XJTLU-XJTU-UoL Joint Doctoral Supervision Project (Full-time)

Reference No.	SFXJTU2532
XJTLU School	School of Advanced Technology
PhD Programme	Computer Science and Software Engineering
Supervisors	XJTLU supervisor: Professor Zhijie Xu XJTU supervisor: Professor Shuai Zheng UoL supervisor: Dr Mohammad Hasan XJTLU Co-supervisors: Nan Xiang and Yushan Pan
Project Title	Intelligent Analysis and Simulation Algorithm of Gas-Liquid-Solid Coupled Flow Field 气液固耦合流场智能分析与仿真算法研究
Application Deadline	Open until the position is filled

Requirements:

A UK first-class or upper second-class honours Bachelor's degree and a UK Master's degree with Merit (or their equivalent) are required for PhD admissions. Exceptional candidates holding only a Bachelor's degree may be considered on an individual basis.

Evidence of good spoken and written English is essential. The candidate should have an IELTS (or equivalent) score of 6.5 or above, if the first language is not English.

For more information about entry requirements and admission procedures of PhD programme at XJTLU, please visit:

Entry Requirement - Xi'an Jiaotong-Liverpool University

How to Apply - Xi'an Jiaotong-Liverpool University

Other Requirements (if any):

N/A

Programme Structure:

Doctoral students in the joint programme are registered with both XJTLU and the UoL. Upon successful completion of the programme, the students will be awarded a PhD degree from University of Liverpool.

During their doctoral studies at XJTLU, students are expected to conduct research at XJTU as visiting students. Additionally, students have the opportunity to apply for a three to six-month research visit to UoL.

Project Description:

To address the complex coupling issues among inerting gas, fuel, and fuel tanks in aircraft fuel systems under high-angle-of-attack and large-overload conditions, a gas-liquid-solid coupling mathematical model based on Smoothed Particle Hydrodynamics (SPH) was adopted to develop numerical tools for efficient numerical simulation analysis. Given that the coupled flow field solving capabilities of existing commercial fluid analysis software are constrained by the extremeness of flight conditions and the massive data in the solution space, the goal is to develop industrial software for analyzing, predicting, and regulating the inerting flow field in complex aircraft fuel tanks under different extreme high-dynamic service conditions. The specific details are as follows:

① Research on deduction and prediction methods for multiphase coupled flow field characteristics integrating momentum conservation constraints.

Explore spatial eigenvalue extraction methods for fluid particle point clouds using convolution kernels to achieve step-by-step deduction of fluid particle positions and velocities over time scales. By combining antisymmetric convolution kernels with momentum conservation constraints on fluid particle states, the computational accuracy and efficiency of data-driven simulation analysis solvers are enhanced.

② Development of simulation software for visualized analysis and regulation of three-dimensional flow field characteristics under extreme conditions.

Develop solver-based prediction programs for multiphase coupled flow field characteristics to achieve efficient solving of flow field characteristics under extreme conditions and environmental parameters. Design a 3D flow field characteristic cloud rendering engine and modular interface during the deduction and prediction process to enable high-quality human-machine interaction, data visualization, and performance analysis and evaluation.

针对飞机燃油系统惰化气体、燃油、燃油箱在大姿态、大过载 条件下的复杂耦合问题，采用基于 SPH 的气液固耦合数学模型，建 立了数值工具，通过高效数值仿真分析。考虑到现有商用流体分析 软件的耦合流场求解能力受限于飞行工况的极端性和解空间的巨量 数据，目标实现飞机复杂燃油箱在不同极端高动态服役工况下的惰 化流场分析、预测、调控的工业软件开发。目标实现飞机复杂燃油 箱在不同极端高动态服役工况下的惰化流场分析、预测、调控的工 业软件开发。具体如下：①融合动量守恒约束的多相耦合流场特性推演预测方法研究。探索卷积核对于流体粒子点云的空间特征值提取方法，实现流体粒子位置与速度在时间尺度上的步骤推演，结合反对称卷积核对流体 粒子状态的动量守恒约束，提高数据驱动型仿真分析求解器的计算 求解精度与效率。 ②极端工况下三维流场特性可视化分析调控的仿真软件开发。 开发基于求解器的多相耦合流场特性预测程序，实现极端工况与环 境参数下流场特性高效求解；开发推演预测过程中三维流场特性云 图渲染引擎及模块化界面，实现高质量的人机交互、数据可视化与 性能分析评估。

