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

Title: DTP: Integrating machine learning/AI with image recognition toolkits for improved independence in autonomous, self-adapting systems.

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.

Project description:
Autonomous systems generally rely on structured inputs at some point in order to function and complete tasks within what are mostly controlled environmental surroundings. By definition, this makes their function automatic but not fully independent. Environmental awareness can be improved through an array of sensing devices and imaging technologies. This enables improved but not optimal functional independence. As the application of automated and autonomous technologies has percolated more and more societal functions and industrial sectors, there is an increasing need for autonomous operation to include more *'independent autonomy'* where systems rely less and less on human, decision based inputs. The interpretive functions within systems which are required to reduce this reliance need to better represent the abilities of their human equivalent to use their situational awareness in order to react and adapt to any given scenario particularly in non-structured environments. This approach needs to include developments in sensing hardware as well as the AI / machine learning capability needed to interpret, act on and learn from the incoming data.

Aims and Objectives:

Aim: To investigate the development and integration of novel sensing techniques (focusing on image recognition) in the control and operation of autonomous / semi-autonomous vehicle–based systems. Methods to reduce human inputs and decision making will be investigated in order to develop optimal operation under non-structured conditions.

1. Identify exemplar system & conduct background study & evaluation of commercially available products: Capture information required to provide a base line system to develop understanding and to use as the basis for future improvements. (Examples to consider: drone, adapted RC, scaled vehicle).

2. Explore novel technology for image recognition: Conduct a literature / technology review to examine latest research / applications in the area relative to the requirements identified by Objective 1.

3. Develop new configuration concepts and interaction modalities (image system to hardware control) for system in a multi task scenario: Based on the requirements of Objective 1 and the outcomes from Objective 2, the existing configuration and new layouts will be developed virtually (based on CAD models) for approval.

4. Understand potential application of AI: Determine if AI can be safely and effectively used to aid or take over live decision-making processes based on the systems independent knowledge. A successful system will integrate situation awareness, machine learning and mission execution functions. The work will define the limitations of current and forthcoming hardware technology and will seek to mitigate these limitations through intelligent software. A review of literature will be required to determine suitability of AI for real time decision making. A sample situation based on existing and new interface design and system performance will be developed with and without AI to quantity benefit.

5. Recommend new product development opportunities: Due consideration will be given to the outcomes of Objectives 1 – 4 and recommendations will be given regarding any new system and the associated effects this will have on independent autonomy.

Key skills required for the post: Applicants must have a degree in Electrical Engineering, Computer Science, 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 academic or industrial experience relevant to AI, image recognition, engineering modelling and / or programming would be advantageous, but is not essential.	

Key transferable skills that will be developed during the PhD: 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.	
Lead supervisor:	Dr Joe Butterfield, SMAE, j.butterfield@qub.ac.uk
Other supervisor(s):	Prof. Karen Rafferty, EEECS, k.rafferty@qub.ac.uk Prof. Adrian Murphy, SMAE, a.murphy@qub.ac.uk Dr Ivor Spence, EEECS, I.Spence@qub.ac.uk
Guaranteed stipend:	This is a 3.5 year funded Queen's DfE DTPs studentship with Training Grant, to commence on 1 October 2020 (N.B. stipend for 20/21 is not yet known, but is likely to exceed £15,000). The studentship covers fees and maintenance and is available for UK residents (see full eligibility criteria - nationality, residency, and academic qualification at: http://go.qub.ac.uk/dfeterms). **When applying using the Queen's portal please ensure you include "DTP:" along with the project title.**
Conditional top-up available:	
PhD students in the School have the opportunity to apply to be demonstrators on undergraduate modules. Compensation for this can amount to in excess of £2,400 per year.⌗	

Queens University Belfast is a diverse and international institution which is strongly committed to equality and diversity, and to selection on merit. Currently women are under-represented in research positions in the School and accordingly applications from women are particularly welcome.