Turning an Automated System into an Autonomous system using Model-Based Design

Autonomous Tech Conference 2018

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Autonomous System

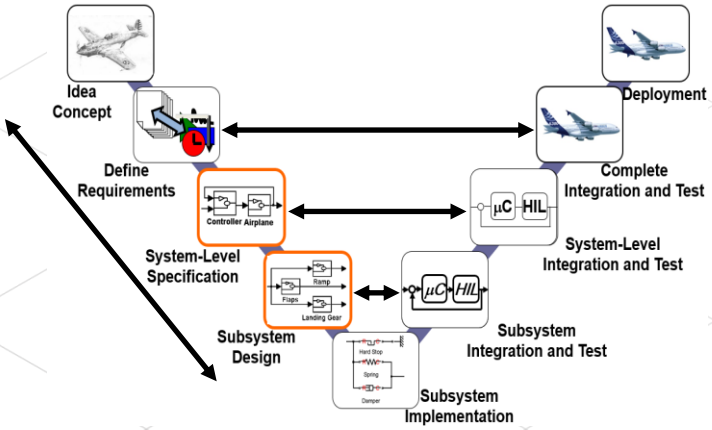
A system that functions **independently** or in a **supervised** manner and operates under conditions of uncertainty, in an unknown and unpredictable dynamic environment

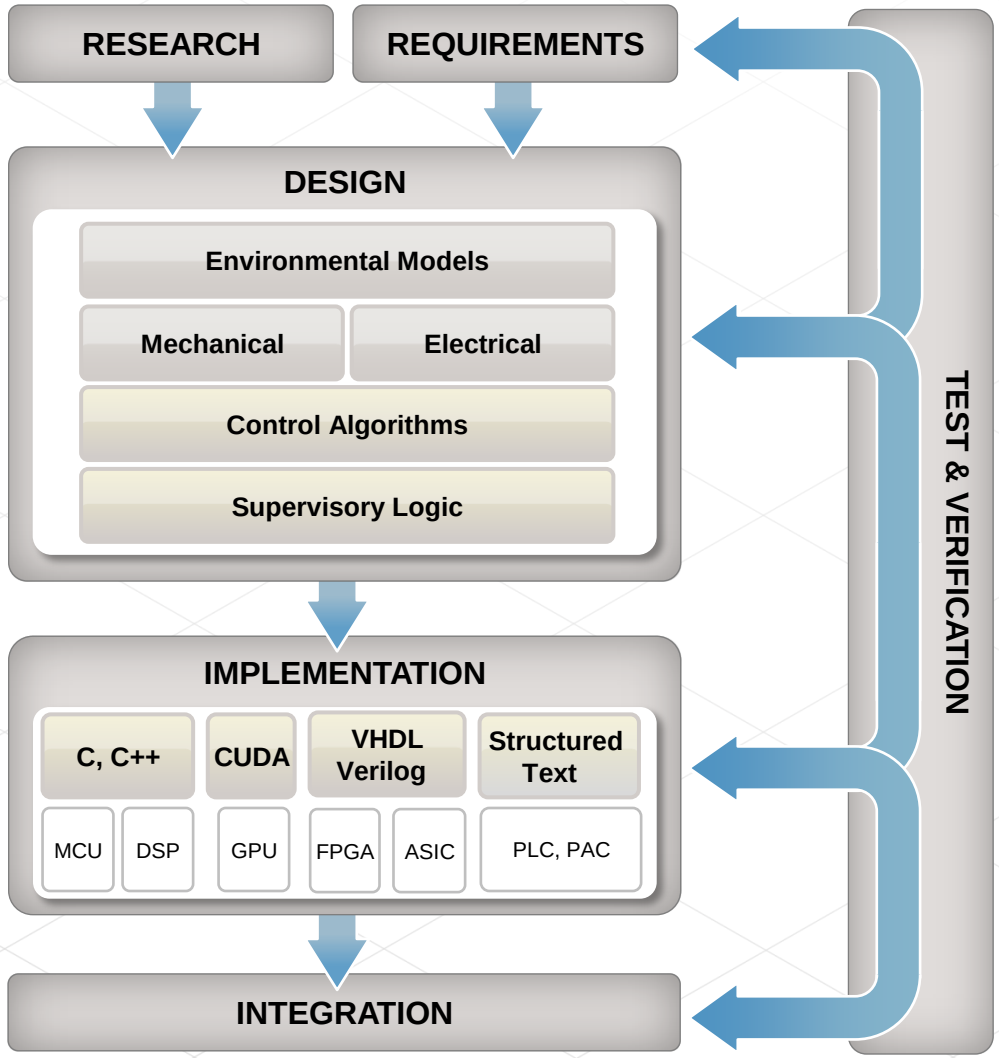
- Platform
- Sense
- Perception
- Planning
- Control
- Connect

Model-Based Design (MBD)

Systematic use of models **throughout** the development process

Scope: Electronic systems that interact with the **physical** world





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Automated Driving - Sensors Definition

Sense

Camera

Radar-based object detector

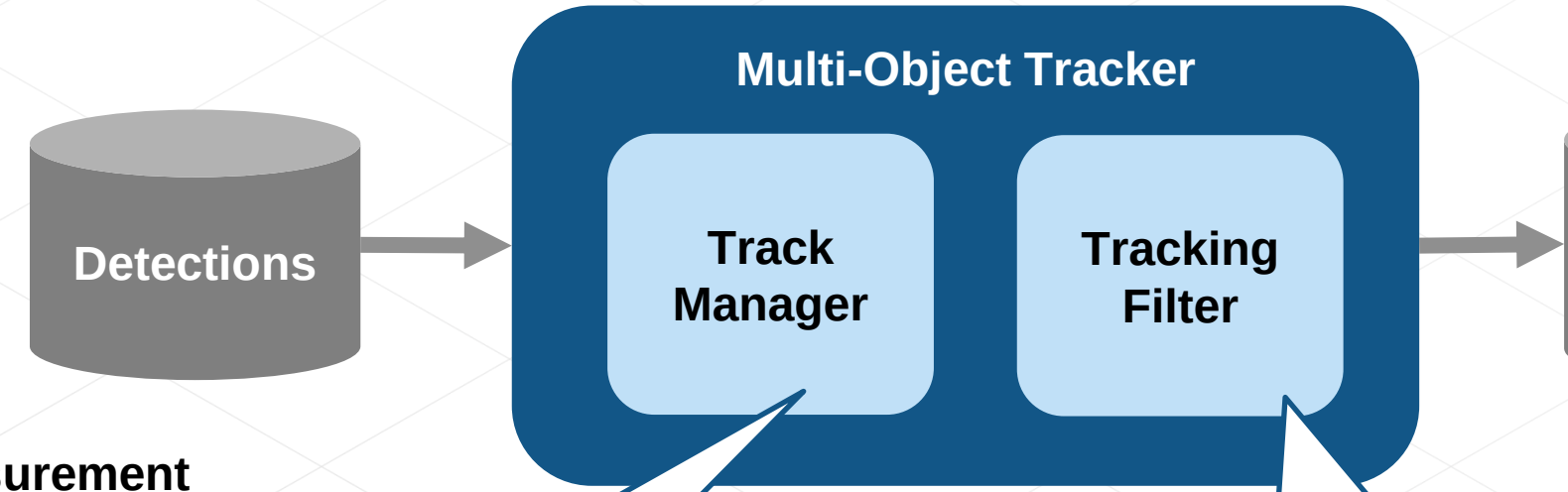
Vision-based object detector

Lidar

Lane detector

Inertial Measurement Unit

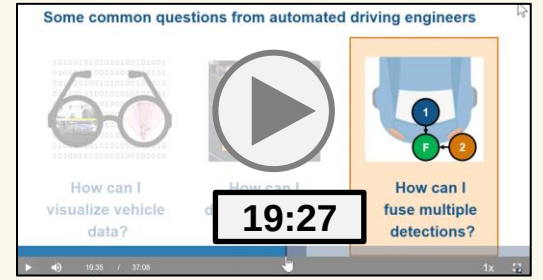
Multi-object tracker to develop sensor fusion algorithms



