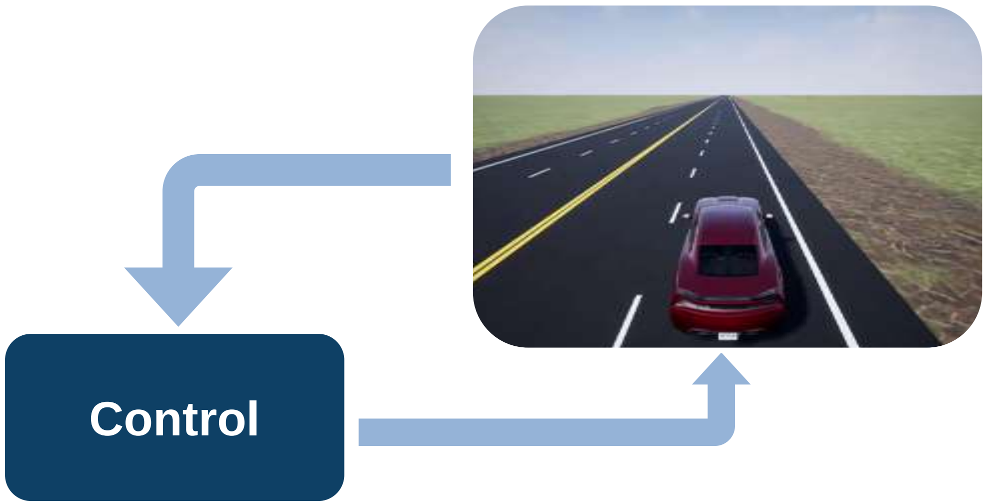
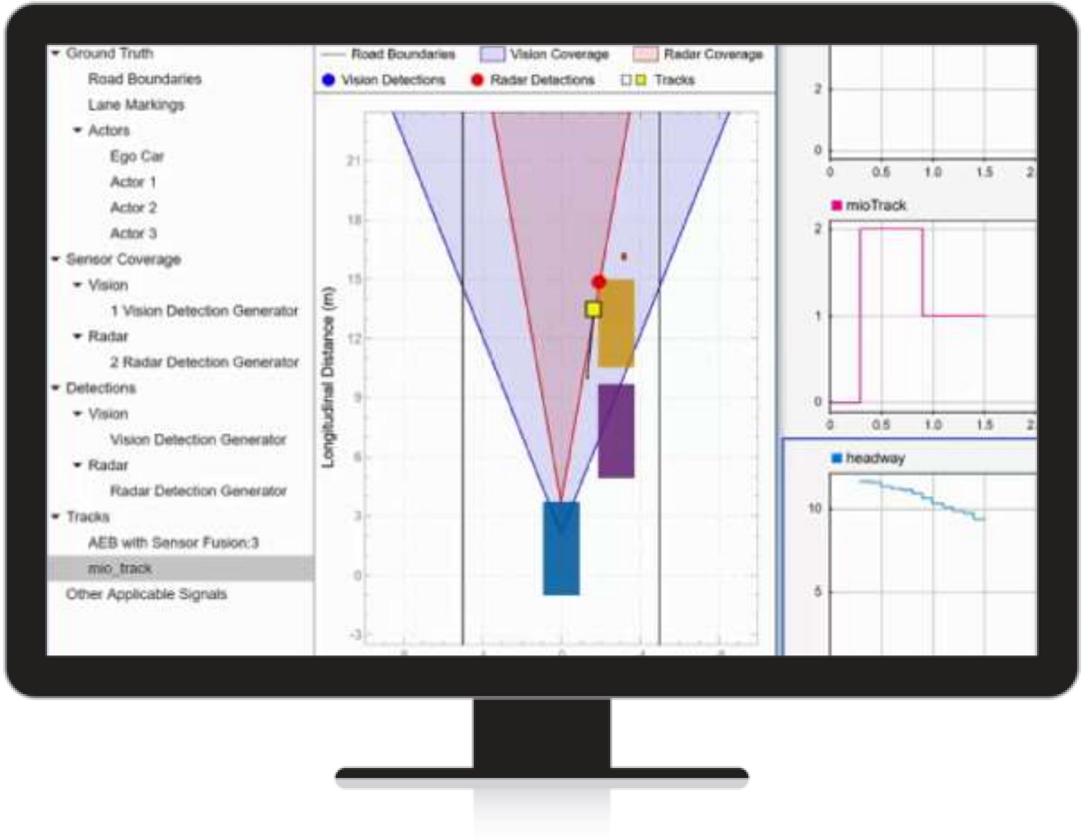
MATLAB EXPO 2019

