Artificial Cognitive System Architectures for long-term reliable automated driving

Automated driving will need unprecedented levels of autonomy, reliability and safety for market deployment. The average human-driver fatal accident rate is approximately 1 (fatality) every 100 million miles in the US and the EU. Hence, automated vehicles will have to provably, and significantly, best these figures. Unfortunately, according to many reports on the disengagements of prototype automated driving systems, today we are far from demonstrating these levels and, even worse, a large amount of resources appear to be still necessary towards achieving this objective.

This talk presents the position of the partners of the H2020 Dreams4Cars research project (a Research and Innovation Action funded under the EU Robotics banner) regarding the architecture, and consequently the abilities, of agents capable of long-term reliable driving.

Today almost all approaches to automated driving implicitly assume the sense-think-act paradigm (aka perception-decision-action). Several examples of such current approaches will be examined. We believe that the agent architecture, implicitly assumed, besides being very hungry in terms of resources for development, is also inadequate to achieve robust autonomy for the same reasons it was unsuccessful in other similar robotic applications. We review several critical aspects of this architecture, from scalability to maintainability and validation; including some considerations regarding recent examples of Deep Neural Network implementations that still retain many of the weaknesses of the paradigm.

Then, I will introduce and motivate a (biologically inspired) layered control architecture that, we believe, can scale much better to deal with the complexity of the real world. I will also describe a learning mechanism similar to human dreams, in which the agent itself can anticipate potential threats and prepare to act in threatening situations before they are even met. This way the agent may become expert (like senior drivers are compared to young drivers) by learning from discovered potential threats. Besides increased autonomy and robustness, this approach looks to be more economical in terms of resources needed for development.

The talk will give many details about implementation of the agent, which uses Deep Neural Networks as building block but writhing a network of networks that reproached the main functionalist of the human brain, including simultaneous affordance generation, episodic simulations, robust adaptive action-selection, sensory anticipation. I will also mention how the similarity of the function implementation may allow to trigger a “mirroring” mechanism with the humans, which makes the agent capable of “understanding” human intentions and being naturally understood by humans (this will be contrasted with the known causes of accidents occurred so far in AD testing).

In the end, recent developments in the Dreams4Cars project will be presented. In particular how to engineer artificial drivers that can learn by rehearsing their own experiences, in a way that is very similar to human dreams.