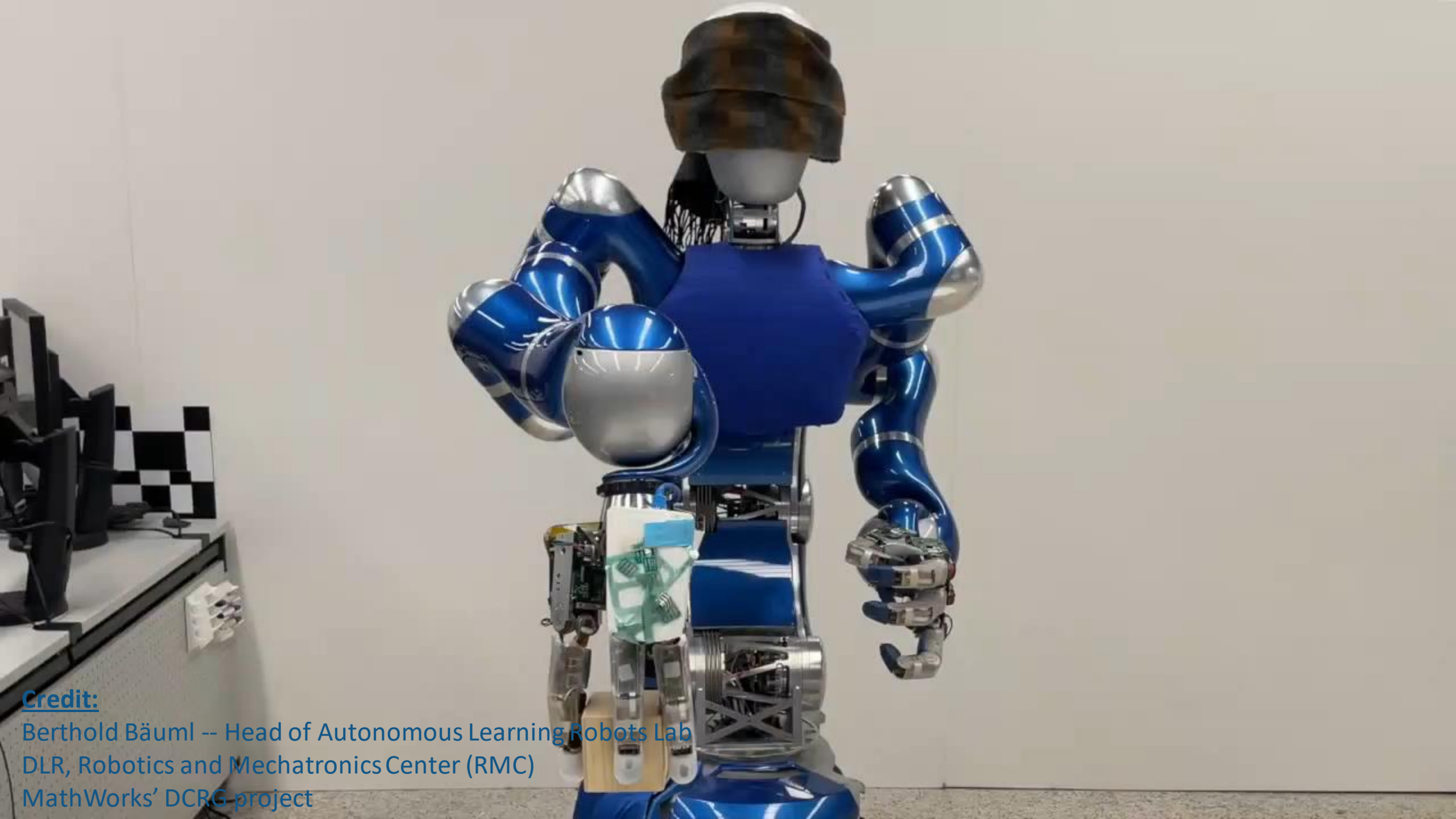
MATLAB EXPO

MATLAB을 이용한 AI 기반 자율로봇 구현

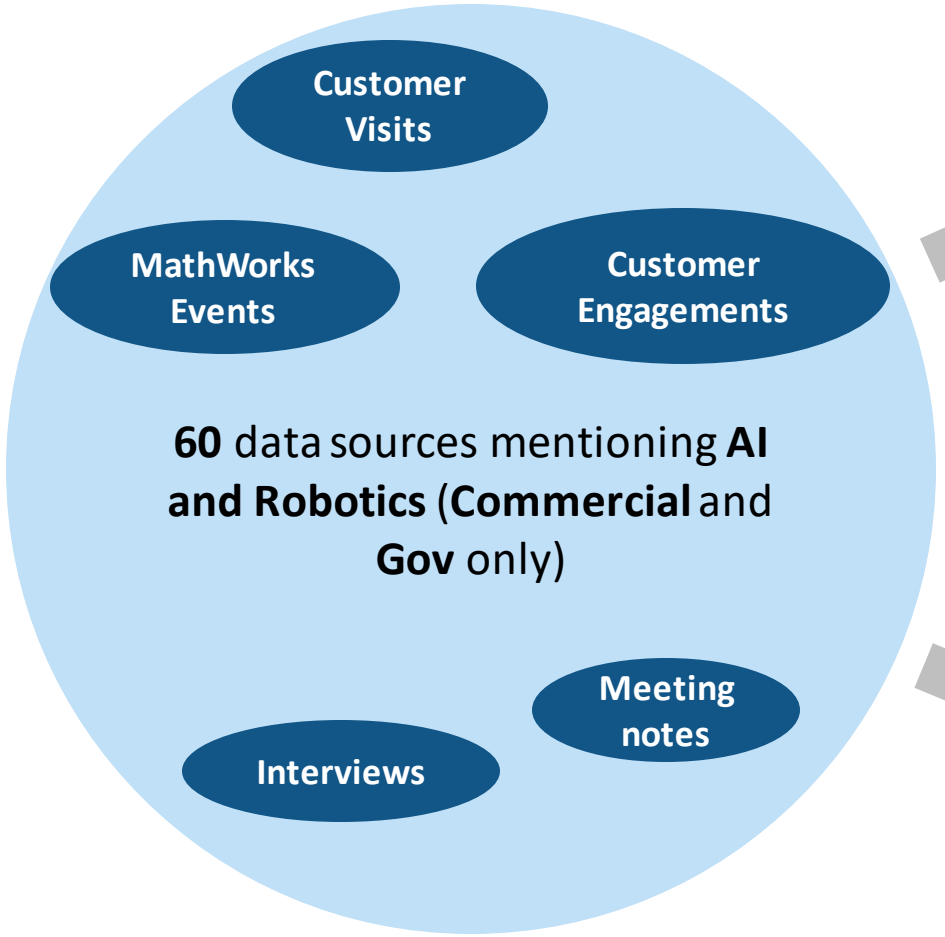
김종헌 부장, 매스웍스코리아

MathWorks

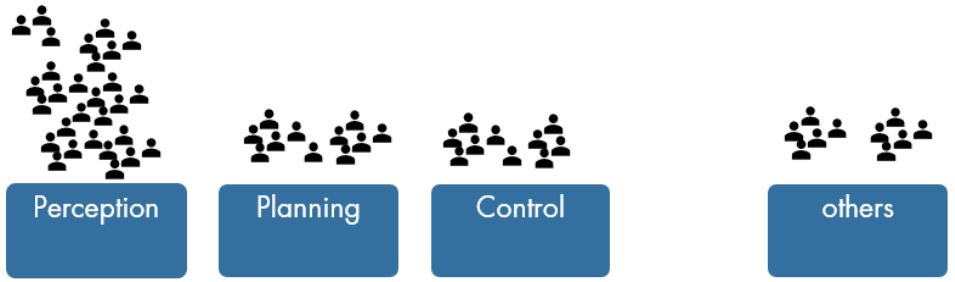


Credit:
Berthold Bäuml -- Head of Autonomous Learning Robots Lab
DLR, Robotics and Mechatronics Center (RMC)
MathWorks' DCRG project

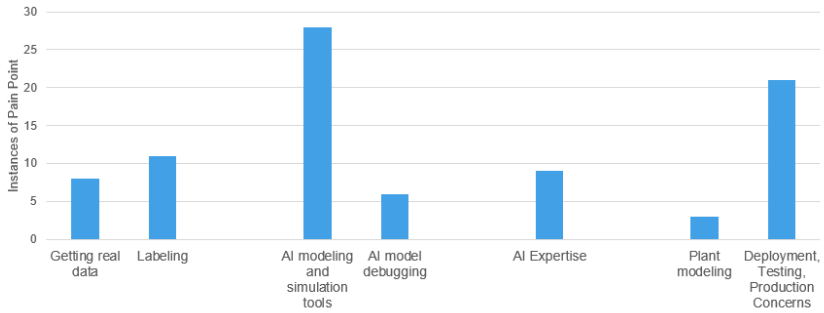
User Study - roboticists interested in AI to learn how they are using it



Where is AI used in robotics?



What challenges have engineers encountered?



