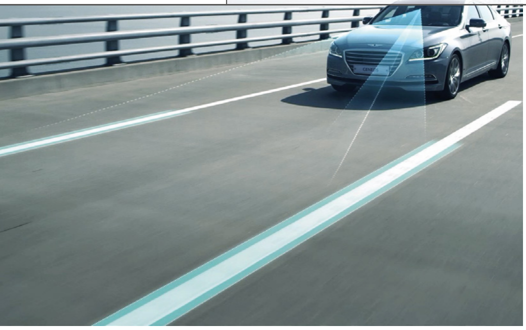


Source: © Hyundai MOBIS

Developing modern driver assistance systems involves an ever-growing amount of data which must be processed in real time. Hyundai MOBIS uses a HIL setup that is based on dSPACE SCALEXIO and can develop and test multiple driver assistance systems at the same time.

Developing driver assistance functions with a simple method in the laboratory means that it must be possible to simulate the various driving situations realistically and reproducibly on a test bench under defined conditions. This task is becoming more complex because many driver assistance functions involve combining and evaluating measurement data from different environment sensors in real time. One of many examples is automatic emergency braking. In this example, first the cameras visually detect the road users, while the radar measures the distances and velocities of these traffic participants. On the basis of this overall picture, the vehicle computer can then decide whether emergency braking is required and calculate the appropriate instructions for the brakes. This combining of measurement data from different sensors in a split second, also called sensor fusion, is one of the biggest challenges when developing the driver assistance systems of tomorrow.

Six in One Blow

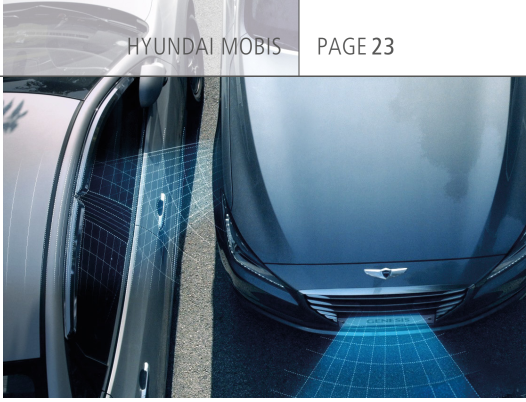
Besides automatic emergency braking, there are many other situations in which several driver assistance systems need to interact with each other. In the first step, Hyundai MOBIS is using a SCALEXIO® HIL simulator to test a total of six driver assistance functions:

- Parking assistance system (SPAS = Smart Parking Assist System)
- Lane departure warning system (LKAS = Lane Keeping Assist System)
- Automatic proximity control (SCC = Smart Cruise Control)
- Emergency braking (AEB = Autonomous Emergency Braking)
- Assisted steering (MDPS = Motor Driven Power Steering)
- Electronic stability control (ESC = Electronic Stability Control)

Realistic Driving in the Lab

The central elements of the setup are a dSPACE SCALEXIO HIL simulator equipped with simulation models from dSPACE, and 3-D online animation via dSPACE MotionDesk to visualize the driving maneuvers. This development environment is connected to multiple test benches for various driver assistance systems (figure 2). There is one test bench for the radar scan of the vehicle environment, one for camera-based

