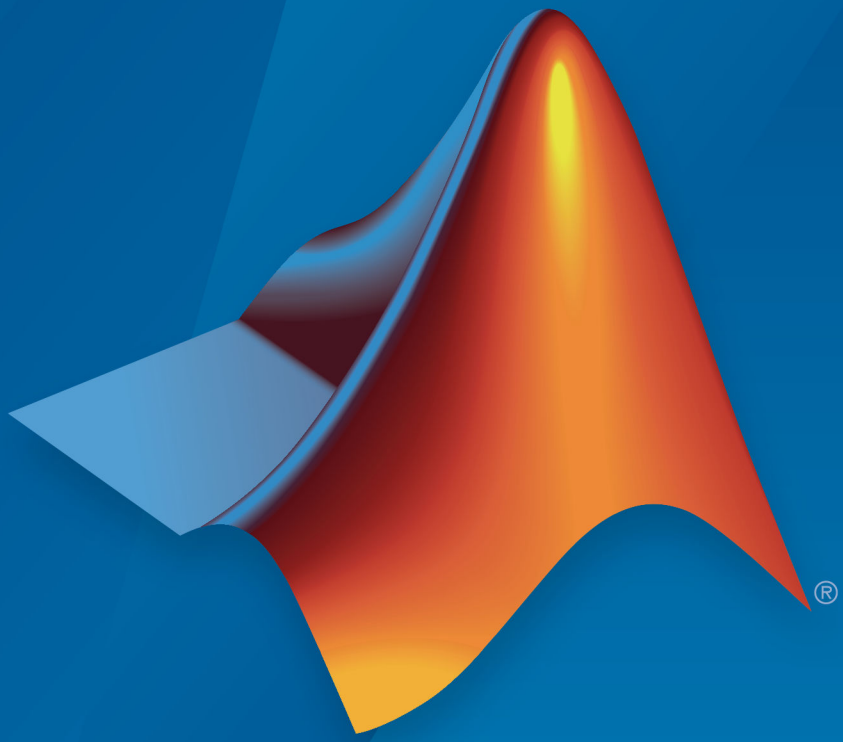
Automated Driving Toolbox™ Release Notes



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Automated Driving Toolbox™ Release Notes

