Comment from David Howarth

I work for IPG Automotive in the US, and we make the automotive simulation package CarMaker. We work with automotive OEMs and Tier1s who are developing and validating ADAS systems. According to a recent AAA report, some of these systems fail most of the time in practice, even though manufacturers test them extensively.

Web link to the report: https://newsroom.aaa.com/2019/10/aaa-warns-pedestrian-detection-systems-dont-work-when-needed-most/

We at IPG Automotive are working with manufacturers to add significantly more simulation to the development and validation of their ADAS systems. Far more test cases can be run, including sensitivity analysis on the performance of the sensors, perception algorithms, planning, and control algorithms. The sensitivity analysis consists of running the simulations with a significantly large number of combinations of ego vehicle velocity, traffic/pedestrian velocity, angles, and timing. This approach enables a clear understanding of the limits of these ADAS systems in a wide variety of conditions, including weather. The base scenarios used would be the exact same scenarios used in the final physical testing. These base scenarios are used as the basis for the large number of variant scenarios using a classical Design of Experiments engineering approach.

Synthetic edge-cases, real-world edge cases, weather, etc. can all be added to the simulation scenarios, and can also be varied in great detail as part of generating the extensive library of variant simulation scenarios.

But in the end, the simulations are useful only if they can be correlated with physical testing with a high degree of fidelity. Manufacturers are accomplishing this today with IPG CarMaker using ViL (Vehicle-in-the-Loop).

What is ViL?
OEMs/Tier1s are using ViL to validate their ADAS functions in a physical vehicle but with sensor bypass that injects simulation into the sensors. The sensors do not report what they sense in the real world, but instead the sensors report what they see in the simulation that is running while the driver is driving. ADAS vehicle validation tests (e.g. NCAP) can then be run in an empty parking lot using a physical vehicle and a simulated environment.

For example, an AEB test. The driver is driving 40 mph in an empty parking lot to conduct an NCAP test, and is simultaneously running the CarMaker NCAP simulation test scenario on the PC. The vehicle sensors "see" a pedestrian step in front of the vehicle, and the AEB controller kicks in, even if the driver has their foot on the accelerator. The driver can also see the pedestrian via virtual reality goggles or via a monitor with CarMaker. The pedestrian is part of the CarMaker scenario and is detected by the vehicle sensors (camera, radar, lidar, ultrasonic). This is a very easy way to test all ADAS controls with actual NCAP tests in a physical vehicle.

Using ViL to correlate Physical Testing and Simulation with a high degree of fidelity
To correlate the simulated results with physical testing, a subset of the simulation scenarios can be run for the physical tests. For example, the tests specified by NHTSA. These would have been the same tests used as base tests in the simulation. Using ViL, the exact same base scenarios from the simulation can be run in the physical vehicle. The results can be measured, e.g. stopping distance, or distance to a lane marking. These physically measured results can then be compared to the results from those same scenarios in the simulation. The key is that the ViL vehicle is running the exact same simulation scenarios. If the correlation result is high-quality, then the manufacturer has far more confidence in the overall sensitivity analysis and edge-case testing from the simulation. They know that their vehicle model, simulated sensors, powertrain, etc. are all working in simulation

the same as in the physical vehicle. They have confidence in all the other simulation scenarios that were also run. If the result is low-quality, then they know more development is required.

OEMs/Tier1s use this technology today. A similar approach is used in Europe for ESC certification/homologation, where simulation is accepted for the vast majority of the testing instead of physical testing.

One additional important element is a high-fidelity vehicle model for correct vehicle dynamics. This is needed to achieve high quality consolations between simulation and physical testing.

The physical testing for ADAS is very important and the research work for this project is also important. This should not be replaced. The approach described in this comment is a way to extend these physical tests into simulation and correlate the two worlds for a provable result with a much higher level of confidence. The ViL approach also saves manufacturers considerable development time and cost, and the investment in money and time is minimal.