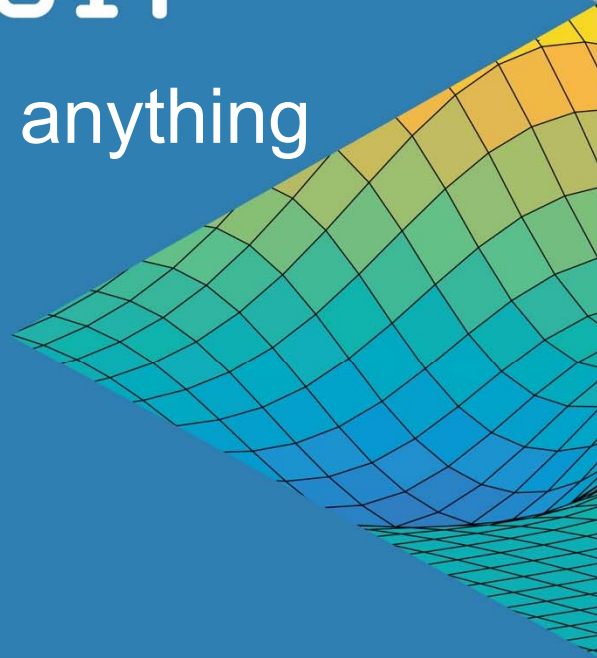


MATLAB EXPO 2017

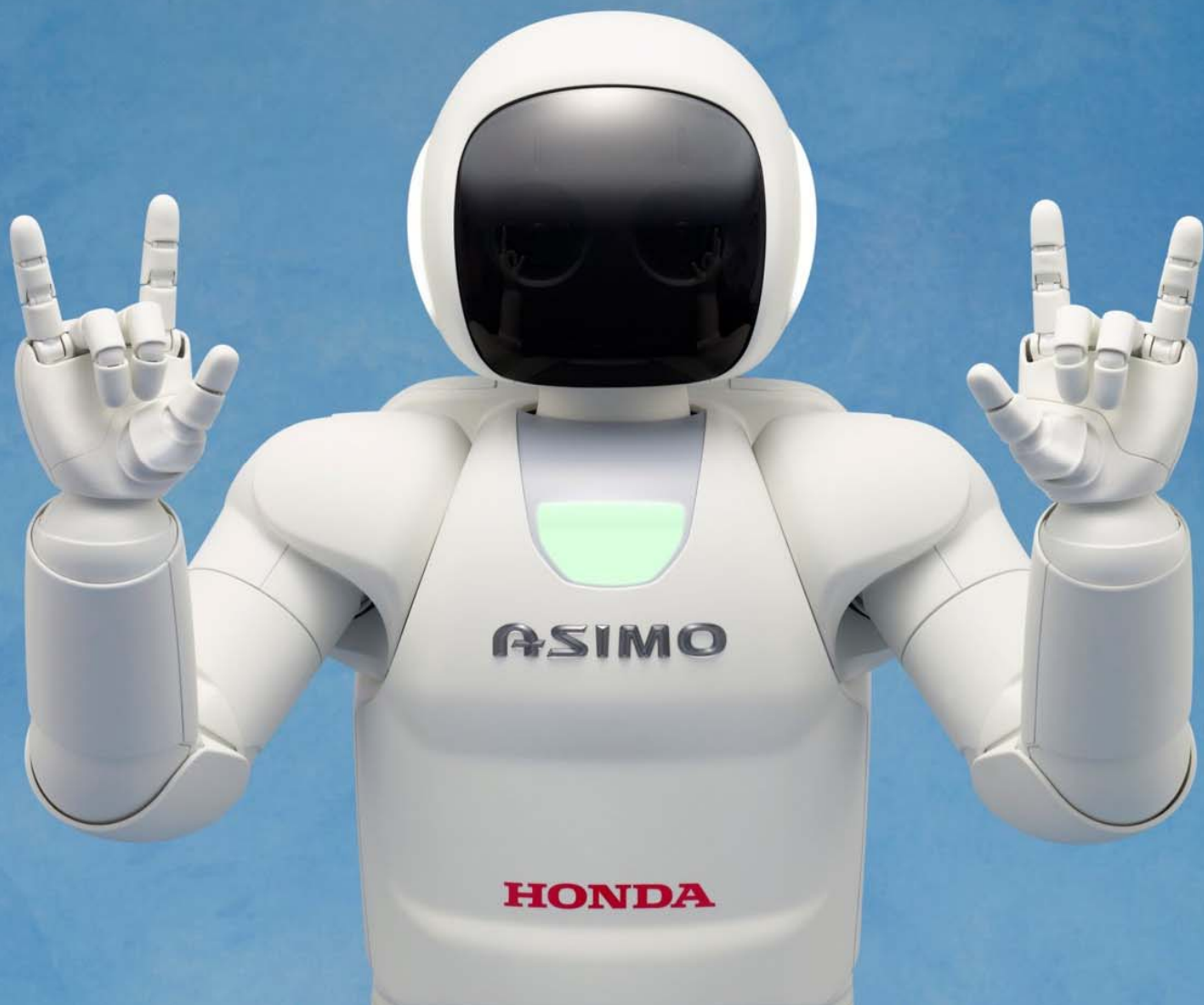
How to build an **autonomous** anything

Michelle Hirsch

Head of MATLAB Product Management
MathWorks







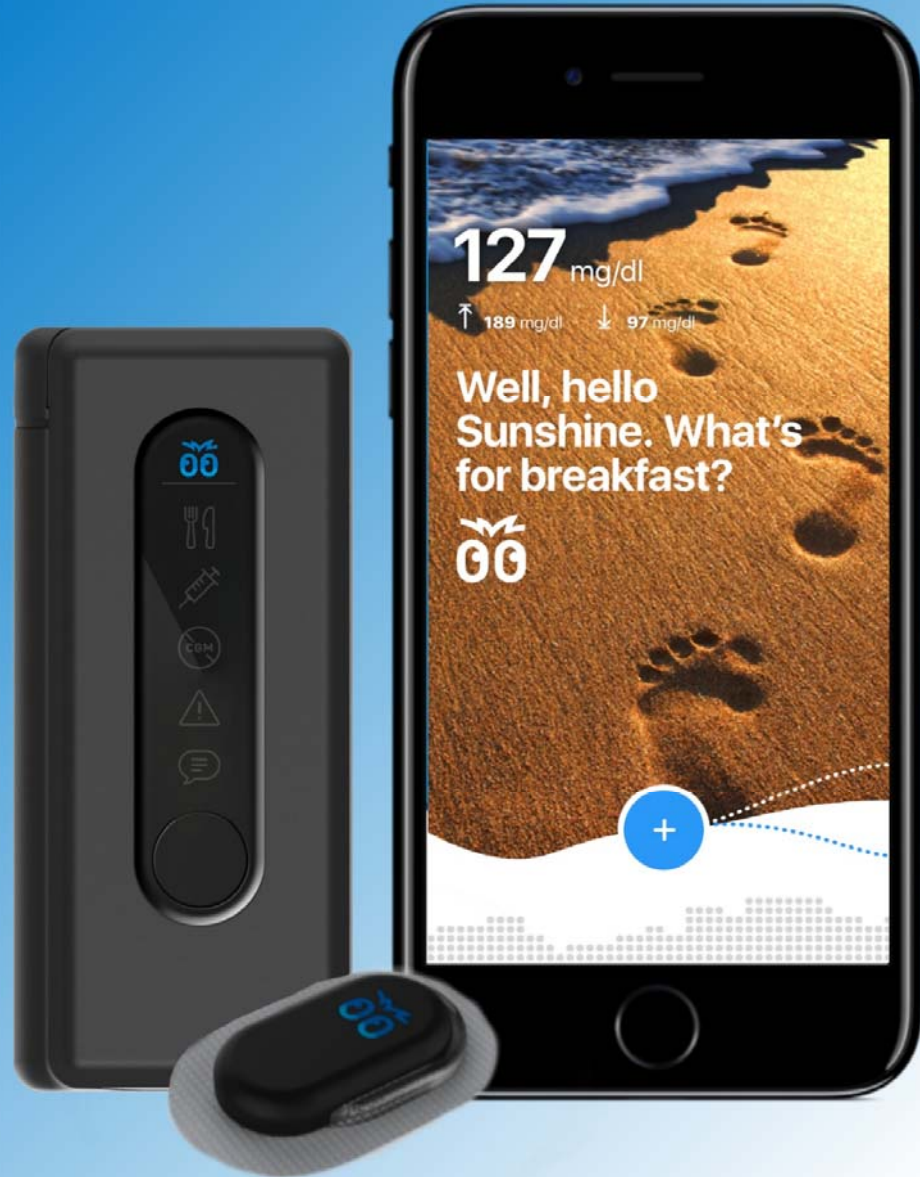
ASIMO

HONDA









Autonomous Technology

Autonomous

Having the power for self-governance

Autonomous Technology

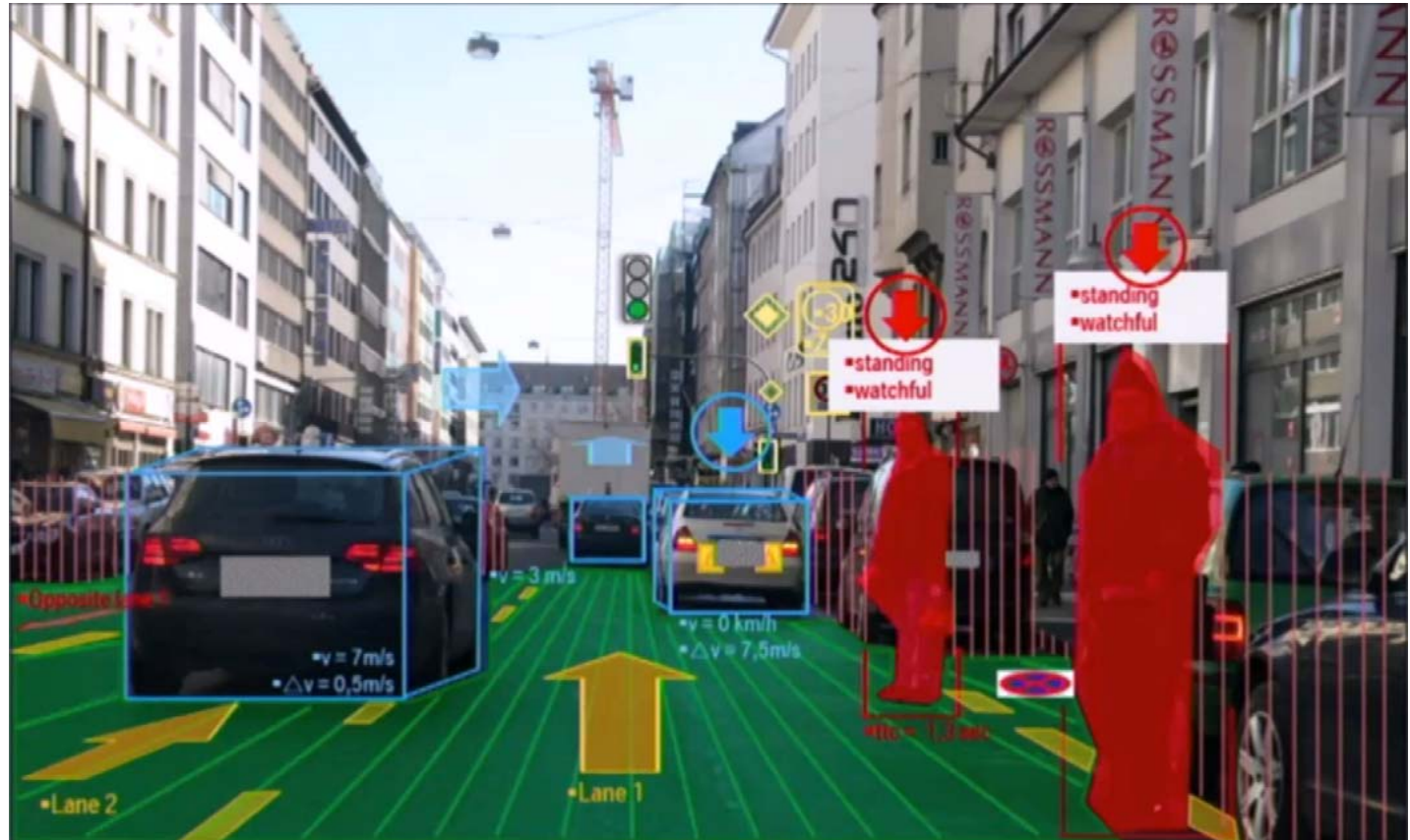
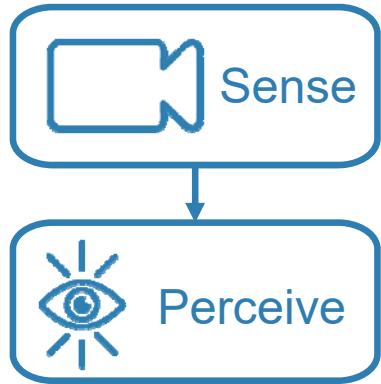
*Provides the ability of a system to act
independently of direct human control
under **unrehearsed** conditions*



