

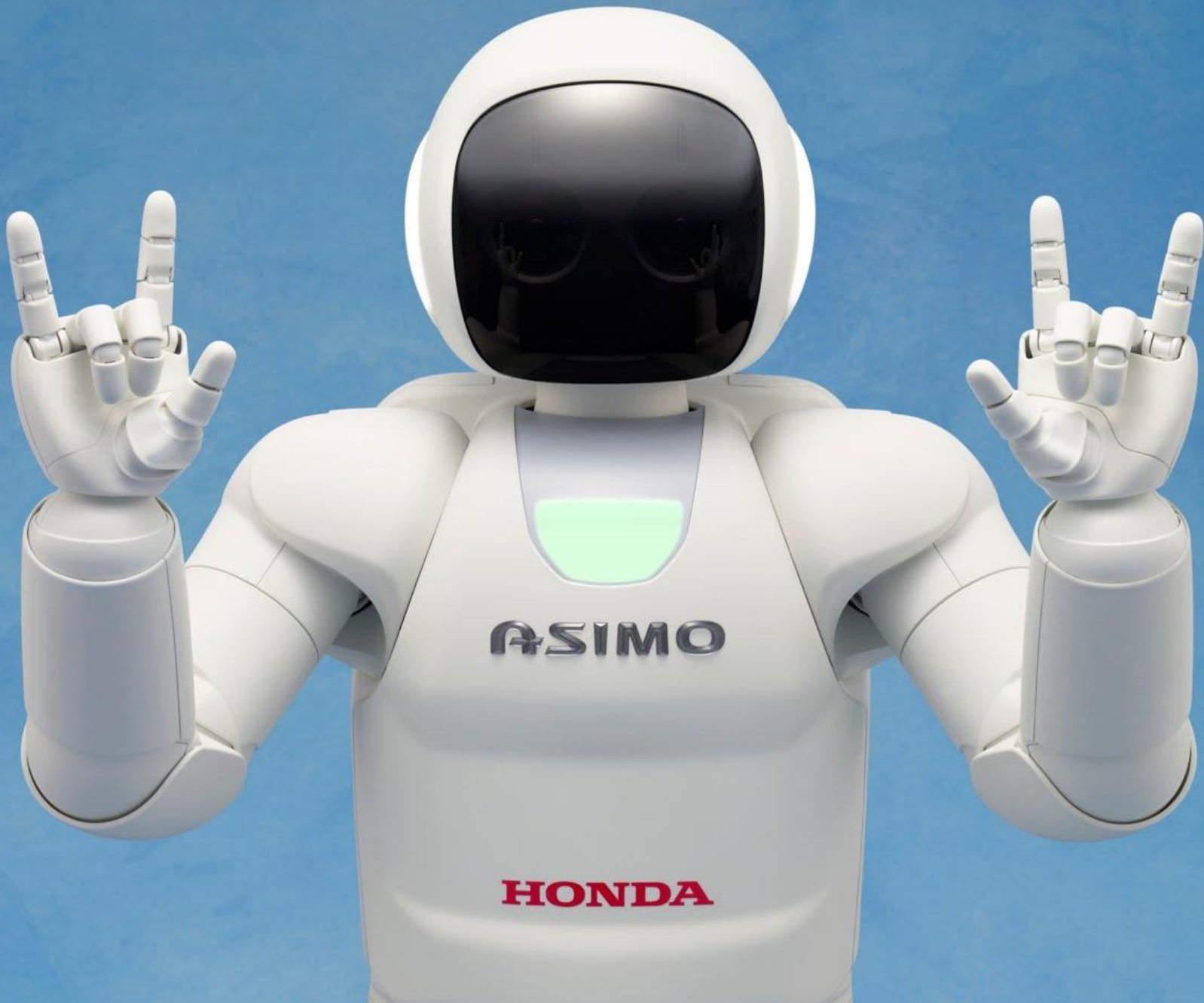
MATLAB CONFERENCE 2017

How to build an
autonomous
anything

Mischa Kim

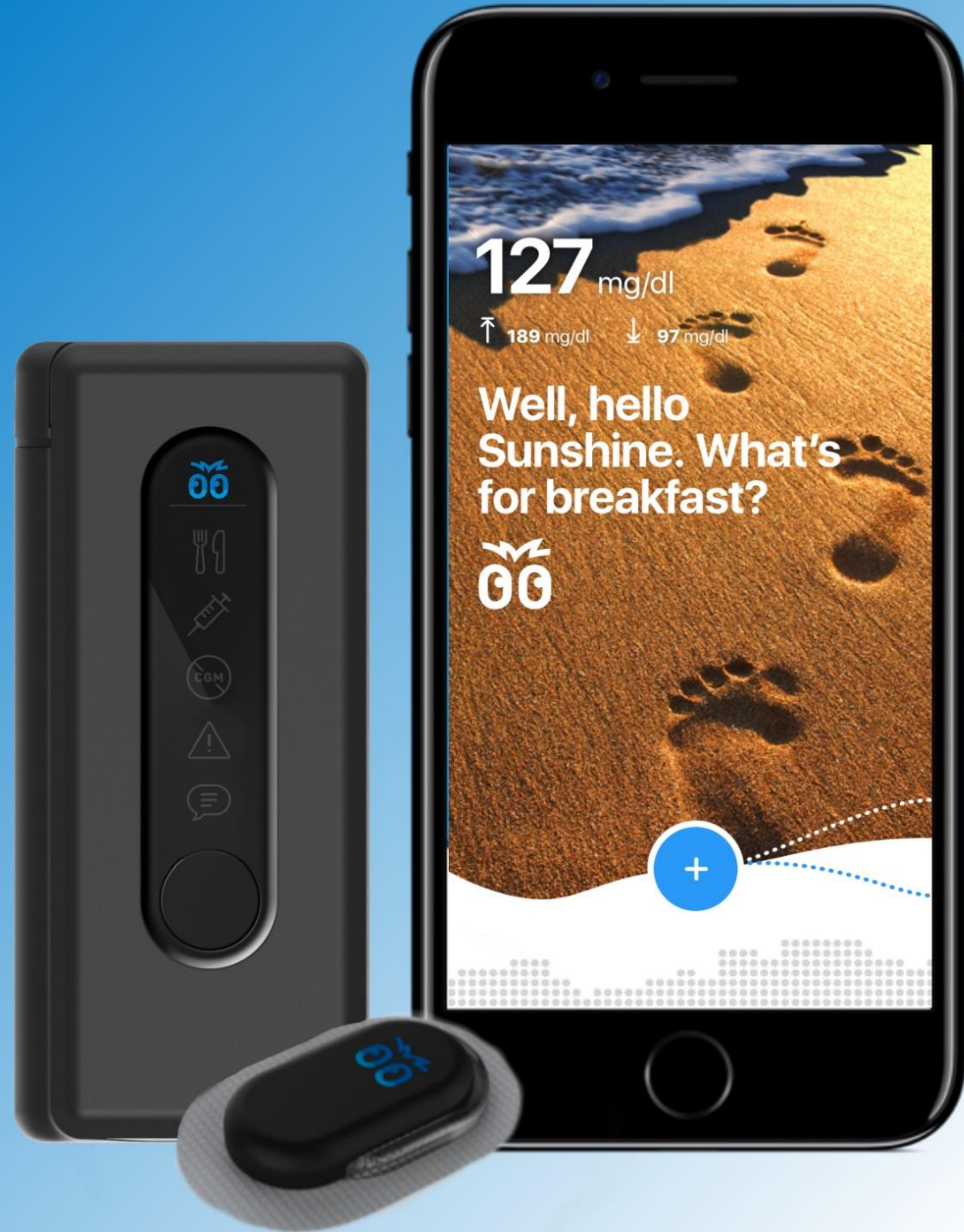












127 mg/dl

↑ 189 mg/dl ↓ 97 mg/dl

Well, hello
Sunshine. What's
for breakfast?

00



Autonomous Technology