Contents

R2019b

R2019a

R2018b

R2018a

R2017b

R2019b

Version: 3.0

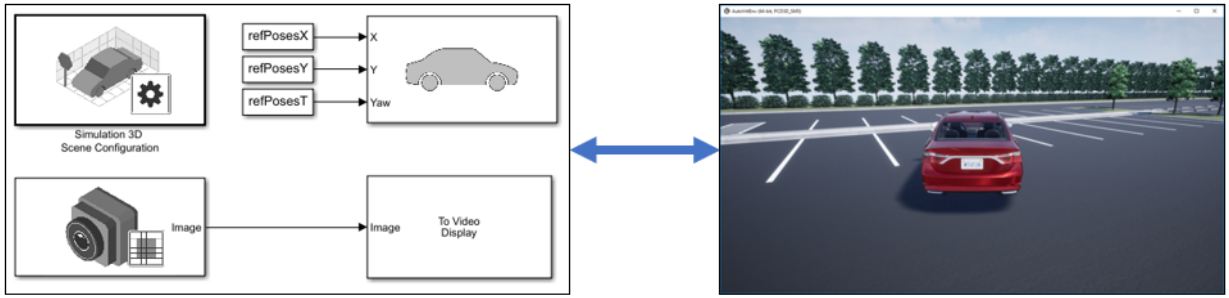
New Features

Bug Fixes

Compatibility Considerations

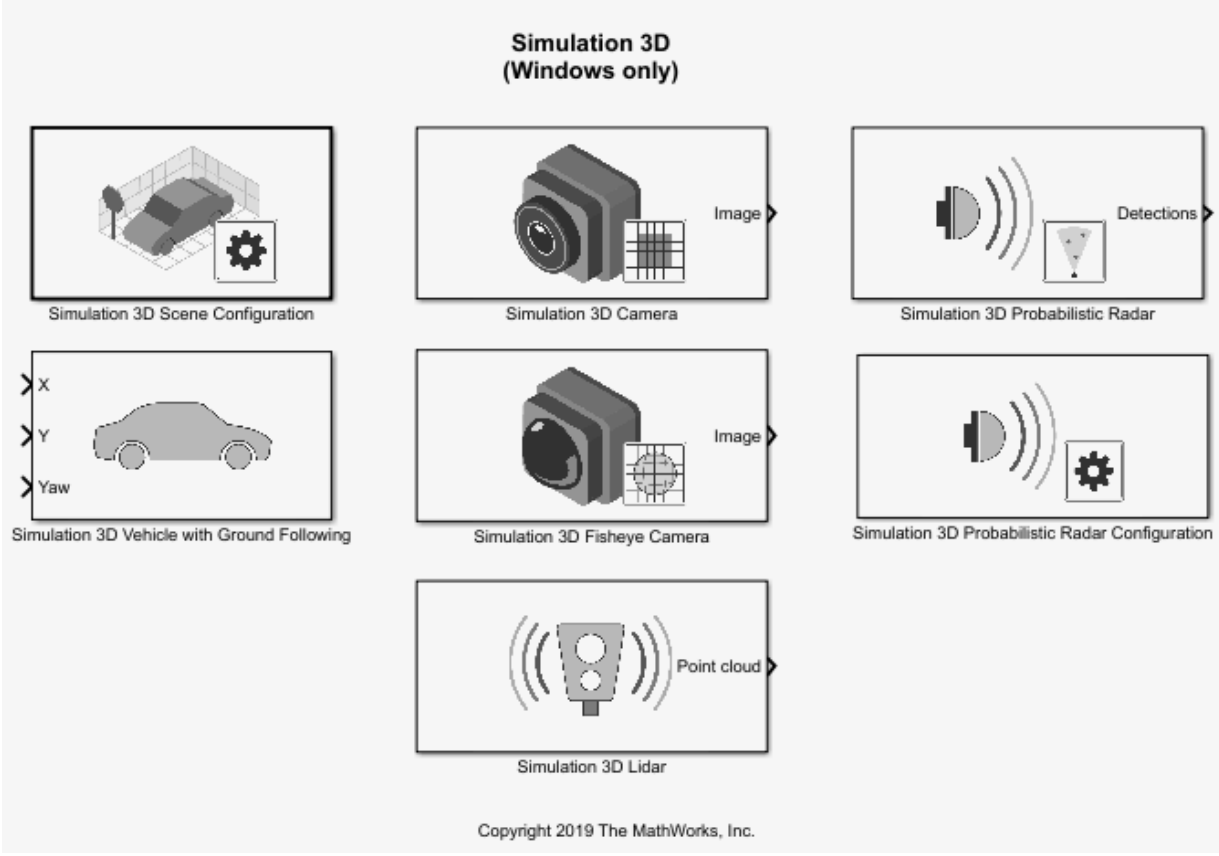
3D Simulation: Develop, test, and verify driving algorithms in a 3D simulation environment rendered using the Unreal Engine from Epic Games

Automated Driving Toolbox provides a cosimulation framework for modeling driving algorithms in Simulink® and visualizing their performance in a 3D environment. This 3D simulation environment is rendered using the Unreal Engine® from Epic Games®.



To use the provided 3D simulation blocks, open the Simulation 3D block library.

```
drivingsim3d
```



Using these blocks, you can:

- Configure prebuilt scenes in the 3D simulation environment.
- Place and move vehicles within these scenes.
- Set up camera, radar, and lidar sensors on the vehicles.
- Simulate sensor outputs based on the environment around the vehicle.
- Obtain ground truth data for semantic segmentation and depth information.

Use 3D simulation to supplement real data when developing, testing, and verifying the performance of automated driving algorithms. If you have a vehicle model, you can use sensor blocks to perform realistic closed-loop simulations that encompass the entire automated driving stack, from perception to control.

To get started, see these examples:

- “Select Waypoints for 3D Simulation”
- “Design of Lane Marker Detector in 3D Simulation Environment”
- “Visualize Automated Parking Valet Using 3D Simulation”
- “Simulate Lidar Sensor Perception Algorithm”
- “Simulate Radar Sensors in 3D Environment”

To learn more, see “Unreal Engine Driving Scenario Simulation”.

Note 3D simulation is supported on Windows® only.

drivingScenario Import: Read programmatically created driving scenarios into the Driving Scenario Designer app and Simulink

You can now import programmatically created driving scenarios into the **Driving Scenario Designer** app or Simulink by using the Scenario Reader block. You can create programmatic driving scenarios by generating a `drivingScenario` object from the app or specifying a `drivingScenario` object at the MATLAB® command line. These objects enable you to create multiple variations of scenarios. You can then import these scenarios into the app or into Simulink and test your driving algorithm on these variations. For more details, see “Create Driving Scenario Variations Programmatically”.

Driving Scenario Designer Export to Simulink: Generate Simulink models of driving scenarios and sensors

You can now generate a Simulink model from a scenario developed using the **Driving Scenario Designer** app. The generated models contain a Scenario Reader that reads roads and actors from the scenario and sensor detections blocks that recreate the sensors defined in the app. For more details on generating these blocks, see “Generate Sensor Detection Blocks Using Driving Scenario Designer”.

drivingScenario Enhancements: Create roads with driving, parking, border, shoulder, and restricted lanes

Use the `laneType` function to define different lane types for roads in a driving scenario. You can define driving, parking, border, shoulder, and restricted lanes. To create a driving scenario containing roads with different types of lanes, follow these steps:

1. Define lane types by using the `laneType` function to create a lane type object.
2. Create lane specifications for a road by using the `lanespec` function. Add the lane type object to lane specifications by using the `'Type'` name-value pair of the `lanespec` function.
3. Add roads with specified lanes to the driving scenario by using the `road` function.

roadNetwork Enhancements: Import additional lane types of OpenDRIVE roads into a driving scenario

You can now read and import parking, border, shoulder, and restricted lane types in an OpenDRIVE® road network into a driving scenario by using the `roadNetwork` function. Previously, only driving lanes were supported. To show lane types in the driving scenario plot, use the `'ShowLaneTypes'` name-value pair of the `roadNetwork` function.

