Testing the Unexpected: New Frontiers in Automotive Development

Stuttgart
04.12.2017
Efforts in development and validation

Engine & Transmission

User

Assistance

Safety

Standards and laws on CO₂ / NOₓ / Noise

2015
Viewpoint of Supercomputing

2015

Thermodynamics (CFD)

Crash (FEM)

Fluidodynamics (CFD)
Efforts in development and validation

2025

- User
- Engine & Transmission
- Safety
- Assistance
- Standards and laws on CO$_2$ / NO$_X$ / Noise
Viewpoint of Supercomputing

2025

Engine & Transmission

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Standards and laws on CO$_2$ / NO$_x$ / Noise
Challenge: algorithm-based decision making

Assistance (ADAS)
Testing the Unexpected:
Model-based system validation
Model-based development ‘til 2015

Requirements
- Stakeholder management
- System integration
- System verification
- Distributed systems
- IoT

Workflow
- Collaborative development
- Coupled systems
- Autonomic computing

Modellierung / Simulation
- LifeCycle management
- Interfaces
- Cybernetics
- Cyber-Physical Systems
- FMI
- FMU

Model-based development until 2015

Confidential
Model-based development ‘til 2015

- Requirements Management
- LifeCycle Management
- Interfaces
- FMI
- Cyber Physical Systems
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Requirements

- Stakeholdermanagement
- System Integration
- System Verification
- Collaborative development
- Coupled Systems
- Distributed Systems
- Autonomic Computing
- IoT
- MBSE
- Model-Based Systems Engineering
- Cognitive Systems Engineering
- Self-organizing Systems

Workflow

Model / Simulation

Data

- Self-Learning
- Big Data
- Artificial Intelligence
- Test-Data Management
- Customer Data
The development process

Development of
Advanced Driver Assistance Systems

Road tests

Unspecified virtual test scenarios

Known basic virtual test scenarios
Our approach

Fortissimo 2 Experiment 908
Massively Parallel Virtual Testing of Safety-Relevant Driving Systems

ISV & Domain expert: Spicetech GmbH
HPC expert: XLAB d.o.o.
HPC centre: Höchstleistungsrechenzentrum Stuttgart
End-user: Automotive suppliers / Car manufacturers represented by Valeo and Porsche
Challenge 1: Scenario modeling

Intensity of ambient light (Var A)
Density of fog (Var B)

Classification of Object A

Classification of Object B

- Speed of object B (Var C)
- Color of object B (Var D)
- Color of lane marks (Var E)
- Texture of pavement (Var F)
- Color of pavement (Var G)

image source: www.pexels.com
Challenge 2: Multi-dimensionality

- strictly $n$-dimensional data model
- pre- and postprocessing separated to condense results
- systematic quantification of variational space
- MPI-parallel scenario distribution
Challenge 3: Machine Learning

- validation basis: broad grid in $n$-dimensional space
- fast explorer: based on local support vector machines
- systematic enhancement of validation: test prioritization by uncertainty / cost function
Key benefits

• Service gives fast and reliable feedback for functional development and maturity of systems

• Iterative improvements of systems leads to multiple usage of service

• Service will significantly reduce on road testing costs and time

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