MATLAB® 및 Simulink® 를 이용한 자율주행 시스템 설계 및 시뮬레이션

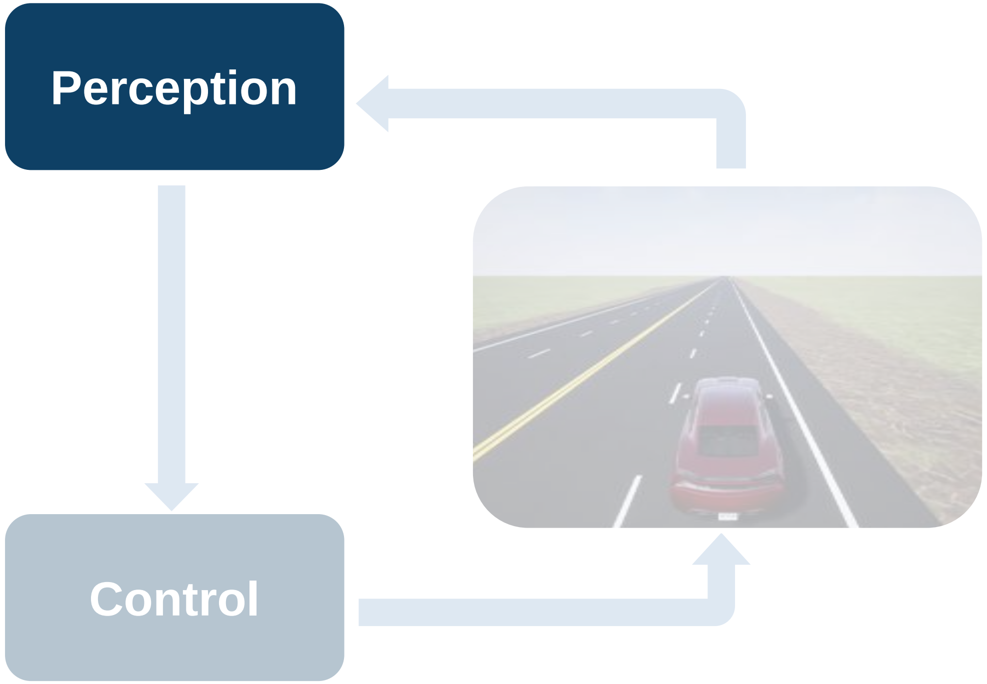
김종헌

Develop Automated Driving Control Systems with MATLAB and Simulink

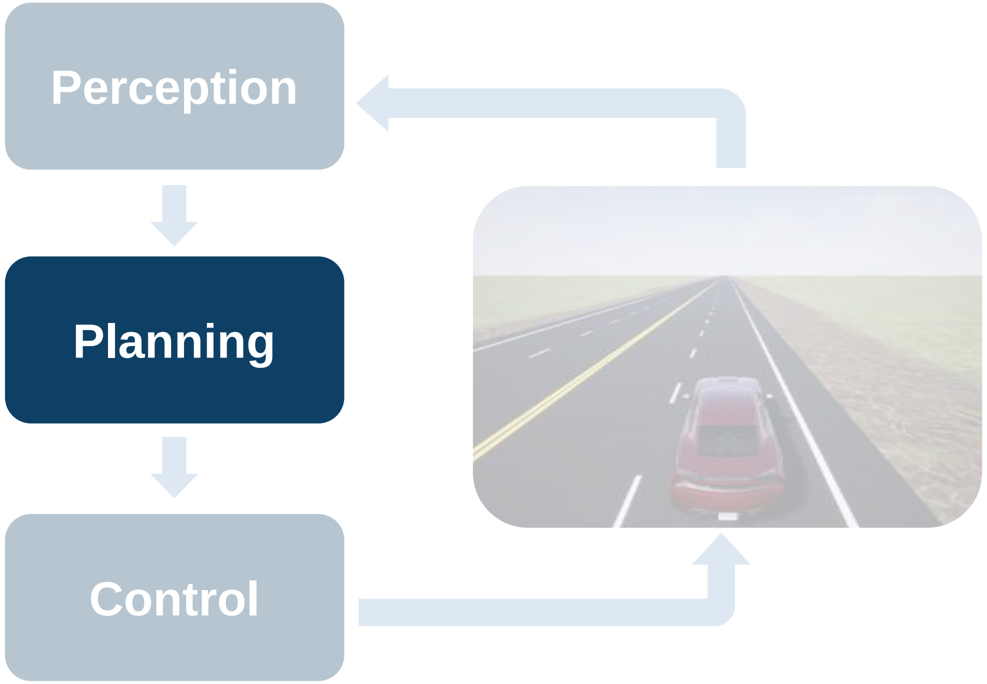


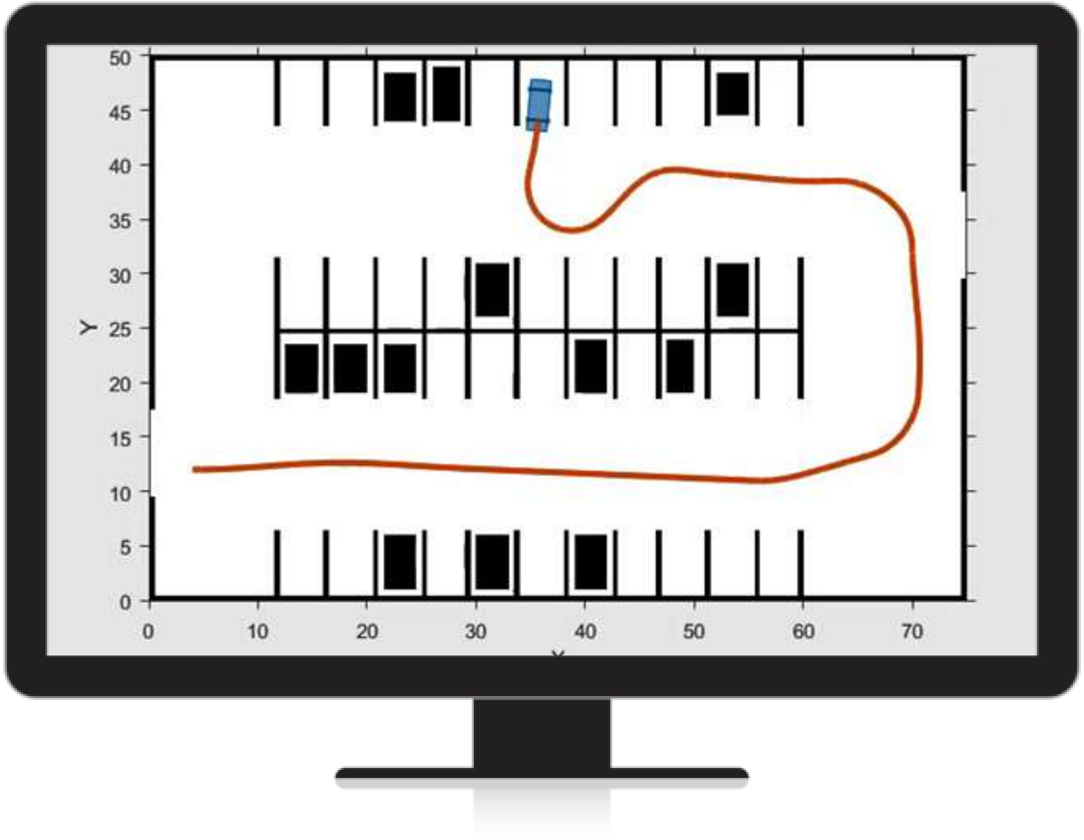


Develop Automated Driving Perception Systems with MATLAB and Simulink

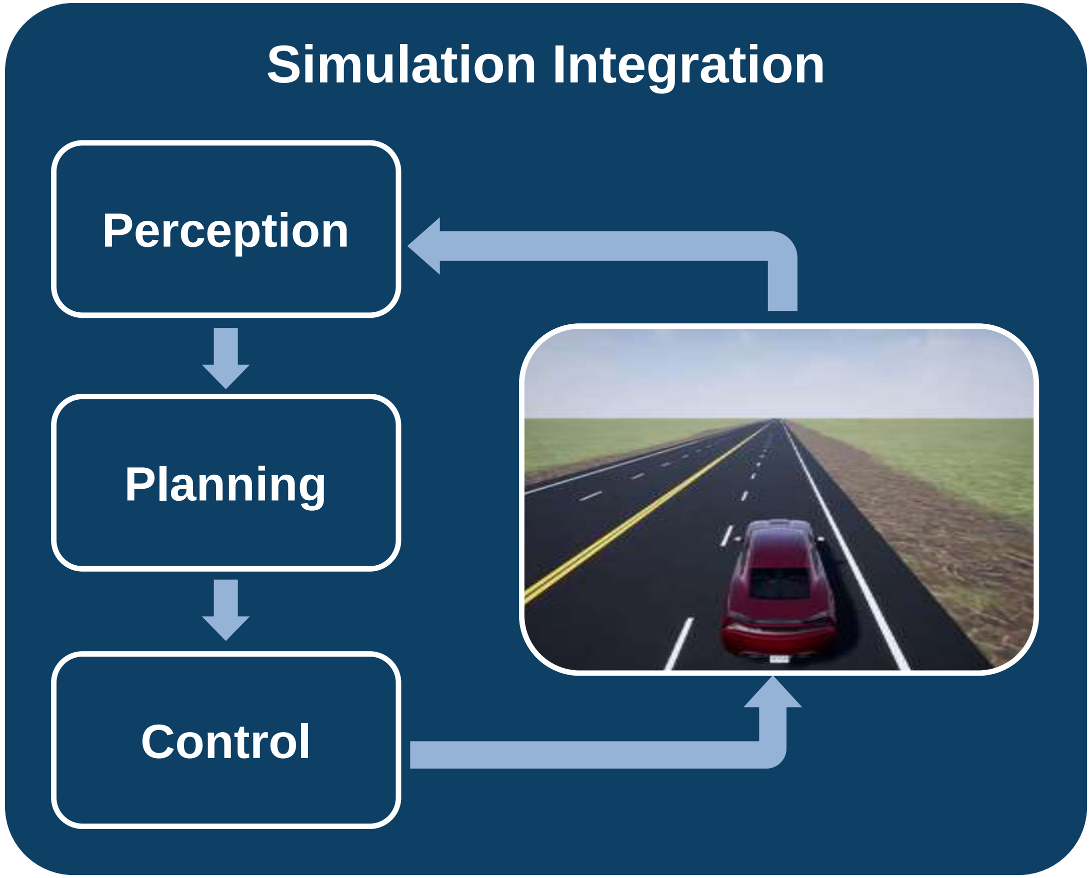


Develop Automated Driving Planning Systems with MATLAB and Simulink

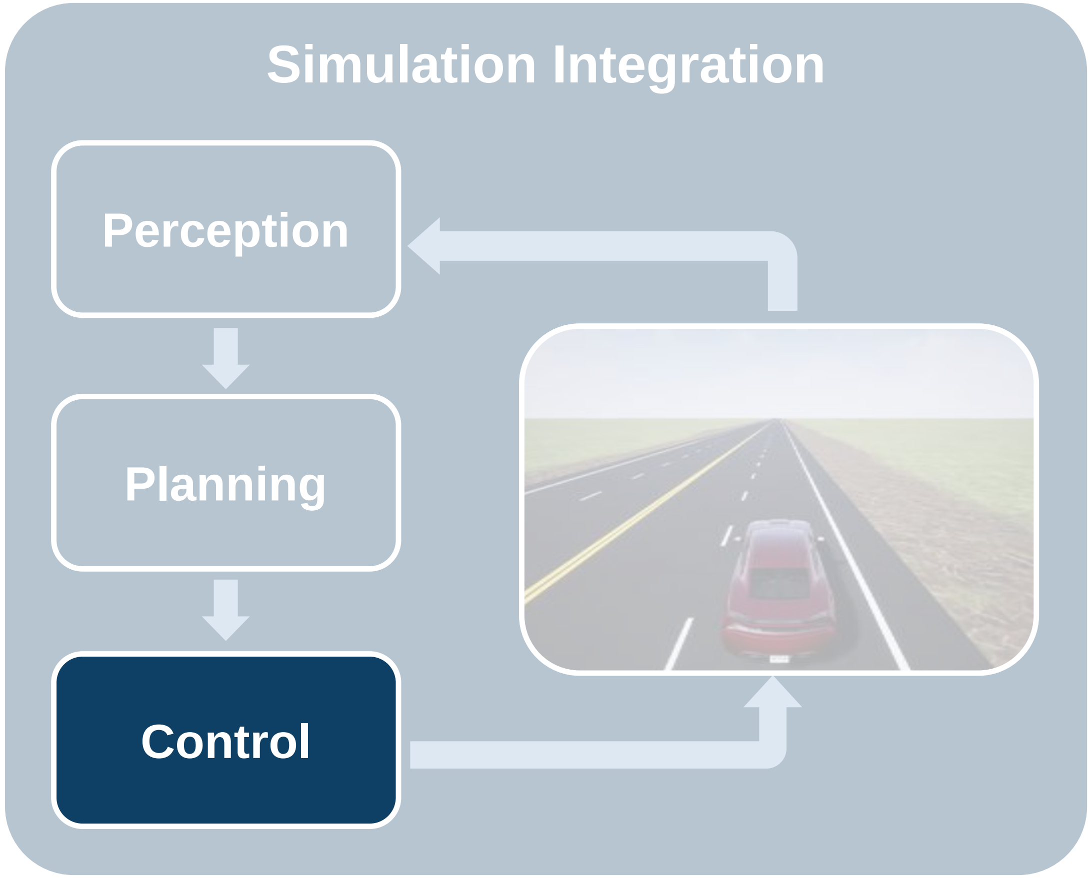




Develop Automated Driving Systems with MATLAB and Simulink



Develop Automated Driving Control Systems with MATLAB and Simulink

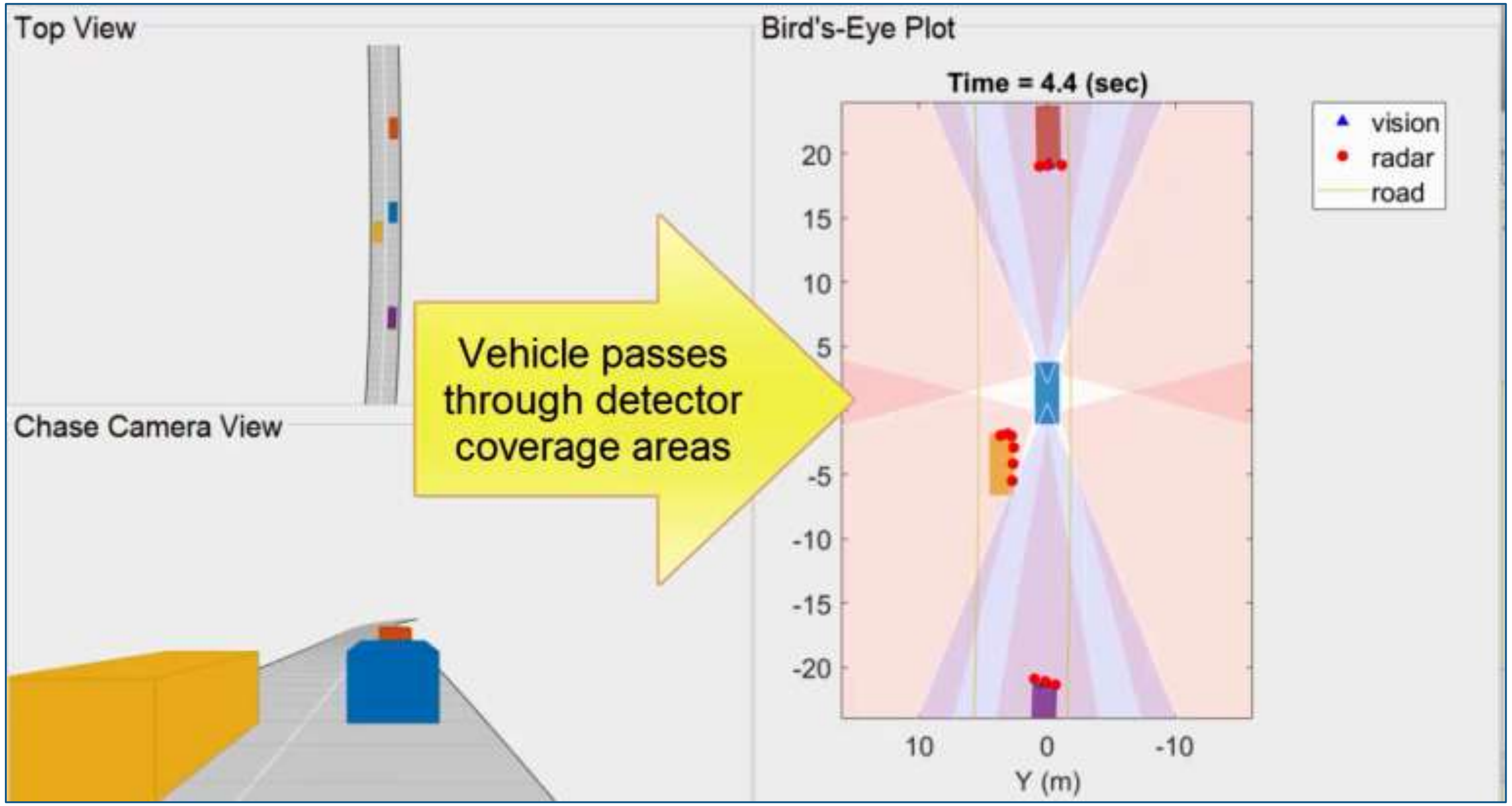


Some common control tasks

- Connect to recorded and live CAN data
- Synthesize scenarios and sensor detections
- Model vehicle dynamics
- Design model-predictive controllers
- Design reinforcement learning networks
- Automate regression testing
- Prototype on real-time hardware
- Generate production C/C++ code
- Certify for ISO26262

Synthesize Driving Scenarios to Test Sensor Fusion Algorithms

- Driving Scenario
  - Create scenario
  - Add probabilistic radar and vision sensors
  - Create tracker
  - Visualize coverage area, detections, and tracks



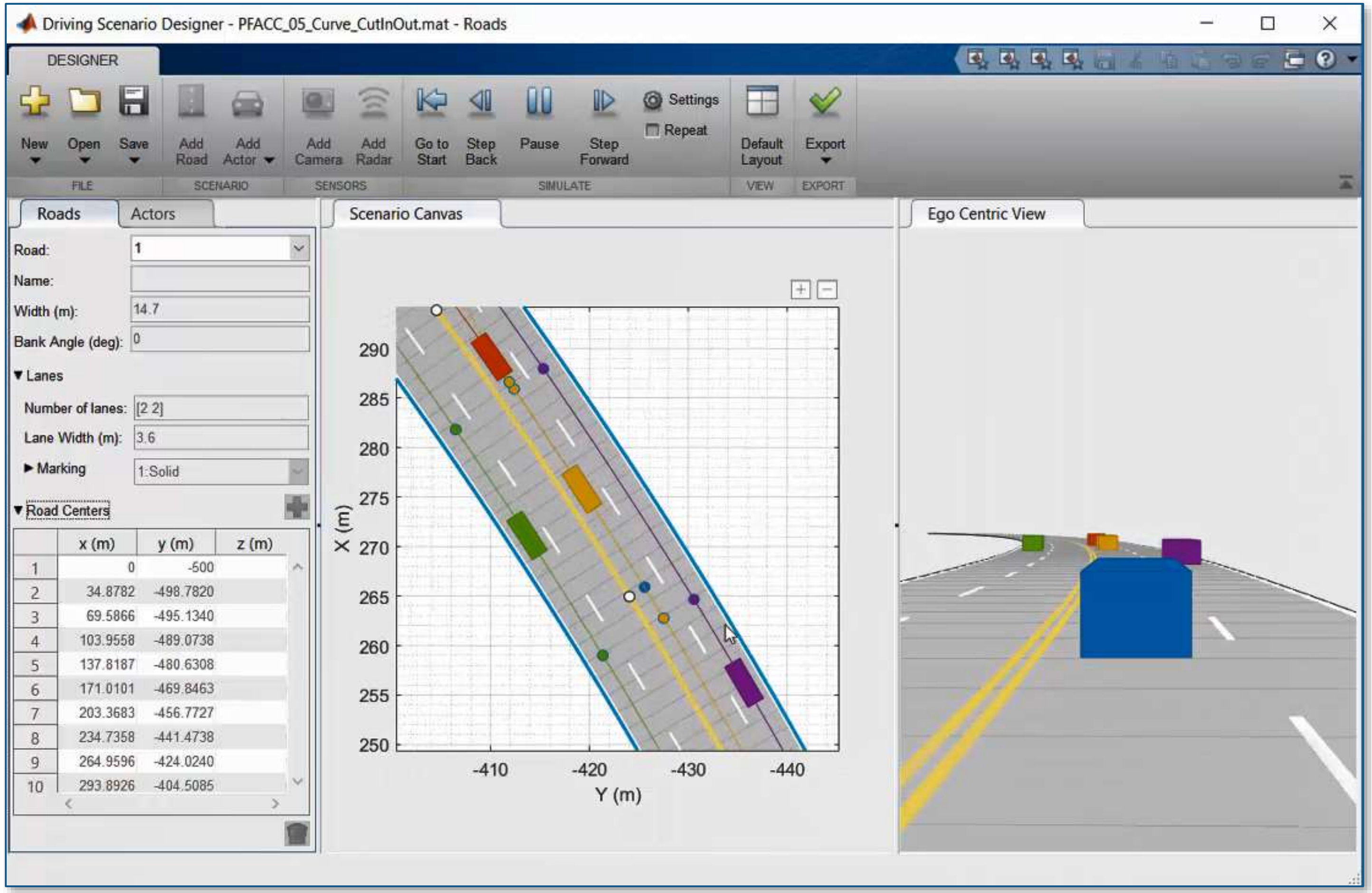
Automated Driving Toolbox™

[Sensor Fusion Using Synthetic Radar and Vision Data]

Graphically Author Driving Scenarios

R2018a

- Driving Scenario Designer
  - Create roads and lane markings
  - Add actors and trajectories
  - Specify actor size and radar cross-section (RCS)
  - Explore pre-built scenarios
  - Import OpenDRIVE roads

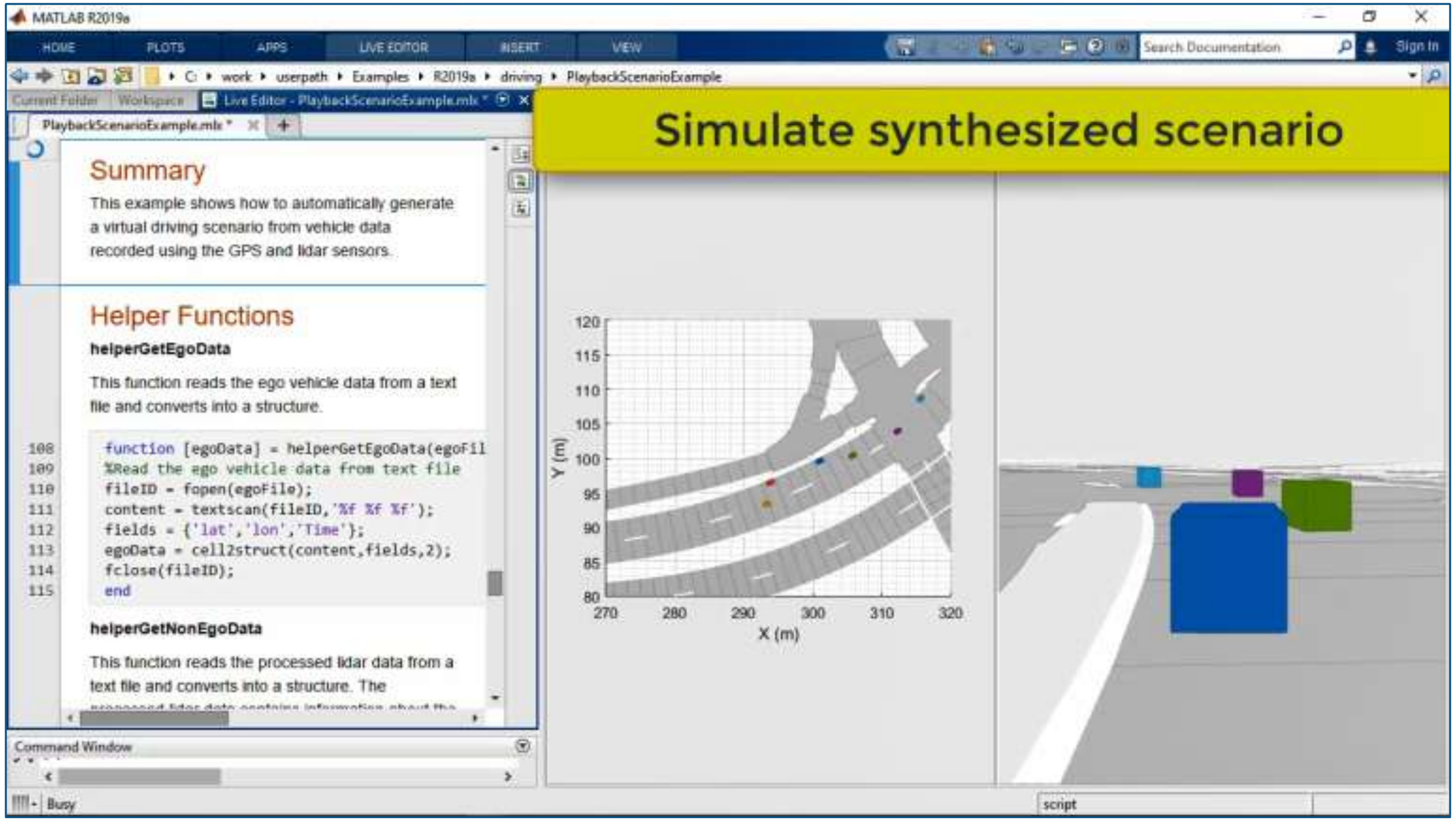


Automated Driving Toolbox™

[Driving Scenario Designer Example]

Synthesize Driving Scenarios from Recorded Data

- Scenario reconstruction
  - Visualize video
  - Import OpenDRIVE roads
  - Import GPS
  - Import object lists



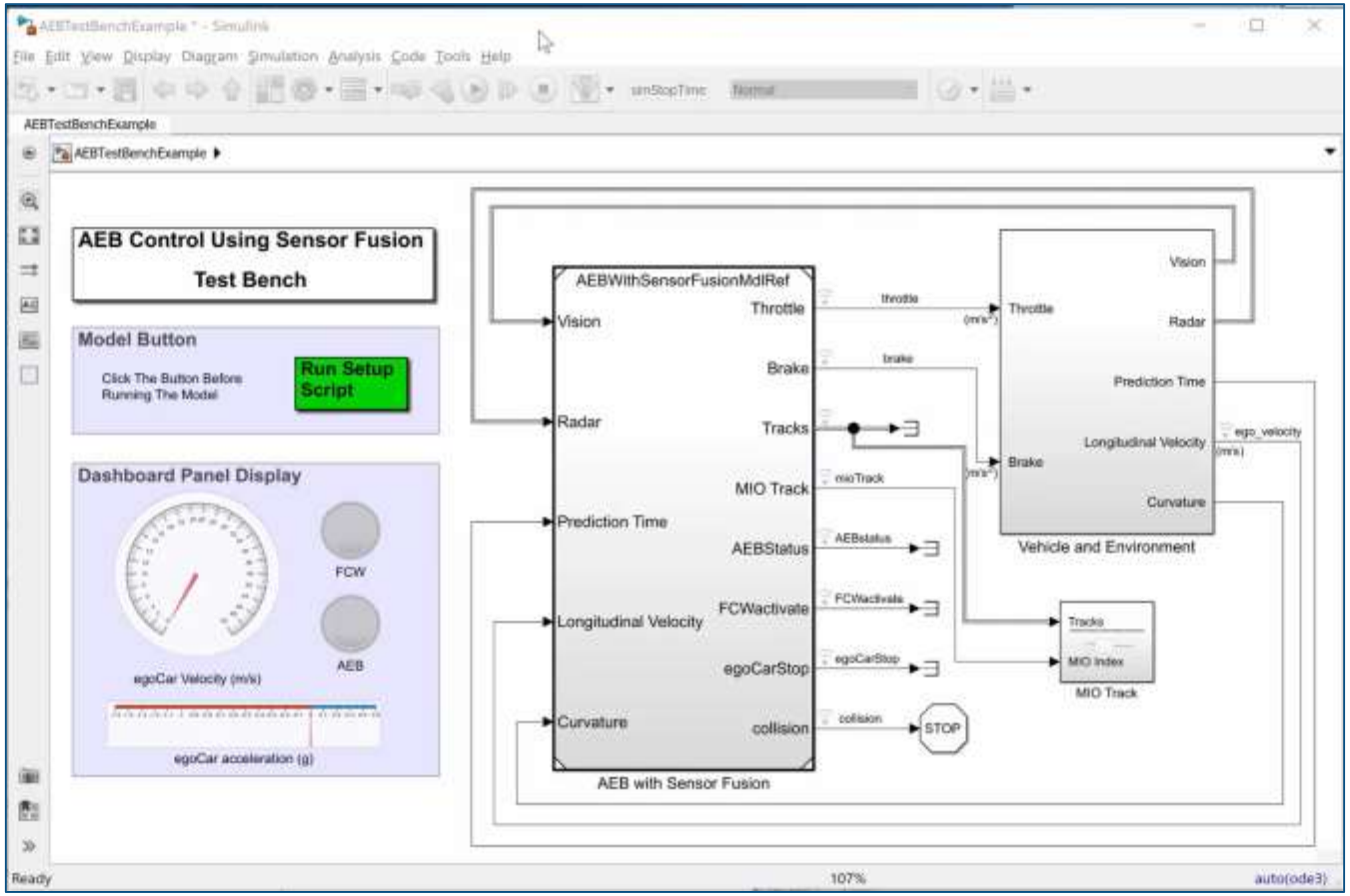
*Automated Driving Toolbox*TM

[***Scenario Generation from Recorded Vehicle Data Example***]()

