Collaborative multimodal perception for automated vehicles

Summary

The goal of this research is to enhance the safety and efficiency of automated vehicles by developing a collaborative multimodal perception system. This system integrates data from various sources, such as cameras, LiDAR, radar, and V2X communication, to create a comprehensive understanding of the vehicle's surroundings. The research will be run in the Autonomous Vehicles research group within the TalTech facility and using the innovative iseAuto shuttle v.2.0. By sharing perception data with other vehicles and infrastructure. The research aims to improve the detection of complex environments, anticipate hazards, reduce accidents, and optimize traffic flow, ultimately enabling safer and smarter autonomous driving.

Research field:	Production and materials engineering, robotics, transport and logistics
Supervisors:	Prof. Dr. Raivo Sell Prof. Dr. Mauro Bellone
Availability:	This position is available.
Offered by:	School of Engineering Department of Mechanical and Industrial Engineering
Application deadline:	Applications are accepted between October 01, 2024 00:00 and October 25, 2024 23:59 (Europe/Zurich)

Description

The research

Recent studies on intelligent transportation systems suggest that the coordination of vehicles in traffic constitutes an important aspect of urban planning, generating significant savings and improving safety in transportation systems. Among the countless open research problems, collective perception is a relevant topic involving artificial intelligence functionalities. The candidate for this position will contribute to the body of knowledge by enhancing the safety, reliability, and efficiency of automated vehicles by developing a collaborative multimodal perception system. This system leverages data from multiple sources, such as cameras, LiDAR, radar, and V2X (Vehicle-to-Everything) communication, to create a more comprehensive understanding of the vehicle's surroundings.

By integrating and fusing these diverse data streams, the project aims to improve the vehicle's ability to detect and interpret complex driving environments, including other vehicles, pedestrians, cyclists, and potential obstacles, even in challenging conditions like low light, fog, or heavy traffic.

Additionally, this project focuses on enabling vehicles to share and receive perception data with nearby vehicles and infrastructure, leading to a collective awareness of road situations that individual sensors alone might miss. This collaboration can help anticipate potential hazards, reduce accidents, optimize traffic flow, and enable more coordinated and intelligent decision-making for autonomous driving.

Ultimately, the project aims to advance the development of safer, smarter, and more efficient automated vehicles by creating a robust perception framework that leverages the full spectrum of available data sources.

The thesis should address the following questions: 1) How can one improve perception systems using data coming from different sources? 2) How to integrate data to realize collective-distributed perception? 3) How to buld reliable navigation solution based on limited sensor data

The study goal is to carry out high-quality research in this domain involving both theoretical and practical aspects of perception systems, with the potential to generate publications in high-ranked journals and conferences using both simulations and robotic vehicles. To this end, the candidate is expected to have a good knowledge of programming tools and acquire knowledge about our custom systems during the initial stage of the doctoral studies.

Responsibilities and (foreseen) tasks

- Investigating the topic of perception for autonomous vehicles in the context of CCAM
- Self-driving vehicle behaviour in complex urban environments
- Co-operational behaviour based on V2V and V2X communication
- Autonomous driving algorithms and technologies (e.g. vehicle control, path planning, scheduling) and sensors (e.g. lidars, radars, cameras, and GNSS)

- High-level integration of autonomous driving techniques with open-source autonomous driving software (for simulation and testing)

Applicants should fulfil the following requirements:

- a master's degree in engineering sciences (preferably in computing, robotics, AI)
- a clear interest in the topic of the position
- excellent English communication skill
- strong and demonstrable writing and analytical skills
- capacity to work both as an independent researcher and as part of an international team
- capacity and willingness to provide assistance in organisational tasks relevant to the project

(The following experience is beneficial:)

- Computer science skill
- Programming in C++ and python
- Experience with ROS, Autoware and Matlab/Simulink recommended
- Experience in designing software systems
- General overview and understanding of working principles of sensors and robotics

The candidate should submit a research plan for the topic, including the overall research and data collection strategy. The candidate can expand on the listed research questions and tasks, and propose theoretical lenses to be used.

We offer:

- 4-year PhD position in one of the largest, most internationalized and leading technical research centers in Estonia with a large portfolio of ongoing pan-European and national research projects
- The chance to do high-level research connected to physical hardware, including the full-scale autonomous shuttle vehicle
- Opportunities for conference visits, research stays and networking with globally leading universities and research centers in the fields of engineering and ICT

About the department

The position is supervised in a combination of two units in TalTech.

Department of Mechanical and Industrial Engineering (EMI) is an engineering and research unit of Tallinn University of Technology, School of Engineering that focuses on mechanical, industrial and robotics engineering in an interdisciplinary way. The research group **Autonomous Vehicles** is a future-oriented research group with the main strengths and focus topics:

- Self-driving vehicles, driving algorithms and cyber-physical system
- Sensor fusion, perception and big data
- Cybersecurity, automotive networking
- Simulations, verifications and validations of autonomous vehicles
- Human-machine interfaces and interactions
- Self-driving shuttle bus deployment and experimentation

FinEst Centre for Smart Cities (FinEst Centre) is an independent organisation under the Tallinn University of Technology. The aim of the FinEst Centre is to improve urban environments by testing new technologies and thereby grow into an internationally renowned research and development centre. FinEst Centre is an international organisation founded by Tallinn University of Technology, Aalto University, Forum Virium Helsinki and the Estonian Ministry of Economic Affairs and Communications. When FinEst Centre for Smart Cities started, researchers were divided into different streams by topic according to their area of interest. These streams have some level of autonomy and are led by renowned researchers in that field. One of the research streams is Smart Mobility. In order to operate future transport systems safely and efficiently, there is a need to design and implement a collaborative system where (automated) vehicles and infrastructure exchange information and coordinate their actions. This vision requires numerous and significant advances in multiple areas, including traffic flow, control systems, and communication networks.

(Additional information)

For further information, please contact Prof Raivo Sell raivo.sell@taltech.ee and Prof. Mauro Bellone mauro.bellone@taltech.ee or visit https://autolab.taltech.ee/

To get more information or to apply online, visit https://taltech.glowbase.com/positions/852 or scan the the code on the left with your smartphone.