Emission-Intelligent Cooperative Adaptive Cruise Control

Alexander Massoner, AVL List GmbH
Alexander.Massoner@avl.com, Tel.: +43 316 787

Peyman Mohajerin Esfahani
P.MohajerinEsfahani@tudelft.nl

Introduction

Advanced vehicle (semi)-autonomous driving systems will play an integral part in the future for sustainable, convenient and safe mobility. This development has traditionally focused primarily on decreased driving effort and enhanced driving safety. Due to the increasing regulation and climate change, research is however additionally being driven towards development of functions that enhance energy efficiency and reduce emissions.

Aside from a growing number of vehicles being equipped with the means for direct Vehicle-to-Vehicle (V2V) communication, first-generation driver assistance functions utilizing Vehicle-to-Infrastructure (V2I) information from traffic lights are already commercially available. Functions utilizing V2I communication include the Audi *Traffic Light Assist*, which can be activated on a selection of US routes since 2017. This system uses a digital dashboard display to inform when an upcoming traffic light will turn green, allowing drivers to adapt the velocity accordingly.

Source: AUDI US

By combining Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communication with information about the upcoming route, energy consumption and pollutant emissions can be significantly improved while maintaining safety and comfort.

Problem Background

AVL is developing Cooperative Adaptive Cruise Control (CACC) strategies for a wide range of driving scenarios. AVL's green CACC makes predictions of the surrounding traffic as well as the upcoming route, including traffic light Signal Phase And Time (SPAT) information, curvature and speed limits, to identify energy-efficient speed trajectories in particularly urban traffic. This is achieved using a Model Predictive Control (MPC) strategy which incorporates constraints over a receding horizon.

In addition to reducing energy consumption, future development of the CACC will additionally consider CO_2 and Real Driving Emissions (RDE). Since 2017, emissions of vehicles in the European Union are evaluated during real-world driving, whereas before emissions had only been evaluated on the testbed. To reduce emissions and pass RDE & CO_2 standards, it is critical that key variables such as the engine exhaust and after treatment system are accounted for in the overall vehicle control strategy.

The main contribution of the thesis will be an investigation into how CO_2 and RDE (e.g., NOx, particulate matter), may be influenced by modifying the existing CACC and by using predictive information (e.g. load profile between traffic lights) that the CACC can provide to any other on-board system. This investigation will preferably be carried out with a 48V hybrid powertrain in mind. It should be possible to adjust the balance between accepted levels of emissions and other performance indicators in the CACC, such as energy consumption, travel time, and mechanical jerk. To ensure that the CACC in a later phase may be executed on real hardware, it is furthermore crucial that the enhanced control strategy maintains real-time capability.

Your Assignment

- Conducting extensive literature research to elaborate modelling approaches for emission models;
- Extending the green CACC functionality to reduce CO_2 & RDE emissions. This includes:
  - Understanding of existing functions including the underlying control & optimization techniques;
  - Understanding of relevant powertrain topologies and powertrain control systems;
  - Understanding of state of the art methods for modelling combustion emissions (CO2, RDE);
  - Deduction of requirements for an emission intelligent CACC;
- Building & testing simulation models in MATLAB/Simulink, AVL Cruise, AVL BOOST & AVL VSM;
- Documenting & reporting project results.

Your Profile

- Studies of Telematics, Electrical Engineering, Control Engineering, Software Development, or similar;
- Experience in MATLAB/Simulink, knowledge & interest in Control Architectures & Software Development;
- Basic understanding of passenger car powertrains, control systems and optimization techniques;
- Interest in working in a multidisciplinary team;
- Good command of English.

AVL is looking for a highly motivated student who wants to write his/her Master's Thesis in this field in close collaboration at the AVL facilities in Graz, Austria. According to the Austrian Employment of Foreign Nationals Act it is unfortunately not possible to assign graduate work to third-country nationals (non-EU citizens) and Croatian citizens studying outside of Austria. The student will receive a financial remuneration with successful submission.