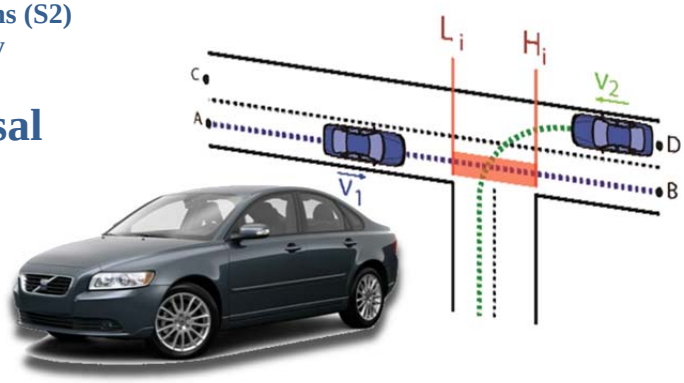
Division of Control, Automation and Mechatronics
Department of Signal and Systems (S2)
Chalmers Institute of Technology

Master thesis proposal



Cooperative collision avoidance strategies at intersections

Keywords: Cooperative driving, intelligent transportation systems, collision avoidance; distributed control.

Background

Self-organized swarming behaviors in biological groups with distributed individual-to-individual interactions became the scientific motivation for studying multi-agent systems and the inherent coordination mechanisms. The fundamental property of the cooperation among several agents is that the group behavior is not dictated by one of the individuals. On the contrary, the behavior results implicitly from the local interactions between the individuals and their neighbors.

The capability of communicating and interacting with other vehicles and road infrastructures is commonly referred to as “Cooperative Driving” and is deemed to be the next challenge in vehicle technology. In fact, many problems in transportation systems could be cast as the problem of coordinating, in a distributed fashion, a set of vehicles in order to achieve a common objective. In particular, provided that each vehicle can communicate with other vehicles, self-organizing behaviors may be established such that each vehicle accomplishes its own driving task while avoiding collisions. Consider, for instance, a traffic intersection. The right of way or yielding may be cooperatively decided, rather than relying traffic lights and rules, in order to, e.g, minimize the aggregate fuel consumption or alternatively the travelling time to destination.

Problem description

In this thesis, we are interested in cooperative driving strategies considering, in particular, intersections where conventional traffic control devices, e.g., stop signs and traffic signals, are removed. The objective is to provide to each vehicle the mechanisms enabling distributed cooperative decision making and leading to a solution that is guaranteed to be collision-free. This thesis should focus on the fundamental aspects of the underlying decision making problems, its implementation and its robustness to embedded sensors and measurements.

Purpose and goals

The objective is to study collision avoidance techniques for a completely autonomous system. The student should focus on the mechanisms enabling distributed cooperative decision making and on the control formulation leading to a solution that is guaranteed to avoid collisions. A particular attention will be paid to recent research results focusing on how to quantify the degrees of freedom that each vehicle disposes to avoid a potential collision. Solutions on how to moderate the influence of a given vehicle's decisions on the evolution of the remaining ones is also within the scope of this thesis. Finally, the student should also cope with the implementation of the resulting algorithms, using a simplified robotic system or the S2's Volvo S60 and the Collision Avoidance Simulator.

Requirements

- a highly motivated student from the master program in Systems, Control and Mechatronics or student with a similar background. Knowledge in automatic control and signal processing is required.
- the ideal candidate should have interest in the theoretical aspects of the problem.
- solid programming skills are required and a particular experience with MATLAB/SIMULINK is an asset.
- good communication skills in English both oral and especially written are also appreciated.

Outstanding students with only a partial match to this list are encouraged to apply.

The master student will gain competences on

(i) cooperative systems;
(ii) distributed control and optimization;
(iii) automobile applications;
(iv) simulation and implementation techniques.

Contacts

For any further information or to apply, please contact:

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Chalmers has a long tradition of research in Transportation Systems, with intensive collaboration with society and automotive industry. A large part of such research is performed at the Department of Signals and Systems (S2), which is engaged in both fundamental and applied research spanning a large variety of domains.