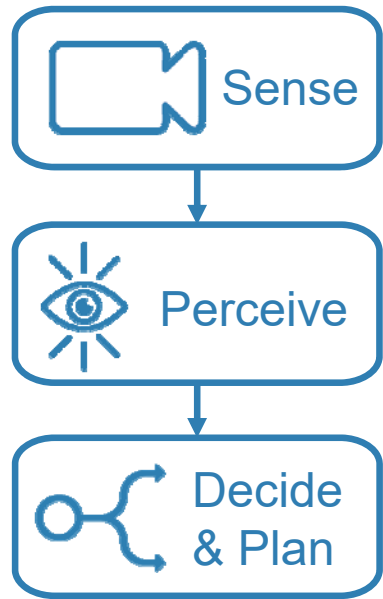
Capabilities of an Autonomous System



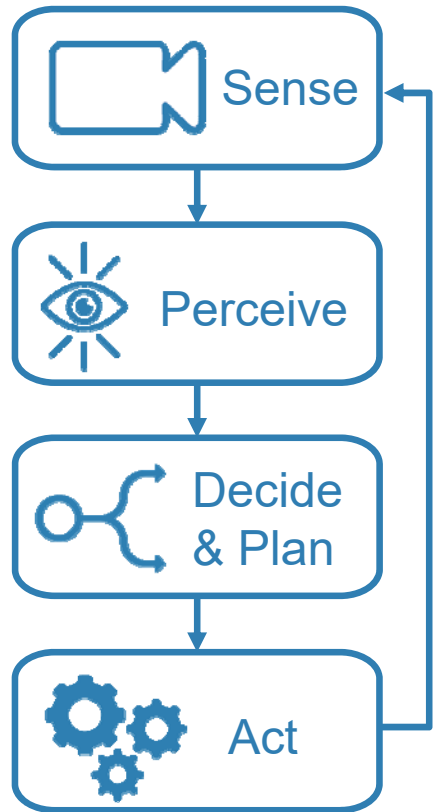
Capabilities of an Autonomous System



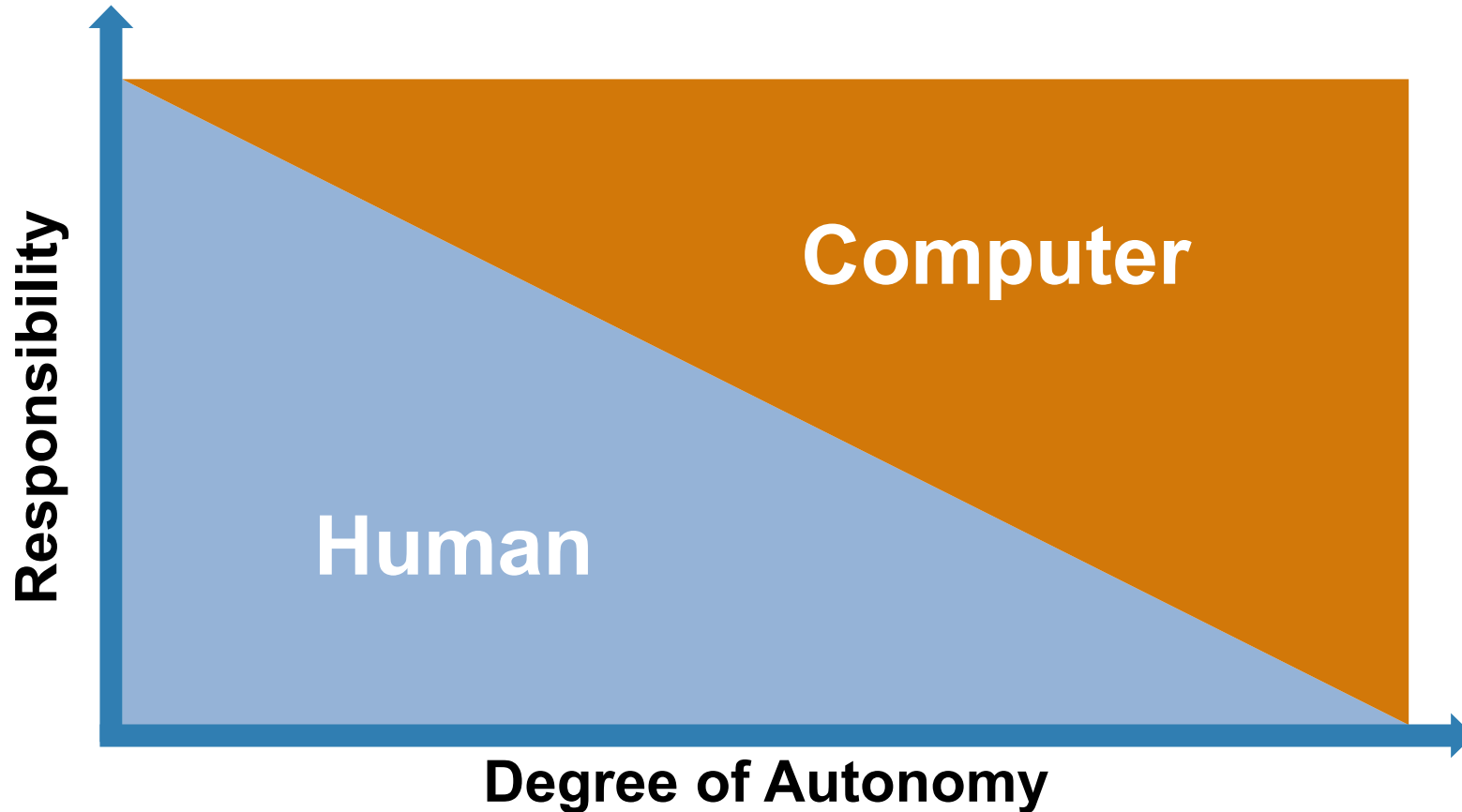
Capabilities of an Autonomous System



Capabilities of an Autonomous System



Autonomous Technology Transfers Responsibility to Computers



Cost of rig: >\$1M

Repair cost: \$100,000

Cost of valve: \$200



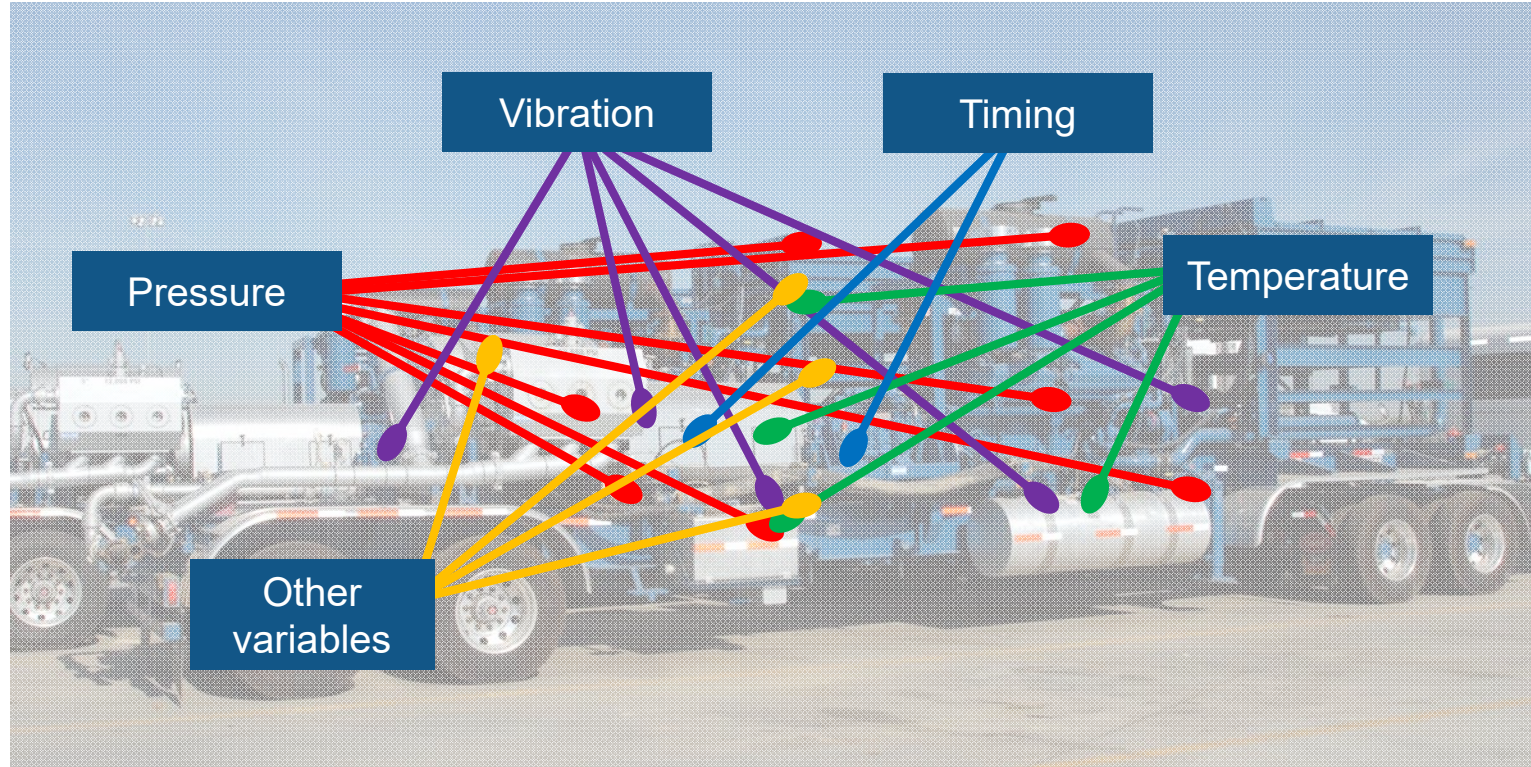




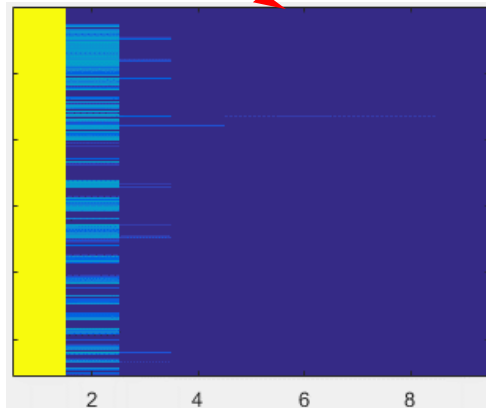
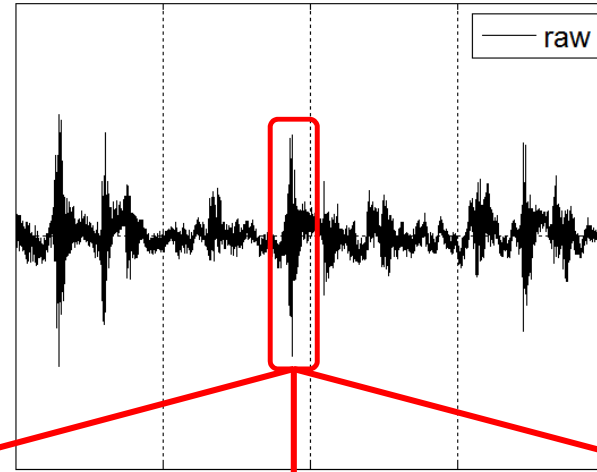