- Assigns detections to tracks
- Creates new tracks
- Updates existing tracks
- Removes old tracks

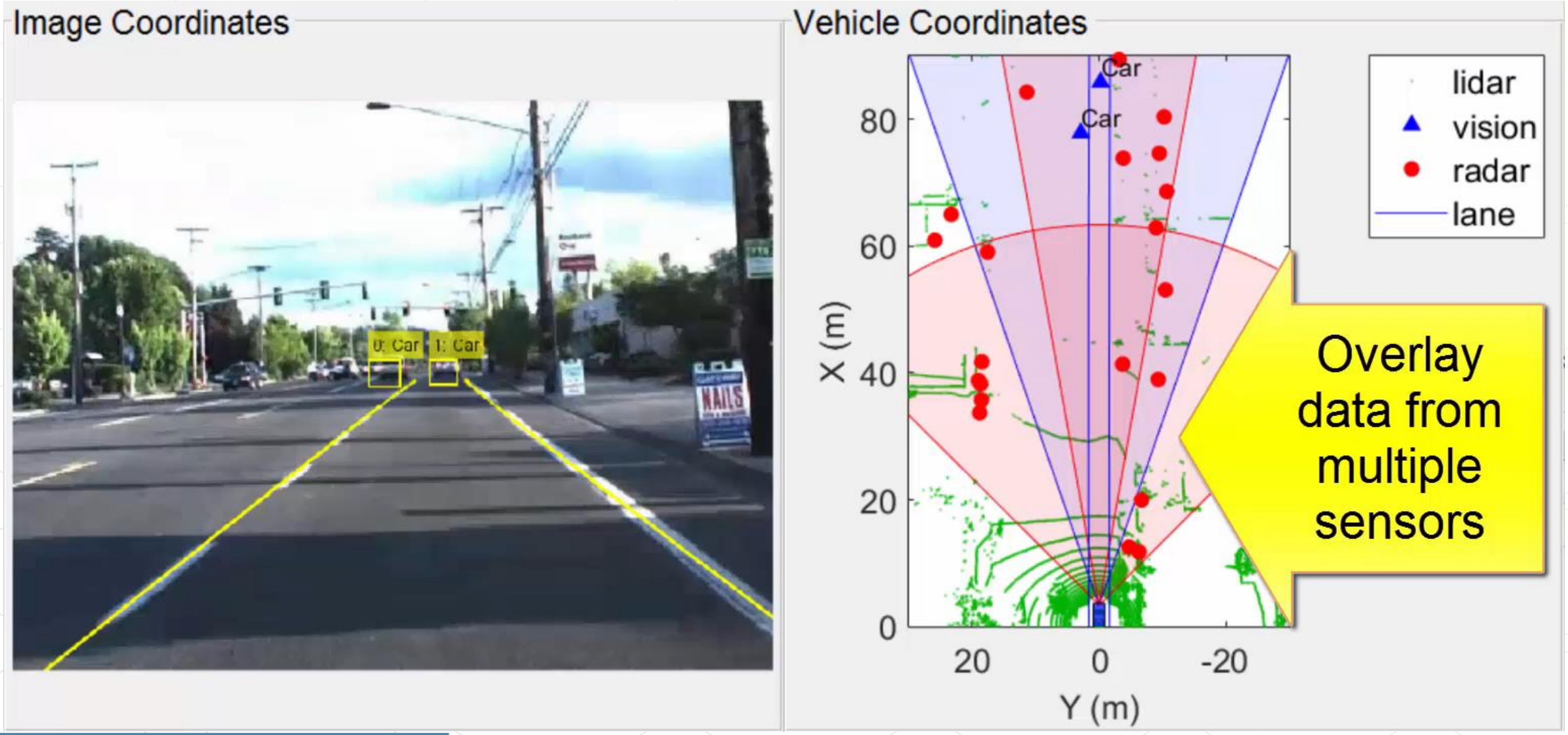
- Predicts and updates state of track
- Supports linear, extended, and unscented Kalman filters

Videos and Webinars



Introduction to Automated Driving System Toolbox

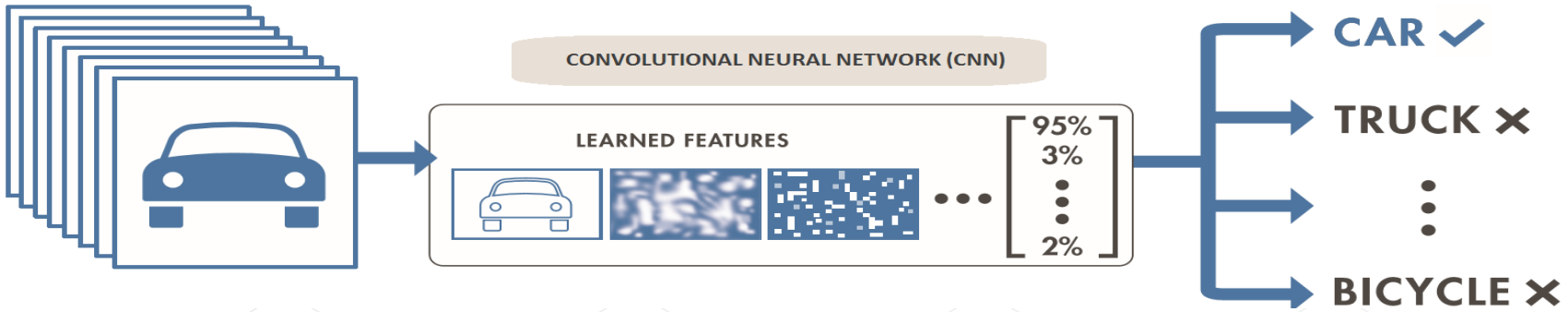
Fuse detections with multi-object tracker



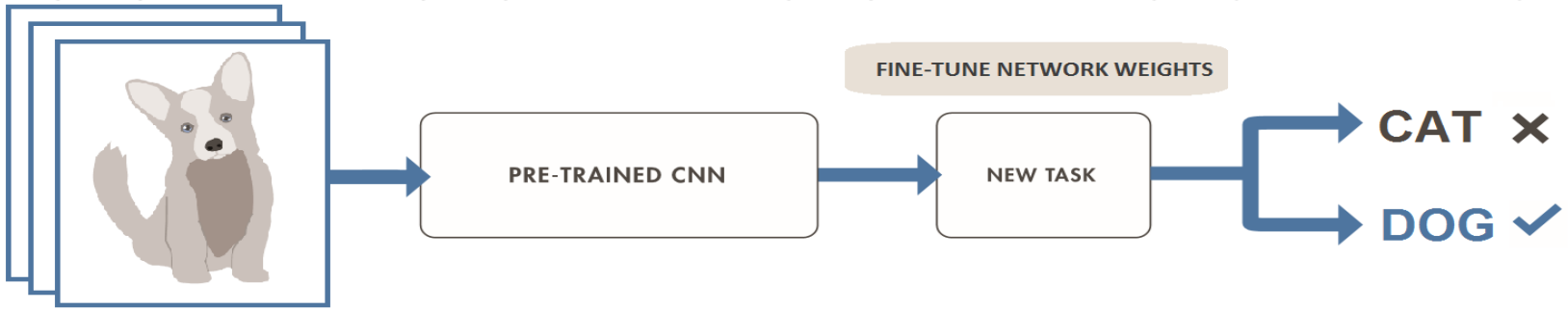
What is Deep Learning ?