Autonomous Technology

Having the power for self-governance

Autonomous Technology

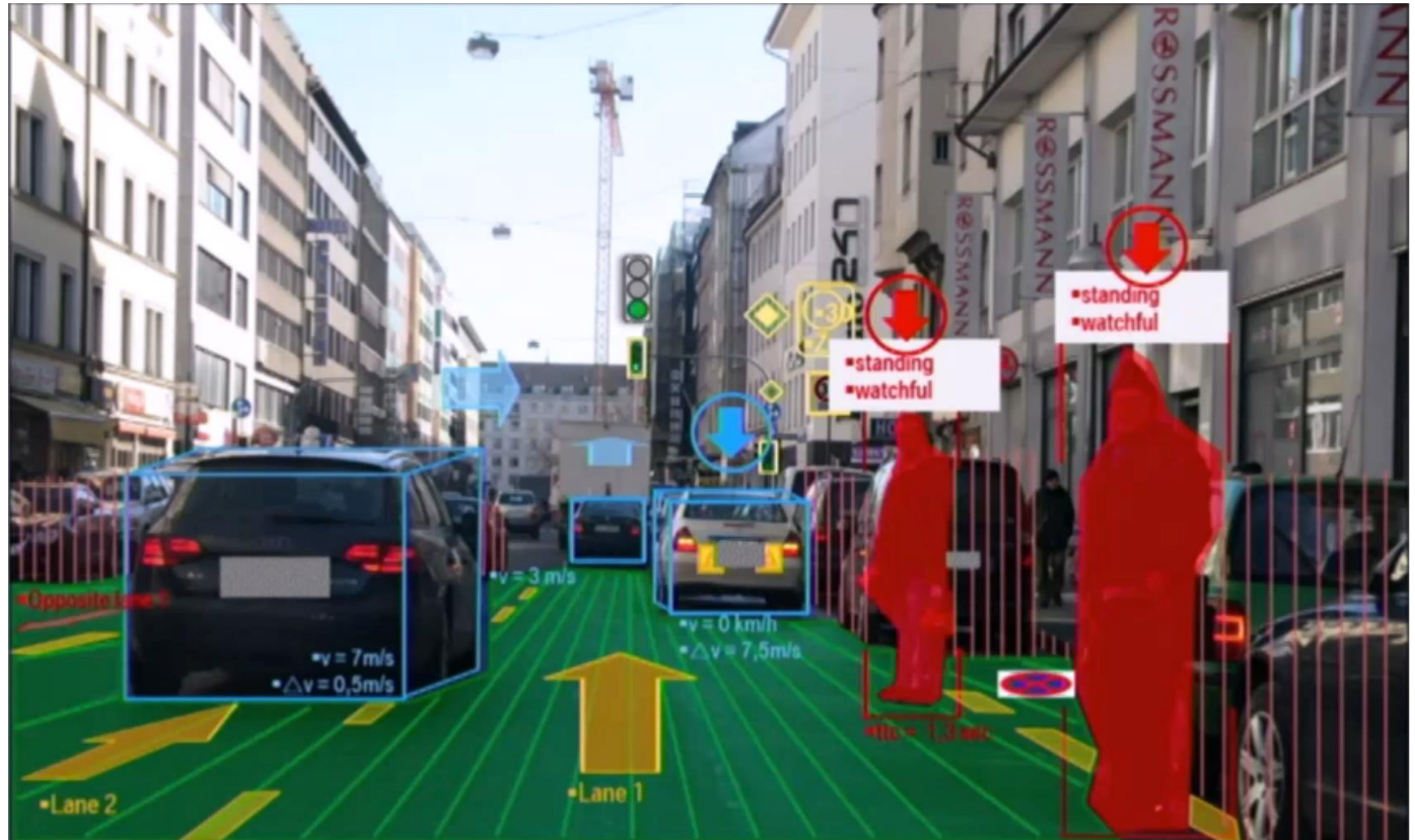
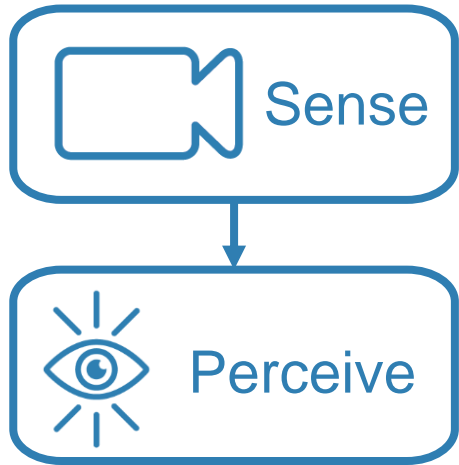
*Provides the ability of a system to act **independently** of direct human control under **unrehearsed** conditions*