Commercial robotics customers: **Where is AI being used in Robotics?**

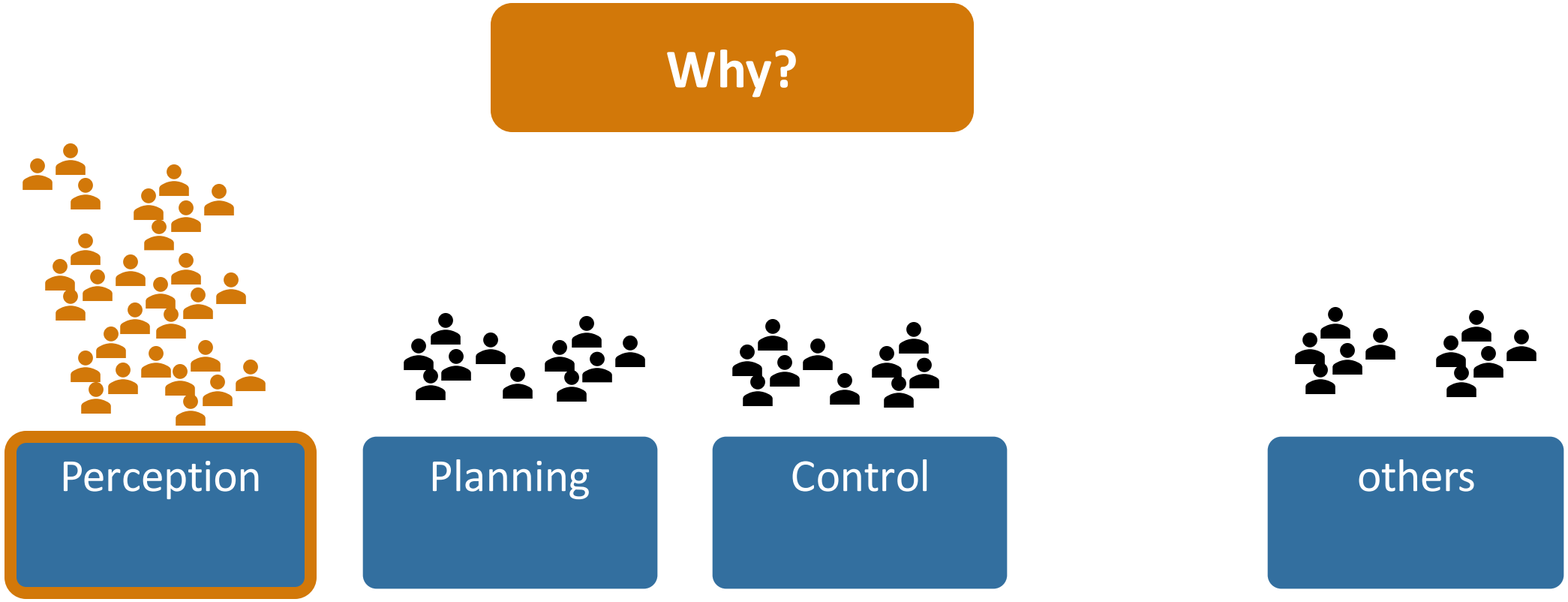
Perception

Planning

Control

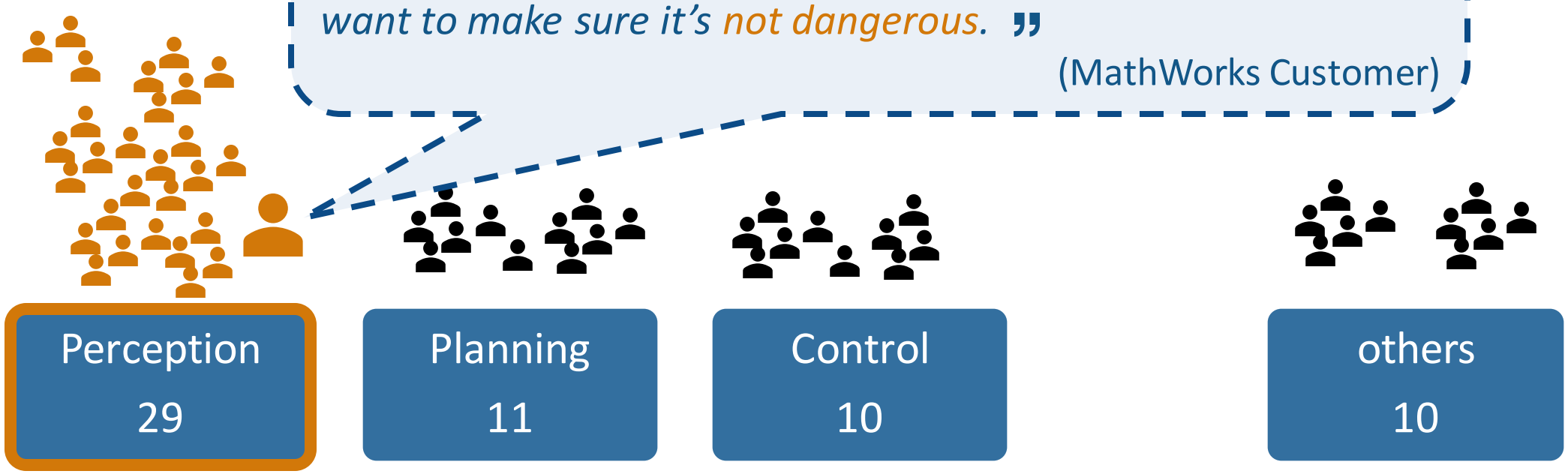
others

Commercial robotics customers are using AI more for ***Perception*** than elsewhere

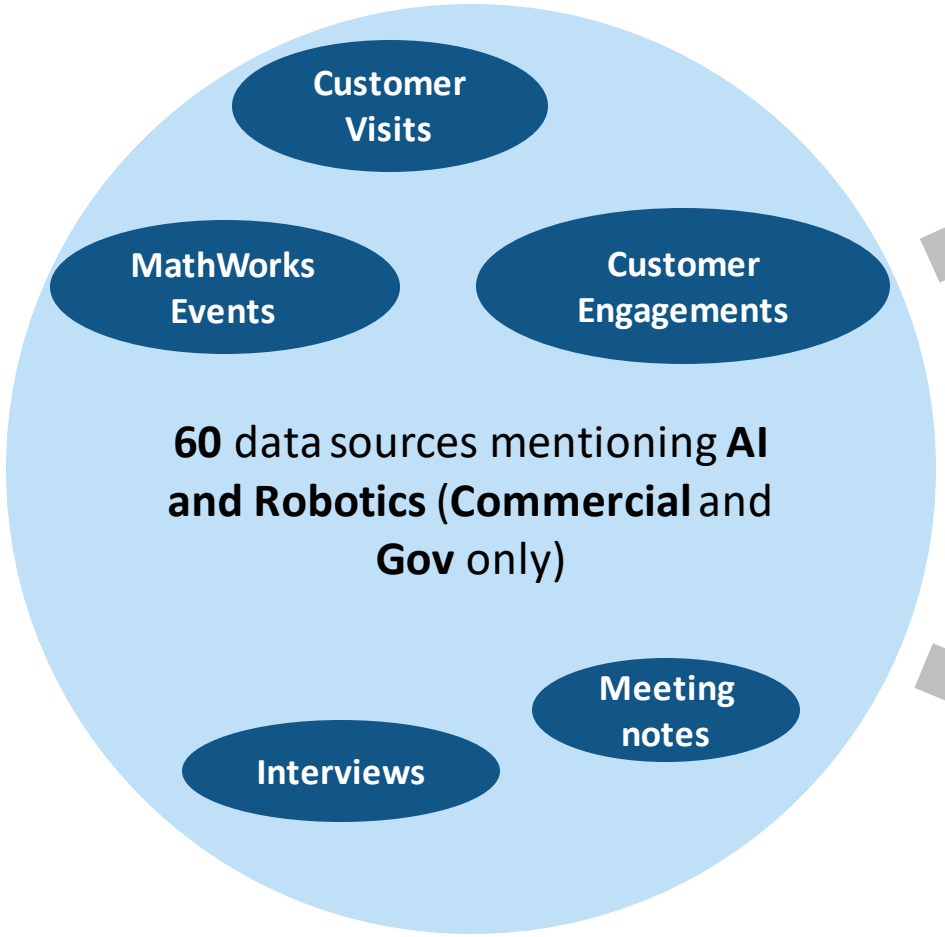


Safety, robustness, and certifications matter for production. Traditional algorithms have an advantage over AI in this regard.

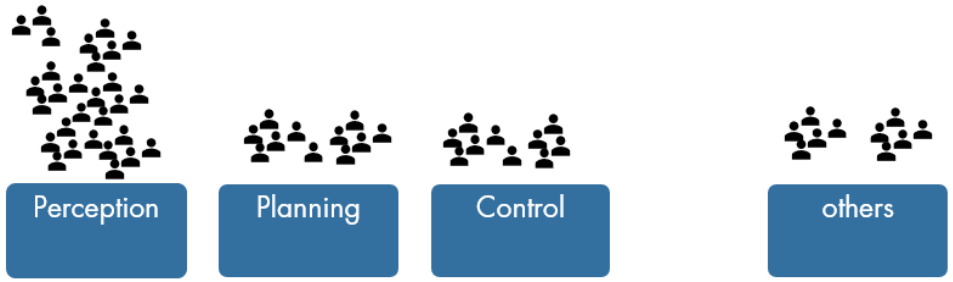
> *“We want to limit whatever the neural net – or even (for) teleop…. whatever action is commanded there. We want to make sure that it[Robot]’s not stupid. Or even if it’s stupid, we want to make sure it’s not dangerous.”*
>
> (MathWorks Customer)



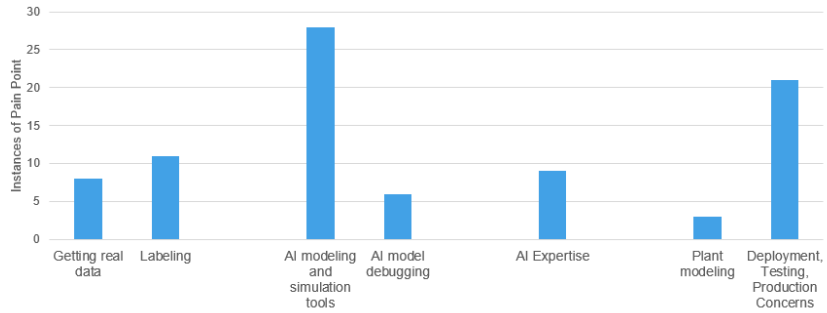
UX researched roboticists interested in AI to learn how they are using it



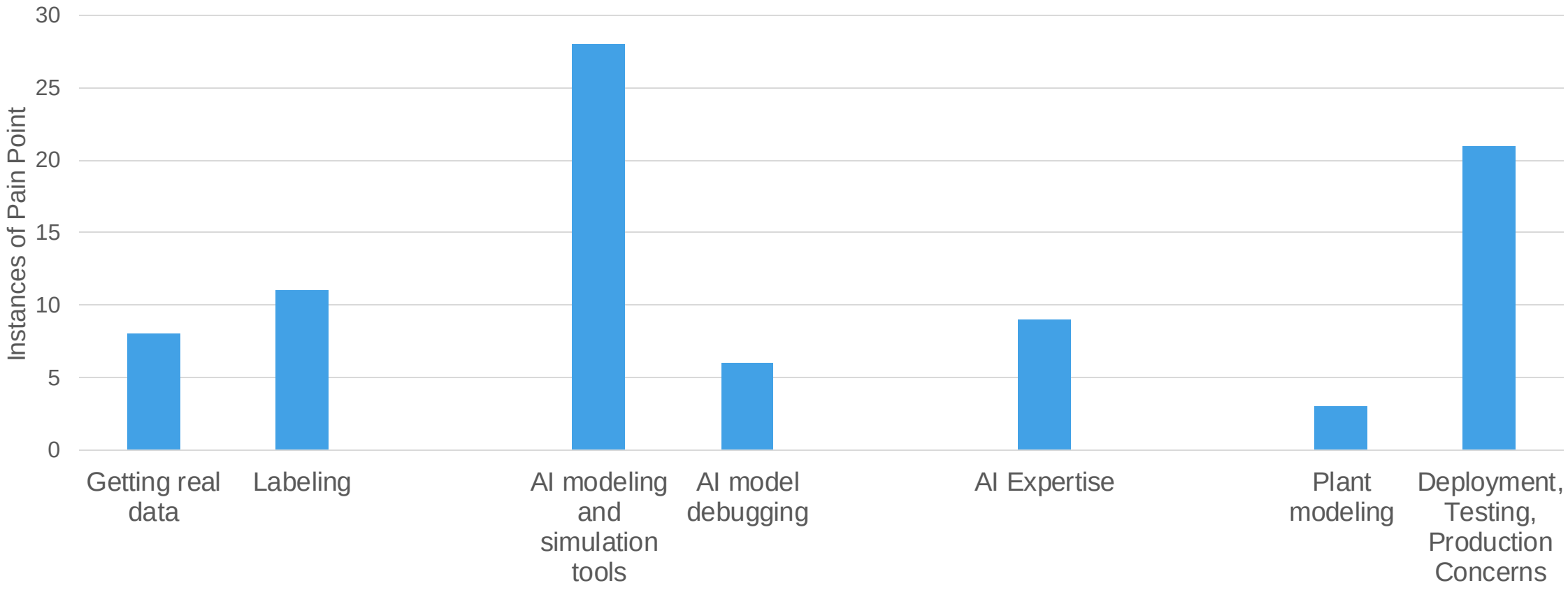
Where is AI used in robotics?



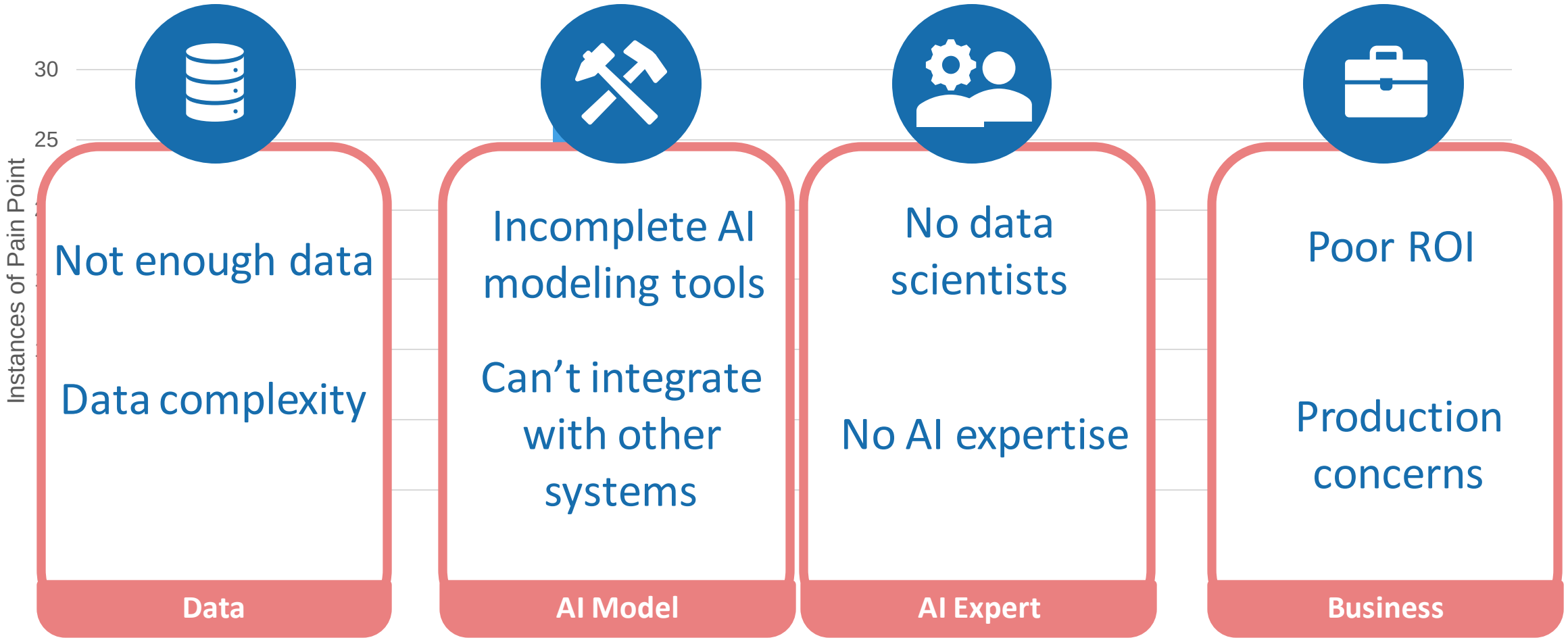
What challenges have engineers encountered?