Deep learning is a type of machine learning that performs end-to-end learning by learning tasks directly from images, text, and sound.

1. Train a Deep Neural Network from Scratch

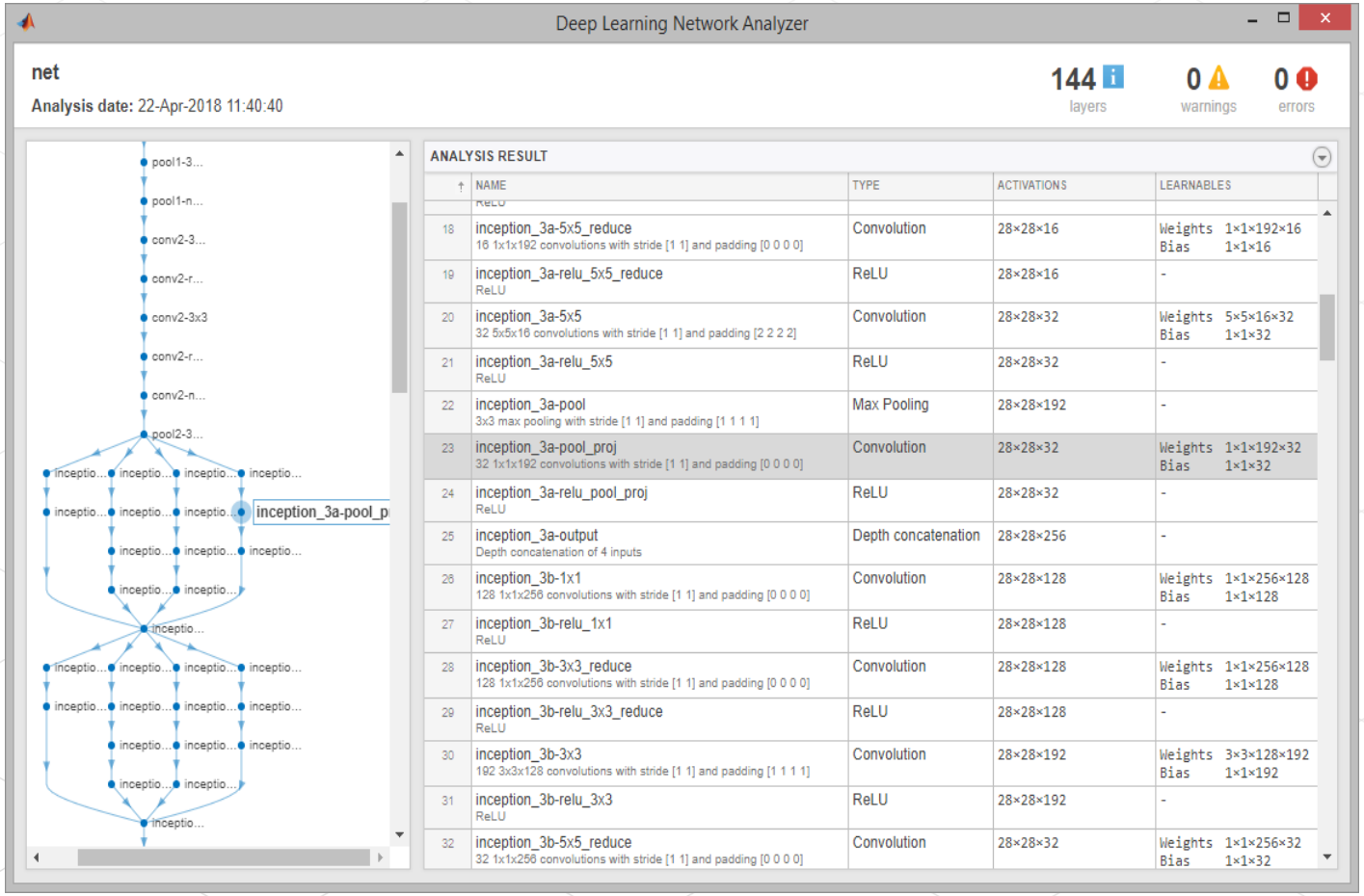


2. Fine-tune a pre-trained model (transfer learning)

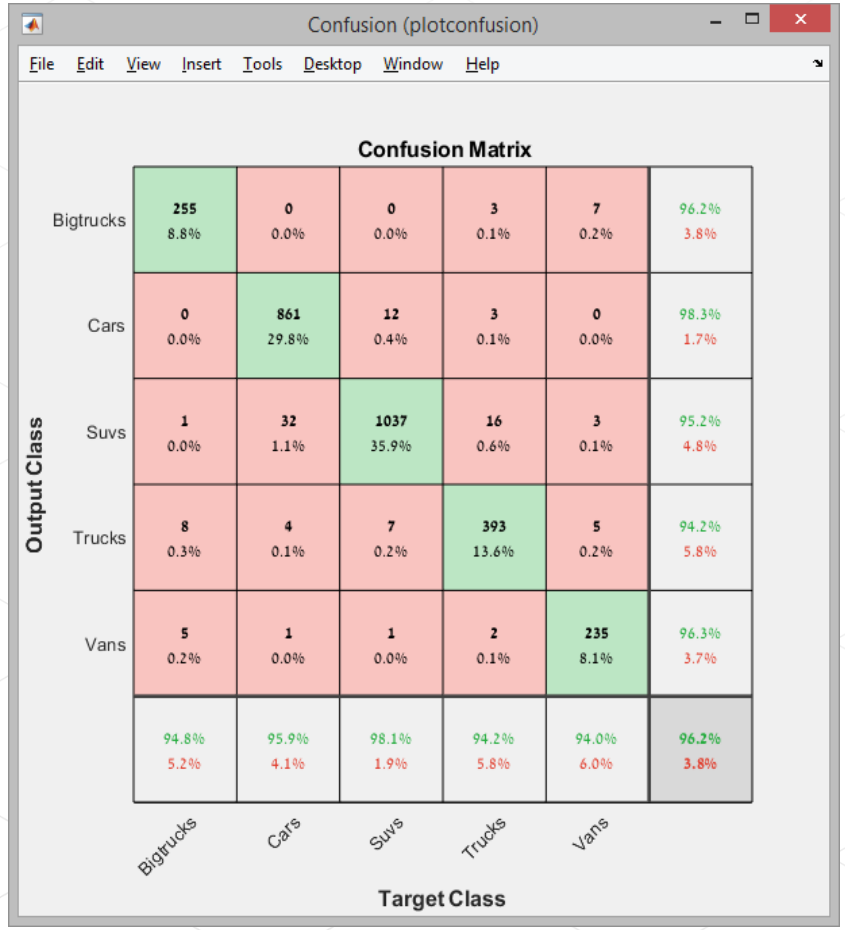


Network Analysis

Network Analyzer



Confusion Matrix



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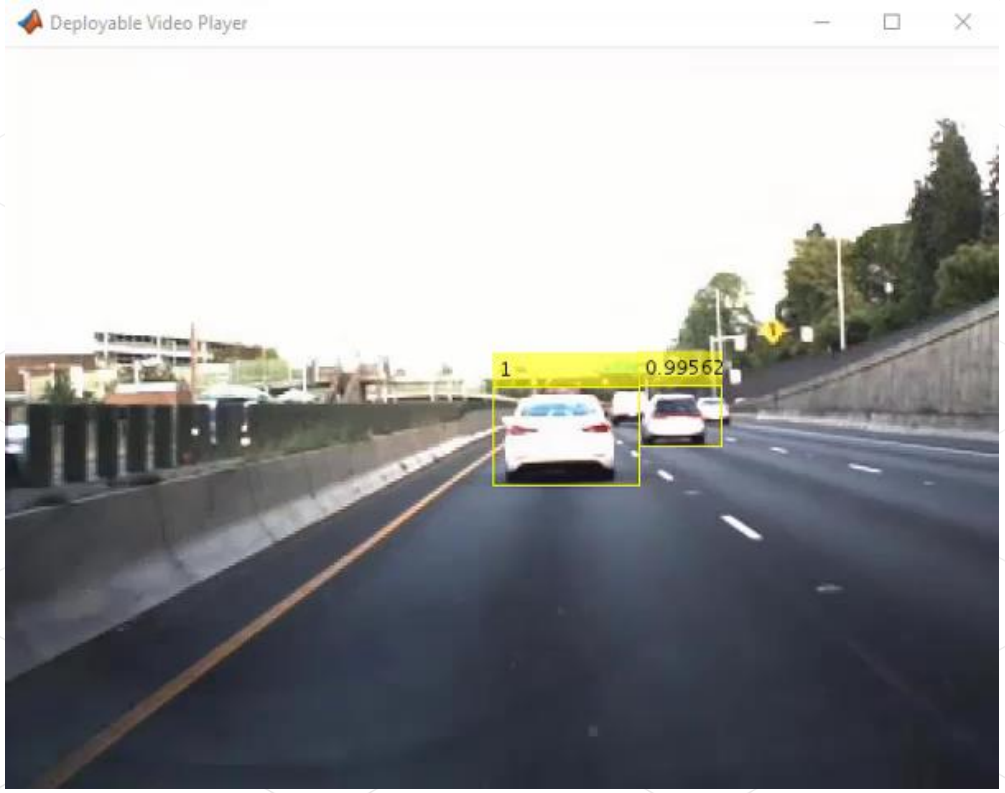
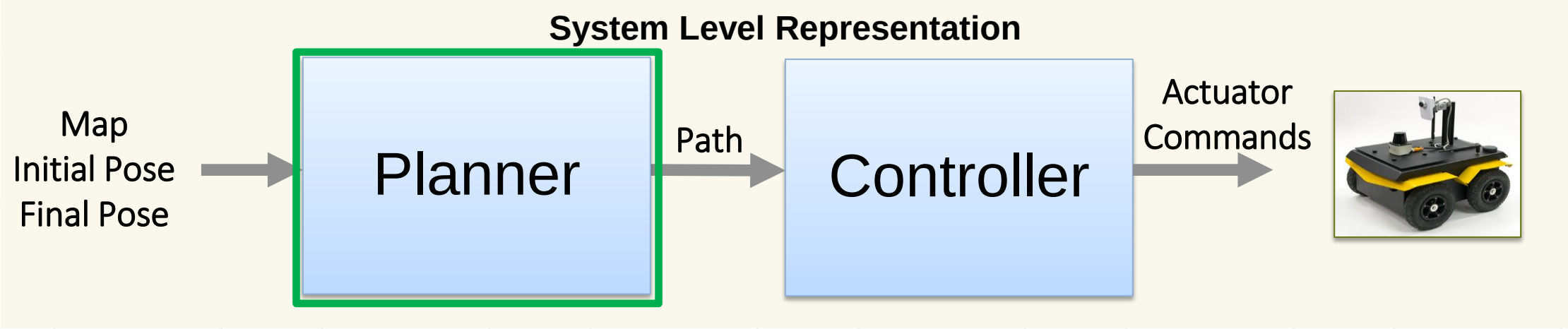
R-CNN Vs. Semantic Segmentation



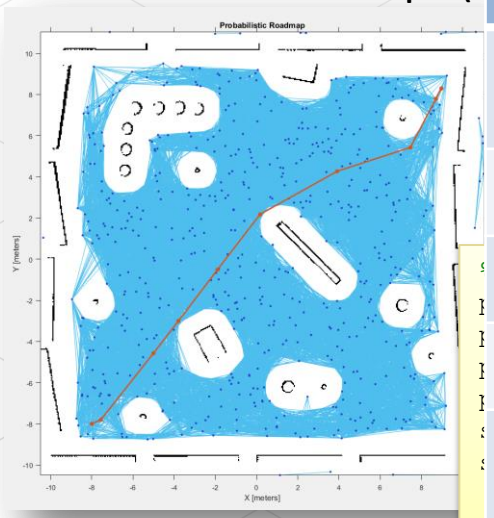
Regions with Convolutional Neural Network Features (R-CNN)

