Automated learning of Pedestrian-Vehicle interactions for steering the vehicles towards truly full automation

Context and motives

Driving is a complex task requiring diverse interactions with other humans for sharing space in a dynamic environment. These interactions are more complex when they involve pedestrians and cyclists that are vulnerable population. There are several levels of decision making. The decision making is not limited only to the intersection zone between the vehicle and the pedestrian. For instance, in an area with a dense presence of pedestrians, the human driver reduces his speed and raises his attention, to be able to react to unforeseeable behavior.

The low-level tasks are detection, tracking and segmentation of the surrounding traffic participants. However, for realizing autonomy for automatic vehicles, these tasks are largely insufficient to give help to comprehensive scene understanding and making decision. For instance, what are and how about the past, the on-going and the future of the scene? This deep question actually steers the vehicles towards truly full automation, just like human beings. Event detection, intention prediction and understanding interactions between the driver and pedestrian are all required for decision making. Both pedestrian and driver behaviors modeling are necessary.

Goal of the PhD thesis

Recently there are many available dataset for allowing researcher community to provide accurate models for the interaction between pedestrian and drivers. Moreover many driver and pedestrian behavior models are proposed in the literature. The thesis focuses on middle-level tasks that are intention prediction and understanding the interactions. This helps to propose first a warning system to the driver and later an algorithm able to slowdown the vehicle, or to deviate the vehicle trajectory according to the situations.

Agent Based approach is the most advanced approach for modeling complex systems. In our studied system, the single parts and the whole are often very hard to model. The aim of the thesis is to use deep learning based approach to extract hidden patterns from large collections of data. These patterns will be used to model the behavior of the agents. Simulations and real tests by means of an automatic vehicle equipped by sensors will be conducted to compare and validate the model.

The thesis program is as follows:

- State of the art about the behavior of driver and pedestrian
- Multi-agent modeling of the interaction between drivers and pedestrians

- Choice and implementation of the model based on deep learning and on Multi-agent systems
- Learning stage by using the dataset of the community as well as data of the equipped vehicle of the laboratory
- Validation of the model

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Some references

A Lombard, A Abbas-Turki, A El Moudni, V2V-based memetic optimization for improving traffic efficiency on multi-lane roads, IEEE ITS Magazine, 2018.

F Gechter, A Koukam, C Debain, B Dafflon, M El Zaher, R Aufrère, R Chapuis, J-P Derutin. Platoon Control Algorithm Evaluation: Metrics, Configurations, Perturbations and Scenarios. In Journal of Testing and Evaluation. 2018.

M Cossentino, N Gaud, V Hilaire, S Galland, A Koukam, ASPECS: an agent-oriented software process for engineering complex systems, Autonomous Agents and Multi-Agent Systems 20 (2), 260-304

F Béhé, S Galland, N Gaud, C Nicolle, A Koukam, An ontology-based metamodel for multiagent-based simulations, Simulation Modelling Practice and Theory 40, 64-8