and identifying entrepreneurial opportunities, and entrepreneurs with previous entrepreneurial experience or management experience can often bring enterprises on the right track faster.
2. Social entrepreneurs often have clear ideas about enterprise operation and entrepreneurial content, but the positioning of their products, including brand marketing methods, is not clear enough.
3. Most consumers have a positive attitude towards social enterprises, and think that the profits of social enterprises are closely related to their social responsibilities.

However, whether consumers will buy products of social enterprises is still affected by consumers' own needs, product quality, enterprise reputation and product price. Finally, some policy practice suggestions for the government and social entrepreneurs were proposed in this research.

Keywords: Social Entrepreneurship, Social Orientation, Market Orientation, Suzhou

Key issues solved:

1. How did entrepreneurs view the identity of 'social entrepreneur'?
2. How did social orientation, innovation orientation and market orientation affect social entrepreneurship?
3. What opportunities and challenges are the operation and management of social enterprises facing?

Research achievements:

Research Report:

Research on the Relationship Mechanism of Social Entrepreneurship Orientation, Process and Performance of Social Organizations in Suzhou

Project 16: Investigation on Corporate Social Responsibility in Suzhou Industrial Park

| **Xuanwei Cao & Juelin Yin**

Research field: Corporate Social Responsibility

Introduction: From a national perspective, China's corporate social responsibility practice has made rapid development since 2006, presenting a five-in-one pattern of government guidance, industry promotion, enterprise practice, social participation and international cooperation. Some areas have even raised corporate social responsibility to the height of regional development strategy, and regard the construction of corporate social responsibility as an important work to realize regional development strategy and planning. However, the degree of perfection of policies and measures varies greatly in different regions, and there are also some differences in the effectiveness of policies and measures in promoting the construction of corporate social responsibility. The main reasons for this difference include that the leading departments within the government are quite different, and the organizational construction of corporate social responsibility is not perfect; there are doubts about the operability of government policies, enterprises are lack of the ability to build social responsibility, and government guiding principles are difficult to be implemented.

With the continuous development and innovation of the theoretical research and practice of corporate social responsibility, the discussion of corporate social responsibility in Europe and America has begun to use the discourse of 'creating shared value' (CSV) to replace corporate social responsibility (CSR). First, 'creating shared value' (CSV) emphasizes the unity of enterprise and society in cognition. The business objectives of enterprises are consistent with the social development objectives, and the business development of enterprises depends on a healthy and well-functioning society. By incorporating social issues into the core business strategy of enterprises, the enterprises can not only achieve economic benefits, but also solve some social and environmental issues, thus creating shared value. In this term, it is difficult for the leaders and executives of enterprises in the park to compete with the world's leading enterprises in cognition and action. The purpose of this research report is to review and sort out the work of Suzhou Industrial Park Corporate Social Responsibility Alliance in the past four years systematically, and provide reference policy suggestions for the relevant guiding departments of the park to further promote and enhance the construction of corporate social responsibility. In this research, the enterprises of different ownership types in Suzhou Industrial Park were taken as the research samples. Based on discussion, visit, in-depth interview and literature research, the current situation, shortcomings and gaps of corporate social responsibility in Suzhou Industrial Park were systematically understood. And, based on the successful practice cases of promoting corporate social responsibility in China, the targeted suggestions for the development path of establishing a national corporate social responsibility demonstration zone in the next three years was proposed.

Keywords: Suzhou Industrial Park, Corporate Social Responsibility, Government Guidance, Innovation and Opening up

Key issues solved: The construction of corporate social responsibility in Suzhou Industrial Park still has a long way to go. In terms of action strategy, the Industrial Park needs to improve the overall regional social responsibility action guidelines, establish the guiding principles and core contents of promoting the construction of social responsibility, and clarify the path to achieve the phased objectives. In terms of working mechanism, in the coming period, the continuous and in-depth development and strengthening of corporate social responsibility still needs to be implemented in an orderly manner under the leadership of government departments and under the action of institutional constraints and incentive measures. Gradually, the government's role in corporate social responsibility alliance should change from leading to serving, establish the working mechanism of corporate social responsibility alliance, create an open social communication mechanism, promote the participation and cooperation of more third-party organizations and public welfare partners, and innovate the content and organizational mechanism of corporate social responsibility. In terms of enterprise, the production and management philosophy of enterprises must be reversed in order to continue to focus on innovation-driven and shared value creation, give full play to the diversity of enterprises, their advantages in capital, technology and cooperation network, and unite with other social forces to solve the challenges encountered in regional economic and social development, produce more beneficial social impacts, and push the

society forward in the direction of sustainable development. In the future, with the active participation of all sectors of society, Suzhou Industrial Park will be built into an influential demonstration zone of corporate social responsibility nationwide.

