

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

Reference No.	SFXJTU2502
XJTLU School	School of Advanced Technology
PhD Programme	Electrical and Electronic Engineering
Supervisors	XJTLU supervisor: Dr Tianru Zhang XJTU supervisor: Professor Jinhua Du UoL supervisor: Dr Lin Jiang
Project Title	Intelligent Loss-Minimizing Control of Electro-Actuation Systems Based on Wide Bandgap Devices with Nonlinear Parameter Compensation 基于宽禁带器件的智能电作动系统能耗最小控制与非线性参数补偿研究
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):

Candidates with a background in power electronics, electric machines, signal processing, control theory, and machine learning are preferred.

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:

Abstract:

Controllable shockwave stimulation represents a next-generation, waterless alternative to hydraulic fracturing and is emerging as a transformative technology in shale oil reservoir enhancement. The core driver of this method is an electro-actuation system capable of withstanding extreme thermal, pressure, and impact conditions. Wide-bandgap (WBG) power devices—such as SiC and GaN—offer superior performance in such harsh environments due to their high efficiency and thermal robustness, making them ideal for driving compact, high-speed actuation systems. However, the electro-actuator's dynamic behavior under nonlinear saturation, high-impact loads, and environmental variations leads to significant challenges in control design. Particularly, parameter drift, cross-coupled electromagnetic effects, and fast-switching transients from WBG inverters must be actively compensated to maintain safe and efficient operation. This proposal introduces an AI-augmented, minimum-loss control framework that learns and adapts to evolving system conditions.

Key Scientific Problem:

Design of intelligent, minimum-loss control strategies for WBG-powered electro-actuation systems operating under extreme environmental and load variations.

Main Research Objectives and Content:

- 1. Nonlinear Parameter Estimation and Compensation using Machine Learning:**
Develop lightweight ML-based observers to estimate the bias in position sensing caused by nonlinear electromagnetic parameter shifts (e.g., magnetic saturation, cross-coupling). These models will be trained to recognize dynamic patterns in system states and output adaptive compensation for real-time controller adjustment.
- 2. Loss-Minimization Strategy under Extreme Conditions with WBG Inverter Integration:**
Model the impact of temperature, pressure, and mechanical shock on system behaviors including current ripple, magnetic flux distortion, and switching transients. Use this model to co-optimize inverter switching sequences and voltage control, leveraging the high switching speed and thermal efficiency of WBG devices. The control objective is to minimize total system losses while ensuring dynamic robustness.
- 3. Hardware-in-the-Loop Simulation and AI-in-the-Loop Testing:**
Construct a HIL simulation platform with embedded WBG inverter modules and machine-learning-based control logic. Study parameter variability under sudden load transients and validate the effectiveness of the intelligent control strategy in achieving both energy efficiency and operational reliability.

Expected Outcomes:

- A novel, real-time machine learning-enhanced estimation and compensation framework for saturation and nonlinear electromagnetic parameters.
- A validated minimum-loss control strategy optimized for WBG-powered systems in

high-impact, high-temperature field conditions.

- A HIL testbed demonstrating resilient performance of the system under realistic shale reservoir stimulation scenarios.

Joint Supervisory Team:

XJTLU supervisor: [Dr Tianru Zhang](#)

XJTU supervisor: [Professor Jinhua Du](#)

UoL supervisor: [Dr Lin Jiang](#)

How to Apply:

Interested applicants are advised to email Dr Tianru Zhang (Tianru.Zhang@xjtlu.edu.cn) and cc Professor Jinhua Du (jinhua@xjtu.edu.cn) with the following documents for initial review and assessment (please put 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