Master's Thesis Proposal

Assessing the Safety of Autonomous Vehicles using Virtual Simulations

Background and Problem Description

Automated vehicles (AVs) have been rapidly advancing and are becoming an integral part of modern transportation systems. These vehicles, equipped with autonomous driving functions (ADF), have the potential to revolutionize road networks by enhancing traffic safety and optimizing traffic flow. As technology and innovation continue to evolve, the deployment of ADF in motorized vehicles promises to create a safer and more efficient transportation ecosystem. As they become more automated and capable of performing various driving tasks with a higher level of autonomy, it is imperative to continuously evaluate their safety to ensure their seamless integration into our transportation systems.

This proposed Master's thesis topic is closely aligned with the "Hi-Drive" project\(^1\), which stands for "Deployment of higher automation". The primary objective of this project is to investigate how highly AVs can contribute to safe, sustainable and efficient transport, particularly in scenarios involving interactions with vulnerable road users (VRUs), such as pedestrians and cyclists. Real-life experiments can be both expensive and ethically challenging, as they might expose road users to risks. Therefore, this Master’s thesis project focuses on assessing the safety of AVs through virtual simulations. These simulations provide a controlled and cost-effective environment to analyse the behaviour of AVs in various traffic scenarios, allowing for a comprehensive evaluation of their safety features.

Objective

The objective of this Master's thesis project is to design, set up, and perform counterfactual simulations using models of highly ADF in vehicles. The main focus is to investigate the performance of these AVs in interactions with VRUs at intersections and evaluate their safety performance.

Specifically, this project aims to quantify the safety impact of AVs in intersection driving scenarios. Safety impacts will be assessed by estimating the number of potentially avoided crashes using simulations and evaluating crash data.

The simulations tool used for counterfactual simulations in this project is based on an open-source simulation engine called ESmini\(^2\). This engine has a role of loading scenarios and providing runtime environment. A complete framework for simulations will consist of Python (or C++) scripts interacting with ESmini. ESmini works with the OpenDRIVE\(^3\), and OpenSCENARIO\(^4\) data formats.

The primary input to this safety impact assessment will be reconstructed crash data collected from in-depth crash databases. Simulation models of driver, vehicle and road environment will be employed

\(^1\) [https://www.hi-drive.eu/](https://www.hi-drive.eu/)
\(^2\) [https://esmini.github.io/](https://esmini.github.io/)
\(^3\) [https://shorturl.at/ezWY0](https://shorturl.at/ezWY0)
\(^4\) [https://shorturl.at/fHKL8](https://shorturl.at/fHKL8)
to evaluate traffic safety under driving scenarios in intersections, allowing us to draw meaningful conclusions regarding the safety benefits of AVs.

In conclusion, this Master's thesis project will offer valuable insights into the safety advantages of AVs, helping us to understand the potential benefits of their widespread adoption in our transportation systems. It addresses a critical need for assessing the safety of AVs, given their increasing prevalence on our roads and their potential to transform the future of transportation.

**Prerequisites:** Python or C++. Knowledge of OpenDRIVE and OpenSCENARIO is meritorious.

**Number of students:** 1 - 2.

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