ArchitectECA2030

SC 4 Demo 4.4 Key Card

Automated Driving Demonstrator

Main aim	
This demonstrator focuses on Monitoring the ADAS function behaviour subjected to sensor anomalies and signal degradation. In doing so, the development and demonstration of ADAS functions capable of operating with at least two sensor sources and the fusion of the corresponding sensor information according to the status/quality of the respective sensor data are implemented. Moreover, a demonstration of a MonDev prototype on the overall automated driving system in a real demonstrator vehicle was implemented and tested for the representative use cases.	
Partner	*VIF*
ECS value chain	*OEM / Tier-1*

State-of-the-art	**Beyond SotA / Innovation**	**Targeted TRL**
• *No unified framework for run-time risk assessment on the overall automated driving system level* • *LKA & ACC typically work only with one sensor* • *Some new combined automotive sensor products include multiple sensor sources to achieve more robust object detection, which are implemented at component level rather than the system level*	• *Use of component and sub-system level quality metrics as a source of risk assessment* • *Demonstration of the overall concept for risk assessment and monitoring functionality on the whole automated driving system level* • *Monitoring of ADAS function behaviour subjected to sensor anomalies and sensor signal degradation and demonstration of the robustness of the corresponding ADAS functions under compromised conditions*	*Level 4-5*

Link to project objectives

Objective	***Addressed (Y/N)***	***How***
O1 – Continuous robust design optimization for each part in the ECS value chain	*Y*	*Continuous robust design optimization of the* ***environment perception system*** *(sensor fusion) feeding the ACC and LKA driving functions to improve their main behavior competences including all layers (SC: Radar Sensor Controller ->* ***C: Radar Sensor -> SS: Perception System (Sensor Fusion) -> SS: ACC/LKA behavior competence -> S: vehicle****)*
O2 – Framework for safety validation of ECS value chain	*Y*	*The combination of the two developed safety validation frameworks (****first: addressing the needs of S, SS and C layers*** *and second: specific needs of the SC layer) cover the entire ECS value chain.*
O3 – Identification & management of residual risks over the entire ECS value chain	*Y*	*Identification and management of residual risks on SC (Radar Sensor Controller) and C (Radar sensor) level ->* ***management of the residual risks on SS (Perception System - Sensor Fusion) and S level (reduced ODD and behavior competences of the ECA vehicle).***
O4 – End-user acceptance by trustworthy ECS value chain	*Y*	*Improved ADAS/AD robustness and fault tolerance by using redundancies and monitoring device thereby reducing driver handovers.*
O5 – Zero emissions, zero crashes, zero congestions by ECA2030-car	*Y*	*Improved reliability of the ADAS/AD Systems reducing accidents caused by human error (approx. %90 of the accidents).*

Joint demonstrator (JDEM1)					**Linked supply chains (Y/N)**		**Considered MonDev layers**	
DEM1.2	**DEM1.3**	**DEM4.1**	**DEM4.2**	**DEM4.4**	**SC1**	Y	**System (S)**	Y
					SC2	N	***Subsystem (SS)***	*Y*
					SC3	N	***Component (C)***	*Y*
					SC4	Y	***Subcomponent (SC)***	*Y*

Setup

Demo 4.4 was developed by VIF and the demonstration concept and building blocks are represented in Figure 1 *and the ADD test vehicle where the implementations were made are shown in* Figure 2*. The test vehicle includes full access to all vehicle controls. The driving functions (ACC and LKA) utilized in the scope of the demonstrator have been developed in former projects, however they were adapted to utilize multiple sensor sources and the corresponding sensor fusion solutions. Sensor fusion approaches were implemented in high level programming languages, cycle times and the delays of the algorithms were measured. The MonDev concept utilized in the demonstration was based on Demo 1.3 from SC1. In doing so, sensor and component-level health status and quality information were utilized as a basis for risk assessment and monitoring functionality as also illustrated in* Figure 1*.*

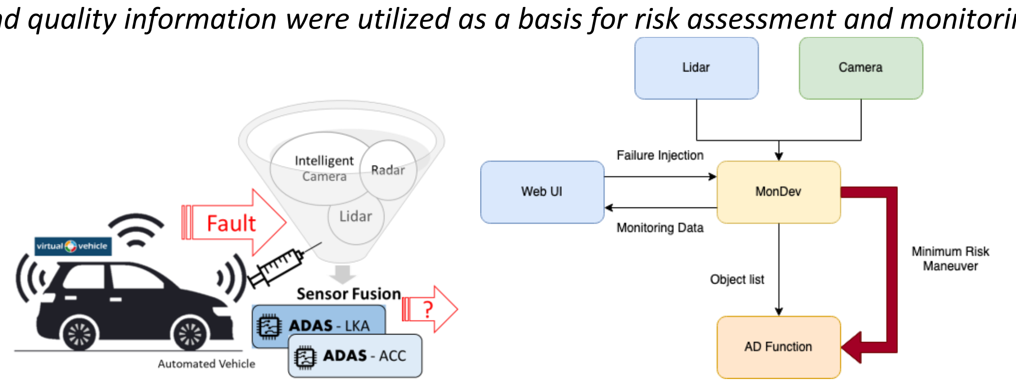

Figure 1: Setup and the demonstration concept of the Demo 4.4

Figure 2: VIF's generic Automated Driving Demonstrator (ADD) vehicle

Benchmark scenario/mission/etc.

