Research project and supervisory team

Supervisory Team	Supervisor Name Jianwei Zhang Jiajun Yang Marco Rivera
Short introduction & description of research project	With the rapid integration of renewable energy sources and wide applications of power electronic devices, modern power systems face declining natural inertia and increased stability challenges. Traditional power systems rely on synchronous generators that inherently provide voltage and frequency support through their rotating mass and excitation systems. However, there are no such support in renewable power generation systems with traditional grid-following (GFL) control strategies such as P/Q (active/reactive power) control, maximum power point tracking control. Nowadays, grid-forming control (GFM) is emerging as a promising control scheme to enable the power electronic converter-interface systems to act like synchronous generators to provide voltage and frequency support to the system. Therefore, the GFL- and GFM-controlled systems will co-exist in the system, thus putting forward a demand for the coordinated control of such hybrid system. This project will investigate the theoretical foundations, model development and control methodologies necessary for effective coordination between GFM and GFL converters for energy storage systems in modern power systems. The research addresses the fundamental question of how to optimally combine the complementary characteristics of these two converter types to enhance overall system stability, reliability, and efficiency. Firstly, the characteristics and stability of GFL- and GFM-controlled energy storage systems under different grid strength scenarios described by short circuit ratio will be investigated. Then the model of a hybrid system comprising GFL- and GFM-controlled energy storage systems will be developed to analyze the characteristics and stability. Based on the established model and analysis, a coordinated control strategy considering grid strength will be proposed to regulate the hybrid system to improve the overall performance and enhance system stability. The simulation and hardware implementation will be utilized for verification of feasibility and effectiveness of the analysis and control performances.
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Supervisory Team	Supervisor Name Yulin Wang Chengbo Wang

Short introduction & description of research project	**Project Title:** Contact-free Motion Detection and Real-Time Motion Correction in MRI **Project Area:** This PhD project lies in the field of magnetic resonance imaging (MRI) and biomedical engineering, focusing on contact-free motion detection and real-time motion correction using Beat Pilot Tone (BPT) technology. The research platform is based on the Zhejiang Provincial Engineering Research Centre. Key facilities include a 1.5 T rotatable cryogen-free MRI scanner and the BPT technology developed in this project will be seamlessly integrated into this unique platform. The center also provides MRI sequence programming and image reconstruction environments, and access to clinical partners for validation studies. **Project Introduction:** Physiological motion from breathing and heartbeat remains a major source of image artefacts in magnetic resonance imaging (MRI). Conventional gating methods—respiratory belts and ECG electrodes—are cumbersome, unreliable in certain patients. This PhD project develops a contactless, sequence-independent motion sensing technology based on Beat Pilot Tone (BPT). A small external dual-channel RF transmitter injects a low-power pilot signal into the MRI environment; its beat component is extracted directly from raw k-space data, providing continuous respiratory and cardiac signals that can be used for triggering or processing. **Project Objectives:** ♦ Design and build an MRI-compatible BPT hardware prototype. ♦ Develop signal-processing algorithms to isolate and decompose motion components. ♦ Validate real-time gating performance against conventional methods. ♦ Demonstrate motion-corrected imaging in practical MRI application. This technology will simplify MRI workflows, improve image quality in vulnerable patient groups, and enable cardiac imaging on platforms that cannot accommodate conventional gating—transforming the patient experience while expanding access to high-quality cardiovascular MRI.
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Supervisory Team	Ahmed Nasr Abdelwahed, Shuo Wang, Giampaolo Buticchi
Short introduction & description of research project	**Title**: Real-Time Physics-Informed Digital-Twin Fusion for Adaptive Cooperative Model Predictive Control of Multi-PMSM Drives in More Electric Aircraft **Summary**: The More Electric Aircraft (MEA) employs multiple permanent magnet synchronous motor (PMSM) drives for high-performance applications such as distributed electric propulsion (DEP) and redundant flight control electromechanical actuators (EMAs). Cooperative model

