Model based testing in parking assistance systems

Vector Congress (28. – 29.11. 2012)
Model based testing in parking assistance systems

Agenda

- Parking assistance systems
- Organisation
- Applicable Tools
- Challenges
- Model based testing
- Test development with Open Test
- Outlook
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Parking assistance systems

Parking Aid

Parking Assistant

Side View Assist (SVA)

Side Distance Warning
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Products

Ultrasonic Sensor

- USS w/ range up to 2.5 m
- USS w/ range up to 4.5 m

PP-Front

PSC, SVA, SDW

PP-Rear

SVA, SDW

ECU

Park Pilot ECU

Automotive Electronics

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# Model based testing in parking assistance systems

## Test organisation

<table>
<thead>
<tr>
<th>Where?</th>
<th>Who?</th>
<th>How?</th>
</tr>
</thead>
</table>
| Laboratory | Developer | Unit test environment  
Complete SW env. |
| Laboratory | Test engineer | Hardware in the loop  
environment |
| Vehicle | Appl. engineer | Manually, supported by Application Tools |
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Applicable Tools

Test planning
Requirements Management
Test Design
Test execution
Test reporting
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Test execution environment

- GPIB
- USB
- CAN
- Ethernet
- A2L
- XCP

Vector CANdb++ Editor - C:\CANoe\G

Audio_Master_Amplifier_Nuts (0x066a)
Audio_Master_Amplifier_Setting (0x067a)
Audio_Master_Arbitration_Command (0x068a)
Audio_Master_Source_Status_LS (0x072c)
Audio_Source_Status_LS (0x076b)
Auto_High_Beam_Status (0x1e4a)
Aux_Coolant_Heater_Status_LS (0x130a)
Auxiliary_Heater_Actor_LS (0x37e8)
Auxiliary_Heater_Status_LS (0x066a)
Battery_Voltage (0x124a)
Bidirectional_Remote_Info_1_LS (0x383a)
Challenges (technical)

→ Electrical / Electronical interfaces:

- Up to 12 sensors, each sensor 10 possible failures
- ~35 input signals
- ~100 CAN failures (timeout, invalid, …)
- ~100 diagnostic services
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Challenges (technical)

- System complexity:
  
  - Complex scenarios for activation (~ 4000 use cases)
  
  - approx. 20 different fault reactions, dependent on failure severity and affected function
  
  - Different Human Machine Interfaces for different customers (discrete / CAN)
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Challenges (timing)

- High amount of projects with short project duration (30 – 40 customer projects running in parallel)

- approx. 40 Software release candidates each project

- 2-4 variants each release candidate

- High amount of software changes during project development
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Challenges (organisational)

- 3 domains involved in testing

- Independent test domain

- Worldwide software and test development (Germany, India, Hungary)

- Platform development

- CMMI / A-Spice compliance
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Expectations

Test should...

... be reusable
... be reproducible
... find defects
... be referenced to requirements
... require little resources
... be independent from development
... be reviewed

Requirement Specification

Test Result

- Error prone
- High effort for maintenance
- High effort for variant development
- Dedicated to a test system
- High effort for reviews (Design and Specification)

+ Finds also defects which are not in direct focus of test case
Automated testing (2008)

Reproducible

Fast regression testing

Automated report generation

High effort for maintenance

Specific knowledge for test automation necessary

High effort for reviews (Design and Specification)
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Model based testing (2011)

- Review on design level (visualisation) without domain specific knowledge
- Attractive role “test designer”
- Easy to maintain: changes are only done in model
- Test design reusable for different customer projects
- Automatic generation of test specification and test script out of model
- Main effort in test design
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Model based test development

- Product Requirements
- Test design
- Test specification
- Test script (XML)
- Test report
- Test catalogue

Open Test

CANoe
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Open Test History

→ Initial development by Bosch (AE / EMS)

- Evolved from practice

→ Internal decision to commercialise Open Test together with Vector:

- Bosch focus is on testing

- No support network
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Open Test at a glance

Test design model

Classifications
System Inputs and Outputs

Mapper Classes
HIL specific mapping of Classifications

public enum PowerMode { Off, Accessory, Run, CrankRequest }
public enum Gear { Park, Reverse, Neutral, Forward }
public enum TrailerHitch { Off, On }
public enum Turn_Indicator { Neutral, Left, Right }
public enum Ambient_Light_Level { Daytime, Nighttime, Unknown }
public enum LED_State { Off, On, Blinks }
public enum ButtonState { ShortPress, LongPress, Push, Release }

initialize = TestFunctionFactory.CreateInitialize();
initialize.signalName = "rbbpGear";
initialize.Value = String.Format(CultureInfo.InvariantCulture, "{0}",
    ctRow.Gear.Value == Gear.Reverse ? "Reverse Range A" : 
    ctRow.Gear.Value == Gear.Park ? "Park Range" : 
    ctRow.Gear.Value == Gear.Reverse ? "Reverse Range" : 
MultipleInitialize.SignalInits.Add(initialize);

Graph

Framework
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Example: Create test design

- Create diagramm
- Attach requirements to elements
- Write transfer functions

```java
public void StateTransition_2e699c0a_e692_4031_8042_9b4
{
    transfer.SetGear(GearStates.Reverse);
}
```

```java
public void ECU_State_7343e68b_aa35_4499_ab37_6f836248753(ITable transfer, IOutputService outputServ
{
    transfer.CheckSignal(signal:"PH_Systemzustand",value: "Anlage durch einlegen R-Gang aktiviert");
}
```
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Outlook

➔ Focus on worldwide Roll-Out

➔ Establish standard test designs for all customer projects

➔ Add test script generation for Real time HIL system
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- Wiper Systems
- Engine cooling
- Pumps & Valves
- Actuation systems
- eBike
  - Batterie (BMS) & Drive Unit (DU)
- Battery management
Model based testing:

Main effort in test design, review without domain specific knowledge
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Thank you for your attention