Minimum-Violation Motion Planning with spatio-temporal Constraints

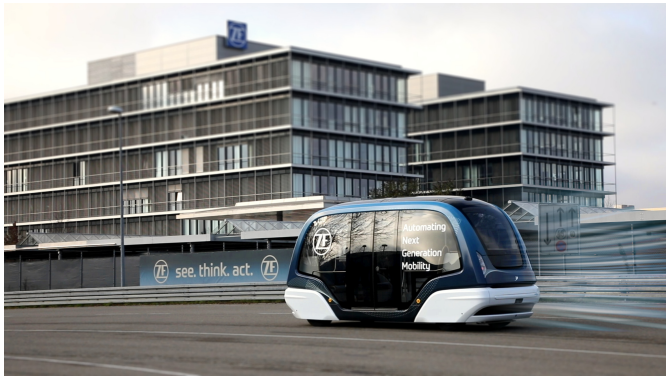

Fig. 1. The autonomous shuttle of ZF.

Description

Are you interested in being part of the exciting world of autonomous driving? As this field rapidly evolves, so does the responsibility to ensure the safety of passengers and others on the road. In our thesis, we tackle the challenge of ensuring that autonomous vehicles follow traffic rules while also navigating the unpredictable behavior of human drivers. This is where the concept of *Minimum-violation Planning* [1] comes in, which aims to minimize the violation of traffic rules while still maintaining a reasonable trajectory. We will explore the mathematical proofs required by manufacturers to ensure that their autonomous driving functions never violate traffic rules.

Traffic rules are often formalized in Signal Temporal Logic (STL) [2, 3], which allows for the expression of spatio-temporal constraints and offers a robustness measure expressing the extent to which a rule is satisfied or violated. Examples of STL rules are “The car shall eventually arrive at its destination” and “The car shall stop once it arrives at its destination”.

The aim of this thesis is to tackle a current issue in motion planning problems, where space-robustness (e.g. how much the velocity limit is violated by) and time-robustness (e.g. when the velocity limit is violated) are treated separately (see [4, 5]), which can lead to undesirable behavior of the autonomous vehicles. For example, if we only use space-robustness, it would mean that once the velocity limit is violated, it could be repeatedly violated to the same extent as often as desired. The proposed solution is to integrate both space- and time-robustness into the motion planning process, to provide a more comprehensive and effective approach to the problem. This will e.g. ensure that the velocity limit is not only respected in terms of how far it is violated, but also in terms of when it is violated, avoiding the issue of repeatedly violating the limit once it has been exceeded. The developed approach shall be demonstrated in CommonRoad[1].

Tasks

- Literature review on STL robustness and motion planning algorithms s.t. STL constraints
- Comparison of methods and definitions combining space- and time-robustness
- Selection or development of combined spatio-temporal robustness measures
- Integration of the combined robustness measures into a motion planning algorithm
- Evaluation of the combined robustness measures based on CommonRoad scenarios

[1] https://commonroad.in.tum.de/

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Programming language:
Python

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