Master Thesis: Method development and modelling for the correlation of acceptance criteria with continuous reference and evidence from a scenario-based validation approach for the release of an automated driving system

AVL is the world's largest independent company for the development, simulation and testing of powertrain systems (hybrid, combustion engine, transmission, electric drive, batteries, fuel cell and control technology) for passenger cars, commercial vehicles, construction, large engines and their integration into the vehicle.

AVL Software and Functions GmbH is the center of competence for Powertrain Software- and Function Development, as well as Electronics and Systems integration. Our fields of activity include highly innovative projects in the area of Combustion Engines, E-Mobility and ADAS / AD. Our vision "Why not – move different!" is challenging us to develop solutions for the future of mobility.

Introduction:

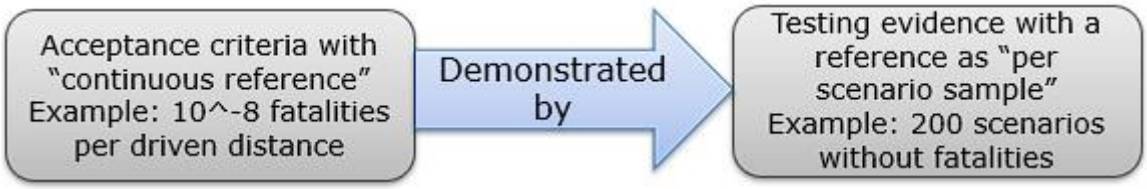
No system is fully free of risk. This statement is especially true for new technologies with high complexity such as autonomous driving. Therefore, so called risk tolerant principles are commonly applied. The basic idea behind such an approach is: A certain level of risk can be accepted by the society and hence, a new technology is accepted although there is a residual risk.

Typically, the performance of the human driver (with respect to risk) is used as a reference for the acceptable level of risk. Therefore, a commonly accepted development goal is "better than the human driver" (expressed as a positive risk balance).

The resulting acceptance criteria are stated as a rate of negative incidents per driven distance (or operational time (example: 10^{-8} fatalities per driven mile). Additionally, legislation standards such as UNECE 1426 Regulation state such type of rates as mandatory precondition for the release of automated driving functions.

A statistical demonstration of such low failure rates typically results in an unmanageable effort due to the limitation within the available resources. Therefore, the industry seems to be heading towards a scenario-based validation approach (Research project such as PEGASUS, VVM, ISO 21448, etc.). Basic idea is that only a minor portion of the open world testing activities is of interest and brings a benefit in terms of knowledge gain. Hence, by focusing on the "interesting" part, the overall required effort for validation can be significantly reduced.

Therefore, the target (acceptance criteria) and the evidence (test results) seem to be in a different "units":



Any comparison (and answering the main question "Is the risk acceptable?") requires making the target (left side) and the evidence (right side) comparable.

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Objective of thesis:

The above shown relations directly lead to following research questions:

- What is the correlation between a “continuous reference/target” and sample/scenario specific evidence?
- How can both values be made comparable?
- What is the value in terms of driven distance/operational time of a tested scenario sample?

Even so these questions are of major importance for the automated driving industry, they seem to be highly neglected. Main goal for the thesis is to provide a sound basis for solving these questions.

Solution approach:

- State-of-the-art research: Creation of a clear picture of available solutions within the industry
- Evaluation of available approaches/methods: Identification of weaknesses of the available approaches
- Extension of approaches: Based on identified disadvantages, the methods shall be extended with required improvement
- Prove of concept. Create a prove of concept for the extended methods via statistical modelling within an adequate tooling (e.g. MATLAB, Python, or similar)

Expected result:

- Overview on the state-of-the-art
- Advanced method as potential solution along with an initial prove of concept
- List of open topics along with recommendation of further steps

References:

[1] ISO 21448 Road vehicles — Safety of the intended functionality, 2022, C.2.2.3 Modelling of the hazardous event

[2] UNECE 1426: 2022 Type-approval of the automated driving system (ADS) of fully automated vehicles

If there are questions concerning the technical content, then please feel free to contact us and we arrange a short alignment meeting.

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