Research achievements:

Research Report:
Investigation on Corporate Social Responsibility in Suzhou Industrial Park

Project 17: Rational Use of Water in Suzhou - A Discrete Choice Modelling Approach

| **Jose Grisolia & Shihao Eddy Fang**

Programme category: Soft Science Research Programme of Suzhou Association for Science and Technology

Introduction: It's well known that China has maintained strong economic growth in the past two decades. However, the industrial economic structure dominated by manufacturing industry also led to corresponding environmental pollution. For example, greenhouse gas emissions, air and water pollution and other environmental issues are becoming increasingly serious. At the same time, environmental awareness and various projects to improve the environment are also emerging in various fields. China's investment in environmental protection is far ahead of the international community. In 2010 alone, China's investment in environmental protection was as high as $54.4 billion, which is 40% more than that of the third-ranked United States (Watts, 2011). China's booming 'green revolution' is also reflected in its cap on carbon dioxide emissions in the domestic market. China is also far ahead in this field, given that cap-making of carbon dioxide emissions has encountered considerable legislative resistance in many developed countries.

Keywords: Environmental Economics, Water Conservation, Hedonic Pricing, Discrete Choice Experiment
Key issues solved:
1. What kind of policies can promote rational water use most efficiently?
2. What kind of policy can most directly and effectively change the household water use habits?
3. What do individual family thinks of high-quality water resources?
4. What is people's consumption intention for clean water resources?
5. Under what circumstances are individuals and families willing to consume clean water resources?
6. What is the price of water they can afford and are willing to spend?

Research achievements:

Research Report:
Rational Use of Water in Suzhou - A Discrete Choice Modelling Approach

Project 18: Path Dependence and Creation in Industry Transformation and Upgrading – A Case Study of Suzhou

| **Xuanwei Cao**

Research fields: Industrial Economy, Regional Development

Programme category: Suzhou Social Science Planning Programme - Applied Strategy

Introduction: For Suzhou, which is in the late stage of industrialization, it is necessary to speed up the transformation of economic development mode and promote the construction of an innovative city actively in order to avoid the future development path being 'locked' in the 'thinking map' of the industrialization era. Currently, the difficult economic recovery in Europe and America, the slowdown of China's economic growth, the intensification of resource and environment constraints and other severe challenges all put forward urgent requirements for the adjustment of industrial structure and the transformation of economic growth mode. In the face of the important historical opportunity that Suzhou is fully committed to building an innovative city and moving towards the goal of 'taking the lead in realizing modernization', only by promoting the transformation of development mode and upgrading and optimizing industrial structure can we cope with environmental changes at home and abroad, break through the path dependence in the development process, realize industrial transformation and upgrading and the transformation of economic growth mode actively so as to realize the innovation and creation of development path.

Keywords: Industrial Transformation and Upgrading, Path Creation
Key issues solved: Issues in Suzhou's industrial transformation and upgrading

Research achievements:

Research Report:
Path Dependence and Creation in Industry Transformation and Upgrading – A Case Study of Suzhou

Project 19: Cycle and Performance of Risk Investment in China – An Analysis on Venture Capital Investment at Suzhou

| **Xiaoming Ding**

Programme category: Suzhou Social Science Planning Programme - Applied Strategy

Introduction: The rise of venture capital is an inevitable choice for China's financial system to face the dual challenges of accelerating the change trend of domestic industrial structure and the tide of information economy with globalization as the background. In this study, we focused on the current situation of venture capital in Suzhou, including the cycle and performance of venture capital. Through the research on the current situation of Suzhou venture capital from 2000 to 2013, it is indicated that the larger the scale of funds managed by venture capital institutions, the larger the amount of investment, and the higher the book return accordingly. In addition, the book returns of foreign investment institutions were significantly higher than those of Chinese investment institutions, but the contrast between the book returns of state-owned venture capital institutions and non-state-owned investment institutionswas not significant. Different from our prediction, the longer the venture capital institution is established, the lower the book return. However, the longer the exit period, the higher the book return. In addition, in the A round of financing, the book return will be higher. And, the exit channels of domestic venture capital are cash dividends and IPO. The capital occurred during the development period of the project.