Semantic Segmentation using SegNet

Path Planning

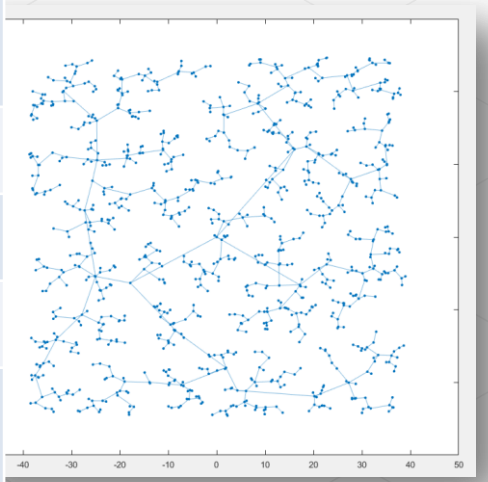


Probabilistic Roadmaps (P

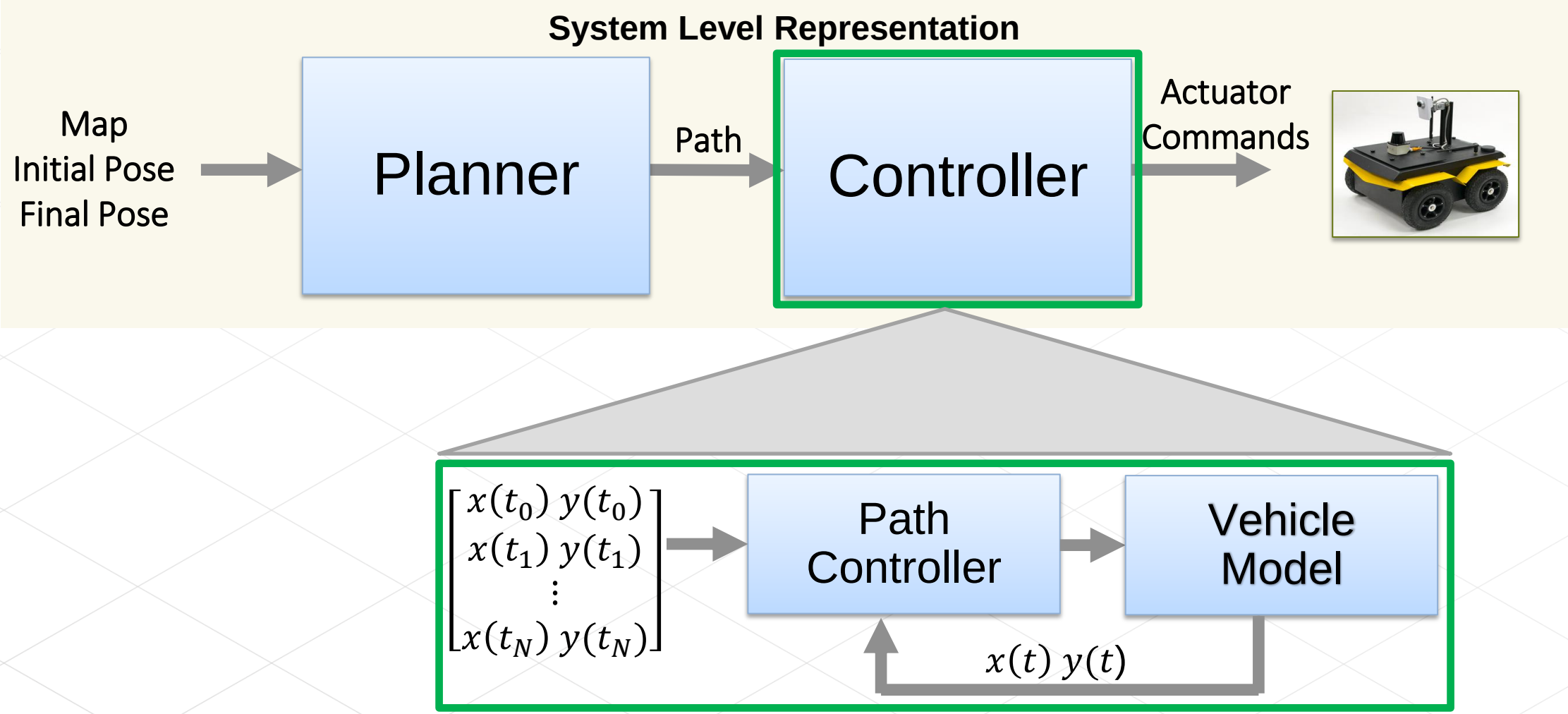


Algorithm	Application Area	MATLAB Implementation
PRM	Ground Robots	`% Only for differential robots` `>> robotics.PRM`
RRT/RRT*	ADAS, Manipulators	`% Only for vehicles (3D)` `>> pathPlannerRRT`
Implicit A* search Hybrid A*	ADAS, Ground Robots	`% RST` `% RST in future release`
Polynomial Interpolation	Automotive, Ground Robots, Manipulators	`% General functions` `>> spline, pchip,…`
Model-Predictive Control	Automotive, Humanoids	`% MPC Toolbox` `>> mpc`

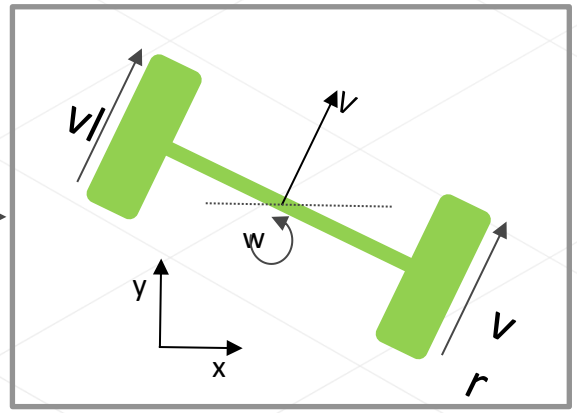
-exploring random tree (RRT)

