

WASP Project Course 2021

Safe shared situational awareness and decision-making for automated vehicles using intelligent intersections

Background

In recent years, a significant portion of the research on automated and connected vehicles (CAVs) and intelligent transportation systems (ITS) has emphasized safety. Safety issues are especially critical in traffic bottlenecks such as intersections, highway ramps and roundabouts, collisions and traffic jams are often caused by the insufficient situational awareness of vehicles due to occlusion and inefficient vehicle control and traffic coordination. To guarantee a safe and fluent traffic through bottlenecks, we will require an integration of estimation and control to be successfully implemented over a network shared by vehicles and traffic infrastructure.

In this project, we will formulate and implement a solution for improving safety in traffic bottlenecks such as an intelligent intersection leveraging recent results in situational awareness and control in networked intelligent transport systems. An example scenario is shown in Fig. 1, an ego vehicle (yellow) approaches the four-way crossing and its sensor view (yellow shaded area) is affected by occlusions (orange shaded areas). Undetected road users due to the occlusion and limited sensor range of the ego vehicle will cause increased risk for collision or delayed response which in turn could lead to degradation in traffic performance. To better handle such situations and to guarantee safety for road users, we will develop a situational awareness approach that allows vehicles and the intersection to inform each other of potential dangers based on reachability analysis. Then, we will investigate the tradeoffs between centralized and decentralized control/decision-making approaches for coordinating trajectories through the intersection, and will integrate the result of our investigation in a networked fashion. To validate the integrated solution, we will implement the framework on the Small-Vehicles-for-Autonomy (SVEA) platform in the Smart Mobility Lab at KTH.

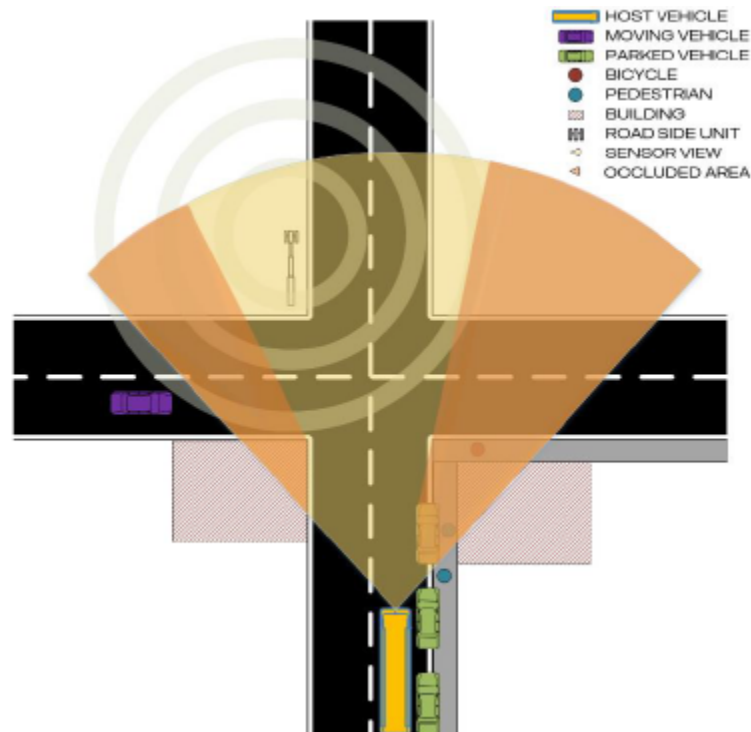


Fig 1 : The proposed experimental scenario. The host vehicle (yellow) approaches a four-way intersection. Its perception of the environment is limited due to the presence of parked cars and buildings.

Constraints: Experiments will be carried out at the Smart Mobility Lab in KTH.

Participants

Industrial partner: Scania CV AB

Industrial supervisor: Laura Dal Col (laura.dal.col@scania.com)

Academic supervisor: Jonas Mårtensson (jonas1@kth.se)

Coordinating WARA representative: None

Suggested WASP PhD students: Vandana Narri, Xiao Chen, Frank Jiang..

Challenges to investigate

- The underlying communication architecture.
- Task oriented communication protocols.
- Systematic fusion between local and communicated information.
- Computation complexities and the distribution of them over networks.
- Synchronization between different submodules such as estimation and control.
- Safety and robustness of the framework.

Resources

- Lab equipments and technical support in Smart Mobility Lab
- SVEA hardware and software stack

Deliverables

- Well defined use cases: it should be based on group interests and could be one or several
- Standardized Communication Architecture and Protocols tailored for defined use cases
- Implementation of Communication Architecture and Protocols
- Integrated framework for defined use cases including possibly estimation and coordination
- Demos and/or papers out of the integrated framework and/or use cases

References

[1] V. Narri, A. Alanwar, J. Mårtensson, C. Norén, L. D. Col, and K. H. Johansson, “Set-Membership Estimation in Shared Situational Awareness for Automated Vehicles in Occluded Scenarios,” arXiv preprint <http://arxiv.org/abs/2103.01791>. Accepted in 2021 IEEE Intelligent Vehicles Symposium (IV21).

Keywords

Estimation, reachability analysis, centralized and decentralized optimization, V2X communication, intelligent transport systems, traffic coordination