20. Newsletter
December 2024

Dear Ladies and Gentlemen, Dear Colleagues,

we are very pleased to present you today our 20th SAFIR Newsletter and hope you enjoy reading it.

You can also find all previous newsletter issues for download on our website www.thi.de/go/safir under News. If other colleagues or partners of yours would like to receive our newsletter automatically in the future, please contact Camila Heller by e-mail, at camila.heller@thi.de.

Our newsletter aims to provide you with regular updates on news, current topics and dates of interest relating to the SAFIR research partnership. We look forward to your feedback as well as constructive suggestions and requests for changes!

We wish you and your loved ones a peaceful Advent season, a relaxing festive season and a good start to the New Year.

Best wishes and ho, ho, ho from the

SAFIR management team

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- ***Review of the SAFIR network event***

The annual SAFIR networking event took place on 21 November 2024 - a highlight of the year at which professors and academic staff from THI, as well as corporate and institutional partners, came together to network, exchange ideas and drive projects forward together.

For the first time, the event was held off-campus at the Ingolstadt Business Start-up Centre (EGZ). The location, right next to the CARISSMA open-air test centre and other state-of-the-art laboratories at Ingolstadt University of Applied Sciences, provided the ideal backdrop for an inspiring day full of discoveries.

The programme was full of exciting activities:

- Inspiring start-up pitches: the companies artiquare GmbH, sdp GmbH and Eximia Engineering GmbH opened the event with impressive presentations of their innovative ideas.
- Research in focus: Our SAFIR researchers presented their projects in a poster session and gave exciting insights into their work.
- Live demonstration on the test track: Technology was brought to life up close on the CARISSMA outdoor test track!
- Exclusive lab tours: Participants were given a look behind the scenes at the Institute for Innovative Mobility (IIMo) and our brand new testing laboratory for sustainable energy systems.

Networking is at the heart of the event. Once again this year, the event offered many opportunities for intensive discussions, the exchange of ideas and the development of new partnerships.

A big thank you to everyone who contributed to the success of this event! We are already looking forward to next year full of innovation, collaboration and joint successes.

- ***Closing report from the explorative project 4 (EP): Cloud-based software architecture for high-automated vehicles (DRAFT)***

Highly automated vehicle functions, more entertainment, strong interconnectivity within the vehicle infrastructure, shorter development cycles, over-the-air update capability and many other factors will present vehicle manufacturers with enormous challenges in the future, especially in the area of software development. A core idea for containing complexity is the decoupling of software (SW) functionality into a software layer (e.g. operating system, cloud interface) and an independent hardware (HW) layer. This core idea is also known as a “software-defined vehicle” (SDV) when combined with an architectural definition.

The objective of DRAFT was to design a new type of SDV vehicle architecture that combines impulses from different domains (e.g. IoT, software development) together with current research approaches from the automotive sector to create a fully integrated solution for research in safe, highly automated driving. Encapsulation, abstraction, load distribution through orchestration, continuous integration and continuous deployment as technological impulses were adopted in a modular cloud-based architecture definition.