Integrate Driving Scenarios into Closed Loop Simulations

R2018b

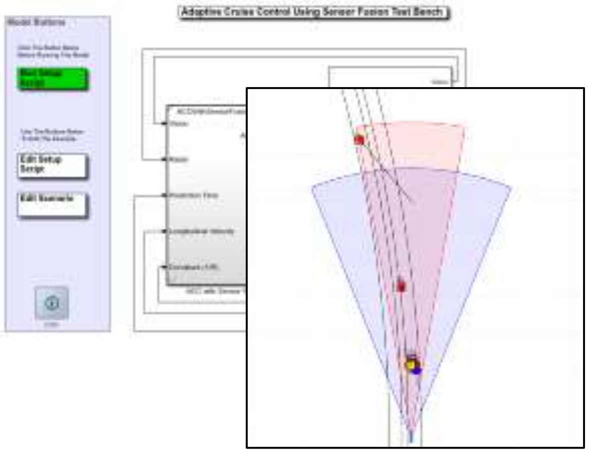
- Automatic Emergency Braking (AEB) with sensor fusion
  - Specify driving scenario
  - Design AEB logic
  - Integrate sensor fusion
  - Simulate system
  - Generate C/C++ code
  - Test with software in the loop (SIL) simulation



Automated Driving Toolbox™
Stateflow®
Embedded Coder®
[Automatic Emergency Braking (AEB) with Sensor Fusion]

Design Lateral and Longitudinal Model Predictive Controllers

Longitudinal Control



[Adaptive Cruise Control with Sensor Fusion]

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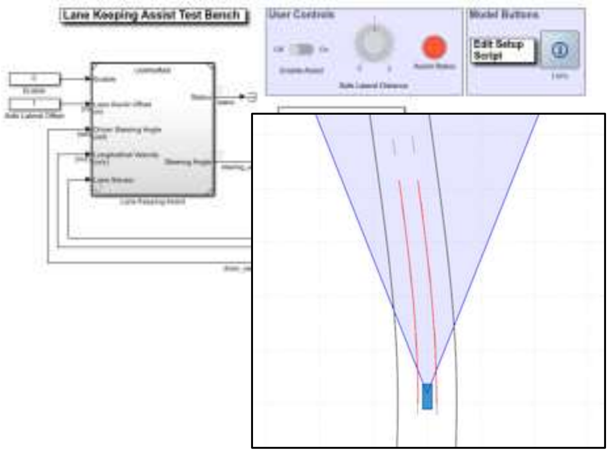
R2017b

Lateral Control



[Lane Keeping Assist with Lane Detection]

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Model Predictive Control Toolbox™

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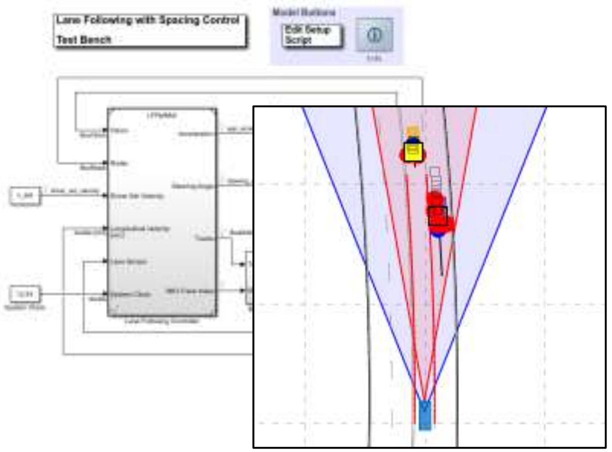
R2018a

Longitudinal + Lateral



[Lane Following Control with Sensor Fusion and Lane Detection]

Automated Driving Toolbox™

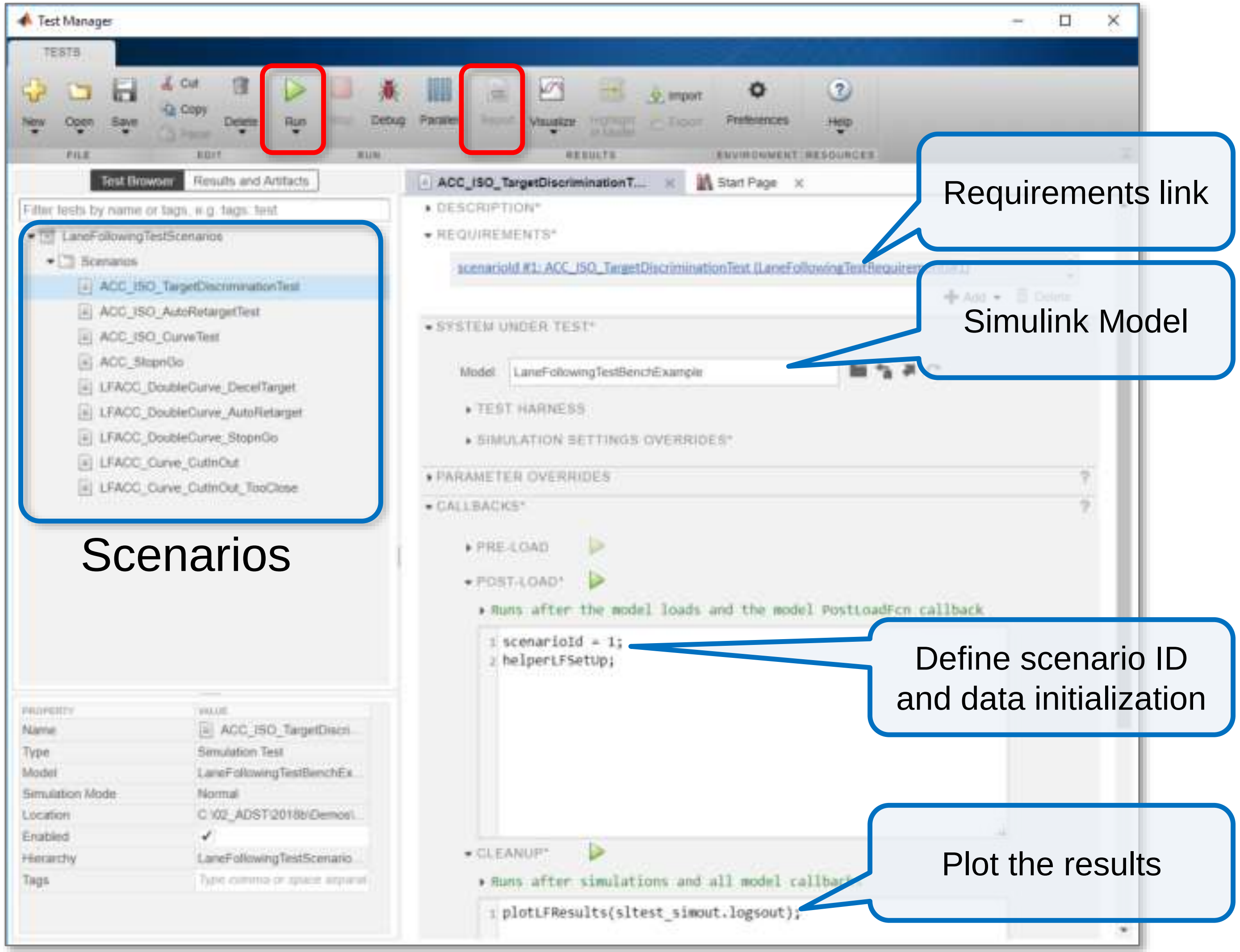
Model Predictive Control Toolbox™

Embedded Coder®

R2018b

Automate simulation tests

- Testing a lane following controller with Simulink Test
  - Specify driving scenario
  - Design AEB logic
  - Integrate sensor fusion
  - Simulate system
  - Generate C/C++ code
  - Test with Software-In-the-Loop (SIL) simulation



Simulink Test™

[***Testing a Lane Following Controller with Simulink Test***]

Automate simulation tests

- Testing a Lane Following Controller with
  - Specify drivi
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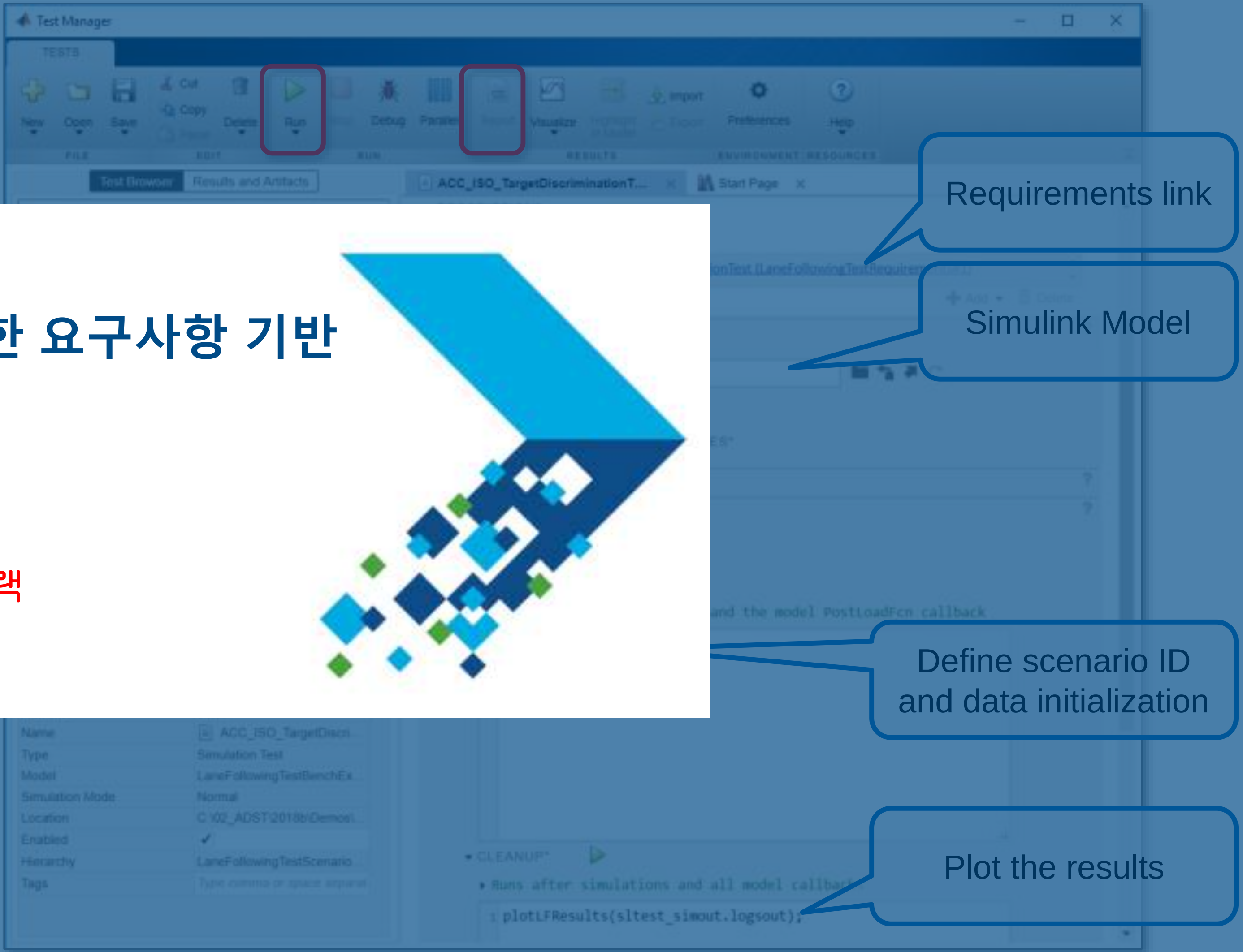
  - Simulate sys
  - Generate C/C
  - Test with Sof (SIL) simulation

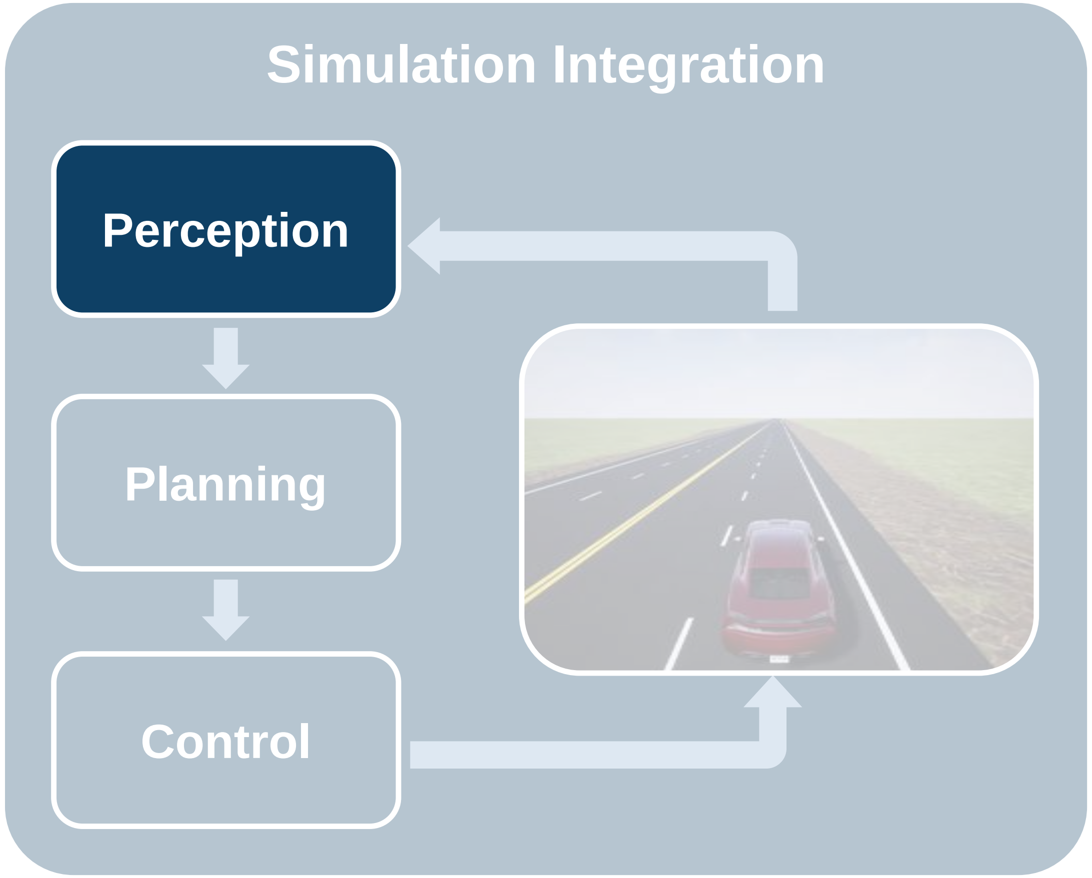
Find out more:
모델기반설계를 이용한 요구사항 기반 검증의 단순화

