Institute of Automotive Technology
TUM School of Engineering and Design
Technical University of Munich

Master thesis/ Term paper

Make Safety Measurable: Influence of Latency and Video Quality on the Safety of Remotely Driven Road Vehicles

Motivation

Autonomous vehicles (AVs) are confronted with a multitude of challenges in the form of unusual and unforeseeable scenarios, known as edge cases, which can include changing weather conditions, unconventional road layouts, and unanticipated obstacles. Due to the vast number of potential edge cases and their inherent complexity, it is unlikely that all of them can be accounted for during the development of AVs. As a result, it is inevitable that AVs will encounter edge cases during their operation on public roads.

To address edge cases during the operation of AVs, teleoperation can provide a fallback solution by enabling a human operator to remotely control or assist the AV. To remotely drive an AV video streams as well as control signals must be transmitted via a data link. Since the connection between the operator and the AV relies on cellular networks, the reliability and bandwidth of the data link are limited. This introduces varying latency and video quality, which have a strong influence on the safety of the whole teleoperation system. However, this impact is not yet measurable.

Project description

This project aims to develop a concept to assess the current safety of remote-driving an AV as a function of latency and video quality. In the first step, metrics for the evaluation of latency and video quality and their suitability for an online safety assessment should be identified. To enable further analysis of latency and the corresponding metrics in our teleoperation software stack, modules that introduce artificial latencies into the system should be integrated. Subsequently, data from dangerous and safe scenarios should be collected. For that, realistic latency and video settings should be determined and used. Appropriate metrics are applied to the collected data, and based on their scenario-dependent response, a subset of metrics that can be combined into a safety score will be derived.

The following **work packages** comprise the student research project:

- Literature research on latency, video quality, and safety metrics
- Analysis and pre-selection of metrics
- Familiarization with our TUM FTM Teleoperation Software
- Implementation of modules to introduce artificial latencies into the teleoperation system
- Identification of suitable scenarios data collection in simulation or in reality
- Evaluation of the metrics on the collected data
- Derivation of a subset of metrics to obtain a safety score
- Documentation and Discussion of the obtained results

Prerequisites

- Intrinsically motivated and interested in the topic of autonomous driving

- Creativity as well as independent and accurate working style
- Programming experience, ideally with C++, ROS 2, Python
- Experience with Git

Contact

If you are interested in this or another project, you can also send me an unsolicited application. Just send an email with a short motivation, your CV and current transcript of records to:

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