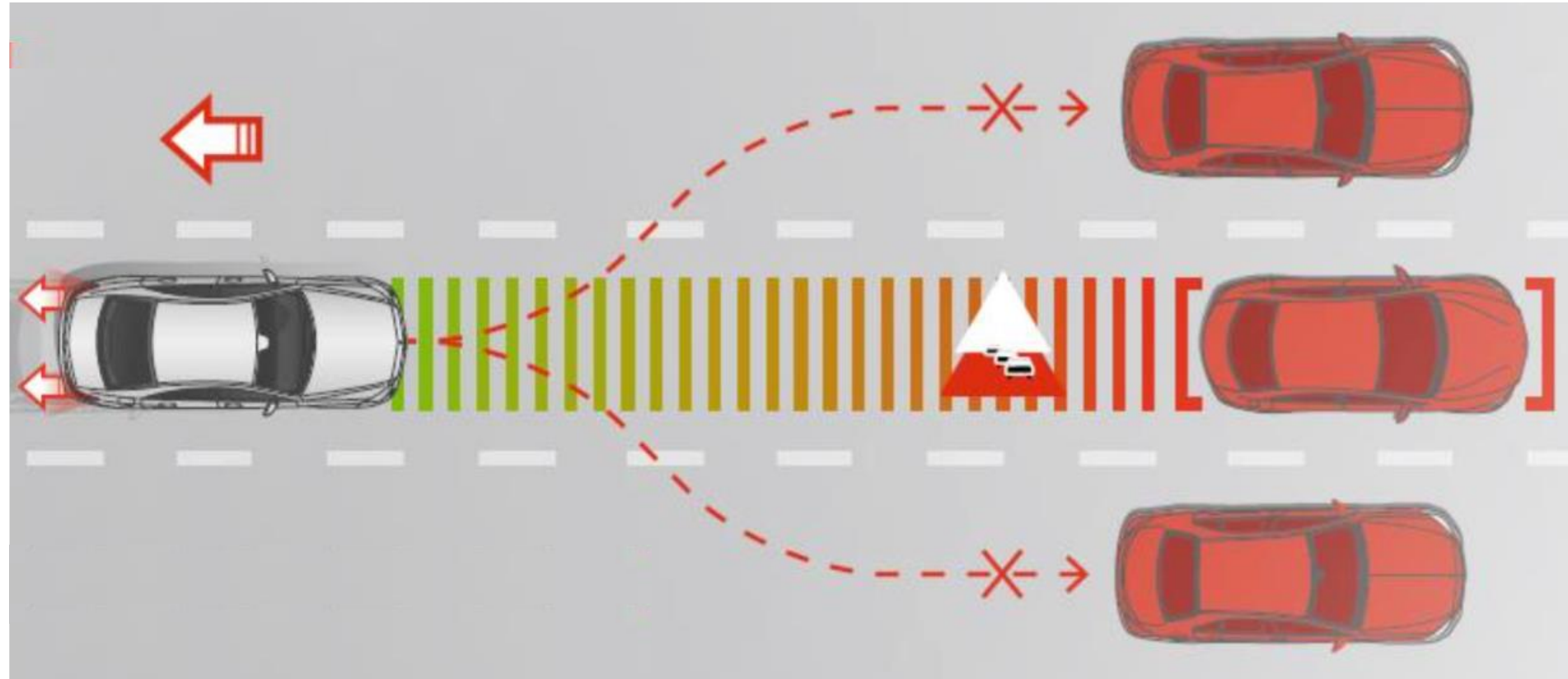
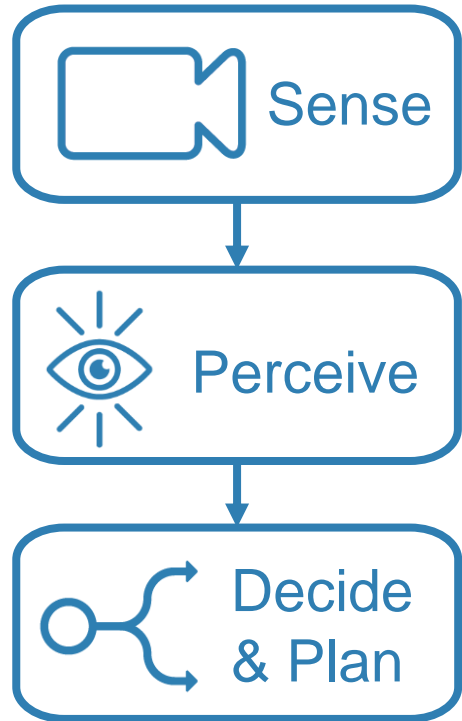
Capabilities of an Autonomous System



