HAVEit

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Executive summary

This report presents a summary and status update of the Joint System integration into the research and demonstrator vehicles at DLR which are part of HAVEit work package 4100: “FASCar – Extended joint system demonstrator” [3].

Vehicle system development and integration concept

As a vertical part in the HAVEit project structure, WP4100 integrates results from several other work packages. These results are delivered in the form of algorithms implemented in software, or hardware units such as sensors or ECUs. The aim is to finally integrate the components in a single vehicle, the Extended Joint System Demonstrator, where they are expected to seamlessly interact with each other in order to demonstrate the feasibility of the overall HAVEit system.

Experiences from the SPARC project show that vehicle integration involving several components in prototype state developed by different organizations is a complex task with many potential pitfalls. Among them are too ambitious time frames and omitting intermediate joint testing of different components which will almost surely lead to problems in the final integration.

The HAVEit approach aims at avoiding such problems by employing a process where parallel development lines are joined together and tested at certain intermediate steps. While most of these intermediate integration steps can be performed on desktop PC level or more sophisticated simulators, real vehicles are still irreplaceable test beds for certain validation procedures. Especially when it comes to testing sensors and control systems acting upon their data, adverse effects due to real world clutter need to be examined in realistic environments.

Integration and validation status report

Despite modern development techniques based on simulation tools, test and integration campaigns in real vehicles driving in real environments are still an important part of the HAVEit development strategy. Such tests have been conducted from very early project stages for validation of simulation results and for accounting real-life effects that cannot be simulated.

After a couple of single system tests had been carried out in the months ahead, a first complete HAVEit system as described in detail in this report and the sensor/actuator configuration were integrated and successfully tested in the FASCar in November 2009. All tests involving active interference into the driving dynamics were conducted on an abandoned military area serving as a test track. Some tests with actuators deactivated were conducted on public roads.

Validation scenarios

For tuning and testing the specified functionalities of the HAVEit system components, five validation scenarios have been defined. The first two scenarios, “lateral and longitudinal control” and “sensor testing on public roads” aim at isolating specific systems, i.e. the sensor fusion and the vehicle controllers, in order to identify any issues with these components in a vehicle environment.

The next two scenarios “lane change to avoid static obstacle” and “detecting and stopping in front of static obstacles” are based on use cases defined in [1]. These scenarios tie the HAVEit systems together, with the complete control loop closed, spanning from the sensors via data fusion, co-pilot, MSU, command generation and validation to the vehicle actuators.

The last validation scenario tests the integration of the C2C / C2I communication unit in the HAVEit framework.

Key results and conclusions

During the integration workshop in November 2009 all co-system components except the Driver State Assessment were integrated and jointly operated in the FASCar for the first time. This was a major step in the development process, as it provided the first proof-of-concept for the Joint System being able to operate in a real-world environment as opposed to former tests being performed in simulators or covering only singular functionalities.

Among the tasks that had the highest priority during the integration workshop was the tuning of the lateral and longitudinal controllers for vehicle guidance in high automation levels. It is very costly and time-consuming to generate a vehicle simulation model realistic enough for controller fine-tuning as such a model would require accurate representation of the mechanical chassis characteristics as well as the drivetrain including highly nonlinear components such as the automatic transmission and – in the HAVEit case – also a representation of sensor and actuator characteristics.

The more practical approach towards vehicle controller development which has been embarked in the HAVEit project is to initially develop controllers based on a coarse vehicle model using simulation tools and then performing fine-tuning on the real vehicle. According to this development approach, the first vehicle integration is a very crucial step because it determines if the controllers will be finally able to fulfill the designated tasks. While there are still some issues remaining, the lateral and longitudinal controllers designed for the FASCar / Extended Joint System Demonstrator took this hurdle during the integration workshop and are expected to perform according to the requirements derived from the HAVEit use cases.

Another important task was the improvement of the Data Fusion which also for the first time directly fed the CoPilot and MSU (mode selection and arbitration unit). While there are still open issues particularly concerning the tracking and classification of objects detected by the laser scanners, significant advances have been accomplished over the past months.

Infrastructure to vehicle communication hardware was physically integrated in the FASCar and the Joint System software framework and tested using a simple proof-of-concept scenario. It is expected that applications such as the transfer of speed limits or other environment relevant data can be realized via this communication channel and applications based upon such data will be demonstrated shortly.

At the end of the integration workshop, a pre-defined set of validation scenarios was test-driven in the FASCar. On the one hand, these test-drives provided a good opportunity to wrap up the current status of the development while on the other hand, the recorded data will support the HAVEit team in improving their system components and shaping a roadmap to follow in the next project phases.

After a phase of distributed work, another integration workshop is planned in early 2010. Key tasks lying ahead are the solving of known issues in the software and the migration of software components from PC hardware to automotive ECUs such as the Continental CSC.

References

[1] HAVEit Deliverable D11.1 “Function description and requirements“, September 2008

[2] HAVEit Deliverable D22.1 “Communication specification“, May 2009

[3] HAVEit Annex I – “Description of Work“, Contract Amendment 2, April 2009

[4] Flemisch, F. et al.: Towards Highly Automated Driving: Intermediate report on the HAVEit-Joint System, “Transport Research Arena Europe”, Brussels, 2010

[5] Boehm, B.W. (1986), A Spiral Model of Software Development and Enhancement. ACM SIGSOFT Software Engineering Notes, v.11 n.4, pp.14-24

[6] HAVEit Deliverable D33.4 “Algorithm (C-code, 1st version) available for partners”, January 2010

[7] HAVEit Deliverable D12.1 “Architecture“, February 2009

[8] Project page of the open source version control system “subversion”: http://subversion.tigris.org/