

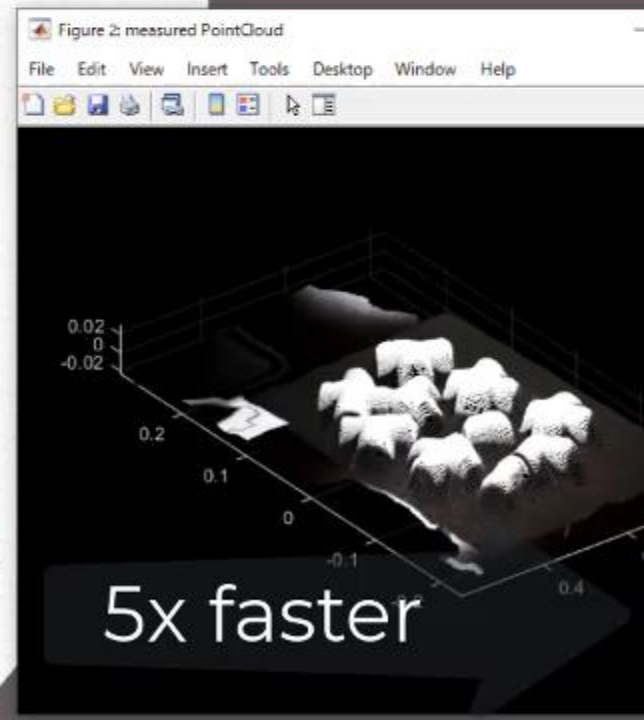
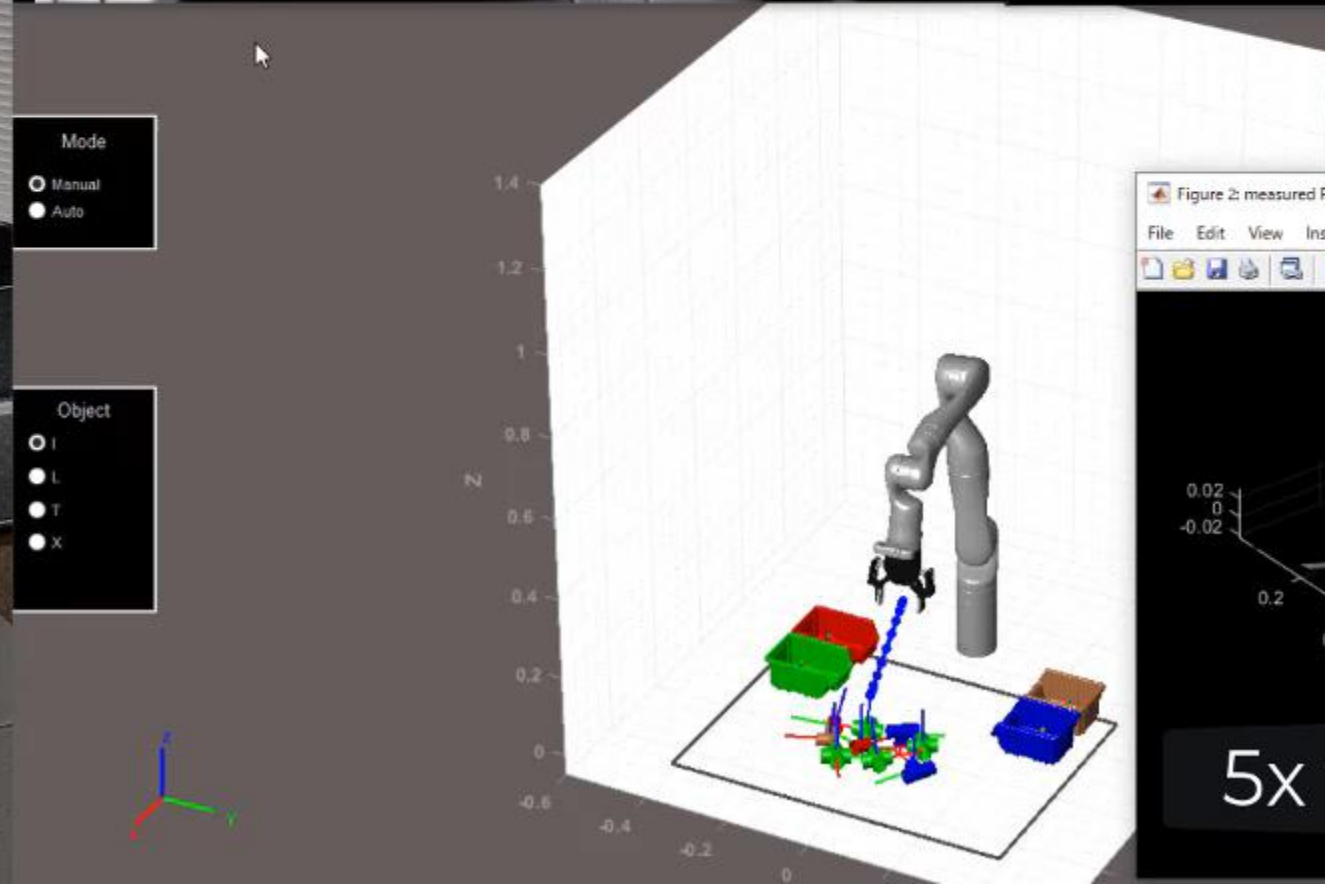
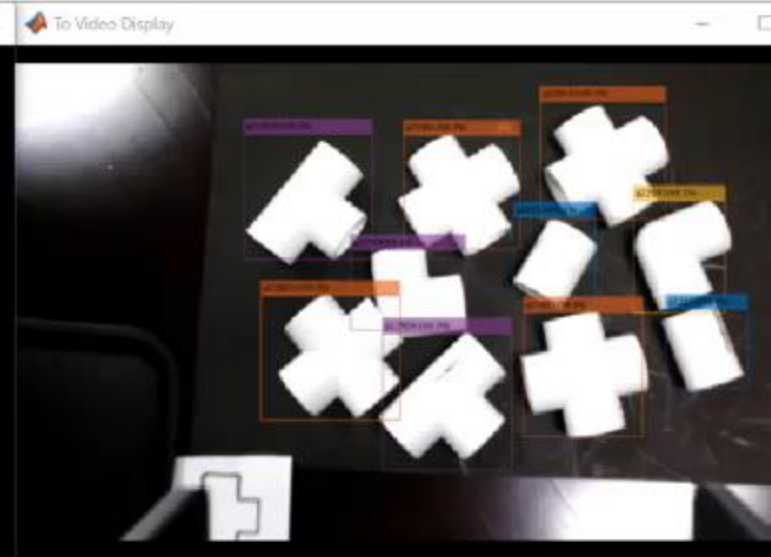
MATLAB EXPO

MATLAB을 이용한 로봇 매니퓰레이터의 Pick-And-Place 데모

김종헌 부장 / (Email : allenkim@mathworks.com)

김학범 부장 / (Email : alexkim@mathworks.com)





