The Electronic Eye

- Hardware-in-the-loop simulation with integrated camera
- Automated visual instrument checks
- Reduced testing workload

A new test system put into operation by dSPACE performs automatic visual checking of an instrument cluster. The system consists of a dSPACE Simulator Mid-Size, a camera, and a Cadillac STS 2006 instrument cluster. The hardware-in-the-loop (HIL) system plus camera makes it possible to perform comprehensive tests on vehicle electronics and replaces the error-prone checks made by human beings. This makes the system very suitable for real-time-tests on instrument clusters.

Hardware-in-the-loop (HIL) simulators from dSPACE have been used for testing dashboard instruments for ten years now, like at AUDI AG, for example.

▲ *The camera (right) "observes" the instrument cluster and passes the signals on to the HIL simulator.*

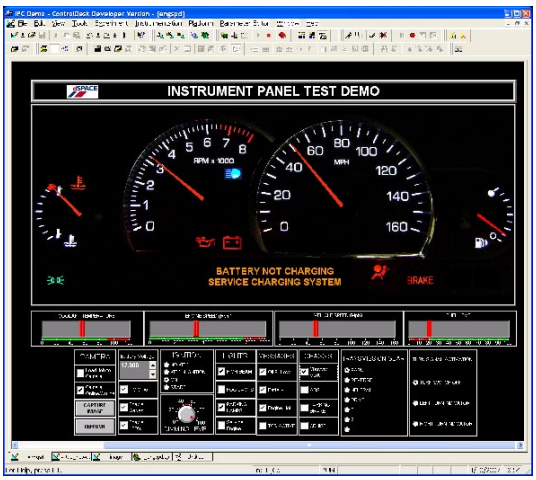
As in-vehicle functions grow in number, driver information systems grow in size. Integrated tests are therefore an increasingly necessary part of instrument testing. To give drivers comprehensive information, modern vehicles are equipped with highly sophisticated display instruments, infotainment systems and navigation systems. Not only important vehicle data such as driving speed, engine speed, fuel level and coolant temperature are displayed, but also maintenance periods, tire pressure, failed lamps, kilometers driven, inside and outside temperature, etc.

Greater Testing Workload

Display instruments are open control loops in which the vehicle data is output to the display, but no electronic feedback is available to report on the functions under test. Thus, until now function testing for indicator needles, messages, and signal lamps has had to rely on visual observation, known as man-in-the-loop testing. These tests have enormous disadvantages in terms of their reproducibility, their resolution regarding the times and positions of the changes observed, and the number of instruments that can be observed simultaneously. Moreover, the human eye soon tires and is easy to deceive. The solution to this challenge is to introduce automated visual tests as part of hardware-in-the-loop (HIL) simulation.

HIL with an Electronic Eye

In a test project, engineers from dSPACE connected a dSPACE HIL simulator with a high-resolution camera that "observes" a Cadillac STS 2006 instrument cluster. The displays were also reproduced via ControlDesk,

