School of Computing, Engineering, and the Built Environment
Edinburgh Napier University

PHD STUDENT PROJECT

Application instructions:
Detailed instructions are available at :
https://www.napier.ac.uk/research-and-innovation/doctoral-college/how-to-apply

Prospective candidates are encouraged to contact the Director of Studies (see details below) to discuss the project and their suitability for it.

Project details

Supervisory Team:

- DIRECTOR OF STUDY: Dr Savvas Papadopoulos (Email: s.papadopoulos@napier.ac.uk)
- 2ND SUPERVISOR: Dr Francisco Vedreno Santos

Subject Group: Cyber Security and System Engineering

Research Areas: Electrical Engineering, Energy Technologies, Control Systems

Project Title: Multi-Three-Phase Drives for Electric Transport

Project description:

The popularity of power electronic drives used to control electrical machines is increasing, pushed by both the surge of renewable energy generation and the ongoing electrification of transport. This trend is expected to continue and rapid developments are happening on multiple fronts; from more efficient wide-bandgap-semiconductors, to new materials and design approaches in electrical machines.

Multi-three-phase drives are at the forefront of academic research as they can combine the advantages of these technologies. They can provide extremely high performance with increased reliability while at the same time enabling features which were not possible with conventional three phase topologies. Recent advances have demonstrated high performance with both centralised and decentralised control while challenges remain in the operation under non-ideal conditions.

This PhD will be focused on the design, modelling and implementation of multi-three-phase drives applied to electric vehicles to improve their reliability and overall performance. The student should develop models for the current state of the art for multi-three-phase systems including techniques like vector-space-decomposition (VSD) by using simulation software. Towards the final stages of the project, a bespoke experimental rig will be designed and manufactured to validate all theoretical and analytical work.

The project is expected to address multiple areas including the control, operation under non-ideal conditions, and the scaling and feasibility of an adaptive multi-three-phase system. Long term, the contribution will enable the use of complex systems with multiple multi-three-phase drives, especially concerning the electrification of aerospace and aviation.

References:

[1] Papadopoulos, S., Galassini, A., Ruksnaitis, L., Farhat, N., Kiselychnyk, O., Midgley, W., & Degano, M. (2019). SMART: Modular Architecture for Reliable Transportation. https://doi.org/10.1109/IECON.2019.8926931

[2] Galassini, A. Costabeber, M. Degano, C. Gerada, A. Tessarolo and R. Menis, "Enhanced Power Sharing Transient With Droop Controllers for Multithree-Phase Synchronous Electrical Machines," in IEEE Transactions on Industrial Electronics, vol. 66, no. 7, pp. 5600-5610, July 2019, doi: 10.1109/TIE.2018.2868029.

[3] X. Wang et al., "Torque Ripple Reduction in Sectored Multi Three-Phase Machines Based on PWM Carrier Phase Shift," in IEEE Transactions on Industrial Electronics, vol. 67, no. 6, pp. 4315-4325, June 2020, doi: 10.1109/TIE.2019.2931239.

Candidate characteristics

Education:

A first-class honours degree, or a distinction at master level, or equivalent achievements in Electrical Engineering

Subject knowledge:

- With a good fundamental knowledge of Power Electronics, Electrical Machines and Drives and their control.

Essential attributes:

- Experience of fundamental concepts of power electronic drives and basic control techniques.
- Competent in the use of simulation softare such as PSIM or PLECS, Matlab and Matlab Simulink as well as competence in a lab envirnonment and carrying out experimental work.
- Knowledge of electrical machine operation and their modelling. Knowledge of popular power electronics topologies, modulation techniques, semiconductor technologies and control techniques. Overall these are the building blocks needed to create electrical drives.
- Good written and oral communication skills
- Strong motivation, with evidence of independent research skills relevant to the project
- Good time management

Desirable attributes:

- Experience in designing circuits and using PCB design software. Confidence with real-time programming and knowledge of programming languages such as C# or C++.