Maneuver decision for autonomous vehicles, considering vehicle dynamics and perception uncertainties

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Key words: Autonomous vehicle; Vehicle dynamics; Control and Decision-making under uncertainties; Perception and modelling uncertainties; Risk assessment and Management.

Autonomous vehicles are in full development worldwide. This technology has mobilized many academic and industrial teams for more than two decades. Various competitions have been organized around the autonomous vehicle, to make from competitions a driving force stimulating rapid technological advances. These competitions include the DARPA Challenges in the USA (2004, 2005, 2007), the Korean competitions for autonomous vehicles, the European GCDC competitions (2013, 2016), and many others. Despite the undeniable development of "low level" automation technologies, there are still many locks to raise in order to achieve decision-making autonomy that can mimic human intelligence in the face of complex driving situations. Notably, some advanced driver assistance systems, which include automating the steering wheel for lateral control of the vehicle (e.g., lane keeping, lane centering, etc.) or pedals for longitudinal control (e.g., Cruise Control, Active Cruise Control, etc.) on highways, have been developed and marketed. But by adding the decision-making under uncertainties dimension, the complexity is much higher. The objective is to navigate on road, by avoiding collisions with other road occupants, in high dynamical situations, and in the presence of uncertainties (perception uncertainties, unknown intentions of other vehicles, etc.). Usually, the decision-making is done in the trajectory and maneuver-planning step. This step consists to decide the trajectory to follow for some horizon, function of the environment dynamical situation. At this level, the vehicle dynamics are not finely considered in general, they are neglected or limited to some constraints. This fact reduces the spectrum of safe possible maneuvers that can be executed by the vehicle and do not integrate at all the passengers’ comfort. On the other side, the uncertainties (perception, others intentions, …) in the environment, and how they are considered, are the key for the decision-making step, that will be a compromise between safety and non-restrictiveness of the vehicle’s dynamics.

In this context, this internship aims to deal with the decision-making aspect in the presence of perception and modelling uncertainties, and when considering explicitly the vehicle dynamics in order to improve the safety and the fluidity of the vehicle movement.

The internship will be organized with respect to the following steps:

- Bibliographical study on vehicle dynamics, and, on maneuver planning and decision making in autonomous vehicles in presence of uncertainties.
- Definition of some driving situations to be considered.
- Development of a new maneuver planning approach that considers vehicle dynamics, and, perception and modelling uncertainties.
- Validation of the proposed approach on Matlab/Simulink, and eventually on the robotized vehicle Renault-Zoé available at Heudiasyc Laboratory (if the progress of the work allows it).

Expected candidate profile / background:
- Good mathematical background.
- Good knowledge in automation/robotics.
- Good programming skills in Matlab/Simulink and/or C/C++ or Java/Phyton.
- An expertise on ROS will be really an important asset.

**Candidacy and contacts:** The candidates should send ASAP, to Lounis Adouane (lounis.adouane@hds.utc.fr) and to Reine Talj, reine.talj@hds.utc.fr the following materials: a Cover Letter describing background, motivation and a CV.

**References:**


