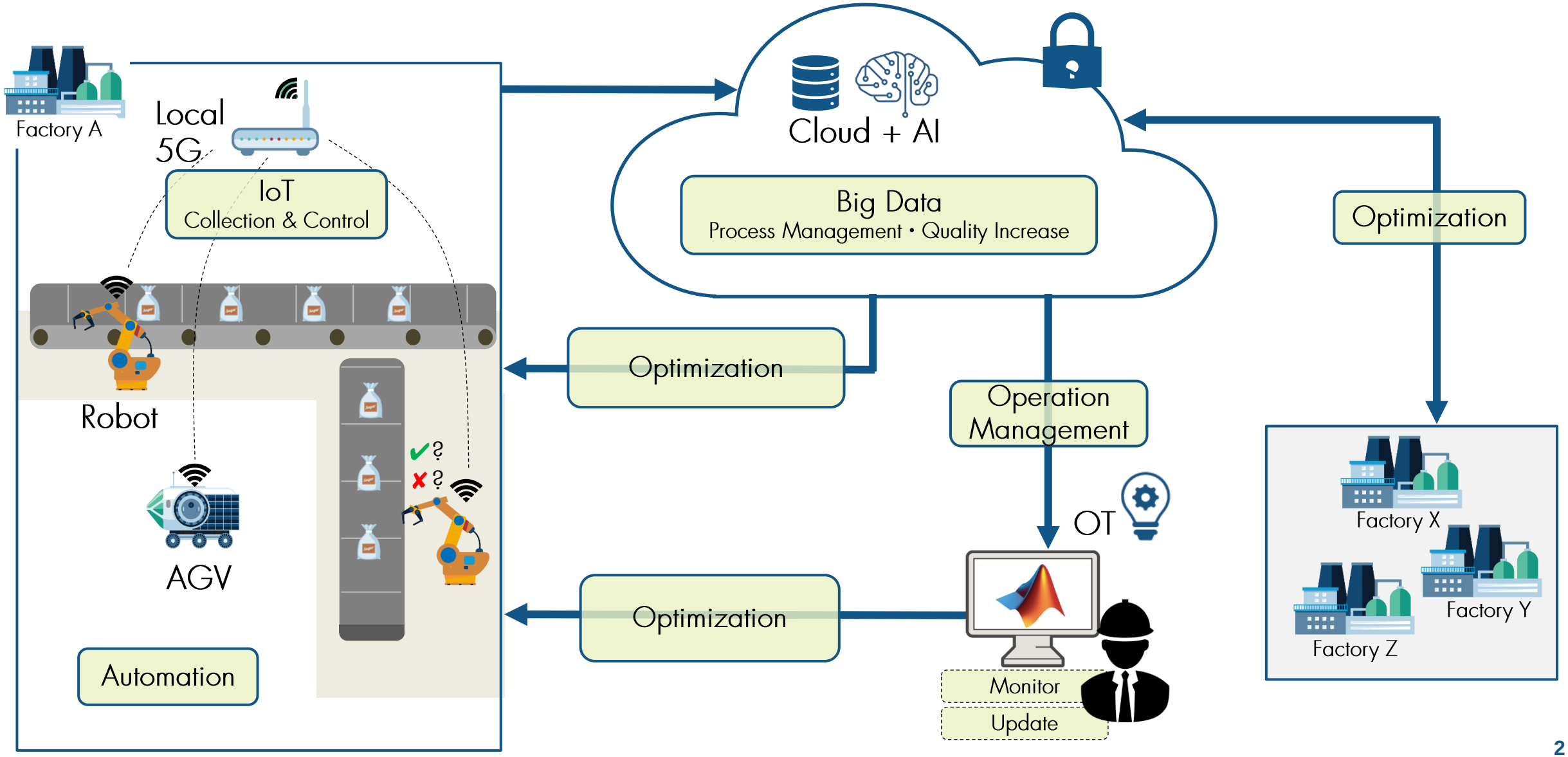
Realizing Smart Factories with MATLAB® & Simulink®