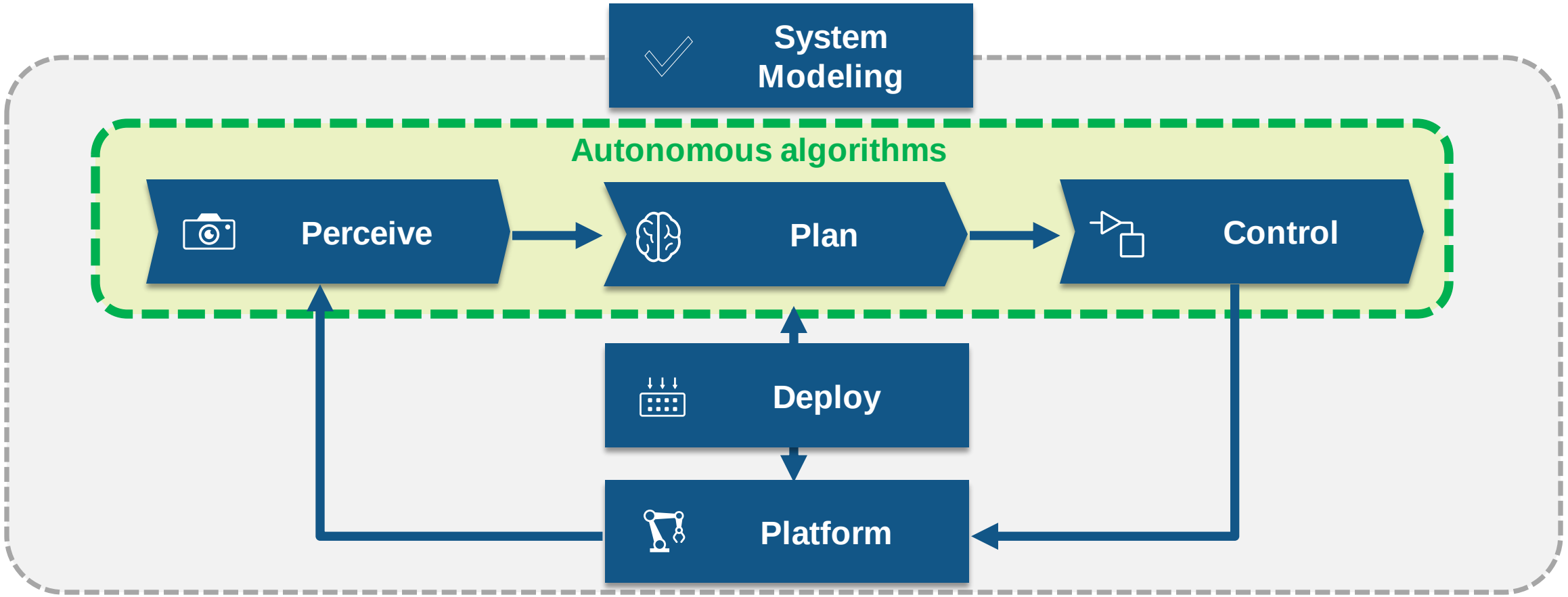
What pains and challenges have engineers encountered?



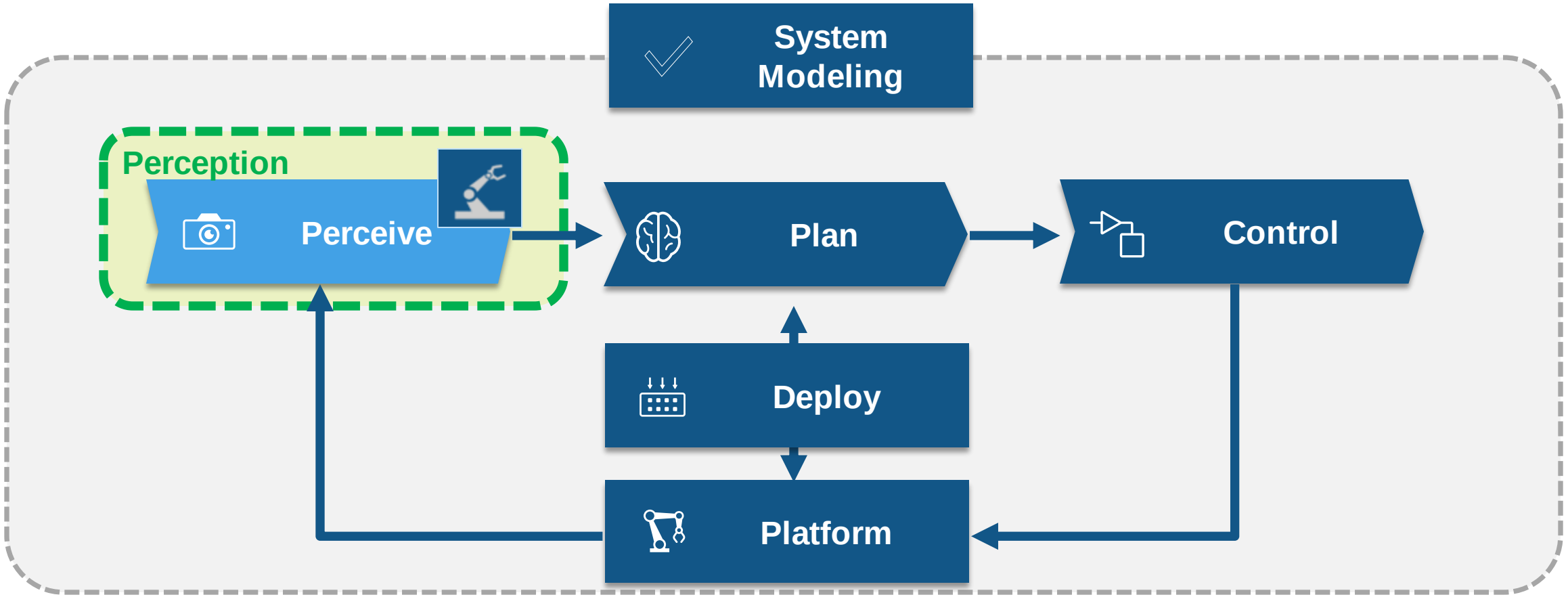
What pains and challenges have engineers encountered?



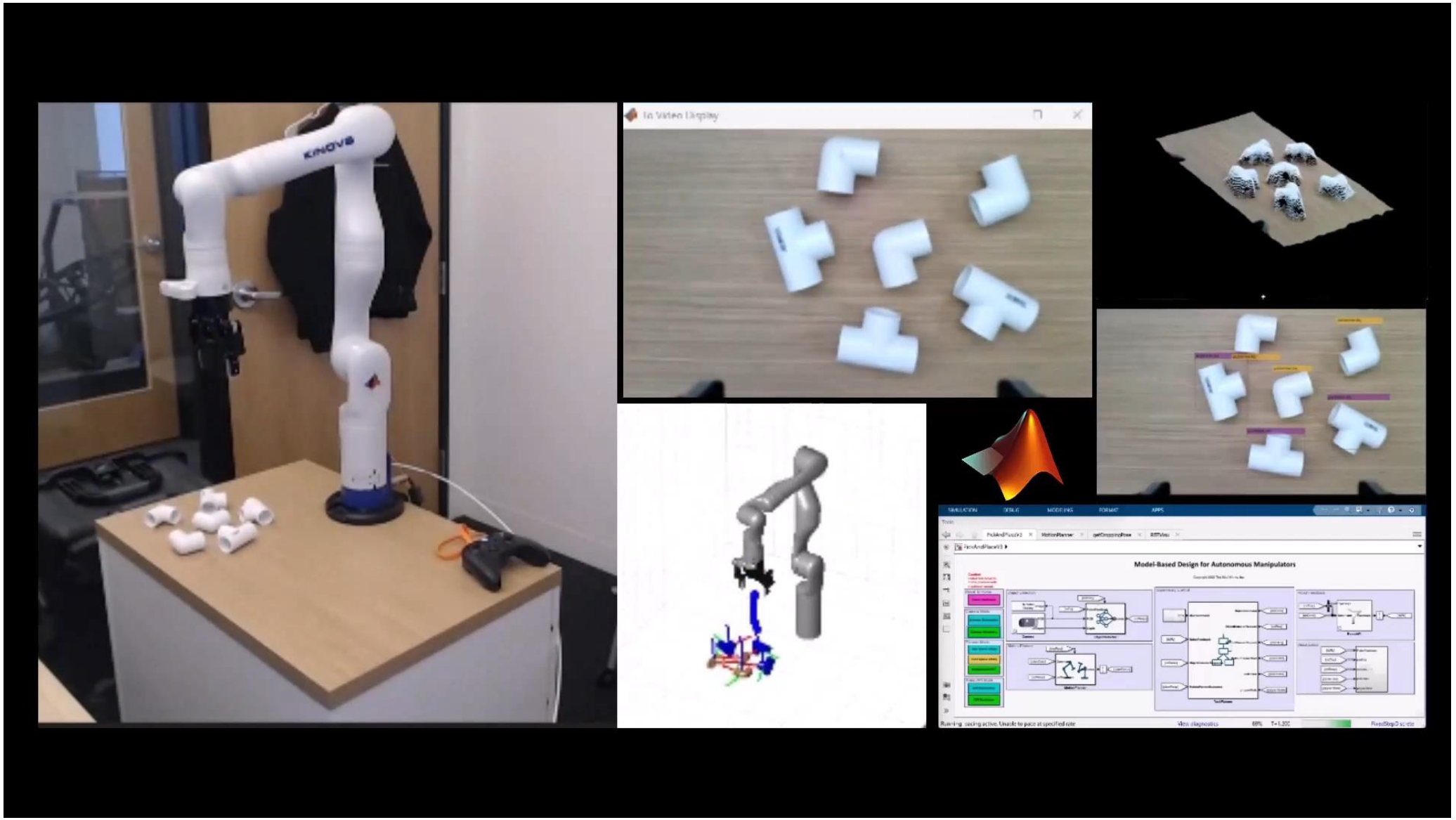
Autonomous system design workflow



Autonomous system design workflow



Developing pick & place application using cobot



How to get data for training?