Autonomous Service for Predictive Maintenance

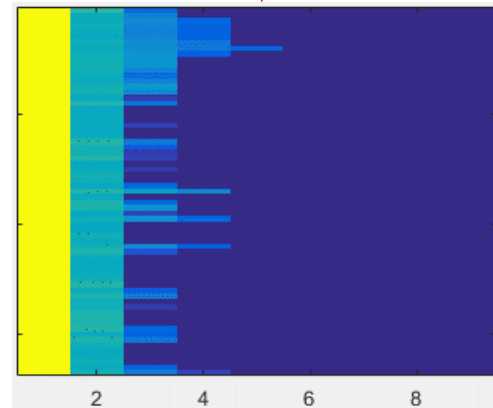
Which sensor values should they use?



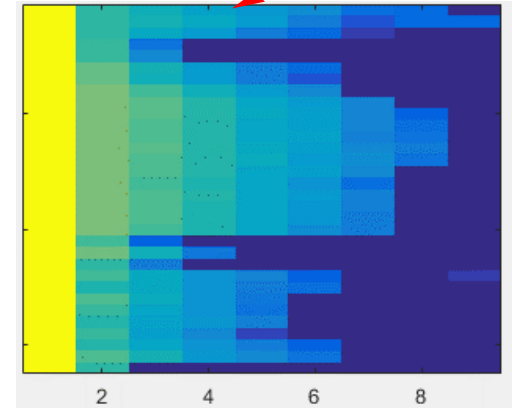
Autonomous Service for Predictive Maintenance



Normal Operation



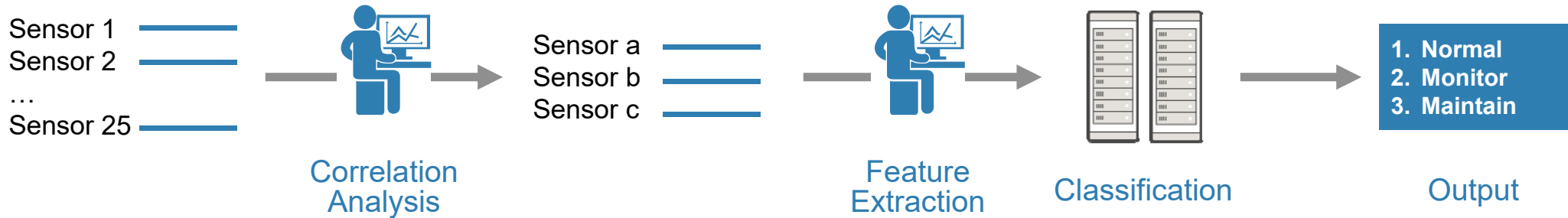
Monitor Closely



Maintenance Needed

Machine Learning or Deep Learning?

Machine Learning Approach



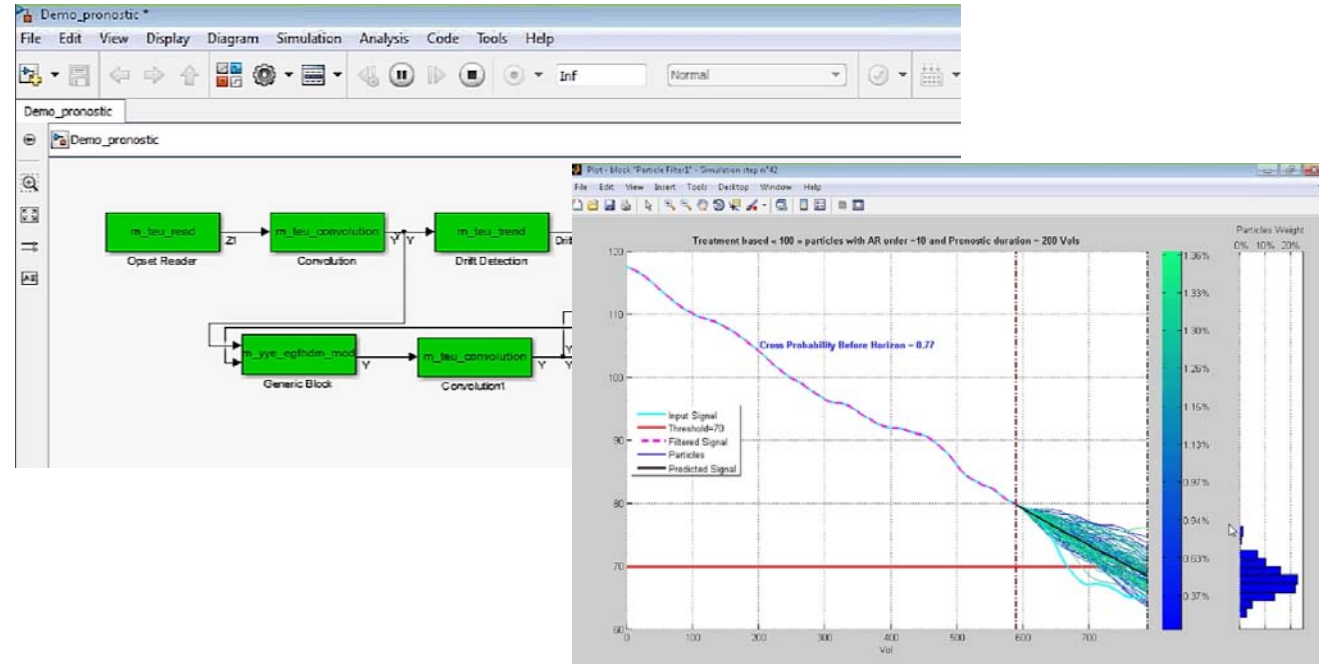
Deep Learning Approach



What are the best predictors?

- Data-driven
- Model-driven

Jet Engine Monitoring

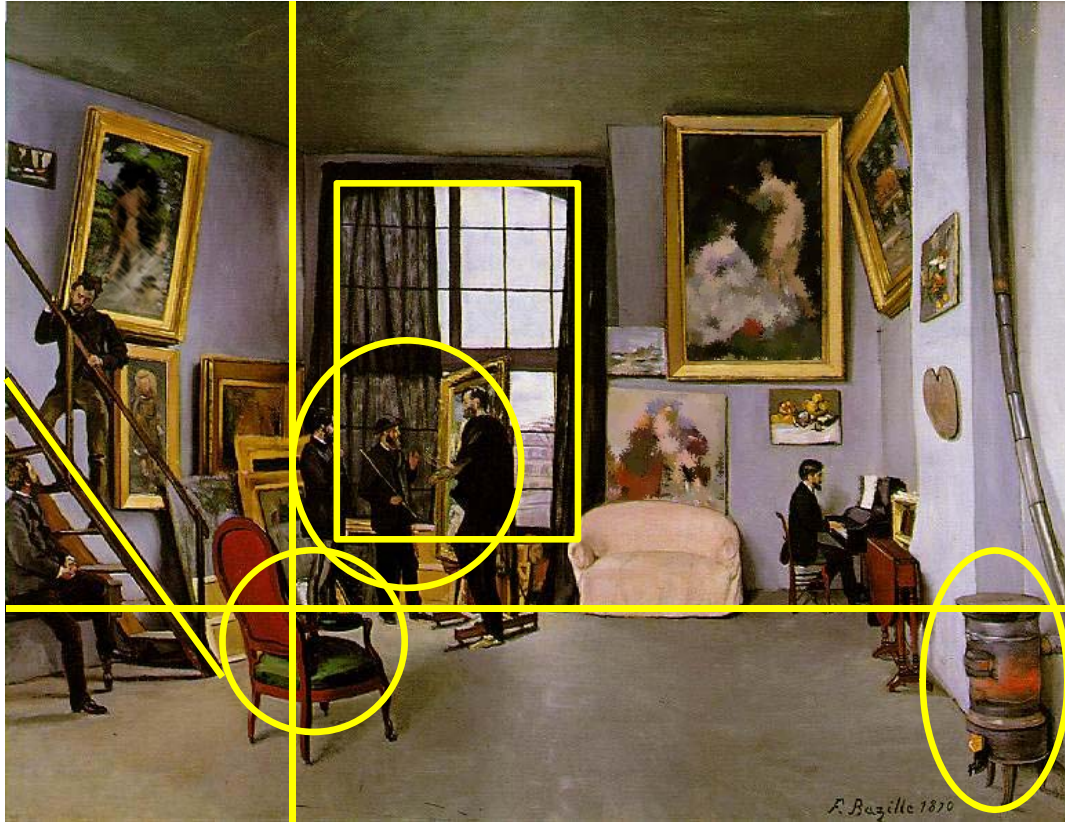




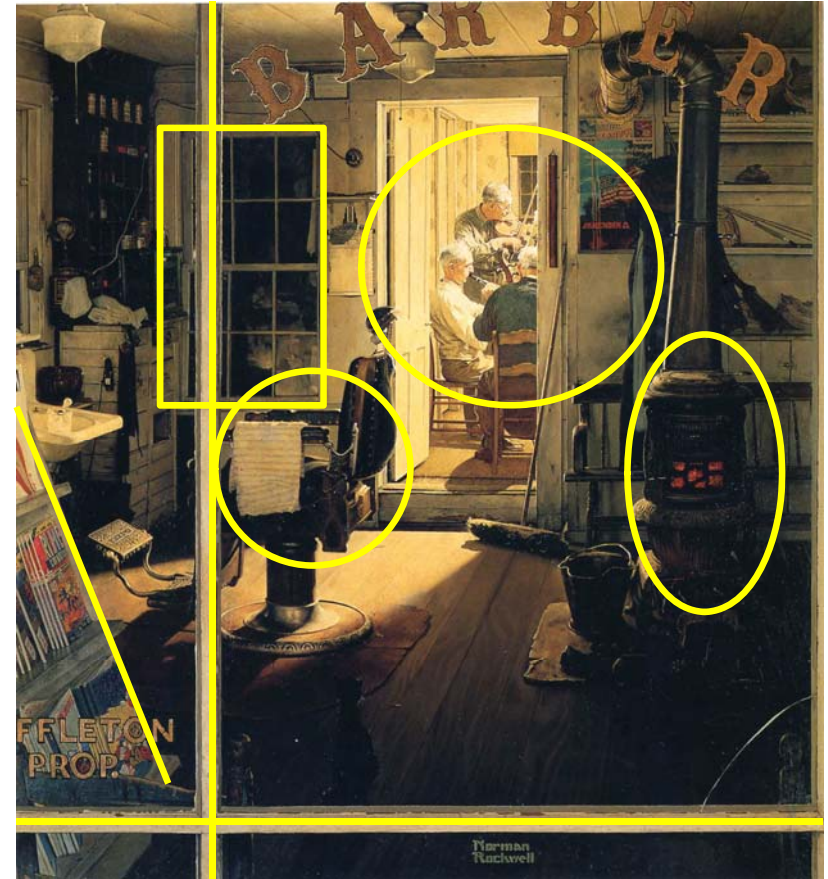
Bazille's Studio
Frederic Bazille (Paris, 1870)