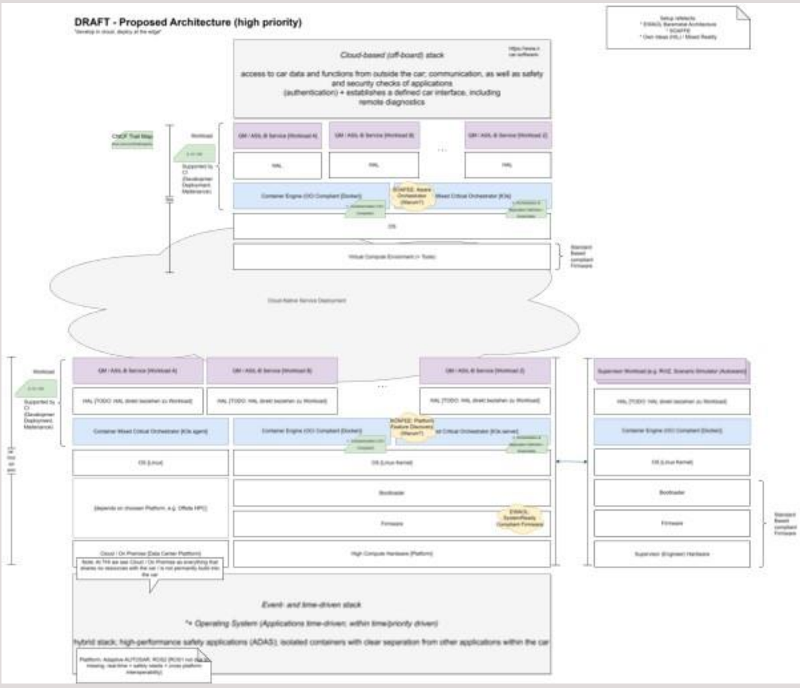

Fig. 1: High-level software architecture of the research demonstrator. The blue color indicates the container functionality and orchestration, the lilac areas are containerized software components.
Source: THI

This new vehicle architecture (see figure) was defined, implemented and tested as part of DRAFT. The architecture is divided into three areas: The “Event- and Time-Driven Stack” manages the software within the vehicle, with applications being executed in containers depending on criticality and urgency. These containers are abstracted from the operating system and can be flexibly scaled to different computing resources, supported by an orchestrator and CI/CD for dynamic deployment. The "cloud-based stack" performs similar tasks to the vehicle stack, but independently of the vehicle, for example, non-critical workloads can be outsourced. Finally, the "Supervisor System", which performs complementary tasks for research activities.

A hardware-independent implementation of standardized software components (workloads) and interfaces was demonstrated. Using a demonstrator vehicle from the successfully completed SAFIR project EP 1 - AutoBit (FKZ: 13FH7I3IA) as an example, this architecture was put into operation. DRAFT ensures fast, simple, robust and secure data collection for research operations.

Research assistant in the DRAFT project

M.Sc. Matthias Meyer
Matthias Meyer has been a research assistant at THI since April 2019. As a graduate of the "Applied Research in Engineering Sciences" program, he has since been conducting research in the field of model-based testing as well as the application of standards within the realm of automated driving. His work combines the challenges posed by the automotive sector with insights into software development.

Funding reference number DRAFT: 13FH7I06IA

- ***News from the impulse project 12: Functionalsafety for Automotive Objekt Recognition of Optical sensors by state monitoring of CameRAs (AURORA)***

Vehicle sensors, crucial for safety-relevant environment detection, degrade over time. The AURORA project, led by Prof. Elger, is centered on Predictive Health Monitoring to anticipate this degradation, ensuring enhanced safety. The project's ambition is not only to refine the SelfX diagnostic function but also to use advanced machine learning algorithms. These algorithms are designed to identify potential sensor malfunctions early, further safeguarding vehicular operations.

WP1 and WP2: Development of Monitoring Systems for Lens and Optical Modules

A comprehensive measurement system is being developed to monitor the condition of objectives and optical modules, focusing on key indicators such as sharpness and aberrations, especially under temperature fluctuations in aged components. The optic module monitoring system, still in development, combines a KUKA robot that moves a collimator to simulate different object angles for the optic module, allowing for MTF (modulation transfer function) calculation from images of a cross pattern. This process will track MTF changes over time, providing insights into sharpness degradation as the module ages.

The objective measurement system is fully assembled with a Shack-Hartmann wavefront sensor for measuring Zernike polynomials and the wavefront map and is currently undergoing final calibrations. It will measure objectives over time to quantify aging effects on performance. Using the data from both measurement systems, WP4 will train an algorithm to predict the remaining useful life (RUL) of lenses and optical modules.

WP3 Influence of Camera Properties on Object Detection

This work package investigates the influence of defocus on object detection performance. A measurement setup was developed to allow independent movement of the sensor from the objective, enabling data collection across static driving scenarios with defocus levels from -50 to +30 µm and distances ranging from 2 to 100 meters. The collected images were processed through various object detection models, analyzing recall and confidence metrics to defocus and object distance.