Simulink 3D Animation
Robotics System Toolbox
Computer Vision Toolbox

Synthetic data generation with simulator

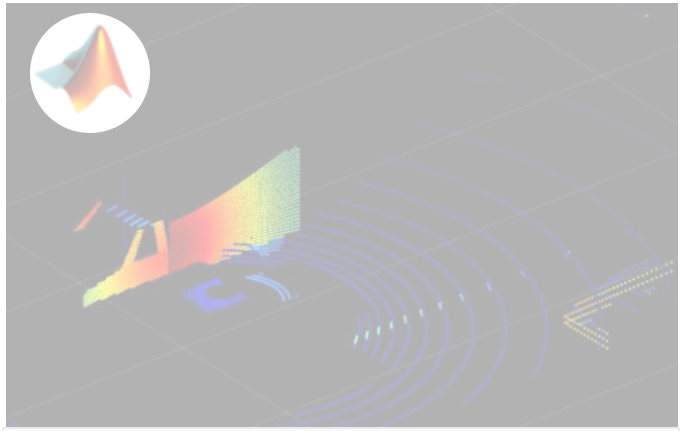
Data acquisition with hardware

Generate synthetic data to improve your datasets

Semantic Segmentation from Unreal for UAV

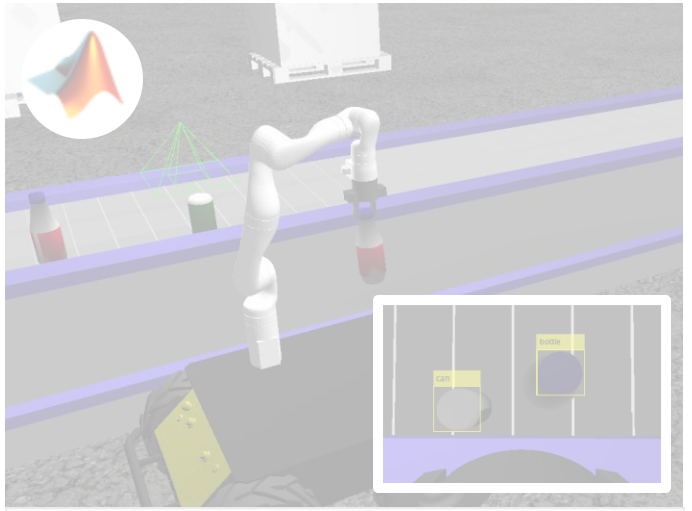
UAV Toolbox

Simulink



Lidar Sensor Model: Simulate lidar sensor and generate point cloud data

Lidar Toolbox



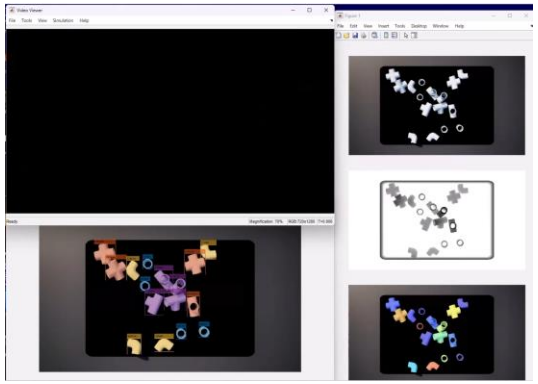
Gazebo Co-simulation with a Pretrained Deep Learning Model to Detect Recyclable Parts

Robotics System Toolbox

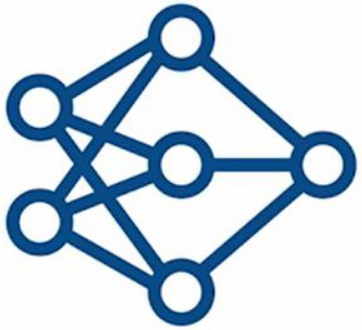
ROS Toolbox

Automated labeling apps save you weeks to months

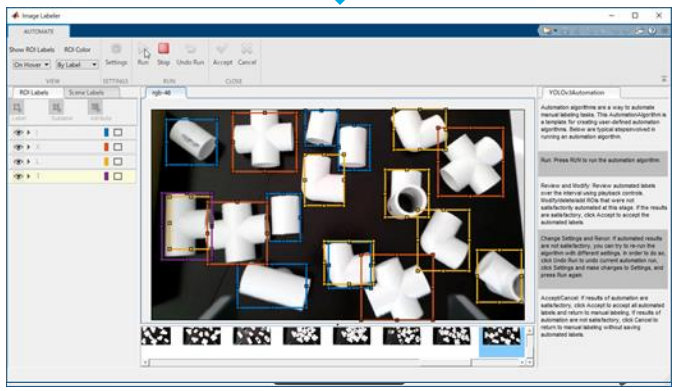
Computer Vision Toolbox
Deep Learning Toolbox
Simulink 3D Animation



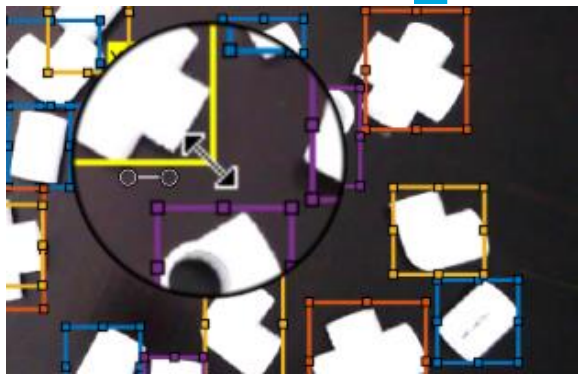
Synthetic data generation with CAD models