Bird's-Eye Scope World Coordinates View: Visualize scenarios in world coordinates

Using the **Bird's-Eye Scope**, you can now view the ground truth of a scenario in world coordinates. Previously, the scope displayed scenarios in vehicle coordinates only. You can simultaneously view scenarios in both vehicle coordinates and world coordinates.

Velocity Profiler: Generate the velocity profile of a driving path given kinematic constraints

The Velocity Profiler block generates a velocity profile of a driving path that satisfies a set of specified kinematic constraints. These constraints include the physical limitations of the vehicle and comfort criteria such as maximum allowable speed, maximum lateral acceleration, and maximum longitudinal jerk.

You can use the generated velocity profile as the input reference velocities of a longitudinal controller, as shown in the “Automated Parking Valet in Simulink” example.

For more details on using the Velocity Profiler block, see these examples:

- “Velocity Profile of Straight Path”
- “Velocity Profile of Path with Curve and Direction Change”

Ground Truth Labeling Enhancements: Copy and paste pixel labels, improved pan and zoom, and improved frame navigation

With the **Ground Truth Labeler** app, you can now:

- Copy and paste pixel labels
- Pan and zoom more easily within the labeling window.
- Navigate to a specific frame by clicking on the scrubber or visual summary timeline

Lane Boundary Detection Algorithm: Automate the labeling of lane boundaries using the Ground Truth Labeler

The **Ground Truth Labeler** app now includes a built-in algorithm for automating the labeling of lane boundaries in a video or image sequence. Select this algorithm from the **Automate Labeling** section of the app toolstrip.

Lidar Example: Build a map from lidar data

The “Build a Map from Lidar Data” example shows how to process 3-D lidar sensor data to progressively build a map, with assistance from inertial measurement unit (IMU) readings. You can use these built maps to plan paths for vehicle navigation or to perform localization. The example also shows how to evaluate and improve the built maps using global positioning system (GPS) readings.

This example requires a Mapping Toolbox™ license.

Track-to-Track Fusion Example: Fuse tracks from multiple vehicles to increase automotive safety (requires Sensor Fusion and Tracking Toolbox)

The “Track-to-Track Fusion for Automotive Safety Applications” example shows how to fuse tracks from multiple vehicles to provide a more comprehensive estimate of the

environment than can be seen by either vehicle alone. This example requires a Sensor Fusion and Tracking Toolbox™ license.

HERE HD Live Map Linux Support: Read and visualize high-definition map data on Linux machines

`hereHDLMReader` objects are now supported on Linux machines. The HERE HD Live Map service is now supported on all platforms (Windows, Mac, and Linux®).

YOLO v2 Acceleration: Acceleration support for YOLO v2 object detection

The `detect` function used with `yolov2ObjectDetectorMonoCamera` objects now supports performance optimization in both CPU and GPU execution environments. To set the performance optimization, use the `'Acceleration'` name-value pair of the `detect` function.

Code Generation: Generate C/C++ code using MATLAB Coder

These objects and functions now support code generation:

- `acfObjectDetectorMonoCamera`
- `birdsEyeView`
- `segmentLaneMarkerRidge`

Functionality being removed or changed

InflationRadius and VehicleDimensions properties of vehicleCostmap object will be removed
Warns

The `InflationRadius` and `VehicleDimensions` properties of `vehicleCostmap` objects will be removed in a future release. Instead:

1. Use the `inflationCollisionChecker` function to create an `InflationCollisionChecker` object, which has the properties `InflationRadius` and `VehicleDimensions`.

2 Specify this object as the value of the `CollisionChecker` property of `vehicleCostmap`.

If you do specify these properties for `vehicleCostmap`, the values in the corresponding properties of `CollisionChecker` are updated to match.

When the `vehicleCostmap` object was introduced in R2018a, this object inflated obstacles based on the specified inflation radius and vehicle dimensions only. The `InflationCollisionChecker` object, which is specified in the `CollisionChecker` property of `vehicleCostmap`, provides additional configuration options for inflating obstacles. For example, you can specify the number of circles used to compute the inflation radius, enabling more precise collision checking.

Update Code

The table shows a typical usage of the `InflationRadius` and `VehicleDimensions` properties of `vehicleCostmap`. It also shows how to update your code by using the corresponding properties of an `InflationCollisionChecker` object.