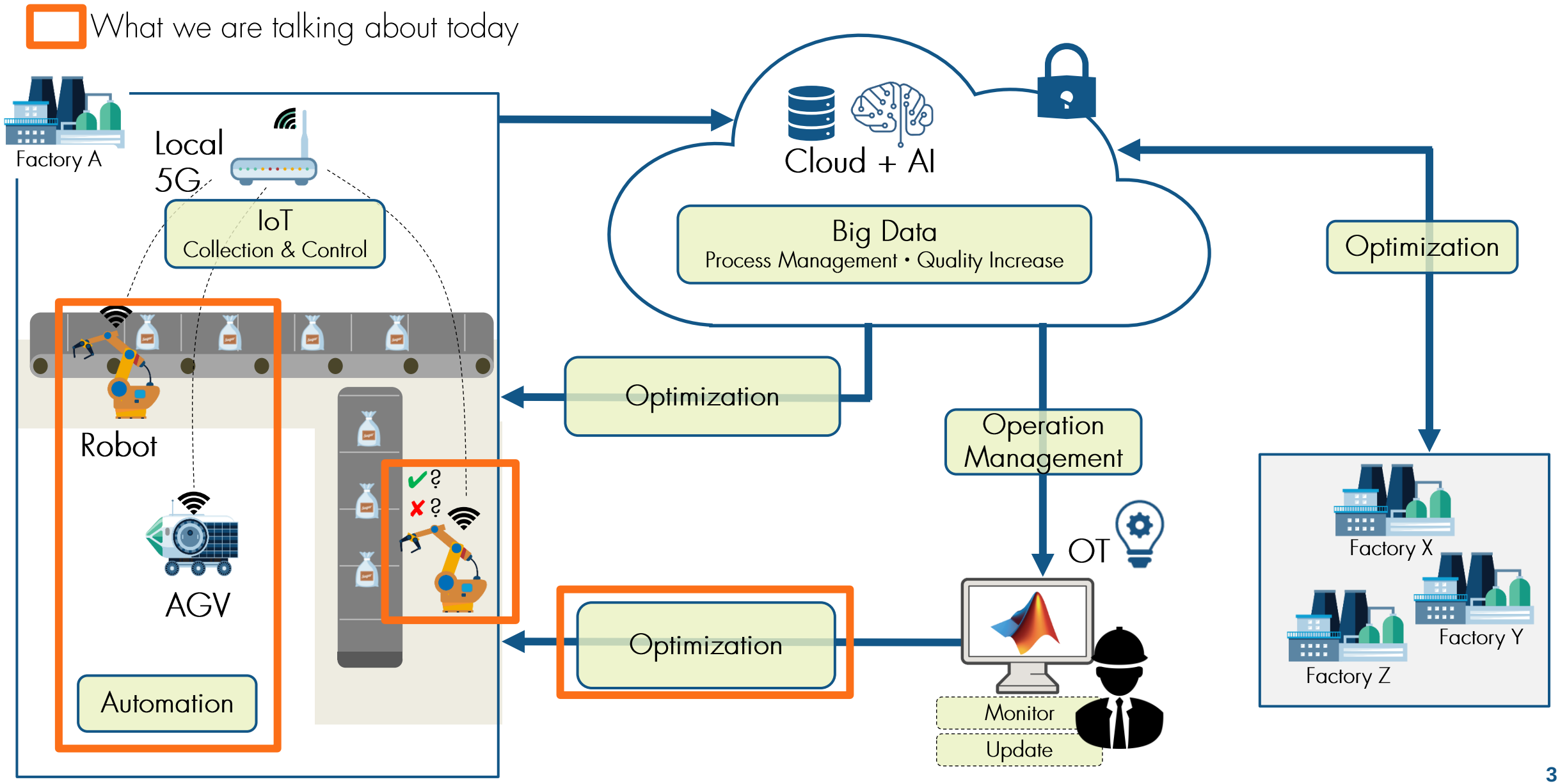
Robotics Trends in Smart Factories

MathWorks

Smart Factory Concept: Quality & Cost Optimization with Cloud & AI

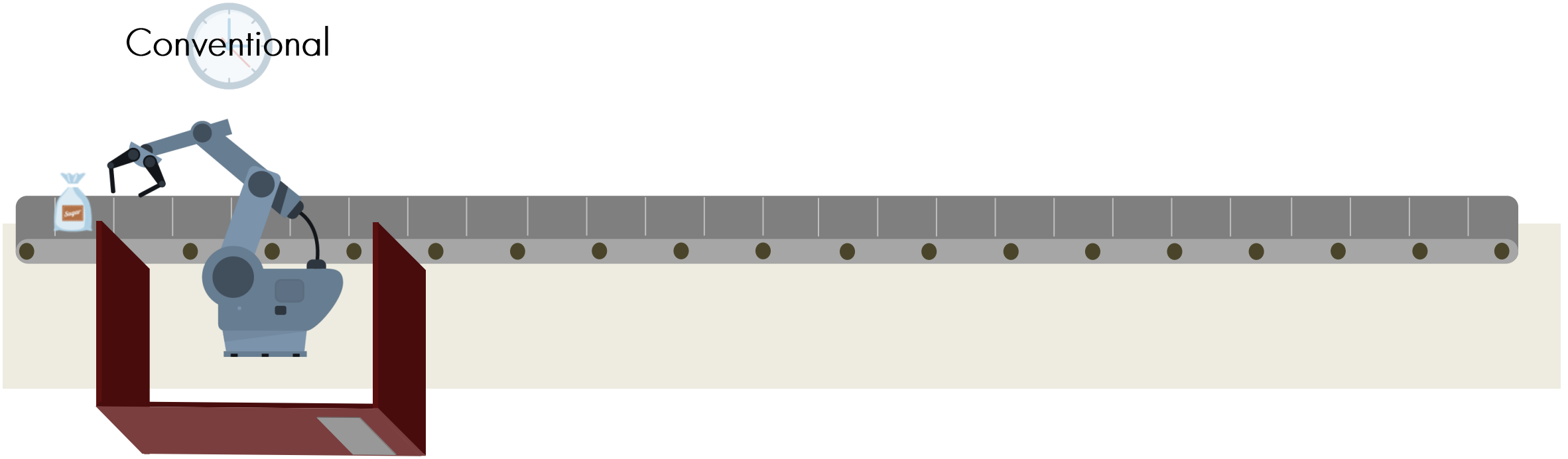


Smart Factory Concept: Quality & Cost Optimization with Cloud & AI



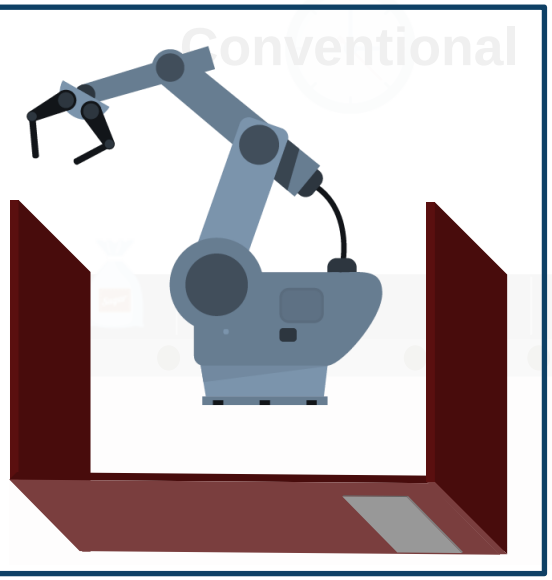
Robotics in Smart Factory: Trends and Directions

Conventional



- Automated Systems
- Repetitive tasks
- Manual programming
- Safety frame needed

Robotics in Smart Factory: Trends and Directions



Mitsubishi Heavy Industries Develops Robotic Arm for Removing Nuclear Fuel Debris

Challenge

Design a multi-axis robot for removing molten fuel debris from the Fukushima Daiichi nuclear power station

Solution

Use MATLAB and Simulink to perform hardware measurement tests and to model and simulate individual robot axes and controllers

Results

- Development time halved
- Positioning accuracy requirement exceeded
- Shared platform for interorganizational collaboration established