Train object detector



Automated labeling with actual images



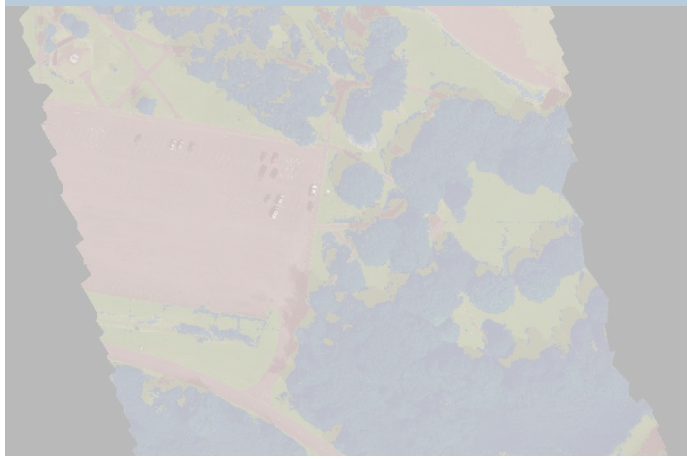
Correct wrong labels

Start with a complete set of algorithms and pre-built models

Object Detection with YOLOv4

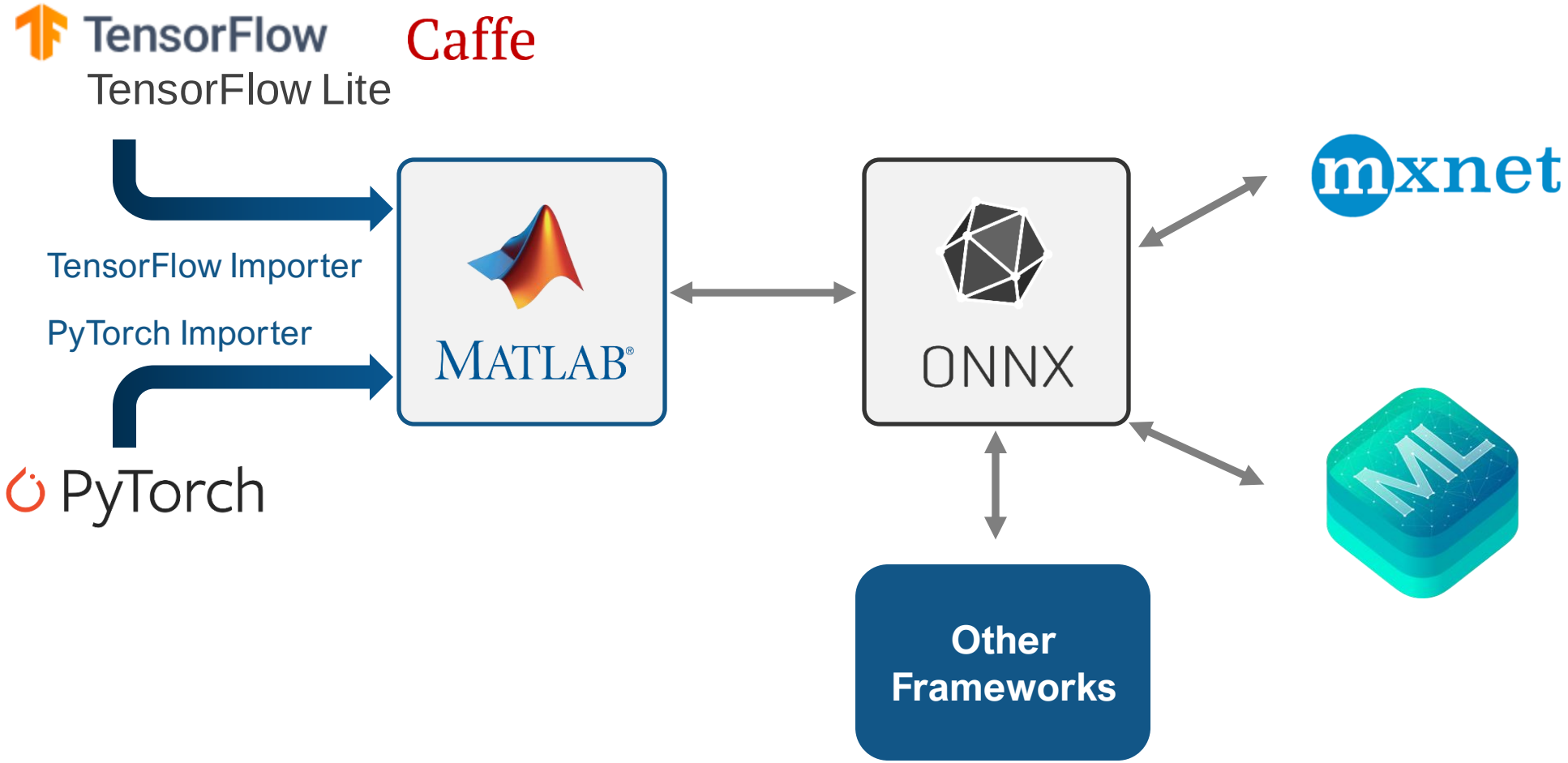
Instance Segmentation with Mask R-CNN

Semantic Segmentation with U-Net

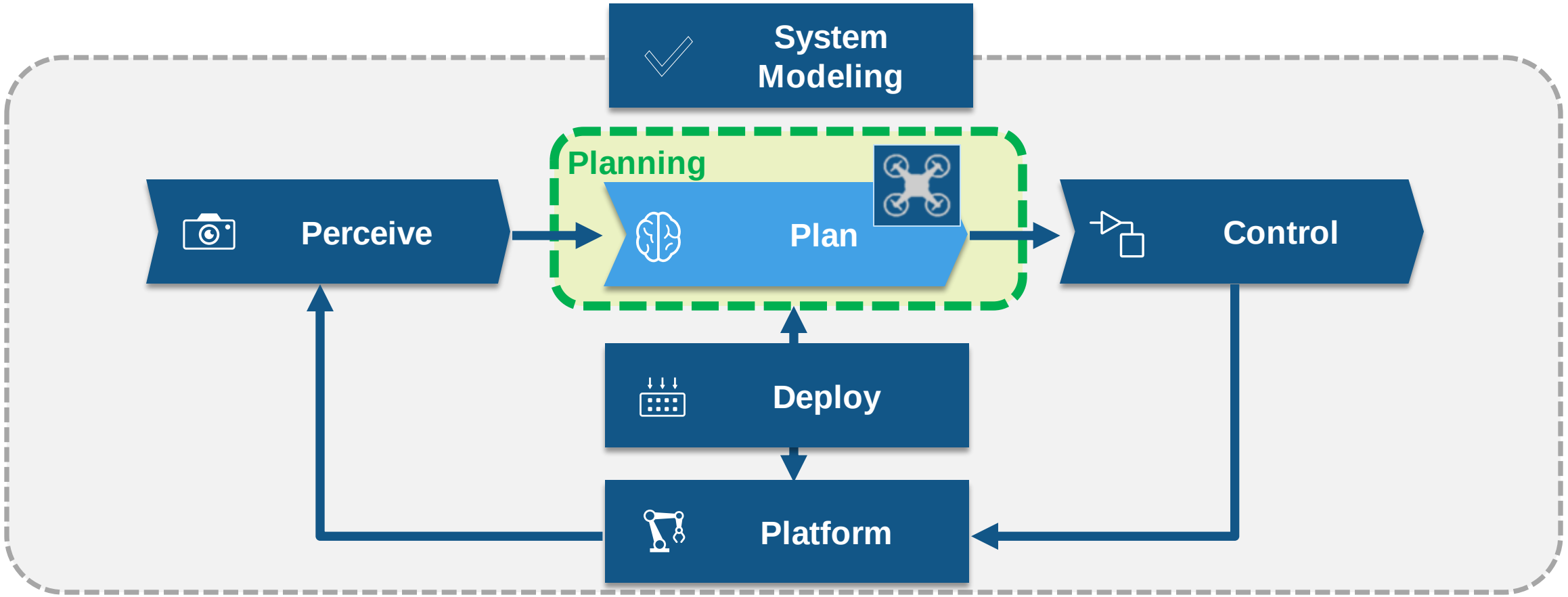


Deep Learning Toolbox
Image Processing Toolbox
Computer Vision Toolbox

Access AI models from the broader AI community



Autonomous system design workflow

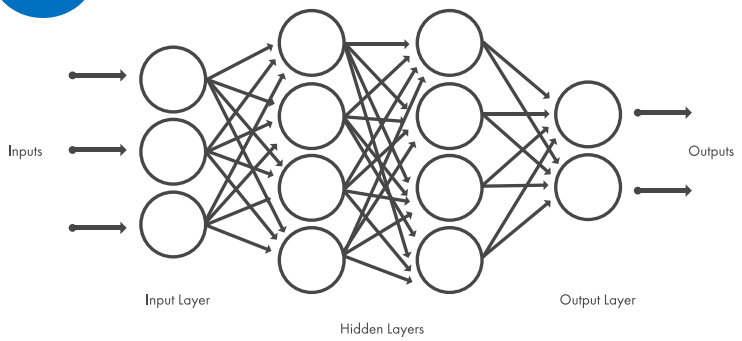


Pre-built AI model is ready to use for perception in UAV application

1

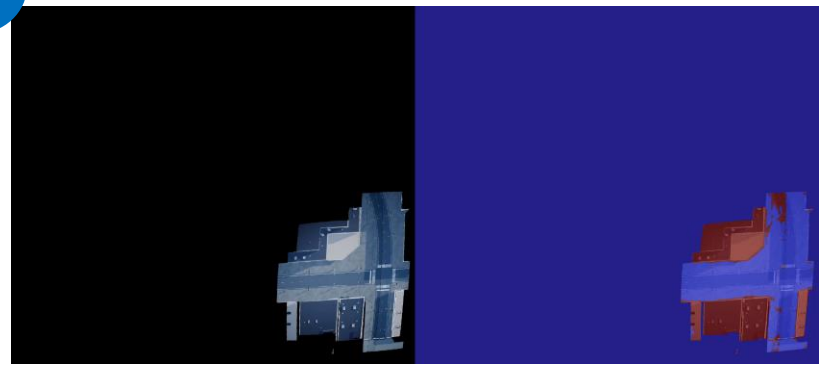
Obtain drone captures images and convert into orthophotos

2



Pass through semantic segmentation network

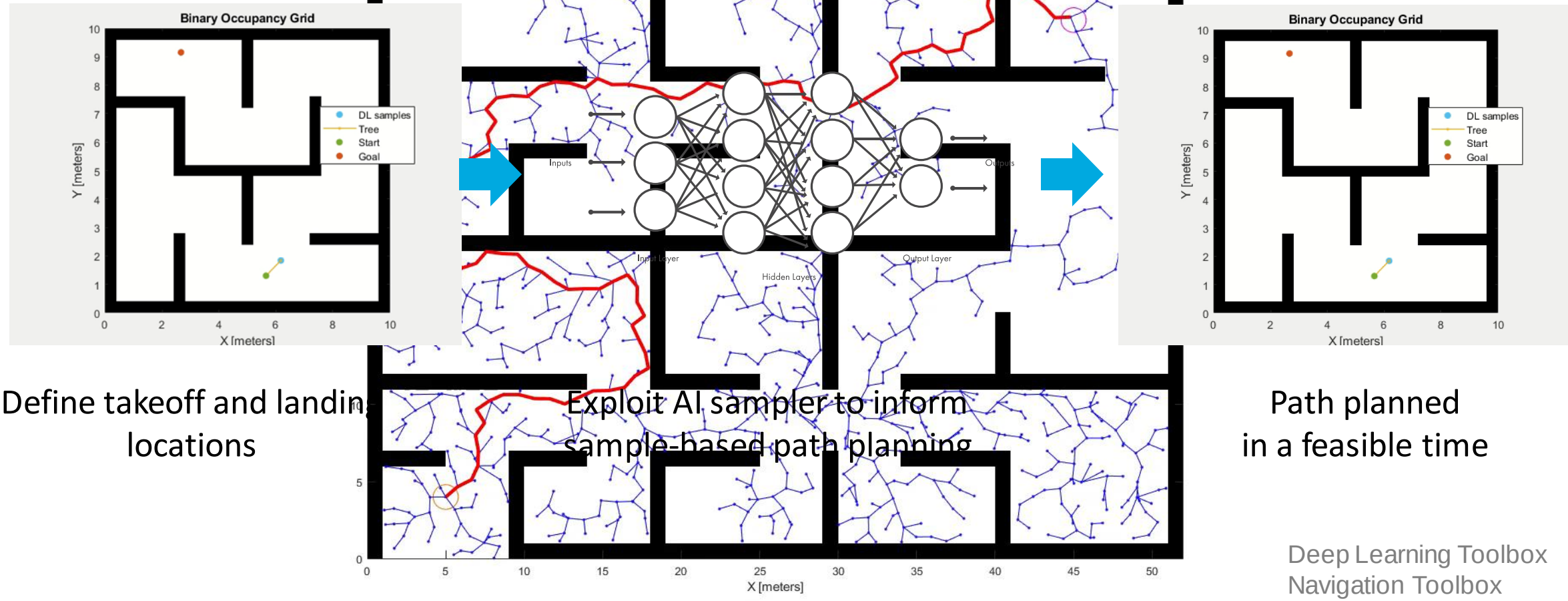
3



Combine output labels to get final 2D map

Deep Learning Toolbox
UAV Toolbox
Computer Vision Toolbox
Navigation Toolbox

AI model for motion planning in UAV application



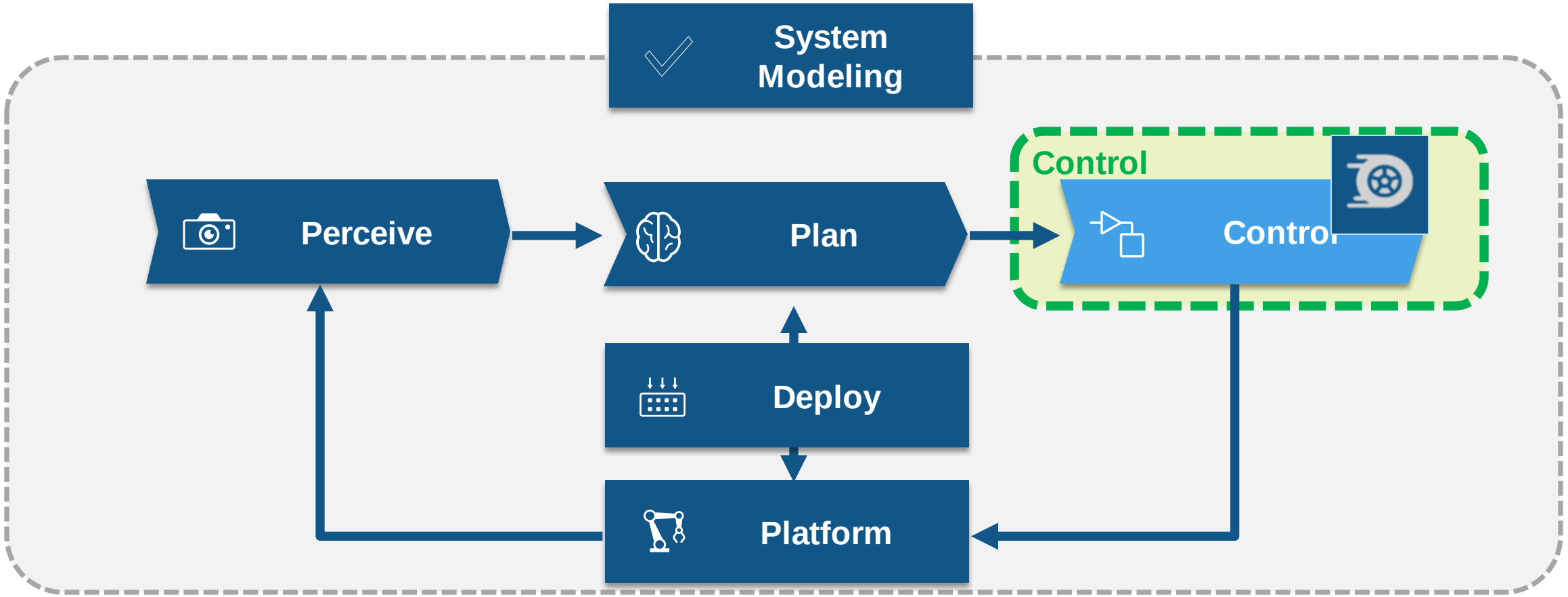
Define takeoff and landing locations

Exploit AI sampler to inform sample-based path planning

Path planned in a feasible time

Deep Learning Toolbox
Navigation Toolbox

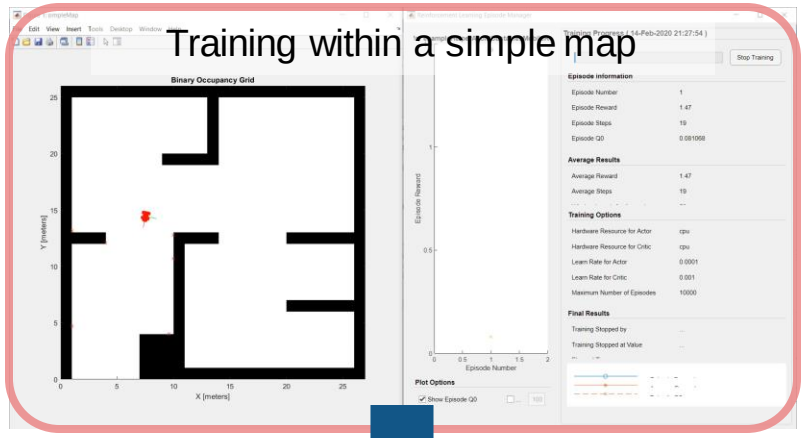
Autonomous system design workflow



Obstacle avoidance with reinforcement learning

Define lidar sensor model → Define RL agent → Training in simple env. → Scale up to realistic env. → Validation