Key issues solved: Cycle and Performance of Venture Capital in Suzhou

Research achievements:

Research Report:
Cycle and Performance of Risk Investment in China – An Analysis on Venture Capital Investment at Suzhou

Awards:
2014 年获：苏州市社科联，优秀论文二等奖
2014 年获：江苏省社科联，优秀论文三等奖

Project 20: Research on Street Community Management Innovation in the Process of Urban-Rural Integration

| Youmin Xi & Ying Chang

Research fields: Management Sciences

Programme category: Research Project of Suzhou Expert Advisory Group in 2013

Introduction: Through policy review, field investigation and interview, we sorted out and summarized the current situation and issues in the process of urban-rural integration in Suzhou Industrial Park, and put forward some suggestions on community grass-roots governance in the next transformation of Suzhou Industrial Park with reference to excellent cases at home and abroad.

Keywords: Urban-Rural Integration, Community in Transition

Key issues solved:

What are the issues in the process of urban-rural integration in the transformation of Suzhou Industrial Park? What are the possible solutions?

Research achievements:

Research Report:

Research on Street Community Management Innovation in the Process of Urban-Rural Integration

Project 21: Towards an Effective Integration of Urban-Rural Tourism: Mapping Agritourism Development on Suzhou Urban Fringe

| Yiwen Wang

Research fields: Urban and Rural Planning, Urban and Rural Planning Management

Programme category: Research Programme of Philosophy and Social Sciences in Suzhou

Introduction: The main purpose of this research is to investigate the existing leisure agricultural tourism resources in Suzhou suburbs, to understand the spatial distribution and types of rural tourist destinations and to make a systematic analysis of leisure agricultural resources and rural tourism development in Suzhou by using maps, satellite images, network resources and research information, and draw a tour guide map so as to provide suggestions for the integration strategy of urban and rural tourism resources in Suzhou.

Keywords: Rural Tourism, Leisure Agriculture, Integration of Tourism Resources, Integration of Urban and Rural Areas

Key issues solved: From the perspective of architectural heritage and cultural landscape protection, we sorted out the current situation and issues of rural tourism resources in Suzhou, and discussed the strategies of urban-rural tourism integration, so as to expand the existing urban tourism market in Suzhou, attract tourists to rural areas, and market the value of Suzhou's water town image cultural heritage, thus promoting the integration of urban and rural development.

Research achievements:

Research Report:

Towards an Effective Integration of Urban-Rural Tourism: Mapping Agritourism Development on Suzhou Urban Fringe

Project 22: The Suzhou Local Food System Planning-Analysis of the Quality of the Food and Agro-Demand

| Giulio Verdini

Programme category: Research Project of Philosophy and Social Sciences in Suzhou

Introduction: In China's coastal provinces, the surplus agricultural land on the urban fringes is shrinking due to the expansion and merger of urban areas. This phenomenon has a strong impact on the environmental quality at the regional level, the transformation of rural landscapes and ultimate quantity and quality of local food supplies (Altermann, 1997; Morgan, 2009).

In recent years, with the support of FAO, UN-Habitat and other international organizations, the international community has paid more and more attention to the research on local food systems in emerging countries (Argenti, Marocchino, 2008). The reason is that by rebuilding the link between local consumption and local production, local food systems make it possible to realize sustainable local development models on the urban fringe and even in emerging countries such as China (Sonnino, 2009).

As consumers under the influence of globalization, urban residents need more differentiated food. For example, in China, the consumption structure has undergone fundamental changes in the past few years (Huang, 2011). The evaluation of local consumption patterns can be used as the basis for developing the sustainable management planning policies in Suzhou urban fringe. However, the local consumption patterns depend on many factors, such as household income level and education level (financial capital and cultural capital). For this reason, we chose to conduct a questionnaire survey in Suzhou Industrial Park. In the past few years, the industrial park has attracted many high-quality professionals at home and abroad, who have high spending power.

Keywords: Urban Fringe, Local Food System, Science Park, Creative Class, Agriculture, Public Preference

Key issues solved: The food consumption structure of Suzhou Industrial Park and the public preferences of different classes were analyzed, such as the demand for healthy food and the demand for leisure activities in rural areas.

