From rapid prototyping up to release tests – CarMaker in the ESC development process

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From rapid prototyping up to release tests

Agenda

1. Motivation
2. Requirements to a simulation environment
3. ESC* system overview
4. Simulation within ESC development process
5. Conclusion & Outlook

*ESC: Electronic Stability Control
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Motivation

Advantages of simulation within the ESC development

- TestRun database ➔ Reuse of defined test cases
- Limited vehicle availability ➔ Focus on performance application
- Transfer of selected vehicle tests into simulation ➔ Increase test depth and reduce development costs
- Independence of environmental test conditions ➔ Proving ground, weather, vehicle condition, reproducibility
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Requirements to a simulation environment

Requirements to a simulation environment

- Intuitive manoeuvre definition → Less time for training
- Visualization of simulation results → Focus on vehicle behaviour
- Universal manoeuvre definition → Same test cases for all sim. environments
- Generic manoeuvre definition → Same test cases are applicable for all projects
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ESC system overview

The components of Bosch ESC

1. Hydraulic unit with attached control unit
2. Wheel-speed sensor
3. Steering-angle sensor
4. Yaw-rate and lateral acceleration sensor
5. Communication with engine management
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Simulation within ESC development process

System Req. & Design

Software Req. & Design

Module specification

Implementation

System test

Integration test

Module test
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Simulation within ESC development process

- System Req. & Design
- Software Req. & Design
- Module specification
- Module test
- Integration test
- System test

Rapid prototyping

- Feasibility analysis
- Making ideas visible
- Reduction of development time

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Simulation within ESC development process

- System Req. & Design
- Software Req. & Design
- Module specification
- Module test
- Integration test
- System test
- Development Environment

- Rapid prototyping
  - Feasibility analysis
  - Making ideas visible
  - Reduction of development time

- Implementation
  - Verification of the algorithm
  - Check coding errors
  - Data overflow

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Simulation within ESC development process

- System Req. & Design
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Rapid prototyping

- Feasibility analysis
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Development Environment

- Validation of component req.
- Verification of signal chain
- Boundaries of interfaces

Implementation

- Verification of the algorithm
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Simulation within ESC development process

- **Vehicle**
  - Hardware-in-the-loop
  - Validation of system req.
  - Using target hardware
  - Final release tests

- **Software-in-the-loop**
  - Validation of component req.
  - Verification of signal chain
  - Boundaries of interfaces

- **Development Environment**
  - Verification of the algorithm
  - Check coding errors
  - Data overflow

- **Rapid prototyping**
  - Feasibility analysis
  - Making ideas visible
  - Reduction of development time

- **System Req. & Design**
  - Module specification

- **Software Req. & Design**
  - Module test

- **Integration test**
  - System test

- **System test**
  - Final release tests

- **Implementation**
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Rapid prototyping

→ Idea becomes visible in the earliest stage of development
→ Confirmation of technical feasibility
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Software-in-the-loop

- Verification of integrated module within Application Software
- Focus on: Signal chain, interactions to other modules, interfaces

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Hardware-in-the-loop

Verifying and validation of the complete ESC Software
Focus on: Functional implementation and requirements on system level
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Vehicle

- Verification and validation of the complete ESC Software
- Focus on: Performance and requirements on vehicle level
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Test concept

1. Definition of test cases

2. Configuration Management

3. Project-specific execution

Test Series y

TestRun x

TestRun #n
TestRun #2
TestRun #1

HiL
SiL

: project-specific

: project-independent

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Use cases @ BEG

Making ideas visible (Emergency Brake Assist)

Save development costs (Launch Control)

Event triggered manoeuvre (Hill Hold Control)

µ=0.1
µ=1
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Conclusion & Outlook

**Conclusion**

Uniform GUI across all simulation environments → Save time for training, consistent test definition, wide usage of simulation

Defined test cases can be used in different projects → High reusability increases test depth and reduces development costs

Event triggered manoeuvre definition → Simple implementation of complex driving manoeuvre

**Outlook**

Universal test automation → Consistent concept for automatic manoeuvre execution in SiL and HiL
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Thank you for your attention

Questions?