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: Semi-supervised learning for advanced manufacturing applications

Principal Supervisor: Prof Seán Mcloone

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Research Area
Machine Learning/Statistics/Data analytics

Proposal open to other School (indicate area of Interest)
Computer Science, Mathematics and Physics

Degree linked to ELE (delete as appropriate)

Degree linked to CSC (delete as appropriate)

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:

With the rapid development in sensing, communication and storage technologies, companies are now collecting and storing large quantities of data on their manufacturing processes – temperatures, pressures, flow rates, etc. While there is generally no restriction on capturing 'input data', the matching output data needed for modelling building is frequently limited. For example, measuring the final product quality is generally only done through infrequent sampling, due to the cost and time involved (e.g. testing product quality may require destructive testing, or take several hours). Other process characteristics such as the state-of-health of machinery may only be available following scheduled maintenances or when a process failure occurs.

To achieve better control of manufacturing processes and improved efficiency in terms of waste and energy consumption real-time measurements of product quality and machine health are desirable. One approach to solving this problem that is an active area of research in many industries is to use machine learning techniques to develop so called soft sensing models that can predict these quantities from the available process measurements. One of the major challenges with building these models is that datasets are often ill-conditioned with a large number of candidate process variables available as model inputs but only a small number of output training samples (referred to as labelled data). The current practice is to discard the large volume of data collected which does not have corresponding labelled data. Discarding this data (referred to as unlabelled data) represents a huge waste of resource and a missed opportunity.

As such, researchers are increasing looking at how to take advantage of unlabelled data to enhance the learning process in machine learning applications, a strategy referred to as semi-supervised learning. The focus of this PhD is to explore how semi-supervised learning can be achieved in manufacturing applications such as soft sensing of quality metrics and condition monitoring of production machines, where there is a wealth of unlabelled data, and a dearth of labelled data.

Objectives:

The objectives of this PhD are to explore techniques for utilizing unlabelled data to enhance model building and to develop methodologies that can make the best use of all available data in the development of robust soft sensors for advanced manufacturing applications.

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