Discouraged Usage	Recommended Replacement

`vehicleDims = vehicleDimensions(5,2);`
`inflationRadius = 1.2;`
`costmap = vehicleCostmap(C, ...`
`  'VehicleDimensions',vehicleDims, ...`
`  'InflationRadius',inflationRadius);`
	`vehicleDims = vehicleDimensions(5,2);`
	`inflationRadius = 1.2;`
	`ccConfig = inflationCollisionChecker(vehicleDims, ...`
	`  'InflationRadius',inflationRadius);`
	`costmap = vehicleCostmap(C, ...`
	`  'CollisionChecker',ccConfig);`

R2019a

Version: 2.0

New Features

Bug Fixes

HERE HD Live Map Reader: Read and visualize data from high-definition maps designed for automated driving applications

Use the `hereHDLMReader` object to read road and lane network data from the HERE HD Live Map[1] (HDLM) web service, provided by HERE Technologies. HERE HDLM content provides highly detailed and accurate information about the vehicle environment and is suitable for applications such as localization, scenario generation, navigation, and path planning.

To configure the reader object to read in map data from a specific catalog or version, use a `hereHDLMConfiguration` object. To manage your HERE HDLM credentials, use the `hereHDLMCredentials` function.

For more details, see Access HERE HD Live Map Data. For an example, see Use HERE HD Live Map Data to Verify Lane Configurations.

Note HERE HDLM reader objects do not work on Linux machines.

Custom Basemaps: Choose geographic basemaps on which to visualize driving routes in geoplayer

The `geoplayer` object now supports the use of custom basemaps from providers such as HERE Technologies and OpenStreetMap®. To specify a custom basemap, use the `addCustomBasemap` function. To remove a custom basemap, use the `removeCustomBasemap` function.

Scenario Reader: Read driving scenarios into Simulink to test vehicle controllers and sensor fusion algorithms

The Scenario Reader block reads the roads and actors from a scenario file created using the **Driving Scenario Designer** app. Use the output actor poses and lane boundaries to test your vehicle control and sensor fusion models. The block supports open-loop and closed-loop models and can return outputs in either vehicle coordinates or world coordinates.

For more details on using the Scenario Reader block, see these examples:

1. You need to enter into a separate agreement with HERE in order to gain access to the HDLM services and to get the required credentials (app_id and app_code) for using the HERE Service.

- Test Open-Loop ADAS Algorithm Using Driving Scenario
- Test Closed-Loop ADAS Algorithm Using Driving Scenario

Ground Truth Labeling: Organize labels by logical groups, use assisted freehand for pixel labeling, and other enhancements

With the **Ground Truth Labeler** app, you can now:

- Create groups for organizing label definitions. You can also move labels between groups by dragging them.
- Use the assisted freehand to create pixel regions of interest (ROIs) for semantic segmentation. This tool automatically find edges between selected points in an image.
- Move multiple selected ROIs in an image.
- Edit previously created label definitions.
- Add additional list items to a previously created attribute.

Longitudinal Controller: Control the velocity of autonomous vehicles

The Longitudinal Controller Stanley block computes the acceleration and deceleration commands needed to control the velocity of a vehicle. The block computes these commands using the discrete proportional-integral control law. Use this block in a closed-loop simulation to adjust the velocity of a vehicle as it follows a path.

Dynamic Lateral Controller: Control the steering angle of autonomous vehicles considering realistic vehicle dynamics

The Lateral Controller Stanley block now includes an option to specify a dynamic bicycle vehicle model. Use this model to compute the steering angle of vehicles in highway scenarios or other high-speed environments.

Path Smoother: Smooth a planned vehicle path

Use the Path Smoother Spline block and `smoothPathSpline` function to smooth paths that were planned using a `pathPlannerRRT` object or other path planner. To generate a

smoothed path, the block and function fit a parametric cubic spline onto the original path. The generated paths are smooth enough for vehicle controllers to execute.

Code Generation for Path Planning: Generate C/C++ code for vehicle path planning using MATLAB Coder

These path planning functions and objects now support code generation:

- `vehicleDimensions`
- `inflationCollisionChecker`
- `vehicleCostmap`
- `checkFree`
- `checkOccupied`
- `getCosts`
- `setCosts`
- `pathPlannerRRT`
- `plan`
- `driving.Path`
- `interpolate`
- `driving.DubinsPathSegment`
- `driving.ReedsSheppPathSegment`
- `checkPathValidity`
- `smoothPathSpline`

For information on code generation limitations for any function or object, see its individual reference page. For a code generation example, see Code Generation for Path Planning and Vehicle Control.

You can also generate code from these functions and objects in Simulink by using the MATLAB Function block.

YOLO v2 Object Detection: Detect objects in a monocular camera using a "you-only-look-once" v2 deep learning object detector

The `configureDetectorMonoCamera` function can now configure a YOLO v2 object detector, returning a `yolov2ObjectDetectorMonoCamera` object.

Scenario Generation Example: Generate virtual driving scenarios from recorded vehicle data

The Scenario Generation from Recorded Vehicle Data example shows how to generate a virtual driving scenario from GPS and lidar data recorded from a vehicle.

