Master Project

Automated Control Generation for a Mixed-Integer model of Powertrains

Anand Srikrishna, Delft Center for Systems and Control, TU Delft
A.SRIKRISHNA@student@tudelft.nl

Peyman Mohajerin Esfahani, Delft Center for Systems and Control, TU Delft
P.MohajerinEsfahani@tudelft.nl

Context

Powertrain modelling and control has been an important area of research for many automotive manufacturers. The aim has always been to lower their fuel consumption and reduce emissions. Many important powertrain applications are Hybrid Electric Vehicles (HEVs), dredging systems in ships etc. HEV applications have been considered important over the past decade. Many governments encourage the use of HEVs as they improve local air quality and reduce fuel costs. The sales of HEVs in the Netherlands as a percentage of passenger car sales has increased from 4.7% to 11.8% from 2016 to 2022. The number of charging points in Netherlands has almost tripled over the last 5 years (Source : I&W).

Many powertrain models pose a mixed integer optimization problem. In HEVs, the mixed integer element can arise from engine/battery on/off modes or gear choice with torque split. In dredging systems, these can arise from choosing to run one or multiple generators for optimal power output. Along with these, the model will have to consider non-linearity in these systems resulting in non-convex optimization problems.

The focus of this project is to formulate a distributed mixed integer optimal control problem (MIOCP) for scalability. Then, the project will come up with methods to solve this MIOCP using predictive strategies in energy management systems (MPC-EMS). The strategy will then be implemented in an existing system and will be compared against current strategies such as equivalent consumption minimization strategy (ECMS). By implementing these methods, the aim is to bring about a smarter controller which can reduce the fuel consumption and computational efforts compared to the current strategies. By solving MIPs, it brings a better method of mode selection in powertrain applications.

Project tasks

This master thesis project is aimed at developing a mixed integer model of a powertrain and develop an MPC for it:

1. Fix a system in which mixed integer and non-linearity in the model exist
2. Formulate a distributed MIOCP for the system, using energy management system (EMS) strategies
3. Develop a predictive solution to the optimization problem, thus generating an MPC
4. Validate developed solution against current standard strategies (ECMS)

This master thesis project is done in cooperation with TNO, Powertrains Department. The solution will be designed and validated experimentally.