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 Yuyang Zhou (Email: y.zhou@napier.ac.uk)
- 2ND SUPERVISOR: Dr Yanchao Yu

Subject Group: Engineering & Mathematics

Research Areas: Engineering - control system/machine learning

Project Title: UAV Obstacle Avoidance Using Hierarchical Reinforcement Learning and Stochastic Control

Project description:

The rapidly evolving field of UAV navigation presents significant challenges, particularly when operating in dynamic and unpredictable environments. Traditional control methods often struggle with these complexities due to their reliance on static models and predefined paths. To address these limitations, this project aims to integrate Hierarchical Reinforcement Learning (HRL) with advanced stochastic control techniques.

This research seeks to enhance the ability of UAVs to navigate through environments with moving obstacles, variable conditions, and other uncertainties. By leveraging HRL and stochastic control, the project will develop more adaptive and resilient obstacle avoidance strategies. The goal is to create a robust control framework that improves both the safety and efficiency of UAV operations across various applications, including disaster response, agriculture, and urban logistics.

The project emphasizes practical implementation, combining theoretical research with real-world testing. This approach ensures that the developed algorithms are not only innovative but also applicable to industry needs. By bridging the gap between academic theory and industrial application, this research has the potential to make significant contributions to the field of UAV technology.

Candidate characteristics

Education:

A first degree (a minimum 2:1) in Control Systems Engineering, Electrical and Electronic Engineering, Computer Science, Mathematics (with a focus on stochastic processes or optimization)

Subject knowledge:

Control Theory: Understanding of feedback systems, stability analysis, and control design is crucial for developing UAV navigation algorithms.

Machine Learning: Familiarity with supervised, unsupervised, and reinforcement learning methods, particularly as they apply to dynamic environments and real-time decision-making.

Programming: Proficiency in programming languages commonly used in control systems and machine learning, such as Python, MATLAB, or C++, is necessary for implementing and testing algorithms.

Robotics and Automation: Basic principles of robotics, including kinematics, dynamics, and path planning, are important for understanding UAV motion and control.

Essential attributes:

- Strong Analytical Skills: The ability to analyse complex problems, develop innovative solutions, and critically assess the performance of algorithms is essential for this research.
- Proficiency in Programming: Strong coding skills in languages such as Python, MATLAB, or C++, which are commonly used for developing and testing control algorithms and machine learning models.
- Foundational Knowledge in Control Systems: A solid understanding of control theory, including feedback mechanisms, stability, and system dynamics, is crucial for the development of UAV navigation strategies.
- Understanding of Machine Learning: Familiarity with various machine learning techniques, particularly reinforcement learning, and their application to dynamic and uncertain environments.

Desirable attributes:

- Knowledge of Stochastic Processes: An understanding of stochastic modelling, probability theory, and how to manage uncertainties in control systems
- Problem-Solving Ability: The capability to tackle complex and unpredictable challenges, particularly in the context of autonomous systems and dynamic environments
- Attention to Detail: Precision in designing and implementing algorithms, as well as in analyzing experimental data.

- Good Communication Skills: The ability to articulate complex concepts clearly, both in writing and verbally, is important for collaborating with team members and presenting research findings
- Self-Motivation and Initiative: The drive to work independently, manage time effectively, and take ownership of the research project
- Collaboration and Teamwork: The ability to work well within a multidisciplinary team, as collaboration with other researchers and industry partners is a key aspect