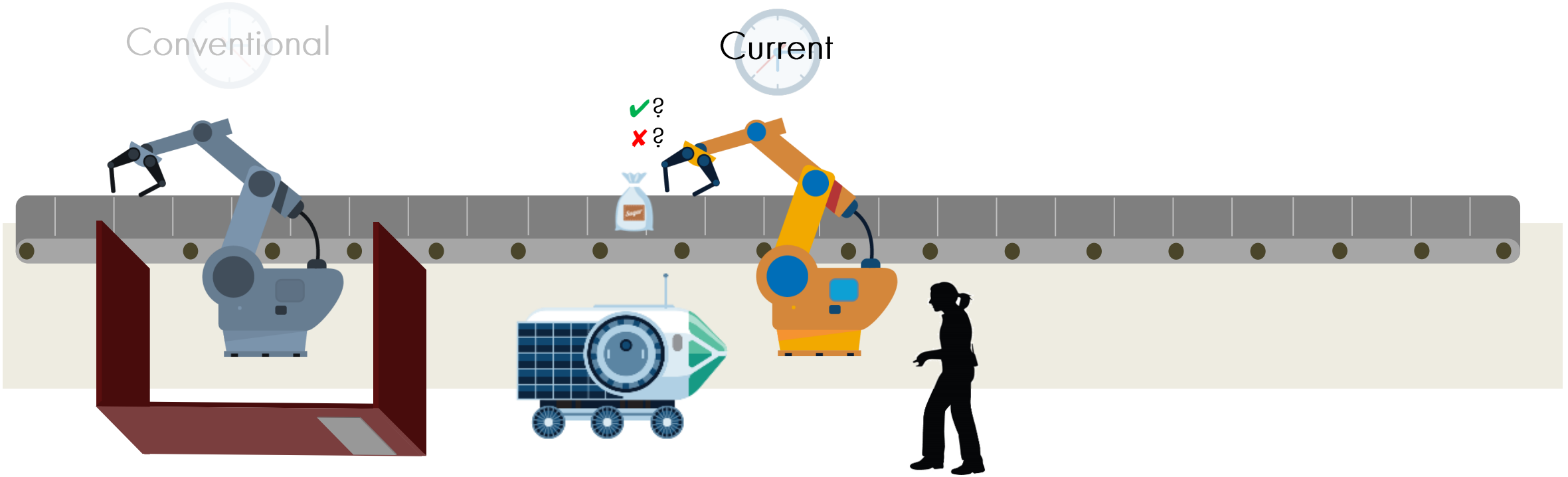
Rendering of Mitsubishi Heavy Industries' seven-meter-long robotic arm capable of withstanding up to 2000 kg of processing reaction force

"Model-Based Design with MATLAB and Simulink supports a wide range of options, from classic to modern control, which made it possible to respond easily to any changes in design constraints and to meet the demanding accuracy requirement for this robot."

- Tadashi Murata, Mitsubishi Heavy Industries

Link to user story

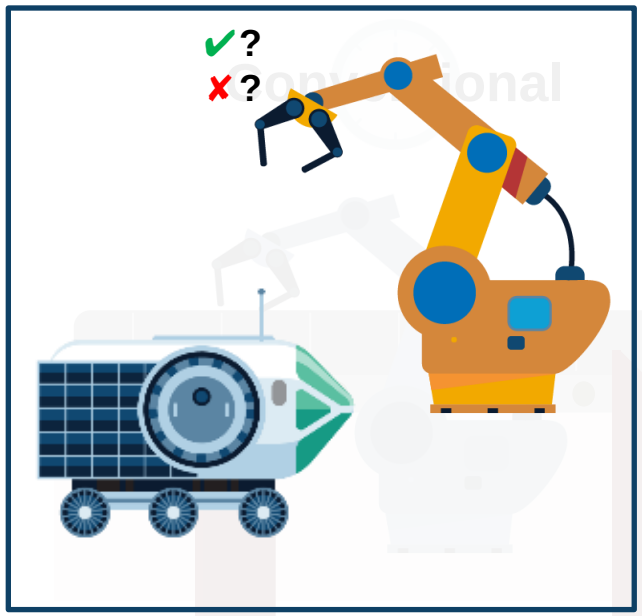
Robotics in Smart Factory: Trends and Directions



- Automated Systems
- Repetitive tasks
- Manual programming
- Safety frame needed

- Autonomous Technologies
- Flexible task execution
- Advanced algorithm
- Collaborative robot