제어 및 임베디드 시스템 트랙
홍혁기



R2018b

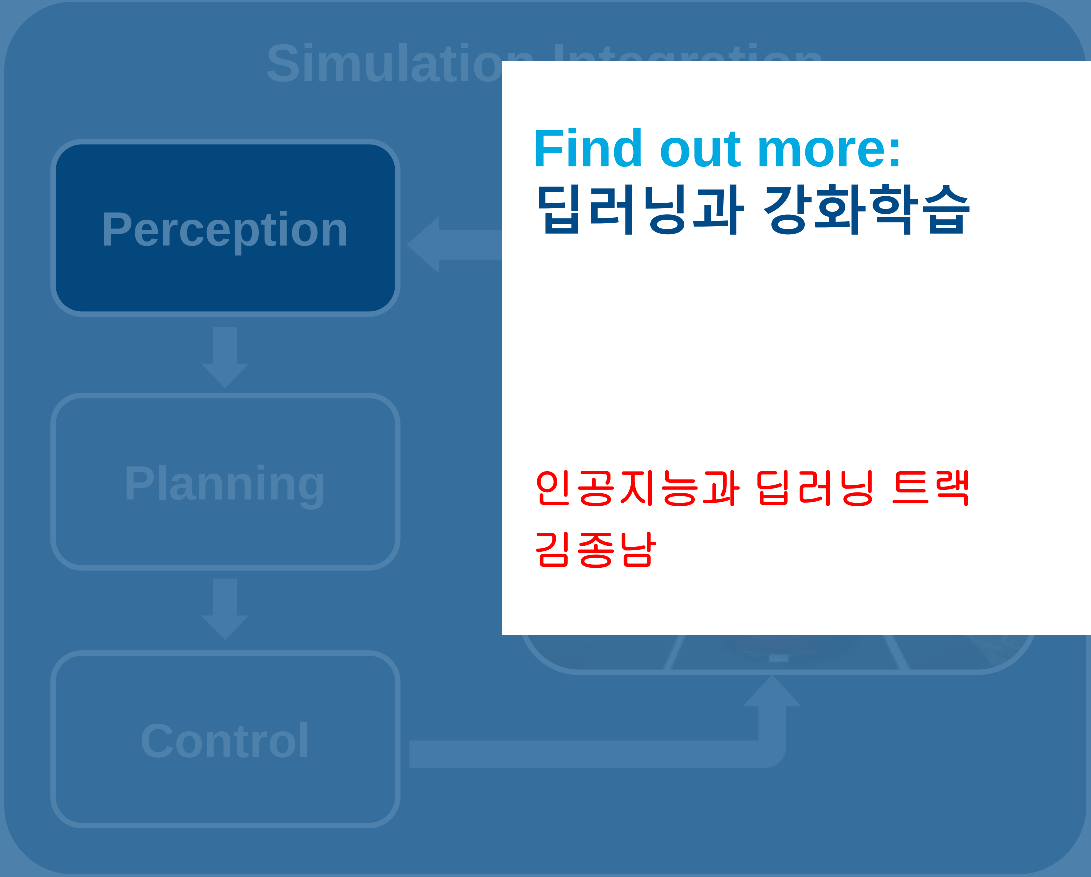
Develop Automated Driving Perception Systems with MATLAB and Simulink



Some common control tasks

- Visualize images, detections, and point clouds
- Label sensor data
- Synthesize scenarios and sensors
- Design fusion and tracking algorithms
- Design vision algorithms
- Design lidar algorithms
- Generate C/C++ code
- Design deep learning networks
- Generate GPU code

Develop Automated Driving Perception Systems with MATLAB and Simulink



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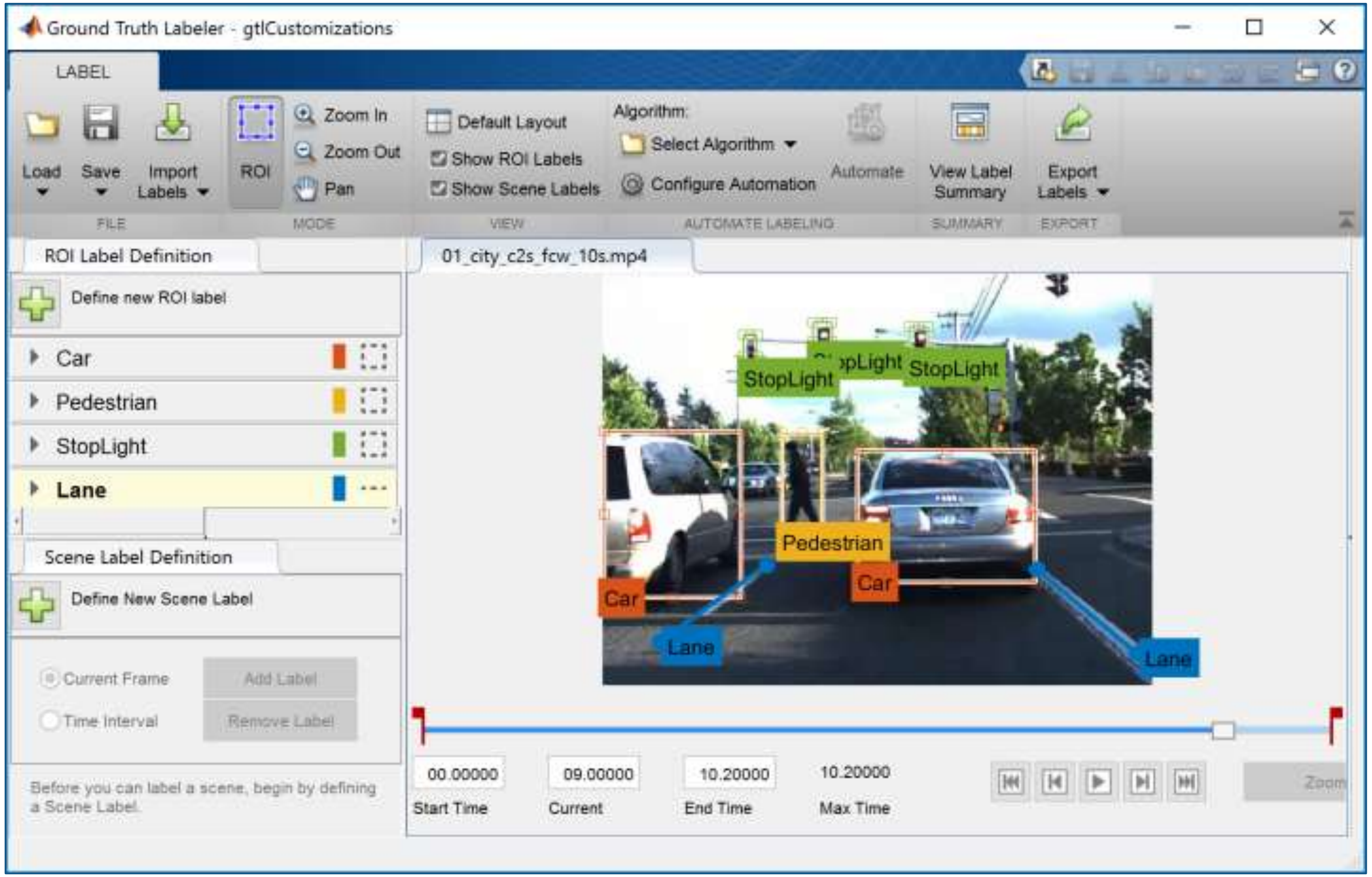
Find out more:
딥러닝과 강화학습

인공지능과 딥러닝 트랙
김종남

MathWorks R2017a

Interactively Label Sensor Data

- Get started with the Ground Truth Labeler
  - Label scenes
  - Label regions of interest
  - Label lanes



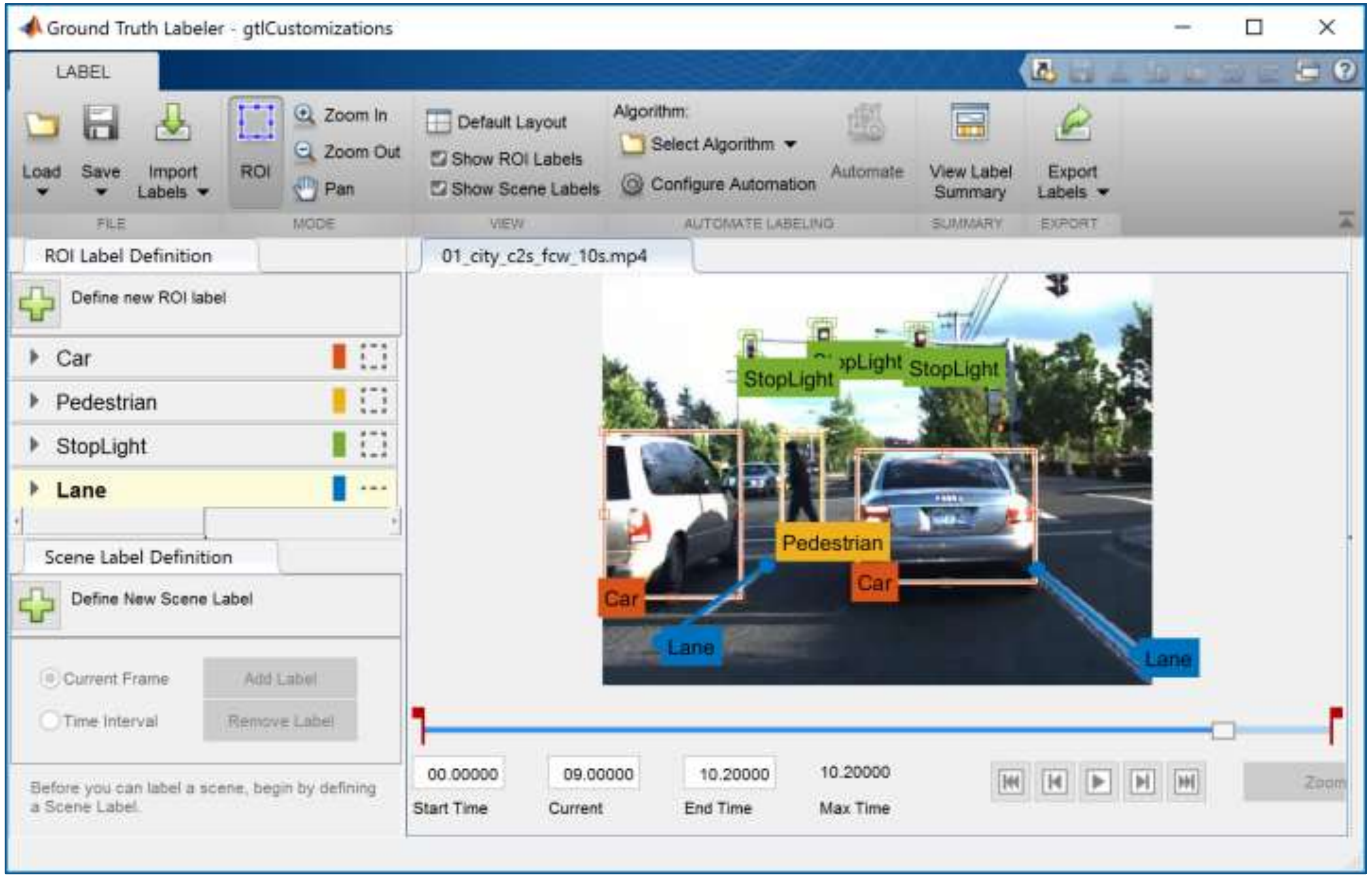
Automated Driving Toolbox™

[***Get Started with the Ground Truth Labeler Example***]

Interactively Label Sensor Data

MathWorks
R2019a

- Get started with the Ground Truth Labeler
  - Label scenes
  - Label regions of interest
  - Label lanes
  - Label pixels
  - Add label attributes
  - Create sub-labels
  - Group labels

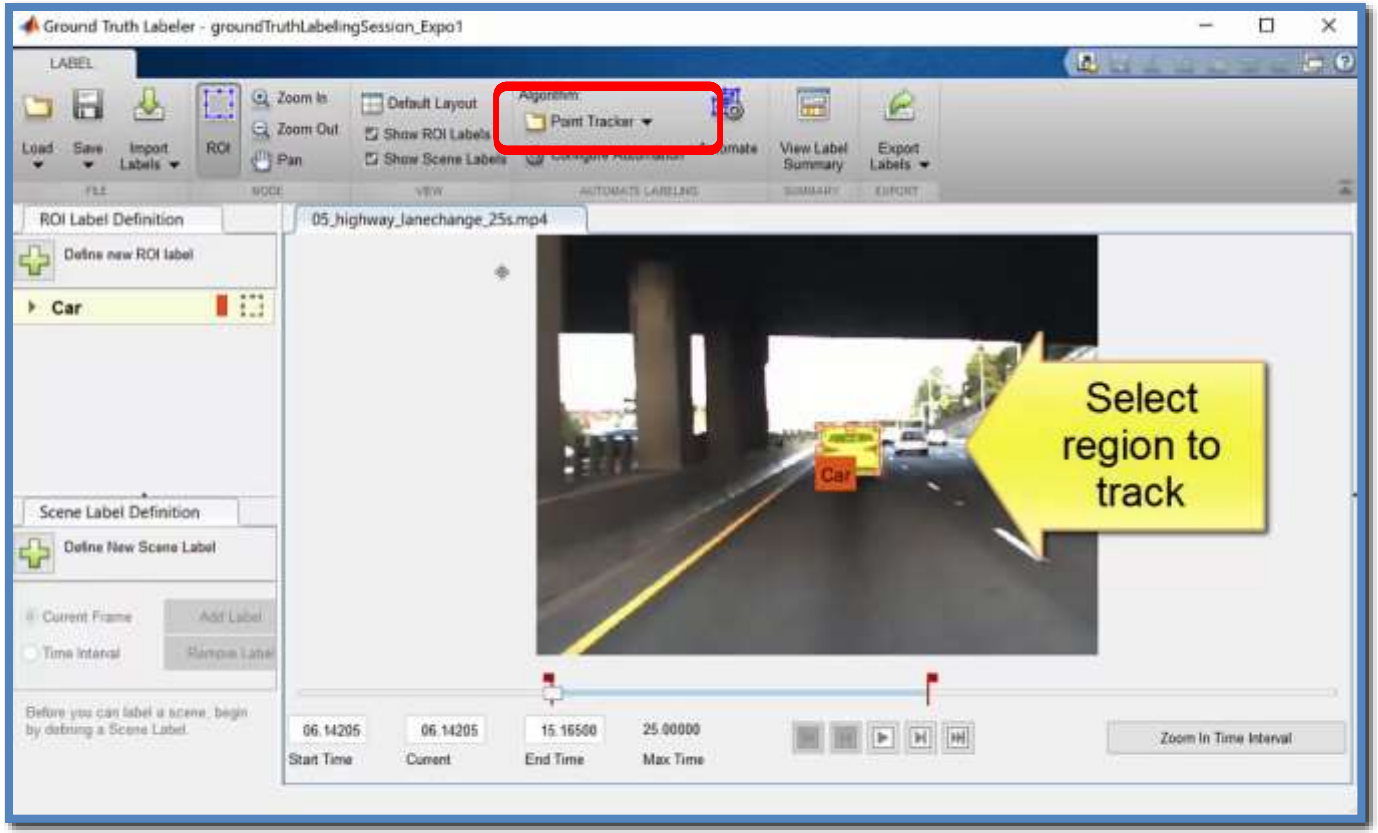


Automated Driving Toolbox™

[***Get Started with the Ground Truth Labeler Example***]()

Automate Attributes of Labeled Objects

- Detect vehicles from monocular camera
  - Temporal Interpolation
  - ACF Detector
  - Optical Flow
  - Import automation algorithm into Ground Truth Labeling App
- Run automation algorithm and interactively validate labels



Automated Driving Toolbox™

[*Automate Attributes of Labeled Objects Example*]

Evaluate and Compare Metrics for Fusion and Tracking Algorithms

- Design multi-object trackers
  - GNN + Kalman Filter (KF, EKF, UKF)

