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Effective and Efficient Simulation for AD and ADAS Systems

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The simulation and overall testing of AD (Autonomous Driving) and ADAS (Advanced Driver-Assistance Systems) systems is probably one of the most complex tasks today. We cannot talk about a specific class of simulation in this case, it is about the management of *many* parallel simulations describing the behaviour of a highly complex autonomous or ADAS-equipped vehicle. Even the nuances can be considered in the models; the aerodynamics, the suspension and powertrain system, the electronic subsystems and the ADAS sensors as well as the AI-based perception and control systems. This is all embedded in a virtual environment where the road, the weather, visual conditions, pedestrians and similar vehicles are modelled and simulated. It sounds like a very difficult environment to simulate! So why do all the OEMs bother? There is a good reason; it is *impossible* to effectively validate AD and ADAS systems without simulation.

There is an excellent example to demonstrate the inevitability of simulations for validation of AD or ADAS systems. If one has the intention to statistically validate the safe function of a relatively simple emergency brake assist system, then an approximately 2.4x10^8 km long test-driving series would be necessary to achieve the goal. When assuming 100 km/h average speed during these tests, 274 *years* of driving would be needed to carry out the test series [1][2]. This amount of driving need is very frustrating, not to mention the possibility of injuries and accidental death cases during the tests. It seems unrealistic to perform these tests. So, when testing is not possible and we fail to solve the problem in analytical ways, simulation is the only hope, as a third way of engineering. Of course, the markets have recognized this need, the large simulation software developers have extended their portfolio promptly with AD and ADAS related simulation tools and new software companies have also been established to fulfil consumer needs.

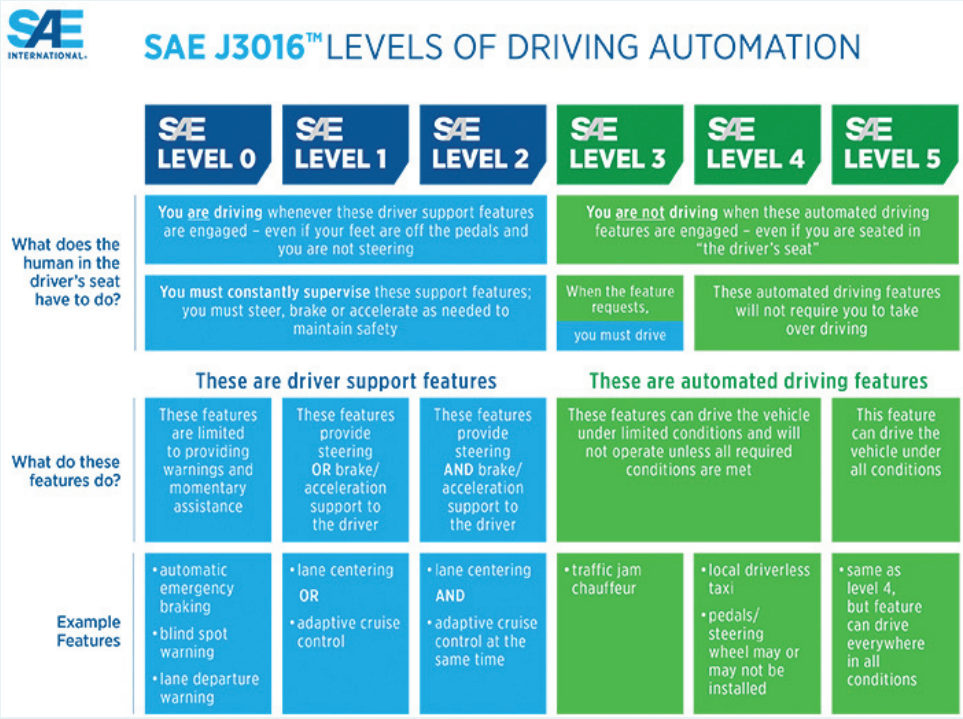

Figure 1: Levels of Driving Automation (courtesy of SAE International).

'Based on current standards, today, only real-world tests with real cars and human drivers are accepted in the validation of any automotive system. This is about to change in the near future; we are heavily working on getting simulation results accepted as a part of the validation process. This not only involves many industry-wide discussions but, from a technical perspective, requires an evolution of environment simulation methods to bring high physical fidelity to model ADAS / AD sensor behaviours. Making these simulations accurate enough for sensor simulation and opening up their real-time engines for sensor producers through APIs is one of the critical challenges of automotive simulation. Since efficiency remains a significant factor, we need to create an integrated simulation platform where high-level scenario simulations and CPU & GPU consuming sensor- simulations can co-exist in an integrated and automated process.'

- Mr. Szabolcs Janky, aiSim product manager, AIMotive

'Beneath the steady improvement of environment and physics modelling methods, efficiency remains the key, applying parallelisation cloud technology and automation. During the verification and validation tests an enormous amount of data is generated, that has to be assessed and returned in the form of Coverage and KPIs. The world is going to scenario-based V&V where a massive number of scenario variants has to be generated, executed and assessed automatically.'

- Roy Fridman Business Development, Sales & Marketing Executive, Foretellix'

In this special field there are more stages of the V&V process where the virtual simulation and physical tests are coupled with each other. The next example to illustrate this relates to special, so-called Driver in the Loop (DiL) simulations. According to new EU regulations for new vehicle types, driver awareness has to be monitored, which is especially important at L3 level automation (Figure 1) where vehicle control is transmittable between the driver and the automated vehicle itself.

At this level of automation, the driver's sense of security might be misleading and can lead to dangerous situations when the driver's attention is distracted. It means that not only does the system have to be tested out, but many of the dangerous scenarios need to be simulated with human drivers too. This can be realized in the DiL simulator where realistic circumstances can be imitated. Of course, the DiL system has to be equipped with all the interfaces to connect the whole Human Machine Interface system, driver monitoring sensors and a head-up display for example. It means that the most integration- ready systems will be the tools of future simulations. In optimal cases these simulators will be settled directly at a test track where the developments can be immediately tested, or even synched with the digital or semi digital twins.

It is not possible to pick one or even a few specific trends and call it the future of AD and ADAS simulations. One thing is for sure; for the V&V of AD and ADAS systems a simulation-based approach is the key. The improvement of simulation methods and management is needed to achieve even more realistic simulation results, and to become even more effective.

[1] Feilhauer M., Häring J. (2017) A real-time capable multi-sensor model to validate ADAS in a virtual environment. In: Isermann R. (eds) Fahrerassistenzsysteme 2017. Proceedings. Springer Vieweg, Wiesbaden.

[2] H. Winner, "Quo vadis, FAS?," in ATZ/MTZ-Fachbuch, Handbuch Fahrerassistenzsysteme: Grundlagen, Komponenten und Systeme für aktive Sicherheit und Komfort, H. Winner, S. Hakuli, F. Lotz, and C. Singer, Eds., Wiesbaden: Springer Vieweg, 2015, pp. 1167–1186.

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