>>



All You Can Test

Performing parallel tests on multiple driver assistance systems

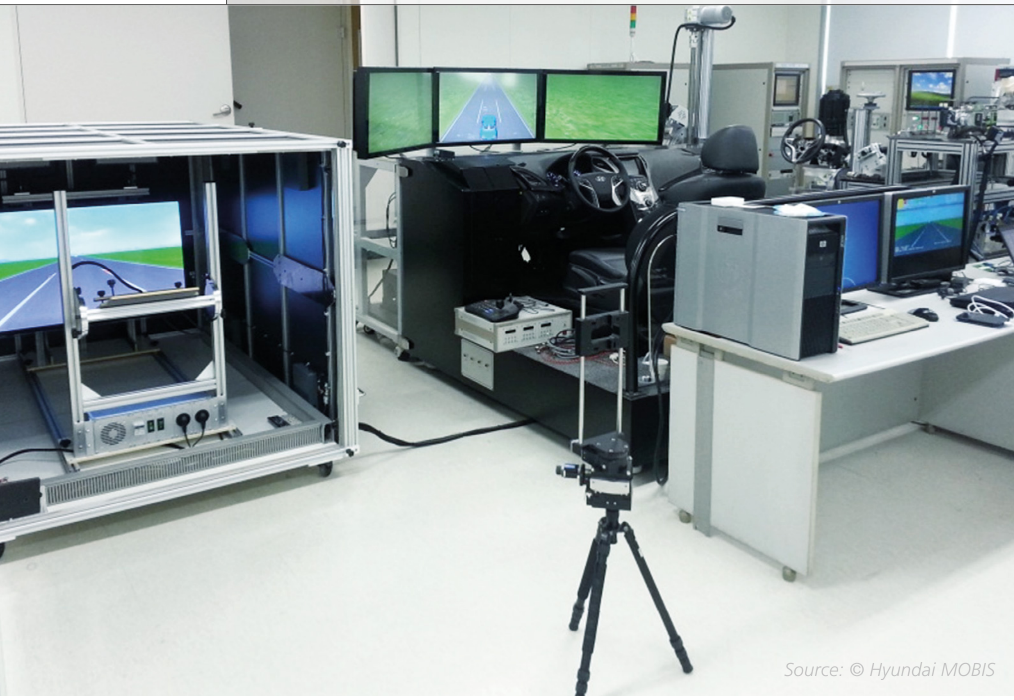

Source: © Hyundai MOBIS

Figure 1: Part of the lab setup: The camera test bench (on the left), the driver's seat (in the middle), and the HIL simulator (in the back right).

detection of driving lanes, another for the ultrasound-based parking assistant, and one for the steering assistant and the brakes.

The Automotive Simulation Models (ASM) from dSPACE for vehicle dynamics and traffic applications are run on the HIL simulator so that the various tests can be performed realistically. ASM Traffic includes generic sensor models for radar and ultrasonic applications, like detecting object contours for park assistance systems. The radar system control unit and the SPAS control unit are connected as actual control units, and the LKAS control unit is initially replaced by a dSPACE MicroAutoBox®. To develop the algorithms in the radar control unit for the proximity control SCC, for example, the radar control unit can also be replaced by a MicroAutoBox. In the real-time simulation, the radar sensor model uses the behavior of the test vehicle's dynamics and the traffic environment as a basis to generate information, such as the speed difference, distance and azimuth of the vehicles ahead, which is transmitted via CAN to the SCC algorithm on the MicroAutoBox. To integrate the actual radar control unit in the closed-loop simulation, a radar target simulator is planned to be used to generate the reflections resulting from the relative velocities and distances of the vehicles ahead as a real radar echo.

1 Radar test bench

The radar sensor test bench is used to perform basic function tests of the radar sensor. It is an anechoic chamber with electrically conductive walls that electromagnetically shield the interior chamber from the outside world (Faraday cage). To recreate realistic traffic situations, the appropriate generic sensor model from ASM runs on the HIL simulator. A dSPACE MicroAutoBox takes on the role of the radar control unit.

2 Camera test bench

The key to testing camera-based driver assistance systems in the lab is a real-time representation of realistic vehicle environments, which are interpreted as real traffic situations by the front camera. The driving situations are visualized by dSPACE MotionDesk and thus perfectly stimulate the camera. At this measuring station, a dSPACE MicroAutoBox is initially used to calculate the LKAS algorithms, because the development of the final control unit has not been finished yet.

The test and experiment software dSPACE ControlDesk is used to monitor the experiments, record data, generate specific errors, and postprocess data, to name just a few tasks. In the future, for the

> "The test benches of dSPACE hardware and software gave us the capability to efficiently test multiple driver assistance systems in interaction."
>
> *Tae Seung Kim, Hyundai MOBIS*

Tae Seung Kim
Tae Seung Kim is responsible for the Active Safety Test Development Team in the System Test Development Division of Hyundai MOBIS in Yongin-Shi, South Korea.