Robotic manipulator arm

Kinova Gen3 Ultra Lightweight Robot

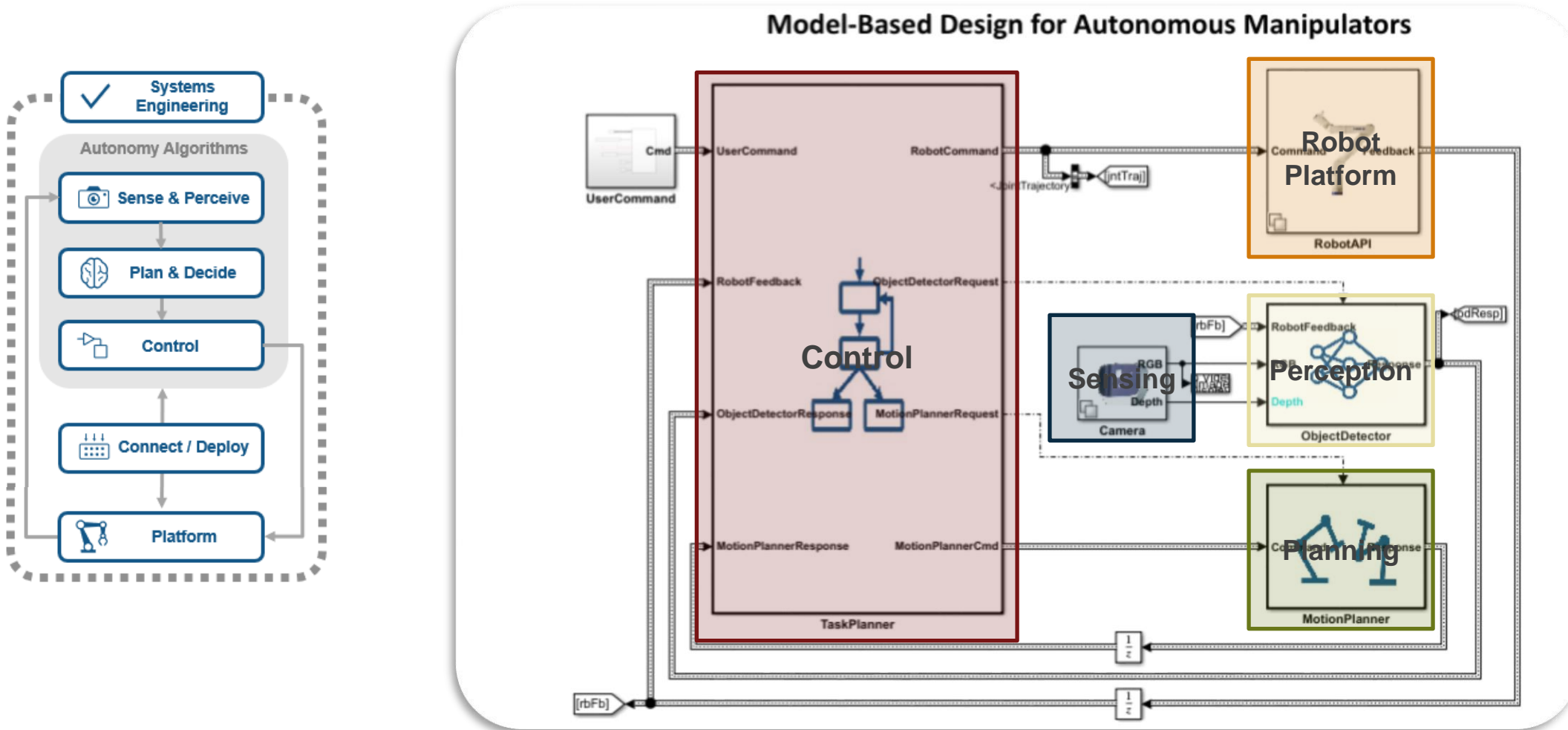
[Connection Program Partner](#)

- 7 degrees of freedom
- 2-finger RobotiQ Gripper
- ROS compatible
- Position/Velocity/Torque control
- Torque sensor in each joint
- Embedded 2D/3D Vision
- Portable (8.3 kg)



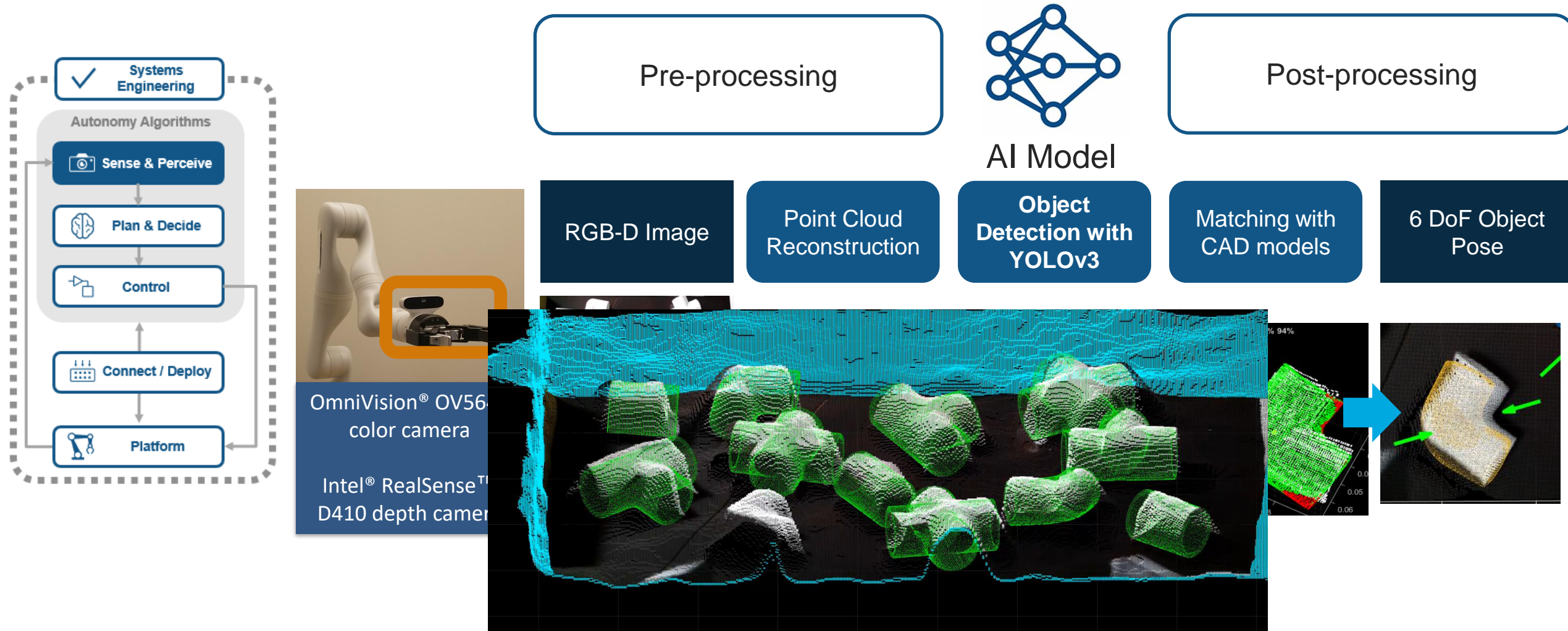
Pick and Place

Object detection, obstacle avoidance and trajectory optimization



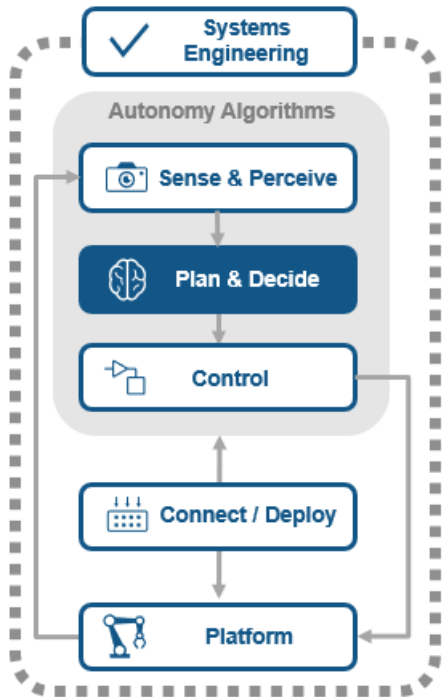
Perception

CAD-mode based pose estimation pipeline



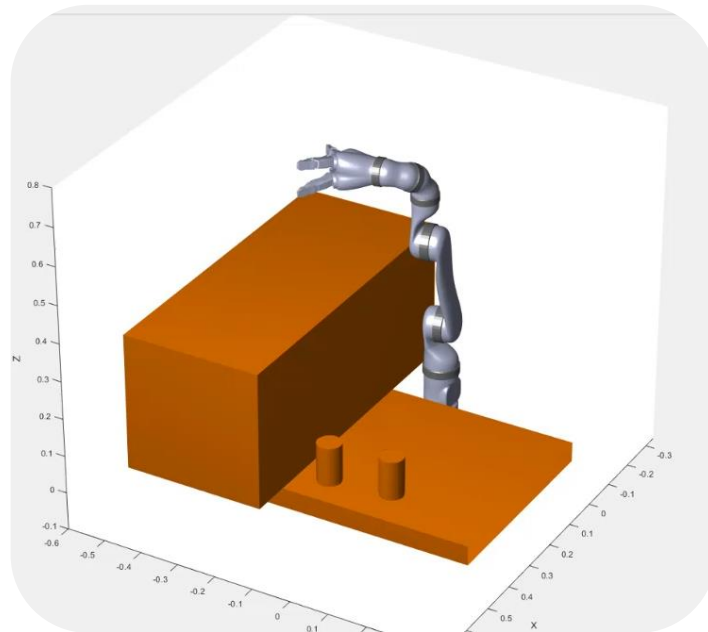
Motion Planning

Motion Planners for Manipulators



`manipulatorRRT`

a bi-directional RRT planner that ships directly in Robotics System Toolbox



Use existing and future planners in Navigation Toolbox with manipulators

- State space and state validators for the robot and its environment
- Provides users with enhanced capability and customizability for users

