Newsletter Year 3

February 2023

ArchitectECA2030

Trustable architectures with acceptable residual risk for the electric, connected and automated cars

ArchitectECA2030 project aims to provide a harmonized pan-European validation framework enabling mission-oriented validation of electronic components and systems (ECS) for electric, connected and automated (ECA) SAE L3 to L5 vehicles to improve reliability, robustness, safety and traceability.

Project Facts

Project Coordinator:
Dr. Georg Stettinger
Infineon Technologies Germany AG

Project Start: 01.07.2020
Duration: 42M
Total investment: ~€M 13
Requested EU contribution: ~€M 4
Requested National cont.: ~€M 3

Participating organizations: 20
Number of Countries: 8

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SC4: Methods for monitoring and/or automated driving

The aim of SC4 is to work on and demonstrate a concept for a monitoring device along the ECS levels for detecting faults and assessing risks for safety, security, privacy supporting on overall system architecture. SC4 demonstrators focus on monitoring methods to address failure modes, fault detection and residual risk during the operating lifetime for safety, security, and privacy supporting an overall system architecture. Within the last project year, partners elaborated a concrete example based on three of the SC4 demonstrators which also have a connection to two Demonstrators in SC1. Related demonstrators:

- D4.1: Hardening automatism for Power or Motor Control Design
- D4.2: Lifetime Drift Model for Discrete Parameters
- D4.3: Virtual Verification & Validation Framework
- D4.4: Automated Driving Demonstrator
- D1.2: Robust physical Sensors
- D1.3: Robust virtual perception

Demonstrator D4.1, which operates on the subcomponent level, contributes a hardening mechanism investigating failure propagation during which bit-flips are detected. Demonstrator D4.2, which also operates on the subcomponent level, develops a model for the lifetime drift of discrete data. The bit-flip counter is such a discrete parameter that changes over time. More bit-flips in the same time interval are an indication of degradation. Therefore, the model from demonstrator 4.2 can be applied to the data from demonstrator D4.1. The benefits are reduced residual risk and a remaining useful lifetime can be calculated with quantified uncertainty.

Based on this information, some action can be proposed by the decision system, e.g., preventative maintenance can be scheduled. If exceedance lies further in the future, the part may be automatically replaced during routine maintenance. An autonomous car may drive to maintenance itself to get serviced if expected RUL becomes too short. Interval estimations offer more room for safety targets.

The model, developed in D4.2, is based on discrete transition kernels in a semiparametric Markov model (Figures 1, 2).

$$D_k := X_k - X_{k-1}$$
$$D_{\Sigma_k} := D_1 + \ldots + D_k$$

$$D_{\Sigma_k} | (D_{\Sigma_{k-1}} = j) \sim d\left(\frac{\widehat{D_k} - \alpha_1(j)}{\alpha_2}\right)$$

$$D_{\Sigma_k} = \beta_0 + \beta_1 \cdot D_{\Sigma_{k-1}} + \epsilon_k$$

$$d(x) = \int_{x-0.5}^{x+0.5} \frac{1}{n} \sum_{i=1}^{n} K\left(\frac{x - x_i}{h}\right) dx$$