Using virtual scenarios, you can:

- Visualize and study the real scenario being recreated from the recorded vehicle data.
- Synthesize scenario variations by programmatically modifying the virtual scenario. You can use these variations when designing and evaluating autonomous driving systems.

Tracking Examples: Track vehicles using lidar; evaluate the performance of extended object trackers

The Track Vehicles Using Lidar: From Point Cloud to Track List example shows how to use a joint probabilistic data association (JPDA) tracker to track vehicles with a lidar sensor.

In addition, the Extended Object Tracking example now shows how to track extended objects using a probability hypothesis density (PHD) tracker. The example also shows how to use error and assignment metrics to evaluate the results of different trackers.

These examples require a Sensor Fusion and Tracking Toolbox license.

R2018b

Version: 1.3

New Features

Bug Fixes

Compatibility Considerations

Bird's-Eye Scope for Simulink: Analyze sensor coverages, detections, and tracks in your model

The **Bird's-Eye Scope** displays streaming detections and object tracks from your model on a bird's-eye plot. You can use the **Bird's-Eye Scope** to:

- Inspect the coverage areas of radar and vision sensors.
- Analyze the sensor detections of lanes and actors in a driving scenario.
- Analyze the tracks of moving objects.

To get started using the scope, see Visualize Sensor Data and Tracks in Bird's-Eye Scope.

Prebuilt Driving Scenarios: Test driving algorithms using Euro NCAP and other prebuilt scenarios

In the **Driving Scenario Designer** app, you can now test that your algorithms comply with ADAS industry standards by using prebuilt Euro NCAP® driving scenarios. These scenarios model multiple variations of Euro NCAP test procedures for lane keeping assist, automatic emergency braking, and emergency lane keeping. For more details, see Generate Synthetic Detections from a Euro NCAP Scenario and the Automatic Emergency Braking with Sensor Fusion example.

In addition to Euro NCAP scenarios, the app includes prebuilt driving scenarios of common driving maneuvers at intersections. See Generate Synthetic Detections from a Prebuilt Driving Scenario

OpenDRIVE File Import Support: Load OpenDRIVE roads into a driving scenario

In the **Driving Scenario Designer** app, you can now include roads built using the OpenDRIVE format specification. For more details, see Add OpenDRIVE Roads to Driving Scenario.

You can also load these roads into a `drivingScenario` object by using the `roadNetwork` function.

Improved Collision Checking in vehicleCostmap Object: Configure collision checking to plan paths through narrow passages

The `inflationCollisionChecker` function creates a configuration object that specifies how the `vehicleCostmap` object checks for collisions. You can use this collision-checking configuration object to reduce the amount of obstacle inflation in the costmap. By reducing this inflation amount, path planning algorithms can plan collision-free paths through narrow passages such as parking spots.

For compatibility considerations, see “InflationRadius and VehicleDimensions properties of vehicleCostmap object are not recommended” on page 3-5.

Kinematic Lateral Controller: Control the steering angle of an autonomous vehicle

The Lateral Controller Stanley block and `lateralControllerStanley` function compute the steering angle of a vehicle using the Stanley method, a kinematic control algorithm. Use this block or function in a closed-loop simulation to adjust the steering angle of a vehicle as it follows a path. To learn more, see Lateral Control Tutorial.

Monocular Camera Parameter Estimation: Configure a monocular camera by estimating its extrinsic parameters

The `estimateMonoCameraParameters` function estimates the extrinsic parameters of a monocular camera that has been calibrated using a checkerboard pattern. For more details, see Calibrate a Monocular Camera.

Radar Sensor Model Enhancements: Model occlusions in radar sensors

In the `radarDetectionGenerator` System object™, use the `HasOcclusion` property to generate detections only from objects for which the radar has a direct line of sight.

Obtain transition poses and direction changes from a planned path

The `driving.Path` object returned by `pathPlannerRRT` now contains more specific descriptions of path segments, including their motion lengths, motion directions, and motion types (Dubins or Reeds-Shepp). Use the `interpolate` function to sample poses along the path, including transition poses, and to return changes in direction. You can then use these sampled poses and direction changes to develop a path smoothing algorithm.

For compatibility considerations, see “connectingPoses function and driving.Path object properties KeyPoses and NumSegments are not recommended” on page 3-6.

Define multiple custom labels in Ground Truth Labeler connector

You can now synchronize the **Ground Truth Labeler** app with external labeling tools containing multiple custom labels. Specify these labels and their descriptions using the `LabelName` and `LabelDescription` properties of the `driving.connector.Connector` class.

Ground Truth Labeler enhancements

The **Ground Truth Labeler** app now includes visuals indicating the relationship between the labels and sublabels of an image. For more details on the label-sublabel relationship, see Use Sublabels and Attributes to Label Ground Truth Data (Computer Vision System Toolbox).

In addition, in the Label Summary window, you can now navigate between unlabeled frames. For more details on the Label Summary window, see View Summary of Ground Truth Labels (Computer Vision System Toolbox).