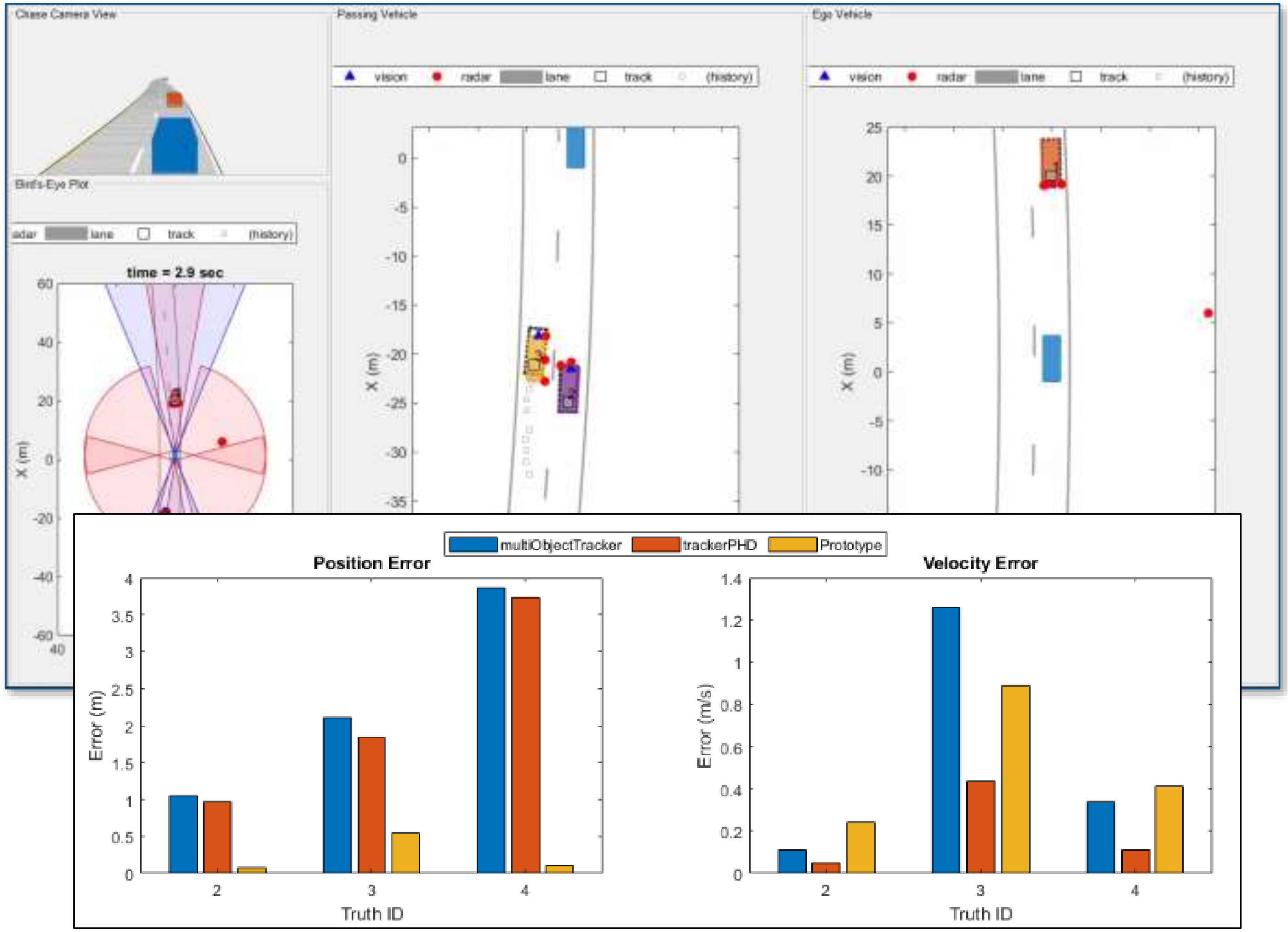
R2017a

  - MHT, IMM, JPDA

R2018b

- Evaluate tracking metrics
- Evaluate desktop execution time

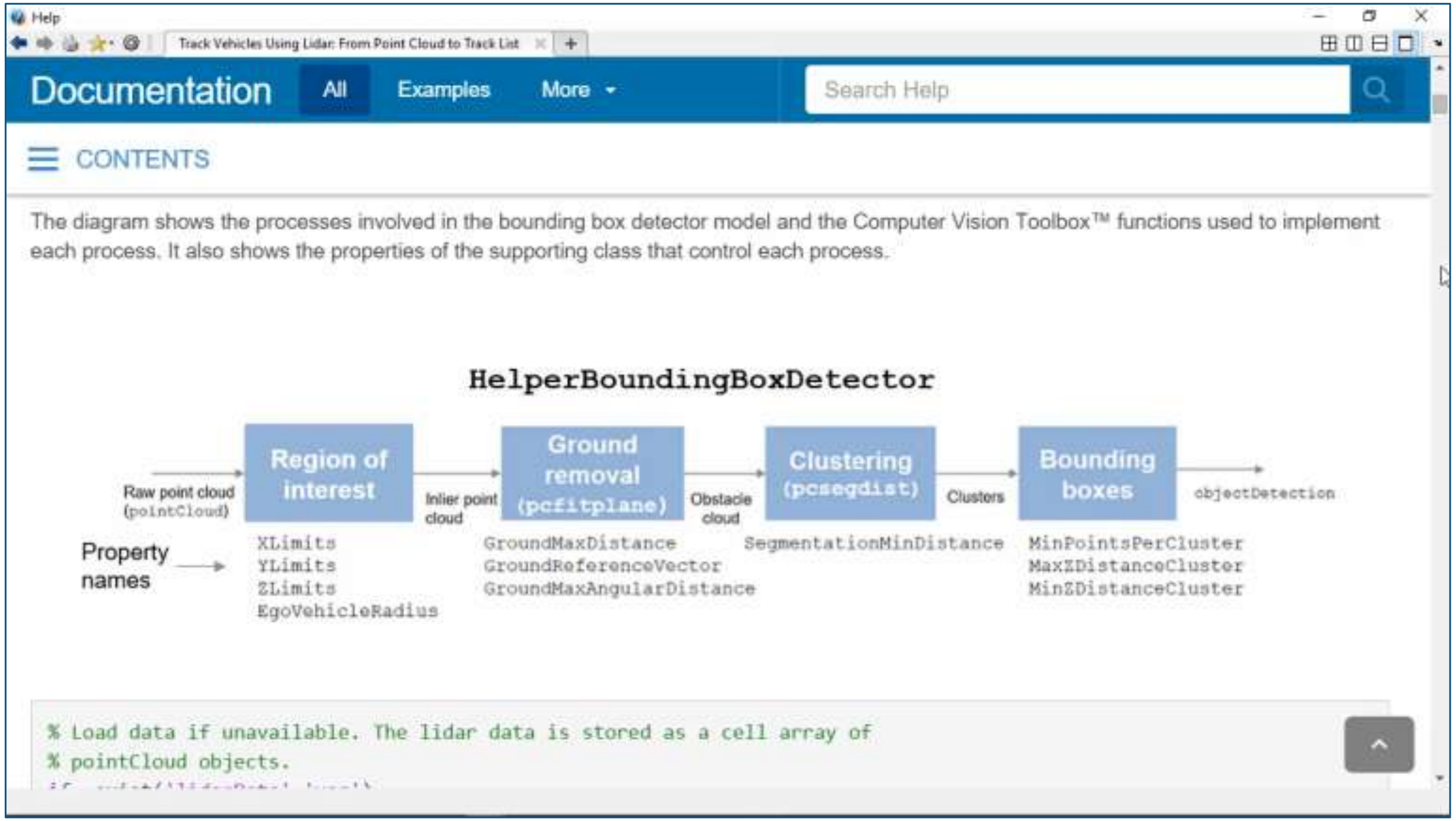
R2019a



Sensor Fusion and Tracking Toolbox™
Automated Driving Toolbox™

Design Detector and Tracker for Lidar Point Cloud Data

- From point cloud to track list
  - **Design 3-D bounding box detector**
  - Design tracker (target state and measurement models)
  - Generate C/C++ code for detector and tracker



Sensor Fusion and Tracking Toolbox™
Computer Vision Toolbox™

[***Track Vehicles Using Lidar: From Point Cloud to Track List Example***]

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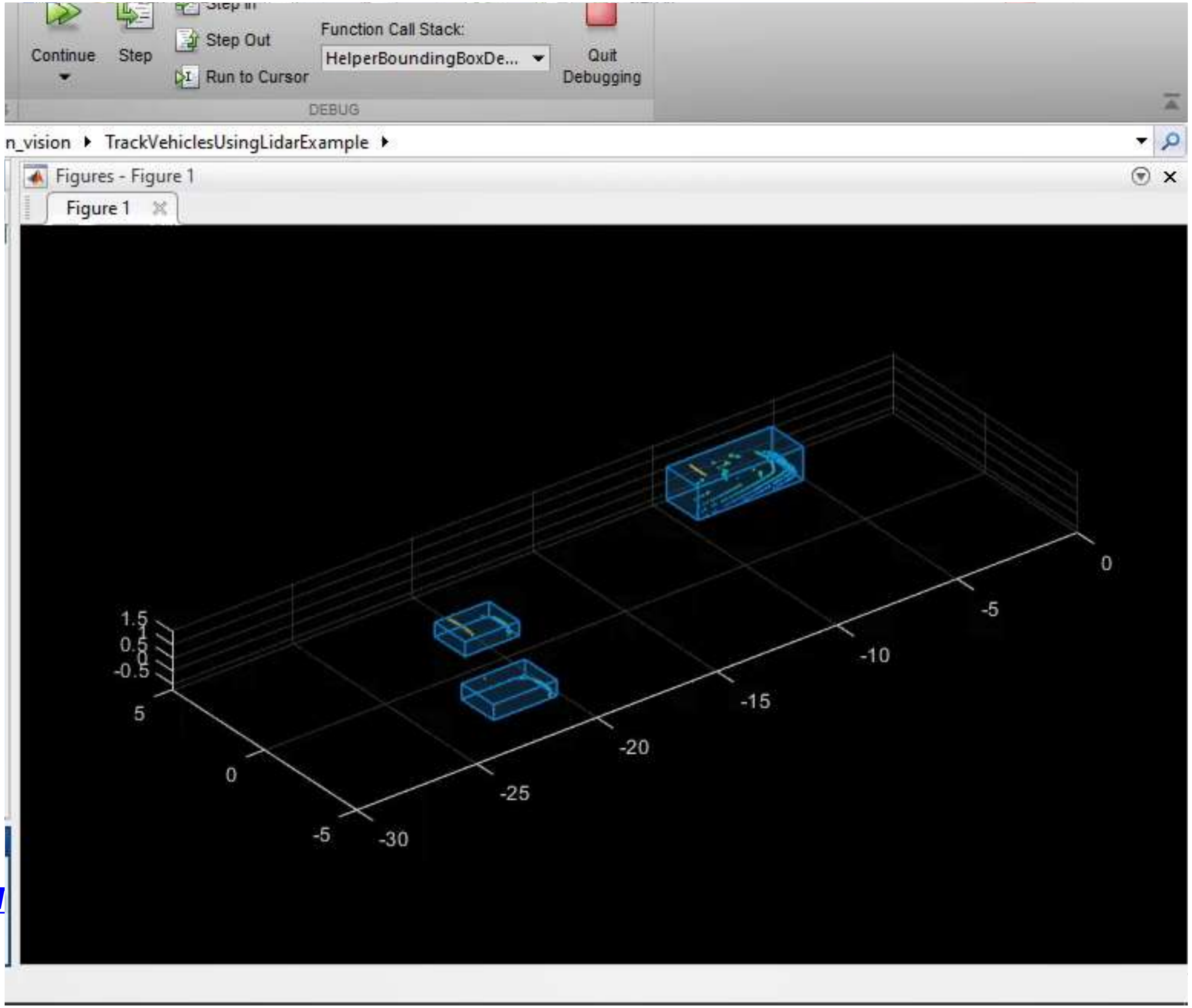

Sensor Fusion and Tracking Toolbox™
Computer Vision Toolbox™

[***Track Vehicles Using Lidar: From Point Cloud to T***](#)

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R2019a

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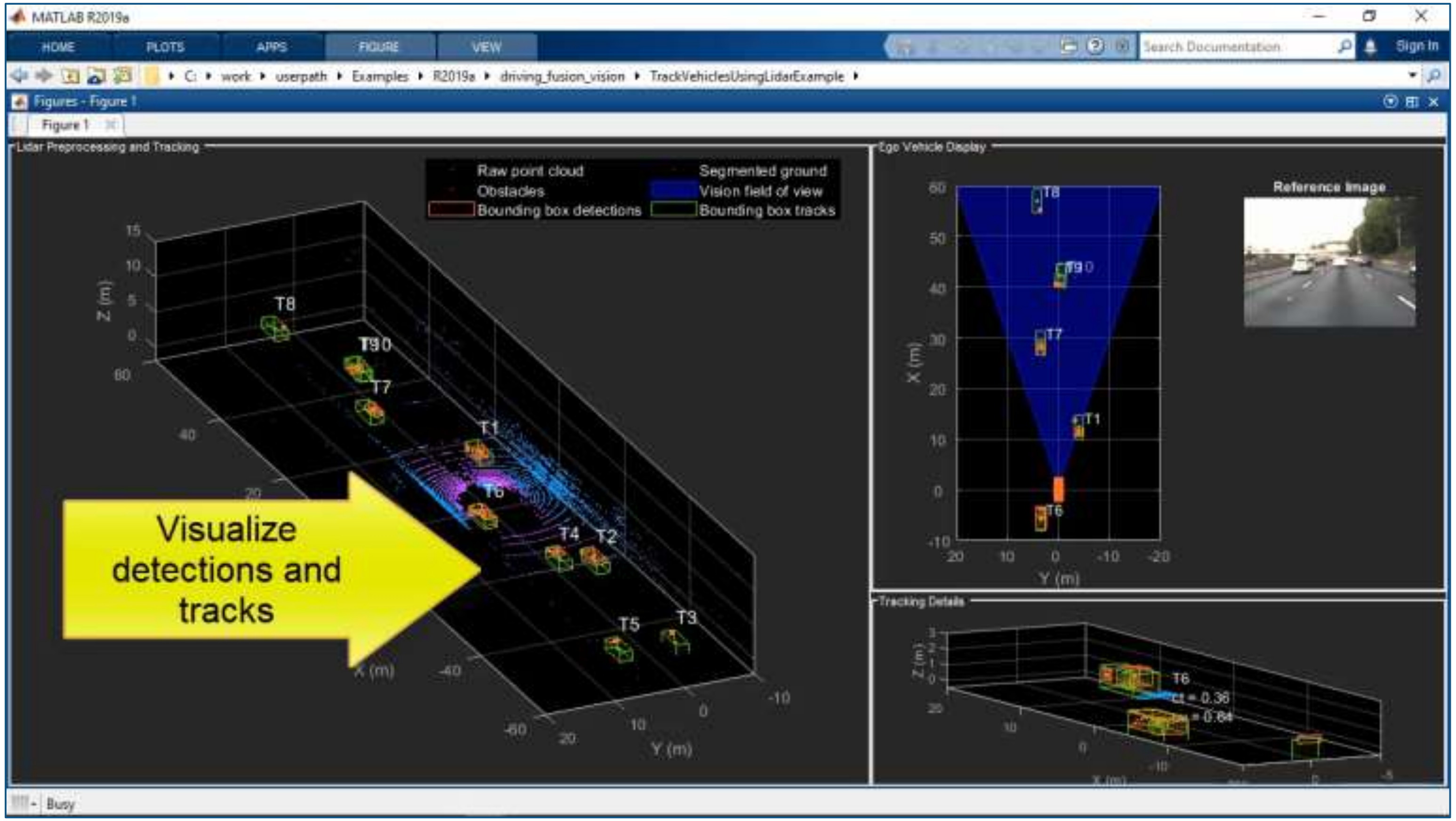

Sensor Fusion and Tracking Toolbox™
Computer Vision Toolbox™

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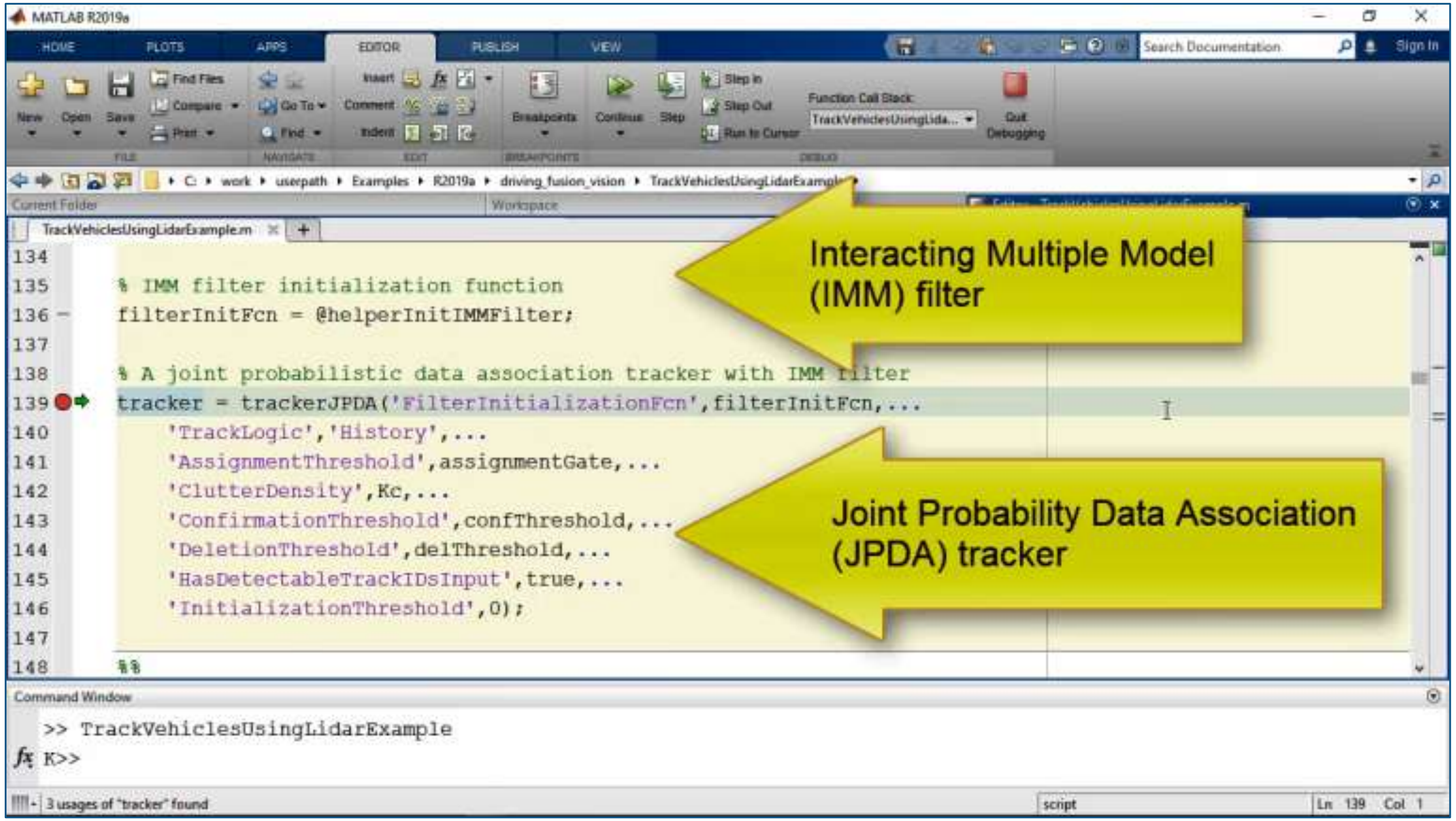