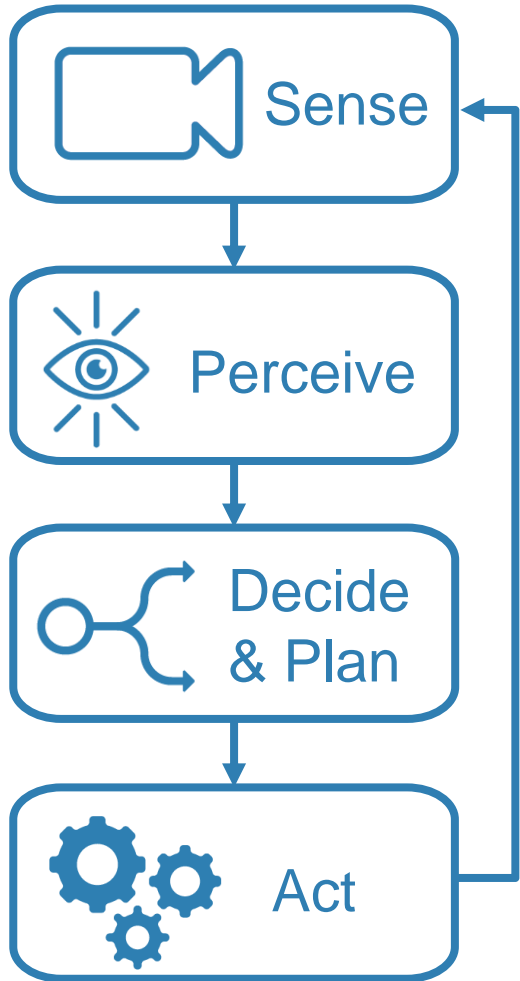
Capabilities of an Autonomous System



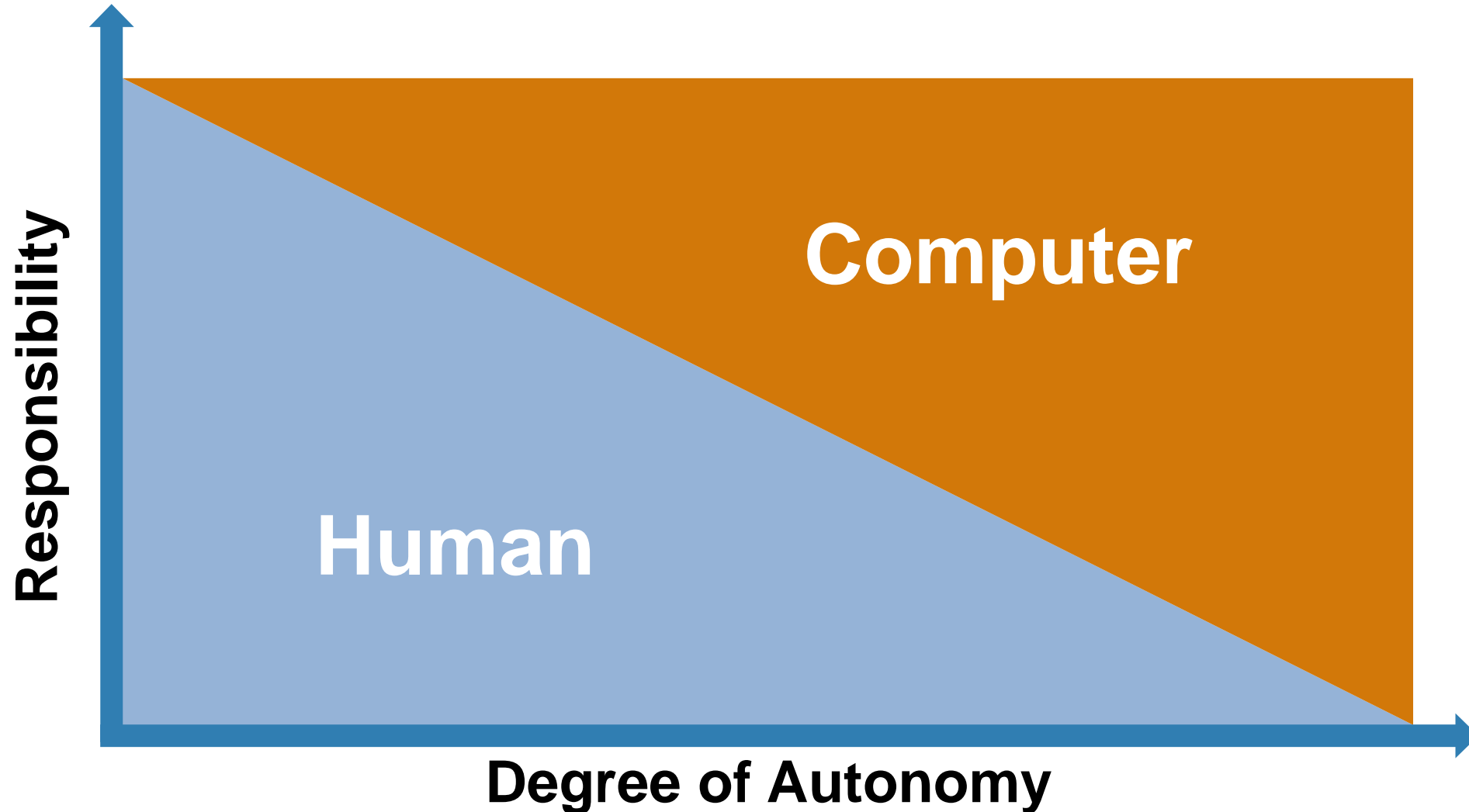
Capabilities of an Autonomous System

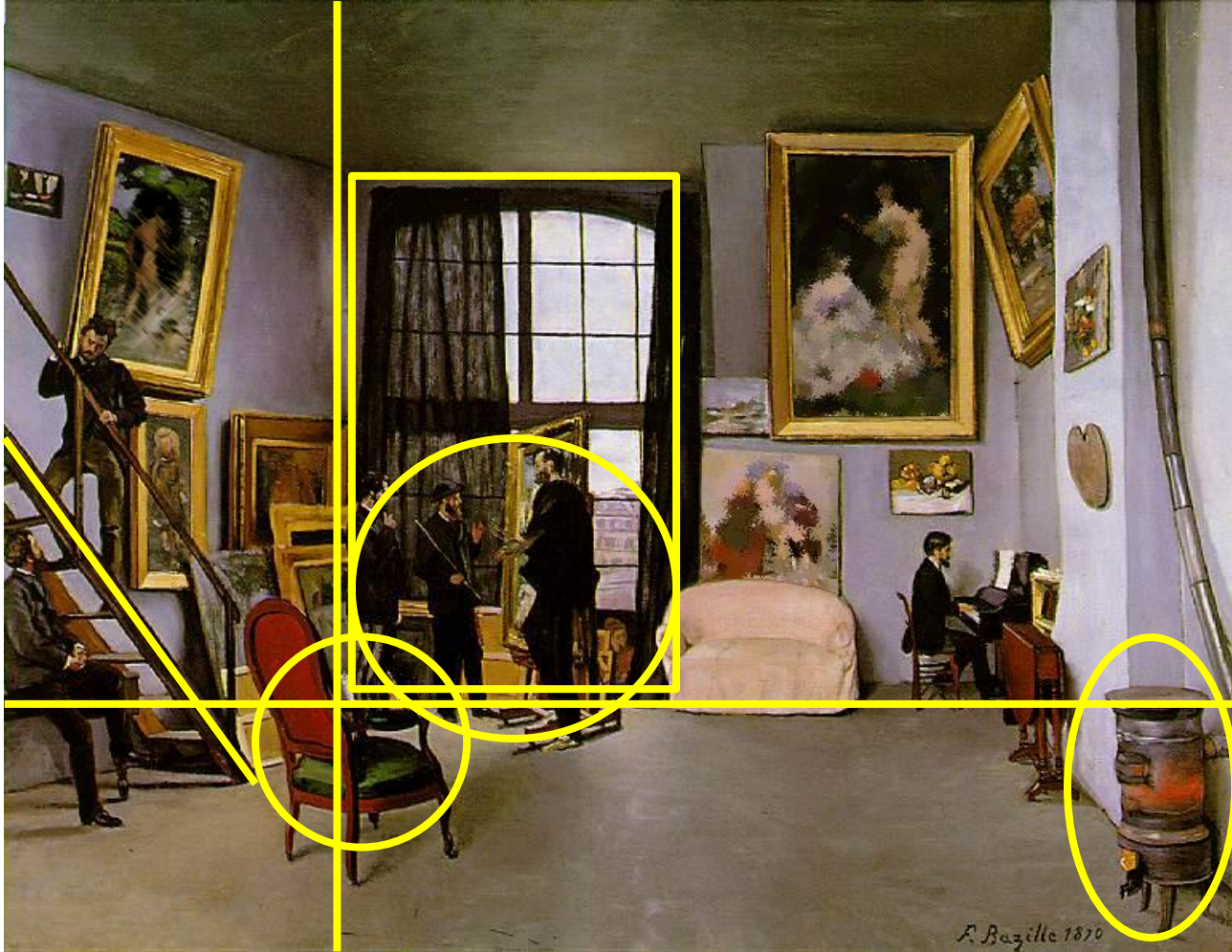


Capabilities of an Autonomous System



Autonomous Technology Transfers Responsibility to Computers





