Developing Active Safety Systems Using MATLAB and Simulink

MathWorks
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Introduction & Motivation

- Active Safety Systems must operate consistent and robust also in unpredictable environments

- Testing these systems in a real world environment is dangerous and can cause serious damage

- Examples:
  - Lane Keeping Systems
  - Adaptive Cruise Control Systems
  - Automated Emergency Braking
Develop and verify your active safety system functionality and improve robustness using system level simulation.
What is Active Safety?

- Safety systems that are active *prior* to an accident
  - Use an understanding of the state of the vehicle and its environment to avoid and minimize the effects of a crash.
  - Interpret signals from various sensors and decide how to help the driver to control the vehicle.
Case Study: Lane Keeping System

- Detect the vehicle's departure from its lane
- Warn the driver or actively steer the vehicle
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A Multi-Domain Problem
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The Challenge: Closed Loop with Environment
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Developing the Vision Algorithm Part

- MATLAB based workflow provides
  - Easy to debug scripting environment
  - Pixel level, 2D, 3D visualization
  - Easy-to-use powerful image processing, and computer vision algorithms
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Developing the Controller Part

- **Goal**
  - Keep the vehicle within a lane by controlling steering input

- **Controller configuration**
  - Mode Selector (Stateflow)
  - Risk Assessment (Stateflow)
  - Steering angle compensator (Simulink)
    - Feed-back steer angle using heading & lateral offset
    - Feed-forward steer angle using curvature & vehicle speed

- **Control Parameter Tuning**
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Developing the Controller Part

- Determining Control Mode – creating the model

System Off

Engine On  No System Fail  Engine Off || System Fail

System Ready

SystemSW == On  System SW== Off

System On

Lane Departure Warning

Lane Keeping System

VehicleSpeed
LaneValidity

Not Active
Active

DriverSelection == LKS
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Developing the Controller Part

- Determining Control Mode – creating the model
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System Level Simulation

- Closed-loop test harness model for system level validation
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System Level Simulation
Need for Sensor Fusion
Case study: Automated Emergency Braking

Accurate CIPV (Critical In-Path Vehicle) selection
Example: Radar and Camera Data Fusion
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