MASTER THESIS PROPOSAL NOVEMBER 6, 2020

Vehicle model validation using reachset and simulation conformance

- an assessment of offline and online methods

Contacts:

Peter NILSSON
peter.q.nilsson@volvo.com

Thorsten HELFRICH
thorsten.helfrich@volvo.com

Mohamed TAKKOUSH
mohamed.takkoush@fcc.chalmers.se

Examiner:

Mathias LIDBERG
mathias.lidberg@chalmers.se

Keywords

Classical model validation, model conformance, reachability analysis, vehicle modeling, uncertainty modeling, tractor semitrailer

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FRAUNHOFER CHALMERS
RESEARCH CENTRE FOR INDUSTRIAL MATHEMATICS

Background

Automated driving is nowadays in the center of all automotive discussions and research, whether in terms of communication, economic and environmental measures, or of course safety and traffic flow [1], and more... Automated transport systems can and has significantly improved the transport efficiency of people and goods. Autonomous vehicles connected to control and command centers and used in confined areas like harbors and mines already exist. For example, the use of autonomous trucks at Qingdao New Qianwan Container Terminal in China has reduced labor cost by 70% while increasing efficiency by 30% [2]. However, significant improvements in transport efficiency require a multi-modal transport system with automated road vehicles.

The vehicle- and function safety of road vehicle automation are currently a major area of research and development. The demand on producing autonomous vehicles to increase safety for road occupants is putting a huge pressure on engineers to come up with innovative ideas and solutions to not only meet the demands but also conform to set regulations. This calls for having validation processes that are trustworthy which would ease the development of automated vehicle models [3].

Aim

Given an abstract- and an implementation model, the aim of this thesis is to perform model validation using reachset and simulation conformance, compare the results and assess the offline and online feasibility.

Scope

The master thesis project will include:

- Comparison between different model validation approaches.
- Working with tractor semitrailer models with hierarchical fidelity.
- Understanding and modeling various sources of uncertainties.
- Exploring the feasibility of reachability analysis in offline and online methods.

Tasks

The main tasks for the master thesis include but not limited to:

- Establish model requirements and limitations for industrial applications.
- Perform classic model validation with the objective to assess a tractor semitrailer vehicle model.
- Compare performance of 1. classical and 2. model conformance approach for model validation ([4]) and assess the pros and cons of the two approaches.
- Study the development needs of model conformance (comparison between different types of model conformance).
- Assess the feasibility of the studied approaches in online model validation.

Student Profile

- We are looking for students that are highly motivated and have a genuine interest in vehicle dynamics as well as in mechanics and mathematics.
- Master's degree students in: Mathematics, Applied Mechanics, Systems, Control and Mechatronics or similar.
- The student(s) preferably has a history with Matlab and Mathematica.
- Communication skills are an important asset.

Status

- Period: 1 Semester, 30 hp credits
- Starting date: January 2021
- Number of students: suitable for 1-2 students

Location

- Main office at CampX (Volvo Group) or FCC.
- Meetings to be carried out in person or online depending on availability.
- Presence at the premises should follow COVID-19 protocols.

Application

- Attach your CV and cover letter stating your interest within the given area and your thoughts and credentials.
- Send the application to the contact persons.
- Selection process will be ongoing.

References

[1] S. Heinrich, "Obstacle Avoidance with Safety Guarantees Feasibility of MPC-based Steering Algorithms Master's thesis in Signals and Systems", Tech. Rep. [Online]. Available: http://publications.lib.chalmers.se/records/fulltext/229150/229150.pdf.

[2] L. Doe, *Asia Enters Fully Automated Terminal Era*, 2017. [Online]. Available: https://www.porttechnology.org/news/asia_enters_fully_automated_terminal_era/.

[3] M. Takkoush, "Formal Model Validation by Reachset Conformance between Low and High Order Tractor Semitrailer Vehicle Models", Tech. Rep., 2020. [Online]. Available: https://odr.chalmers.se/handle/20.500.12380/301756.

[4] H. Roehm, J. Oehlerking, M. Woehrle, R. Bosch GmbH MATTHIAS ALTHOFF, and M. Althoff, "Model Conformance for Cyber-Physical Systems: A Survey", *Cyber-Physical Systems: A Survey. ACM Trans. Cyber-Phys. Syst*, vol. 26, no. 3, 2019. DOI: 10.1145/3306157. [Online]. Available: https://doi.org/10.1145/3306157.