	predictive control (CMPC) has emerged as an advanced control strategy to regulate the complex dynamic load sharing, fault tolerance, and speed/position synchronization. However, the CMPC performance inherently depends on the accuracy of the predictive model. Under harsh operating conditions of MEA, PMSMs exhibits significant thermal fluctuations and magnetic saturation. These unmodeled dynamics results in undesired mismatches between the physical system and the prediction model, degrading the control performance. While data-driven digital twins (DT) offer an advanced solution for health monitoring, they are computationally intensive for real-time control and lack the adaptation to the varying operating conditions. To overcome this issue, this PhD project proposes an innovative real-time physics informed digital twin (PI-DT) framework to drive the CMPC of multi-PMSM systems. The proposed PI-DT will imbed the fundamental electromagnetic and thermodynamic equations that govern the PMSM into lightweight machine learning architectures (such as physics-informed neural networks), enforcing the physical constraints on the learning process. In this way, the data dependency and computational burden of the prediction model can be significantly reduced while ensuring the prediction accuracy under both healthy and faulty conditions. Furthermore, by fusing real-time sensor data (e.g., stator current, rotor position, thermal measurements) with the governing equations, the PI-DT can be adapted to the machine parameters variation. Therefore, depending on the high-fidelity predictions provided by the proposed PI-DT, the CMPC can adjust its cost function and constraints to ensure optimal load sharing and robust speed synchronization under different operating conditions.
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Supervisory Team	Supervisor Name **Dr. David Chieng and Dr. Pengyuan Wang**
Short introduction & description of research project	PhD project title: **AI-Driven Design and Radiation Pattern Optimization of Dynamic Metasurface Antennas** Dynamic Metasurface Antennas (DMAs) provide a compact and hardware-efficient platform for adaptive beamforming and electromagnetic radiation control. By electrically tuning distributed metasurface elements along a guided-wave structure, DMA systems enable flexible radiation pattern reconfiguration without the need for conventional phase-shifter networks. Depending on implementation requirements and operating environments, DMA unit cells may be realized using PIN-diode switching structures,

	varactor-diode continuously tunable elements, or liquid crystal-based permittivity modulation. These mechanisms allow both discrete and continuous control of the aperture response, and therefore the proposed work does not restrict the DMA to a single hardware form. Despite their structural simplicity, DMA systems exhibit complex electromagnetic behaviour. Strong interactions among feed-wave propagation, element loading, and mutual coupling lead to a nonlinear and high-dimensional mapping between reconfigurable element states and the far-field radiation pattern. This complexity becomes more pronounced when extending from one-dimensional (1D) linear apertures to two-dimensional (2D) planar configurations, where a larger state space and stronger coupling effects pose significant challenges for systematic pattern synthesis. Achieving stringent radiation requirements—such as low sidelobe level, high gain, adaptive null generation for interference suppression, and sum–difference beam synthesis—remains difficult using conventional analytical synthesis techniques. This project aims to develop a systematic AI-assisted design workflow for DMA modelling and radiation pattern optimization. The core idea is to integrate full-wave electromagnetic simulation with surrogate modelling and efficient search/optimization strategies, enabling rapid evaluation and synthesis of DMA control states under practical electromagnetic constraints.
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Supervisory Team	Supervisor Name Weiduo Zhao, Sze Shin Low, Chiew Foong Kwong
Short introduction & description of research project	The increasing demand for safer and more intelligent transportation systems has highlighted the need for real-time monitoring of driver physiological states. Professional drivers are frequently exposed to fatigue, stress, and metabolic imbalance, which can significantly impair performance and increase accident risk. Existing monitoring approaches—such as camera-based fatigue detection and heart rate tracking—primarily capture external or indirect indicators and often fail to detect early biochemical changes preceding visible symptoms. Wearable electrochemical biosensors offer a promising solution by enabling continuous, non-invasive monitoring of physiological biomarkers in biofluids such as sweat. However, their real-world deployment remains limited due to signal instability caused by biofouling, motion artifacts, and

	dynamic variations in biofluid composition. These challenges are particularly pronounced in high-mobility environments such as driving. This project aims to develop **adaptive wearable electrochemical biosensors** capable of reliable operation in complex and dynamic physiological conditions. The research will focus on designing **ratiometric and self-calibrating sensing strategies** that compensate for environmental disturbances and improve signal accuracy. Flexible sensor platforms will be developed and integrated with portable electronics to enable continuous monitoring during real-world use. The proposed system will be evaluated for detecting key biomarkers associated with fatigue and physiological stress, such as lactate, cortisol, and electrolyte imbalance, within simulated driving scenarios. By combining adaptive sensing with wearable integration, this research seeks to advance electrochemical biosensors from laboratory demonstrations toward robust, real-world health monitoring technologies. The outcomes of this project will contribute to next-generation wearable diagnostics and support the development of intelligent driver monitoring systems within smart mobility environments.
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Supervisory Team	**C.F. Kwong (**Supervisor**)** https://research.nottingham.edu.cn/en/persons/cf-kwong/ Waqas Khalid (Co-supervisor) https://research.nottingham.edu.cn/en/persons/waqas-khalid/
Short introduction & description of research project	**Project Title**: *Secure and Intelligent Communications in Dense Vehicular Networks* This proposed PhD study will develop secure and intelligent vehicular communication networks that are based on three research streams including: i) physical-layer security to protect wireless transmissions against eavesdropping, jamming, spoofing, and other physical-layer attacks, ii) reconfigurable intelligent surfaces (RIS) for dynamic coverage and propagation control, and iii) artificial intelligence (AI) /machine learning (ML) for optimization, resource allocation, decision-making, and network management. The research project aims to address critical national and global needs for secure, energy-efficient, and highly reliable 6G vehicular networks essential for autonomous driving, intelligent transportation systems (ITS), and vehicle-

