Postgraduate Studentships Queen's Doctoral Training Programme on Secure Connected Intelligent Design and Manufacturing

School of Electronics, Electrical Engineering and Computer Science

PhD Studentship 2020/21

Proposed Project Title: Real-time and non-restrictive safety enforcement for robots living in dynamic environments; the factory of the future challenge

Principal Supervisor:
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Research Area

Robotics, Control Engineering, IIoT, Planning, Formal Verification

Proposal open to other School (indicate area of Interest)

Computer Science, Mechanical Engineering, Mathematics

Degree linked to ELE

Degree linked to CSC

This project is part of the Queen's Doctoral Training Programme in Secure Connected Intelligent Design and Manufacturing. Many of today's industrial approaches require transformative changes to ensure long term societal, economic and environmental resilience and sustainability. PhD projects in this programme explore the potential of emerging digital technologies, such as artificial intelligence, robotics, and the Internet of Things, to transform the way we design, manufacture and operate products and services.

The programme offers a bespoke research and training programme that aims to develop students into cross-disciplinary, industry-conscious thinkers and leaders who will influence the roadmaps of future advanced manufacturing technologies and their applications. They will have a balanced understanding of ICT (security, communications and data analytics) in the context of their application to Advanced Manufacturing and High Value Design.

Project Description:

Modern cyber-physical systems are increasingly difficult to control; First, they are large scale, have complex dynamics and live in both the continuous and discrete worlds: For example, the production line in a typical factory consists of many interconnected subsystems, and requires several distributed computing components and a network of sensors/actuators to be controlled. Second, the performance specifications and objectives have become themselves extremely complicated as well. For example, in a logistics warehouse, consisting of many autonomous mobile robots and manipulators, the goal is to not only move products from a point A to a point B, but to do so in a provably safe way, minimizing energy consumption, implying ultimately real-time communication and collaboration between all autonomous agents involved (mobile robots, manipulators, humans).

An especially timely and critical challenge in Digital Manufacturing, which calls for the development of smart control algorithms, is the safe human-robot and robot-robot collaboration. This is a prerequisite for the realization of Industry 4.0, as it is needed to realize the factories of the future, with ant/hive-like manufacturing centres that will be able to produce extremely customizable products. The existing solutions for this type of formulations come from several different research fields, however, they are either too simple, thus unable to guarantee an optimal and safe behaviour, or too complicated, thus not implementable.

The proposed project, rooted at the i-AMS centre, aims to use tools from applied mathematics, control engineering and computer science to propose provably correct, implementable controllers for benchmark problems in cobotics. The project will start by building on and adapting recent preliminary results on scalable algorithms for the reachability analysis and control of a large class of hybrid automata. An experimental setup will be also built for benchmarking the performance of the developed research against the state-of-the-art, while the results will also be tested on the facilities of the Northern Ireland Technology Centre.

Objectives –Propose a hybrid dynamical systems framework for multi-agent robotic systems.

- Formulate and solve planning problems for mobile robotic agents moving/working in dynamic environments with humans. Emphasis will be given on real-time, scalable algorithmic implementation of decision mechanisms.
- Perform safety analysis (and enforce safety via new decision mechanisms) using techniques from both Control Engineering and Computer Science.
-Apply a collection of developed algorithms in a challenging real-world robotic installation in the EEECS labs and/or the NITC (Northern Ireland Technology Centre).

Academic Requirements:

A minimum 2.1 honours degree or equivalent in Engineering, Computer Science, Applied Mathematics, or relevant degree is required.

GENERAL INFORMATION
This 3.5 year PhD studentship, potentially funded by the Department for Employment and Learning (DfE), commences on 1 October 2020.

Eligibility for both fees and maintenance (approximately £15,000) depends on the applicants being either an ordinary UK resident or those EU residents who have lived permanently in the UK for the 3 years immediately preceding the start of the studentship. Non UK residents who hold EU residency may also apply but if successful may receive fees only.

Applicants should apply electronically through the Queen's online application portal at: https://dap.qub.ac.uk/portal/

Further information available at: https://www.qub.ac.uk/schools/eeecs/Research/PhDStudy/

Closing date for applications: 15 March 2020