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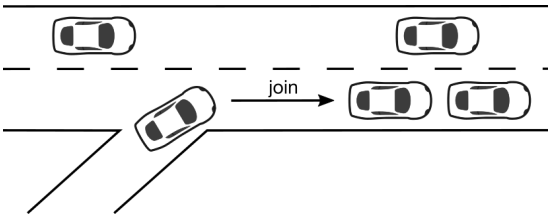
Master's Thesis

Designing Cooperative Maneuvers for Platooning

The ongoing growth of passenger transport results in more road traffic and, therefore, more traffic jams and pollution. Researchers and car manufacturers are trying to improve driving, using Inter-Vehicle Communication (IVC), resulting in trends like Intelligent Transportation Systems (ITSs) or cooperative driving. One promising development in this field is *platooning* (i.e., Cooperative Adaptive Cruise Control (CACC)), which aims to improve today's driving for example on freeways.



Maintaining an existing platoon has been researched many times already. In order to drive together in a convoy however, individual vehicles first of all have to form a new platoon (or join an existing one). Furthermore, vehicles need to leave an existing platoon at some point, e.g., for exiting the freeway.
All of these actions should be performed in a coordinated and controlled manner among all vehicles involved to ensure driving safety – they have to execute *cooperative maneuvers*.

Early work on cooperative maneuvers for platooning uses IVC to perform simple synchronized actions [1]. Using micro maneuvers [2], more complex maneuvers can be constructed and performed. Recently, the consortium of the EU HORIZION 2020 project ENSEMBLE proposed definitions of maneuvers [3]. However, comprehensive and complete definitions for these maneuvers are still missing. Especially validation and tests are crucial to ensure robustness and thus driving safety.

Goals

The goal of this thesis is to model (some of) the basic maneuvers for platooning on freeways (e.g., join, merge, leave, split, lange-change) in corresponding Finite State Machines (FSMs). Existing work on cooperative maneuvers should be considered in the design process and might serve as a base for the model (e.g., [3]).

After modeling, the FSMs need be theoretically validated and checked for robustness (e.g., determinism, complete specification). Furthermore, they should be implemented in our platooning simulator Plexe and tested in different traffic scenarios. Finally, the robustness and safety of the developed maneuvers should be evaluated by performing large-scale simulation studies.

Requirements

You should have a basic understanding of *Vehicular Networking*, *FSMs*, *Network Simulation*, and *C++*.

[1] S. Lam and J. Katupitiya, "Cooperative Autonomous Platoon Maneuvers on Highways," in *IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM 2013)*, Wollogong, Australia: IEEE, Jul. 2013, pp. 1152–1157. DOI: 10.1109/AIM.2013.6584249.

[2] M. Amoozadeh, H. Deng, C.-N. Chuah, H. M. Zhang, and D. Ghosal, "Platoon management with cooperative adaptive cruise control enabled by VANET," *Elsevier Vehicular Communications*, vol. 2, no. 2, pp. 110–123, Apr. 2015. DOI: 10.1016/j.vehcom.2015.03.004.

[3] B. Atanassow and K. Sjöberg, "Platooning protocol definition and Communication strategy," H2020 ENSEMBLE, Deliverable D2.8, Dec. 2018, pp. 1–55.

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