

Corso di Dottorato in ICT

Doctoral Course in ICT

Research project for a PhD curriculum in ICT – Curriculum: Electronics and Telecommunications

Tutor: Prof. Paolo Falcone

(Possibile) Italian Co-tutor: Luigi Biagiotti (Unimore), Mario Zanon (IMT, Lucca), Marko Bertogna (Unimore).

(Possibile) Foreign Co-tutor:

Proposed Title of the research: Motion planning and control with safety guarantees for autonomous driving applications

Keywords: (3) Automatic Control, Model Predictive Control (MPC), Intelligent Transportation Systems

Research objectives: --(max 10 rows)

Autonomous systems are required to operate without, or with limited, human supervision, while guaranteeing the desired performance levels. In *safety critical* applications, the autonomous system has to guarantee *safety* at all times. This is the case, for example, for highly automated factories, industrial manipulators, *self-driving vehicles*. In particular, a self-driving (or autonomous) vehicle has to plan and control its motion in order to guarantee a collision free operation. Such problem *must* be solved without introducing unnecessary conservativeness, which may not be accepted by the final user.

The objective of this Ph. D. research project is to develop and experimentally validate motion planning and control algorithms, with safety guarantees. The algorithms must be proven to deliver *correct-by-design* motion trajectories, under a set of well-defined, yet mild assumptions.

Proposed research activity --(max 10 rows)

Motion planning and control for self-driving vehicles have been approached, in the automatic control community, from different angles. A very popular control technique adopted for this problem is Model Predictive Control (MPC). Although MPC allows imposing safety requirements through state and input constraints, an MPC-based motion planning and control problem may result into an intractable mathematical problem to be solved in real-time. This can especially happen because of a large number of constraints arising from the safety guarantees requirements. In this research project, the Ph. D. candidate will explore machine-learning algorithms to refine model-based invariance conditions, which are well-known to guarantee (safety) constraints satisfaction. The objective is to blend model-based and data-driven methods for the calculation of control invariant sets.

Supporting research projects (and Department)

The research activity will be mainly accomplished at the Department of Engineering “Enzo Ferrari” and is currently not supported by specific research projects.

Possible connections with research groups, companies, universities.

1) University of California at Berkeley, CA, USA, 2) Chalmers University of Technology, Gothenburg, Sweden, 3) IMT, Lucca, Italy.