Robotics System Toolbox

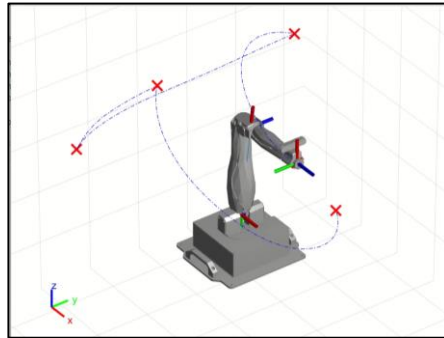
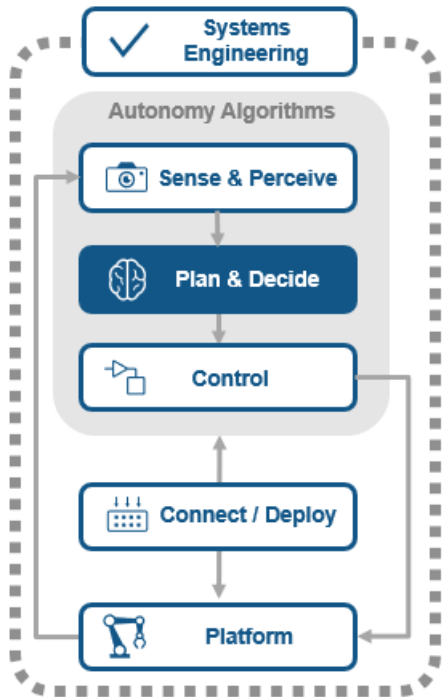


Navigation Toolbox

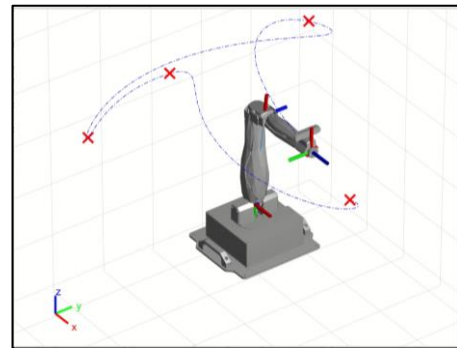
`plannerBiRRT`
`plannerRRT`
`plannerRRTStar`
`plannerPRM`
...

Motion Planning

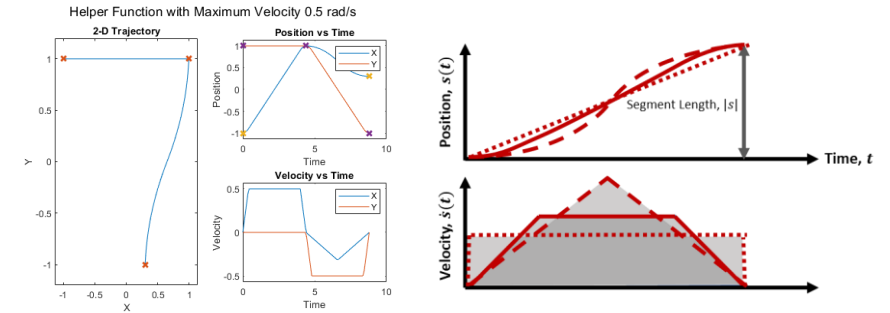
Generate the Right Trajectory for your Application



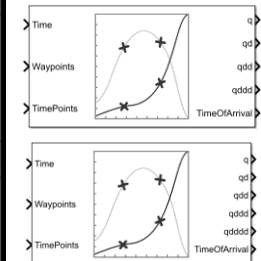
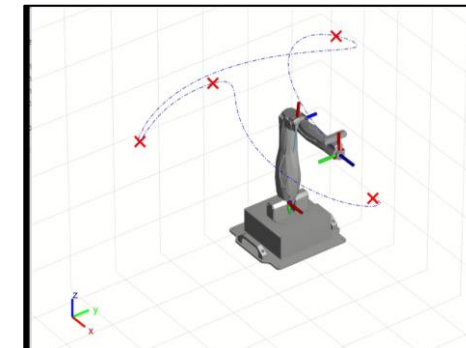
Trapezoidal Velocity Profile Trajectory
Point-to-point motion with allowing velocity / acceleration bounds



Polynomial Trajectories
Fully customizable 3rd and 5th order polynomial trajectories



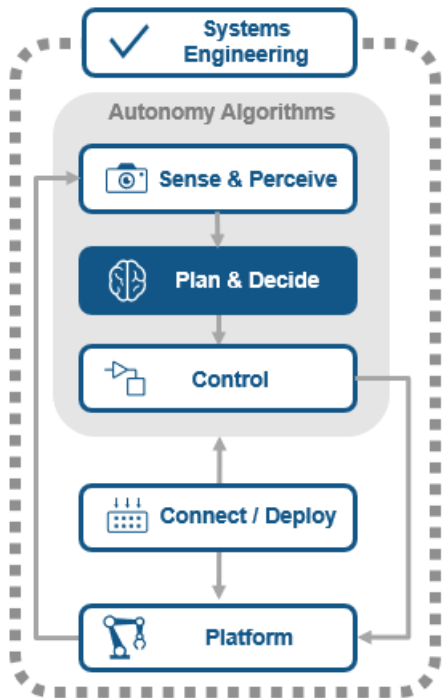
Example: Design Trajectory with Velocity Limits Using Trapezoidal Velocity Profile
Detail documentation on trapezoidal profile and helper functions to make it more accessible



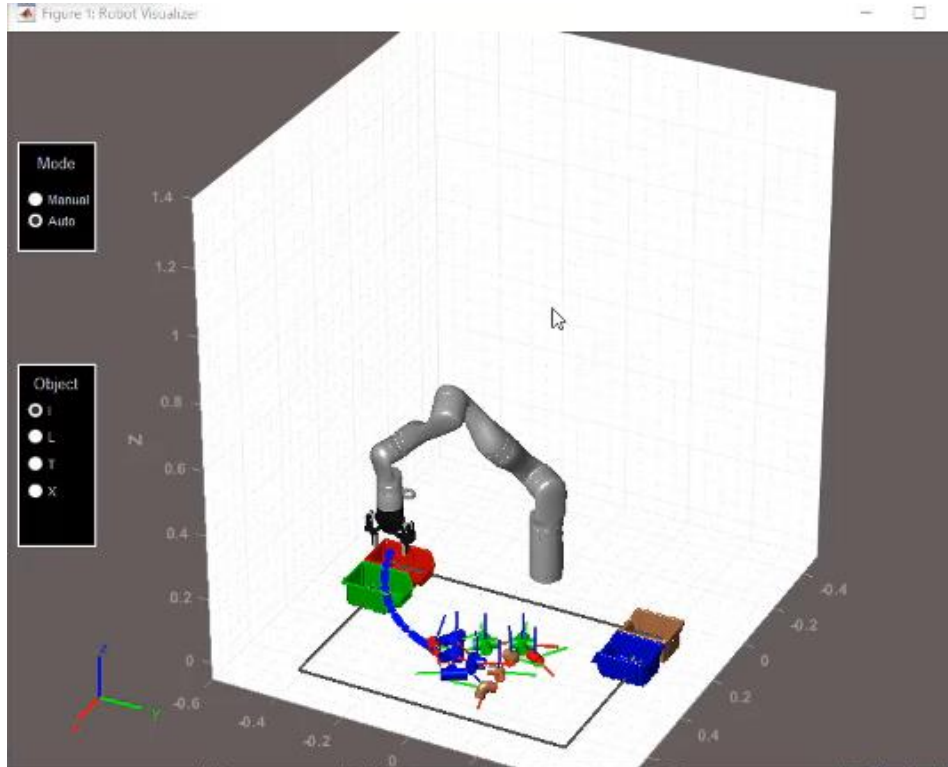
Minimum Jerk & Snap Trajectories
Smooth continuous motion with optional time allocation

