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Master Thesis: Sensor Fusion and Vehicle Tracking for Intelligent Transportation Systems

Background

Within the PROVIDENTIA project, a section of the highway A9 between Munich and Nuremberg was converted to a testing site for autonomous driving. As part of this, a large sensor network system has been set up along the highway to allow monitoring and steering of traffic as well as to improve the coordination between autonomous and traditional cars. The primary task of the intelligent system is to create a digital traffic twin that accurately represents the physical road situation in real-time. Based on this digital twin, the smart infrastructure can provide a far-reaching and comprehensive view to the drivers and autonomous cars in order to improve their situational awareness within the current traffic environment. A video about the PROVIDENTIA project is available on https://youtu.be/4oCnQlGFuc4.

Description

A key challenge lies in the reliable and accurate fusion of the various data generated from the different sensors (radars, cameras, event-based cameras, LiDARs, etc.) and the precise tracking of the individual vehicles. 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 various fusion architectures and algorithms for infrastructure and vehicles sensors**
- **Research on various tracking algorithms:** Compare classic Bayesian Filters (e.g. Kalman Filter) with Deep Learning-based tracking methods
- **Research on dynamic sensor reliability:** Different sensor types (e.g. radar, camera, event-based cameras, LiDAR) provide varying data quality and reliability depending on the current weather and lighting conditions. How can the varying sensor reliability be incorporated into the fusion process?
- **Research on fusion quality rating:** How can the fusion system provide an estimate on the accuracy and reliability of its output? How to rate the input data quality based on the reliability of sensors and the degree of conflict between the sensors?
- **Research on the temporal alignment of sensor signals:** How to fuse highly asynchronous data in a multi-rate sensor system? How to handle Out-of-Sequence measurements?
- **Research on anomaly detection:** How to detect erroneous sensors that decrease the overall fusion quality and as a result limit their bad influence on the fusion process?

Your Tasks

- Familiarization with fusion and/or tracking algorithms via literature research
- Development of a solution approach for the specific problem
- Evaluation of the concept using real-life data

Requirements

- A strong interest in autonomous driving, sensor fusion and tracking algorithms
- High motivation and ability to work independently
- Good mathematical understanding
- Good knowledge in at least one programming language: C++, Python, Matlab

Supervisor: Prof. Alois Knoll
Contact: Leah Strand (leah.strand@tum.de)

Technical University of Munich
Faculty of Informatics, Chair of Robotics, Artificial Intelligence and Real-time Systems