Virtual validation of advanced driver assistance functions

Translation of “Virtuelle Absicherung von Fahrerassistenzfunktionen”

Published at: HANSER automotive, 7-8/2013
The European Commission has declared the aim of cutting the number of casualties on European roads. In parallel to this, vehicle manufacturers are facing tougher European NCAP evaluation criteria in the area of safety features. The resulting developments are focusing on modern driver assistance systems that continuously monitor the vehicle’s environment and (partly) autonomously react to dangerous situations. These systems intervene actively in the engine and transmission control, or in the brake or steering system. The functions are strongly networked across several ECUs, so employing them makes tough demands on development and validation. It is becoming increasingly necessary, in this context, to integrate new software components into existing ECUs on a PC at an early stage and test them continuously in parallel to development work (Figure 1).

**PC Offline Simulation Platform**

Model-based function development based on MATLAB®/Simulink® has an established role in the automobile industry. The ability to represent the entire functionality of an ECU in Simulink is therefore a frequent requirement. This means that the existing software parts have to be provided as function models or C code and connected to the new driver assistance functions to form a virtual ECU (V-ECU). If dSPACE’s PC offline simulation platform VEOS® is used, object code can also be integrated as a black box, so to speak, to guarantee IP protection for suppliers. VEOS also provides the ability to simulate virtual ECUs, including task scheduling and the behavior of the basic software, and interconnect them via a virtual CAN bus provided they are described according to the AUTOSAR standard. The first open-loop tests can be performed on this basis. Because the number of stimulus tests executed with a V-ECU is usually very high, the performance capability of the simulation platform is decisive. VEOS is not only able to run a simulation on common PCs considerably faster than real time, it is also completely automatable. Changes to new driver assistance functions can therefore be validated very quickly by automated test sequences. Another important point in this context is that the data sets and measurement data generated in test drives and on test benches have to be reusable. By calibrating a V-ECU with real data sets and stimulating it with real measurement data, developers can perform actions such as reproducing test drives on their own PCs. In VEOS, V-ECUs are accessed via the standardized ASAM XCP interface. The AUTOSAR standard and ASAM HIL API are also supported to ensure compatibility with customers’ established tools.

**Plant Models and Soft ECUs**

Validating modern driver assistance functions in closed-loop mode requires detailed models for simulating the vehicle and its environment. The dSPACE Automotive Simulation Models (ASMs) provide plant models that are tailored to this need. They are based on open Simulink models that are designed for both PC of-

![Figure 1: Virtual validation of networked driver assistance functions on a PC.](image-url)
offline and hardware-in-the-loop (HIL) real-time simulation. Figure 2 shows how V-ECUs are created in VEOS and connected to the ASM plant models.

To simulate how the vehicle under test reacts to other road users and the traffic infrastructure, the vehicle must be equipped with suitable environment sensors, and the traffic environment has to be assembled from fellow vehicles, traffic signs and roadside structures. The traffic environment model interacts with the ASM vehicle dynamics simulation, enabling developers to define the behaviors of several independent road users, equip the test vehicle with different sensors for object recognition, and validate the driver assistant function in virtual test drives. 3-D visualization of driving maneuvers provides a direct impression of a test drive.

Modern driver assistance systems often intervene in the control of the engine torque, the brake and the transmission, so the reactions of these ECUs have to be taken into account in integration tests for new software functions. Not infrequently, however, there is no real software available for numerous ECUs at this stage of development. Simplified behavior models of these ECUs, also called soft ECUs, provide a way out. The Automotive Simulation Models provide a variety of soft ECUs for this application case.

**Seamless Integration Between PC Offline and HIL Simulation**

Car manufacturers are today systematically using HIL simulation to validate driver assistance systems. The distributed functions can be verified with a high test depth by means of integration tests. Thus, with the HIL field as the driving force, large investments were usually made in creating simulation models, suitable model parameterizations, test libraries, and user interface panels. The goal must be to incur these costs only once in the development process, and to use the results for ECU function validation on a PC as well as for HIL simulation. Because its interfaces with the outside world are largely based on those of a HIL platform, VEOS provides systematic support for this requirement. This means that users not only have ample resources in terms of models and test libraries from the HIL world to draw on, they can also reproduce on their own PCs errors that occurred in HIL testing, and debug them and test any necessary software component changes directly with the same test cases (Figure 3).

**Summary and Outlook**

With their high level of networking, modern driver assistance systems require a validation process that is supported by simulation. To meet the quality goals and deadlines set by the OEM, new software functions have to be integrated and tested in the ECU network at an early stage. There is a need for a PC-based virtual validation platform which allows the reuse of test cases and tools from HIL simulation. This seamless integration is indispensable if the frontloading approach is to boost efficiency in the development process. The dSPACE simulation platform VEOS implements this requirement systematically. Also available are plant models and soft ECUs that are suitable for the closed-loop simulation of virtual ECUs.

In the future, functional software-in-the-loop tests will be another fix-
ture in the ECU software validation process. Because plant models and the associated simulation tools used can vary depending on the OEM and department, it is anticipated that VEOS will require an open model exchange interface. The further development and increasing establishment of the Functional Mock-up Interface (FMI) standard is laying the foundation for integrating third-party plant models.

Figure 3: Seamless integration between PC offline and HIL simulation.

Dipl.-Ing. André Rolfsmeier is Lead Product Manager Advanced Applications and Technologies at dSPACE GmbH in Paderborn, Germany.
© Copyright 2013, dSPACE GmbH.

All rights reserved. Written permission is required for reproduction of all or parts of this publication. The source must be stated in any such reproduction. dSPACE is continually improving its products and reserves the right to alter the specifications of the products contained within this publication at any time without notice.
dSPACE is a registered trademark of dSPACE GmbH in the United States or other countries, or both.
See www.dspace.com/goto?trademarks for a list of further registered trademarks. Other brand names or product names are trademarks or registered trademarks of their respective companies or organizations.