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: DTP: GPU acceleration of discrete-event simulations of digital twins

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Research Area

Parallel computing, accelerators, Discrete-event simulation

Proposal open to other School (indicate area of Interest)

School of Mechanical and Aerospace Engineering (Discrete-event simulations)

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:

Virtual factory simulations, using discrete-event simulation (DES), have been used to configure and optimise factories and their control mechanisms for many years. DES represents the operation of a system as a (discrete) sequence of events in time. Each event occurs at a particular instant in time and marks a change of state in the system. For a production configuration and a set control strategy such simulations can evaluate a diverse range of metrics such as unit cost, schedule, quality and resource utilisation. The benefit to date has been the ability to do this without the need to build a physical system or disturb an existing production system. However the true potential of simulation technology is the possibility to formulate viable production designs for autonomous and self-adapting production systems. In such a case the virtual factory simulation will become a key element of the production control and monitoring strategy, using the new predictive capability to optimise in real-time individual operational tasks to achieve higher-level business objectives. A major obstacle to this vision is that simulations are compute-intensive processes. Thus this project aims to research on the use of graphics processing units (GPUs) to accelerate discrete-event simulations. This acceleration will potentially allow real-time predictive factory simulations. A secondary goal is to quantify the resources and approaches to subdivide or idealise simulations to match resources as the feasibility of implementing this approach in a real scenario will depend on the amount of resources required.

Objectives:

- Review GPU acceleration and DES simulation methods and visions for future production systems (Industry 4.0).
- Assemble a project hierarchical database of production scenarios (exemplars), for use through-out the project to develop and demonstrate GPU acceleration.
- Using a standard simulation approach undertake a series of systematic GPU acceleration studies using a traditional production control strategy and the hierarchical database of production scenarios, identifying the most promising approaches and understanding resource requirements.
- Down select a GPU acceleration method and a production scenario to test a real time self-adapting control strategy.
- Quantify the benefits of the proposed GPU acceleration methods and the potential to enable real time self-adapting control via or supported by predictive simulation, benchmarking against current state of the art.
- Write-up thesis and journal papers.

Academic Requirements:

A minimum 2.1 honours degree or equivalent in Computer Science or Electrical and Electronic Engineering 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