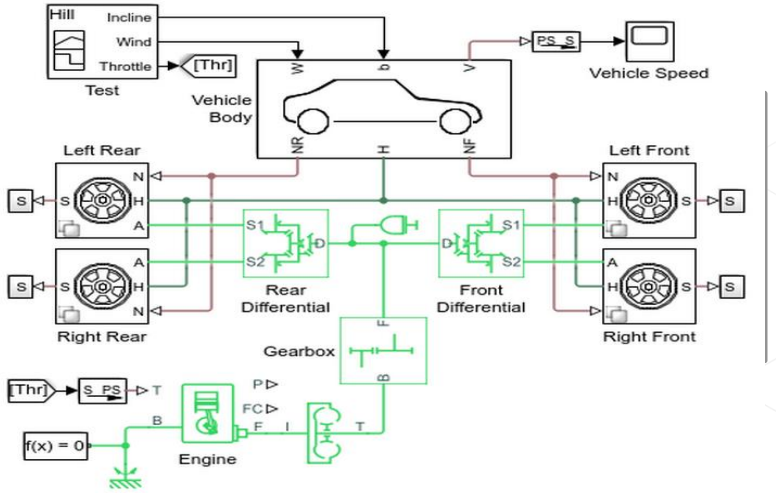


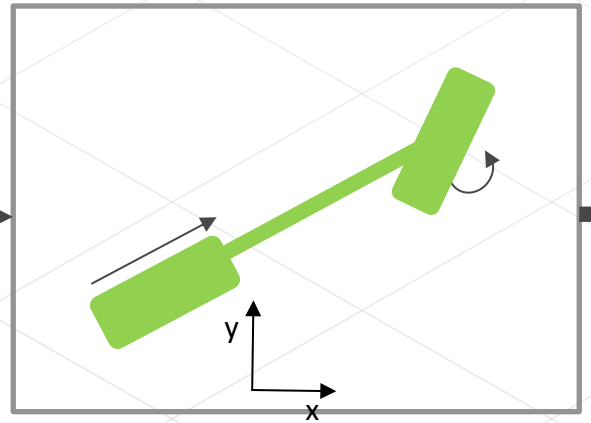
Path Control

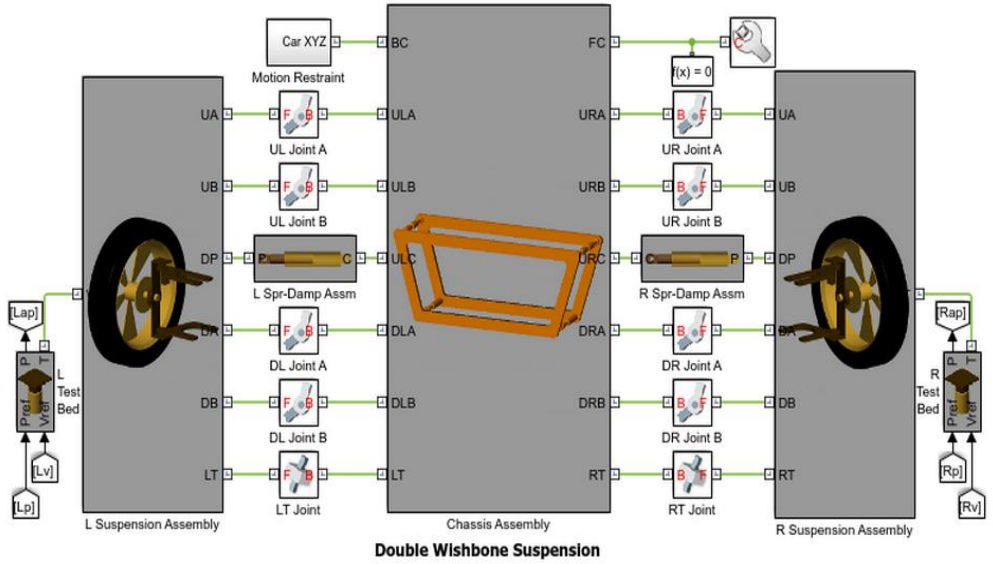


Vehicle Modeling









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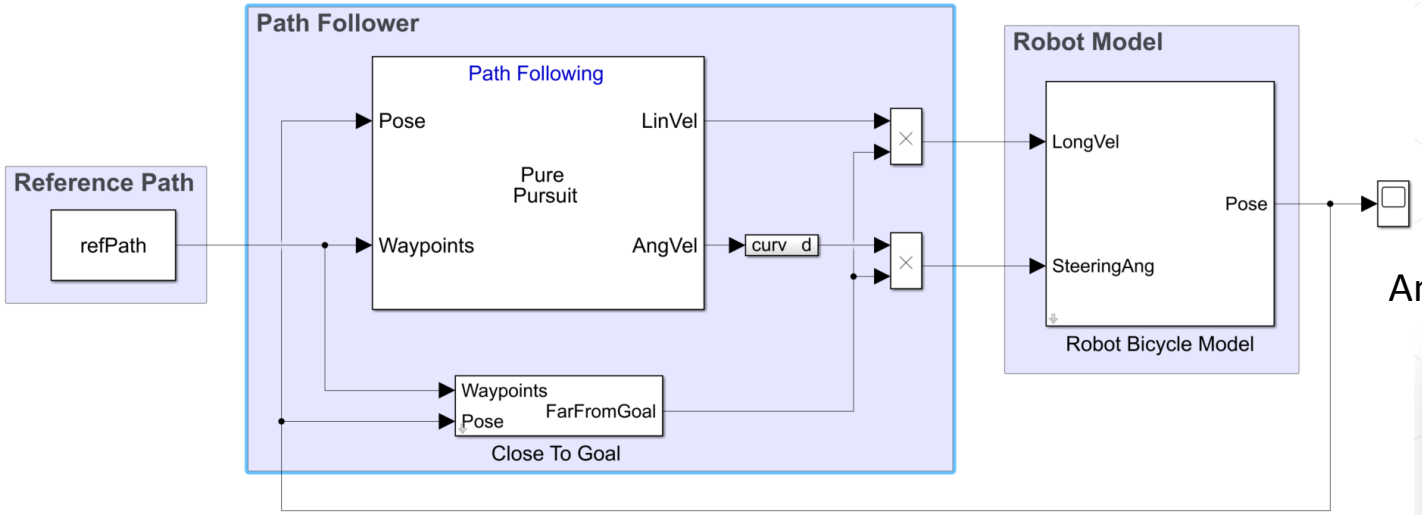
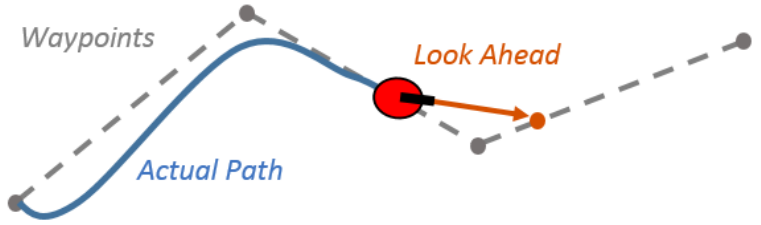
Path Control – Explore Built-In Algorithms





Angular velocity to go from current position to the lookahead

```
% Create a pure pursuit object
pp = robotics.PurePursuit;

% Assign a sequence of waypoints
pp.Waypoints = [0 0;1 1;3 4];