Sensor Fusion and Tracking Toolbox™
Computer Vision Toolbox™

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Sensor Fusion and Tracking Toolbox™
Computer Vision Toolbox™

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Sensor Fusion and Tracking Toolbox™
Computer Vision Toolbox™

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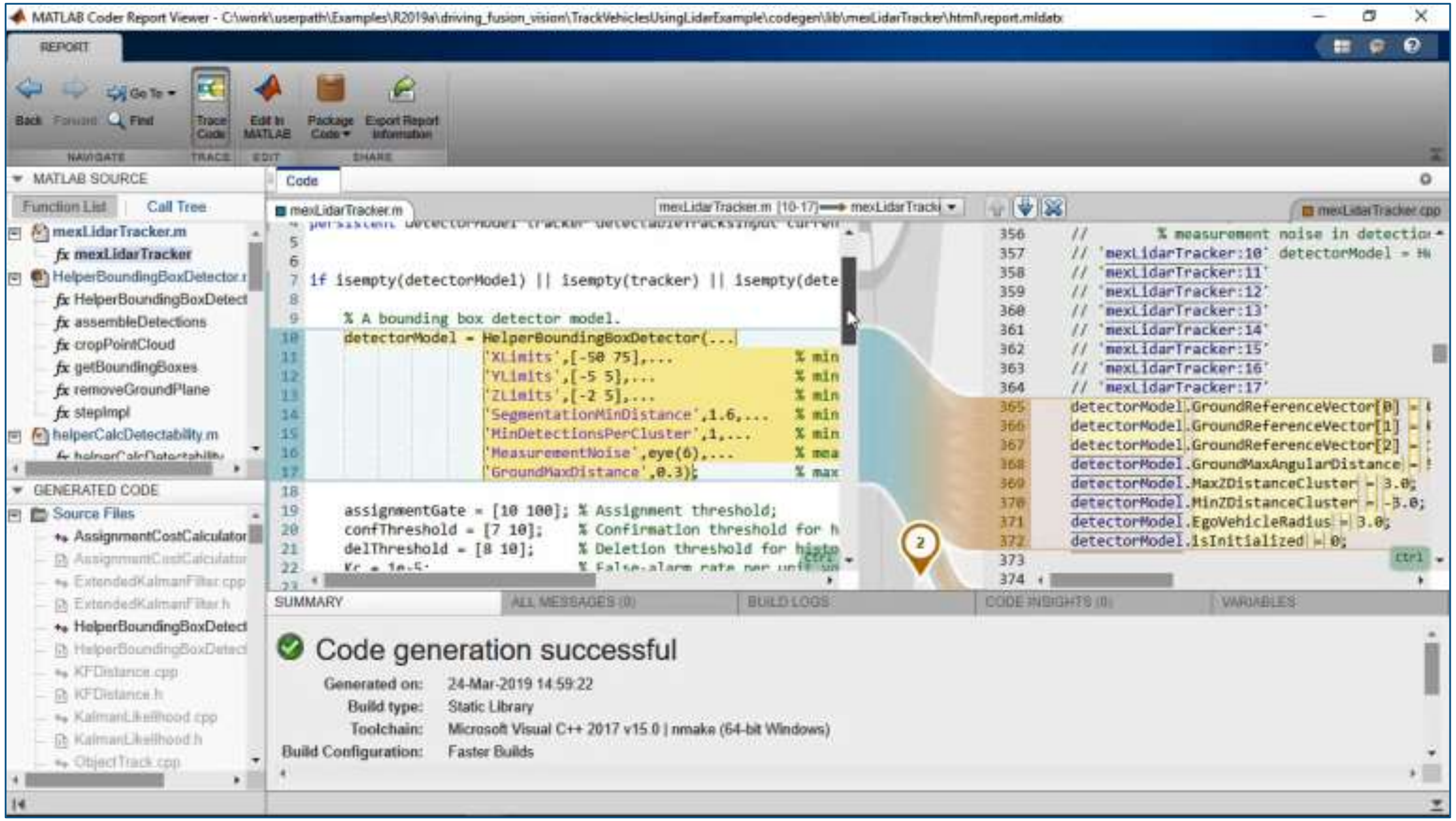
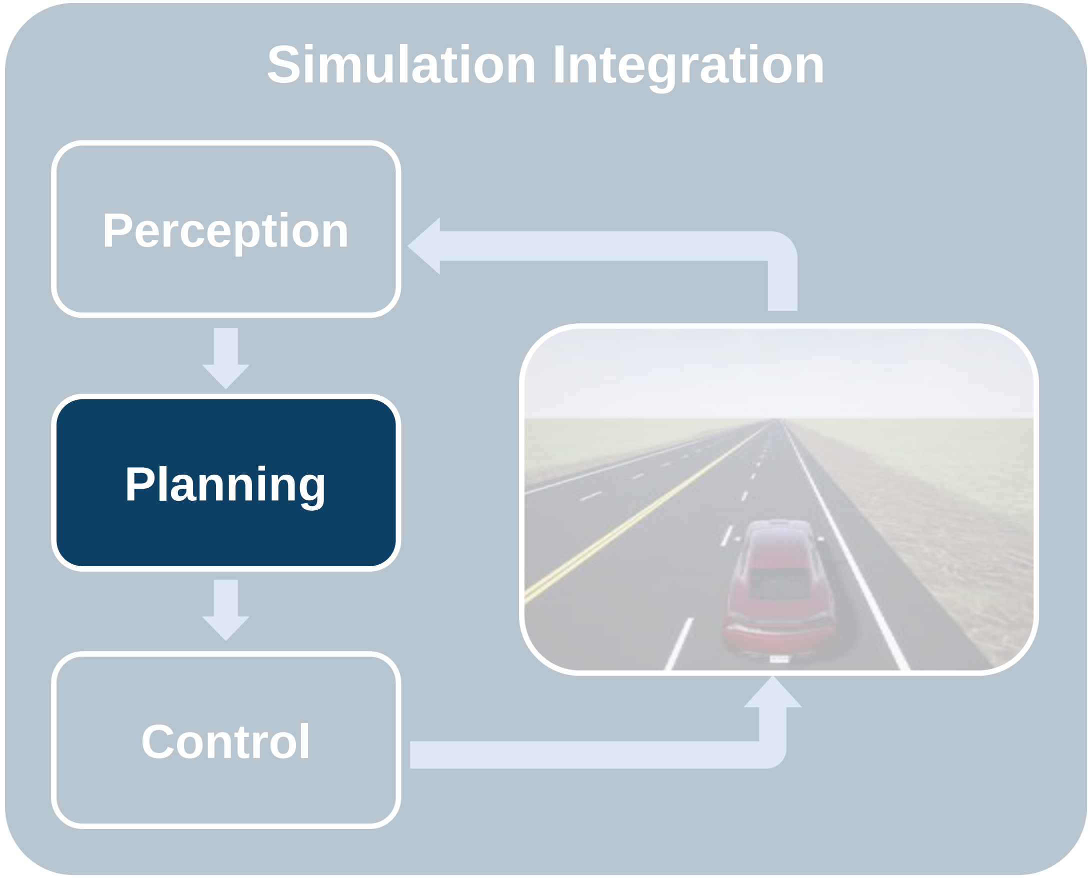


Sensor Fusion and Tracking Toolbox™
Computer Vision Toolbox™

[***Track Vehicles Using Lidar: From Point Cloud to Track List Example***]

Develop Automated Driving Planning Systems with MATLAB and Simulink

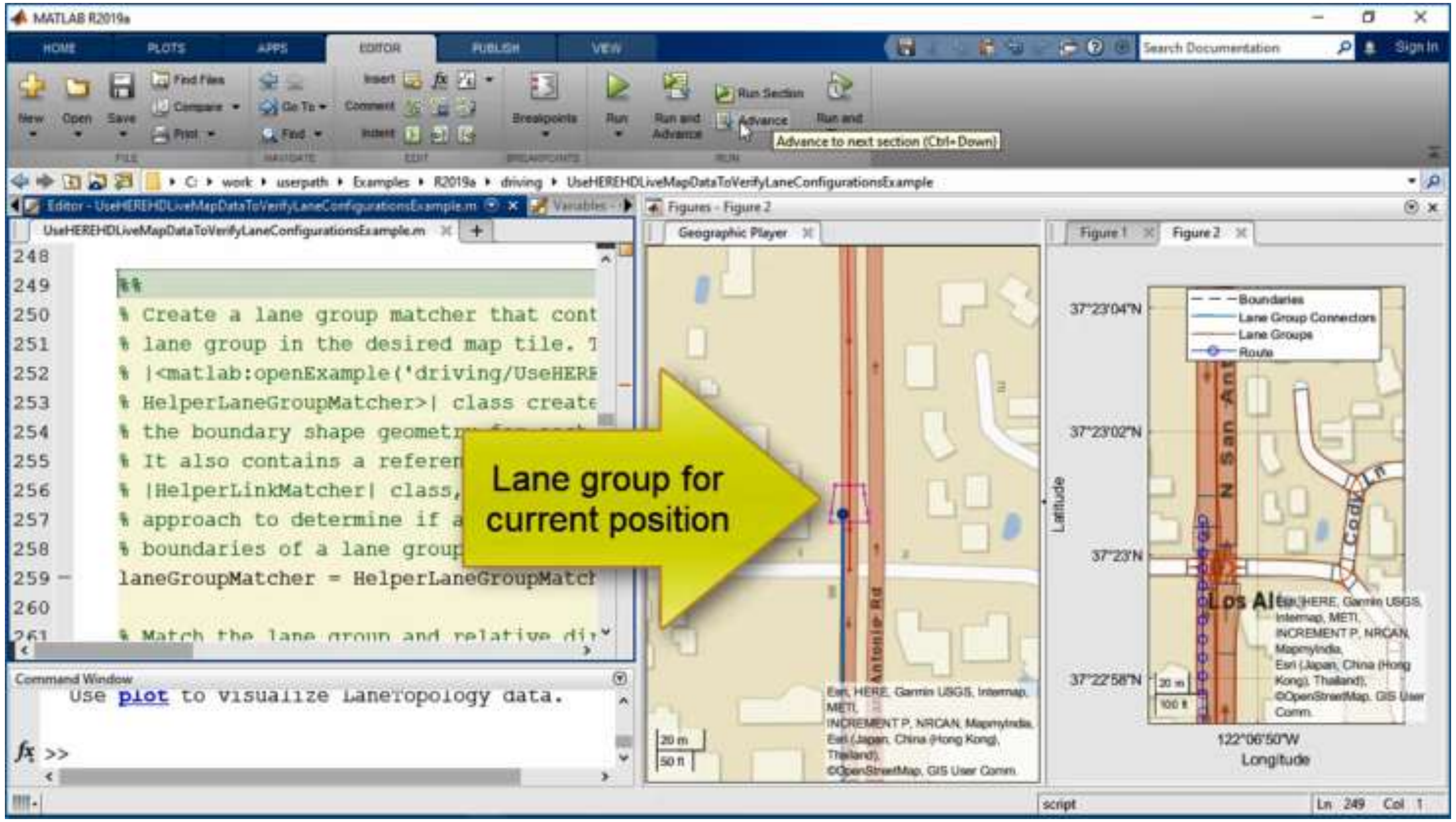


Some common planning tasks

- Visualize street maps
- Connect to HERE HD Live Map
- Connect to recorded and live ROS data
- Design path planners
- Generate C/C++ code

Read Lane and Speed Information from HERE HD Live Map Data

- Use HERE HD Live Map data to verify lane configurations
  - **Load camera and GPS data**
  - **Retrieve speed limit**
  - **Retrieve lane configurations**
  - Visualize composite data

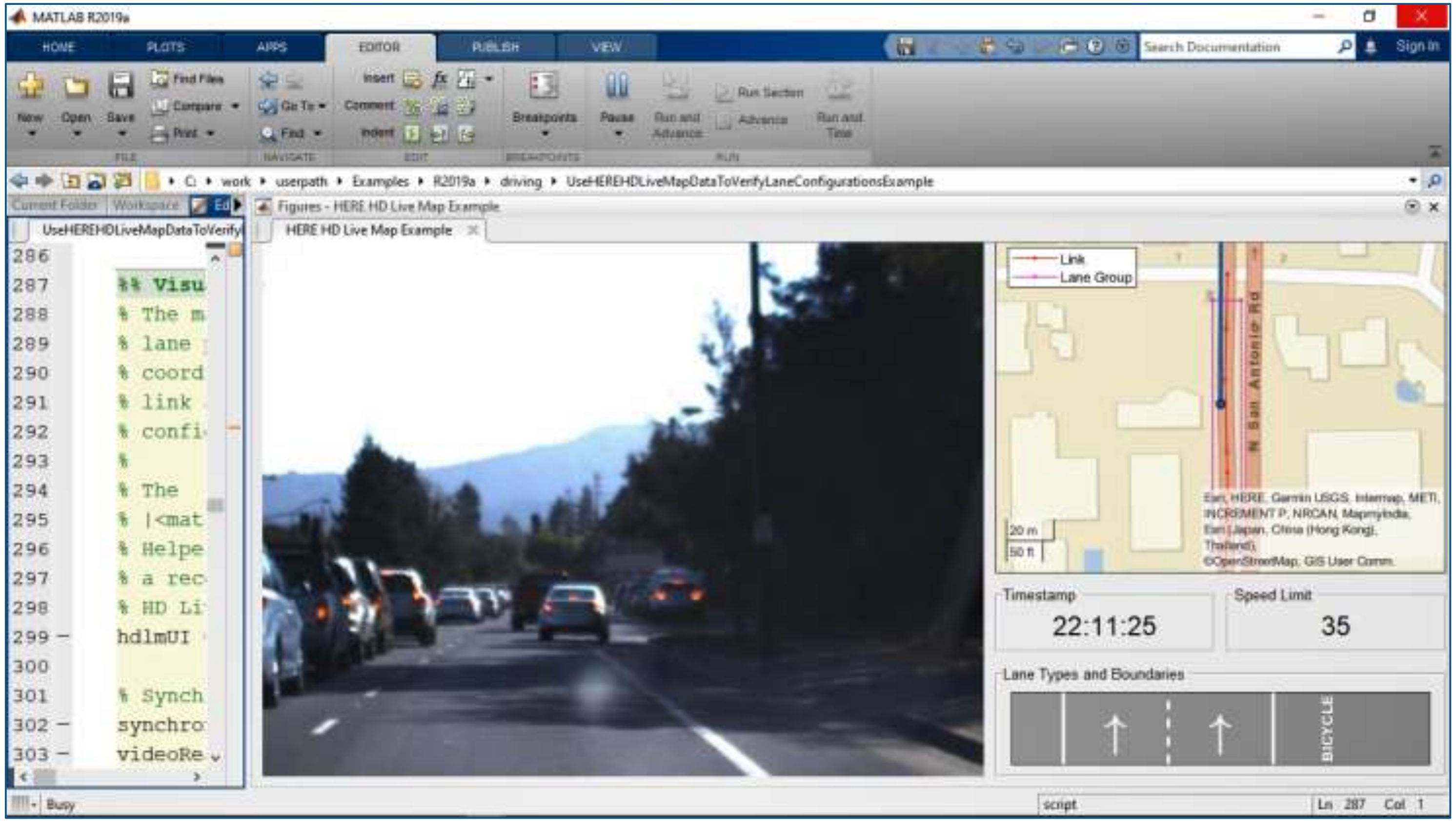


Automated Driving Toolbox™

[*Use HERE HD Live Map Data to Verify Lane Configurations*]()

Read Lane and Speed Information from HERE HD Live Map Data

- Use HERE HD Live Map data to verify lane configurations
  - Load camera and GPS data
  - Retrieve speed limit
  - Retrieve lane configurations
  - **Visualize composite data**

