AD-EYE: A co-simulation platform to verify functional safety concepts (FSCs) in self-driving vehicles
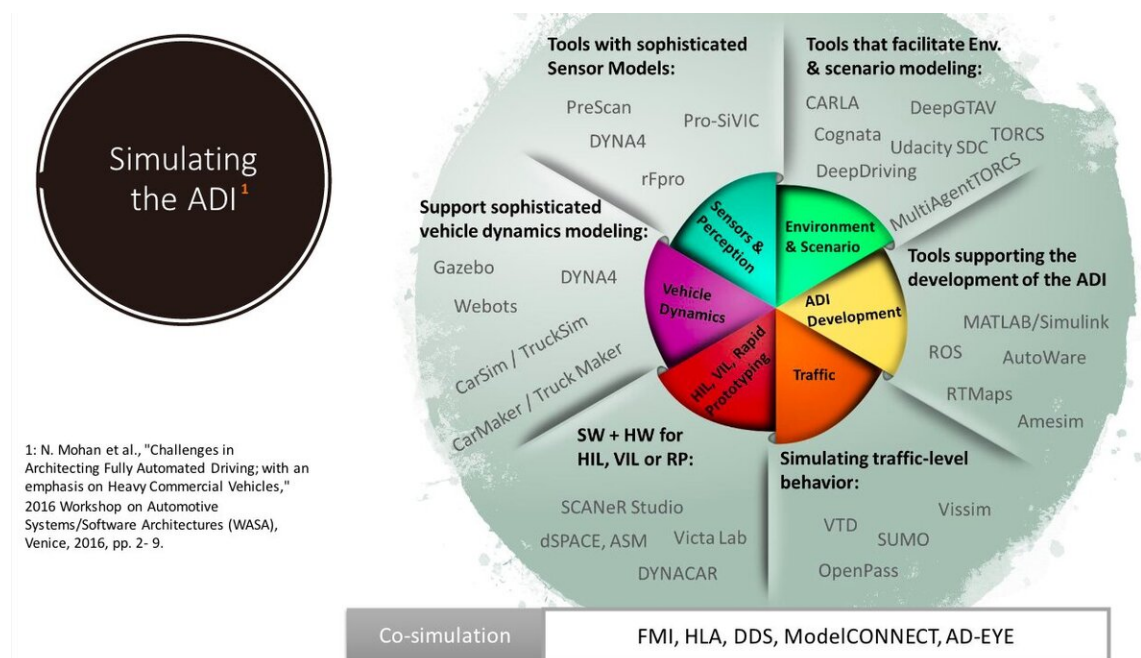
December 24 2019, by Ingrid Fadelli

Figure summarizing some of the tools for simulating automated driving. Credit: Xinhai Zhang.

Over the past few years, a growing number of researchers and companies worldwide have been developing techniques for automated driving. Before self-driving vehicles can be introduced on real roads, however, their efficiency and safety will need to be ascertained.

Simulation platforms have proved to be particularly effective for training and testing automated driving tools before integrating them in real vehicles. Among other things, these platforms can be used to facilitate safety engineering processes, by evaluating the performance and limitations of a model in a variety of dynamic scenarios.

Two researchers at KTH Royal Institute of Technology in Sweden, leading a team of software developers, have recently developed a co-simulation platform that engineers can use to evaluate design decisions and refine functional safety requirements (FSRs) of tools for automated driving. The new platform, dubbed AD-EYE, was introduced in a paper pre-published on arXiv.

"The core of the problem that AD-EYE solves relates to the complexity of automated driving and the near infinite possibilities in design," Naveen Mohan, one of the researchers who carried out the study, told TechXplore.