Motion Planning

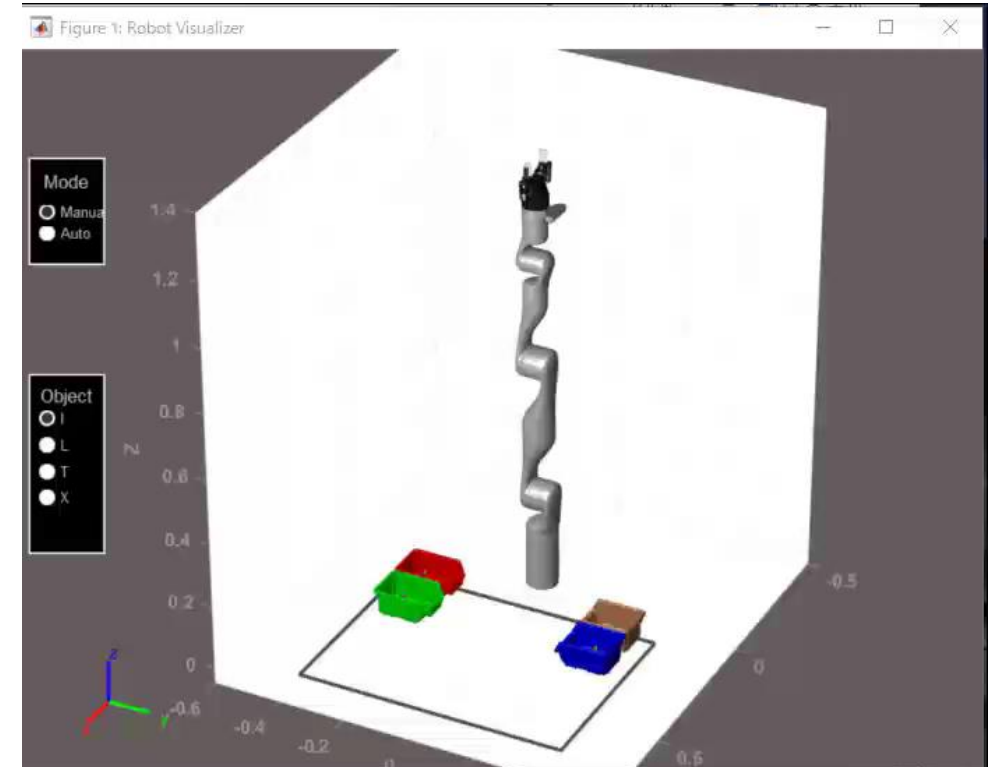
Joint Space Vs. Task Space Motion Planner



Joint space planning with RRT

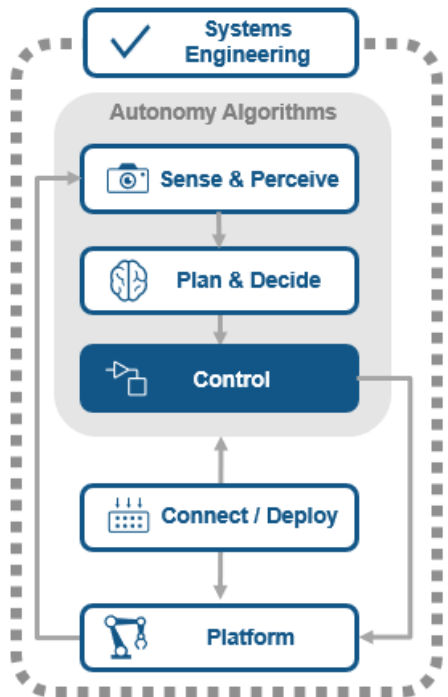


Task space planning with interpolation

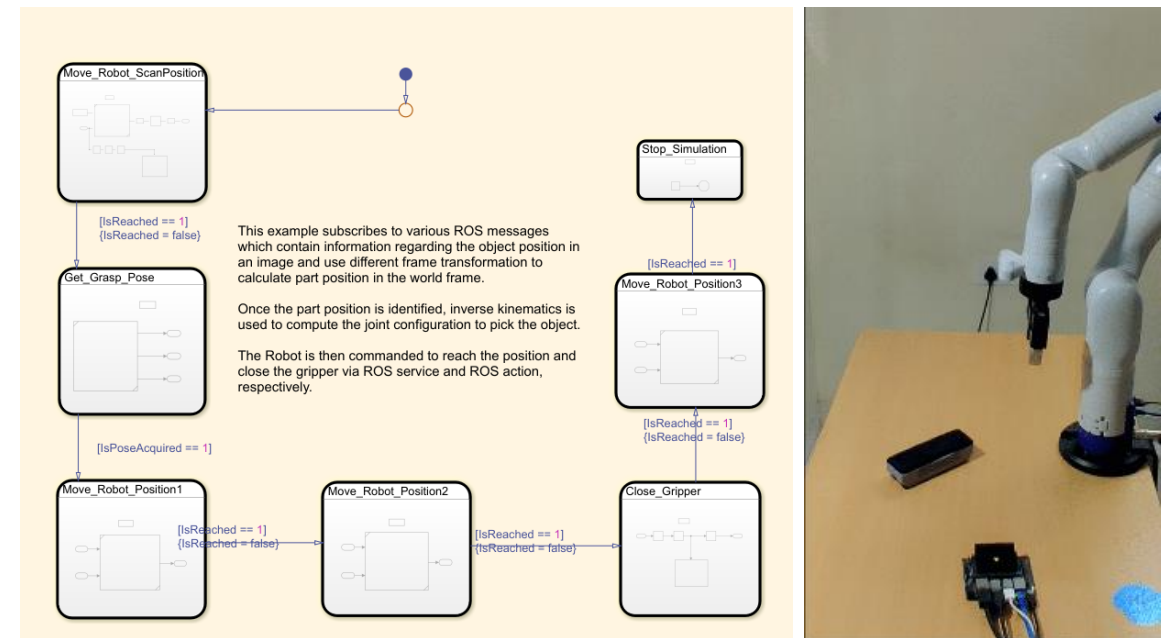
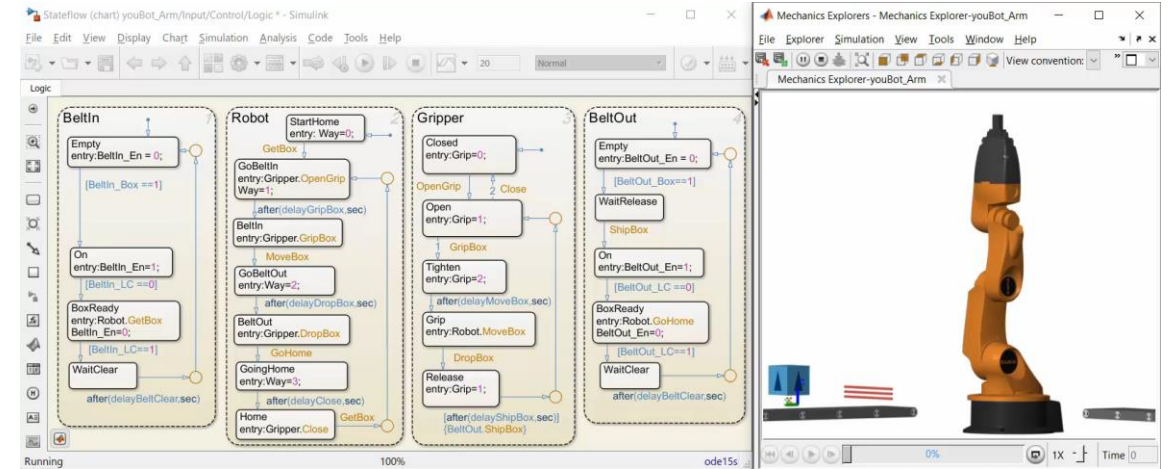


Control

Design control logic for robots



- Model and simulate decision logic for reactive systems:
 - supervisory control
 - task scheduling
 - fault management



