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

Title: DTP: Personalised AI for Improved Human / Machine Interaction & Optimal Performance of Complex 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:
The design of human / machine interfaces (HMIs) requires multi-disciplinary understanding and inputs if they are to operate optimally in line with the operational requirements of a semi-autonomous vehicular system. Digital / virtual design and validation methods can configure layouts and facilitate ergonomic optimisation but current state of the art methods fall short of what is required to fully understand / include human factors around situational awareness and effective communication in the HMI design process. This is a significant challenge when groups of individuals have to work collaboratively, communicate effectively and make decisions correctly in order to operate multiple complex systems in what can often be pressured scenarios. Autonomous agents have the potential to improve human / machine system performance by undertaking operations on behalf of the operator thereby reducing user workload. In order to realise this potential a HMI design paradigm is required to effectively integrate hardware / software, human and agent based methods for complex system design.

Aims and Objectives:
Aim: To investigate the application of novel human computer interaction techniques in the development and operation of autonomous / semi-autonomous vehicle–based systems. As part of the research study, methods to reduce the human decision making workload and coordination of decisions related to multiple system functions will be investigated in order to develop an optimal HMI.

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: Flight simulator, Drive simulator).
2. Explore novel technology for HMI: Conduct a literature / technology review to examine latest research / applications in the area relative to the requirements identified by Objective 1. The potential of using virtual and augmented reality for visual stimulus will be considered alongside using other forms of multisensory stimulation (e.g. haptics, audio and any other modalities considered relevant to the programme aim).
3. Develop new configuration concepts and interaction modalities for system user in a multi task scenario: Based on the requirements of Objective 1 and the outcomes from Objective 2, the existing configuration and new interior layouts and methods for HMI design will be developed virtually (based on CAD models). These will be used for qualitative and quantitative testing with end users comparing existing and proposed systems.
4. Understand impact of autonomous agent: Determine if autonomous agents can be safely and effectively used to aid or take over some of the decision-making processes of the user. For high workload or sensory overload scenarios, these agents should integrate learning, communication, collaboration and knowledge management. 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 agents for real time decision making. A sample situation based on existing and new interface design and interface interaction will be developed with and without autonomous agents to quantity benefit.
5. Investigate & evaluate new user roles & responsibilities: Investigate / review the role that the user will play within new HMIs based on outcomes from Objectives 1 - 4. Using the virtual prototypes developed in Objective 3 and any inclusion of agents from Objective 4, optimised modes in interaction and user responsibilities can be determined. This will involve testing and measuring behaviours in a number of end users where human sensory load / overload will also be monitored and assessed. A select number of typical operation scenarios will be used to do this. The workload of the operator will be assessed through appropriate behavioural measures.
6. Recommend new product development follow-ups: Due consideration will be given to the outcomes of

Objectives 1 – 5 and recommendations will be given regarding any new HMI and the associated effects this will have on user workload.	
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 HMI design, engineering modelling, programming or AI 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
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.