Bazille's Studio
Bazille 1870



Shuffleton's Barbershop
Rockwell 1950

Autonomous Artistic Style Classification

Rutgers University

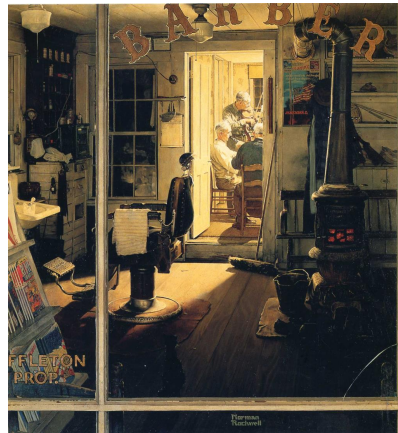
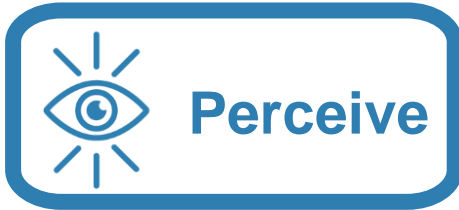
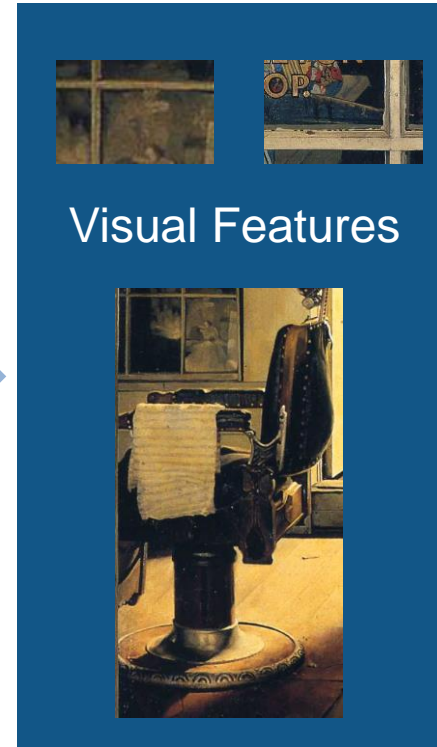