Actors follow road elevation and banking angles in Driving Scenario Designer

In the **Driving Scenario Designer** app, when you create an actor and specify waypoints for it to follow, the actor now travels along the elevation angle and banking angle of the road.

Monocular camera setup with fisheye lens example

The Configure Monocular Fisheye Camera example shows how to set up a monocular camera that has a fisheye lens.

Sensor fusion and tracking examples

The following examples require a Sensor Fusion and Tracking Toolbox license.

- The Extended Object Tracking example shows how to track objects whose dimensions span multiple sensor resolution cells.
- The Visual-Inertial Odometry Using Synthetic Data example shows how to estimate the pose (position and orientation) of a vehicle by using an inertial measurement unit (IMU) and a monocular camera.

Functionality being removed or changed

InflationRadius and VehicleDimensions properties of vehicleCostmap object are not recommended
Still runs

The `InflationRadius` and `VehicleDimensions` properties of `vehicleCostmap` are not recommended. Instead:

1. Use the `inflationCollisionChecker` function to create an `InflationCollisionChecker` object, which has the properties `InflationRadius` and `VehicleDimensions`.
2. Specify this object as the value of the `CollisionChecker` property of `vehicleCostmap`.

There are no current plans to remove the `InflationRadius` and `VehicleDimensions` properties of `vehicleCostmap`. If you do specify these properties, the values in the corresponding properties of `CollisionChecker` are updated to match.

When the `vehicleCostmap` object was introduced in R2018a, this object inflated obstacles based on the specified inflation radius and vehicle dimensions only. The `InflationCollisionChecker` object, which is specified in the `CollisionChecker` property of `vehicleCostmap`, provides additional configuration options for inflating obstacles. For example, you can specify the number of circles used to represent the vehicle shape, enabling more precise collision checking.

Update Code

The table shows a typical usage of the `InflationRadius` and `VehicleDimensions` properties of `vehicleCostmap`. It also shows how to update your code using the corresponding properties of an `InflationCollisionChecker` object.

Discouraged Usage	Recommended Replacement

`vehicleDims = vehicleDimensions(5,2);`
`inflationRadius = 1.2;`
`costmap = vehicleCostmap(C, ...`
`    'VehicleDimensions',vehicleDims, ...`
`    'InflationRadius',inflationRadius);`
	`vehicleDims = vehicleDimensions(5,2);`
	`inflationRadius = 1.2;`
	`ccConfig = inflationCollisionChecker(vehicleDims, ...`
	`    'InflationRadius',inflationRadius);`
	`costmap = vehicleCostmap(C, ...`
	`    'CollisionChecker',ccConfig);`

connectingPoses function and driving.Path object properties KeyPoses and NumSegments are not recommended

Still runs

The `connectingPoses` function and the `KeyPoses` and `NumSegments` properties of the `driving.Path` object are not recommended. Instead, use the `interpolate` function, which returns key poses, connecting poses, transition poses, and direction changes. The `KeyPoses` and `NumSegments` properties are no longer relevant. `KeyPoses`, `NumSegments`, and `connectingPoses` will be removed in a future release.

In R2018a, `connectingPoses` enabled you to obtain intermediate poses either along the entire path or along the path segments that are between key poses (as specified by `KeyPoses`). Using the `interpolate` function, you can now obtain intermediate poses at any specified point along the path. The `interpolate` function also provides transition poses at which changes in direction occur.

Update Code

Remove all instances of `KeyPoses` and `NumSegments` and replace all instances of `connectingPoses` with `interpolate`. The table shows typical usages of `connectingPoses` and how to update your code to use `interpolate` instead. Here, `path` is a `driving.Path` object returned by `pathPlannerRRT`.

Discouraged Usage	Recommended Replacement
`poses = connectingPoses(path);`	`poses = interpolate(path);`

Discouraged Usage	Recommended Replacement

`segID = 1;`
`posesSegment = connectingPoses(path,segID);`
	`interpolate` does not have a direct syntax for obtaining segment poses. However, you can sample poses of a segment using a specified step time. For example:
	
	`step = 0.1;`
	`samples = 0 : step : path.PathSegments(1).Length`
	`segmentPoses = interpolate(path,samples);`

Corrections to Image Width and Image Height camera parameters of Driving Scenario Designer
Behavior change

Starting in R2018b, in the **Camera Settings** group of the **Driving Scenario Designer** app, the **Image Width** and **Image Height** parameters set their expected values. Previously, **Image Width** set the height of images produced by the camera, and **Image Height** set the width of images produced by the camera.

If you are using R2018a, to produce the expected image sizes, transpose the values set in the **Image Width** and **Image Height** parameters.