% Compute control inputs for pose
[v, w] = pp([0 0 0]);
```

Designing a system object so you can use your algorithm interchangeably in MATLAB and Simulink:

- Cross tracking errors
- Closest point to a line
- Lookahead instance

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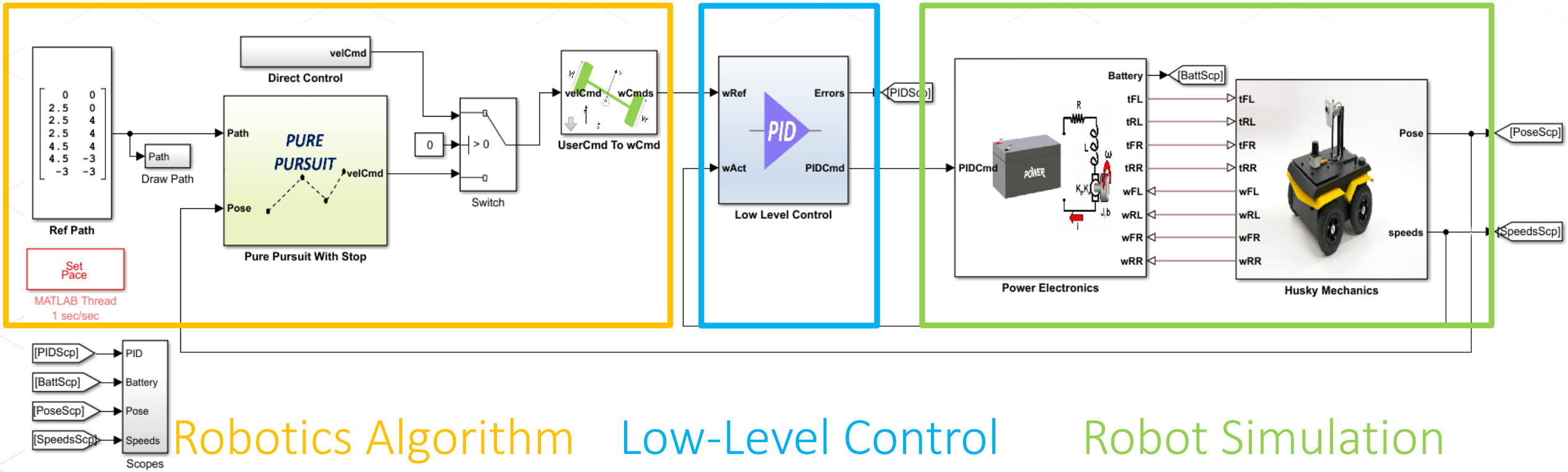
Multi-domain Simulation

Connect



Robotics Algorithm Low-Level Control Robot Simulation

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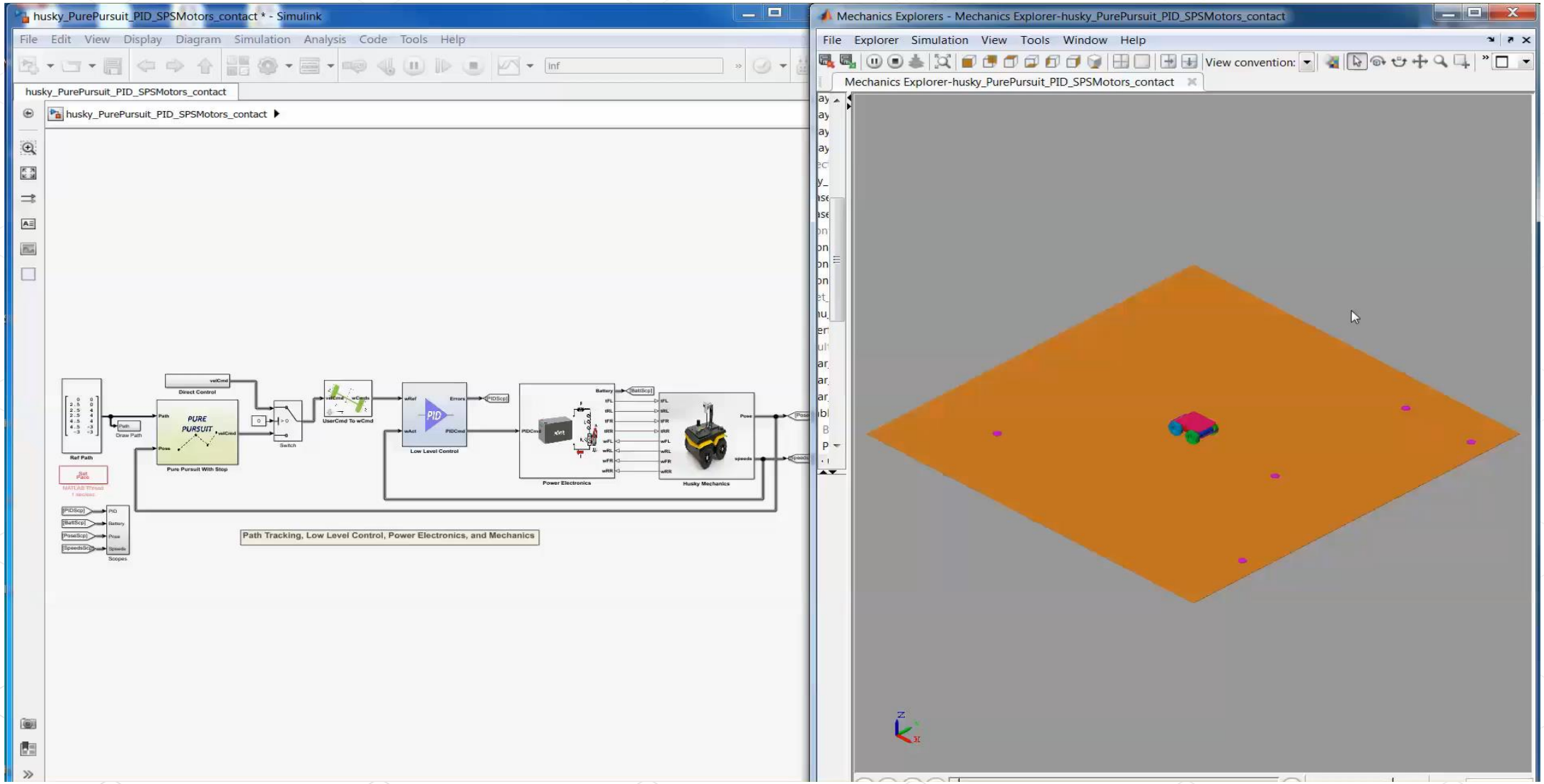
Physical Modeling Environment