Robotics in Smart Factory: Trends and Directions

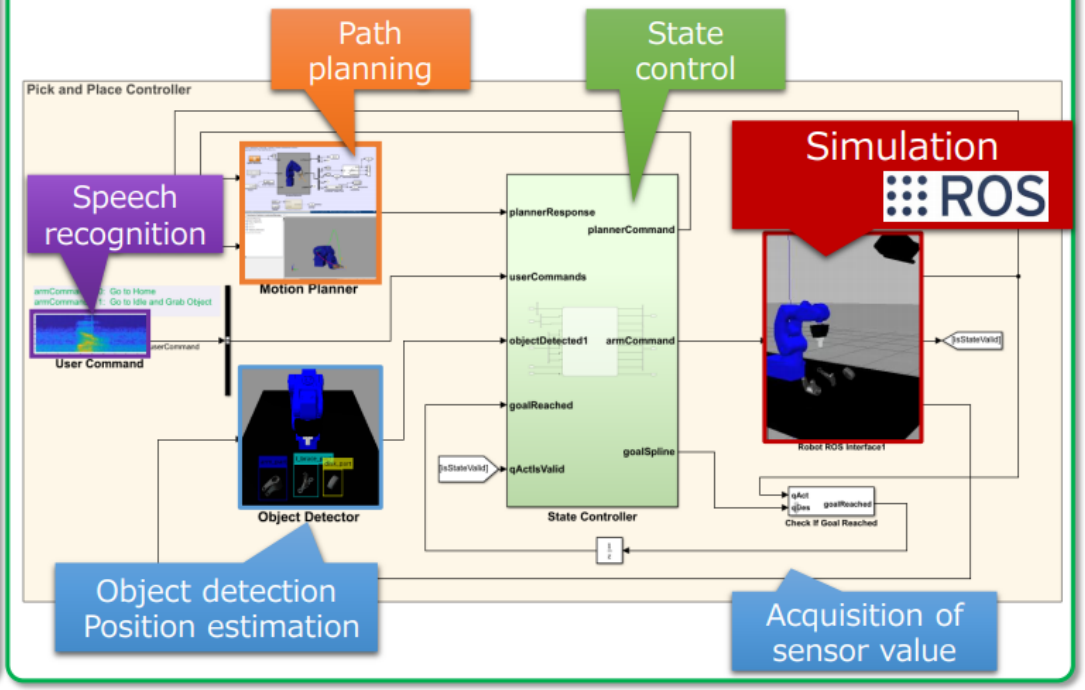


Sample app overview

Flow of explanation

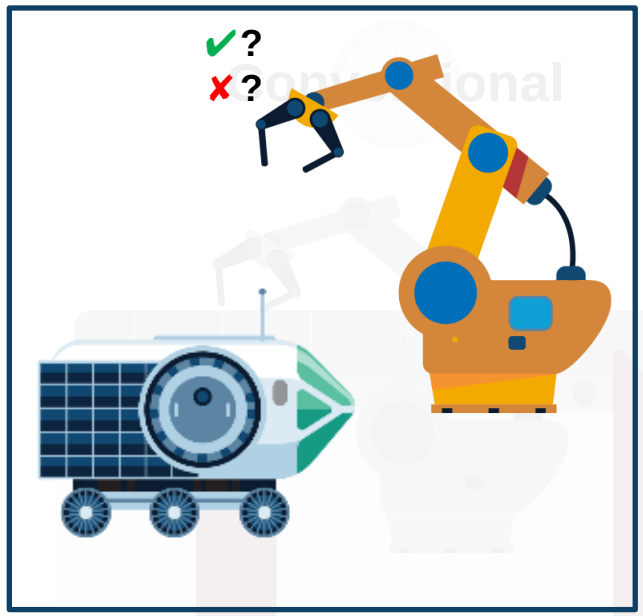
1. Object detection Position estimation
2. Path planning
3. Speech recognition
4. State machine

Block diagram (Simulink model)



MATLAB EXPO 2019 in Japan
Customer Presentation

Robotics in Smart Factory: Trends and Directions



- MATLAB/Simulink + ROS/Gazebo
- High-precision localization, object detection, and path planning
- MathWorks Consulting Services utilized

