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Project Note 73

Modular Energy Optimisation Design Tool for Zero Emission Heavy Duty Vehicles

Hydrogen Fuelled Vehicles Project Funded by Scottish Enterprise, 2021 - 2022

In this project, ISC addressed the problem of optimising energy use whilst reducing the degradation of expensive components, particularly fuel cells and batteries, in zero-emission heavy-duty vehicles powered by a combination of hydrogen fuel cells and batteries. The combination of fuel cells and batteries is needed to provide a faster response and to enable energy to be captured through regenerative braking.

A new energy management control system was produced. The Energy Management System (EMS) software, for implementation on vehicles in micro control units, was developed and tested using a simulation of the vehicle model and different driving cycles. Various control solutions, ranging from a relatively simple logic-based switching baseline design without optimisation to the advanced predictive controllers that can allow for nonlinearities in the system, were obtained and simulated. These were tested in a feedback loop and the results were analysed and retuned/optimised. The software provided the basis of a design facility which is in an early stage of development but demonstrates the feasibility of the approach. It enables different controllers to be compared and the advantages of the advanced control solution based on model predictive control to be demonstrated.

The advanced controller has been shown to have real benefits. One of these is handling hard constraints in the system such as amplitude or rate limits. It also enables prediction to be included so that model information can be exploited to produce the best optimal solution given some future knowledge of driving conditions.

The technical information on the project has been distributed to companies involved in the manufacturing or design of hydrogen vehicle-based systems that have kindly provided vehicle or road data and are interested in future involvement. A commercial project has also been undertaken in the area. Moreover, encouraged by the success of the above approach, similar techniques have been applied to the development of hydrogen fuelled ship energy management system controls recently funded by the Department of Transport.

ISC Limited is grateful for the support of Scottish Enterprise.

ISC Limited supplies control consultancy services to various areas of the automotive industry, including EV/HEV powertrain, combustion engine, autonomous vehicles, and batteries/storage. The services supplied include Model-based optimal control for engine management, engine and SCR catalyst system modelling and calibration, system identification and nonlinear parameter estimation for engine models, comparative evaluation of classical and advanced control for electronic throttle position, evaluation of control strategies for engine temperature control.

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