R2018a

Version: 1.2

New Features

Compatibility Considerations

Driving Scenario Designer: Interactively define actors and driving scenarios to test controllers and sensor fusion algorithms

Use the **Driving Scenario Designer** app to design a synthetic driving scenario composed of roads and actors (vehicles, pedestrians, and so on). You can generate visual and radar detections of actors in the scenario to test your sensor fusion and control algorithms. To learn how to generate detections, see Generate Synthetic Detections from an Interactive Driving Scenario.

Path Planning: Plan driving paths using an RRT* path planner and costmap

Use the `pathPlannerRRT`, `vehicleCostmap`, and `checkPathValidity` functions to plan a driving path by using an optimal rapidly exploring random tree (RRT*) motion-planning algorithm. To learn how to use these functions to plan a path, see the Automated Parking Valet example.

Streaming Geographic Map Display: Visualize a geographic route on a map

Use the `geoplayer` function to create an interactive map that displays the streaming geographic coordinates of a driving route.

Ground Truth Pixel Labeling: Interactively label individual pixels in video data

In the **Ground Truth Labeler** app, you can now interactively label individual pixels in video data for training semantic segmentation algorithms. You can also automate the labeling. See Automate Ground Truth Labeling for Semantic Segmentation.

Ground Truth Label Attributes: Organize and classify ground truth labels using attributes and sublabels

In the **Ground Truth Labeler** app, you can now attach attributes to labels and create hierarchical sublabels. For more details, see Define Ground Truth Data for Video or Image Sequences.

Lidar Segmentation: Quickly segment 3-D point clouds from lidar

Use the `segmentLidarData` function to segment organized point clouds into clusters.

ACC Reference Application: Use a reference model to simulate and test adaptive cruise controller (ACC) systems

The ACC reference application is a model of an ACC system implemented using sensor fusion. Use this model to design your own ACC system, test it in Simulink using synthetic radar and vision data generated by Automated Driving System Toolbox™ blocks, and automatically generate C code. To learn more, see Adaptive Cruise Control with Sensor Fusion.

Point Cloud Reader for Velodyne PCAP Files: Import Velodyne lidar data into MATLAB

Use a `velodyneFileReader` object to read point cloud data from Velodyne® packet capture (PCAP) files.

Detect lanes more precisely by using third-degree polynomial lane boundary models

Use the `cubicLaneBoundary` and `findCubicLaneBoundaries` functions to create and find lane boundaries using third-degree polynomial models. You can display detected lanes on a bird's-eye-view plot, and overlay the lane markings onto images, by using the `insertLaneBoundary` function.

Add and detect lanes in Driving Scenario

You can add lane markings to roads in a driving scenario simulation using the new lane marking function, `laneMarking`, and lane specification function, `lanespec`. The driving scenario `road` method accepts a lane specification as an input. To plot lane markings in `birdsEyePlot`, use `laneMarkingPlotter` and `plotLaneMarking`.

In addition, the vision detection generator System object, `visionDetectionGenerator`, can now detect lanes in a driving scenario simulation. The corresponding Simulink block, Vision Detection Generator, can also detect lanes.

Transform [x,y,z] locations in vehicle coordinates to image coordinates

The `vehicleToImage` method of `monoCamera` now accepts three-dimensional [*x*,*y*,*z*] point coordinates. Previously, `vehicleToImage` accepted only [*x*,*y*] coordinates. By transforming [*x*,*y*,*z*] locations in vehicle coordinates, you can display point locations above the road surface.

Path method being removed

The `path` method of the `actor` and `vehicle` classes is being removed. Use the `trajectory` method instead.

Compatibility Considerations

Functionality	Result	Use Instead	Compatibility Considerations
`path` method	Still runs	`trajectory` method	Replace all instances of `path` with `trajectory`. The `path` syntax which assumes a default speed does not exist in `trajectory`. You must specify a speed input argument.

Direction of Yaw Angle Rotation Adjusted

The `monoCamera` function was updated to correct the direction of rotation for the yaw angle.

Compatibility Considerations

Functionality	Compatibility Considerations
`monoCamera` function	If you are using R2017b version of this function, you must multiply the yaw angle by `-1`.

R2017b

Version: 1.1

New Features

Sensor Fusion Simulink Blocks: Track multiple objects and fuse detections from multiple sensors

Use the Detection Concatenation block and the Multi Object Tracker block to fuse and track objects detected by multiple sensors.

Sensor Simulation Using Simulink Blocks: Generate synthetic object lists from camera and radar sensor models

Use the Radar Detection Generator and the Vision Detection Generator blocks to generate synthetic detections for testing and design of your sensor fusion and tracking algorithms

Ground Truth Labeling App: Reverse playback capability while processing algorithms

In the **Ground Truth Labeler** app, you can now process the video in reverse using the automation algorithm. You can also now dock and undock the Visual Summary display.

Code Generation for Sensor Models: Generate C code for camera and radar sensor models

Use the `radarDetectionGenerator` and `visionDetectionGenerator` System objects to generate C code to generate synthetic sensor detection object lists.

