PhD Project Proposal

ECIT Interdisciplinary PhD Programme

Proposed Project Title:

Computation, Communication and Control: Co-design formulations for Cyber-physical Manufacturing Systems

Principal Supervisor(s): Nikolaos Athanasopoulos / Sean McLoone

Project Description:

Manufacturing systems are very hard to control: They are large scale, complex cyber-physical systems, living both in the continuous and discrete world: For example, modern supply chains or production lines consist of many interconnected subsystems, requiring several distributed computing components as well as a network of sensors/actuators to be controlled. Furthermore, performance specifications and objectives are becoming more complicated as well. For example, mobile robots and manipulators in a factory do not only need to move products from a point A to a point B, but they have to do do so in a provably safe way, minimizing energy consumption, real-time communication, and ultimately enhance collaboration between all autonomous agents involved (including humans).

The Internet of Things (IoT), with low-cost efficient sensors, actuators, and smartphones with augmented processing capabilities, is changing the traditional decision making strategies. On the other hand, partly due to the sheer size of data generated, the processing capabilities of local nodes (sensors, actuators etc) cannot guarantee high performance and fulfilment of time contracts for time and mission critical industrial control applications. Distributed computing seems the natural selection for providing the necessary computing and network resources. A critical part of Industry 4.0 concerns the utilization of the network and computing resources to implement controllers that guarantee a desired behaviour of complex cyber-physical systems. Smart distribution of computing and communication in this case becomes extremely relevant, since systems are large scale and decentralized. A major challenge, not addressed so far by the academic community, is to incorporate the dynamics of these resource allocation mechanisms with the controller and the physical processes dynamics. This project investigates how such an aggregated model can be used to synthesize provably correct decision mechanisms minimizing well defined metrics relating to the network, data and computing resources. In particular, we aim to analyse cyber-physical non-idealities (e.g., time delays, packet dropouts, quantization errors, software and hardware faults), and more importantly their interactions, and identify trade-off to be implemented in the controller design.

Objectives:

The proposed project, rooted at the ECIT Research Institute and 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 Digital manufacturing. The project will start by building on and adapting recent preliminary results on scalable algorithms for large scale dynamical systems. An experimental platform, consisting of an IoT infrastructure and mobile agents will be also built for benchmarking the performance of the developed research against the state-of-the-art.

Academic Requirements:

Students entering the programme will normally be required to have a 2.1 BSc/BEng in Computer Science, Electrical and Electronic Engineering, or a maths based engineering or physical science degree, or equivalent qualification recognised by the University. Students holding an appropriate MEng or MSc (Software conversion) will normally be required to have a 2.1 or commendation (distinction) respectively. Furthermore, additional criteria may be applied. All applicants must have significant mathematical and programming experience.

GENERAL INFORMATION:
This 4 year PhD studentship, potentially funded by the Department for Employment and Learning (DEL), commences on 1 October 2019.

Eligibility for both fees and maintenance 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/

Deadline for applications: Friday 1 March 2019

Contact details:

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