QUB- Mechanical and Aerospace Engineering PhD Project 2018-2019

Title: Engineering Modelling Methods to Drive the Operation of Cyber Physical Production Systems.

Project description:

Increasingly aerospace original equipment manufacturers (OEMs) are looking at automated technologies to drive operational efficiencies in manufacturing. In the light of the technological improvements driven by the consequences of the fourth industrial revolution (Industry 4.0), opportunities exist to improve simulation based technologies and their integrative support frameworks around the specification, implementation and operation of automated production systems. By incorporating predictive engineering models in Product Lifecycle Development (PLM) tools, (OEMs) can simulate the influence of design based decisions in the manufacturing domain. By connecting live production system data to the simulation models, system feedback from the factory floor can then be used within the virtual PLM solution, to drive self-adapting, closed loop production systems. This approach can potentially deliver solutions at both the macro level (Discrete event modelling (DES) for factory simulation) and micro level (Robotic / CNC simulation for individual machines and tools).

The **aim** of this project is to **create and demonstrate engineering modelling methods which can support autonomous production systems,** by simulating production scenarios in the first instance and using live production feedback from the resulting operation to adapt the simulation models and support ongoing production as a Cyber Physical System.

Project outline

- Review simulation methods, production control strategies, and advanced sensing and control technology appropriate for automated production methods in line with Industry 4.0 practice.
- Create a project hierarchical database of production scenarios (exemplars), for use throughout the project to develop understanding and simulation methods.
- Using a standard simulation approach undertake a series of systematic simulation studies using a traditional production control strategy and the hierarchical database of production scenarios.
- Down select a small number of novel autonomous or self-adapting monitoring and control strategies from the literature or state of the art industrial practice.
- Refine the baseline simulations to enable the introduction and assessment of the novel monitoring and control strategies (identifying and developing the additional data streams).
- Capture the relationships between the performance of the monitoring and control strategies and the physical behaviour witnessed within the production environment.
- Develop individual simulation approaches with an integrative framework, to refine the control strategies and monitoring methods and the required modelling approaches to simulate the critical data streams.
- Quantify the benefits of any proposed systems by benchmarking against current state of the art.
- Write-up thesis and journal papers.

Key skills required for the post:

Applicants must have a degree in mechanical or aerospace engineering, or an equivalent qualification at Masters level. Candidates should be able to demonstrate that they are highly motivated, have excellent communication skills, be able to work in a team and undertake challenging tasks using their own initiative. Any experience relevant to manufacturing, engineering modelling or programming would be advantageous, but is not essential.

Key transferable skills that will be developed during the PhD:

This research project will enable the successful student to acquire valuable experience of factory simulation, robotic simulation methods, advanced production sensing and control. All of which are highly sought after within industry. The project will use a combination of advanced commercial simulation tools, validating their predictive capability against real industrial data.

The training approach utilised in the PRP is specifically targeted to enable PhD graduates to secure very high quality employment in leading companies. Training areas will include four domains encompassing; knowledge & intellectual abilities, personal effectiveness, research governance & organisation, engagement influence & impact.

First/Lead Supervisor and their contact details	Dr Joe Butterfield, Tel: +44 (0)28 9097 4878, Email: j.butterfield@qub.ac.uk
Second Supervisor and their contact details:	Prof Adrian Murphy Tel: +44 (0)28 9097 4095, Email: a.murphy@qub.ac.uk
Top up available for this project?	The studentship which is open to UK residents only covers the full university fees and includes an income of up to £13,500 per annum (teaching and demonstration duties will enable the successful applicant to earn up to a further £1,500 GBP per annum).The project will be undertaken in partnership with a number of manufacturing companies. An additional top-up may be offered to very high calibre students.
Pioneer Research Programmes (PRPs) *Enable researchers to form novel interdisciplinary collaborations to address emerging societal challenges.* .	The project will be undertaken within the newly created PRP in 'Intelligent Autonomous Manufacturing Systems'. The PRP is worth up to £1.06 million over three years and includes 9 PhD studentships and funds to develop links with key centres in Europe, US and China. The PRP is design to provide a stimulating environment for the training of the next generation of post-doctoral graduates, directly feeding industry with high quality engineers. The PRP brings together complementary expertise to provide a training programme to develop technical knowledge and professional skills, aimed at preparing the students for their career as future engineering leaders. It also provides a supportive, team environment to undertake research and a wide network of industrial and academic collaborators, enabling students to understand how industry foresees its future engineering and technology needs. The partner companies are based in N. Ireland and the student will work closely with the companies as required by the project phases. The student will also be expected to visit national and international suppliers and participate in the international technical community by attending relevant conferences in North America, Europe and Asia. It is also expected that the student will develop technical papers for leading journals within the research field.