Autonomous Driving Examples

- Sensor Fusion Using Synthetic Radar and Vision Data
- Adaptive Cruise Control with Sensor Fusion
- Evaluate and Visualize Lane Boundary Detections Against Ground Truth
- Radar Signal Simulation and Processing for Automated Driving

R2017a

Version: 1.0

New Features

Ground Truth Labeling

The **Ground Truth Labeler** app enables you to label ground truth data in a video or in a sequence of images. Use the app to interactively specify rectangular and polyline regions of interest (ROIs), and scene labels. You can export marked labels from the app and use them to train an object detector or to compare against ground truth data. The app includes computer vision algorithms to automate the labeling of ground truth by using detection and tracking algorithms. It also provides an API and workflow that enables you to import your own algorithms to automate the labeling of ground truth. You can also use the `driving.connector.Connector` API to display additional time-synchronized signals, such as lidar or CAN bus data.

Ground Truth Labeling Utilities	Description
Ground Truth Labeler	App for labeling ground truth data in a video or sequence of images
`groundTruth`	Object for storing ground truth labels
`groundTruthDataSource`	Create a ground truth data source
`objectDetectorTrainingData`	Create training data from ground truth data for an object detector
`driving.automation.AutomationAlgorithm`	Define automated labeling algorithm in the Ground Truth Labeler app
`driving.connector.Connector`	Interface to connect an external tool to the Ground Truth Labeler app
`evaluateLaneBoundaries`	Evaluate lane boundary models against ground truth

Monocular Camera Sensor Configuration

Use the `monoCamera` object to define your monocular camera configuration. You can use this object to convert locations between vehicle and image coordinate systems. You can also use `birdsEyeView` with the `monoCamera` object to create a bird’s-eye-view image.

Object and Lane Boundary Detection

Detect objects using machine learning techniques, including deep learning. You can also segment, detect, and model parabolic lane boundaries using RANSAC. Configure object

detectors to detect objects of a known physical size using the `configureDetectorMonoCamera` function.

Object Detection

- `vehicleDetectorACF`
- `vehicleDetectorFasterRCNN`
- `peopleDetectorACF`
- `configureDetectorMonoCamera`
- `acfObjectDetectorMonoCamera`
- `objectDetectorTrainingData`
- `fastRCNNObjectDetectorMonoCamera`
- `fasterRCNNObjectDetectorMonoCamera`

Lane Boundary Detection

- `segmentLaneMarkerRidge`
- `findParabolicLaneBoundaries`
- `parabolicLaneBoundary`
- `insertLaneBoundary`
- `evaluateLaneBoundaries`
- `fitPolynomialRANSAC`
- `ransac`

Multi-object Tracking

You can create a multi-object tracker for sensor fusion. The tracker uses Kalman filters for estimating the state of motion of an object. Measurements made on the object let you continuously solve for the object's position and velocity. You can use constant-velocity or constant-acceleration motion models, or define your own models.

- `multiObjectTracker`
- `objectDetection`
- `getTrackPositions`
- `getTrackVelocities`

- `trackingKF`
- `trackingEKF`
- `trackingUKF`

Bird’s-Eye Plot

Use `birdsEyePlot` to display a bird's-eye plot of a 2-D scene in the immediate vicinity of a vehicle. You can use bird's-eye plots with sensors capable of detecting objects and lanes.

Driving Scenario Generation and Sensor Models

The `drivingScenario` class defines road networks, vehicles, and traffic scenarios. A driving scenario is a 3-D arena containing roads and actors. Actors can represent anything that moves, such as cars, pedestrians, and bicycles. Actors can also include stationary obstacles that can influence the motion of other actors. You can use `radarDetectionGenerator` and the `visionDetectionGenerator` to create statistical models for generating synthetic radar and camera sensor detections.

Automated Driving Examples

The release of Automated Driving System Toolbox includes the following examples.

Reference Applications
“Visual Perception Using Monocular Camera”
“Forward Collision Warning Using Sensor Fusion”
“Sensor Fusion Using Synthetic Radar and Vision Data”

Tracking and Sensor Fusion
“Forward Collision Warning Using Sensor Fusion”
“Track Multiple Vehicles Using a Camera”
“Track Pedestrians from a Moving Car”
“Multiple Object Tracking Tutorial”
“Code Generation for Tracking and Sensor Fusion”

Perception with Computer Vision
“Visual Perception Using Monocular Camera”
“Ground Plane and Obstacle Detection Using Lidar”
“Train a Deep Learning Vehicle Detector”

Algorithm Validation and Visualization
“Automate Ground Truth Labeling of Lane Boundaries”
“Annotate Video Using Detections in Vehicle Coordinates”
“Visualize Sensor Coverage, Detections, and Tracks”
“Evaluate Lane Boundary Detections Against Ground Truth Data”

Scenario Generation
“Sensor Fusion Using Synthetic Radar and Vision Data”
“Driving Scenario Tutorial”
“Define Road Layouts”
“Create Actor and Vehicle Trajectories”
“Model Radar Sensor Detections”
“Model Vision Sensor Detections”