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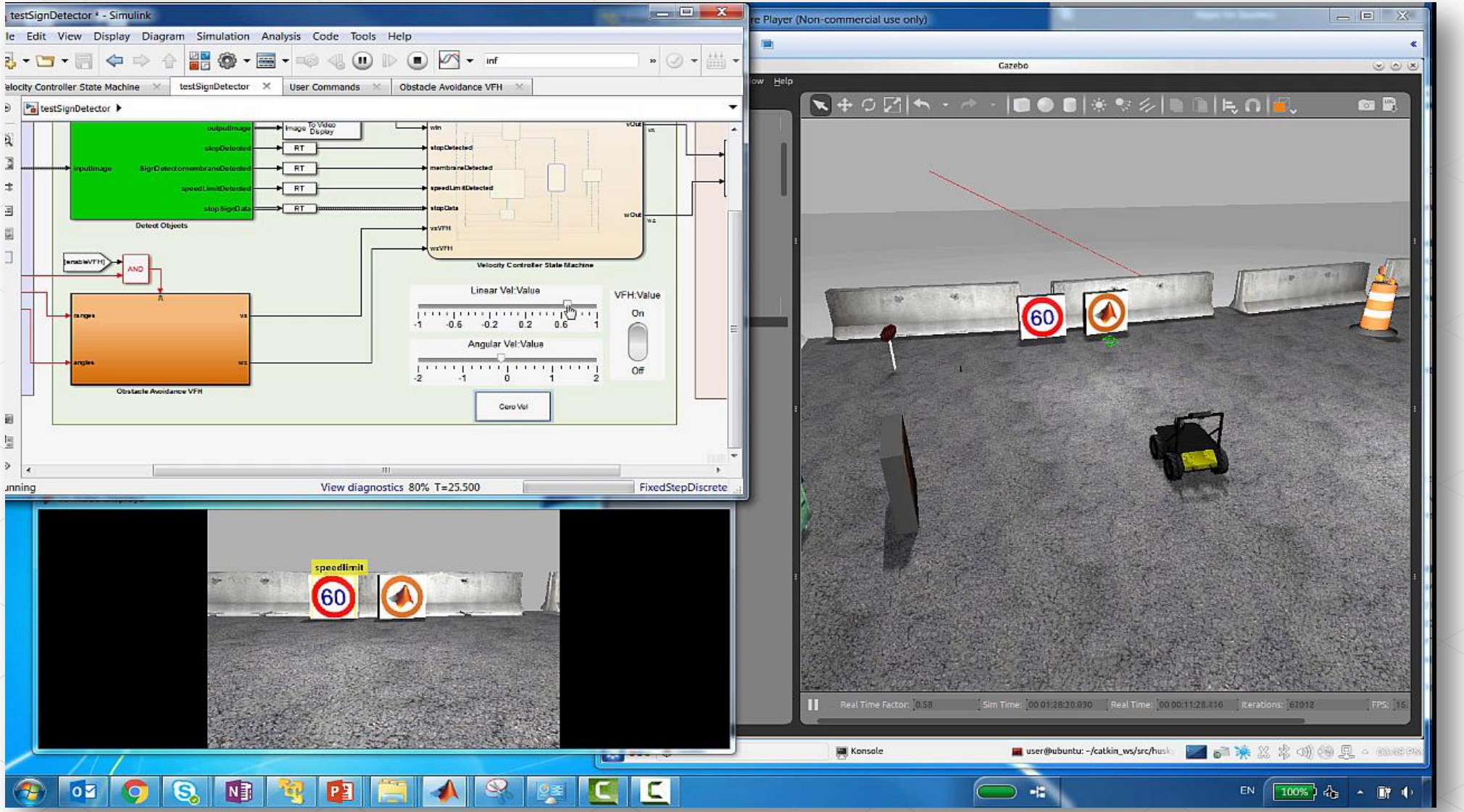
Sign Recognition with Collision Avoidance



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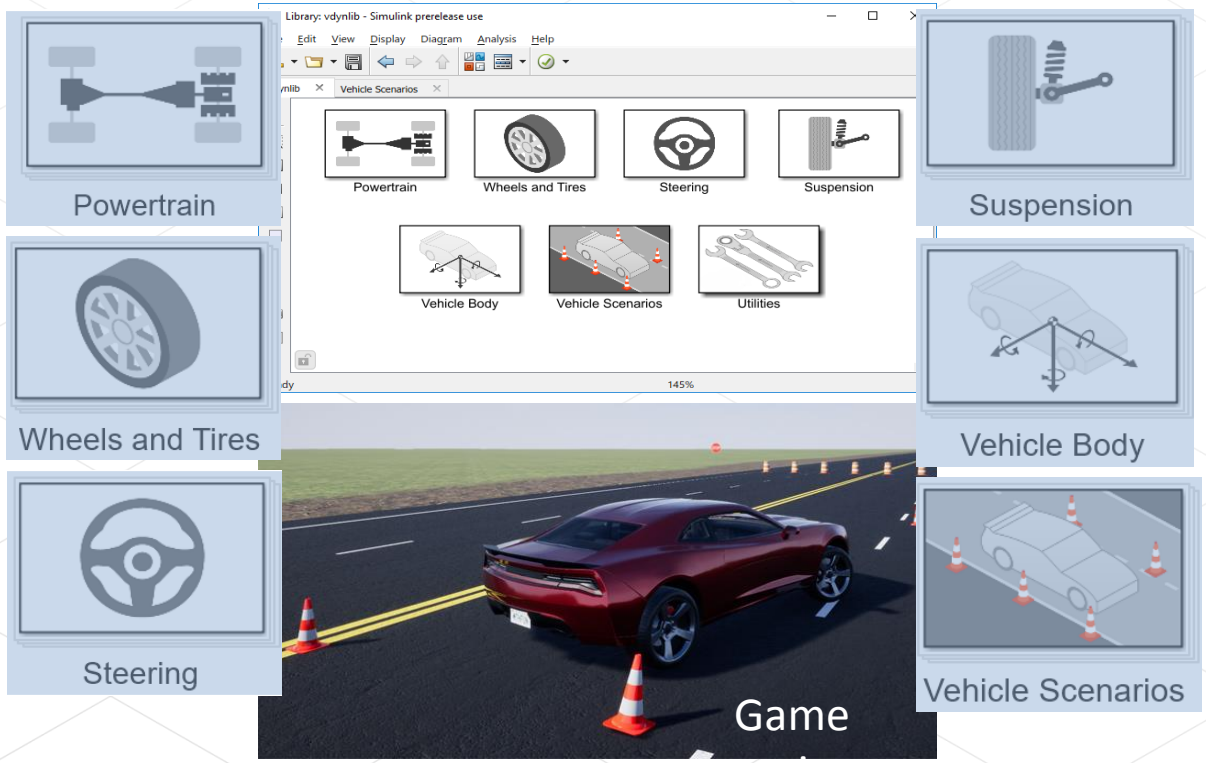
Vehicle Dynamics

