Cooperative Motion Planning of Automated Vehicles using Reachable Sets

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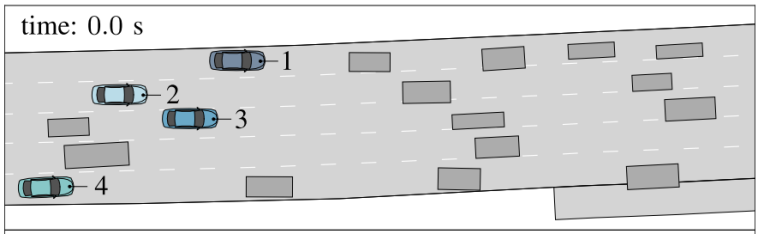
Background

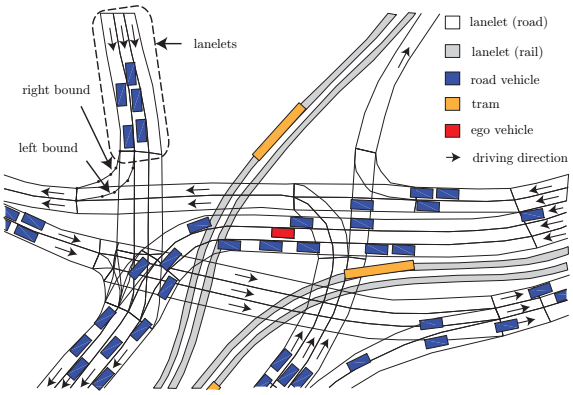
With increasing number of automated vehicles on roads, their cooperation will soon become important to fully unfold the anticipated advantages, which include reduced number of accidents, enhanced traffic flow and passenger comfort, to name a few. One of the remarkable benefits of cooperative driving is that the vehicles can jointly plan maneuvers and trajectories to prevent collisions that are otherwise inevitable.



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

Description

The aim of this thesis is to develop a framework for cooperative motion planning of automated vehicles using reachable sets. The over-approximative reachable sets [1] enclose all states that are reachable by the vehicles, which can be negotiated between vehicles to determine their planning spaces. As a first step, we would like to replicate some of the results from the articles [2, 3] which address this issue. After that, we would like to evaluate the performance of several motion planning algorithms (search, sampling, and optimization-based motion planners, etc.) that incorporates reachable sets, and observe their pros and cons in interactive driving scenarios. 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

Tasks

- Familiarizing with CommonRoad and related software (Reachable set computation, SPOT prediction, different motion planners, interactive scenarios, etc.).
- Implementing a framework for negotiation of reachable sets of vehicles.
- Evaluating the performance of different motion planners on interactive scenarios.
- Demonstration of results with CommonRoad scenarios.

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Research project:
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Type:
Master

Research area:
Cooperative Driving, Reachability Analysis, Motion Planning

Programming language:
Python, C++

Required skills:
Good programming skill, self-motivated, able to work independently

Language:
English

Date of submission:
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- Documentation of codes and other related materials.

References

[1] S. Söntges and M. Althoff, "Computing the drivable area of autonomous road vehicles in dynamic road scenes," *IEEE Transactions on Intelligent Transportation Systems*, vol. 19, no. 6, pp. 1855–1866, 2017.

[2] S. Manzinger and M. Althoff, "Negotiation of drivable areas of cooperative vehicles for conflict resolution," in *2017 IEEE 20th International Conference on Intelligent Transportation Systems (ITSC)*. IEEE, 2017, pp. 1–8.

[3] ——, "Tactical decision making for cooperative vehicles using reachable sets," in *2018 21st International Conference on Intelligent Transportation Systems (ITSC)*. IEEE, 2018, pp. 444–451.

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

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