An Online Verification Framework for Autonomous Driving based on the Open Simulation Platform

Technische Universität München

Fakultät für Informatik

Lehrstuhl für Echtzeitsysteme und Robotik

Background

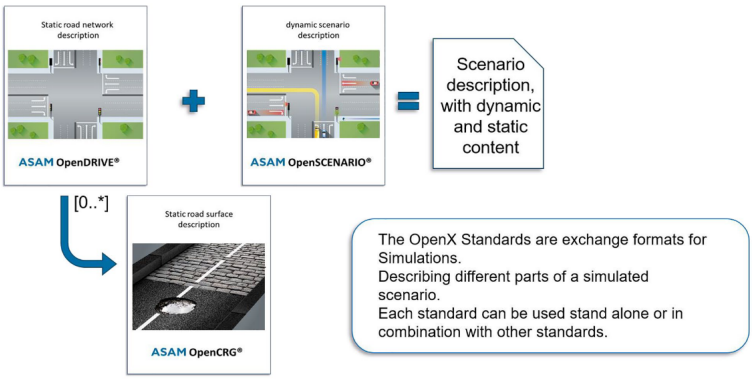
Autonomous driving is currently a topic of much interest within and outside academia. It has been widely studied in the last few decades, and has been put into practice in the early 21st century. In the aspect of motion planning, ensuring the generation of safe trajectories [1] in arbitrary traffic situations is essential. Unlike the safety problems in robot motions, dangerous situations in autonomous driving are often more serious. Although accidents do not often occur, each accident may cause large damage, and it is worth every effort to avoid safety problems in autonomous driving. Moreover, if the predictions show large deviation from the obstacles' real motion behaviors, the planned trajectory of the ego vehicle may not be safe. To deal with this problems, a safety layer can be added before the execution of planned trajectories. The safety in motion planning could be improved, e.g., by online Verification framework as:

1. performing set-based prediction for other traffic participants [2];
2. checking whether the planned trajectory for the ego vehicle is collision-free [3]; and
3. generating a fail-safe trajectory [4].

Description

Virtual simulations are one of the most comprehensive methods to assess the above research questions. Simulations should be able to run a variety of traffic scenarios which depend on human behavior and on system behavior. Thus, online verification in the software-in-the-loop attracts attention from various entities, companies, and research organizations.

ASAM is a standards organization working in autonomous driving with several validation and verification (V&V) activities in an open simulation platform. ASAM contributes to multiple projects for simulation and testing of complex driving scenarios such as OpenSCENARIO[1], OpenDRIVE[2], and OpenCRG[3]. OpenSCENARIO is an open-file standard format, which describes dynamic contents in driving simulation applications. In contrast, CommonRoad[4] is a collection of composable benchmarks for motion planning on roads. It provides useful tools for set-based prediction, road boundary generation, collision check, route planning, fail-safe trajectory planning, motion primitives generation etc. Online verification of motion planning can be done with CommonRoad tools on CommonRoad Scenarios. To utilize the existing CommonRoad verification framework in other platform, we need to collect data from different sources in a uniform standard format to reduce the effort of the safety validation process.



Files transferred between various simulation tools[5].

[1] https://www.asam.net/standards/detail/openscenario/
[2] https://www.asam.net/standards/detail/opendrive/
[3] https://www.asam.net/standards/detail/opencrg/
[4] https://commonroad.in.tum.de/
[5] https://www.asam.net/conferences-events/detail/webinar-asam-opendrive/

Supervisor:
Prof. Dr.-Ing. Matthias Althoff

Advisor:
Yuanfei Lin, M. Sc.

Research project:
-

Type:
Guided Research

Research area:
Motion Planning, Online Verification

Programming language:
Python

Required skills:
Advanced programming skill, able to work independently

Language:
English

Date of submission:
7. März 2022

For more information please contact us:

Phone: +49 (89) 289 - 18111

E-Mail: yuanfei.lin@tum.de

Internet:
www.in.tum.de/i06/people/yuanfei-lin-msc/

Tasks

- Literature review of works related to online verification for autonomous vehicles [1]
- Familiarization with CommonRoad scenario format and other relevant third-party formats (OpenSCENARIO, OpenDRIVE, and open simulation interface[6])
- Familiarizing with the current interface between OpenDRIVE and CommonRoad for the map conversion [5]
- Developing an OpenSCENARIO to CommonRoad converter
- Developing a CommonRoad to OpenSCENARIO converter
- Evaluation of the online verification framework with scenarios in OpenSCENARIO format
- Comparison between different scenario format (CommonRoad and OpenSCENARIO)
- Documentation of codes and other related materials

Technische Universität München

Fakultät für Informatik

Lehrstuhl für Echtzeitsysteme und Robotik

References

[1] C. Pek, S. Manzinger, M. Koschi, and M. Althoff, "Using online verification to prevent autonomous vehicles from causing accidents," *Nature Machine Intelligence*, vol. 2, no. 9, pp. 518–528, 2020.

[2] M. Koschi and M. Althoff, "Set-based prediction of traffic participants considering occlusions and traffic rules," *IEEE Transactions on Intelligent Vehicles*, vol. 6, no. 2, pp. 249–265, 2021.

[3] S. M. M. C. Christian Pek, Vitaliy Rusinov and M. Althoff, "Commonroad drivability checker: Simplifying the development and validation of motion planning algorithms," in *Proc. of the IEEE Intelligent Vehicles Symposium*, 2020.

[4] C. Pek and M. Althoff, "Fail-safe motion planning for online verification of autonomous vehicles using convex optimization," *IEEE Transactions on Robotics*, vol. 37, no. 3, pp. 798–814, 2021.

[5] M. Althoff, S. Urban, and M. Koschi, "Automatic conversion of road networks from opendrive to lanelets," in *Proc. of the IEEE International Conference on Service Operations and Logistics, and Informatics*, 2018.

[6] https://opensimulationinterface.github.io/osi-documentation/index.html