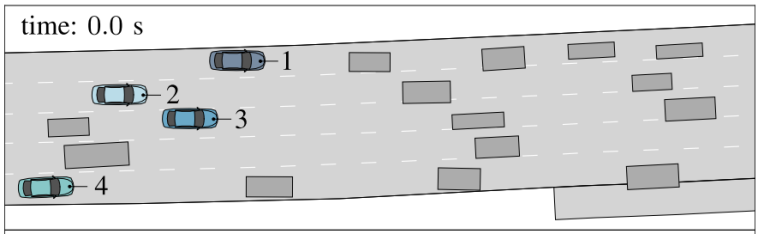
Cooperative Motion Planning of Automated Vehicles Considering Traffic Rules

Background

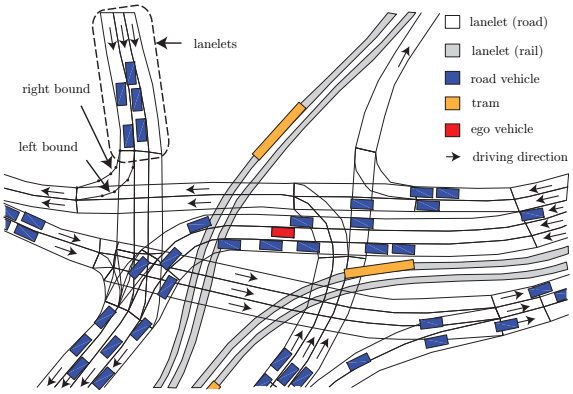
With increasing number of automated vehicles on roads, their cooperation will soon become important to fully unfold the anticipated advantages, which include reduced number of accidents, enhanced traffic flow and passenger comfort, to name a few. One of the remarkable benefits of cooperative driving is that the vehicles can jointly plan maneuvers to prevent collisions that are otherwise inevitable. The planned motions not only should be collision-free with respect to other traffic participants, but also adhere to traffic rules. This can get even more challenging when not all rules can be obeyed at the same time. For example, situation can arise that a collision with other traffic participant is no longer avoidable except for evading into a lane with opposite driving direction.



A highway scenario where both human-driven and automated vehicles co-exist.

Description

The aim of this thesis is to devise an algorithm for multi-vehicle motion planning, which explicitly takes the compliance with traffic rules into consideration. As a first step, motion planning considering traffic rules for single vehicle should be investigated (see [1] for a survey on motion planning with temporal-logic specifications). Compliance with traffic rules can be monitored via our CommonRoad-Monitor (to be released). In the case that not all traffic rules can be satisfied, minimum-violation approaches as in [2] can be incorporated. Following that, an extension could be carried out with multi-agent motion planning algorithms, such as Multi-Agent RRT* [3]. Traffic rules (e.g. safe distances) within the group of cooperating vehicles can be relaxed to ease the multi-vehicle motion planning problem. The results should be demonstrated in CommonRoad [4], which is a collection of composable benchmarks for motion planning on roads. An exemplary scenario in CommonRoad taken from the city center of Munich (Stachus) is shown below:



An exemplary scenario from Stachus in CommonRoad

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Research project:
DFG SPP1835 - cCooperatively Interacting Automobiles

Type:
Master

Research area:
Multi-agent Motion Planning, Temporal Logic, Traffic Rules

Programming language:
Mostly Python, could involve some C++

Required skills:
Advancded programming skill, able to work independently

Language:
English

Date of submission:
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Tasks

- Literature review of works related to motion planning with temporal logic specifications/ minimum-violation planning/ multi-vehicle motion planning.
- Familiarizing with CommonRoad and related software (SPOT prediction tool, traffic rules monitors, etc.).
- Implementation of motion planning algorithm considering traffic rules (single vehicle), with minimum traffic rules violation, if necessary.
- Extension to multi-vehicle settings.
- Demonstration of results with CommonRoad scenarios.
- Documentation of codes and other related materials.

In case of excellent result, submission of the thesis outcome to IV 2021, ITSC 2021 or other renowned conferences is possible.

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[1] E. Plaku and S. Karaman, "Motion planning with temporal-logic specifications: Progress and challenges," *AI communications*, vol. 29, no. 1, pp. 151–162, 2016.

[2] L. I. R. Castro, P. Chaudhari, J. Tumová, S. Karaman, E. Frazzoli, and D. Rus, "Incremental sampling-based algorithm for minimum-violation motion planning," in *52nd IEEE Conference on Decision and Control*. IEEE, 2013, pp. 3217–3224.

[3] M. Čáp, P. Novák, J. Vokřínek, and M. Pěchouček, "Multi-agent rrt*: Sampling-based cooperative pathfinding," *AAMAS*, 2013.

[4] Commonroad. https://commonroad.in.tum.de/.