Training within a simple map

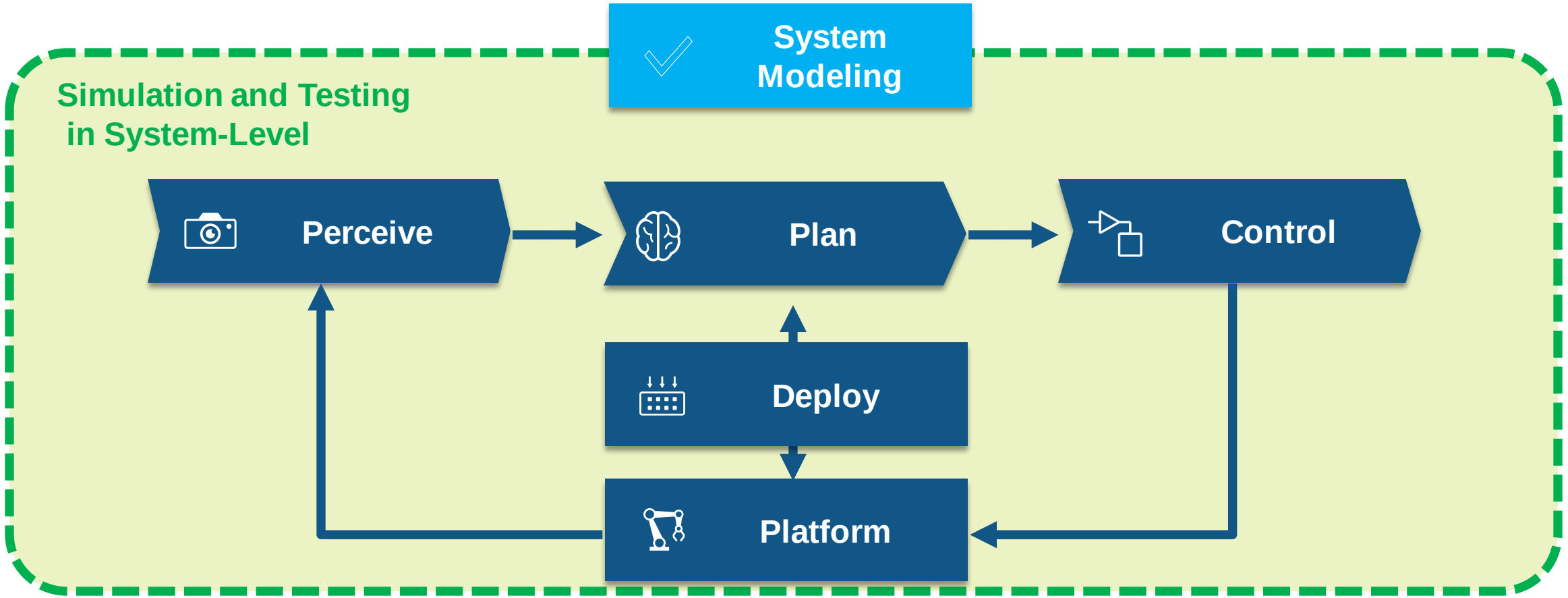


After training within a simple map

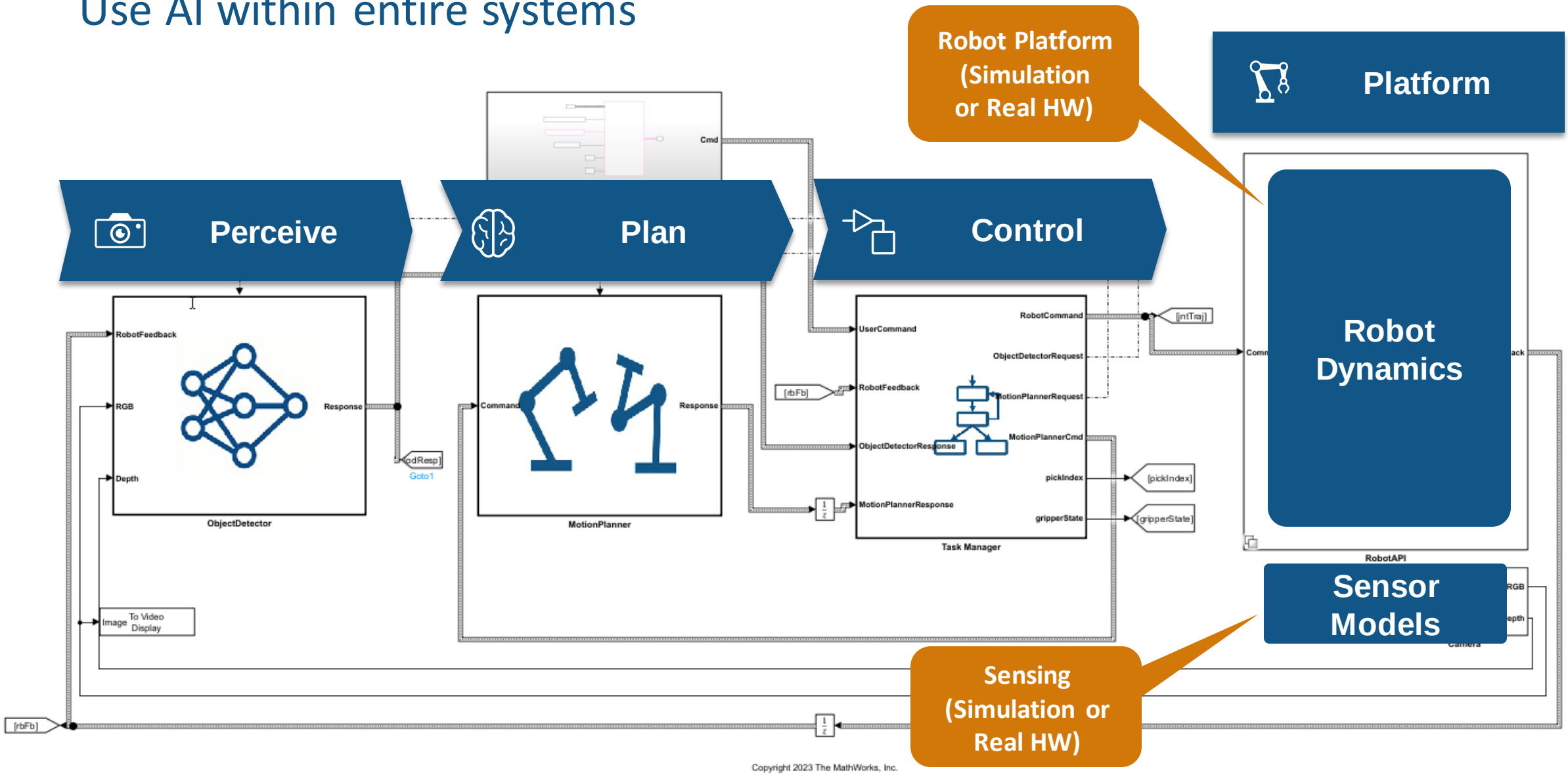
Visualized in a realistic environment

Reinforcement Learning Toolbox, Robotics System Toolbox, Automated Driving Toolbox