Manipulator Hardware Support

Kinova Gen 3 Hardware Support Package

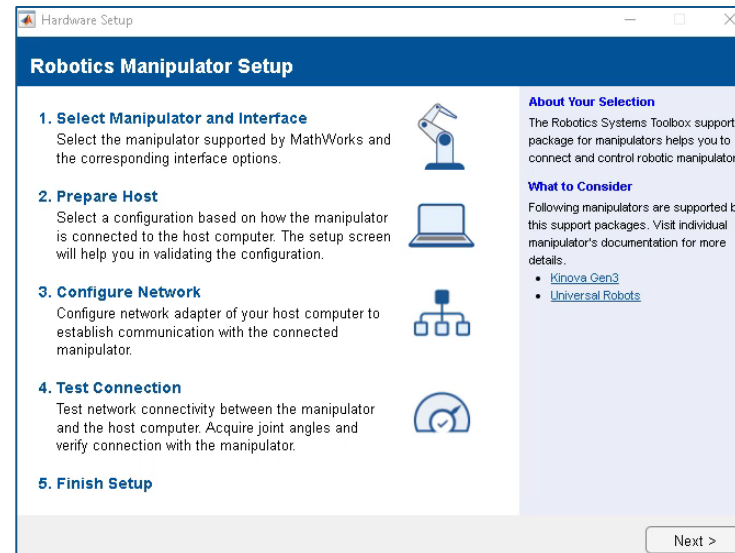
Robotics System Toolbox Supported Hardware

Support for third-party hardware

[Get Support Package Now](#)

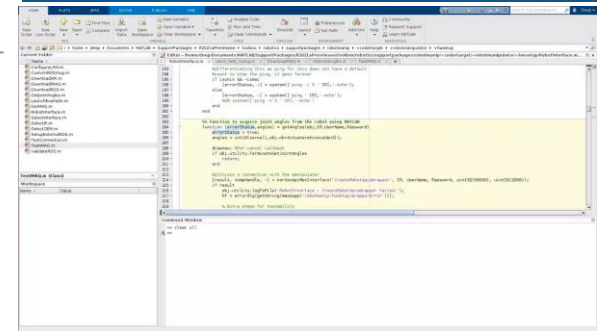


Manipulator Setup



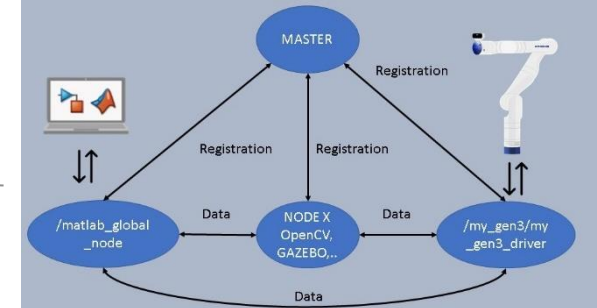
R2020b

MATLAB MEX Interface



R2021a

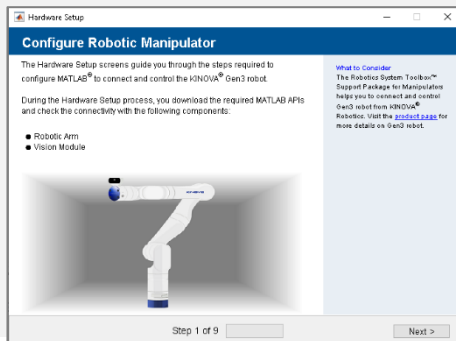
ROS Interface



Manipulator Hardware Support

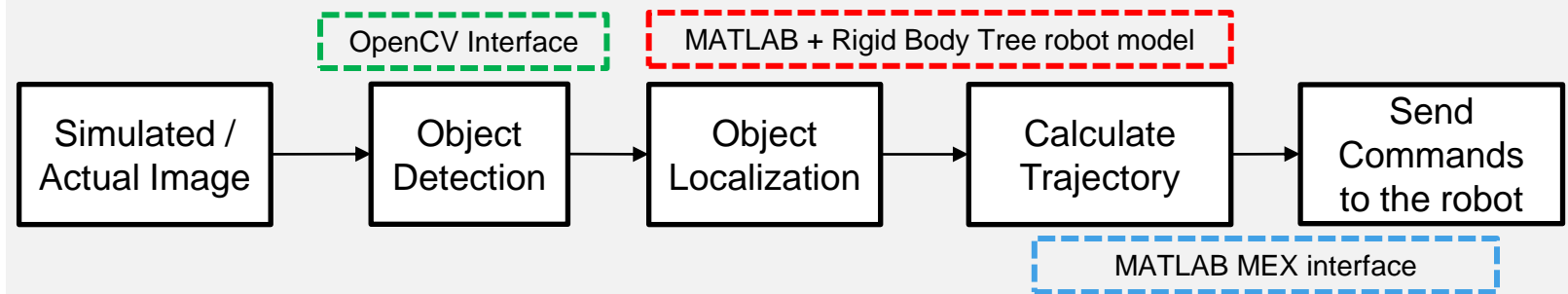
Kinova Gen 3 Hardware Support Package

- Connect to the Kinova Gen3 robot manipulator
- Use “Connect to”, “Control”, and “Read Sensors” commands
- connect with Kinova Gen 3 and use examples



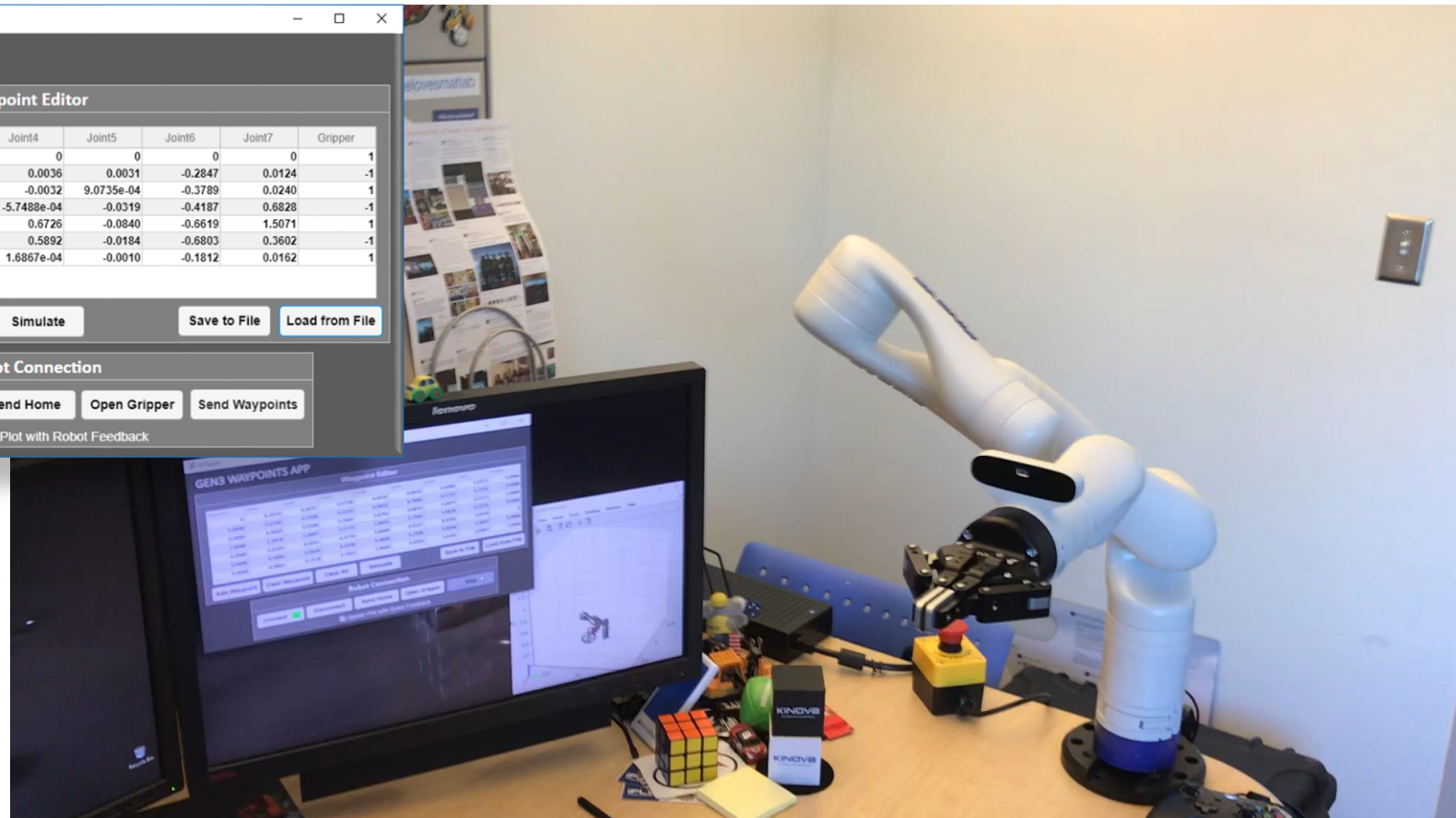
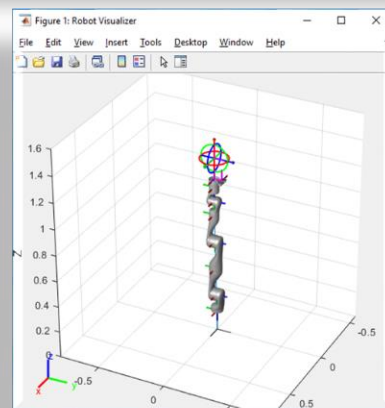
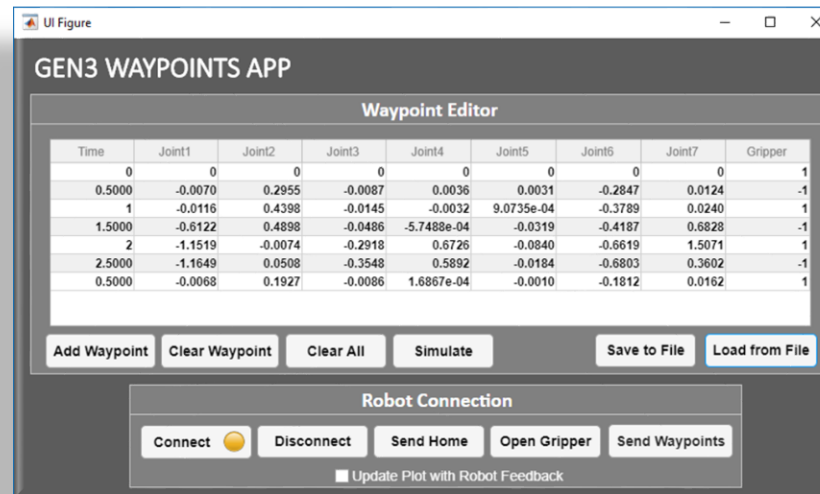
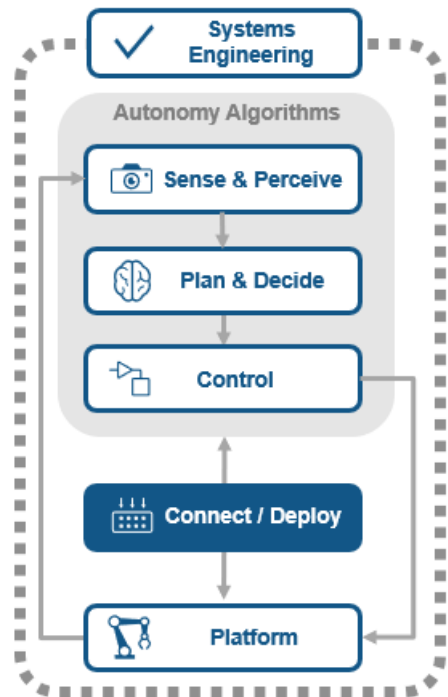
MATLAB MEX Interface

