QUB-
Mechanical and Aerospace Engineering
2020-2021

Title: Enabling Predictive Control of Electric Bus Vehicles

Organisation	Queen's University Belfast
Qualification	PhD
Funding Amount	Fee/studentship funding may be available for UK nationals or EU nationals who have lived in the UK for over 3 years (EU nationals not resident in the UK are only eligible for fees element). Further information regarding DfE studentship eligibility criteria can be found at: http://www.qub.ac.uk/graduate-school/funding-scholarships/uk-eu-prospective-research/.
Duration	3 years
Application Deadline	Ongoing
Anticipated Start Date	October 2020

Project description:

With increasing emphasis on the need for a modal shift to zero net emissions vehicles across all transport sectors, there is increasing research activity in the bus sector around the design and operation of single and double deck fully electric buses. One of the key challenges lies in achieving optimal use of the on-board electric powertrain components in order to maintain vehicle performance throughout its life while maximising the overall energy efficiency. This relies on the development and implementation of a robust and reliable powertrain control strategy. Model predictive control has become an increasingly popular way of developing such energy optimised systems, but still encounters challenges when it is used in changing or uncertain environments, such as heavy traffic, hot/cold weather or varying passenger loads encountered under normal bus operating scenarios. If accurate forecasts of the future operational environment of the vehicle can be achieved, this can be used to realise improvements in velocity tracking, energy management and other onboard functionality. Such effective and reliable model predictive control can also enable future autonomous and connected vehicle operations. Given the predictability of operating routes for bus vehicles, this sector makes a strong candidate for the development and ultimate adoption of these advanced control technologies.

The team at Queen's University Belfast have extensive experience in modelling and performance analysis of a range of bus vehicle types (diesel, hybrid and electric) and the current PhD will join the team to further develop expertise in the modelling of future control systems which can achieve effective energy management across a wide range of operating scenarios.

Key Objectives:

1. To understand the state-of-the-art in electric powertrain technologies, with a focus in control systems development and implementation, including the role of model predictive control in powertrain development.

2. To implement and test a model predictive controller within single and double deck electric bus vehicle architectures which can be used to realise enhanced energy management under standard driving cycle conditions.

3. To use the developed environment to develop the model predictive control problem to consider the connected energy management problem where the vehicle performance and energy management are considered simultaneously under varying environmental conditions (traffic patterns, road gradients, etc).

4. To propose how these advanced control strategies could be embedded into a future connected vehicle network.

Key skills required for the post:

A minimum degree classification of 2:1 (or equivalent) in one of the following areas is required: Engineering, Science, IT, Mathematics or a closely related subject area. A Masters level qualification (MEng/MSc) is preferred, and while other qualifications may be accepted, candidates who do not hold a Masters level qualification should clearly demonstrate their equivalent experience. Candidates must be able to demonstrate a significant level of mathematics and/or data analysis in their primary degree area.

It would be desirable to have some understanding and knowledge in the areas of automotive engineering and data analytics.

Good computer skills are desirable as the project will involve computer modelling, simulations and analysis of results.

Key transferable skills that will be developed during the PhD:

The key transferable skills that will be developed during this PhD project will be in the areas of:

- Matlab/Simulink and Excel based modelling
- Possibly Experimental Testing and Analysis

First/Lead Supervisor and their contact details	Dr Juliana Early (j.early@qub.ac.uk, School of Mechanical and Aerospace Engineering)
Second Supervisor and their contact details:	Dr Geoff Cunningham (g.cunningham@qub.ac.uk) Dr Yuanjian Zhang (y.zhang@qub.ac.uk)