Research achievements:

Research Report:
The Suzhou Local Food System Planning-Analysis of the Quality of the Food and Agro-Demand

Project 23: Research on the Strategies of Promoting the Experience of Suzhou Industrial Park and Developing "Enclave Economy" in Suzhou

| Yunqing Xu

Research fields: Enclave Economy, Knowledge Management

Programme category: Suzhou Social Science Planning Programme - Applied Strategy

Introduction: Although the development of 'enclave economy' is in full swing, the enclave park needs extremely highinvestment in human resources and capital, as well as dynamic long-term effective operation and management, sothere are considerable risks. Currently, the challenges will intensify under the influence of the pandemic with turbulent labor market, siginificant economic anti-globalization and lower population mobility. Professor Liu Zhibiao, president of Yangzi IDEI, thinks that there are not many successful cases of 'enclave economy' so far, and simply copying the model will greatly increase the probability of failure. Thus, in 2017, the National Development and Reform Commission and other departments jointly issued the Guiding Opinions on Supporting the Development of Enclave Economy. Clear policy norms on cooperation mechanism, statistical caliber and methods were made. We need to see that 'enclave economy' should not be regarded as the establishment of investment and cooperative relations alone. Under the background of knowledge economy, the knowledge transfer shall be focused on and its realization path shall be understood. Facing the long-term sound mechanism and capacity building can promote the economic recovery after the epidemic and ensure the healthy and sustainable development of enclave parks.

Keywords: Enclave Economy, Industrial Park, Planning and Construction, Knowledge Transfer

Key issues solved:
1. Understood the knowledge scope that needs to be transferred, easily transferred and difficult to be transferred in the process of enclave park construction, that is, the transfer content.
2. Analyzed the formal and informal sources, networks, methods and processes of knowledge sharing in the construction of enclave parks, that is, transfer processes.
3. Summarized the key success factors of knowledge transfer, including analyzing the formation factors of various mechanisms and abilities of knowledge acquisition, knowledge transformation and knowledge application, including transfer theme and transfer situation characteristics.
4. Established a framework of 'knowledge transfer' optimization process suitable for enclave park development, so as to ensure that it is based on continuous and long-term effective learning and self-improvement in the development process.

Research achievements:

Research Report:
Research on the Strategies of Promoting the Experience of Suzhou Industrial Park and Developing "Enclave Economy" in Suzhou

Project 24: The Current Situation, Existing Issues and Countermeasures of Suzhou's International Cultural Communication Network Media - From the Perspective of Cultural Security and Cross-Culture

| Juming Shen

Research fields: Social sciences

Programme category: Suzhou Social Science Planning Programme - Applied Strategy

Introduction: International Communication, referred to as external publicity for short, refers to the work of publicizing to other countries and regions by using different methods, strategies and ways. Since the founding of the People's Republic of China more than 70 years ago, China's International Communication work has gradually built a modern communication system that matches the development of socialism with Chinese characteristics, and has made important contributions to the promotion of comprehensive national strength and image building. On the one hand, International Communication can introduce the history and current situation of China's economy, culture and society to the international community, which is helpful for the international community to better understand China and enhance its respect, understanding and recognition of Chinese culture. On the other hand, through International Communication, we can also share with the world the attitude and position of the Chinese government and people on the world situation and changes and developments, so that China can better integrate into the international community. In addition, carrying out International Communication is also an important part of building and ensuring national cultural security.

Keywords: International Communication, Cultural Differences, Online Media

Key issues solved:

1. Among the contents communicated by various media, most of them are mainly short-length information release, but lacking long and in-depth detailed information and content statements;
2. In the existing media, the main content of communication is in the form of official release, and no media provides an open interactive forum;
3. Among the contents communicated by English media in Suzhou, whether it is news reports or information communication, the contents are stated from the official perspective, and there is a lack of experience statement of living and working in Suzhou from the first-person perspective of the witness;
4. In the existing online media communication materials, most articles indicate the writing mode of 'Chinese-English translation'.

Research achievements:

Research Report:
The Current Situation, Existing Issues and Countermeasures of Suzhou's International Cultural Communication Network Media - From the Perspective of Cultural Security and Cross-Culture

Project 25: Research on the Way to Improve the Basic Capability and Industrial Chain Level of Biomedicine Industry in Suzhou

| Jie Li

Research fields: Biomedicine

Programme category: Suzhou Science and Technology Development Planning Program

Introduction: In recent years, with the continuous improvement of China's Biomedicine technology industry platform and related supporting industrial facilities, the R&D strength of China's Biomedicine enterprises has been greatlyenhanced, and the technological gap between China and large enterprises in developed countries has been continuously narrowed, and many technologies have leapt to the first echelon in the world. However, the R&D investment of Biomedicine enterprises in China is generally low, and the overall R&D level and innovation ability need to be improved. Suzhou, as the pioneer of Biomedicine industry in Jiangsu Province, has made outstanding achievements in fighting the epidemic in the world, and the level of fighting the epidemic far exceeds that of most developed cities in the world. As the 'double highland' of biomedicine and artificial intelligence in China, how Suzhou organically combines the two and makes full use of artificial intelligence technology to improve the innovation level of biomedicine has an important strategic and demonstration effect. Suzhou has also clearly proposed to build biomedicine as its core competitiveness in the world and the most influential industrial landmark, and strive to form a world-class Biomedicine industry highland in 2030, demonstrating the government's determination and courage to accelerate the development of pharmaceutical industry.