Image
Feature
Extraction



Machine
Learning
Classification



Style:
Regionalism



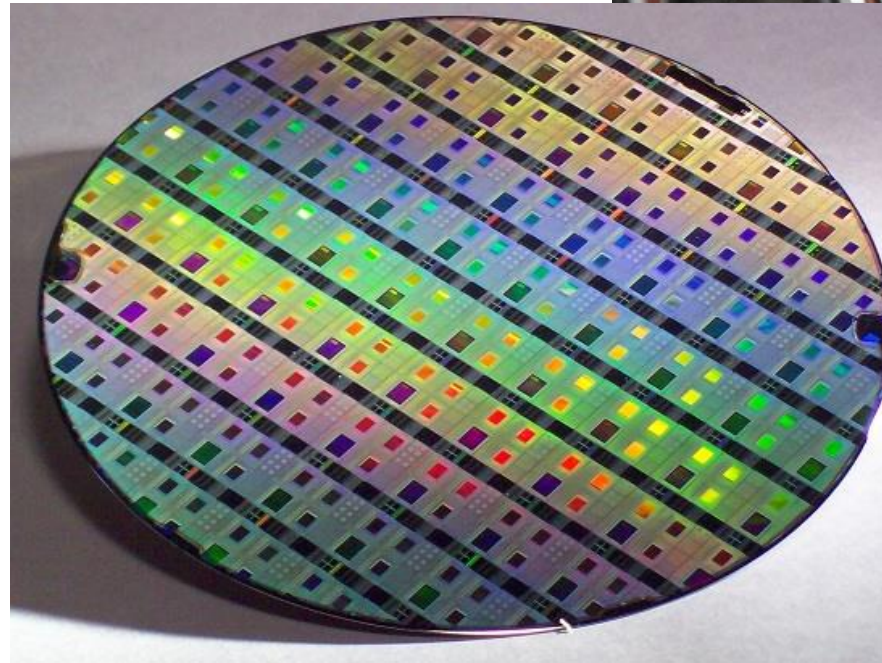
Genre:
Interior



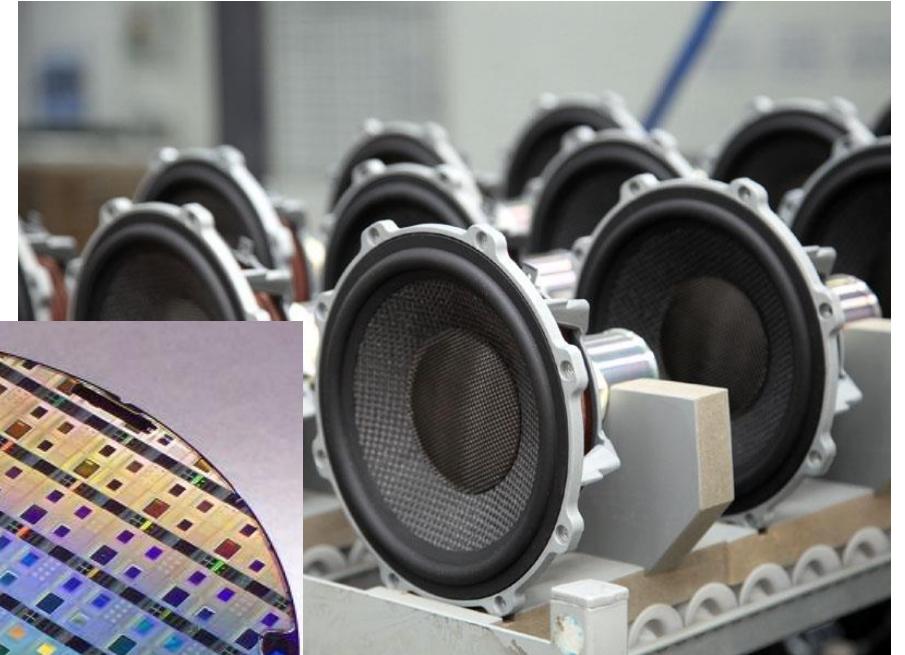
Artist:
Rockwell

Where to add autonomy with perception?

