University of Applied Sciences Kempten, DENSO AUTOMOTIVE Deutschland GmbH, PMSF IT Consulting

Virtual Validation Platform for AD/ADAS Systems using Kempten Digital City

Featured Standard:

ASAM OSI

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Simulation of autonomous driving needs a realistic representation of the environment. There are several options. We propose a method, which uses highly accurate global geo-information (GIS) data from the City of Kempten for testing sensors, sensor fusion and driving functions (algorithms). The geo-information data is converted into an ASAM Open Simulation Interface (ASAM OSI) representation and benchmarked against ASAM OSI ground-truth data. This allows virtual validation and testing against highly accurate geo-referenced data and a realistic environment representation.

The master course “Advanced Driver Assistance Systems” was established in 2014 by Prof. Stefan-Alexander Schneider at the University of Applied Sciences Kempten (UAS Kempten). Thanks to the close cooperation between the City of Kempten and the University, Prof. Schneider started utilizing the geo-referenced data of City Kempten for validation and verification of autonomous driving systems in test drives and simulations. Toward this aim, the UAS and the City of Kempten signed a research contract, which allows UAS to access the GIS data. The City of Kempten recorded over the last years a large amount of geo-referenced data (3D-buildings, traffic signs, traffic lights, hydrant, vegetation, …). In parallel, UAS Kempten and DENSO AUTOMOTIVE Deutschland GmbH launched a new project. One of the main goals of the project was the generation of a high-fidelity virtual environment based on realistic geo-referenced data to validate AD/ADAS related functions. Another target was to unify the sources of the information from the City of Kempten to create a complete virtual test environment using standardized interfaces. The core virtual test environment was developed based on PMSF FMI Bench as simulation engine and its osi3test framework for ASAM OSI-based testing and visualization.

During the project, a new test system architecture was developed as shown in Figure 1. The first step was to create the virtual environment based on the GIS data. In our case, we used ASAM OSI as API to access data from the simulation environment. ASAM OSI has an object-based environment and differentiates ground-truth, sensor view and sensor data. This structure allows an easy way to compare simulation ground-truth and real captured data. The main challenge was the conversion of the GIS data to OSI. The GIS data has different attributes, which cannot be directly mapped into an ASAM OSI representation. E.g., a traffic sign in the GIS data is globally referenced but usually, from an ASAM OSI view, the data is locally referenced. A second challenge was that GIS data is represented by points, lines, and polygons. Therefore, transformations to an ASAM OSI representation of the objects were neces-sary. During the project, the virtual environment was generated for a 1.6 km route in Kempten City. Figure 2 shows the visual correlation between reality (a) and simulation (b) of the same view. The red dots in Figure 2 (b) are the GPS data, which were recorded during the test drive. Note that what we compare is the exact positions of real objects (such as traffic signs) and their virtual counterparts at data level.

There are several ways to compare reality with the virtual environment. For this purpose, we performed a test drive with different sensors (lidar, camera, IMU and GPS), and reconstructed the drive in the simulation environment using the GPS data. At first, a list of the detected objects was generated using the sensor data, and the performance of real sensors and algorithms were benchmarked against ground truth data. Afterwards, the same procedure was repeated in the simulation environment. That means the sensor data was generated from the simulation with sensor behavior models. The output of the virtual test drive was a second object list. The comparison of two object lists indicates the performance of simulation against real test drives. The final performance report was a benchmark about the quality of sensors, sensor fusion and driving functions (algorithms). Early results showed that the developed simulation environment is sufficiently accurate.

This new approach provides many benefits. Such highly accurate simulation platform shall enable reducing the number of test drives, which are required for validation of AD/ADAS function in order to reduce development risk, time and cost. Overall, the project is promoting a uniform format (ASAM OSI) for benchmarking real and virtual tests across platforms, enabled by the ASAM OSI standardization activities. This new approach will be further developed by a startup called ADSUMA which is funded by the EXIST scholarship.

“The role of software in automotive development is increasing. For example, in automated driving, software replaces the human driver. Assuring the safety of such systems while keeping the validation costs in feasible limits is a big challenge. ASAM OpenX standards help us towards achieving scenario-based testing and validation of AD/ADAS functions in simulations. ASAM standard data formats that describe road networks, scenarios, road conditions will be an enabling factor for future automotive systems.”

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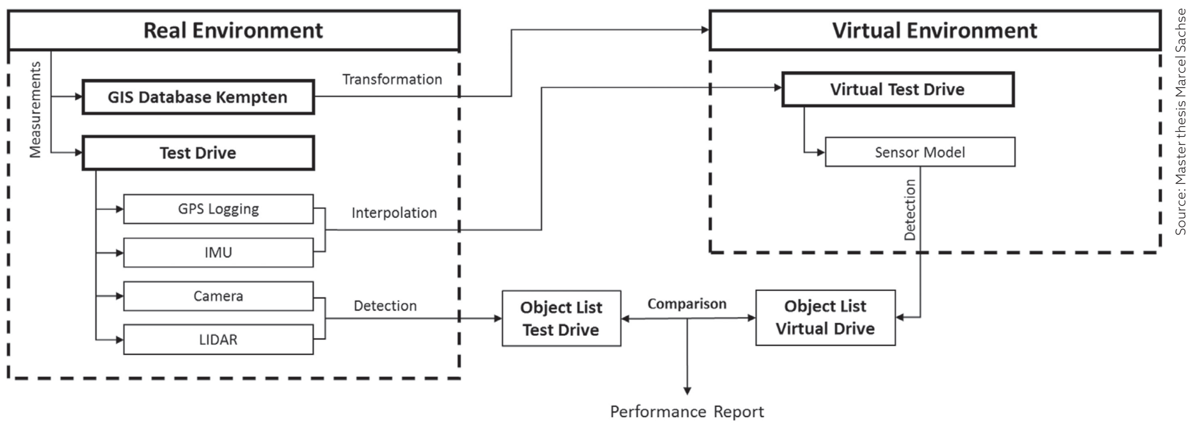
Figure 1

Workflow of the comparison, test drive in reality vs. virtual environment test drive.



Source: Master thesis Marcel Sachse

Figure 2

(a) Reality: Picture from the test drive.

(b) Simulation: Reconstructed test drive. Red dots are the GPS.

Source: Master thesis Marcel Sachse; PMSF FMI Bench