Finanziato dall'Unione europea NextGenerationEU

DAUSY

DM118

Project title: "*Safety-driven mixed model- and learning-based motion planning and control of autonomous systems* "

Research theme title:

Safety-driven mixed model- and learning-based motion planning and control of autonomous systems

Contacts:

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Curriculum of DAUSY:

C1 AS for Automation

Hosting University/Research Centre

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Supervisor:

Prof. Paolo Falcone

Description:

This Ph. D. research project will explore mixed model- and learning-based safe and adaptive motion planning and control algorithms for vehicles and robots operating in crowded structured environments. In particular, the project will explore the following areas, which are of wide interest nowadays to the scientific community:

- novel learning-based prediction tools;
- environment-aware planning and motion control algorithms

These tools and technologies are currently under investigation for their wide applicability in many possible contexts. Besides autonomous driving, they can be applied in assistive technologies, automatic warehouses, autonomous good delivery systems, manufacturing robots, and agricultural automation, just to cite a few examples.

These application fields are approached from either of two philosophies:

- Model-based methodologies
- Learning based methods

Model-based methodologies exploit mathematical models, and optimization tools and algorithms. These optimization tools give feasibility guarantees but are often very computationally demanding, and most of all, they derive their solutions from models. These models are often very expensive to obtain, calibrate and validate especially for the complex scenarios typical of autonomous systems operating in highly complex environment.

Learning based methods, on the other hand, are not based on models, but on data and experiments. These algorithms learn how to deal with complex situations. They have proven their applicability with success in non safety critical applications. Their main limitation is that the solution has low level of interpretability and thus it is difficult to guarantee their performance. This latter problem is particularly daunting for safety critical applications, such as self driving vehicles.

The successful candidate will aim at harnessing these two approaches to take advantage of the ability of learning-based methods, to efficiently deal with complex scenarios, and the guarantees offered by model-based methods.

Specific Information:

Applicants must hold a master's degree, in Engineering or in neighboring disciplines like Engineering Physics, Mathematics, Physics. A solid background in control theory, optimization, robotics is welcome. Good programming and communication skills are required. The candidate should be highly motivated and interested in both theoretical research and experimental validation.

References:

[1]. Batkovic, Ivo, Ankit Gupta, Mario Zanon, and Paolo Falcone. "Experimental Validation of Safe MPC for Autonomous Driving in Uncertain Environments." *arXiv preprint arXiv:2305.03312*(2023).
[2]. Batkovic, Ivo, Mohammad Ali, Paolo Falcone, and Mario Zanon. "Safe trajectory tracking in uncertain environments." *IEEE Transactions on Automatic Control* (2022).
[3]. Hult, Robert, Mario Zanon, Sebastien Gros, and Paolo Falcone. "Optimal coordination of automated vehicles at intersections: Theory and experiments." *IEEE Transactions on Control Systems Technology* 27, no. 6 (2018): 2510-2525.
[4]. https://youtu.be/nS8AFg21MTA
[5]. https://youtu.be/fzkv5beS4uk
[6]. https://youtu.be/rmjJkIlFMJ4

Type of scholarship:

Project funded by PNRR DM118

Study and research period outside the Hosting Institution:

Possible study and research period abroad:

- period length: 6 months;
- Hosting institution: Chalmers Univiersity of Technology