	to-everything (V2X) communications. The urban vehicular environment is a difficult one because vehicles travel at high speeds, there may be line-of-sight obstructions, there is heavy multipath, high levels of interference, dynamic variations in traffic conditions, and strict demands for reduced latency, high reliability, secured data transmission, and sensing. Novel communication approaches are needed to balance all these requirements. The proposed research will enhance the network capacity, secrecy performance, sensing accuracy, coverage reliability, and energy under high-mobility and rapidly varying channel conditions. The outcomes of this PhD project will include new mathematical models, optimization frameworks, AI/ML- algorithms, RIS-aided security mechanisms, simulation results, and performance evaluation for next-generation vehicular networks. This research is also aligned with China IMT-2030 vision and national 6G strategy for intelligent connected vehicles and future smart transportation infrastructure.
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Supervisory Team	Supervisor Name Dr. Qianyu LIU Prof. Zhengbing He Waqas Khalid
Short introduction & description of research project	**Vision-Language Semantic-Enhanced Cooperative Traffic Flow Control for Mixed Traffic at Urban Intersections** Urban intersections are critical bottlenecks in transportation networks, where congestion, safety risks and control inefficiency often emerge from complex interactions among vehicles, pedestrians, cyclists and traffic control facilities. Existing traffic flow control methods mainly rely on numerical traffic states such as flow, speed, density and queue length, but they are limited in representing semantic traffic events, including temporary roadworks, emergency vehicle priority, pedestrian surges, abnormal lane occupation and manual traffic regulation. These semantic factors often have a substantial impact on traffic flow evolution and control performance, yet they are rarely incorporated into existing signal control and cooperative traffic management frameworks. This project aims to develop a vision-language semantic-enhanced traffic flow control framework for urban intersections. The project will first

	construct a multimodal semantic scene representation by integrating roadside visual perception, vehicle-infrastructure cooperative sensing and traffic rule information. It will then investigate how semantic traffic events influence traffic flow dynamics, queue formation and control effectiveness. Based on this, a semantic-enhanced cooperative control model will be developed, where vision-language models provide high-level scene understanding, event interpretation and rule-aware constraints, while reinforcement learning or model predictive control is used to generate safe and efficient traffic flow control decisions. The expected outcome is an interpretable and robust traffic flow control framework that can adapt to complex and long-tail urban traffic scenarios. The project will be validated through multimodal intersection datasets and simulation environments, with performance evaluated in terms of delay reduction, queue mitigation, safety improvement, emergency response efficiency and interpretability of control decisions.
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Supervisory Team	Supervisor Name Sen Yang Zhengbing He Qianyu Liu
Short introduction & description of research project	This project aims to improve safety in Level 3 (L3) autonomous vehicles during the human machine handover process. To ensure a safe transition, we need to accurately assess the driver's 'takeover readiness' using continuous physiological signals, such as cardiac rhythms and electrodermal activity. Currently, intelligent monitoring systems struggle to track these states effectively. Traditional models are often non-temporal, while newer attention-based networks require too much computational power for in-vehicle edge computing platforms. To solve this, we propose a new temporal prediction framework built on linear-time state-space architectures. This method captures long-range physiological data trends efficiently, completely avoiding the computational bottlenecks of existing models. The research involves designing the algorithm using real world driving datasets, optimizing it for hardware performance, and validating its accuracy. Ultimately, this efficient system will proactively predict driver readiness and reduce accident risks during control transitions.
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Supervisory Team	Supervisor Name Dr. Hailin Huang, Assistant Professor in Power Electronics, Machines and Drives Dr. Yuli Bao, Senior Research Fellow in Electric Drive Systems Dr. Shuo Wang, Principal Research Fellow in Power Electronic, Machine and Control
Short introduction & description of research project	This project aims to develop a high-efficiency, highly integrated magnetic-geared motor for low-altitude electric propulsion, including UAV and eVTOL applications. Low-altitude aerial platforms require propulsion drives that are compact, lightweight, efficient and reliable under limited cooling conditions. Conventional motor–gearbox systems add mechanical interfaces, lubrication needs, vibration and maintenance burden. Magnetic-geared machines offer a promising research direction by using magnetic field modulation for non-contact torque transmission and speed conversion, enabling a more integrated and potentially more fault-tolerant drivetrain. The PhD will investigate electromagnetic design, thermal behavior and mechanical integration of air-cooled magnetic-geared motors. The research methods will include analytical modelling, finite-element analysis, multi-objective optimization and prototype-level validation. Typical tools may include JMAG/ANSYS Maxwell for electromagnetic modelling, Motor-CAD or thermal-network modelling for thermal analysis, and MATLAB/Python for optimization and data processing. Depending on project progress, the candidate may also be involved in prototype design, motor testing, torque/speed measurement and temperature-rise assessment. Key activities include: • topology selection and analytical sizing • electromagnetic and thermal modelling • efficiency, loss and torque-density optimization • assessment of integration, manufacturability and cooling constraints • simulation and/or laboratory-scale experimental evaluation Expected outcomes include a feasible design methodology, an optimized integrated motor concept, prototype-level performance evidence, and practical design guidelines for high-efficiency electric propulsion in low-altitude mobility. This project is suitable for candidates with a background in electrical engineering, electric machines, power electronics or applied electromagnetics, and a strong interest in AI-assisted optimization, electrified aviation, low-altitude mobility, and advanced electric machine technologies
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Supervisory **Team**	Supervisor Name Prof. Zhengbing He (www.GoTrafficGo.com) Dr. Qianyu Liu Dr. Chiew-Foong Kwong
Short introduction & description of research project	Intelligent Transportation Systems Smart Cities Computer Science Reinforcement Learning
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Supervisory **Team**	Yury Mikhaylov (Lead supervisor) Jiajun Yang (https://research.nottingham.edu.cn/en/persons/jiajun-yang-3/) Jianwei Zhang (https://research.nottingham.edu.cn/en/persons/jianwei-zhang/)
Short introduction & description of research project	The rapid adoption of wide-bandgap (WBG) devices, particularly gallium nitride (GaN) HEMTs, has revolutionized power electronics by enabling converters with exceptional switching speed, power density, and efficiency—critical for EV onboard chargers, data center supplies, and robotic actuation. However, switching transitions exceeding 100 V/ns generate severe EMI from 150 kHz to over 100 MHz. Conventional EMI mitigation relies on passive filtering (common-mode chokes, inductors, Y-capacitors)—reactive, bulky, and lossy. High dv/dt and di/dt create common-mode currents that passive filters suppress poorly, often requiring multiple stages that compromise stability and volume. This research shifts from reactive filtering to source-level active cancellation and co-design through three synergistic strategies: active common-mode cancellation using auxiliary GaN devices, adaptive spread-spectrum modulation, and layout-embedded passive cancellation with shielded windings and balanced PCB traces. EMI mitigation becomes an inherent converter function. This project equips PhD candidates with expertise in high-frequency WBG device characterization, EMI measurement (CISPR standards), and advanced PCB layout for parasitic minimization. Students will develop skills in active analog circuit design, spread-spectrum control algorithms, electromagnetic field simulation (Ansys/Q3D), and prototype validation using

