Hands off, Eyes off, Mind off: New Validation Possibilities for ADAS and Autonomous Functions at PSA

Groupe PSA is making great strides towards autonomous driving. Advanced driver assistance systems (ADAS), which are comprehensively validated in real-world and virtual test driving, are paving the way. A new and essential element in the validation chain at PSA is vehicle-in-the-loop testing. Vehicle-in-the-loop bridges the gap between standard test methods by integrating a real vehicle into a virtual traffic environment.

PSA is keeping their eyes on the goal: the vision of accident-free autonomous driving. Since mid-2015, several Citroën c4 Picasso by the automobile group have been driving on European speedways in the so-called “hands-off” mode. This expression refers to the second of five automation levels for autonomous vehicles (“hands on”, “hands off”, “eyes off”, “mind off” and “driverless”). In September 2016, the group announced that the vehicles had already traveled 60,000 kilometers without an accident [1].

According to PSA, these tests are focused on the investigation of the various operating safety aspects of the systems and the recognition of potentially dangerous situations with regard to the road or other road users. At the same time, the vehicles are proof of the maturity of these technologies. Groupe PSA is therefore planning on offering automated driving functions – monitored by the driver – starting in 2018. From 2020 on, they envision drivers to hand over the driving task completely to the vehicle.

Profile	
Client	Groupe PSA
Country	France
Challenge	In order to advance autonomous driving, PSA develops novel ADAS, which require validation. Model-based test methods provide effective support. Until now, however, the evaluation of systems integrated into the real whole vehicle was only possible in complex and costly test driving.
Solution	• Vehicle-in-the-loop: A real test vehicle is integrated into a virtual traffic environment. • Drivers can safely test reproducible scenarios.
Products	• VIL system with CarMaker

Until then, vehicles of the brands Peugeot, Citroën and DS Automobiles will gradually be equipped with increasingly autonomous ADAS [2]. The systems will contribute to traffic accident prevention by relieving drivers of routine tasks, enabling them to focus their attention on the traffic. One example is the “Active City Brake”, which is already integrated into the DS 3, 208, CI, 108 as well as the new Partner and Berlingo. By means of windshield sensors, this system can detect collision hazards in city traffic up to a speed of 30 kmh and automatically initiate hard braking if needed [2].

New test method at PSA

In addition to real-world testing on roads and test tracks, development engineers rely strongly on virtual test driving with CarMaker in the development of ADAS. This method is now firmly established in the development of vehicle dynamics and advanced driver assistance systems at PSA in the form of model-, software- and hardware-in-the-loop (MIL, SIL, HIL). The company was in fact a pioneer in the area of simulation-based ESC homologation. Since 2011, PSA has released ESC systems based on virtual test driving with CarMaker/HIL [3].

A new element in the validation chain of control systems is vehicle-in-the-loop (VIL) testing [2]. This method combines the advantages of simulation and real-world test driving by embedding a real test vehicle in a virtual traffic environment. The driver maneuvers the car across an open area while all objects relevant to the test case – such as other vehicles, pedestrians, cyclists, buildings or signs – are generated in the virtual world. The virtual environment is either displayed on a monitor or via augmented reality glasses worn by the driver.

This allows for risk-free and resource-efficient testing of ADAS such as the emergency brake assist. Standard real-world tests use so-called dummy targets for the investigation of emergency brake assist systems to make collision scenarios as realistic as possible. In VIL testing, in contrast, potential crash opponents are generated virtually. Virtual sensors detect the simulated traffic objects and transmit the information to the simulated or real ECU in the test vehicle. The control unit assesses the situation and initiates a real emergency brake intervention if necessary. Drivers act in a mixed reality of the real and virtual world. They perceive real vehicle dynamics (hard braking in this case) and see the virtual traffic objects moving on the real test track.

The VIL method was implemented by IPG Automotive based on CarMaker. As in MIL, SIL and HIL, CarMaker simulates the interplay of vehicle, driver, tires, road, traffic and environmental conditions. The traffic scenarios are defined using the traffic model in CarMaker, independently of specific vehicles or roads, and can therefore be reused at will. Both maneuvers and test cases can thus be applied accurately to later tests without effort, e.g. from MIL to HIL and VIL. The tests are reproducible without limitation and allow for test results of different development stages to be directly compared. The real test vehicle is embedded in the virtual environment via the vehicle model in CarMaker by mapping its movements onto the virtual vehicle. For an exact deter-

Testing an emergency brake assist system with the vehicle-in-the-loop method

mination of the vehicle's position, a high-end IMU (Inertial Measurement Unit) is used in connection with GPS and DGPS.

Conclusion

The validation of functions is one of the greatest challenges in the development of ADAS. Vehicle-in-the-loop enhances the validation options for PSA engineers [2]: They can test absolutely reproducible traffic scenarios without risks in a vehicle with real vehicle dynamics. These tests substantially contribute to the series production maturity of user-friendly assistance systems and the gradual advancement of vehicle autonomy – taking PSA steadily closer to driverless driving.

Sources

[1] „Déjà 60 000 km parcourus en mode autonome sur les routes d'Europe par les démonstrateurs du Groupe PSA", press release by PSA of September 21, 2016
[2] „Plus jamais seuls au volant", article from the newspaper L'Est, published on December 21, 2015
[3] „First Homologation of Electronic Stability Control in Passenger Cars by Vehicle Dynamics Simulation According ECE 13-H - Challenges, Innovation and Benefits", presentation by Dr. Alfonso Porcel at Apply & Innovate 2012

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