Fig. 1 Function

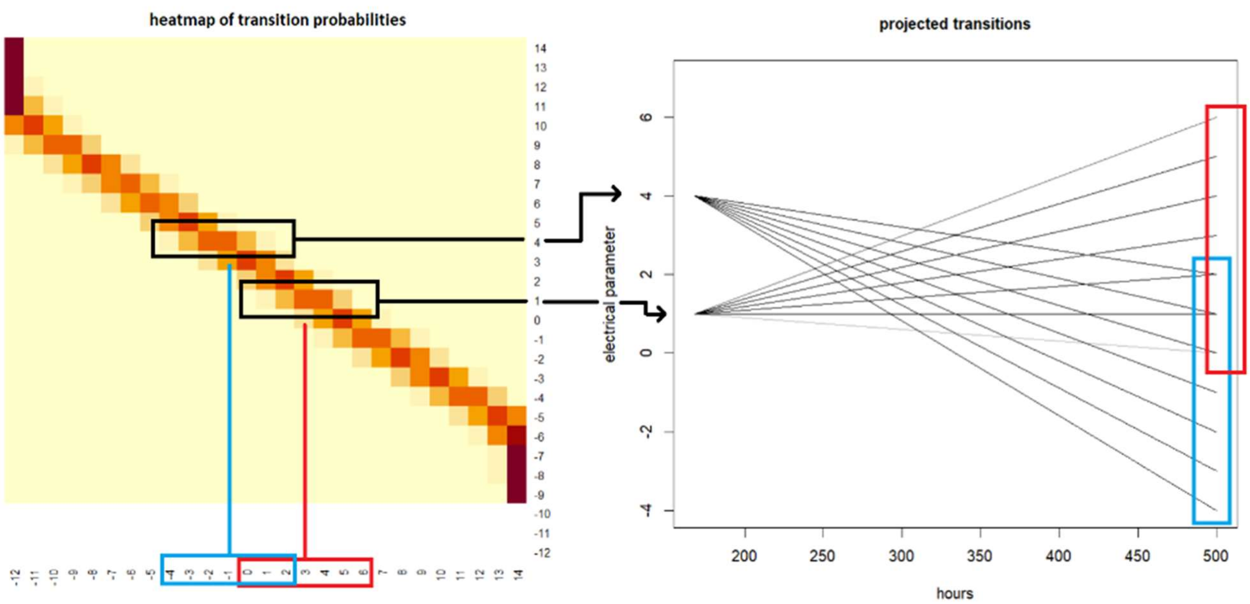

Fig. 2 Heatmap of transition probabilities and projected transitions

In D4.3, in the first half of project year 3, 30.000 test cases were executed in the virtual co-simulation framework with a vehicle making use of an AEB (automatic emergency braking) function to avoid critical scenarios and crashes with other objects moving or placed on the driving road or close environment. By making use of the complex scenario generator, use cases with 5 different types of possible crashes were conducted in the simulation framework. A use case model parameter setup with a strength of t=3 enabled a detailed analysis of model parameters leading to a critical scenario. With the applied novel CT method, 4 different simulation model parameters were identified leading to crashes with a high probability for the provided scenarios. All four deciphered model parameters are related to the starting speed of the ego vehicle and the three moving objects (vehicle, pedestrian) in the environment. A detailed analysis of the simulations (video, signals, parameter) related to the identified parameters tuples has been started and will provide a precise evaluation of the achieved results.

Next Steps:

- Analysis for 4-way tuples based on 3-way results
  - Limited validity
- Further investigate highly suspicious 3-way tuples.
  - New test suite of packed suspicious tuples (~9.000 tests)
  - New tests for eliminating low suspicious parameters/values
  - New tests for hardening suspiciousness of highly susp. tuples
  - Reduction of IPM based on existing results.

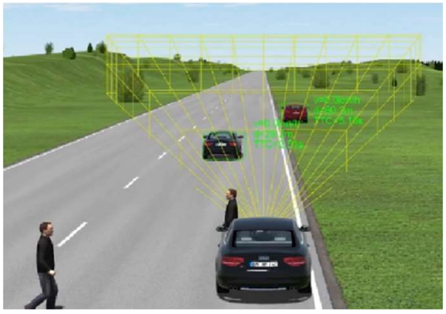

Fig. 3 Simulation

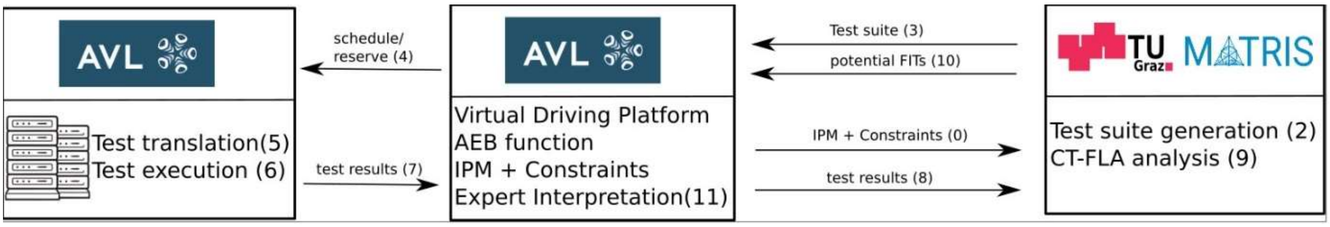

Fig. 4 Colaboration process description

The Demonstrator 4.4 'Automated Driving Demonstrator' will utilize 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 of this demonstrator is to monitor potential system failure in sensors to initiate a fallback sensor or a driver handover based on certain risk levels.

