

Bachelor thesis/Master thesis/Term paper/IDP

# Enabling Remote-Assistance: Visualization Concept for Environmental Perception Data of Autonomous 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. In the case of remote assistance, the operator provides the AV with missing or additional information, allowing it to solve the edge case. To effectively assist the AV, the operator must develop situational awareness and understand the AV's perception of the current situation.



Visualization by Zoox:  
<https://www.youtube.com/watch?v=NKQHutVx78>

## Project description

In this project, an open-source tool for the visualization of the AV's environmental perception is to be developed. The tool's purpose is to enable remote operators to efficiently and accurately comprehend the current state of the vehicle's environmental perception. Only with a correct estimation of the perception status, the remote operator can safely decide on further potential actions. Although visualization tools exist from various companies, they lack public scientific discussion and comparison of different visualization concepts. This project aims to bridge that gap and provide a comprehensive analysis of various visualization approaches.

The following **work packages** comprise the master thesis:

- Literature research on existing visualization concepts
- Familiarization with the existing OpenGL-based visualization framework
- Analysis of the perception data of our test vehicles and simulation—
- Development and Implementation of the visualization tool into the existing framework
- Evaluation of the implemented concepts by comparing at least two concepts
- 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
- Advanced programming experience, ideally with C++, ROS 2
- Experience with OpenGL and/or Game Engines is helpful
- 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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