

Real-Time and Robust 3D Object Detection on the Autonomous Driving Test Stretch Using LiDAR Point Cloud Data

Keywords: Perception – Deep Learning – Autonomous Driving – 3D Object Detection and Tracking – LiDAR sensor – Point Cloud

Background

As part of the research project Providentia++ (a “Digital Test Bed for Autonomous Driving”), a group has come up to conduct research in the field of intelligent transportation systems. The goal is to come up with solutions and recommendations for improving traffic safety, efficiency and comfort. Within the framework of this project, an existing infrastructure for real-time localization of traffic participants on the Highway A9 was extended from the highway into an adjacent urban environment. The infrastructure includes 7 sensor stations and 75 sensors in order to create and distribute digital twins of the traffic in real-time, which in turn can widen the perception range for autonomous cars far beyond the capabilities of onboard sensors.

Project video: <https://youtu.be/4oCnQlGFuc4>.

Description

A key challenge lies in the reliable and accurate detection of road users (e.g. cars, buses, trucks, vans, cyclists, pedestrians, etc.) based on point cloud data generated from different LiDAR sensors (360 degree and forward-looking LiDAR sensors). Due to the complex multi-sensor system subject to real-life conditions and application-oriented challenges, many interesting research topics are available within this project. These include, but are not limited to:

- Research **deep learning architectures** for LiDAR-based 3D Object Detection
- Research **fusion algorithms** to fuse LiDAR sensor data to increase density and resolution
- Research on multi-modal **3D object detection algorithms**
- **Your ideas:** If you have any other ideas for research in this area you are welcome to suggest your own topic.

Your Tasks

- Familiarization with **perception** algorithms
- Research the problem (study the state-of-the-art literature and frameworks)
- Development of a novel solution approach for the specific problem
- **Evaluation** of the solution on the infrastructure hardware **using real-life data**
- Support in creating a new **Providentia++ dataset** (ground truth) for training
- Visualization of 3D Object Detection results

Requirements

- You are currently studying Computer Science, Electrical Engineering or Mechanical Engineering (or similar)
- Strong interest in **object detection**, sensor fusion, deep learning
- High motivation and ability to work independently
- Experience with **deep learning libraries** (Tensorflow or PyTorch)
- Basic understanding of the **Robot Operating System (ROS)**, PCL, Open3D or similar frameworks for handling LiDAR data
- Good knowledge in programming languages: **Python**, C++
- Experience with **Linux** and the command line
- Experience with LiDAR point cloud processing (nice to have)
- Very good communication skills in English or German