The demonstrator concept and building blocks are represented in Figure 5 and the ADD test vehicle where the implementations will be made are shown in Figure 6.

We developed a MonDev concept on a complete automated driving system level and created a simulation environment (Demonstrator D1.3) to show its benefits. Development and set-up of the simulation framework were finished, and first simulation studies are conducted including the analyzation of the results.

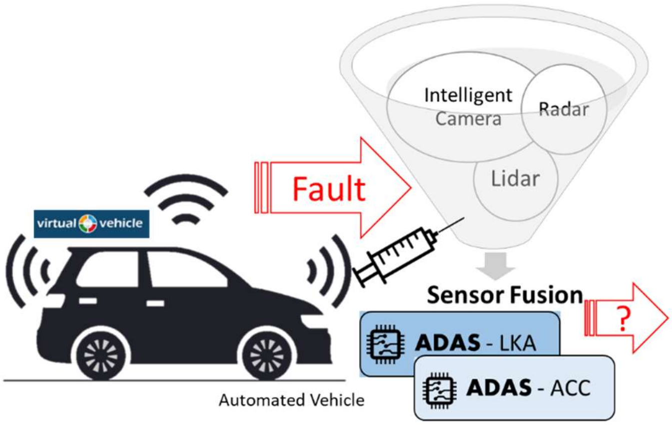

Fig. 5 Setup and the demonstration concept of the Demo 4.4

Fig. 6 VIF's generic Automated Driving Demonstrator (ADD) vehicle

Description of the use case scenario

VIF implemented use cases inspired from ACC/LKA testing and validation standards such as the ISO 15622:2018(E) and UN Regulation No. 157 as shown in Figure 7. Virtually injected failure into sensor signals as seen in Figure 8 with potential accumulation into acceptable risk threshold as shown in Figure 9. This information can consequently be utilized to keep the driving function running or to initiate a minimum risk maneuver.