Keywords: Suzhou, Artificial Intelligence, Biomedicine, Innovation

Key issues solved: In this research, on the basis of full investigation, the 'Suzhou Model' of artificial intelligence boosting the development of biomedical industry was proposed to screen the development priorities for Suzhou Biomedicine industry and to formulate a practical development path around the development priorities.

Research achievements:

Research Report:
Research on the Way to Improve the Basic Capability and Industrial Chain Level of Biomedicine Industry in Suzhou

Project 26: Communicating Public Health Emergencies in Suzhou: A Case of COVID-19

| Xianwen Kuang

Research fields: News and communication

Programme category: Suzhou Science and Technology Development Planning Programme

Introduction: In early 2020, COVID-19 swept the world. During this major public health emergency, how to use media channels to make effective risk communication has become a key issue to reduce the negative impact of this event. This research combined qualitative text analysis, quantitative content analysis, in-depth interviews and questionnaires to analyze the content and communication effect of COVID-19, a public health emergency, disseminated by local government departments and their official media channels. Through the analysis of sample data, the experience and issue in Suzhou's risk communication and dissemination strategy in the epidemic were found out, and some operable suggestions were put forward for Suzhou's future risk communication of public health emergencies. For example, in view of the issues found in the research, such as the mismatch between some reported information and audience needs, the low efficiency of information dissemination in some channels, the widespread public anxiety, the lack of access to information for foreign residents and the excessive adjustment of reporting focus in the process of event development, the researchers suggested that in the work of communicating and disseminating the risks of public health emergencies in Suzhou, the disseminators can accurately locate the public information needs and adjust the distribution of information content; improve the information diversity of various communication channels and strengthen the release of official information of new media channels; and strengthen communication and cooperation with community units, so as to put information transmission into practice in life.

Keywords: Public Health Emergencies, Risk Communication, Communication Effect, Framework Theory

Key issues solved: From the perspective of communication strategy and communication effect, the experience of Suzhou local government in the communication of this risk event and the existing communication effect issues were summarized, and the strategic suggestions for the corresponding issues were provided.

Research achievements:

Research Report:
Communicating Public Health Emergencies in Suzhou: A Case of COVID-19

Project 27: The Sustainable Livelihood Approach for Large-Scale Community of Displaced Farmers

| Ying Chang

Research field: Urban and Rural Planning

Programme category: Suzhou Research Programme of Philosophy and Social Sciences

Introduction: In this survey, the content, manner and quality of the existing spiritual and cultural activities, the space requirements of the existing community activities and how the community guides the residents' autonomy and the construction of the residential area were deeply and meticulously researched in the selected farmers' concentrated residential areas. The main research method was to issue 100 household questionnaires, and the participatory observation and group discussion were carried out on the contents and places of outdoor activities in the community throughout the day. This project has been highly valued by the Community Construction Department of the Social Enterprise Bureau of Suzhou Industrial Park, and how to promote it in the whole region will be considered in the next step.

Keywords: Urbanization, Housing

Key issues solved:

1. After the great change of 'withdrawing villages and building residences', what were the contents and ways of the existing spiritual and cultural life of the residents in the concentrated residential areas of farmers? What is the quantity and quality?
2. When the residential and living space was changed from natural village to urban community, can the residential space meet the needs of their activities? How to improve?
3. How to strengthen community construction by guiding and organizing spiritual and cultural life in the community?