Shuffleton's Barbershop
Norman Rockwell (Vermont, 1950)



Bazille's Studio
Frederic Bazille (Paris, 1870)



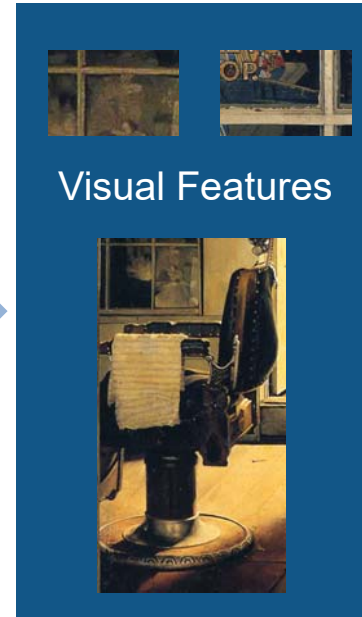
Shuffleton's Barbershop
Norman Rockwell (Vermont, 1950)

Autonomous Artistic Style Classification

Rutgers University



Image
Feature
Extraction



Machine
Learning
Classification

Style
Classifier
(SVM)

Style:
Regionalism

Genre
Classifier
(SVM)

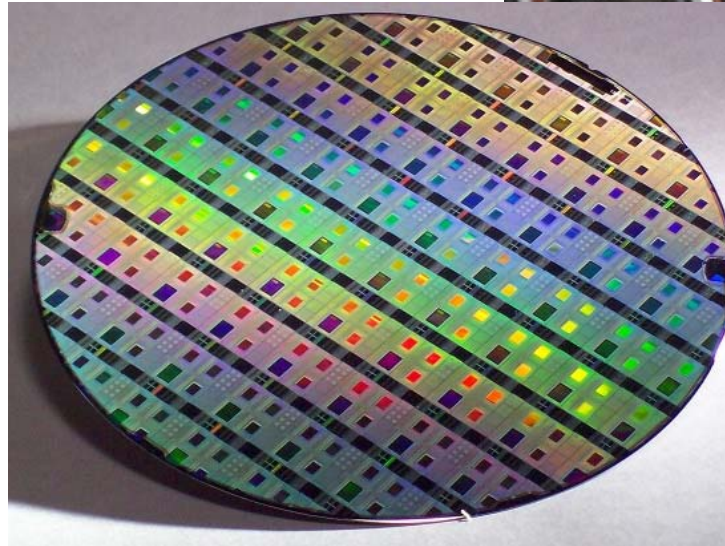
Genre:
Interior

Artist
Classifier
(SVM)

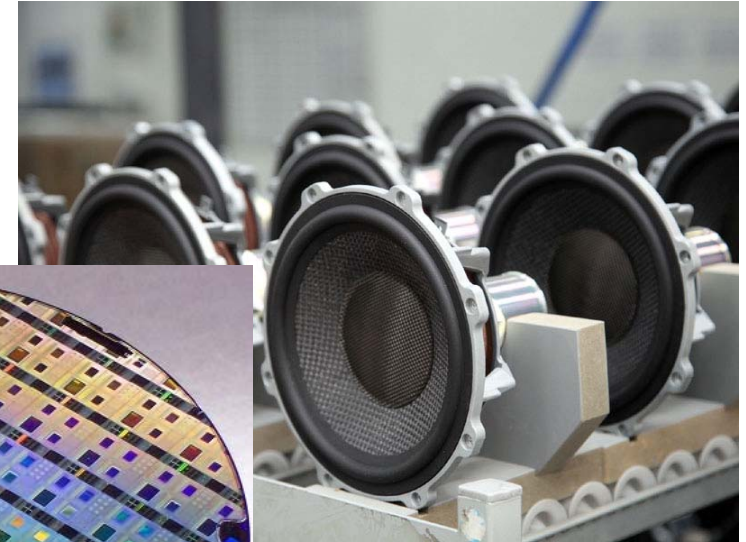
Artist:
Rockwell

Where to add autonomy with perception?

- Analyze more data
- Reduce bias
- Reduce variability
- Save time
- Improve performance