Detect-and-Pick an Object -
Connected I/O using
MATLAB MEX interface with
Kinova Gen 3 Robot



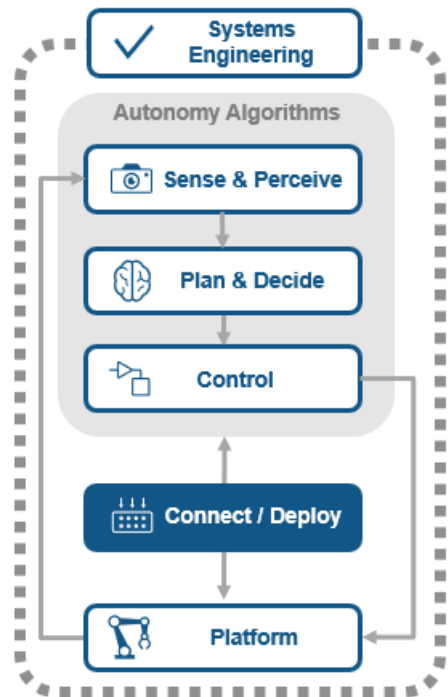
Hardware Connectivity

Waypoint tracking app

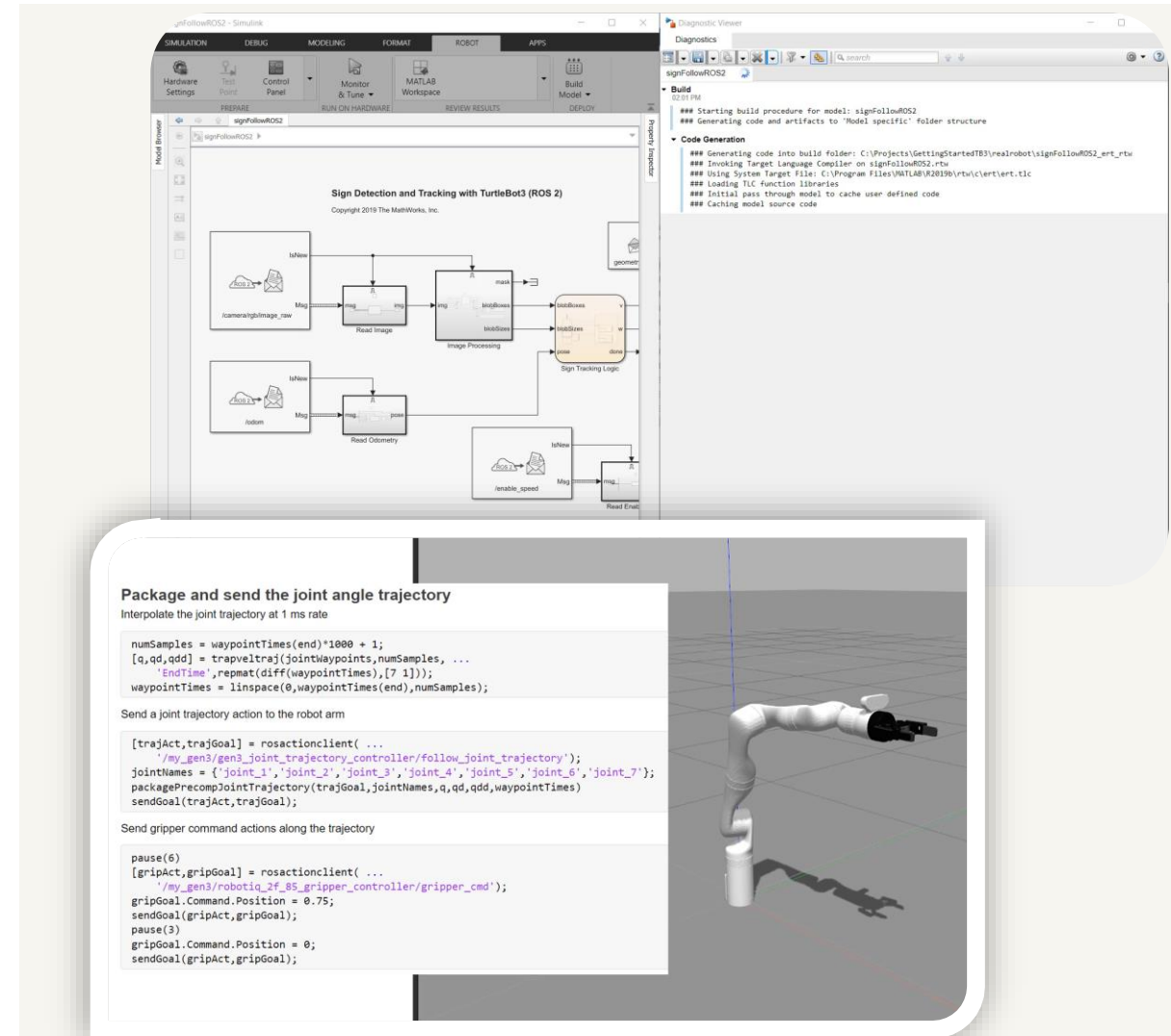


ROS-based Applications

Connecting through ROS and ROS2

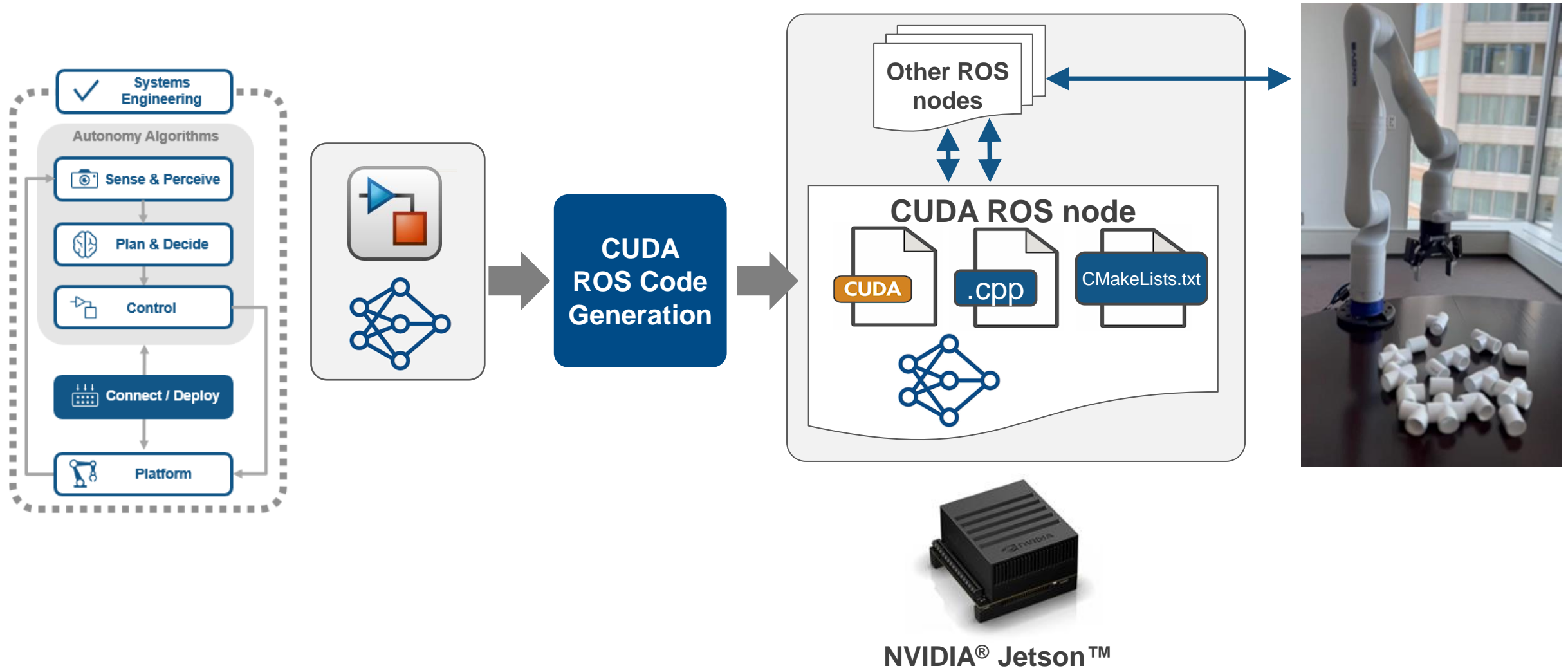


- ROS network and communication
 - Live connectivity from MATLAB and Simulink to ROS and ROS2
- ROS Message
 - rosbag data import and playback