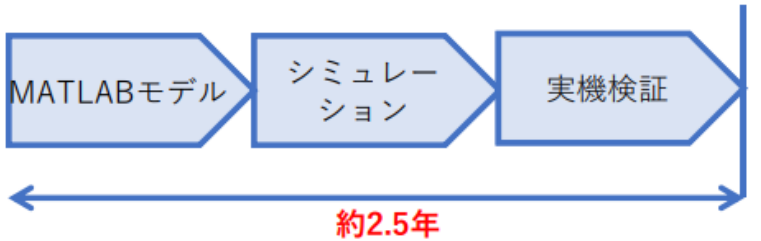
早期開発に向けて

4. コンサルティングの効果

磁気ガイド誘導の従来方式からの変更（AGV）

従来方式（誘導センサが走行軸と一体型）➔ 誘導センサ車体取付方式（誘導センサは走行軸から分離）

コンサルティングを活用したキャリヤの自動誘導開発



MATLABモデルの作成、シミュレーション期間の削減

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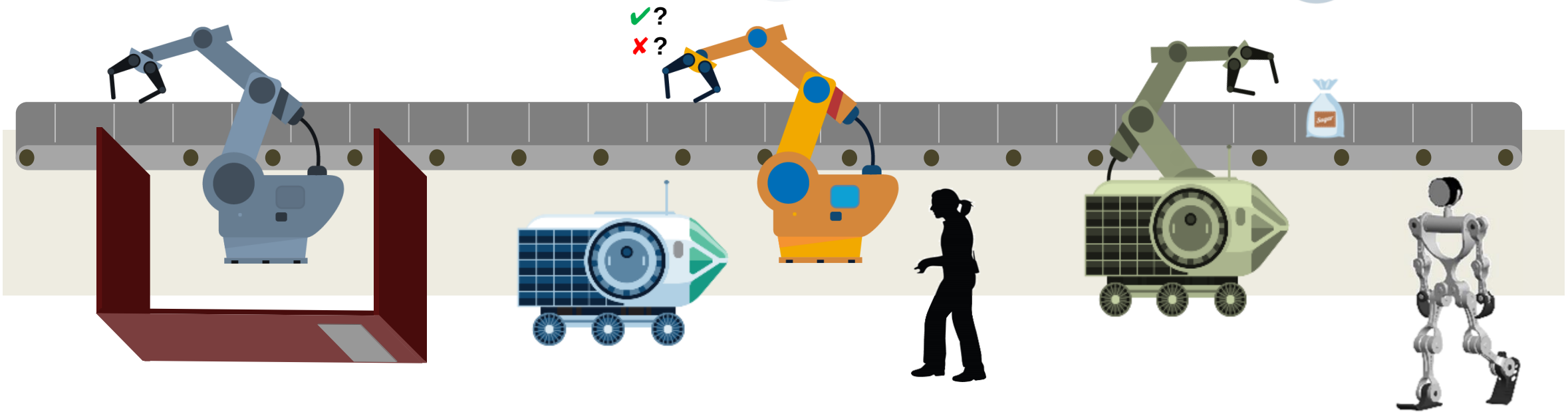
MATLAB EXPO 2020 in Japan
Customer Presentation (Japanese)

Robotics in Smart Factory: Trends and Directions

Conventional

Current

Future

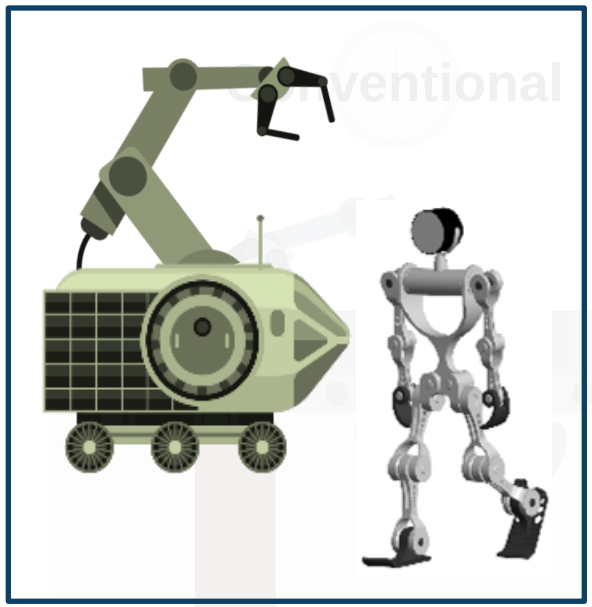


- **Automated Systems**
- Repetitive tasks
- Manual programming
- Safety frame needed