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



Virtual Semiconductor
Manufacturing Calibration



Determine
Loudspeaker
Quality



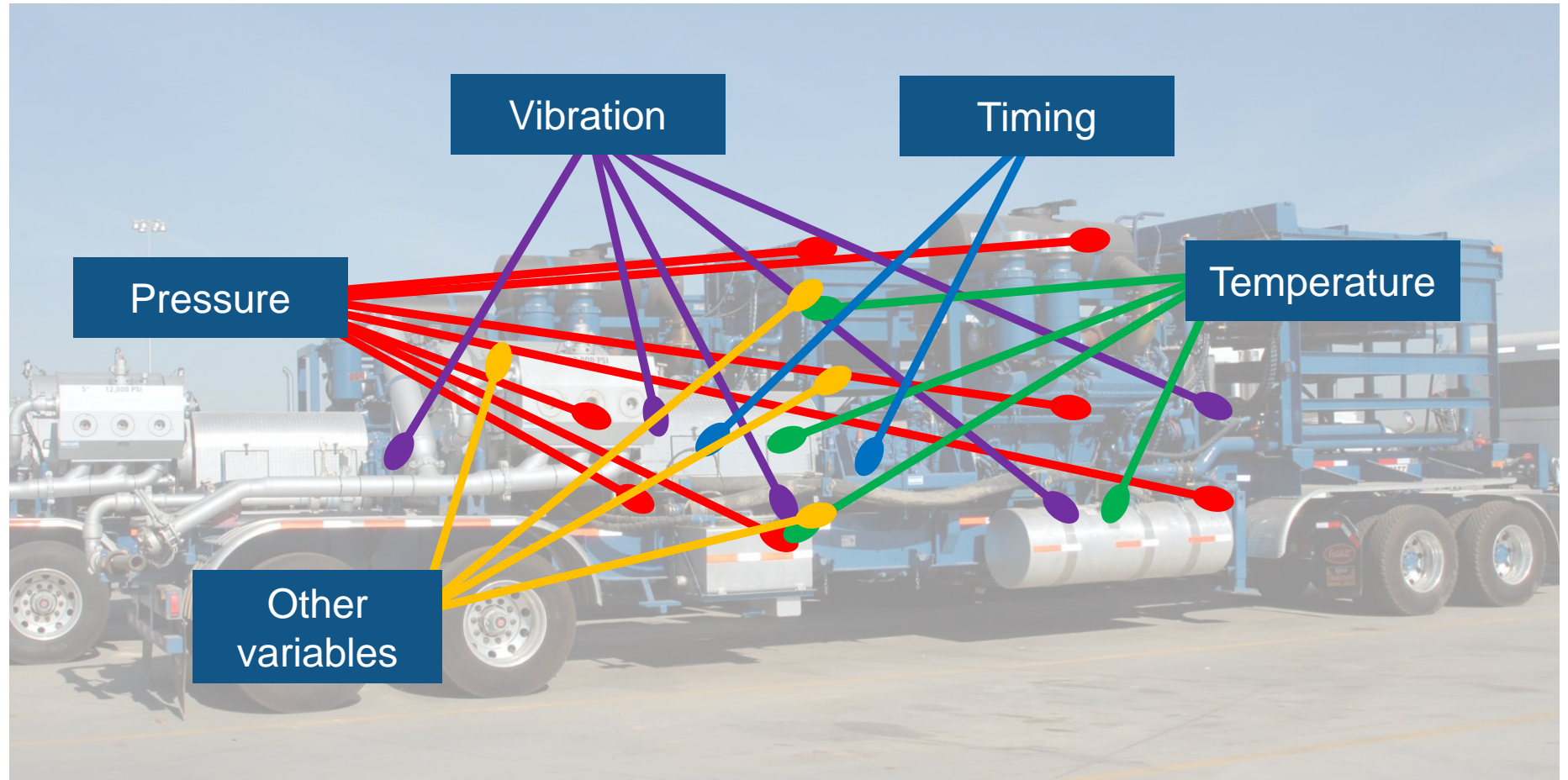
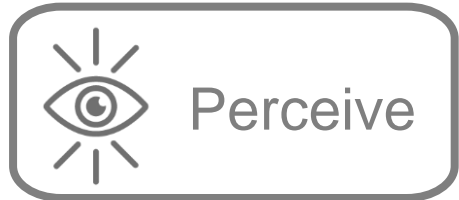