 - Specialized ROS message



ROS-based Applications

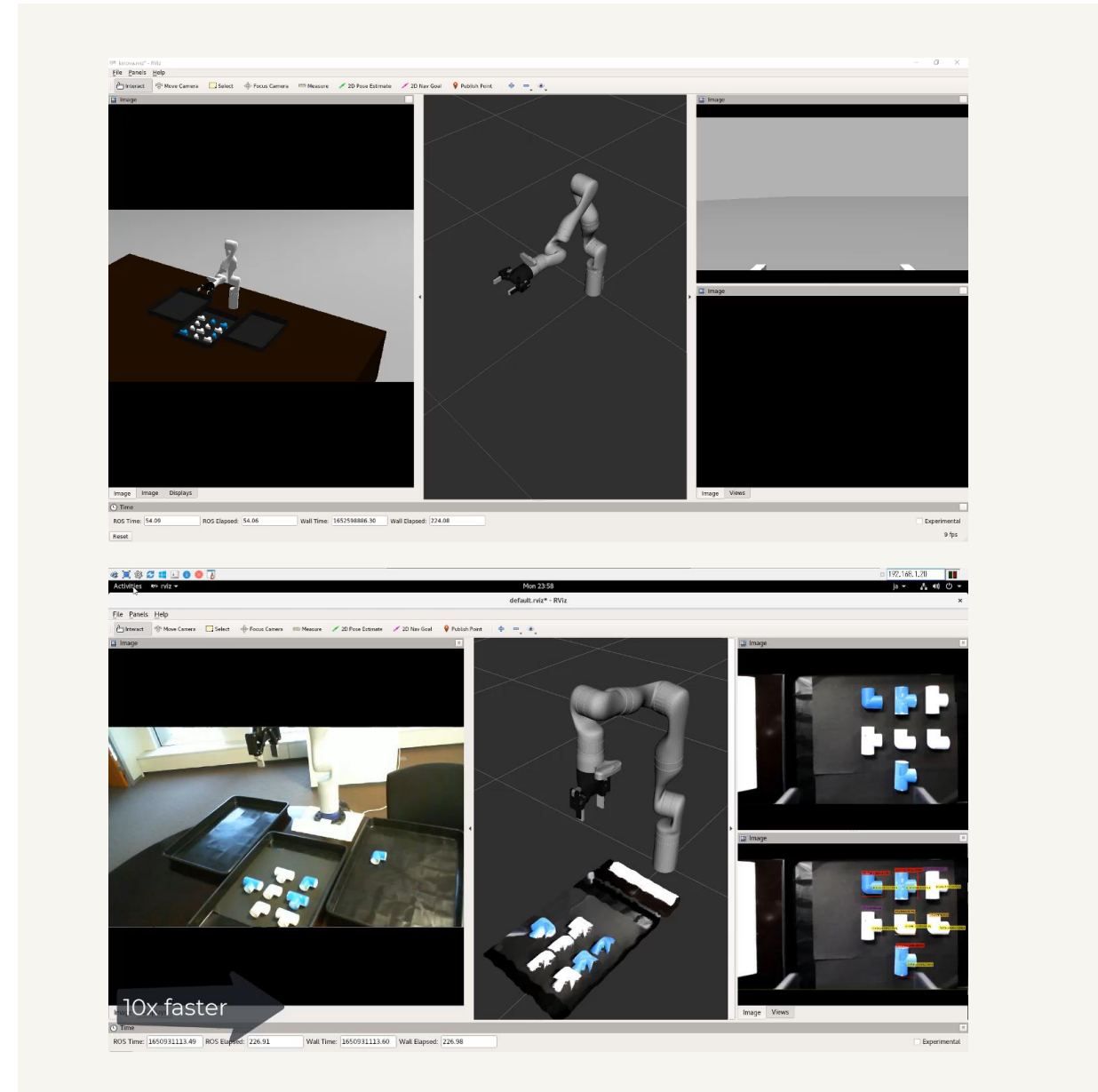
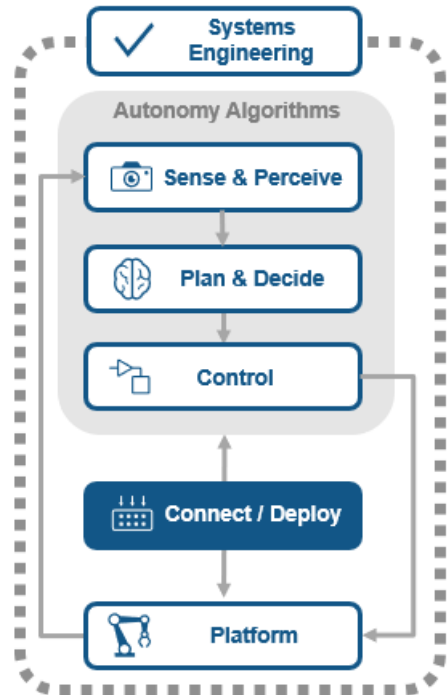
Deployment of CUDA ROS node



ROS-based Applications

Deployment of stand-alone ROS nodes

- ROS node generation
 - Node generation from Simulink for prototyping and deploying autonomous systems
 - C++ ROS node generation for path planning
 - CUDA ROS node generation for YOLOv3 object detection