	oscilloscopes and spectrum analyzers—bridging power electronics, EMC, and control theory.
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Supervisory **Team**	Supervisor Name Professor Thomas Meersmann, Strategic Development of Health Science and Technology Dr. Chengbo Wang, EEE Dr. Galina Pavlovskaya (School of Medicine UNUK)
Short introduction & description of research project	Development of hyperpolarized noble gas MRI for materials science and industrial applications and development of new MRI standards for clinical applications. Hyperpolarized noble gas (HPNG) magnetic resonance imaging (MRI) is attracting an increasing level of attention for clinical pulmonary diagnosis as it enables spatially resolve visualization of the progression of various lung diseases and the efficacy of drug treatment intervention. However, HPNG, in particular hyperpolarized xenon-129 (HP^{129}Xe) MRI also offers a powerful but currently underexplored tool for materials science and chemical engineering applications. The utilizing laser pumping, the technology enables highly sensitive NMR spectroscopy and microimaging and MRI through enhanced nuclear spin polarization. In close collaboration with the University of Nottingham's UK campus (UNUK), UNNC has designed and constructed functioning hyperpolarizer for the production of HPNG that can be used for materials science and engineering applications. Past examples of a similar system at UNUK include the first MRI of a combustion process http://dx.doi.org/10.1039/c2cp43382f ; https://doi.org/10.1073/pnas.1600379113, the study of catalytic converters for diesel engines https://doi.org/10.1016/j.cej.2020.126750, and the exploration of Impact on Structure and Gas Phase Mass Transport of Introducing Controlled Macroporosity into Disordered, Mesoporous, Alumina, Catalyst Support Pellet https://doi.org/10.1016/j.ces.2025.122843. The project will also be of relevance for medical applications as new materials with 3D printed pulmonary microstructure are explored to enable the development of a new universal MRI standard with a spectral

	signature and gas exchange dynamics similar to those found in lungs in health and disease https://doi.org/10.1016/j.jmro.2024.100175. This work requires a student with interest in hardware and software development for MRI in an interdisciplinary environment ranging from electrical engineering to material sciences, chemical engineering and medical applications.
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