Automotive



Simulink

- **Physics of vehicle**
- **Initialization of game engine camera**

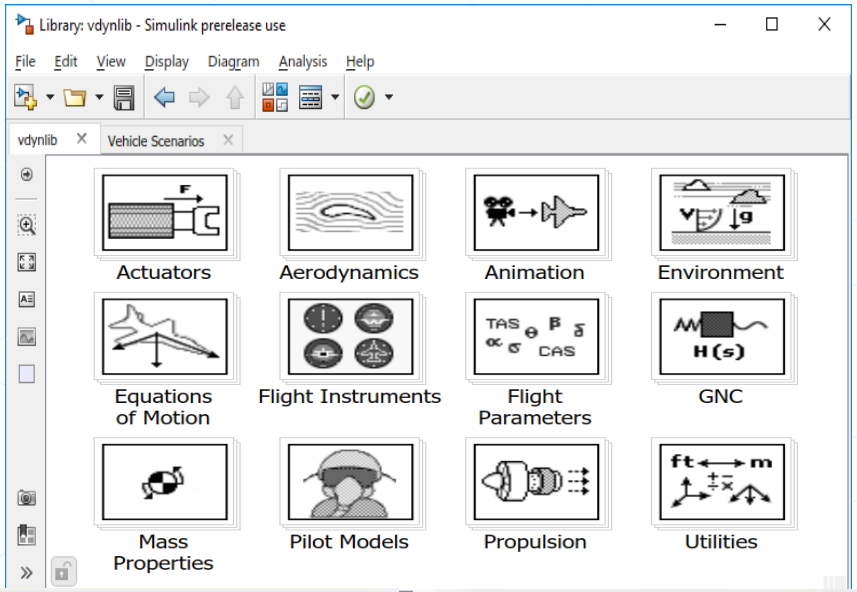
vehicle / camera location

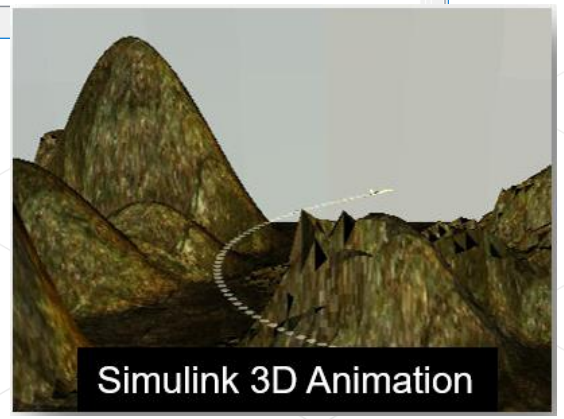
camera image, ground height, …

Unreal Engine

- **Rendering / lighting**
- **Physics of non-Simulink objects**
- **Collision detection**

Aerospace





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Extensive Hardware Support & Customization

MATLAB & Simulink

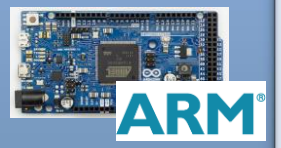
Mass market low cost hardware

Simulink Coder

Rapid prototyping, student competitions, entry boards

Embedded Coder

Industrial strength devices



HDL Coder

High performance SoCs

XILINX

ALTERA

GPU Coder

Optimized CUDA code for deep learning

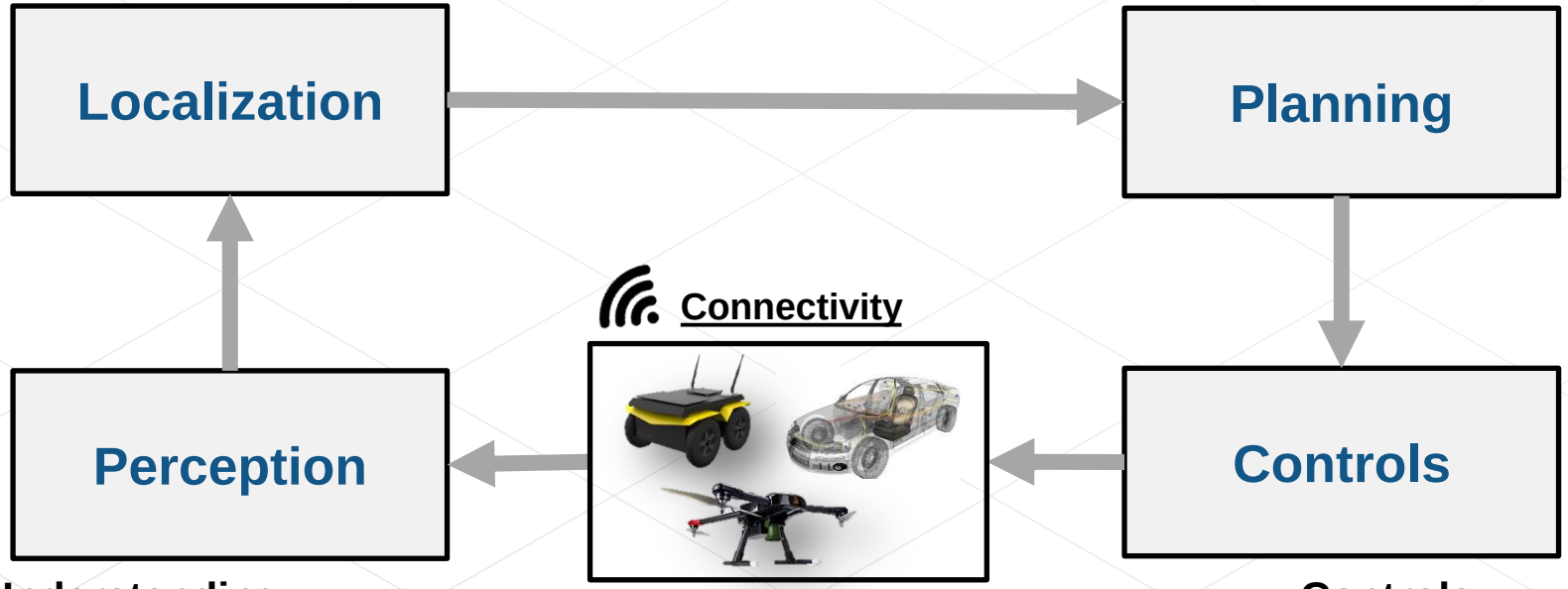
NVIDIA

cuDNN

Autonomous Systems Technologies - Summary

Position Estimation
- SLAM
- Map representation
- Occupancy grid
- State estimation

Mission Planning
- Decision making
- Path and motion planning
- Collision avoidance
- Path following



Platform
Sense
Perception
Planning
Control
Connect

Scene Understanding
- Sensor fusion
- Deep learning
- Object detection
- Object tracking

Sensors
- Cameras
- RADAR
- LIDAR
- GPS

Commands
- Motion Control
- Actuators

Controls
- Feedback controls
- Mode logic
- Gain scheduling
- Trajectory tracking

Contact Us:

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Thank You !