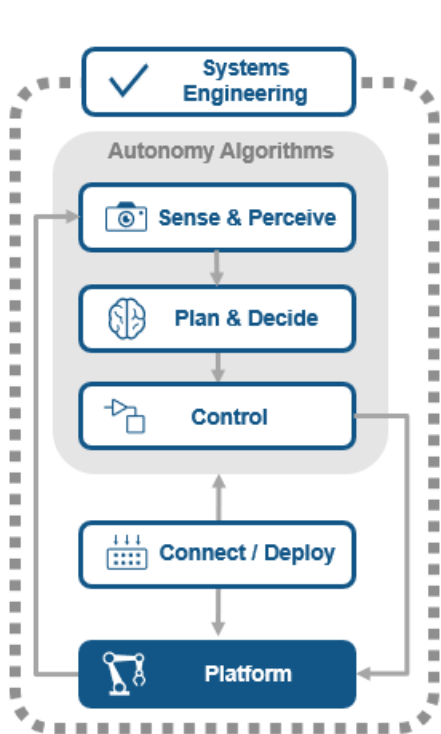
Hardware Platform: Physical Modeling

Importing robot model from SDF and URDF

Gazebo World or *.SDF

URDF

CAD Assembly

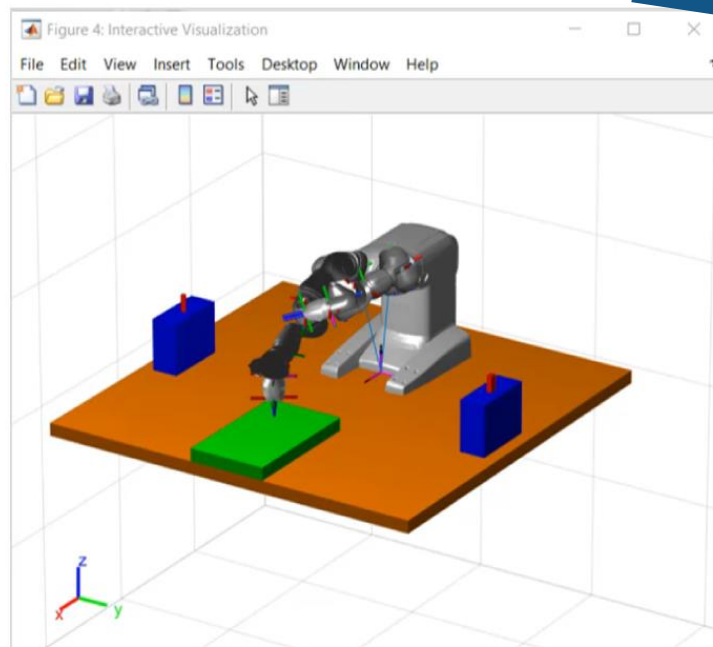


importrobot

importrobot

smimport

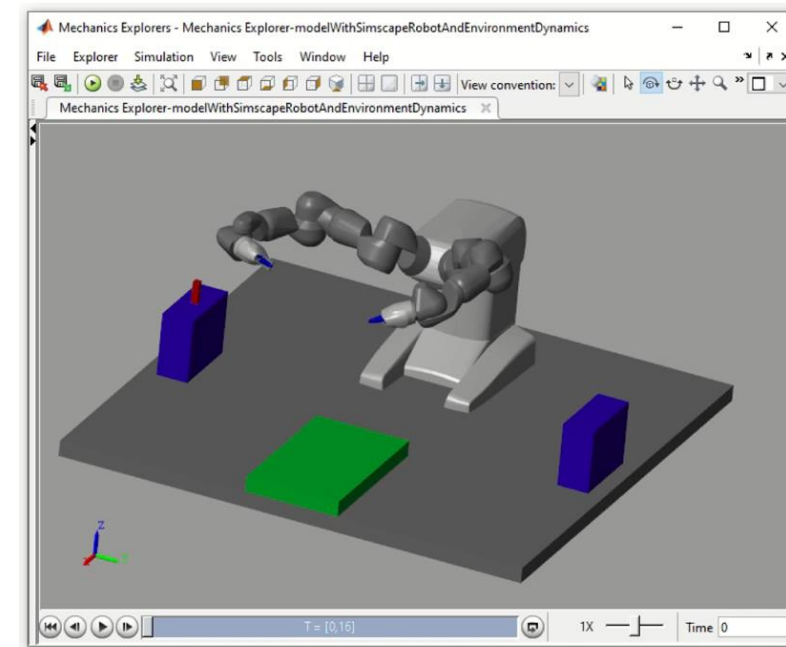
smimport



rigidBodyTree Object

smimport()

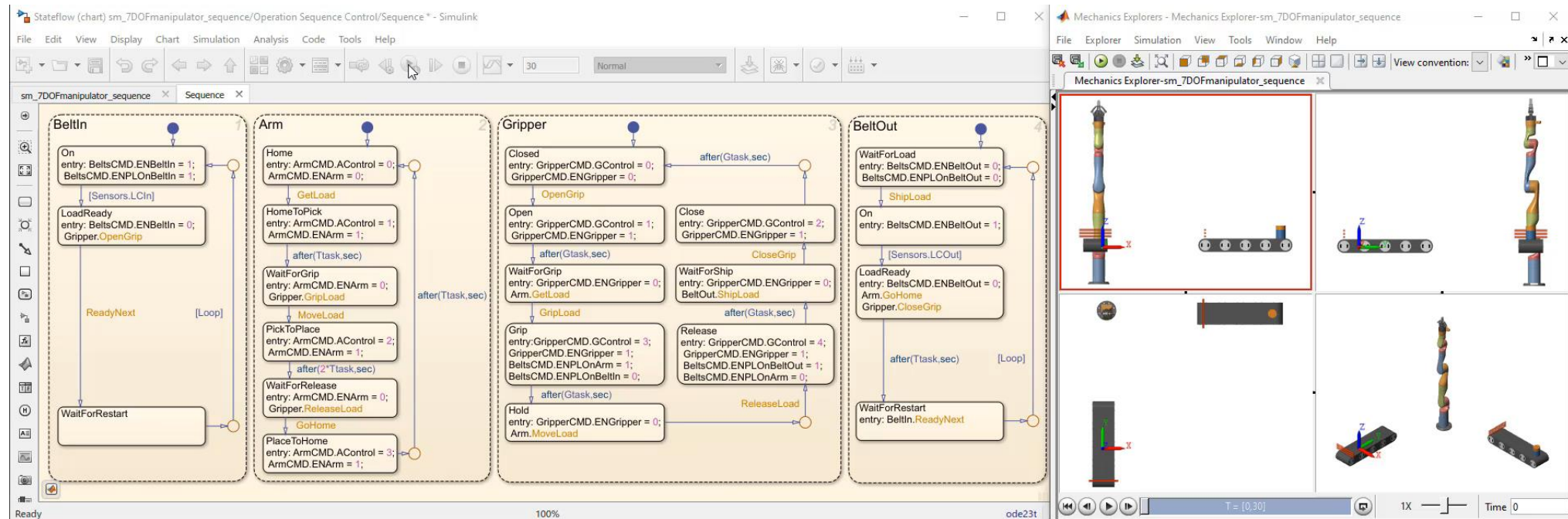
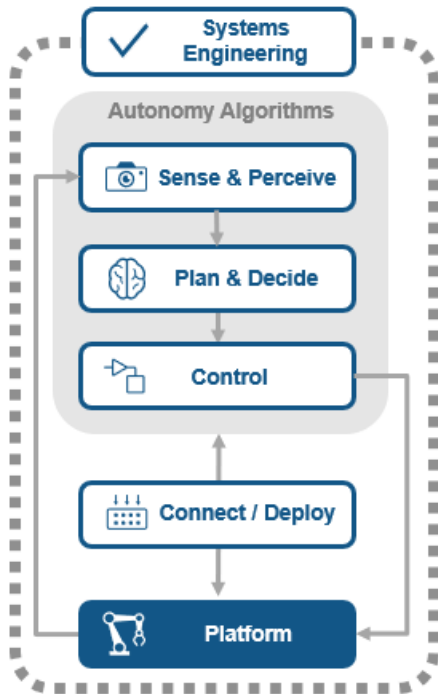
importrobot()



Multibody Model

Hardware Platform: Physical Modeling

Mechanical Modeling : Control of sequential operation – supervisory logic



MATLAB EXPO

Thank you



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