Joint Supervisory Team:

XJTLU supervisor: Professor Zhijie Xu is Head of the Department of Computing at XJTLU. Before joining XJTLU in 2024, he worked as a Full Professor specializing in visual computing at the University of Huddersfield in the United Kingdom. During that time, he undertook undergraduate and postgraduate curriculum development and teaching duties across a wide range of computer science and engineering subjects, including computer graphics, computational geometry, games and extended reality (VR/AR/MR/XR), digital image processing, and computer vision, as well as various team-and-studio-based projects. His research spans over 30 years and delves into real-time graphics, interactive visualization, machine vision, robotics, smart systems, computational linguistics, machine learning, and computer architecture. He has supervised over 20 PhD students to successful completion, published 200 peer-reviewed papers, and edited 5 books. He holds a dozen vision and visualization-related patents, ranging from new algorithms and models to devices and apparatus. He has led, co-led, and peer-reviewed major projects for funding councils such as RCUK and Horizon Europe. He has personally led projects with a total funding of over 1.5 million pounds. Additionally, he has served as an editor for several journals and chaired many conferences.

许志杰教授现任西交利物浦大学计算机系主任，国家部委国家级杰出人才。2024年加入西交利物浦大学之前，他曾任英国哈德斯菲尔德大学全职教授，专攻视觉计算领域。任职期间，他承担了计算机科学与工程多个学科的本科及研究生课程开发与教学工作，涵盖计算机图形学、计算几何、游戏与扩展现实（VR/AR/MR/XR）、数字图像处理、计算机视觉等方向，同时负责各类团队式及工作室项目的指导工作。徐志杰教授拥有 30 余年研究经验，研究领域广泛，深耕实时图形学、交互式可视化、机器视觉、机器人技术、智能系统、计算语言学、机器学习及计算机体系结构等多个方向。他已指导 20 余名博士生顺利毕业，发表同行评审论文 200余篇，主编著作 5 部；持有十余项视觉与可视化相关专利，覆盖新算法、新模型、设备装置等多个维度。他曾牵头、联合牵头多项重大科研项目，并担任英国研究理事会（RCUK）、"欧洲地平线"计划等资助机构重大项目的同行评审专家，个人牵头项目累计获得经费超 150 万英镑。此外，他还曾担任多家学术期刊编委，主持过多个国际学术会议。

XJTU supervisor: Professor Shuai Zheng, PhD Supervisor, is a National Young Talent and a Class A Young Top Talent of Xi'an Jiaotong University (XJTU). He currently serves as the Vice Dean of the School of Software Engineering at XJTU. As a young leader in the field of industrial software, he has long been engaged in the design of industrial software solving cores and software development, focusing on the core technological needs of national high-end manufacturing and addressing the "bottleneck" issues in industrial software. His core research interests focus on the development of industrial software core solvers and specialized industrial software for complex equipment design, simulation, and digital twins, covering three key areas: first, the construction and development of complex assembly and manufacturing process design software cores based on knowledge graphs and large

language models, enabling efficient reuse and automated generation of process knowledge; second, data-driven high-flexibility geometric generation cores that break through the bottlenecks of traditional design space exploration; third, high-efficiency simulation and analysis cores for complex flow field characteristics, providing core support for optimizing the fluid mechanics performance of high-end equipment. Relevant achievements have been applied to the research and development of main battle aircraft in the aviation industry. In terms of research projects, he has presided over numerous national-level projects and industry-university-research cooperation projects, including projects under the National Key R&D Program, General Programs and Youth Programs of the National Natural Science Foundation of China, promoting the industrialization of core technologies. He has achieved fruitful scientific research results, winning one First Class Award of Technological Invention from the Ministry of Education and one Second Class Award of Technological Invention from Shandong Province, providing important technical support for building an independent and controllable system of domestic industrial software.