Virtual Semiconductor
Manufacturing Calibration



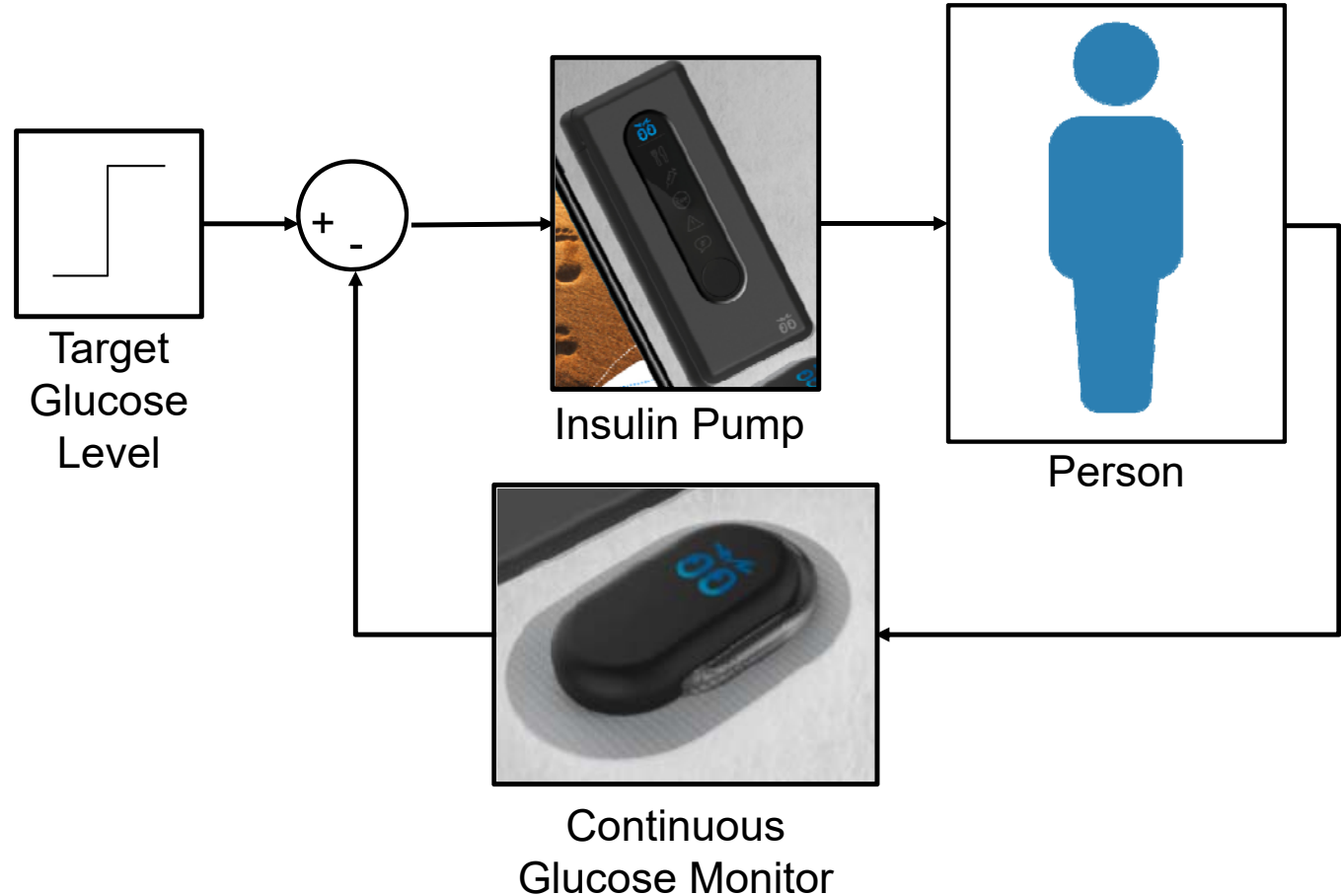
Determine
Loudspeaker
Quality

Autonomous Glucose Level Management



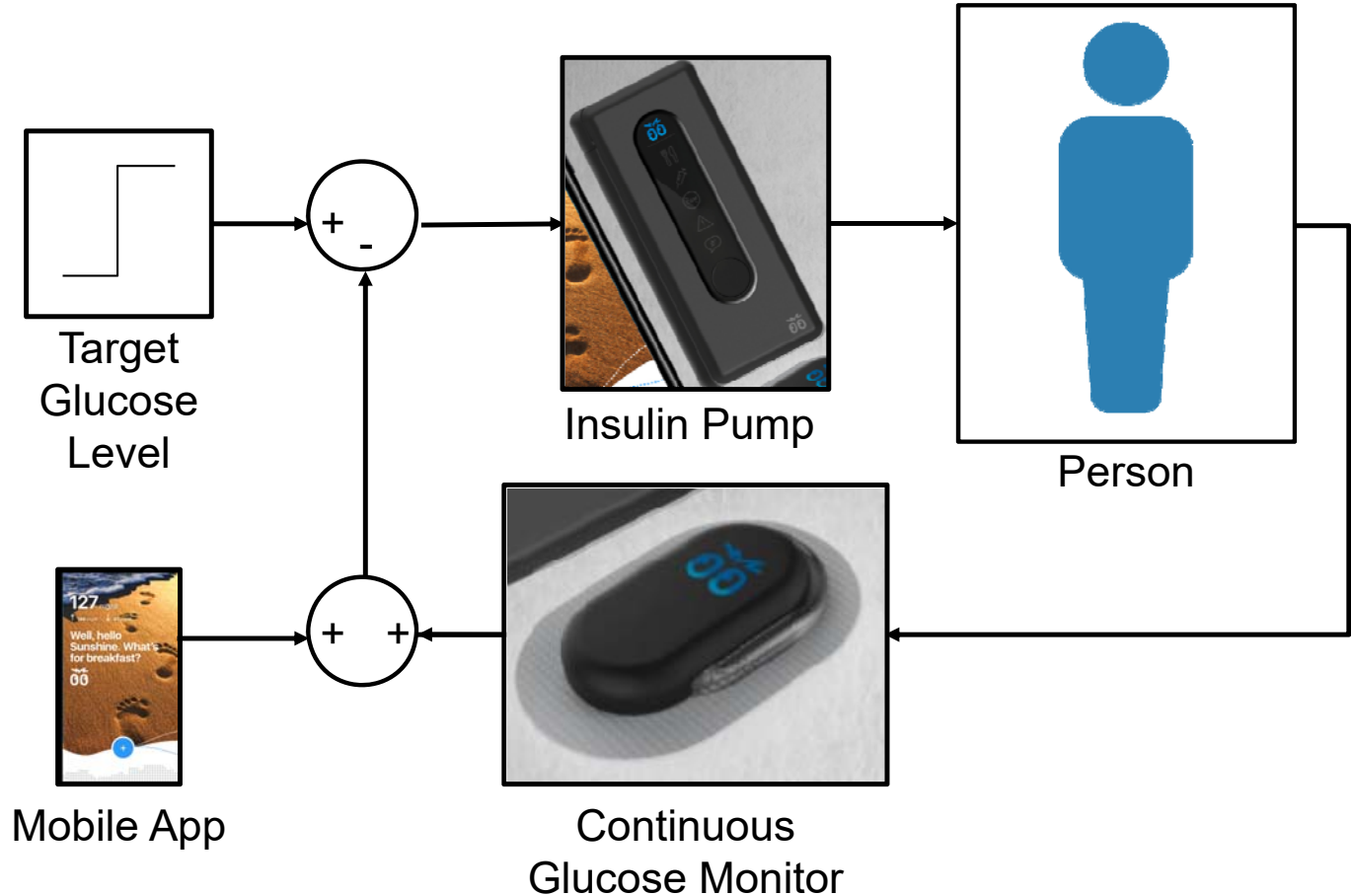
Autonomous Glucose Level Management

Bigfoot Biomedical



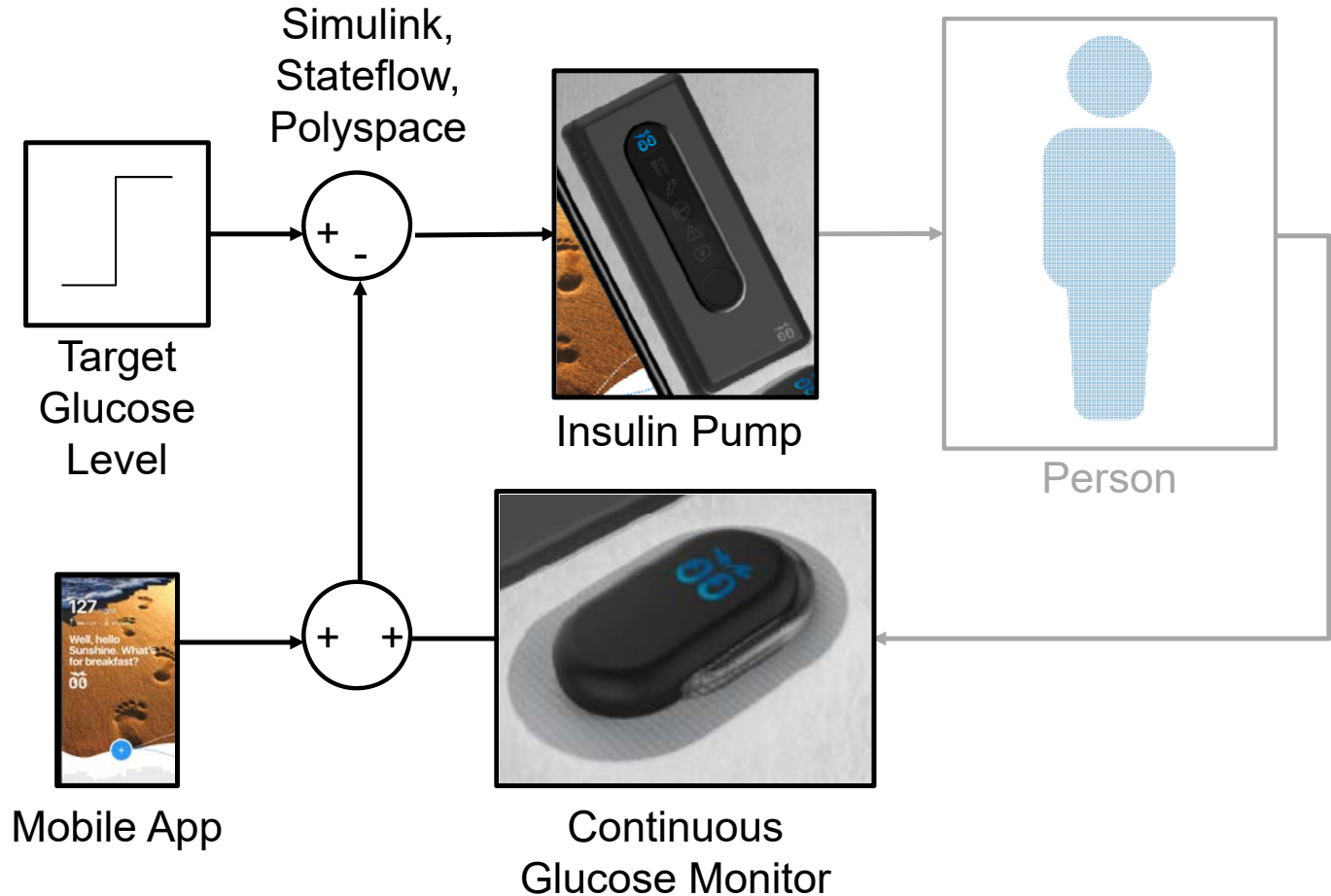
Autonomous Glucose Level Management

Bigfoot Biomedical



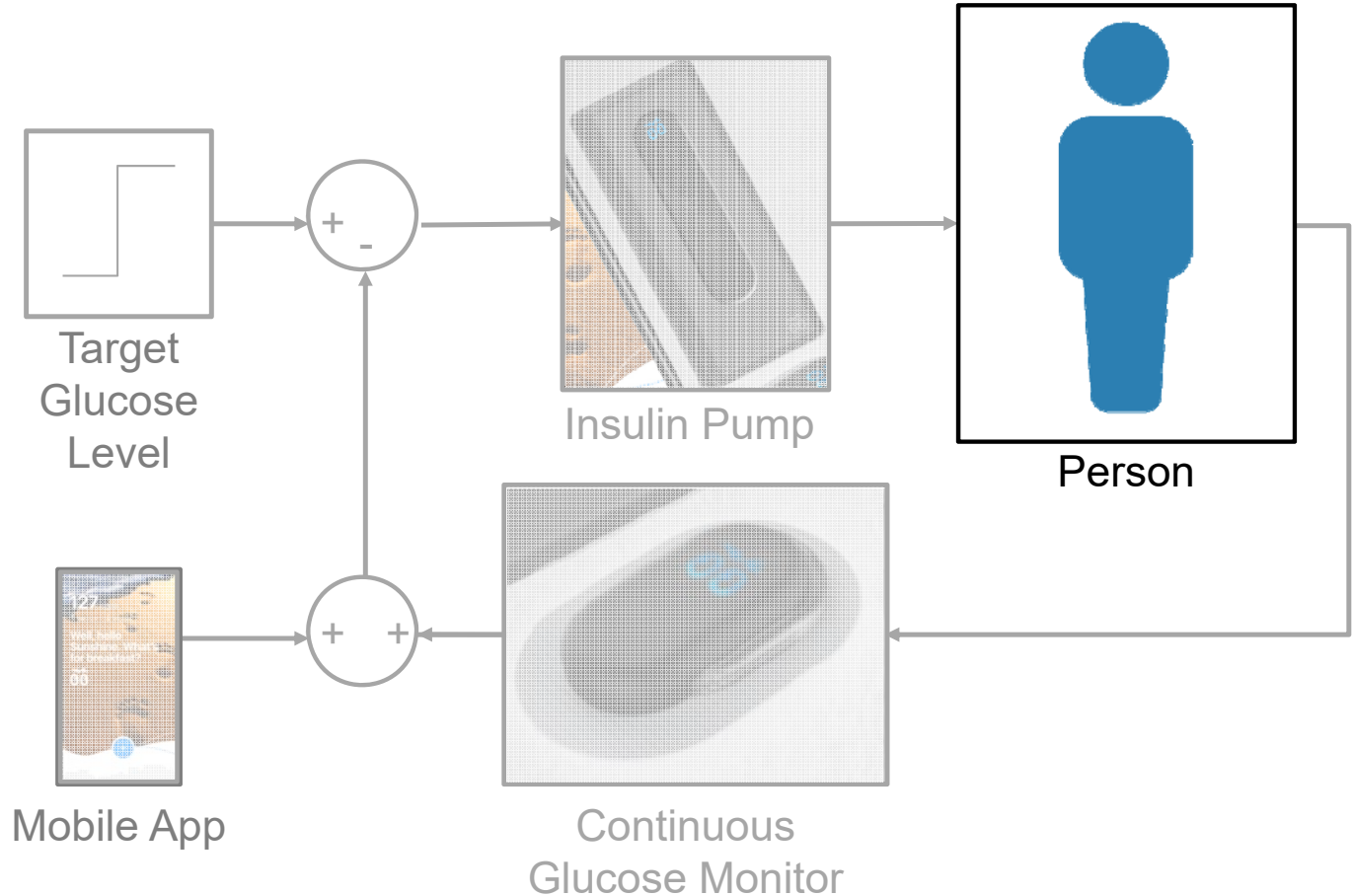
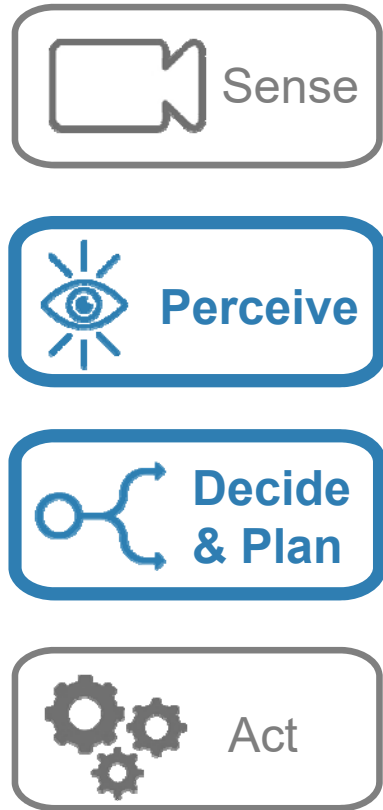
Autonomous Glucose Level Management