The findings demonstrated that sharpness significantly impacts detection accuracy at distances beyond 40 meters, while at closer ranges, object size reduces the influence of defocus on detection. A draft of a journal paper with these results has been submitted, and a response is currently awaited.

WP6 Field Sharpness Monitoring

In this work package, an analytical approach has been developed to estimate a blurring kernel for the camera based on images of traffic signs it captures. The process involves capturing an image of a traffic sign and selecting a slanted edge from the image, which is then compared to the corresponding edge on an ideal reference traffic sign. The modulation transfer function (MTF) of the camera’s slanted edge is compared with that of the ideal edge to identify the blurring kernel.

An initial kernel is estimated and applied to blur the ideal edge, followed by repeated MTF comparisons between the blurred ideal and the camera’s slanted edge. This iterative process continues until the two MTFs show acceptable similarity, resulting in the final estimated blurring kernel for the camera. This kernel not only reflects the current state of the camera's sharpness but can also be used to predict the remaining useful life of the optic module, providing a basis for future health assessments and monitoring in real-world applications.

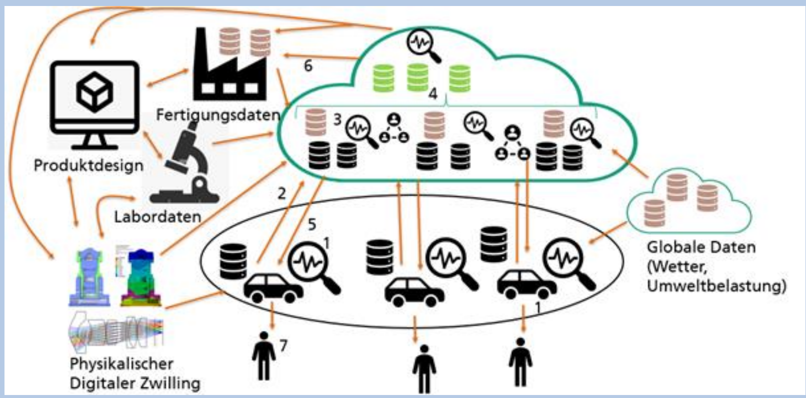

Fig. 2: Based on the manufacturing and laboratory data, an initial lifetime model "0 model" is installed on the vehicles by means of physical models, which assesses the functional state of the sensors based on the key indicators continuously measured via SelfX (1). The vehicles send their measurement data to the "Reliability Cloud" at periodic time intervals (2). In the cloud, an algorithm for anomaly detection and lifetime estimation is trained based on the data using machine learning "1-model" (3). A subset of relevant data is extracted and included in the training data pool. The "0-model" is replaced by the "1-model" in the vehicles (5). The failure and lifetime data will be transferred to the sensor manufacturer and OEM according to agreed usage rights, so that the product design and process can be improved (6). Vehicle users are continuously informed about the condition of their vehicles. Based on the continuously increasing data base, the lifetime model is periodically trained and updated on the vehicles as an "n-model".*
Source: THI

Fig. 3: Illustration showing (a) original scene with two cars, person and bicycle at \qty{40}{\meter} and objects detected by F-RCNN model for image captured at (b) 0 µm defocus (c) -30 µm defocus and (d) -40 µm defocus. A decrease in confidence score and increase in false negative with increase in defocus is seen.
Source: THI

Research Assistant in the AURORA project

M.Sc. Amit Pandey

Amit Pandey graduated with a master's degree in Automotive Engineering from Technische Hochschule in Ingolstadt in 2020. He has worked in the field of FEM and physical simulations previously. He is a researcher at the Institute of Innovative Mobility and currently he works in the research group of Prof. Gordon Elger and his focus is state monitoring of automotive cameras.

Funding reference number AURORA: 13FH7I12IA

Hinweis:
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