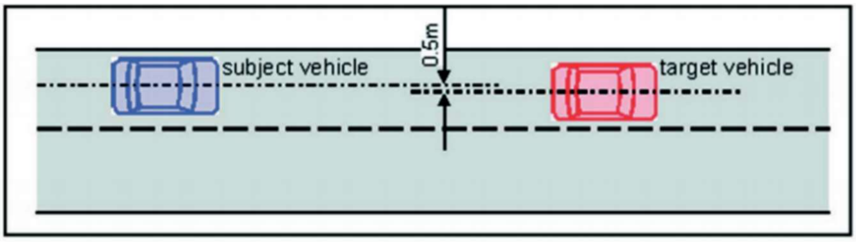

Fig. 7 Setup and the demonstration concept of the Demo 4.4

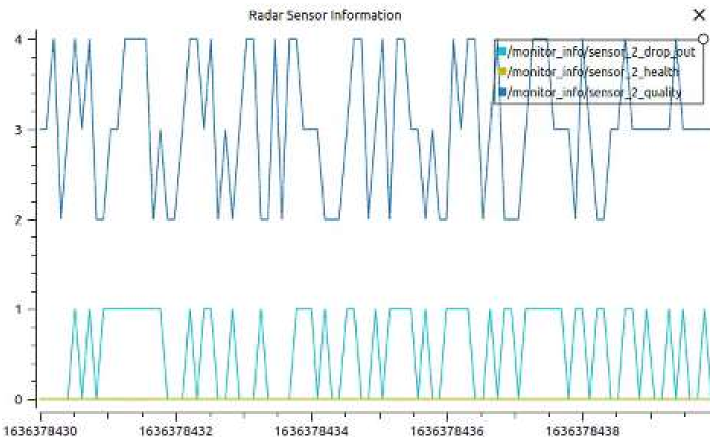

Figure 8: Failure injection on simulated sensor signals

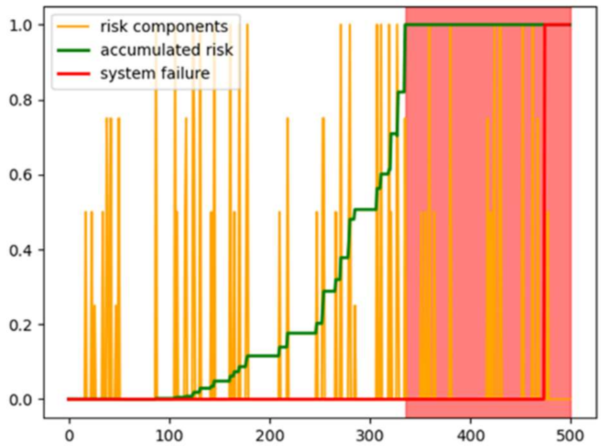

Figure 9: Risk accumulation in time sensor signals

Results

The implementation of the MonDev concept and the corresponding results were demonstrated using two example use cases in the simulation framework. The results show that proposed MonDev can not only increase driving comfort but also reduce driving risks in case of sensor degradation/failure, as shown in Figures 10 and 11.

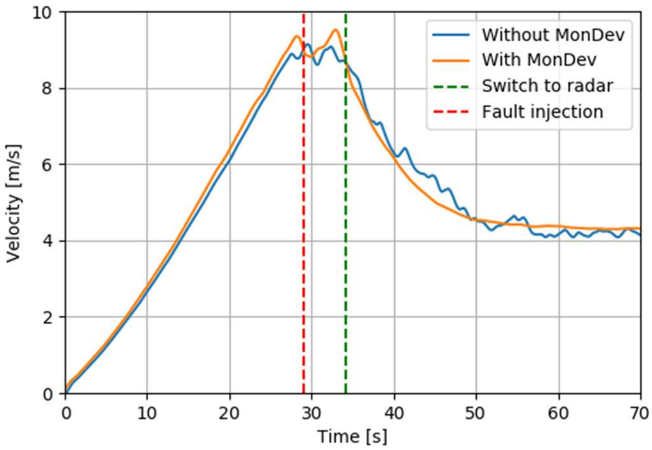

Figure 10: Switch from camera to radar as sensor source

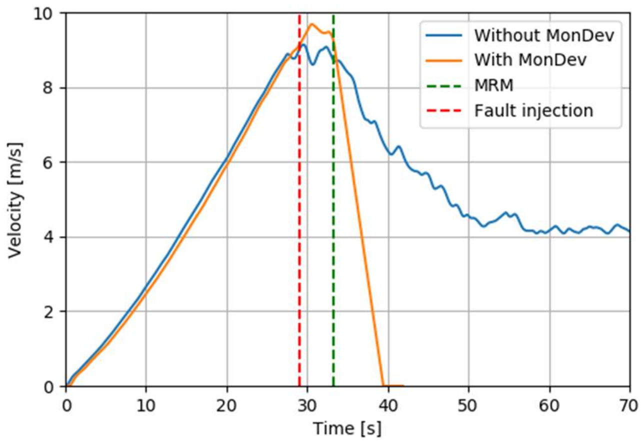

Figure 11: Initiation of a minimum risk manuever by the MonDev as result of excessive risk accumulation due to failure injection

DISSEMINATION

The Research-related Publications

K. Tong, S. Solmaz, Haris S. and Jakob R., 'A Generic Risk Assessment Methodology and its Implementation as a Run-time Monitoring Device for Automated Vehicles', Transport Research Arena (TRA2022), Lisbon, Portugal, 2022, (To appear at Elsevier Transportation Research Procedia in 2023).

K. Tong, S. Solmaz and M. Horn, 'A Search-based Motion Planner Utilizing a Monitoring Functionality for Initiating Minimal Risk Maneuvers,' 2022 IEEE 25th International Conference on Intelligent Transportation Systems (ITSC), 2022, pp. 4048-4055, doi: 10.1109/ITSC55140.2022.9921913.

Conference Presentations

19-20 May 2022, Presentation 'Stochastic Drift Model for Discrete Parameters' at the European Network for Business and Industrial Statistics (ENBIS), Spring meeting, Grenoble, France.

26-30 June 2022, Presentation 'Lifetime Drift Model for Discrete Data for Semiconductor Devices' at the European Network for Business and Industrial Statistics (ENBIS), Annual Conference, Trondheim, Norway.

28-30 July 2022, Presentation 'A Semiparametric Transition Model for Lifetime Drift of Discrete Electrical Parameters in Semiconductor Devices' at 4th International Conference on Statistics: Theory and Applications (ICSTA 2022), Prague, Czech Republic.

FUNDING

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