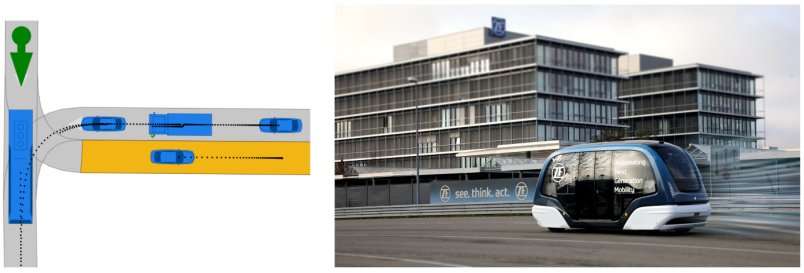
Rule-compliant Motion Planning for Autonomous Vehicles using Path-Integral-Based Optimization



Left: Example CommonRoad scenario. Right: Autonomous shuttle of ZF.

Description

Motion planning for autonomous vehicles requires compliance with a variety of constraints, such as physical limits, safety requirements, traffic regulations, or mission objectives. One method to formalize such constraints and to consider them in the motion planning problem is by using Signal Temporal Logic (STL) [1]. However, the numerical solution of such planning problems is cumbersome and subject of current research. In this work, the solution method of path-integral based optimization [2, 3] shall be applied to planning problems, where the constraints are formalized in STL. The overall goal is to investigate the suitability of this solution method for such motion planning problems. The evaluations shall be performed on typical driving scenarios for autonomous shuttles using the CommonRoad[1] benchmark suite.

Tasks

- Familiarization with path integral-based optimization, the mathematical formulation of relevant constraints in STL and the simulation environment CommonRoad
- Formulation and implementation of optimization problems for given scenarios and constraints
- Validation and evaluation in Simulation using CommonRoad
- Documentation of code and other related materials

Organization

This is a joint work between TU Munich, HTWG Konstanz and ZF Friedrichshafen AG. Additional supervision will be given by Hannes Homburger (HTWG Konstanz) and Dr. Lothar Kiltz (ZF Friedrichshafen AG).

References

[1] A. Donzé and O. Maler, "Robust satisfaction of temporal logic over real-valued signals," in *FORMATS*, 2010.

[2] H. Homburger, S. Wirtensohn, and J. Reuter, "Docking control of a fully-actuated autonomous vessel using model predictive path integral control," in *European Control Conf. (ECC)*, pp. 755–760, 2022.

[3] H. Homburger, S. Wirtensohn, M. Diehl, and J. Reuter, "Feature-based MPPI control with applications to maritime systems," *Machines*, vol. 10, no. 10, 2022.

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

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Research project:
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Type:
Master Thesis

Research area:
Motion Planning, Optimization, Control, Temporal Logic, Traffic Rules

Programming language:
Python

Required skills:
Experience with numerical algorithms and dynamic optimization, good programming skills, ability to work independently, experience with CommonRoad preferable

Language:
English

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