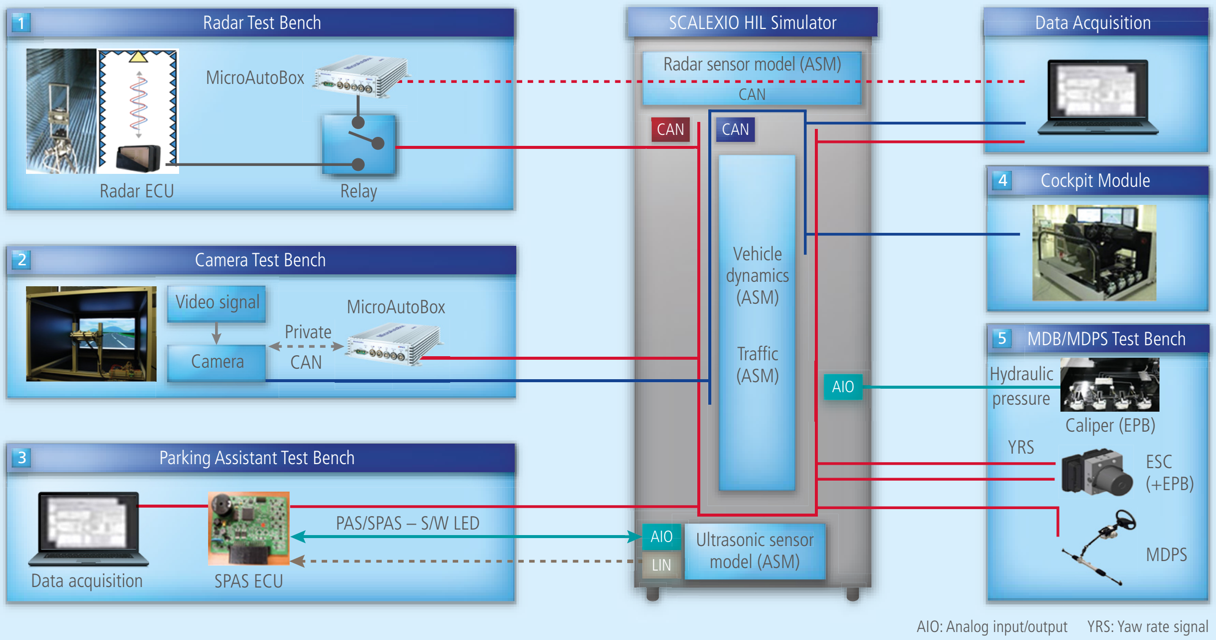


Figure 2: With the test bench of dSPACE hardware and software, several driver assistance systems can be tested in interaction.

3 Parking assistance system

The test bench for the ultrasound-based parking assistance system consists of the final production ECU and the ASM contour sensor model for ultrasonic applications that runs on the dSPACE HIL simulator. Actual ultrasonic waves are not necessary here.

4 Driver's seat

Here the experimenter can intuitively run through any driving maneuver that is calculated by dSPACE ASM and visualized by dSPACE MotionDesk, almost as in real traffic. These maneuvers can then be used for the camera test bench 2 for example.

5 Power steering (MDPS) and ESC

Here, real components (steering rods and brakes, including the ESC control unit) are connected and fed with data from the dSPACE ASM simulation for different driving situations or optional driver inputs to verify that the system functions correctly.

camera measuring station, a stereo camera is planned to be used in addition to the mono camera.

Evaluation of the dSPACE System

Using new technologies like camera and radar directly in a vehicle leads to new challenges for validating the developed systems. The testing system that dSPACE designed in accordance with the requirements of Hyundai MOBIS is the first HIL-based test solution for ADAS developments in Korea. Day after day, the reliability of SCALEXIO and the other dSPACE products are an important basis, allowing the developers to work successfully. The continuous support from dSPACE and MDS, dSPACE's distributor in Korea, helps develop and launch new groundbreaking driver assistance systems.

More Sensor Data in the Future

It can already be foreseen that the future vehicle will continue to have a higher number of sensors. This means an increase in the volume of measurement values that must be processed in real time. Using a HIL simulator in the laboratory under defined conditions helps test the most practical methods for handling these data sets in order to generate meaningful instructions for the vehicle systems. Drivers need to have an overall picture that is easy and fast to comprehend at all times so that the driver assistance systems help them, rather than hinder them. ■

Tae Seung Kim,
Hyundai MOBIS