Autonomous system design workflow

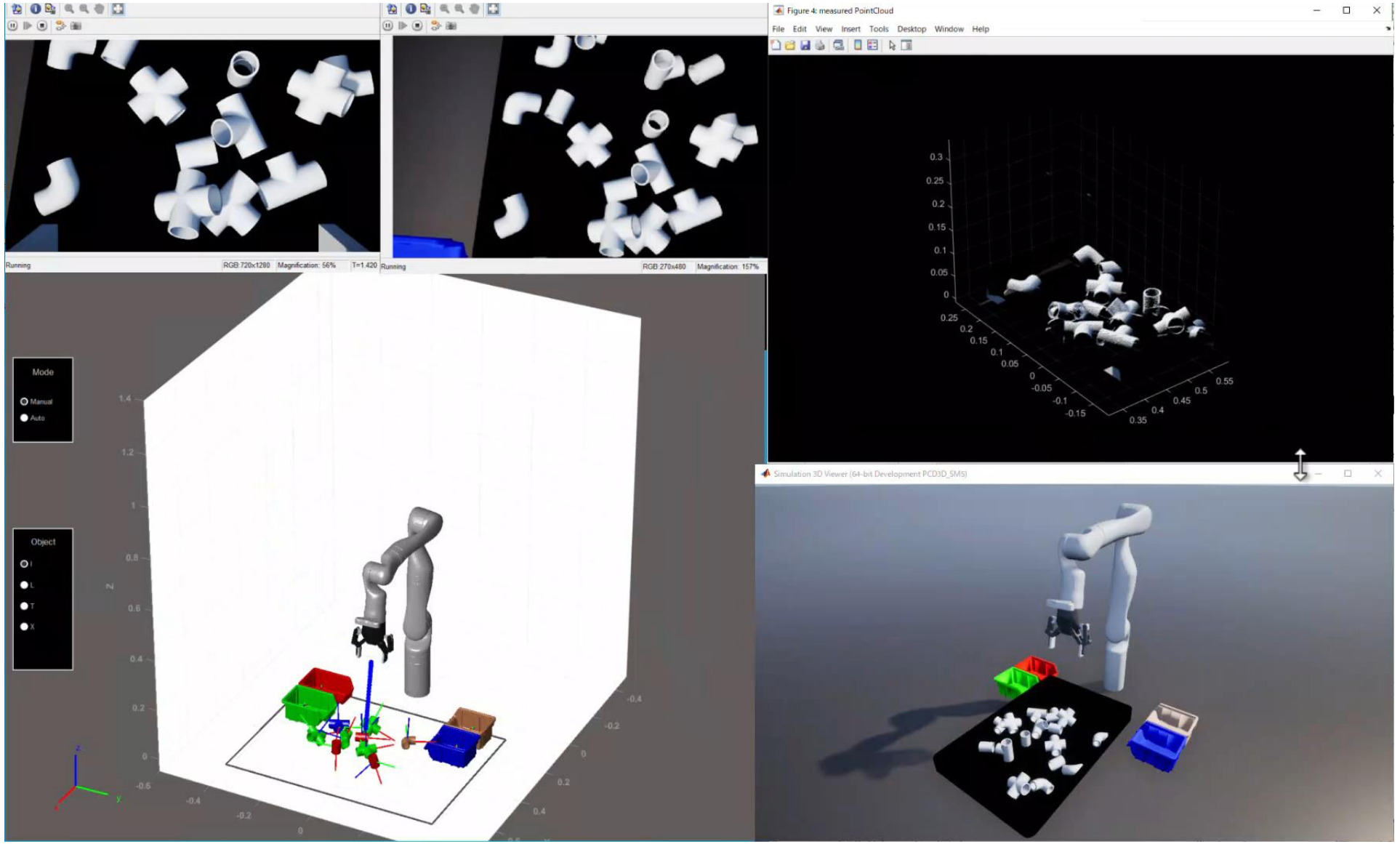


Use AI within entire systems

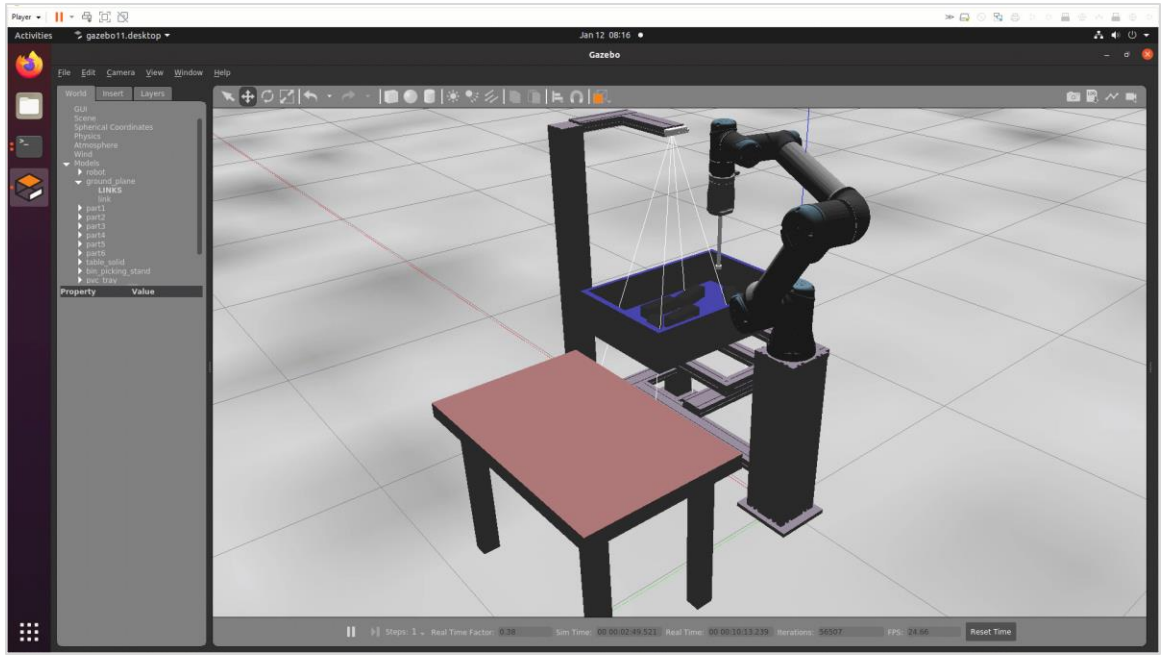


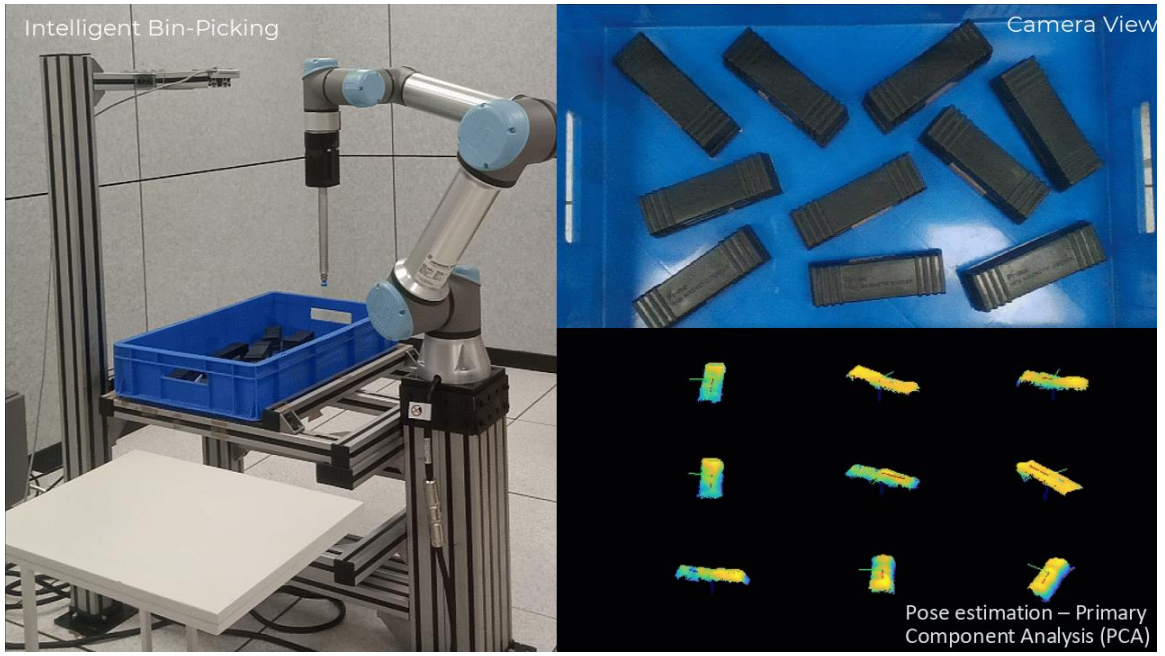
Validation of AI models in end-to-end simulation

Simulink 3D Animation
Robotics System Toolbox
Automated Driving Toolbox



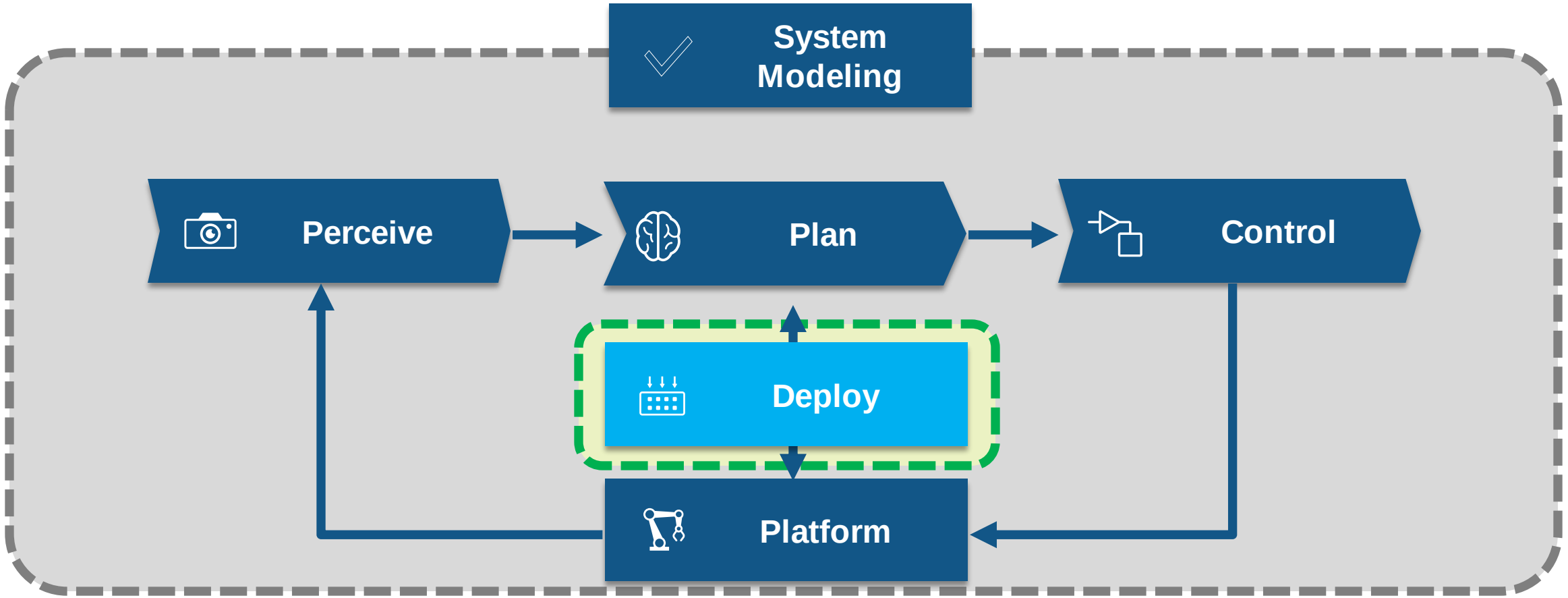
Easy to change the robot hardware



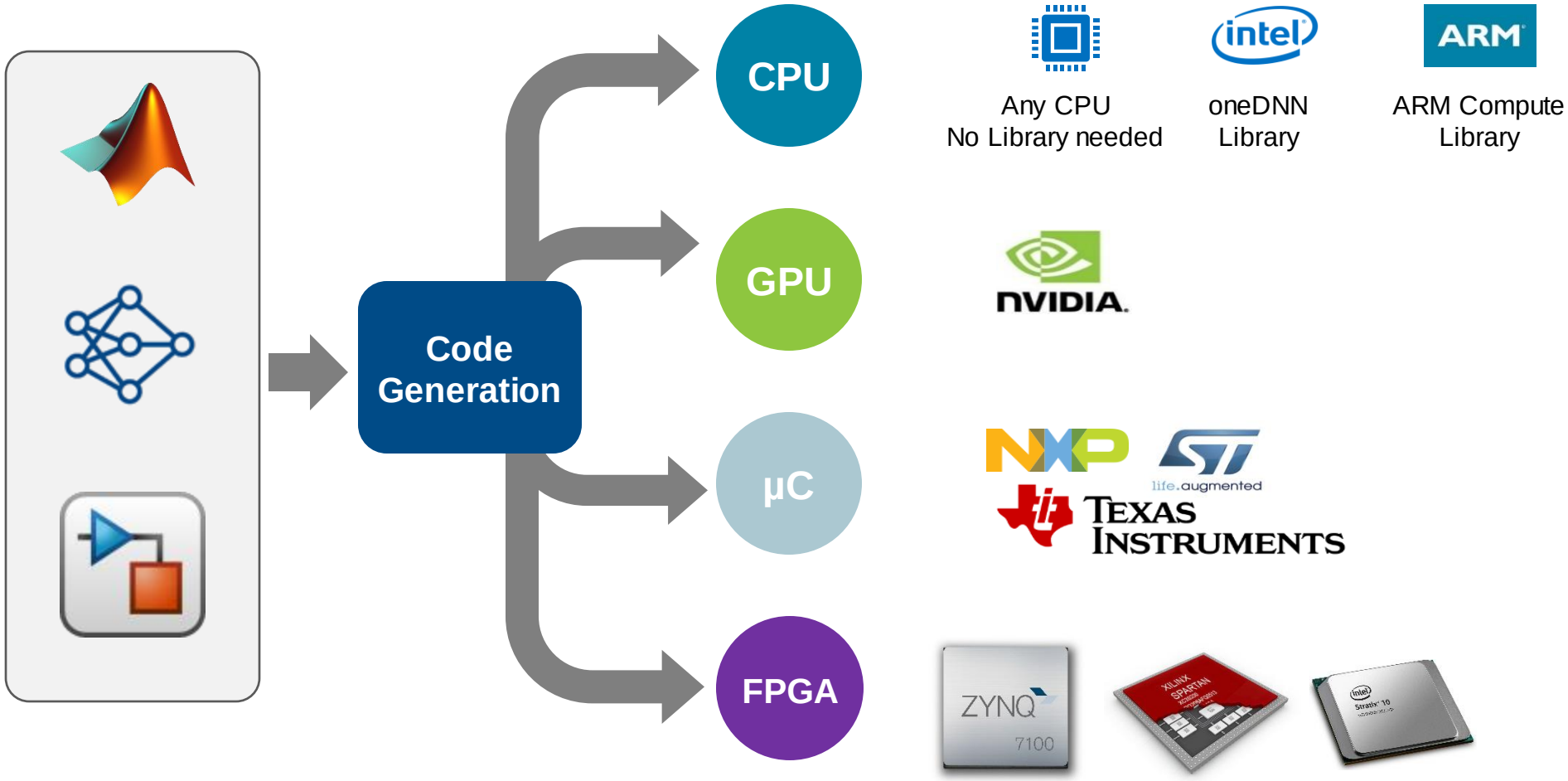


Robotics System Toolbox Support Package for Universal Robots UR Series Manipulators allows user to connect to and control Universal Robots Cobots over ROS.

