Using Virtualization to Accelerate the Development of ADAS & Automated Driving Functions

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Motivation
Virtual Prototypes
Virtual Sensor Models
CarMaker and NVIDIA® DRIVE™ PX 2
Conclusion
Motivation

Virtual Prototypes

Virtual Sensor Models

CarMaker and DRIVE PX 2

Conclusion
Safety-Critical Functions Must Not Fail!

Testing in countless everyday situations

Millions / billions of km necessary to release functions in real-world tests

Changes to the software (code or parameters) \( \rightarrow \) Start testing again!
VIRTUALIZATION TO ACCELERATE THE DEVELOPMENT OF ADAS & AUTOMATED DRIVING FUNCTIONS

Motivation

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CarMaker and DRIVE PX 2

Conclusion
Automotive Systems Engineering in the Development Process
Providing internal departments + suppliers with virtual prototypes

Engineers can test and release their systems in a full vehicle: automotive systems engineering!
Automotive Systems Engineering in the Development Process

Using virtual prototypes throughout the entire development process

Same maneuvers + same evaluation criteria

Reuse of virtual prototypes and maneuvers saves time and costs
Test Scenario

Definition

Dynamic objects
CARS, TRUCKS, PEDESTRIANS, ...

Virtual prototype
AD FUNCTIONS, (SUB-) SYSTEM MODELS, DRIVER, ...

Static objects
TRAFFIC SIGNS, BUILDINGS, ROAD INCL. MARKINGS, ...

Environmental conditions
LIGHTING, TEMPERATURE, PRECIPITATION, ...

Surrounding of virtual prototype
USING VIRTUALIZATION TO ACCELERATE THE DEVELOPMENT OF ADAS & AUTOMATED DRIVING FUNCTIONS

Motivation

Virtual Prototypes

Virtual Sensor Models – Radar as Example

CarMaker and DRIVE PX 2

Conclusion
Use Case-Specific Sensor Models

Overview

The use case drives the level of detail:

- Ideal Sensors for rapid prototyping / proof of concept
- HiFi Sensors for function development & testing
- Raw Signal Interface for component / signal processing development & testing

Use case-specific sensor models for real-time simulation!
Do the algorithms work?

Requirements:
- Function interface (e.g. object list)
- Technology-independent
- Easy to parameterize

Does the function generally work?

Requirements:
- Function interface (e.g. object list)
- Technology-specific
- Physical phenomena
- Processing/Target selection included

Does the sensor component work?

Requirements:
- Raw signal interface
- Technology-specific
- Detailed physical effects
Suitable Sensor Models for Every Use Case
Ideal Sensors for verification and early development phases

- **Scenario**
- **Function / Fusion**

<table>
<thead>
<tr>
<th>Ideal Sensor</th>
<th>HiFi Sensor</th>
<th>RAW Signal Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information extraction</td>
<td>Propagation reduced to essentials</td>
<td>Signal propagation</td>
</tr>
<tr>
<td>Object selection</td>
<td>Target selection</td>
<td>Processing / tracking</td>
</tr>
</tbody>
</table>
Object and Line Sensor

Highlights

- Object sensor detects and tracks surrounding traffic
  - Object list
  - Relevant target
- Line sensor generates object list of lane boundaries
  - Road markings
  - Traffic barriers
- Application areas
  - ACC, LDW, LKA, …
Features:
- Detection based on SNR including occlusion
- Antenna gain
- Object RCS
- Propagation loss
- Object fusion based on resolution cell
- Latency, noise
- False negatives
- (False positives)

Outputs:
Object lists with
- Relative position / velocity / acc
- Classification of object / dynamics / confidence
- Probability of existence / obstacle
- Received power / RCS / SNR

Radar Sensor
Radar RSI – Preview

Effects:
- Multipath propagation
- Repeated path echo
- Coherent addition
- Doppler shift
- False positives/negatives
Motivation

Virtual Prototypes

Virtual Sensor Models

CarMaker and DRIVE PX 2

Conclusion
Coupling of CarMaker and DRIVE PX 2 Platform

- Using IPGMovie as visualization
- Automotive Camera films video output from monitor
- Sample algorithms from Driveworks on DRIVE PX 2 platform do lane recognition or object detection
- Closing the loop is possible

**SOLUTIONS FOR VIRTUAL TEST DRIVING**

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Conclusion

- Virtual prototypes can be used throughout the whole development process
- Virtual sensor models provide the virtual prototype with information about the scenario
  - In different levels of detail for different use cases
- DRIVE PX 2 can be included in the closed-loop simulation process

Virtual testing is crucial for ADAS & Automated Driving functions

IPG Automotive offers the platform