Comparing Invariably Safe Sets with Responsibility Sensitive Safety

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Background

To safely participate in road traffic, automated vehicles should not only drive in their collision-free states but should also be able to safely react to other vehicles in emergency situations. There are different safety frameworks that consider this issue. For exmaple, this can be achieved by computing the invariably safe sets (ISSs) of vehicles [1]: ISSs are regions that allow vehicles to remain safe for an infinite time horizon. If a vehicle is within its ISS, there is always a collision-free trajectory that leads the vehicle into the standstill state. A video explaining the concept can be seen at https://mediatum.ub.tum.de/1451838. Another concept proposed by Mobileye is the so-called Responsibility-Sensitive Safety (RSS) [2], in which the authors defined different situations and proper responses to them. A video introduction can be seen here: https://www.youtube.com/watch?v=HYMnIkqYEIM.

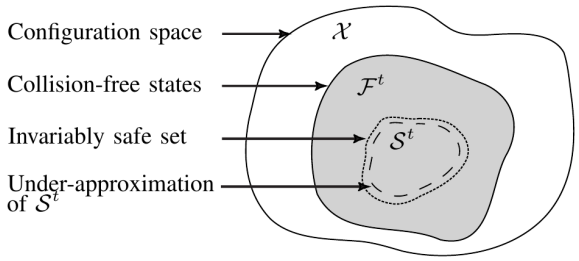
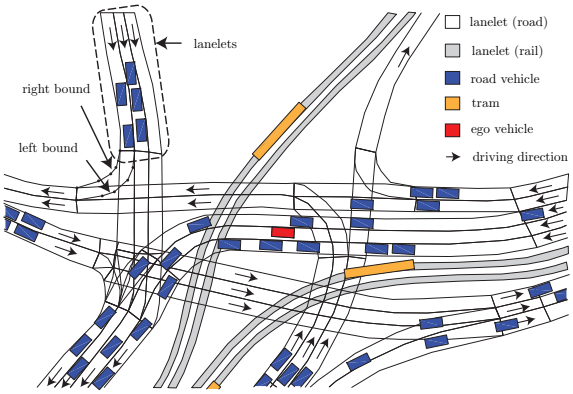


Fig. 1: Relation of the configuration space $\mathcal{X}$, collision-free states $\mathcal{F}^t$, and invariably safe sets $\mathcal{S}^t$.

Description

The goal of this thesis is to look deeply into and compare the performance of ISS and RSS in different traffic scenarios, and to answer the question ***whether and under which scenarios does one perform better/worse than the other***. The comparison result is expected to be shown with tailored scenarios created in CommonRoad [3] and CARLA driving simulator. Part of the thesis will also include further refinement of the existing toolbox for computing ISS (handling various structured/unstructured intersections, etc). 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 platform.
- Familiarizing with ISS and RSS (with connection to CARLA driving simulator).

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Advisor:
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Research project:
-

Type:
Bachelor

Research area:
Safety of Automated Vehicles

Programming language:
Python and C++

Required skills:
Good programming skills, highly motivated, self-organized

Language:
English

Date of submission:
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- Design scenarios to showcase the advantage/disadvantage of ISS over RSS.
- Demonstration of results.
- Documentation of codes and other related materials.
- Writing thesis / report.

The outcome of this thesis is expected to be included in a journal article.

References

[1] C. Pek and M. Althoff, "Efficient computation of invariably safe states for motion planning of self-driving vehicles," in *2018 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*. IEEE, 2018, pp. 3523–3530.

[2] S. Shalev-Shwartz, S. Shammah, and A. Shashua, "On a formal model of safe and scalable self-driving cars," *arXiv preprint arXiv:1708.06374*, 2017.

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

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