China Scholarship Council

Thesis subject - 2022

Title: Reliable hierarchical decision-making for safe autonomous driving

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Autonomous driving has achieved rapid development over the last few decades, including the decision making as an essential part of it. Decision-making is the link between perception and planning tasks, which can be regarded as a cognitive process resulting in the selection of a course of action among several alternative scenarios (i.e. rule-based systems), and every decision-making process produces a final choice [1]. A typical decision system is based on a finite state machine (FSM). However, since perceptual information can be very complex and contain uncertainty and incompleteness, how to make reliable and explainable decisions is crucial for safe operation of autonomous vehicles especially in urban such complex environments.

In order to pursue research in the related filed, in this thesis, we propose to investigate and develop a framework that allows the vehicles to make a reliable decision based on incomplete and uncertain perceptual information. Specifically, a hierarchical structure [2,3,4] is expected to allow the vehicle to first refine and reason about the information on which the decision depends, while the whole process should be explainable, and then combine with the self-awareness of its state and state-transition [5] to make a reliable and safe decision. Specific examples include slowing down, overtaking, bypassing obstacles, giving way, emergency stops, and so on.

EPAN Research Group, which is part of CIAD Laboratory, has many years of experience in Environment Perception and Autonomous Navigation, in particular for autonomous driving under complex and dynamic urban environments. The PhD studentship in EPAN offers the opportunity to engage in international collaboration within an ambitious team, to work with state-of-the-art robotic hardware and software (with experimental platforms: robot and automated vehicles equipped with sensors and communication interfaces), and to benefit from excellent support to produce and disseminate original research contributions in the leading international conferences and journals.

Fig. 1. Automated vehicle equipped with sensors (cameras, lidars, Radar, IMU, GPS, …) and communications interfaces.

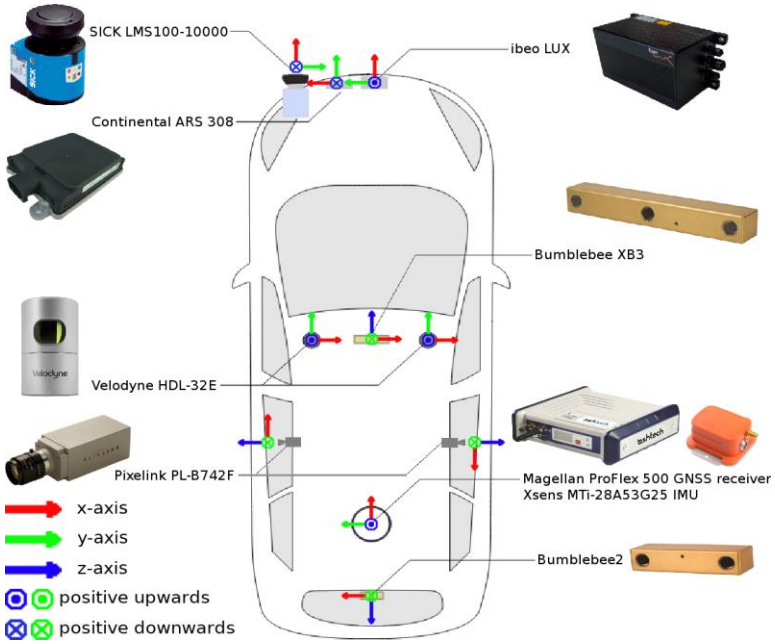

Fig. 2. Multi-sensory data acquisition system with heterogeneous sensors.

Required background:

- Master degree in computer science, robotics, or a related field
- Good theoretical and practical knowledge on robot perception, machine learning and decision making
- Programming skills (e.g. C++, Python, PCL, OpenCV, ROS, etc.)
- Confidence in English writing and speaking

Applications: Please send your cover letter, resume, transcripts, and at least two contacts of reference, to yassine.ruichek@utbm.fr and zhi.yan@utbm.fr

References:

[1] Zhi Yan, Nicolas Jouandeau, and Arab Ali Cherif. **A survey and analysis of multi-robot coordination**. *International Journal of Advanced Robotic Systems*, 10(399):1-18, December 2013.

[2] Jaime F. Fisac, Eli Bronstein, Elis Stefansson, Dorsa Sadigh, S. Shankar Sastry, and Anca D. Dragan. **Hierarchical Game-Theoretic Planning for Autonomous Vehicles.** *ICRA 2019*.

[3] Wonteak Lim, Seongjin Lee, Myoungho Sunwoo, and Kichun Jo. **Hierarchical Trajectory Planning of an Autonomous Car Based on the Integration of a Sampling and an Optimization Method**. *IEEE Transactions on Intelligent Transportation Systems*, 19(2), Feb. 2018.

[3] Zhi Yan, Nicolas Jouandeau, and Vincent Hugel. **L3M-SIM team description**. *RoboCup 2011*.

[4] Zhi Yan, Nathan Crombez, Jocelyn Buisson, Yassine Ruichek, Tomáš Krajník, and Li Sun, **A Quantifiable Stratification Strategy for Tidy-up in Service Robotics**. *ARSO 2021* (under review).