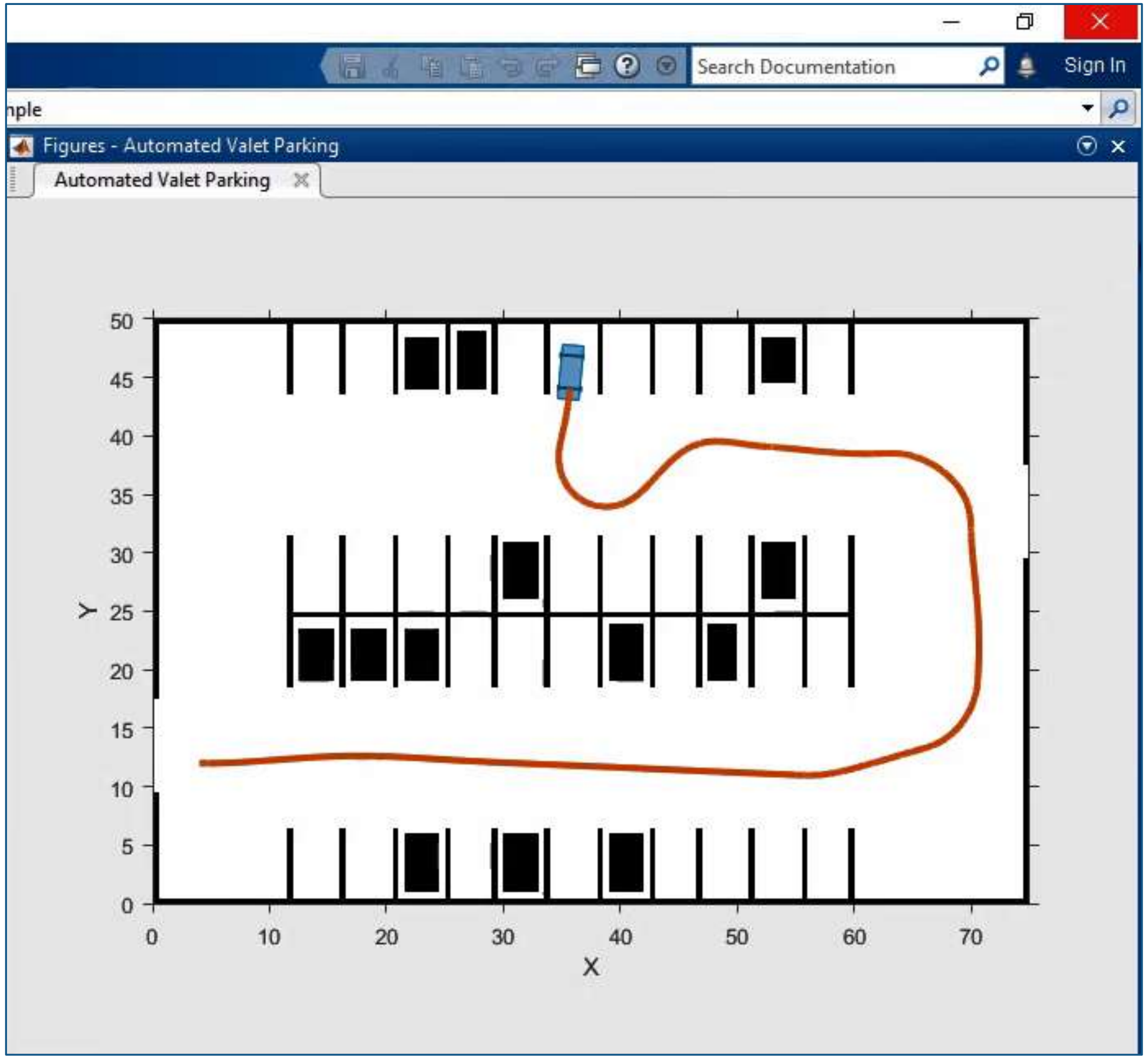


Automated Driving Toolbox™

[*Use HERE HD Live Map Data to Verify Lane Configurations Example*]

Automated Parking Valet

- Design automated parking valet path planner
  - Inflate cost map for collision checking
  - Specify goal poses
  - Plan path using Rapidly exploring Random Tree (RRT*)



Automated Driving Toolbox™

[***Automated Parking Valet Example***]

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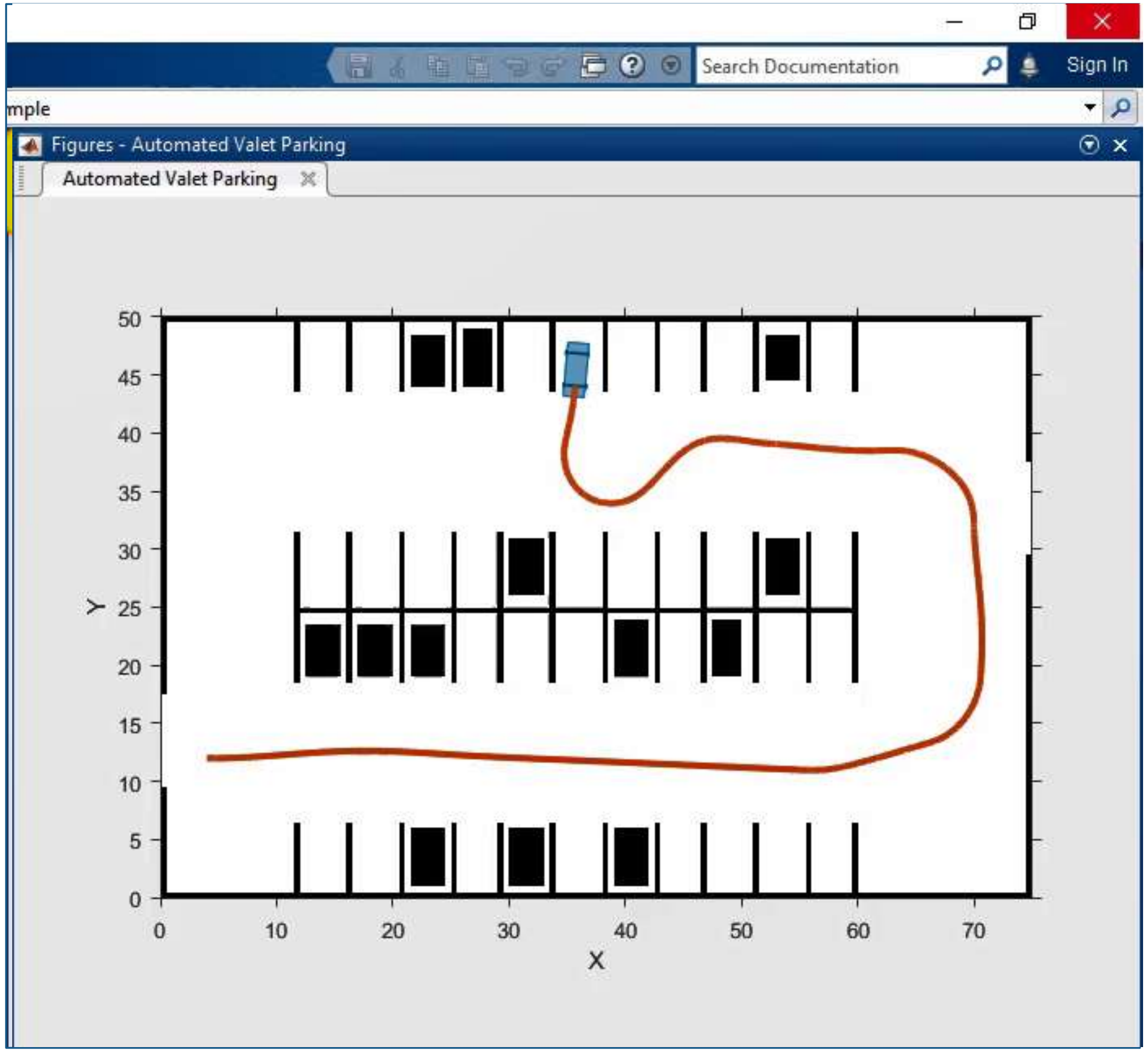
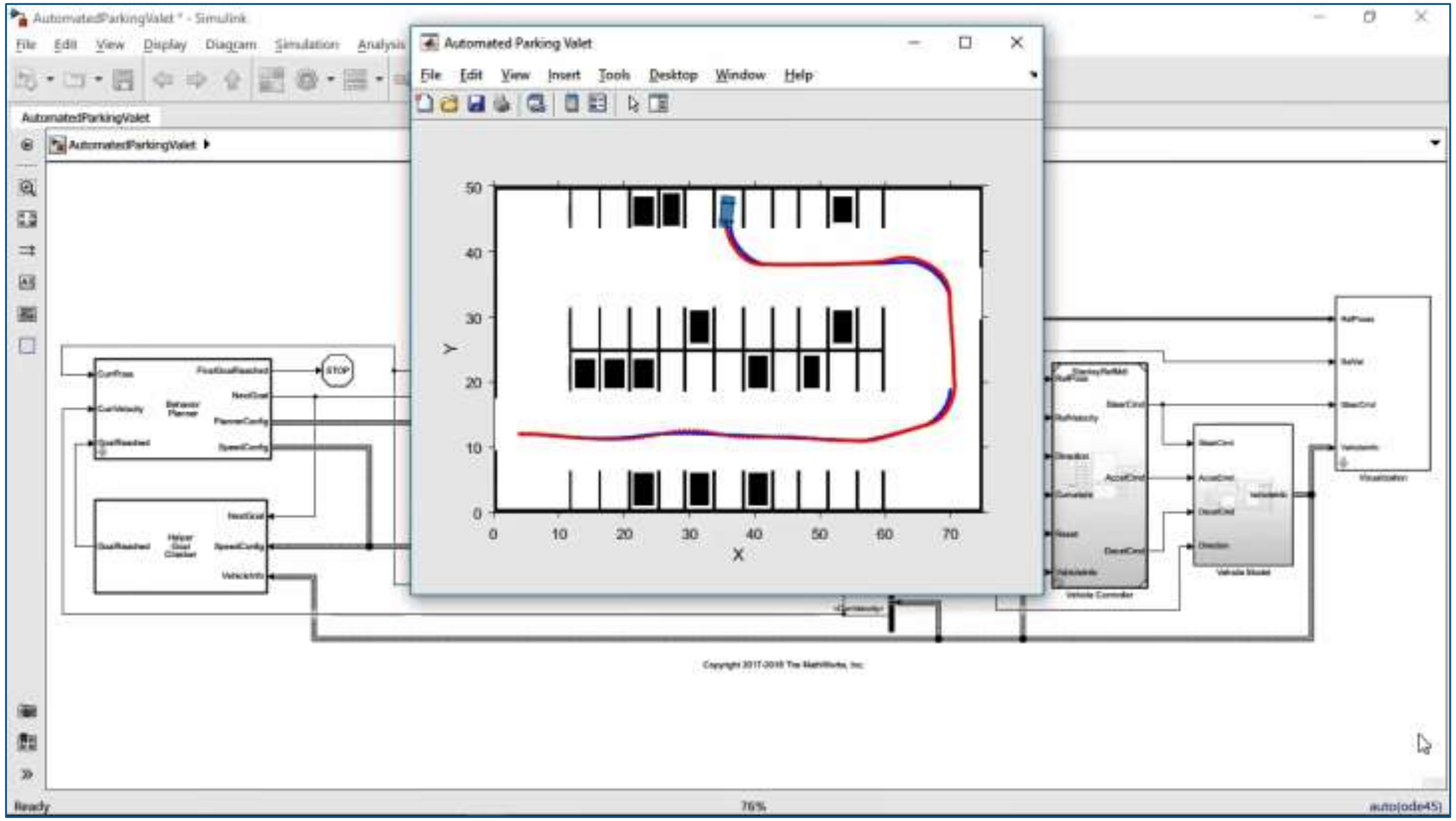


Automated Driving Toolbox™

[***Automated Parking Valet Example***]

Automated Parking Valet with Simulink

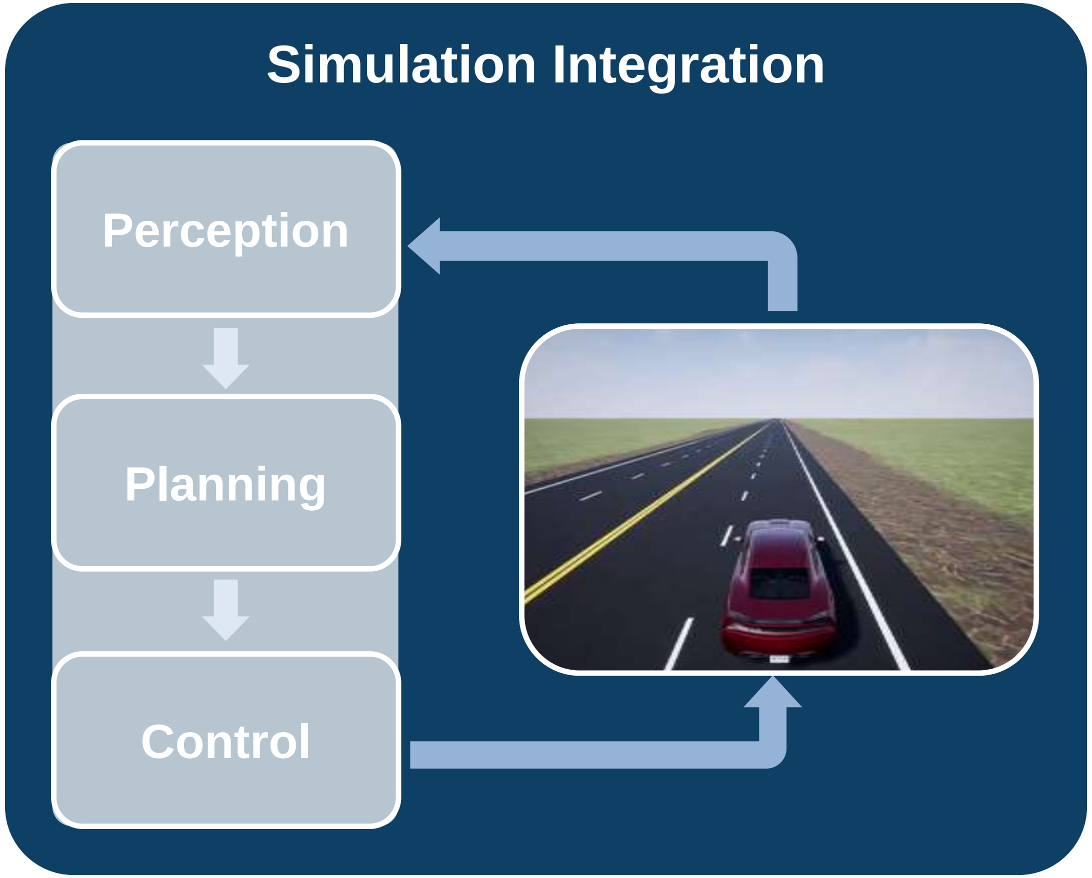
- Design automated parking valet path planner and controller
  - Design lateral controller (based on vehicle kinematics)
  - Design longitudinal controller (PID)
  - Simulate closed loop with vehicle dynamics



Automated Driving Toolbox™

[***Automated Parking Valet with Simulink Example***]

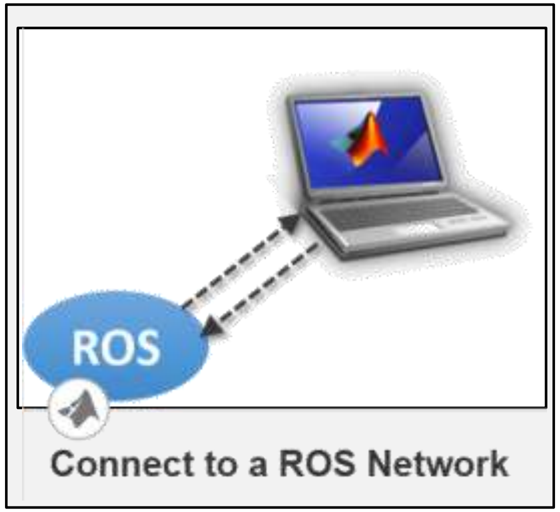
Develop Automated Driving Systems with MATLAB and Simulink



