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Real-Time Prototyping and Testing for ADAS: Lane Keeping and Following Assist Systems



### **The Things You Will Learn**



Virtual Vehicle



How do I perform real-time virtual vehicle simulation? Controls



How can I rapidly prototype and test controls?

Camera Perception



How do I test perception and controls?





### Fast-Track from Desktop to Real-Time Simulation and Testing Turnkey Solution from MathWorks and Speedgoat



Create, deploy, monitor and instrument real-time applications





#### **Outline**







### **Real-Time Virtual Vehicle Simulation**

 Part 1
 How do I perform

 Virtual
 Virtual

 Simulation
 Simulation







### **Need for Virtual Vehicle Simulation & Testing**

- Prototypes are expensive
- Logistics and safety
- Early validation
- Development accelerator
- Synthetize edge scenarios
- Test handoff, platooning
- Repeatability, reproducibility
- Qualified miles











### **Virtual Vehicle Simulation**

- Common challenges:
  - Solutions are expensive and cumbersome
  - Poor Simulink integration
  - Solutions geared towards experts
- Strengths of MathWorks solution:
  - Extensively supported
  - Open, customization possible
  - Integrated, flexible and well connected
  - Fast, ready for Hardware-in-the-Loop deployment







### **Virtual Vehicle: Desktop Simulation**

#### Example: Double-Lane Change Maneuver



• Vehicle Dynamics Blockset<sup>TM</sup>



**Chassis Controls** 







ADAS / AD





### **Virtual Vehicle: From Desktop to Real-Time Simulation**







#### **Virtual Vehicle: From Desktop to Real-Time Simulation**







### **Real-Time Driver-in-the-Loop (DIL) Simulator**



#### Webinar: Building Real-Time DIL Simulators



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#### Success story: Tongji University



"The Speedgoat system works well with many of the tools in MATLAB. It is a very efficient way to construct the test platform so that we can concentrate on the development of the ADAS algorithm."

Professor Hui Chen, Tongji University



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### Part 2: Real-Time Prototype and Test Lane Keeping Controller







### **Expediting Development by Frontloading Virtual Vehicle HIL**







### Lane Keeping Control with Model Predictive Control



- Automated Driving Toolbox<sup>TM</sup>
- Model Predictive Control Toolbox<sup>TM</sup>
- Simulink Control Design<sup>™</sup>

#### Simulate controls with perception



#### Visualize logged simulations





### Lane Keeping Control Real-Time Test Bench



### Lane Keeping Control Real-Time Testbench







### **Customer Success Story: TUM / Roborace**



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#### HiL @ TUM



"The seamless integrated workflow provided by Speedgoat and Simulink Real-Time™ really helped us to minimize the time we had to invest building this HIL simulator and maximized the time we could spend developing the functionalities of our algorithms."

MathWorks Automotive Conference 2019

Thomas Herrmann, TUM RoboraceTeam

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speedgoat

### **Automate Testing in Real-time**

#### Example: Testing a Lane Following

#### Controller with Simulink Test



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#### Reuse Desktop Test Cases for Real-Time Testing

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#### Webinar: Test Automation - From Desktop Simulation to Real-Time





### **Real-Time Test Bench for a Lane Keeping Assistance System**









### **Modern Vision Applications Often Require FPGA Acceleration**

- Lane detection is a critical processing stage in ADAS
- Computational expensive
- Acceleration needed, e.g., on FPGAs











## **Bridging the Gap between Exploration and Deployment**

#### Video series: Vision Processing for FPGA



#### Vision Processing for FPGA

Watch this five-part video series that introduces key concepts and the workflow for targeting vision applications to FPGAs for prototyping and production.

Learn more (5 Videos)

#### Example: FPGA acceleration of lane marking detection









# Lane Marking Detector on FPGA











### Lane Keeping Control Real-Time Test Bench







#### **Demo the Real Thing**





### **What You Have Learned**

Virtual Vehicle



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