郑帅教授，博士生导师，国家级青年人才，西安交通大学青年拔尖人才（A 类），现任西安交通大学软件学院副院长。作为工业软件领域青年领军学者，他长期深耕工业软件求解内核设计与软件开发方向，聚焦国家高端制造核心技术需求，深耕工业软件"卡脖子"难题破解。 其核心研究方向为面向复杂装备设计、仿真与数字孪生的工业软件核心求解器及专用工业软件研发，具体涵盖三大领域：一是基于知识图谱与大语言模型的复杂装配制造工艺设计软件内核构建及开发，实现工艺知识高效复用与自动化生成；二是数据驱动的高柔性几何创成内核，突破传统设计空间探索瓶颈；三是复杂流场特性高效仿真分析内核，为高端装备流体力学性能优化提供核心支撑，相关成果已应用于航空工业主战飞机研发。 科研项目方面，他主持国家重点研发计划课题、国家自然科学基金面上及青年项目等多项国家级与产学研合作项目，推动核心技术产业化落地。科研成果丰硕，获教育部技术发明一等奖 1 项、山东省技术发明二等奖 1 项，为国产工业软件自主可控体系构建提供重要技术支撑。

UoL supervisor: Dr. Mohammad Hasan (UoL) joined the Electrical Engineering and Electronics department as a lecturer in 2017, and was promoted to Senior Lecturer in 2023. He obtained his PhD from the University of Liverpool in 2016, MSc degree from The Royal Institute of Technology (KTH) in Sweden, in 2011, and a BSc in Electrical engineering from Jordan University of Science and Technology in Jordan, in 2008. He is a member of the technological plasma group at the electrical engineering department. The primary focus of his research is numerical modelling of low temperature plasmas, covering fundamental plasma science, plasma interaction with condensed media, as well as technological plasma applications. He uses a variety of techniques including finite element modelling, particle-in cell and molecular dynamics.

穆罕默德·哈桑博士（利物浦大学）于 2017 年加入该校电子电气工程系，担任讲师一职，并于 2023 年晋升为高级讲师。他的学历背景深厚，2016 年获利物浦大学博士学位，2011 年获瑞典皇家理工学院（KTH）硕士学位，2008 年获约旦科技大学电子工程学士学位。哈桑博士是电子电气工程系技术等离子体研究组成员，其研究工作主要聚焦于低温等离子体的数值模拟，研究范畴涵盖等离子体基础科学、等离子体与凝聚态介质的相互作用，以及技术等离子体的应用开发。在研究方法上，他熟练运用多种技术手段，包括有限元模拟、粒子模拟法及分子动力学等，为低温等离子体相关研究提供坚实的技术支撑

XJTLU Co-supervisor: Dr. Nan Xiang (XJTLU) currently is an Assistant Professor in the Department of Computing at Xi'an Jiaotong-Liverpool University. He obtained his PhD in Computer Animation from National Centre for Computer Animation (NCCA), Bournemouth University in 2021. Before embarking on his academic career, he worked in the animation and VFX industry in technical roles, he led a technical team in 3D animation film production and also served as a pipeline technical director in the production of several Hollywood feature films. During his PhD, he focused on the application and research of graphics and computer animation techniques in surgery simulation and cognitive intelligence. His research focus and interests have consistently revolved around Cognitive Intelligence, Computer Animation, Spatial Computing, Simulation, Deep Learning, and SOTA Technologies related to CGI. He has served as a reviewer for many international conferences (e.g. ACM Siggraph, IEEE VR, CGI, CASA, WWW) and journals (e.g. TVC, CAVW, C&G, SPL, AIR). And also, he is a professional member of CSF, CCF, CAAI, ACM, IEEE, and CSIG, also   he serves as a committee member of CSF-Medical Simulation, CCF-CAD&CG, and CSIG-Digital Arts.