The complexity of automated driving as a computational task manifests in multiple ways. For architects, for instance, it involves figuring out how many sensors should be used, what type of sensors are ideal, and the field of view that each of these sensors should have for a given operational design domain.
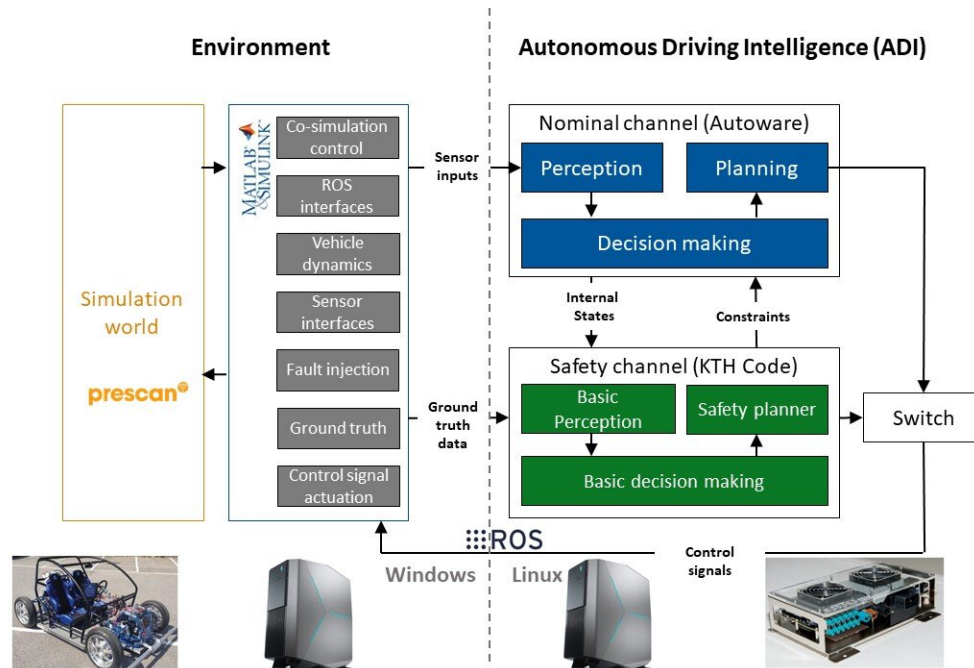
Figure outlining the structure of the simulation platform. Credit: Mohan & Törngren.

Safety engineers, on the other hand, need to determine what scenarios should be considered within this operational design domain, answering questions such as the likelihood that an animal will cross the road, or that a child will jump in front of the vehicle in a traffic jam. Finally, technical experts need to identify planning algorithms that are most effective for each scenario.

"At early stages of development, when the underlying technology has not matured enough to quantify, assumptions must be made so that work can be parallelized, i.e., the roles in the examples can make progress," Mohan said. "Any of the assumptions made in the examples above while designing an automated driving function could change in the presence of faults and changes made too late in the project for safety-critical

automotive systems, and could end up being untenably expensive."

AD-EYE, the platform developed by Mohan and his colleague Martin Törngren, can be used by both architects and safety engineers. At an early stage of development, it can assist architects in making technical decisions that are both feasible and effective, while also allowing safety engineers to create simulation data that can be incorporated in their risk assessments.

Most current tools for automated driving focus on a single aspect of the task, at the cost of others. AD-EYE has a modular structure, so it allows researchers to test these tools both individually and combined with other techniques.

"To improve the realism of simulation driven decisions on functional safety, it is important to have tool-chains rather than tools, where tools can be plugged in (and out) in a modular way," Mohan said. "Flexibility was a key principle that we used in the design."

The co-simulation platform developed by Mohan and Törngren has several important advantages over other simulation techniques. Most notably, it is extremely flexible and it uses open source code, thus allowing architects to evaluate different design decisions based on known information.

On AD-EYE, for instance, architects can test sensor models of different fidelities and evaluate tools with different vehicle dynamics. Moreover, the platform can be used to test code on different computing platforms.

So far, the researchers have demonstrated the effectiveness and flexibility of their platform in several student projects, as well as through industry collaborations with renowned tech companies, such as Scania, QRTECH and Nvidia. In their recent paper, they specifically focused on

the need for early verification of so-called functional safety concepts (FSCs) in automated driving, introducing their platform as a possible solution.

"Our main finding is that there is no silver bullet, the road to safe automated vehicles is longer than various prototypes around the world suggest," Mohan said. "It has become clear to us that there is a need for new design methodology (methods and tools) that are able to handle a new level of complexity for highly integrated smart autonomous system. Our work with Scania, however, has shown that consistent progress can be made by explicitly modeling in assumptions and uncertain information into design."

As part of two EU-funded projects called Prystine and AutoDrive, Mohan and Törngren worked closely with Scania and other companies in Europe, investigating solutions that could improve the safety of automated vehicles. Using AD-EYE, they tested some of the tools developed by these companies, evaluating their feasibility and trying to identify opportunities for further development. The researchers are now continuing their investigations, using their platform to conduct more architectural and functional safety-based evaluations.

"We also want to move our tests to the real world," Törngren, told TechXplore. "We have started the process with the road transport authorities in Sweden and are on our way to becoming the first university licensed team to take part in public road trials in Sweden. This is our immediate next step."

In the future, Mohan and Törngren plan to continue collaborating with several tech companies, including Siemens, Nvidia, Scania, Volvo Cars, AVL, and QRTECH. They have already started conducting a new tests using AD-EYE, specifically aimed at determining which of the enormous amount of possible test cases deliver the most return in the

shortest time.

"Finally, we are also interested in investigating how the behavior of other actors, particularly of a malicious nature can affect us. i.e. the interplay of safety and security."

  More information: AD-EYE: A co-simulation platform for early varication of functional safety concepts. arXiv:1912.00448 [cs.RO]. arxiv.org/abs/1912.00448

www.kth.se/profile/naveenm/publications

www.kth.se/profile/martint/publications

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