ELECTRICAL, ELECTRONICS AND COMMUNICATIONS ENGINEERING

CRT/DET - Multi-level architectures for decision, guidance and control with application to automated driving systems

Funded By	FONDAZIONE CRT CASSA DI RISPARMIO DI TORINO [P.iva/CF:06655250014] Dipartimento DET
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Context of the research activity	Automated vehicles have an immense potential to improve driving safety, passenger comfort and energy consumption performance. To manage the complexity of the driving tasks required to accomplish such objectives, automated vehicles must be capable to make decisions based on the other road users, plan a trajectory, and control the vehicle dynamics, responding in real-time to an evolving environment. The achievement of the described objectives is demanded to suitable control architectures that implements the functions described above.
Objectives	Multi-level architectures make up an affective framework for the development of automated driving applications since they provide more flexible solutions to handle the integration among path planning, decision making and motion control. In fact, in this case, different control methodologies can be employed for each level to exploit their peculiar characteristics in the view of achieving significant overall performance improvements. On the other hand, the hierarchy of such architectures can be organized to optimize the interaction among different tasks. As an example, decision making and path planning are usually implemented by two separate layers implemented as a Finite State Machine (FSM) and a trajectory optimizer respectively. Although such a solution is commonly employed also in commercial cars, in general, it does not lead to safe driving trajectories due to the impossibility of accounting for all the possible driving situations by the FSM and the presence of uncertain driving scenario evolution. In this regard, a more effective solution consists in merging decision making and trajectory planning tasks into a single level function that accounts for the uncertain motion of the surrounding traffic actors. In such a context, the aim of this project is to develop integrated multi-level control architectures to effectively handle automated vehicle manoeuvring for SAE L4 scenario contexts. More specifically, the project includes the following steps.

	1) Development of a combined decision making / path planning layer that computes safe and comfortable trajectories to realize the prescribed manoeuvres. Such a layer is implemented through effective optimization procedures that exploit V2X communication data and time varying potential fields to describe worst case behaviour of the driving environment actors. 2) Design of a suitable motion control algorithms based on optimal control approaches such as, e.g., Model Predictive Control to track the trajectories, analysing conceptual properties such as stability and performance of the overall multi-level architecture and possibly minimizing energy consumption. 3) Extensive simulations tests performed on realistic platforms like CarSim and Carla to validate the effectiveness of the proposed strategy. 4) Small scale experimental tests. An abroad period in a leading international university/institution is planned during the doctorate period.

Skills and competencies for the development of the activity	The PhD candidate must have: Master Degree in Mechatronic Engineering Excellent programming skills in MatLab, Simulink and Python . Solid background in - computational optimization for convex and not convex problems - optimal control strategies such as, e.g., model predictive control - identification of dynamical systems. - neural networks concepts for modeling and control - model based software design principles Good knowledge of basic automated driving functions and control algorithms and related MatLab/Simulink tools. Strong motivation in achieving research objectives