- **Autonomous Technologies**
- Flexible task execution
- Advanced algorithm
- Collaborative robot

- **Autonomous Systems**
- Task cooperation
- Intelligence sharing
- Adapting to the environment

Robotics in Smart Factory: Trends and Directions



German Aerospace Center (DLR) Robotics and Mechatronics Center Develops Autonomous Humanoid Robot with Model-Based Design

Challenge

Develop control systems for a two-armed mobile humanoid robot with 53 degrees of freedom

Solution

Use Model-Based Design with MATLAB and Simulink to model the controllers and plant, generate code for HIL testing and real-time operation, optimize trajectories, and automate sensor calibration

Results

- Programming defects eliminated
- Complex functionality implemented in hours
- Advanced control development by students enabled

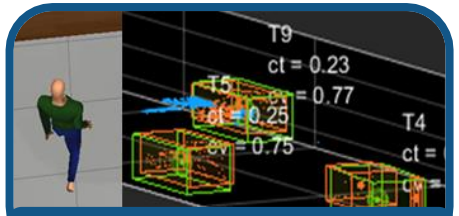
DLR's humanoid robot Agile Justin autonomously performing a complex construction task.

"Model-Based Design and automatic code generation enable us to cope with the complexity of Agile Justin's 53 degrees of freedom. Without Model-Based Design it would have been impossible to build the controllers for such a complex robotic system with hard real-time performance."
- Berthold Bäuml, DLR