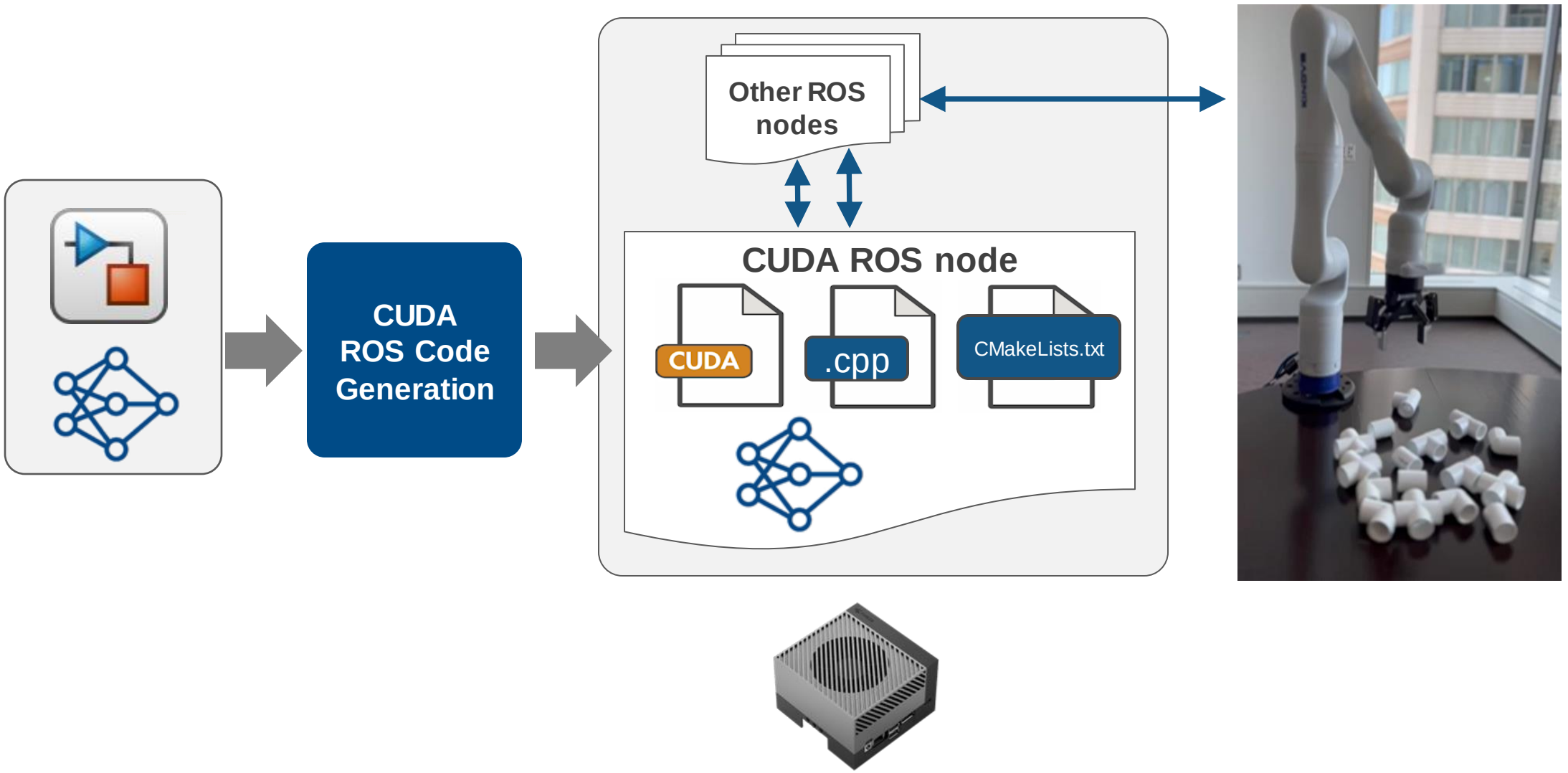
Autonomous system design workflow



Deploy to target with zero coding errors



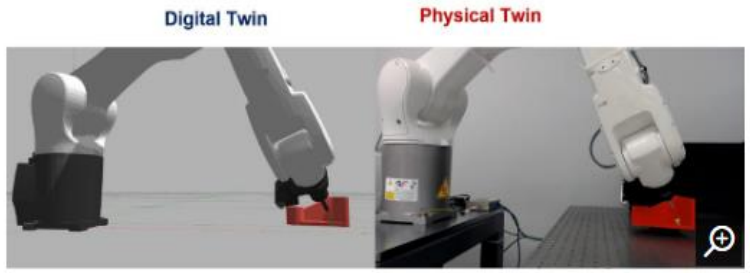
Deploy to Jetson device as CUDA ROS node



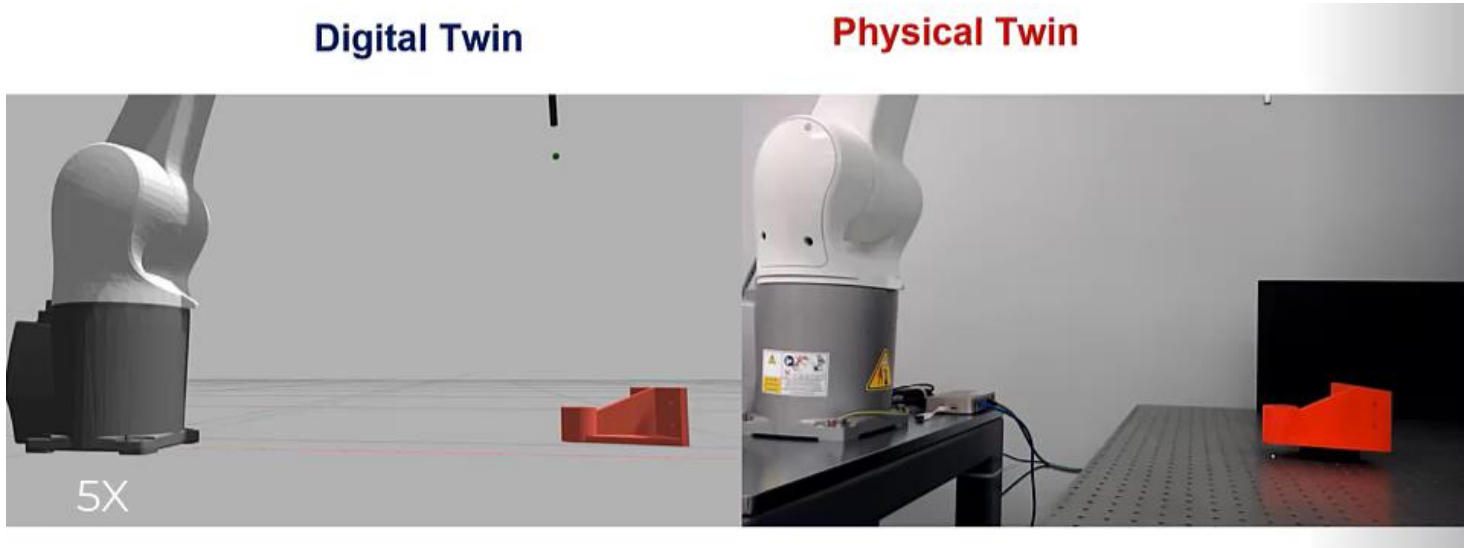
ASTRI Accelerates Development of Robotic Manipulation System Using MBSE Digital Twin

Related Link

> "The integration of MATLAB, Simulink, and Deep Learning Toolbox gave us the confidence to move forward with the MBSE digital twin project."
>
> — *Dr. T. John Koo, ASTRI*



ASTRI created a digital twin to design, build, and validate its robotic welding system.



Challenge

Reduce development time, manual processes, and costs

Solution

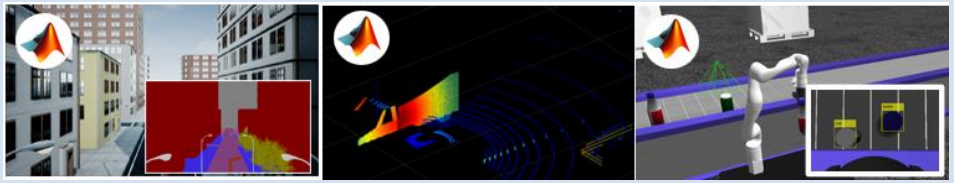
Adopt model-based systems engineering and develop a digital twin with MATLAB, Simulink, and Deep Learning Toolbox

Results

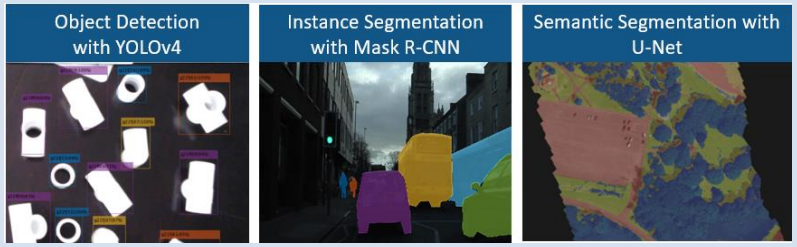
- Integration time reduced by 40%
- Issues resolved in the design stage
- Teams worked collaboratively

Why MATLAB for AI in Robotics?

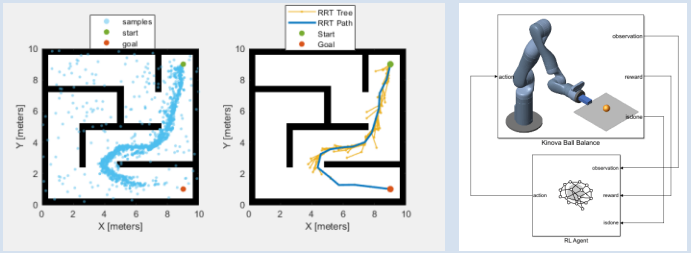
❑ Synthetic Training Data Generation



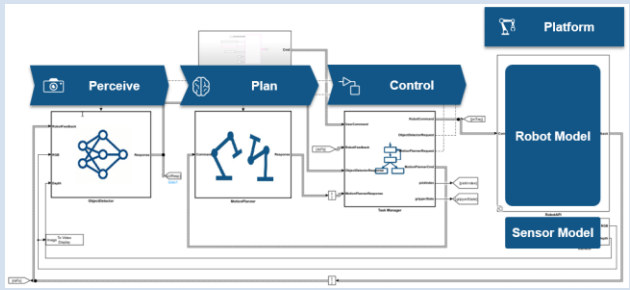
❑ Object Identification & Mapping



❑ Motion Planning & Controls



❑ System Level Testing & Deployment



Challenges using AI fo Solutions with MATLAB

Data Complexity

Simulation

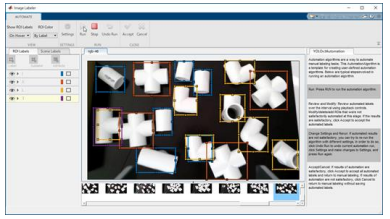


Image Labeler

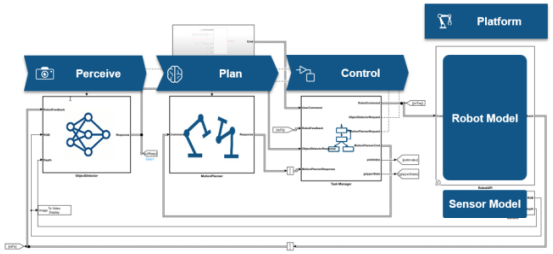
Video Labeler

Signal Labeler

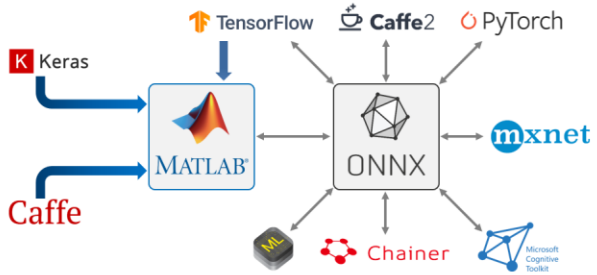
Lidar Labeler

Model Complexity

Pre-trained models



System-level Simulation, testing, & Deployment



Interoperability with other OS AI models

AI Expertise

Robotics Expertise vs. AI

Challenges using AI for your robots:

Data Complexity

Simulation

Image Labeler

Video Labeler

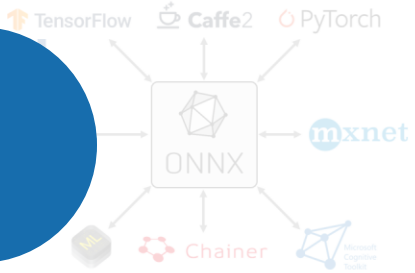
Signal Labeler

Lidar Labeler

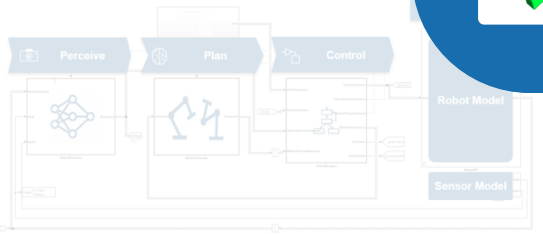
Model Complexity

Pre-trained models

Business



Interoperability with other OS AI models



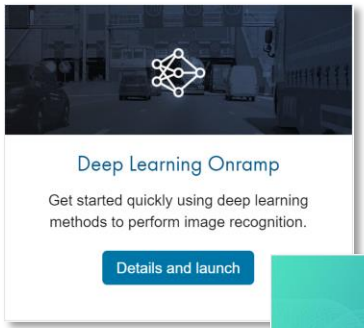
System-level Simulation, testing, & Deployment

AI Expertise

Robotics Expertise vs. AI

Get Started with AI in MATLAB

Onramp



[Deep Learning Onramp]

[Machine Learning Onramp]

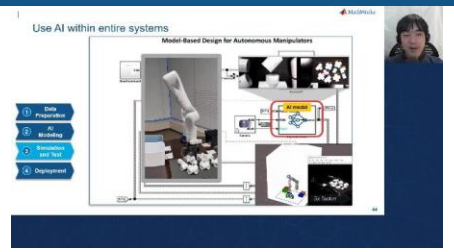
[Reinforcement Learning Toolbox]

Videos

[Deep Learning Tech Talk]

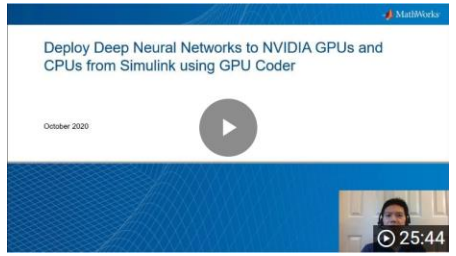
[Reinforcement Learning Tech Talk]

Webinars



[AI for robotics]

[AI for Simulink Users]



[Deploy Deep Neural Networks]

MATLAB EXPO

Thank you