Bigfoot Biomedical



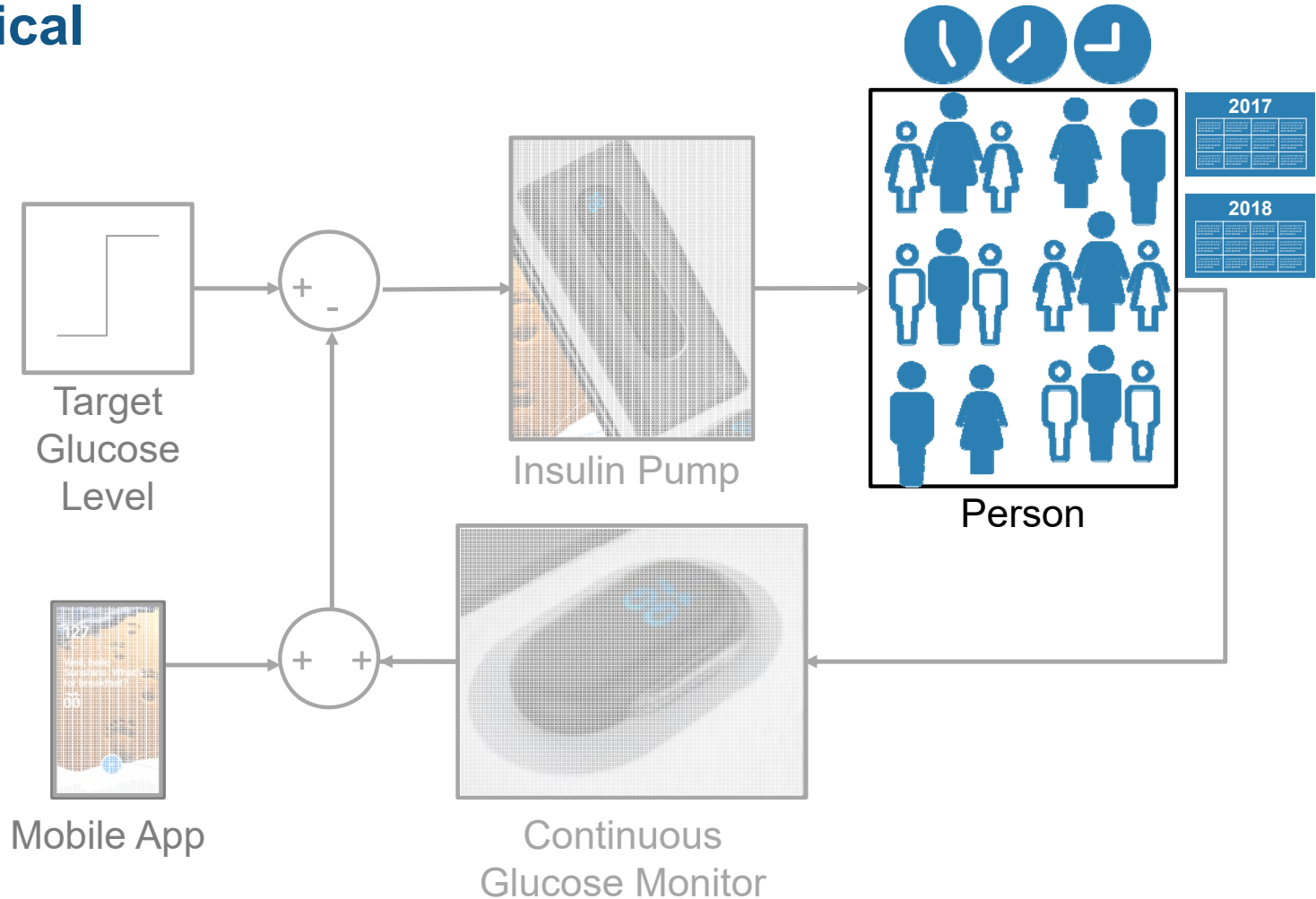
Autonomous Glucose Level Management

Bigfoot Biomedical



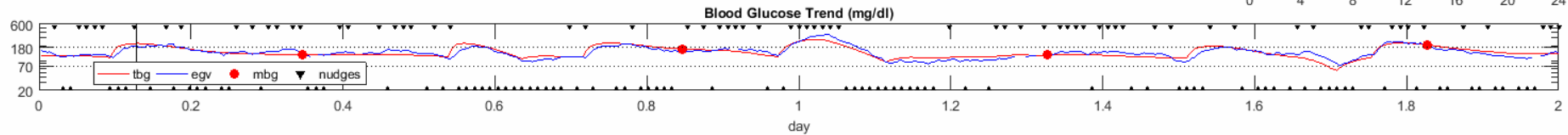
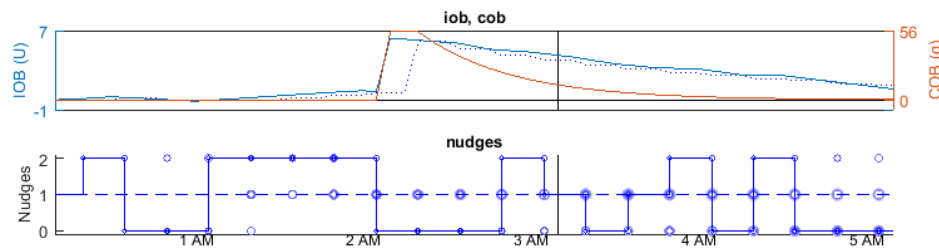
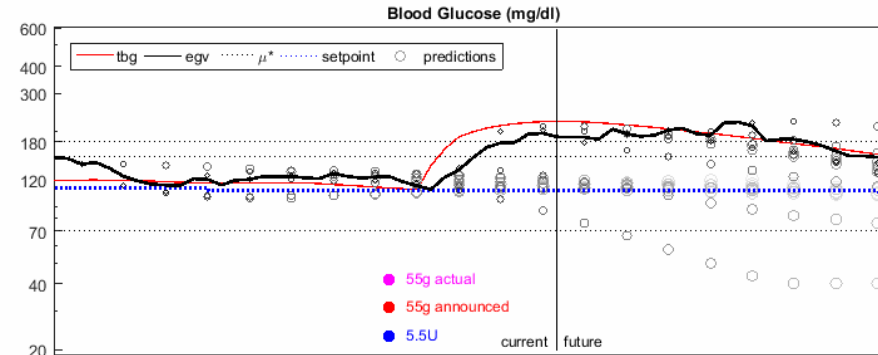
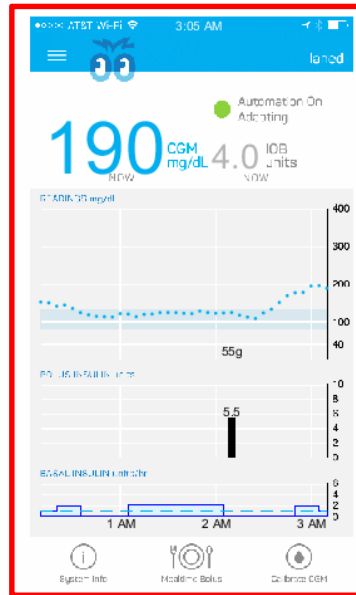
Autonomous Glucose Level Management

Bigfoot Biomedical



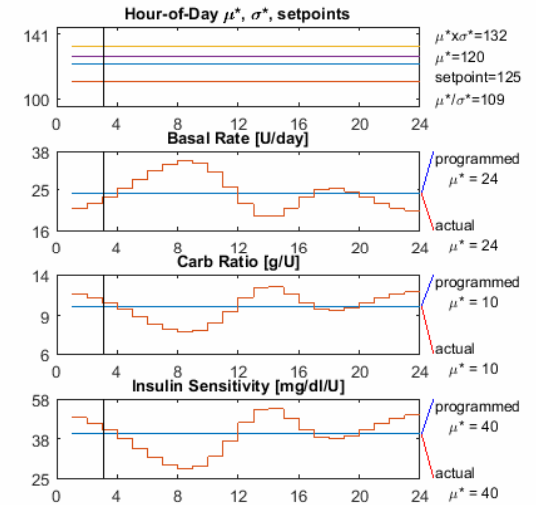
Virtual Clinic

Generating data through simulation



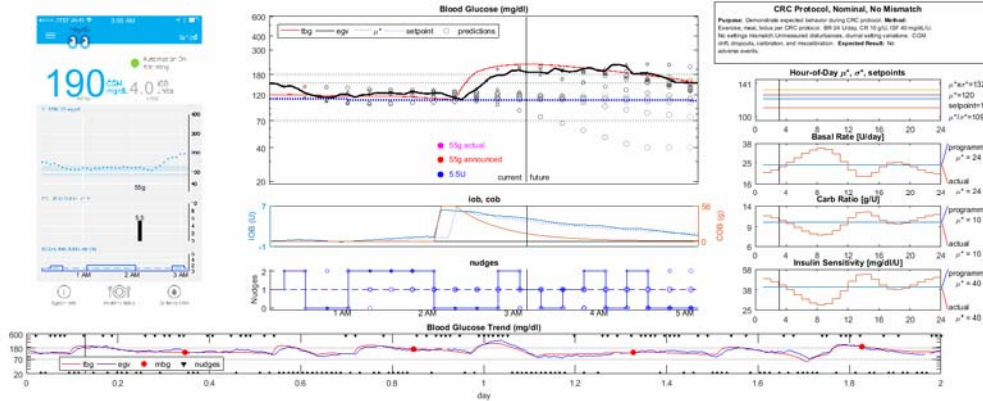
CRC Protocol, Nominal, No Mismatch

Purpose: Demonstrate expected behavior during CRC protocol. **Method:** Exercise, meal, bolus per CRC protocol. BR 24 U/day, CR 10 g/U, ISF 40 mg/dL/U. No settings mismatch. Unmeasured disturbances, diurnal setting variations. CGM drift, dropouts, calibration, and miscalibration. **Expected Result:** No adverse events.



