

# Master Thesis: Real-time Camera-only Object Detection for Intelligent Transportation Systems

## Background

As part of the research project Providentia++ funded by the federal ministry of transport and digital infrastructure under the initiative “Digital Test Beds for Autonomous Driving”, a group of eminent industry partners and research institutes have come together to conduct research in the field of intelligent transportation systems, and 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 A9 Highway will be extended from the highway into an adjacent urban environment. The infrastructure will include multiple sensor stations equipped with a mix of complementary sensors, edge computing devices and state of the art communication networks in order to be able 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 and vastly improve their situational awareness. A video about the Providentia project is available on <https://youtu.be/4oCnQIGFuc4>.

## Description

A key challenge lies in the reliable and accurate detection of road users (such as cars, trucks, buses) using the various sensors, among them standard frame-based cameras and event-based camera. 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 on temporal object detection:** Using video data to process consecutive frames in order to improve the consistency of detection results, e.g. via LSTM
- **Research on monocular 3D object detection:** How can we estimate the 3D characteristics of objects in order to produce 3D bounding boxes using only a monocular camera?
- **Research on object detection using event-based cameras:** How can this new type of sensor be used to complement or replace frame-based cameras for object detection?
- **Research on automatic camera setting and algorithm adaptation for optimal detection performance:** How can we dynamically and automatically adjust our system (e.g. camera settings or the algorithms in use) to improve object detection results in various situations such as rain, fog, and night-time operation.
- **Research on combining deep learning approaches with classical computer vision:** Can we improve the reliability of the detection results by combining a deep learning approach with a classical, non-learning-based computer vision approach?
- **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 object detection algorithms and relevant topics via literature research
- Development of a solution/approach for the specific problem
- Evaluation of the concept using real-world data

## Requirements

- A strong interest in computer vision, deep learning, and object detection algorithms
- High motivation and ability to work independently
- Good knowledge in at least one programming language: Python, C++
- Experience with deep learning libraries (TensorFlow, Keras, PyTorch) is a plus

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