项南于 2021 年从英国国家计算机动画中心（NCCA）获得博士学位，专业方向为计算机动画。此前，曾领导技术小组参与知名三维动画长片电影制作，并作为流程技术指导参与过数部好莱坞知名长篇特效电影的技术研发工作。博士期间专注于图形学和计算机动画技术在手术仿真和认知智能等领域中的研究和应用。研究重心和兴趣包括认知智能，计算机动画，空间计算，虚拟仿真，深度学习，CGI流程技术等。担任多个国际高水平会议（如 ACMSiggraph/IEEEVR/CGI/CASA/WWW等）和 SCI 期刊（如 TVC/CAVW/C&G/SPL/AIR 等）的审稿人。任中国仿真学会医疗仿真专委会、中国计算机学会计算机辅助设计与图形学专委会、中国图象图形学学会数码艺术专委会执行委员

XJTLU Co-supervisor: Dr. Yushan Pan (IEEE M'22, SM'24) grew up in Xi'an, China. After completing his studies there, he spent the subsequent twelve years in Norway—pursuing academic endeavors, building his professional career, and laying down roots. This Nordic educational system, which shares similarities with Germany's higher education model, equipped him with a strong foundation to become a accomplished researcher and educator following the completion of his PhD and Habilitation. In 2022 he returned to China and joined Xi'an Jiaotong-Liverpool University, where he now investigates the sweet spot of Cognitive

Intelligence. Before XJTLU, Yushan was a doctoral researcher at the University of Oslo(2013-2017) and later a senior researcher at the Norwegian University of Science and Technology and the Norwegian Maritime Competence Center (2017-2021). He also spent time at Parametric Technology Corporation as a technical consultant (2011-2013). He is also serving as a Senior Member of IEEE, ACM, and CCF, and as a life member of the Chinese Association of Automation. His curiosity roams from emotional AI and cognitive computing to industrial defect spotting, liveness detection, hyperspectral imaging, and trustworthy AI.

潘昱杉博士（IEEE 会员，2022 年当选；IEEE 高级会员，2024 年当选）出生并成长于中国西安。在西安完成学业后，他前往挪威深造、立业、定居，历时十二载。北欧的高等教育体系与德国模式颇为相似，正是在这一体系的培养下，潘博士在取得博士学位并完成大学任教资格认证后，奠定了扎实的学术基础，成长为一名卓有成就的科研与教育工作者。 2022 年，潘博士归国并加入西交利物浦大学，目前致力于认知智能领域的前沿研究。入职西交利物浦大学前，他于 2013—2017 年在奥斯陆大学担任博士研究员；随后于 2017—2021 年，先后在挪威科技大学及挪威海事能力中心担任高级研究员。此外，他还曾于 2011—2013 年任职于参数技术公司，担任技术顾问。 潘博士目前同时担任电气和电子工程师协会（IEEE）、美国计算机协会（ACM）及中国计算机学会（CCF）高级会员，亦是中国自动化学会终身会员。他的研究兴趣广泛，涵盖情感人工智能、认知计算、工业缺陷检测、活体检测、高光谱成像及可信人工智能等多个方向。

How to Apply:
Interested applicants are advised to email Zhijie.Xu@xjtlu.edu.cn and/or shuaizheng@xjtu.edu.cn the following documents for initial review and assessment (Please include the project title in the subject line).
- CV
- Two formal reference letters
- Personal statement outlining your interest in the position
- Certificates of English language qualifications (IELTS or equivalent)
- Full academic transcripts in both Chinese and English (for international students, only the English version is required)
- Verified certificates of education qualifications in both Chinese and English (for international students, only the English version is required)
- PDF copy of Master Degree dissertation (or an equivalent writing sample) and examiners reports available