China Scholarship Council
Thesis subject – 2021

Title: Multi-sensor-based Situational Awareness for Autonomous Navigation

Supervisors: Prof. Yassine Ruichek, Dr. Zhi Yan, Dr. Nathan Crombez

EPAN Research Group (https://epan-utbm.github.io/)
CIAD Laboratory (www.ciad-lab.fr)
University of Technology of Belfort-Montbéliard (UTBM), France

Situational awareness is crucial for safe and reliable operation of autonomous vehicles (AVs) in urban environments and autonomous robots (ARs) in general [1,2]. AVs (or ARs) should understand not only how the environment “looks like” but also “what's going on here”, while knowledge from the latter can be used to predict future environmental changes of the vehicle (or robot) surroundings, especially the actions of the other dynamic objects in the vehicle's vicinity, which ultimately help the AV to react accordingly.

To do so, in this thesis, we will research and develop methods that allow the AVs (or ARs) to understand the complicated world (scene) especially to answer the question of how to benefit from the multi-sensor-based long-term dynamic object tracking. By combining background knowledge and motion trajectories of dynamic and recognized objects, AVs are expected to be aware (understand and predict the motion/intention) of the other traffic actors in their area of operation and therefore make appropriate decisions and perform safe and reasonable vehicle behavior (like obstacle bypass, intersection crossing, …).

Different from the traditional rule-based method (e.g. FSM), the learning-based method (e.g. neural networks, decision trees, POMDP, etc.) will be our main research goal. In particular, deep neural networks such as CNN [3][5][6] and LSTM [4] have shown great potential in the field of AVs, which are expected to be explored throughout this thesis. We expect that the learning-based method will enhance the deep understanding of the scene, enabling a higher decision-making accuracy especially in environmental changes for a segmented scene.

EPAN Research Group 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.

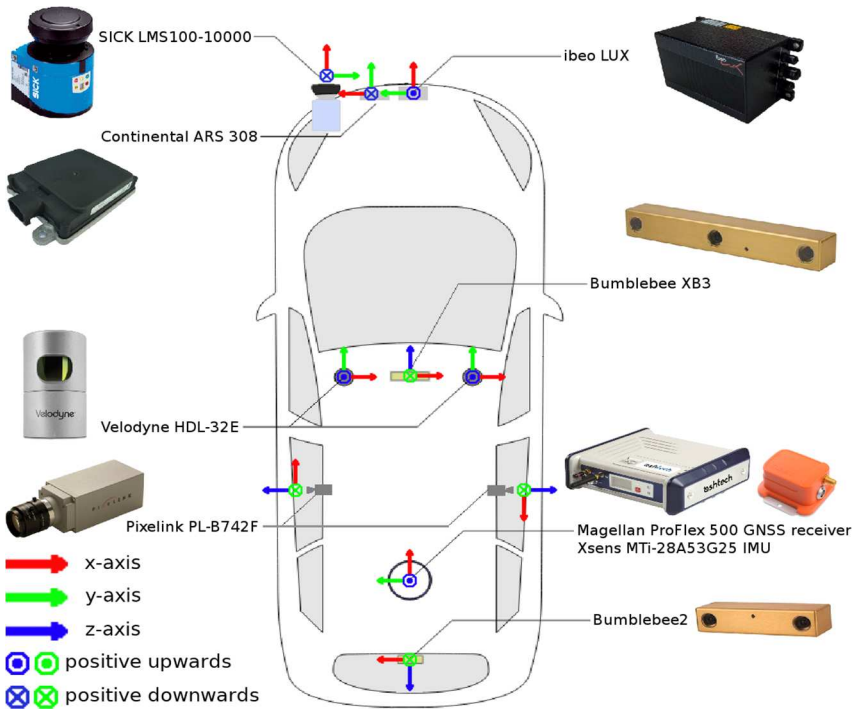

Fig.2. Multi-sensory data acquisition system with heterogeneous sensors.

Required background:

- Master degree in computer science and/or robotics
- Good theoretical and practical knowledge on computer vision (video and Lidar), machine learning and decision making
- Experience in programming (C++, Python, PCL, OpenCV, ROS, etc.)
- Confidence in English writing and speaking

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

References:

[1] Dondrup C, Hanheide M. Qualitative constraints for human-aware robot navigation using velocity costmaps[C]//2016 25th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN). IEEE, 2016: 586-592.

[2] Kollmitz, Marina, et al. "Time dependent planning on a layered social cost map for human-aware robot navigation." 2015 European Conference on Mobile Robots (ECMR). IEEE, 2015.

[3] Bojarski, Mariusz, et al. "End to end learning for self-driving cars." arXiv preprint arXiv:1604.07316 (2016).

[4] Ma, Yuexin, et al. "Trafficpredict: Trajectory prediction for heterogeneous traffic-agents." *Proceedings of the AAAI Conference on Artificial Intelligence*. Vol. 33. 2019.

[5] S. Yang, W. Wang, C. Liu and W. Deng, "Scene Understanding in Deep Learning-Based End-to-End Controllers for Autonomous Vehicles," in *IEEE Transactions on Systems, Man, and Cybernetics: Systems*, vol. 49, no. 1, pp. 53-63, Jan. 2019

[6] Pan, Xingang, Jianping Shi, Ping Luo, Xiaogang Wang and Xiaoou Tang. “Spatial As Deep: Spatial CNN for Traffic Scene Understanding.” *AAAI* (2017).