Research achievements:

1） Publications (SCI、SCIE、SSCI、A&HCI、EI、CSSCI and A Guide to the Core Journal of China only)

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	SSCI	A zone of exception? Interrogating the hybrid housingregime and nested enclaves in China-Singapore Suzhou-Industrial-Park	常莹	Housing Studies	2020

2） Others

Research Report:

The Sustainable Livelihood Approach for Large-Scale Community of Displaced Farmers

Project 28: Public Media Displays in Suzhou: A potential Practical Approach to Accelerate the Development of Media Convergence in Suzhou

| Hai Ning Liang

Programme category: Suzhou Social Science Planning Programme - Applied Strategy

Introduction: Multimedia display devices of different sizes and uses in public areas have been increasingly used in multiple environments and have recently exhibited varying degrees of interactivity. In this paper, we are committed to providing a comprehensive survey to explore the use of these rapidly growing outdoor multimedia display devices (also known as media facades) in the current rapidly developing Chinese cities (especially in Suzhou). The widespread use and popularity of multimedia display devices in Suzhou and other cities makes it a new field for research to explore whether multimedia display devices can support comprehensive media convergence, that is, content communication among multiple multimedia platforms and cooperation among multiple multimedia industries.

Key words: Media Display, Media Convergence, Media Architecture, Interactive Media, Design Principle

Key issues solved: The use and effect of multimedia display equipment in public areas was explored, and the potential role of this equipment in making Suzhou a livable city was explored. In addition, this research is committed to providing design, development and synthesis guidelines to promote the wider use of multimedia display devices in the population

Research achievements:

1） Patents

No.	Category	Status	Patents Title	Application no.	Authorisation no.	Inventor(s)
(1)	发明	授权	一种虚拟环境下交互行为的控制方法及控制系统	CN201710580993.8	ZL201710580993.8	梁海宁 (Hai-Ning Liang)、史昱玮、陆飞羽、岳勇
(2)	发明	实审	一种虚拟环境下视野外目标的可视化方法	CN201711005248.7		梁海宁 (Hai-Ning Liang)、俞迪枫、樊凯旋、张恒、Vijayakumar Nanjappan（维贾雅库马尔 南加潘）

2） Copyright

No.	Status	Category	Title	Author(s)	Application no.	Certificate no.
(1)	授权	软著	VRSVT 三维几何体可视化软件	西交利物浦大学	2019SR0177081	3597838

3） Publications (SCI、SCIE、SSCI、A&HCI、EI、CSSCI and A Guide to the Core Journal of China only)

No.	Category	Title	Author(s)	Journal Title	Publication Date
(1)	EI	VRMController: An Input Device for Navigation Activities in Virtual Reality Environments	Hai‐Ning Liang, Yuwei Shi, Feiyu Lu, Jizhou Yang, Konstantinos Papangelis	Proceedings of the 15th ACM SIGGRAPH International Conference on Virtual‐Reality Continuum and its Applications in Industry (VRCAI 2016).	2016
(2)	EI	Co‐Designing Harm Reduction Intervention for Online Communities of Bodybuilding Drug Users.	Konstantinos Papangelis, Alan Chamberlain, and Hai‐Ning Liang	Proceedings of the 2016 International Conference on Collaboration Technologies and Systems.	2016
(3)	EI	An exploration of usable authentication mechanisms for virtual reality systems.	Zhen Yu, Hai‐Ning Liang, Charles Fleming, Ka Lok Man	Proceedings the 2016 IEEE Asia Pacific Conference on Circuits and Systems (APCCAS'16)	2016
(4)	EI	New Directions for Preserving Intangible Cultural Heritage through the use of Mobile Technologies.	Konstantinos Papangelis, Alain Chamberlain, and Hai‐Ning Liang	Proceedings of the 8th ACM International Conference on Human‐Computer Interaction with Mobile Devices and Services (MobileHCI)	2016
(5)	EI	Usable Authentication Mechanisms for Mobile Devices: An Exploration of 3D Graphical Passwords.	Zhen Yu, Ilesanmi Olade, Hai‐Ning Liang, Charles Fleming	IEEE PlatCon‐16: 2016 International Conference on Platform Technology and Service	2016
(6)	EI	Learning Structured Knowledge from Social Tagging Data: A critical review of methods and techniques.	Hang Dong, Wei Wang, Hai‐Ning Liang	The 8th IEEE International Conference on Social Computing and Networking (SocialCom 2015)	2015
(7)	EI	An investigation of the use of robots in public spaces: Interaction and Privacy Issues.	Guangda Zhang, Hai‐Ning Liang, and Yong Yue	Proceedings of the 5th Annual IEEE International Conference on CYBER Technology in Automation, Control, and Intelligent Systems (CYBER'15)	2015

4） Others

Research Report:

Public Media Displays in Suzhou: A potential Practical Approach to Accelerate the Development of Media Convergence in Suzhou

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西交利物浦大学

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