The Demo 4.4 utilizes synthetically induced failure to assess the performance of the corresponding ACC/LKA driving functions utilizing the system level (i.e., the whole vehicle) MonDev concept. The goal is to monitor potential system failure in sensors as depicted in Figure 3 *to initiate handover to a fallback sensor or a driver handover based on certain risk levels. A cumulative risk assessment logic (*Figure 4*) with forgetting was implemented to keep track of inherent risks and to initiate corresponding fallback or maintenance actions. The initial development of the risk assessment methodology was performed in the scope of the Demo 1.3, which is the simulation interpretation of the Demo 4.4, as shown in* Figure 5.

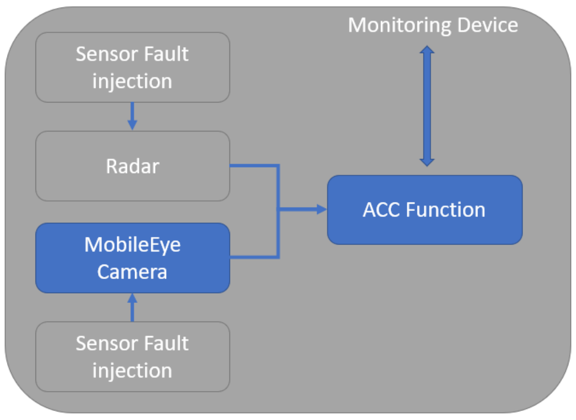

Figure 3: Test scenario for MonDev on the full vehicle level

$$Risk_{t,n} = \sum_{i=1}^{m} w_i r_i$$

Figure 4: Cumilative risk assessment

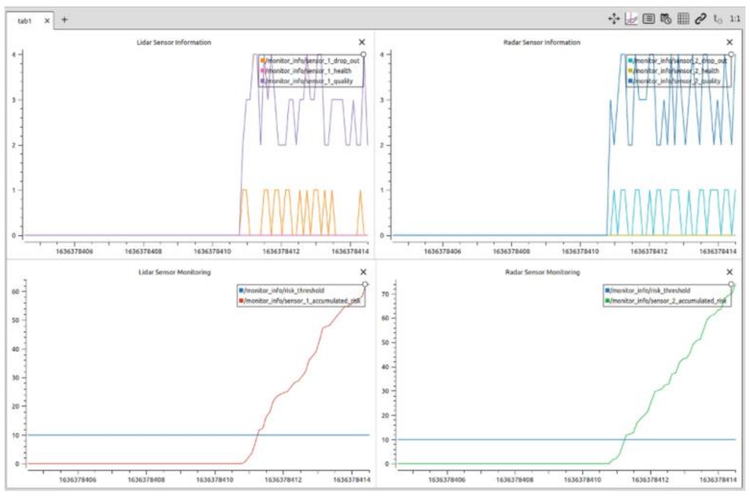

Figure 5: Simulation implementation of risk assesment methodology

KPIs (related to requirements)

KPIs which evaluate the success of the demonstrator in line with the stated requirements

- *The time the driving function can operate despite the sensor errors*
- *Number of driver handover requests*
- *Driving function performance as compared to state-of-the-art systems*

Baseline

Baseline for KPIs:

- *LKA & ACC typically work only with only one sensor without redundancy*
- *In most SAE Level-2 AD examples on the market, any sensor problem leads to an instantaneous driver handover*

Evaluation

*Evaluation platform – Vehicle implementation and testing using the VIF's ADD test vehicle (*Figure 2, Figure 7*)*

Current status/demonstration

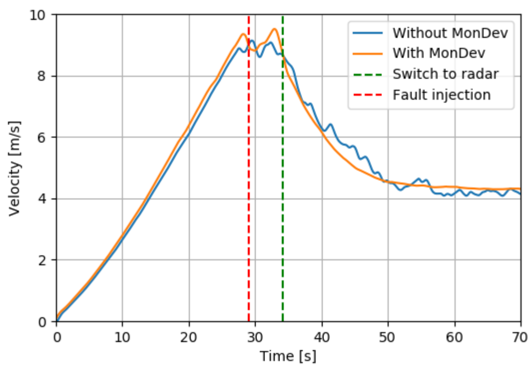

Figure 6: Switch from camera to radar as sensor source in a simulated ACC scenario

Figure 7: Demonstration event for the Demo 4.4

Demo Video: [VIRTUAL VEHICLE ArchitectECA2030 Demonstrator (youtube.com)]

Next steps (timeline)

- *Dissemination of the results as conference and journal publications*
- *Analysis and potential extension of the risk assessment methodology beyond TRL 4-5*
- *Further utilization in other research projects*

Impact

Monitoring of the ADAS function behaviour subjected to sensor anomalies and signal degradation and demonstration of a MonDev concept on the overall automated driving system level on a full vehicle real-life demonstration.

Used standards

- *SAE-J3016; SAE-J3018, SAE J3088*
- *ISO 11270; ISO 17361; ISO 17387; ISO 26262*
- *UNECE/TRANS/WP.29/2020/81*
- *ISO/PAS 21448*

These standards are the international norms relevant to the developed driving functions. The functional conformity to the related standards is outside the scope of the project. These serve only reference purposes.

Future standardization potentials

- *Virtual testing and homologation of ADAS/AD Systems*
- *Having redundant or multi-model sensor configurations as an "object and event detection and response" (OEDR) requirement for improved functional safety of ADAS/AD systems*
- *MonDev as an integral part of the automated driving software stack to monitor the runtime system behaviour of the system*

ECSEL JU

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