Link to user story

Autonomous Robot Development with MATLAB & Simulink

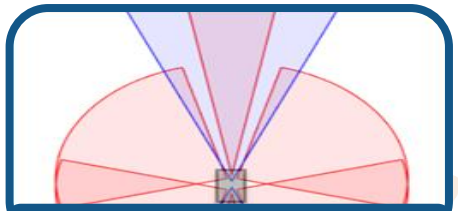
Environment



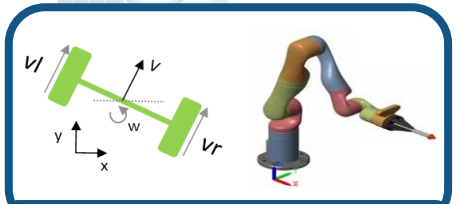
Agents

Scenes

Platform

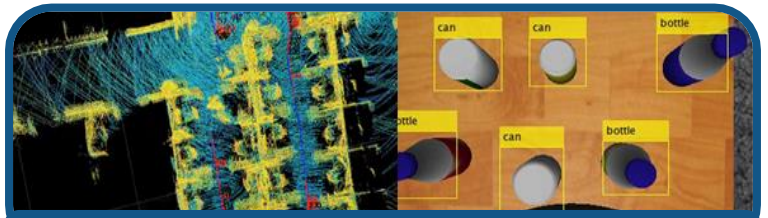


Sensor Models

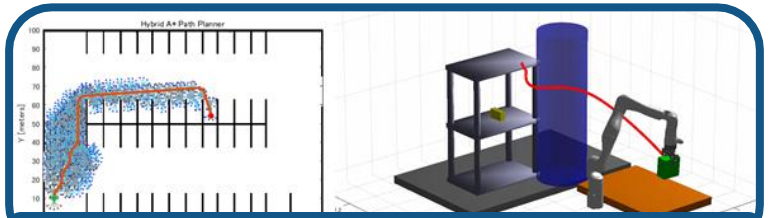


Robot Model

Autonomous Applications



Localization & Perception



Motion Planning & Controls

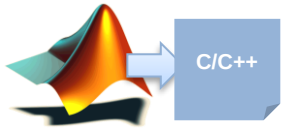
Development Environment

Analyze	Simulate	Design	Implement	Test

Autonomous Robot Development with MATLAB & Simulink

Environment

MATLAB Coder™



ROS Toolbox

Simulink Coder™

Embedded Coder™

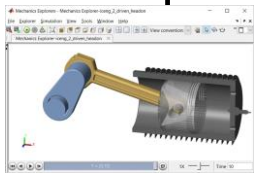
Simulink Real-Time™

PLC Coder™

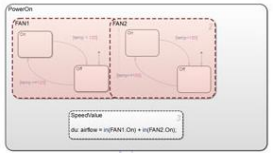
GPU Coder™

Platform

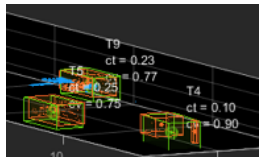
Simscape™



Stateflow®

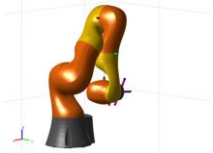


Sensor Fusion and Tracking Toolbox™

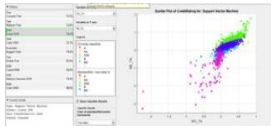


Autonomous Application

Robotics System Toolbox™



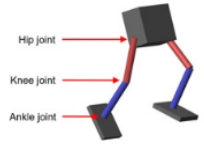
Statistics and Machine Learning Toolbox™



Computer Vision Toolbox™

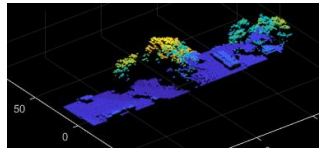
Deep Learning Toolbox™

Reinforcement Learning Toolbox™



Navigation Toolbox™

Lidar Toolbox™

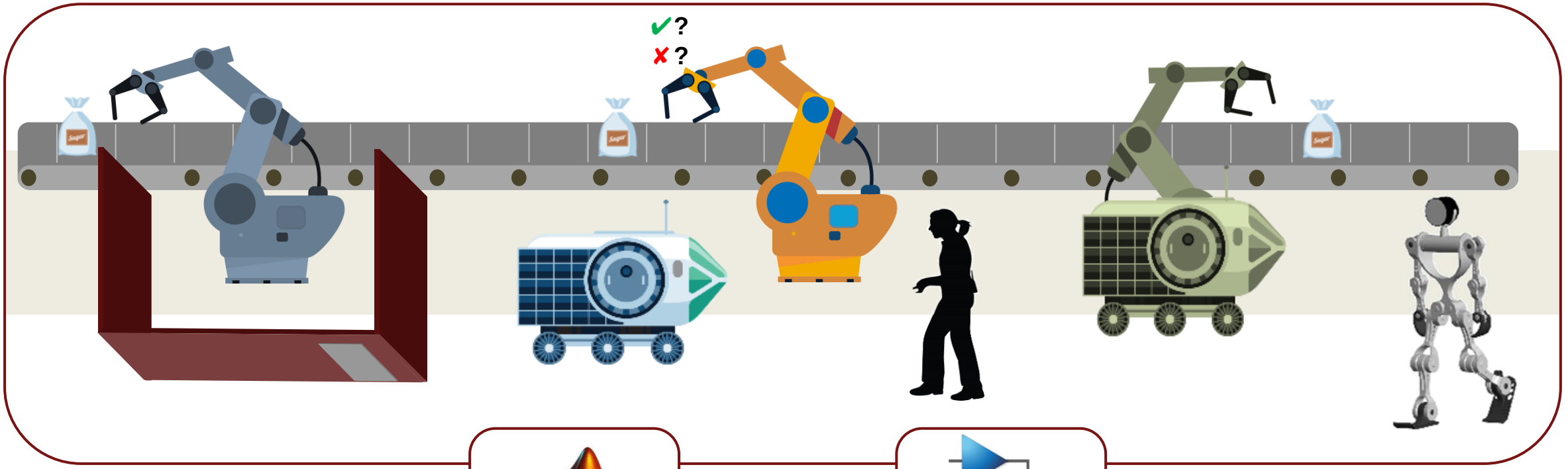


MATLAB

Development Environment

Simulink

Autonomous Robot Development for Smart Factories



MATLAB

Simulink

Develop Autonomous Applications from Perception to Motion Planning and Optimize System-Level Behavior

Supported by MATLAB/Simulink Unified Environment