



## E-Pico Master's Thesis

# Cooperative lane change manoeuvre for HEV/PHEV automated vehicles

In the situation of the multiple-vehicle scenario, the performance of energy management strategies (EMSs) of connected HEVs/PHEVs is generally evaluated on a single lane. However, lane-changing (e.g., overtaking and merging) manoeuvres would occur in realistic traffic conditions, which in turn produces disturbances for a platoon of vehicles. This definitely influences the performance of EMSs and therefore needs a new methodology to coordinate the connected vehicles. Some methods are reported in [1-2-3-4-5] for conventional vehicles regarding the merging and overtaking problem, which adopt stochastic controls to minimize the probability of collision. This can also be expanded to connected HEVs by considering the safety and fuel economy simultaneously.

### ■ Goals

In the connected environment, the subject vehicle can perceive the neighbouring vehicles via V2V communication. In this way, the behaviour of merging and overtaking may be monitored and thus reconsiders a new platooning for EMSs. Therefore, it is very interesting [6] to examine how to coordinate the velocity and devise EMSs for a platoon of HEVs/PHEVs to guarantee fuel efficiency and mobility subject to external disturbances (e.g., merging, overtaking).

### ■ Requirements

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

- [1] Raghavan A, Wei J, Baras JS, Johansson KH. Stochastic control formulation of the car overtake problem. IFAC-PapersOnLine 2018;51(9):124–9.
- [2] van de Hoef S, Johansson KH, Dimarogonas DV. Efficient dynamic programming solution to a platoon coordination merge problem with stochastic travel times. IFAC-PapersOnLine 2017;50(1):4228–33.
- [3] Cicic M, Liang K-Y, Henrik Johansson K., Platoon merging distance prediction using a neural network vehicle speed model. IFAC-PapersOnLine 2017;50(1):3720–5.
- [4] Yugong Luo, Gang Yang, Mingchang Xu, Zhaobo Qin, Keqiang Li, Cooperative Lane-Change Maneuver for Multiple Automated Vehicles on a Highway, Automotive Innovation, Vol. 2, pp. 157–168, 2019.
- [5] Andres Ladino, Meng Wang, A Dynamic Game Formulation for Cooperative Lane Change Strategies at Highway Merges, IFAC 2020.
- [6] Fengqi Zhanga, Xiaosong Hub, Reza Langari, Dongpu Cao, Energy management strategies of connected HEVs and PHEVs: Recent progress and outlook, Progress in Energy and Combustion Science, Vol. 73, pp. 235-256, July 2019.

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