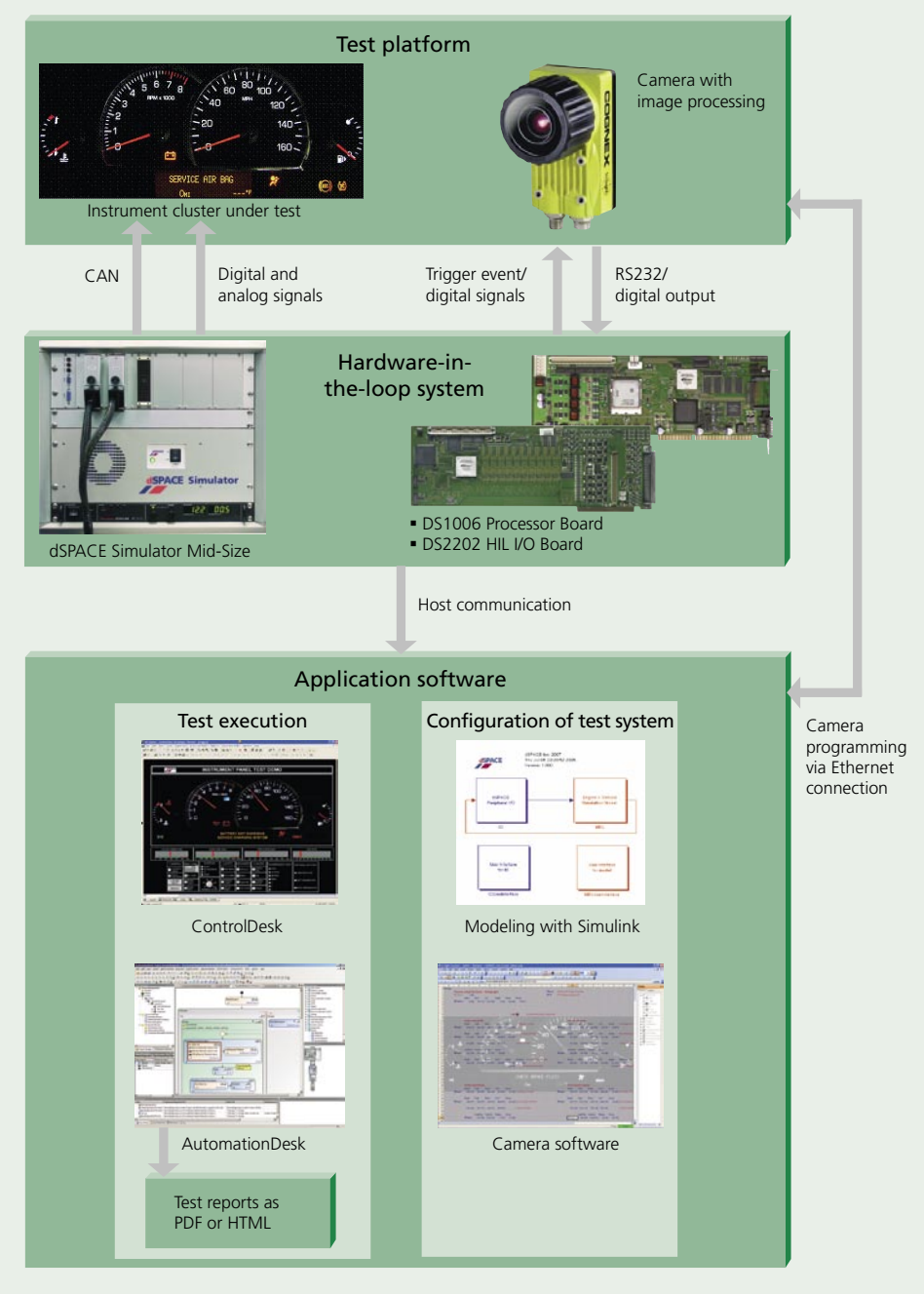


▲ *ControlDesk provides a photorealistic image of the instrument cluster.*

dSPACE's experiment software, so that changes could be recorded, displayed, and if necessary replayed. To create realistic test scenarios, various Automotive Simulation Models (ASMs) from dSPACE were used, for example, for the engine, transmission, driving behavior, driver, and environment. The simulation model for the tests was created in Simulink®. The dSPACE Real-Time Interface (RTI) provides the connection between the dSPACE hardware and Simulink. The HIL simulator emulates the sensor and ECU inputs for the displays.

Test Execution

AutomationDesk, dSPACE's test automation software, is used to create and run the tests. AutomationDesk simplifies the creation of test cases and makes it possible to automate test execution. While the HIL simulator simulates sensor signals according to the test scenarios, the camera's image capturing and image processing software evaluates the needle positions and other display elements by means of algorithms. Whenever changes occur, such as needles moving or signal lamps lighting up, the camera software converts the measured values into angular values and sends them to the HIL simulator via an RS232 interface. The simulator software translates this data into scalar variables, for example, vehicle speed and engine speed. Changes can take place very rapidly, so the observation and testing processes have to be in real time. This is particularly important for registering signal glitches that only show up as tiny needle movements or flickers in signal lamps, and which can occur at any time. ControlDesk's virtual instrument display indicates both the measured values and the reference values. Both values are stored in a list that AutomationDesk accesses to perform test evaluation. When the test has completed, the software produces a test report in either PDF or HTML format.



▲ *Schematic of the test set-up for automated instrument checks.*

Speed vs. Resolution

Initial test runs show that HIL simulation with integrated image capturing and image processing is very well suited to testing instrument panels in real-time. However, there are restrictions with regard to the simultaneous requirements for speed and resolution. Tasks such as needle position capture and needle angle determination require a high resolution, while signal lamp observation requires a high frame rate. Users have to find their own trade-off between these two requirements, depending on what they want to observe.

Instrument cluster monitoring can also be applied to other information systems such as climate control displays and automatic parking systems.