Automated Testing in Automotive Software Development using Vehicle System Simulation

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Motivation: Frontloading in ECU Development

- MiL
- HiL
- SiL

Defect Occurrence
Defect Repair
Motivation: Extend Testing Capabilities in the Lab

Example ADAS application: LDW/LKA/autonomous steering

- Stimulating a camera-based ADAS can be a lot of work!
- Examination of steering controller (LKA, autonomous steering) requires closed-loop testing
Motivation: Extend Testing Capabilities in the Lab

Example application vehicle dynamics: 4WD control

Vehicle Simulation offers:
- Consistent stimulus for ECU
- Closed loop operation:
  - Test controller influence and behaviour
  - Assessment of control quality
  - Pre-Calibration
  - Prepare on-road tests
  - Examine controller changes during on-road-tests

Pushing Innovation
HiL Closed Loop Test Environment for 4WD ECU

Windows PC

XCP calibration & measurement

RBS & maneuver manipulation

maneuver & vehicle states

maneuver selection

DYNA4 Task
Maneuver & road parameter datasets

DYNA4 Vehicle simulation model

Restbus (CAPL)

CANape

CANoe

Vector VN 7600

CAN/FR

Feedback values

Wheel speeds, …

Integrated SW on ECU
Test Automation

Automation project execution

- Load vehicle data & maneuver
- Run test
- Report generation
- Sync test spec and results with requirements
DYNA4 Vehicle and Maneuver Data Management

Vehicle Model & Parameters

Tasks

Dataset Export

Slalom Double Lane Change Circle Race Track
HiL Closed Loop Test Environment for 4WD ECU

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Export

CANape

Restbus (CAPL)

CANoe

DYNA4 Framework

Vector VN 7600

CAN/FR

Feedback values
Wheel speeds, …

Integrated SW on ECU
SiL Closed Loop Test Environment for Virtual ECU

Windows PC

Test Automation

DYNA4 Framework
Test definition, execution & evaluation

 Parameterization Internal Signals Output Signals

Road Data Vehicle Data Virtual Test Driver

DYNA4 Vehicle Simulation Model

Rest-bus

Feedback to Model

SWC 1 Model
SWC 2 (VDC) S-Function: Generated C-Code
SWC 3 Model

SWC 4 (BSW) Simplified Model

Virtual ECU

Pushing Innovation
MiL Closed Loop Test Environment for ECU Model

Test Automation

Windows PC

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Rest-bus

Feedback to Model

ECU Model

- Test definition, execution & evaluation
- Parameterization Internal Signals Output Signals
- Road Data Vehicle Data Virtual Test Driver
- Rest-bus
- Feedback to Model
Test Tasks: Run Maneuvers

Postprocessing Tasks:
- Generate reports
- Summarize results of multiple tests
Software Development Process with Vehicle Simulation

DYNA4 Task
Maneuver & road parameter datasets

SW development

SiL Test

HiL Test

Vehicle verification

Bug report

SW code generation

SW integration

Pushing Innovation
Conclusions

- Advantages of vehicle system simulation
  - Quick validation of SW features with different vehicle variants
  - More Bugs can be found & fixed earlier (Front-Loading)
    $\rightarrow$ High SW quality & maturity

- Advantages of the presented test environments (MiL, SiL, HiL)
  - Reuse of models, maneuvers & tests throughout development process
  - Engineers keep the tools they are used to:
    - Tight integration DYNA4 – CANoe
  - Portability, always available
  - Highly automated and reproducible test execution

More: www.tesis.de/canoe