Virtual Clinic

Scaling computations to simulate 50 million patients a day



-



Autonomous Trailer Filling



Sense



Perceive



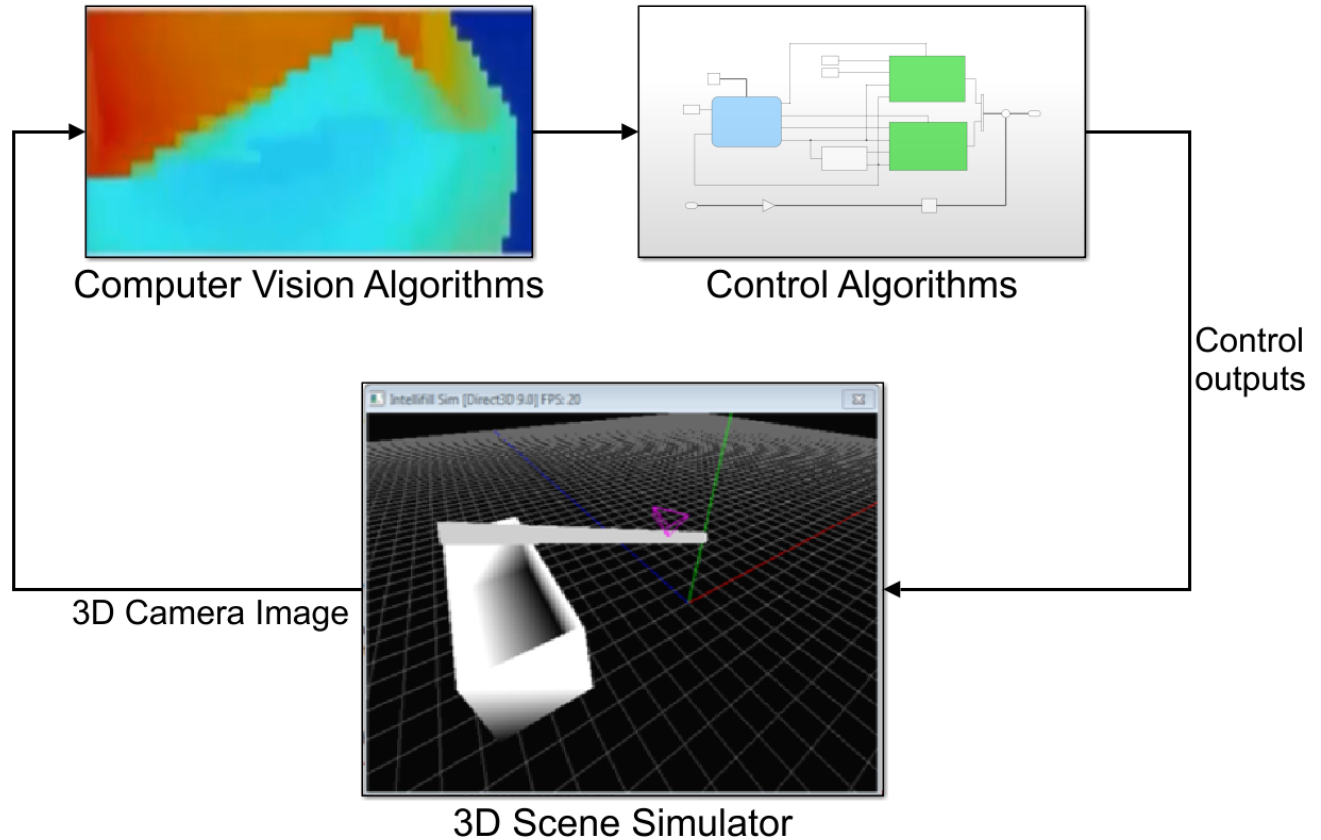
Decide
& Plan

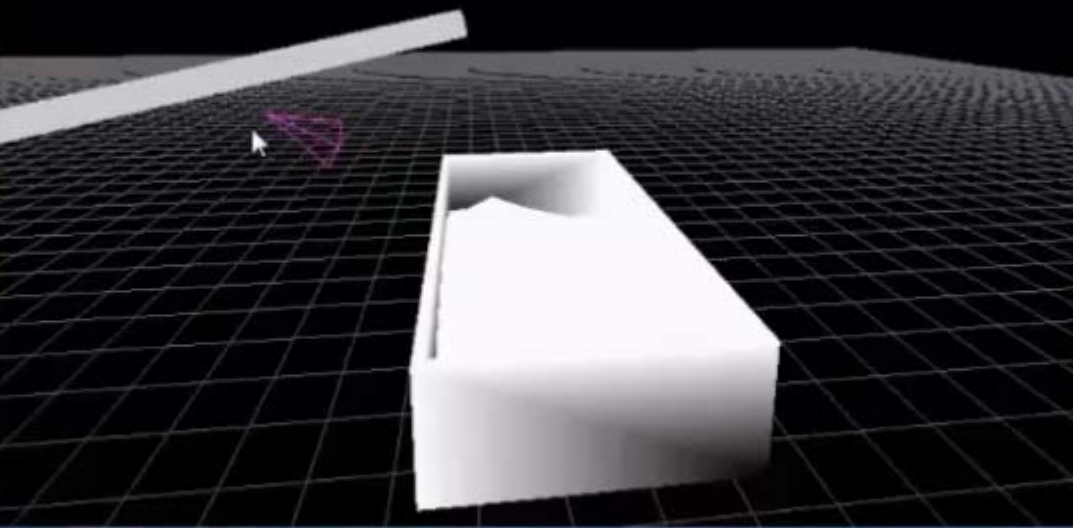


Act



Autonomous Trailer Filling





File Tools View Simulation Help

963%



File Tools View Simulation Help

966%

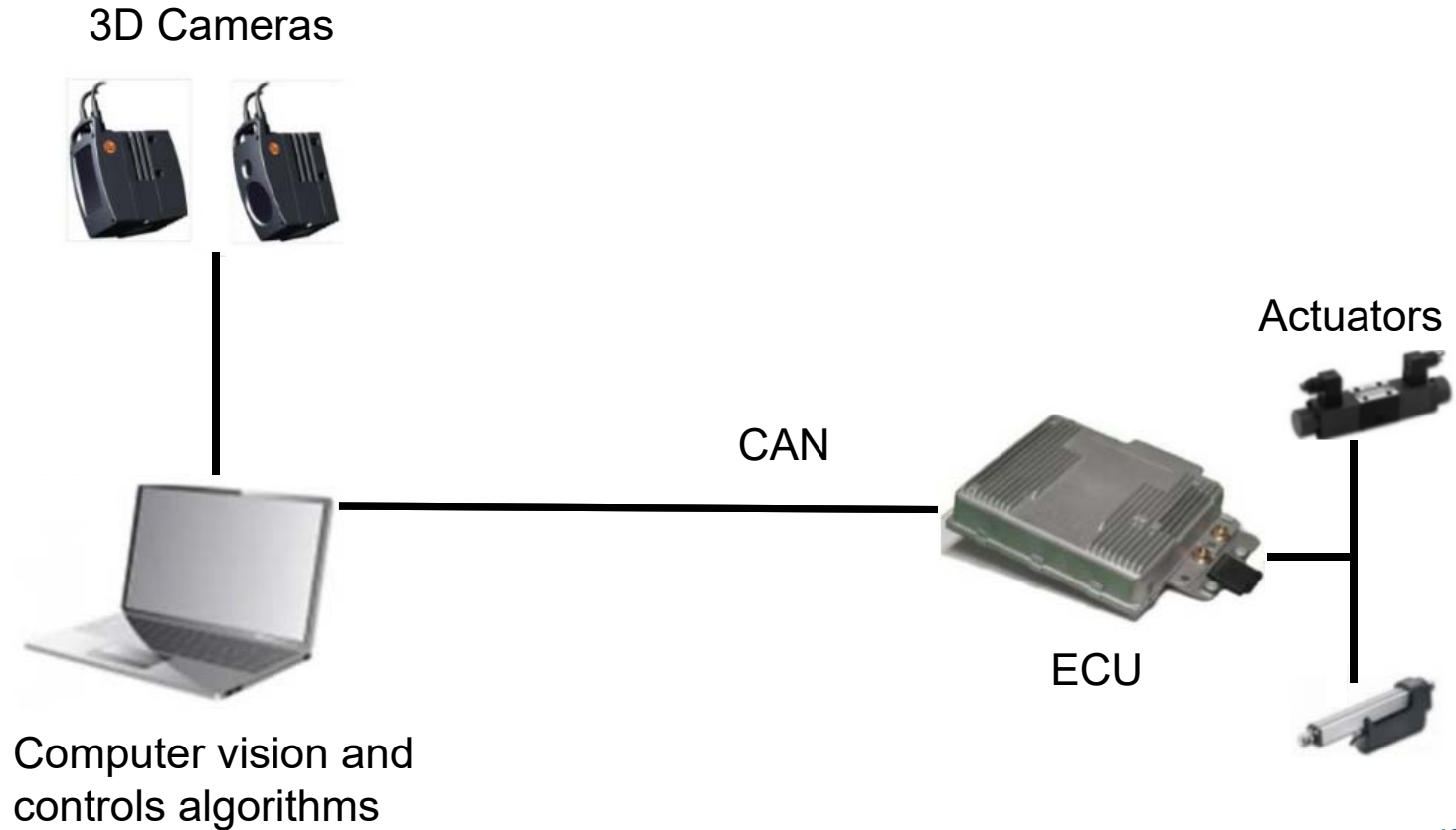


File Tools View Simulation Help

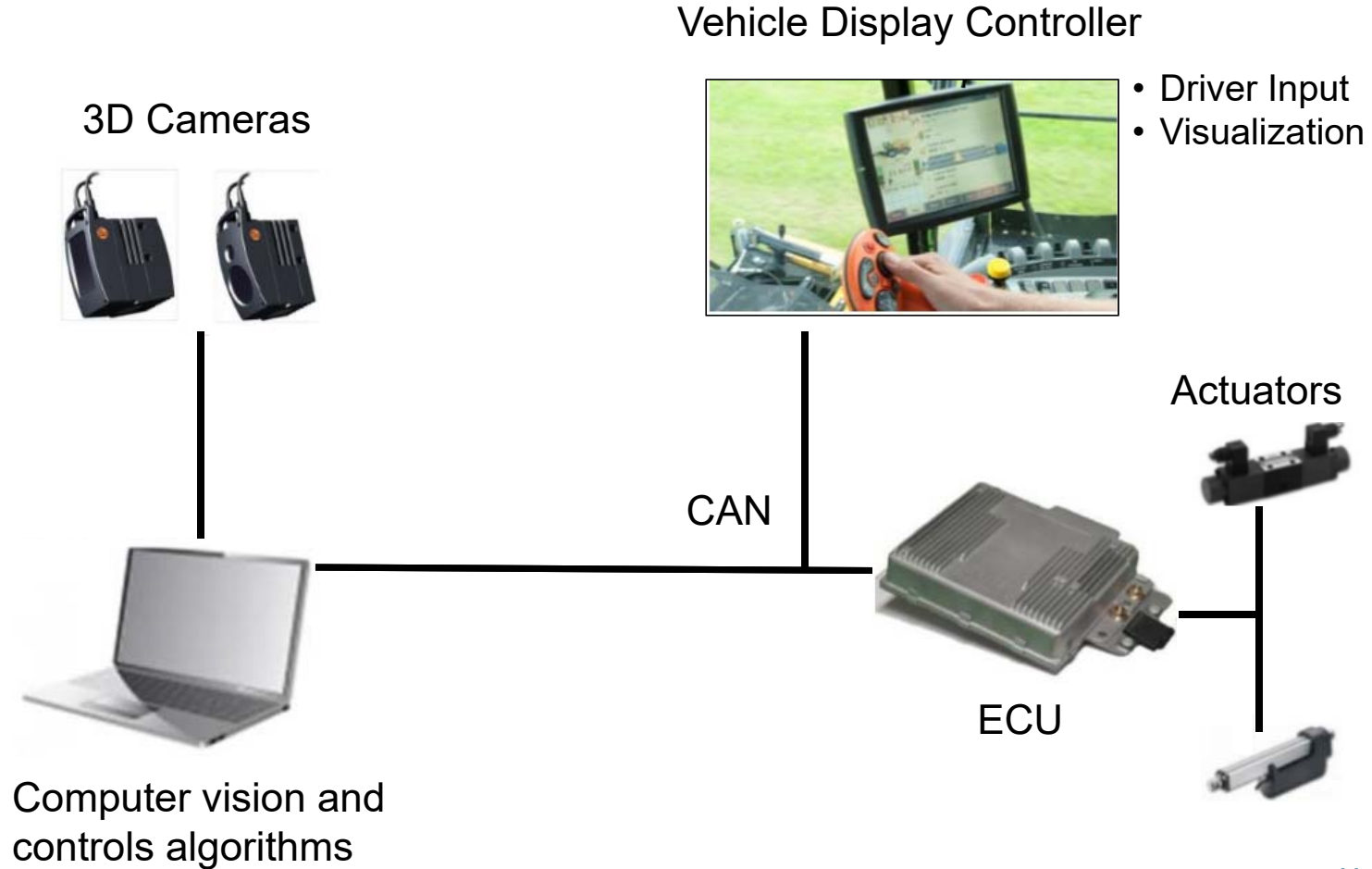
236%



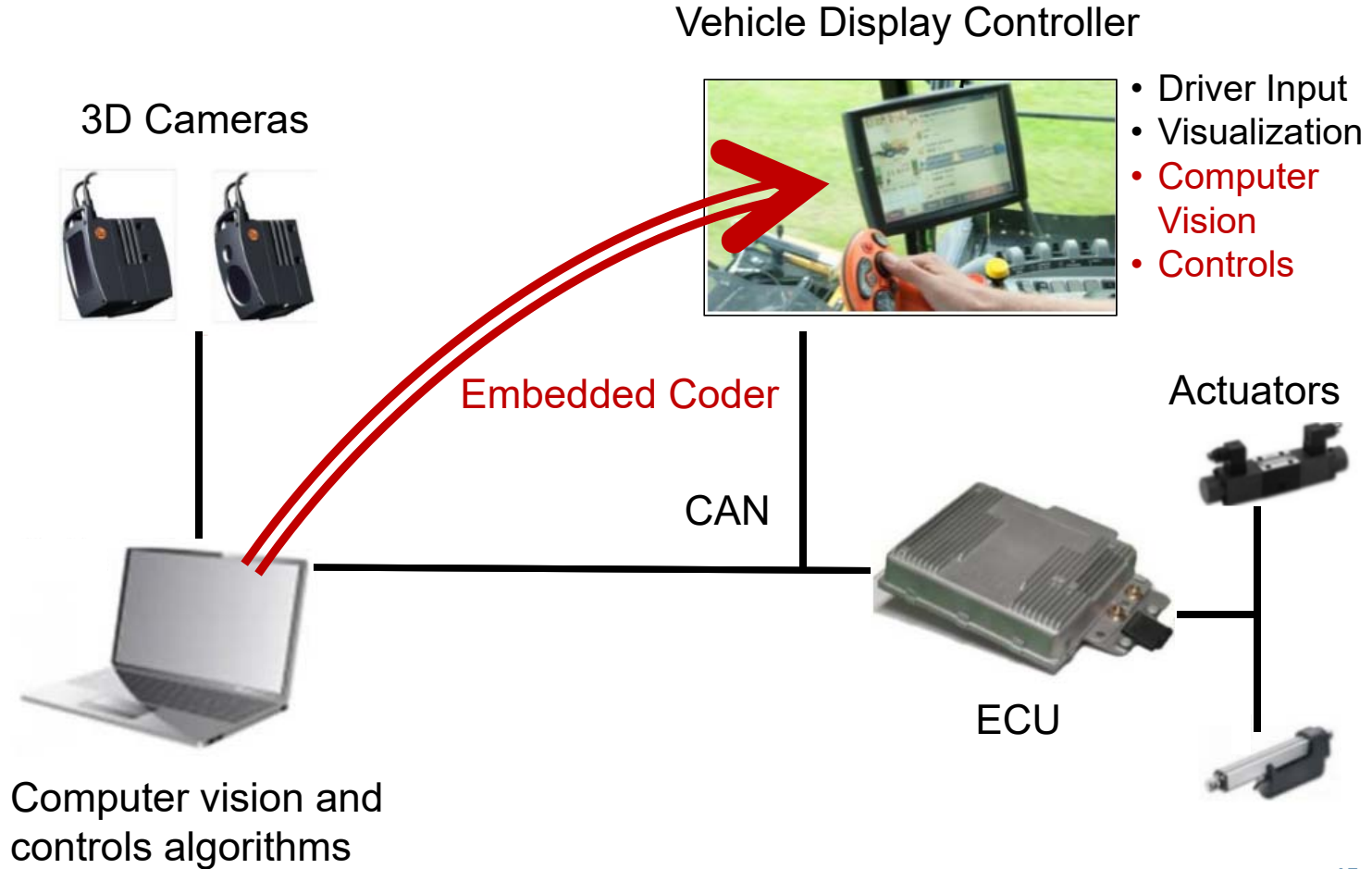
Autonomous Trailer Filling



Autonomous Trailer Filling



Autonomous Trailer Filling



Autonomous Trailer Filling



3D Cameras

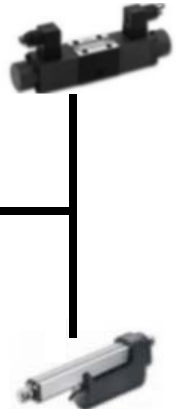


Vehicle Display Controller



- Driver Input
- Visualization
