EPiCo
Electric Vehicle Propulsion and Control

E-Pico Master's Thesis

Traffic control

Traffic queues are becoming more and more critical every day. They do not only origin large costs owed to uncreative time losses; they also increase the opportunity of accidents and have a negative effect on the environment (air pollution, fuel consumption) and on the quality of life (noise, stress). One of such short-term actions that can be applied to alleviate this problem is to increase the capacity of the existing infrastructure by regulating and redirecting the traffic flow on the basis of the information that vehicles exchange with each other (V2V) and with the infrastructure (V2I).

Figure 1: Ramp metering

Goals

In this proposal we consider the modeling and control of traffic flows on highways. After a selection of one or more traffic flow models that best suit our aims, we shall investigate how control actions such as dynamic route information panels, variable message signs, ramp metering (see figure), etc. can be used optimally to decrease the lengths and the frequency of occurrence of traffic jams.
The action of many contemporary traffic controllers is based on the local traffic situation: for example, ramp metering can be switched on when the traffic around the on-ramp is becoming too dense, speed limits are imposed when there is congestion downstream, or route information is given based on congestion in the vicinity of the Dynamic Route Information Panels. While these control actions are designed at solving or alleviating the local problems, they also have a consequence further away (and thus later) in the network. Model predictive control looks to be a good method to tackle this problem, since predictions about the future behavior and the development of traffic flows can be taken in to account (see [3]). Reinforcement Learning (RL) methods are a promising alternative for setting up controls since they can learn and react to different traffic situations without knowing the explicit model of the motorway dynamics managing the information of the present vehicles (see [1], [2]). An interesting topic can be to make predictive control robust through the integration of a term that updates dynamically through the use of useful information from vehicles and infrastructure and the application of reinforcement learning techniques.

Requirements

You should have a good understanding of Hybrid Electric Vehicles models, Battery models, Automatic Control Theory, Connected Vehicles, MATLAB-SIMULINK.

[1] Krešimir Kušic, Edouard Ivanjko, Martin Greguric and Mladen Mileti, An Overview of Reinforcement Learning Methods for Variable Speed Limit Control, Appl. Sci., 10, 4917, 2020.

[2] Fuwen Deng, Jiandong Jin, Yu Shen, and Yuchuan Du, Advanced Self-Improving Ramp Metering Algorithm based on Multi-Agent Deep Reinforcement Learning, 2019 IEEE Intelligent Transportation Systems Conference (ITSC) Auckland, NZ, October 27-30, 2019

[3] D. Bianchi, A. Ferrara, M.D. Di Benedetto Networked model predictive traffic control with time varying optimization horizon: The Grenoble South Ring case study, European Control Conference (ECC), pp. 4039-4044, 2013.

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