Some common integration tasks

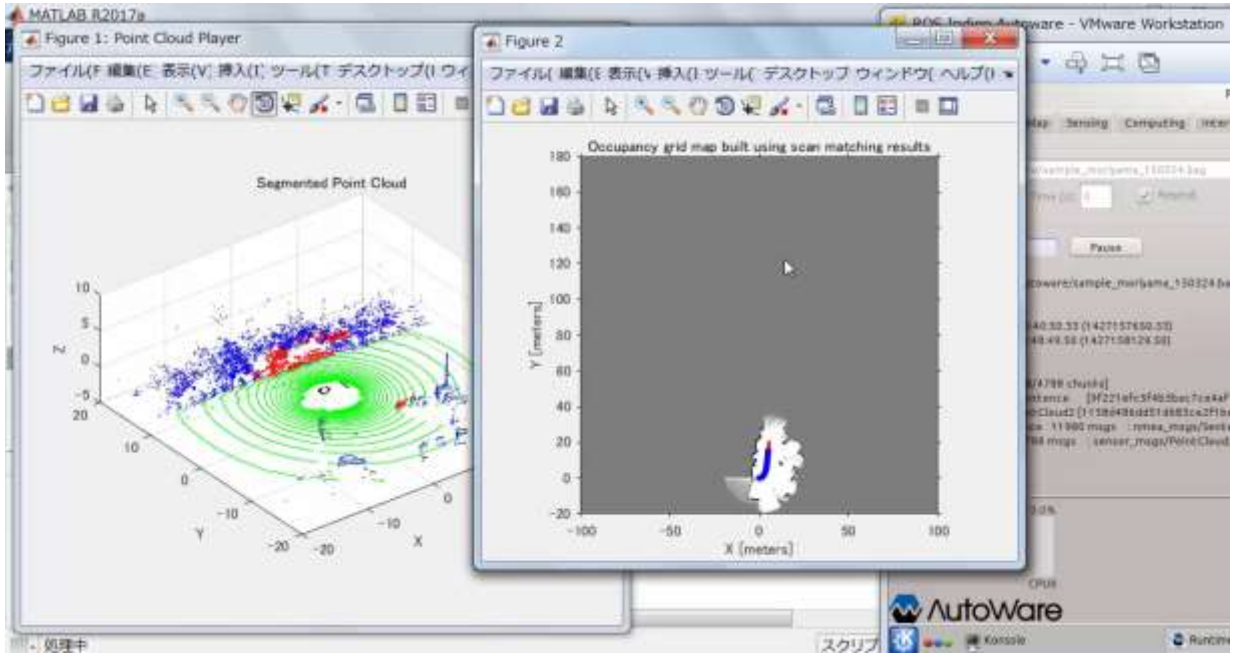
- Synthesize scenes and sensors
- Call C/C++ code
- Call Python code
- Co-simulate through FMI/FMU
- Co-simulate through ROS
- Co-simulate with Unreal Engine
- Co-simulate with third party tools
- Automate regression testing

Integrate with ROS



Communicate via ROS to integrate with externally authored ROS components

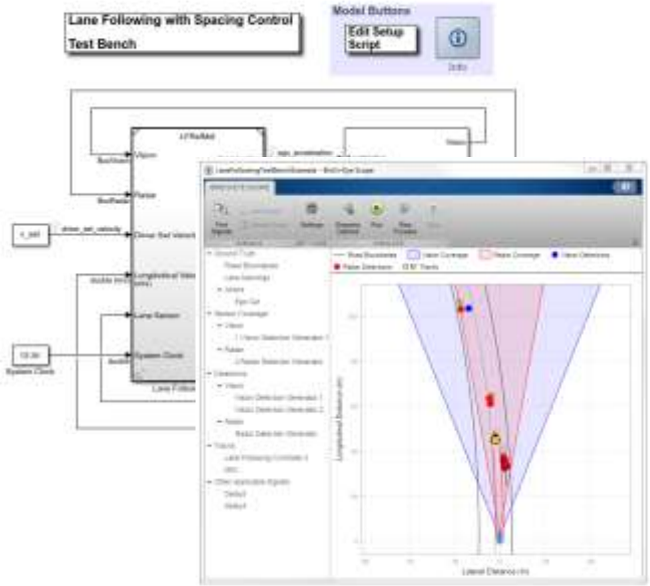
Robotics System Toolbox™

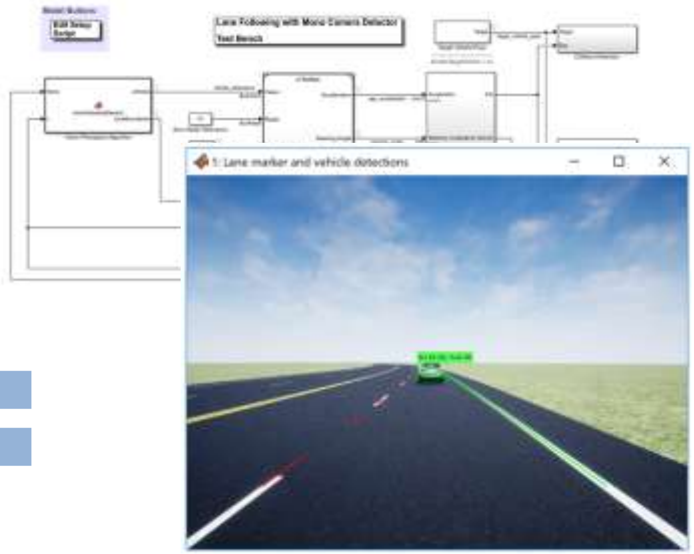


[MATLAB EXPO Japan 2017]

[More Information about ROS-MATLAB Interface :]
[https://www.mathworks.com/academia/student-competitions/tutorials-videos.html]

Simulate Integration of Controls and Perception Systems





[Lane Following Control with Sensor Fusion]

Model Predictive Control Toolbox™

Automated Driving Toolbox™

Embedded Coder®

R2018b

[Visual Perception Using Monocular Camera]

Automated Driving Toolbox™

R2017a

[Lane-Following Control with Monocular Camera Perception]

Model Predictive Control Toolbox™

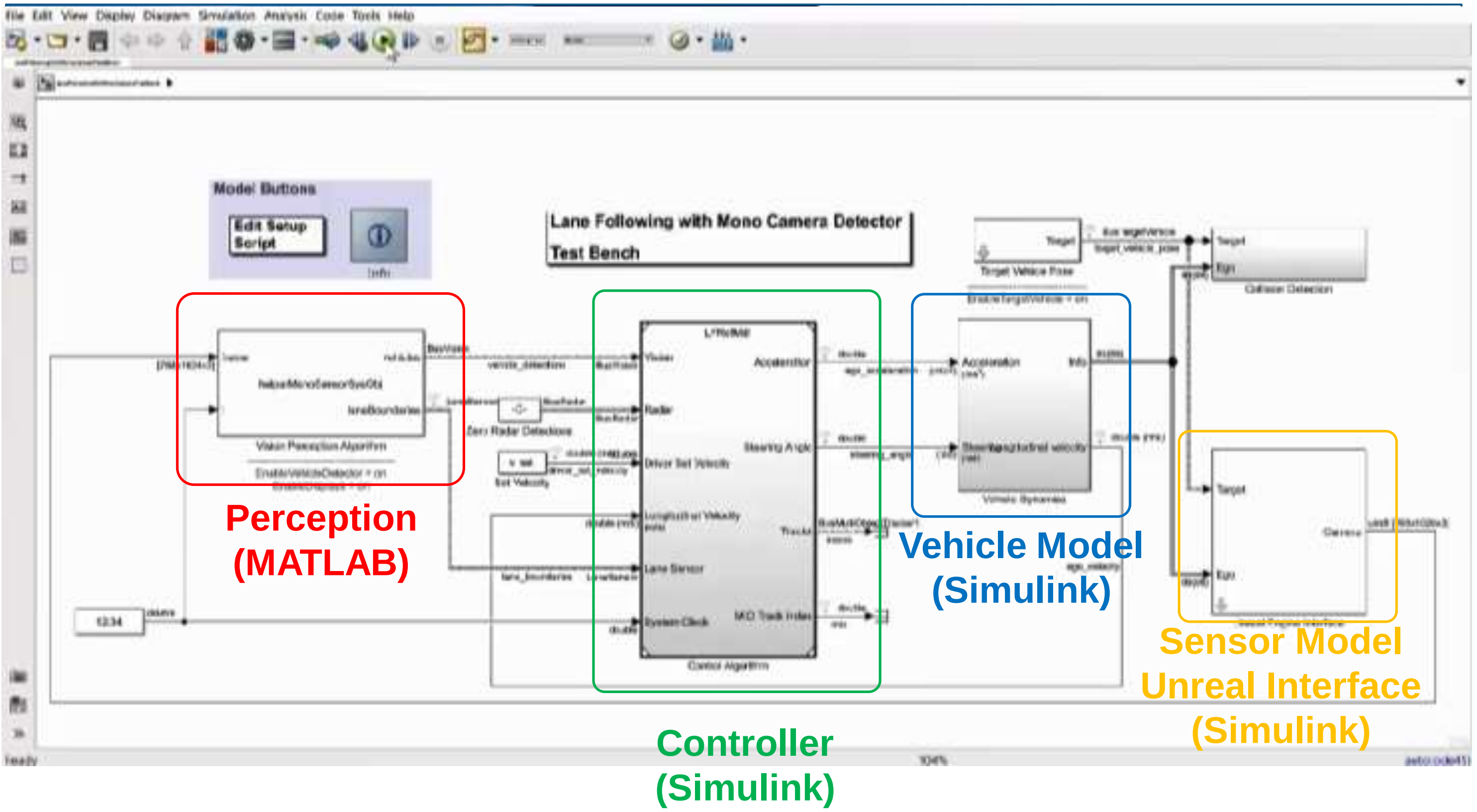
Automated Driving Toolbox™

Vehicle Dynamics Blockset™

R2018b

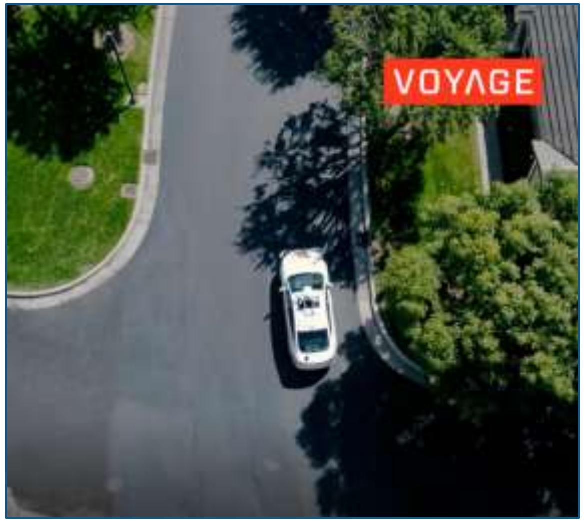
Simulate Lane Following Controller with Vision based Perception

- Lane-following control with camera perception
  - MATLAB perception
    - Lane boundary detector
    - Vehicle detector
  - Simulink controller
    - Lane follower
    - Spacing control
  - Add Simulink vehicle model
  - Synthesize ideal camera image from Unreal Engine



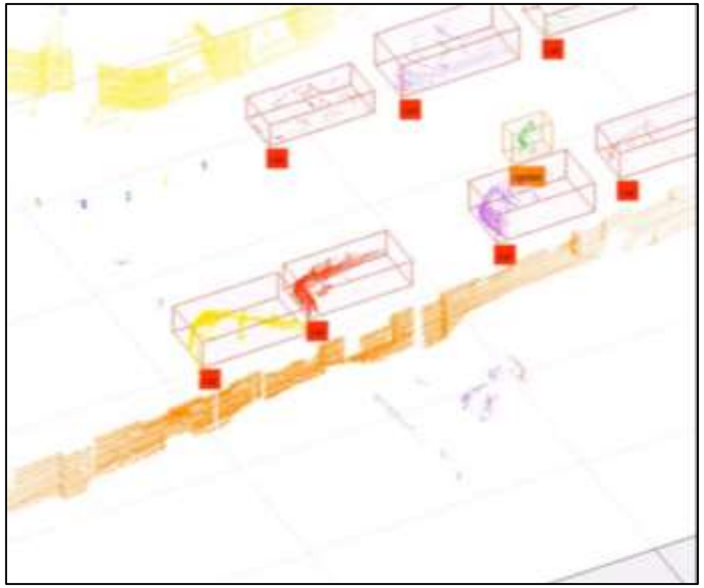
Automated Driving Toolbox™
Vehicle Dynamics Blockset™
[***Lane-Following Control with Monocular Camera Perception Example***]

MathWorks Can Help You Customize MATLAB and Simulink for Your Automated Driving Application



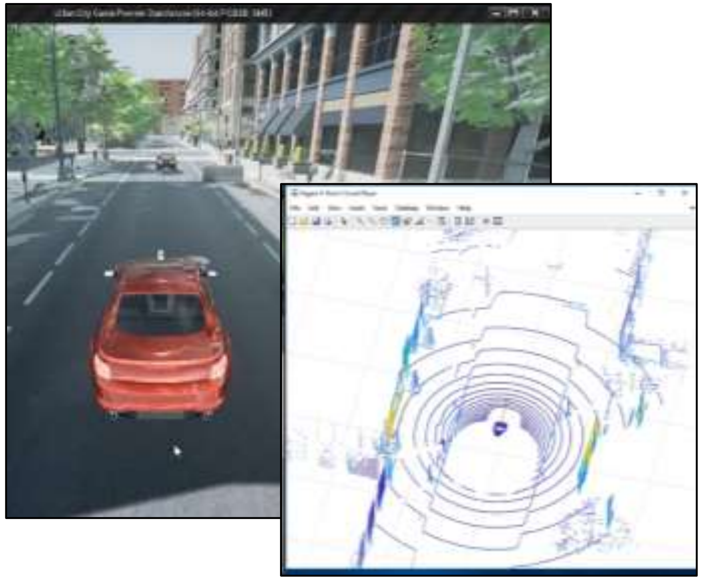
Voyage develops MPC controller and integrates with ROS

- 2018 MathWorks Automotive Conference



Autoliv labels ground truth lidar data

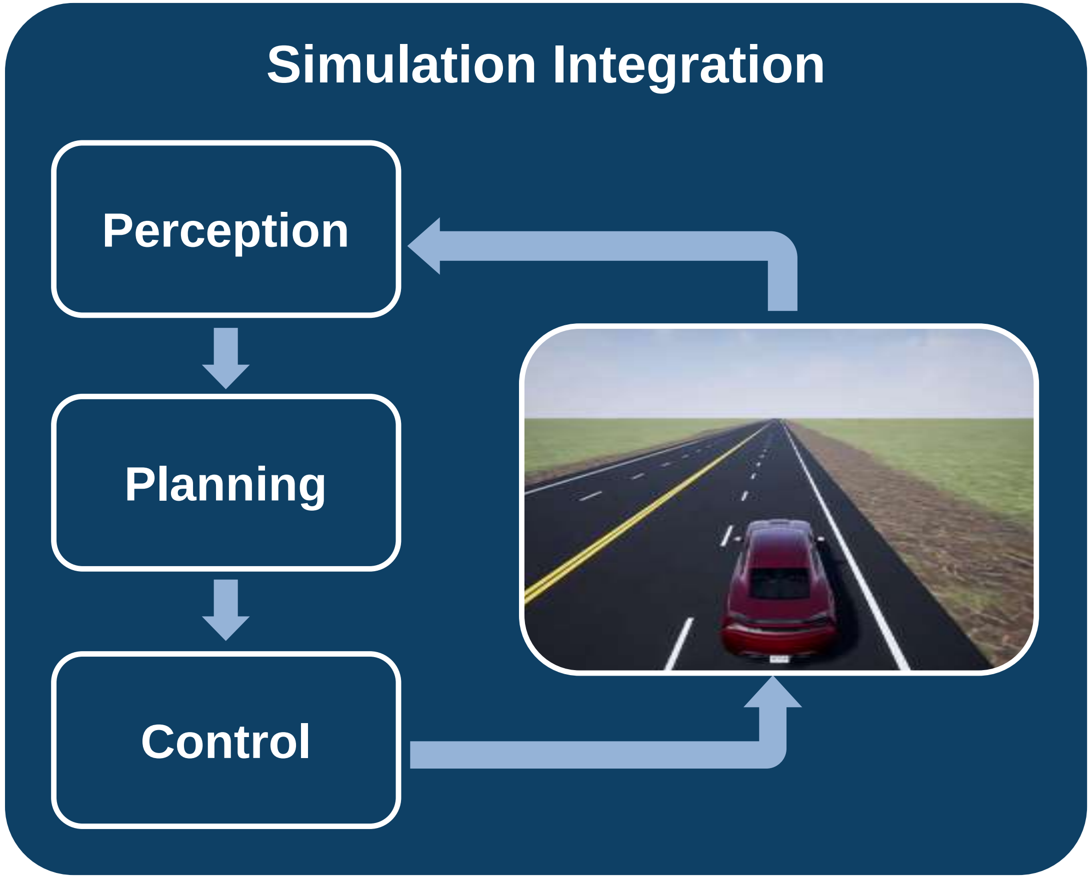
- Joint presentation with Autoliv
- SAE Paper 2018-01-0043
- 2018 MathWorks Automotive Conference



Ford tests algorithms with synthetic Lidar data from Unreal Engine

- Joint paper with Ford
- SAE Paper 2017-01-0107

Develop Automated Driving Systems with MATLAB and Simulink



Discuss your application with a MathWorks field engineer to help you structure your evaluation

- Understand your goals
- Recommend tasks
- Answer questions

MATLAB EXPO 2019

데모 부스와 상담부스로 질문 하시기 바랍니다.

감사합니다