- Computer Vision
- Controls

Actuators



ECU



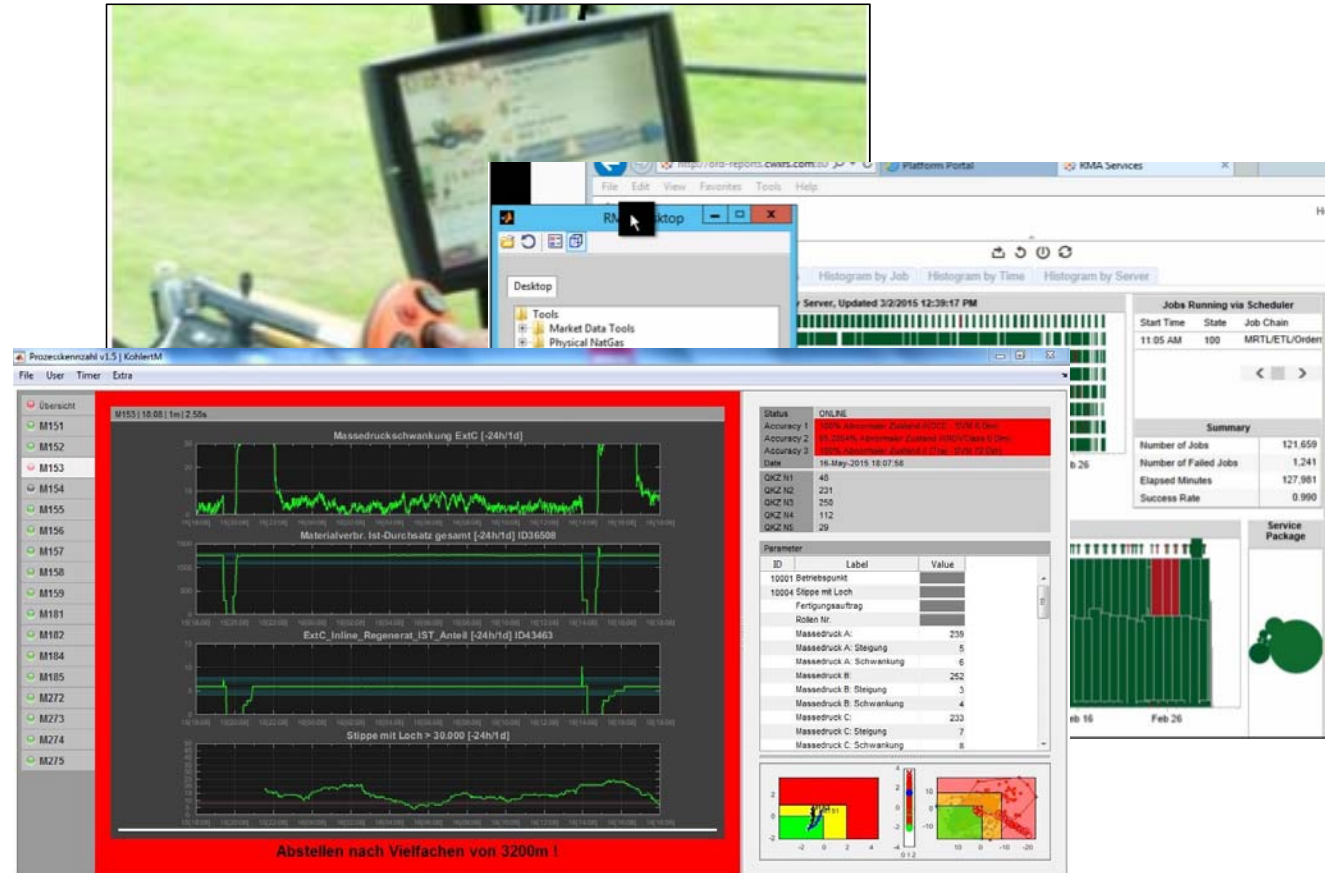
CAN

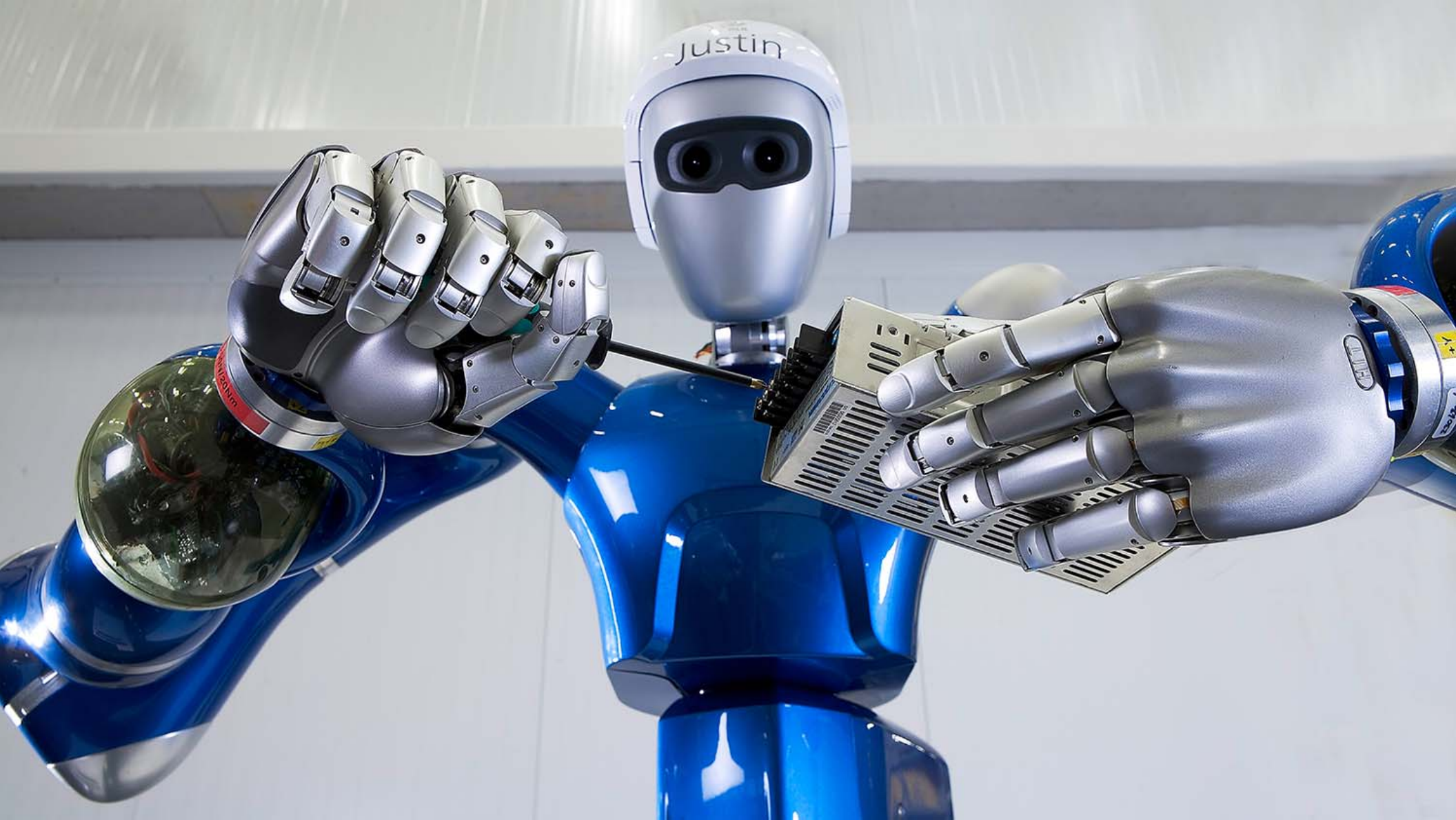


Monitoring

How will you put it into production?

- System Architecture
- Embedded systems
- Enterprise systems
- HMIs





How to build an autonomous anything

Focus on Perception

- Look for autonomy in creative places
 - Do more than manually possible
-

Use the Best Predictors

- Data-driven
 - Model-driven
-

Get the Right Data

- Reduce to actionable data
 - Take advantage of Big Data
 - Use simulation to supplement available data
-

Go to Production

- Address the architecture
- Leverage Model-Based Design for embedded
- Automate integration with enterprise IT systems

What is *your*
autonomous anything?