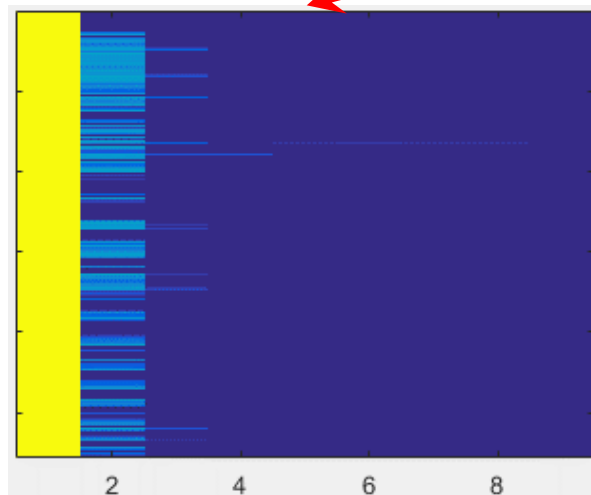
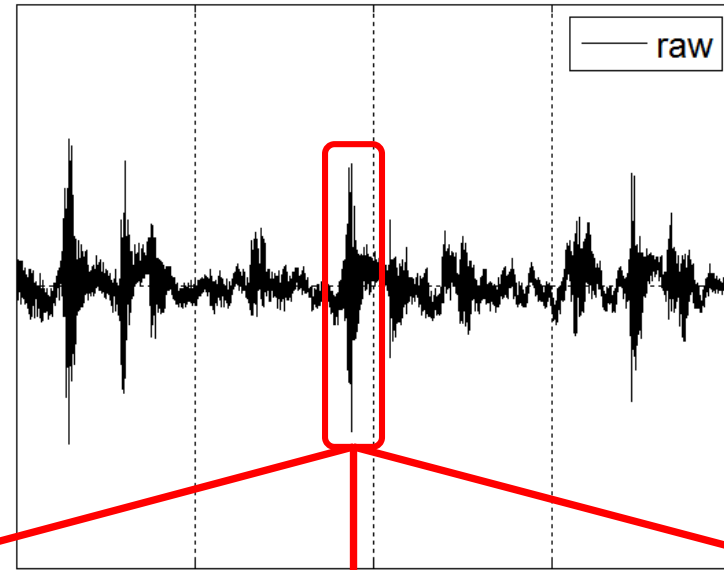
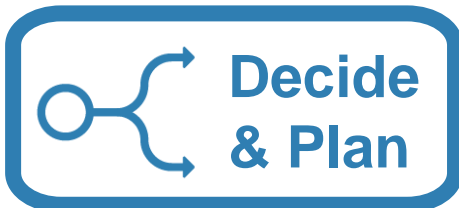
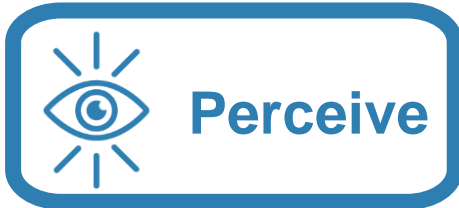


Autonomous Service for Predictive Maintenance

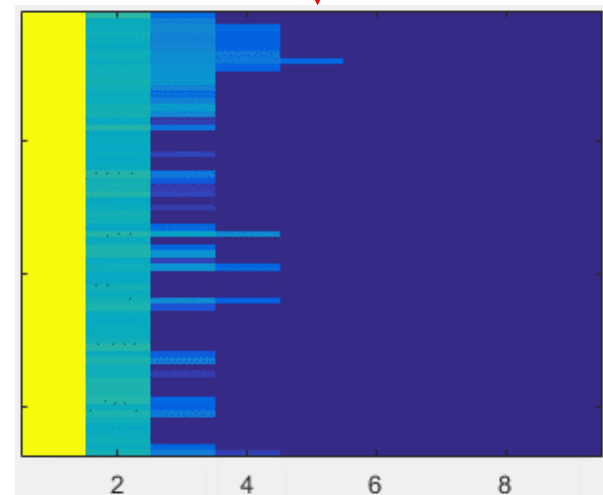
Which sensor values should they use?



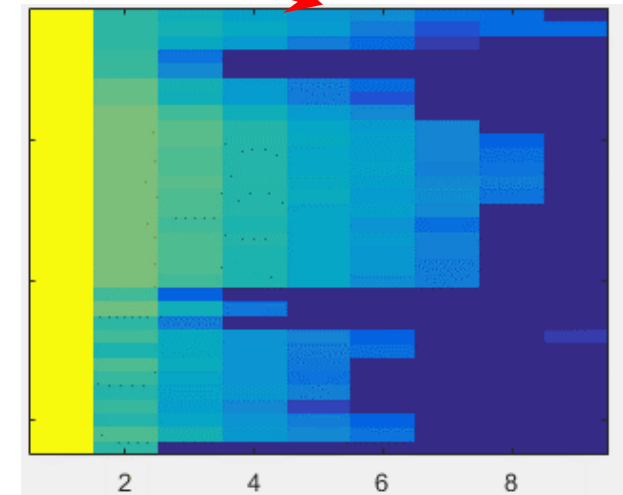
Autonomous Service for Predictive Maintenance



Normal Operation



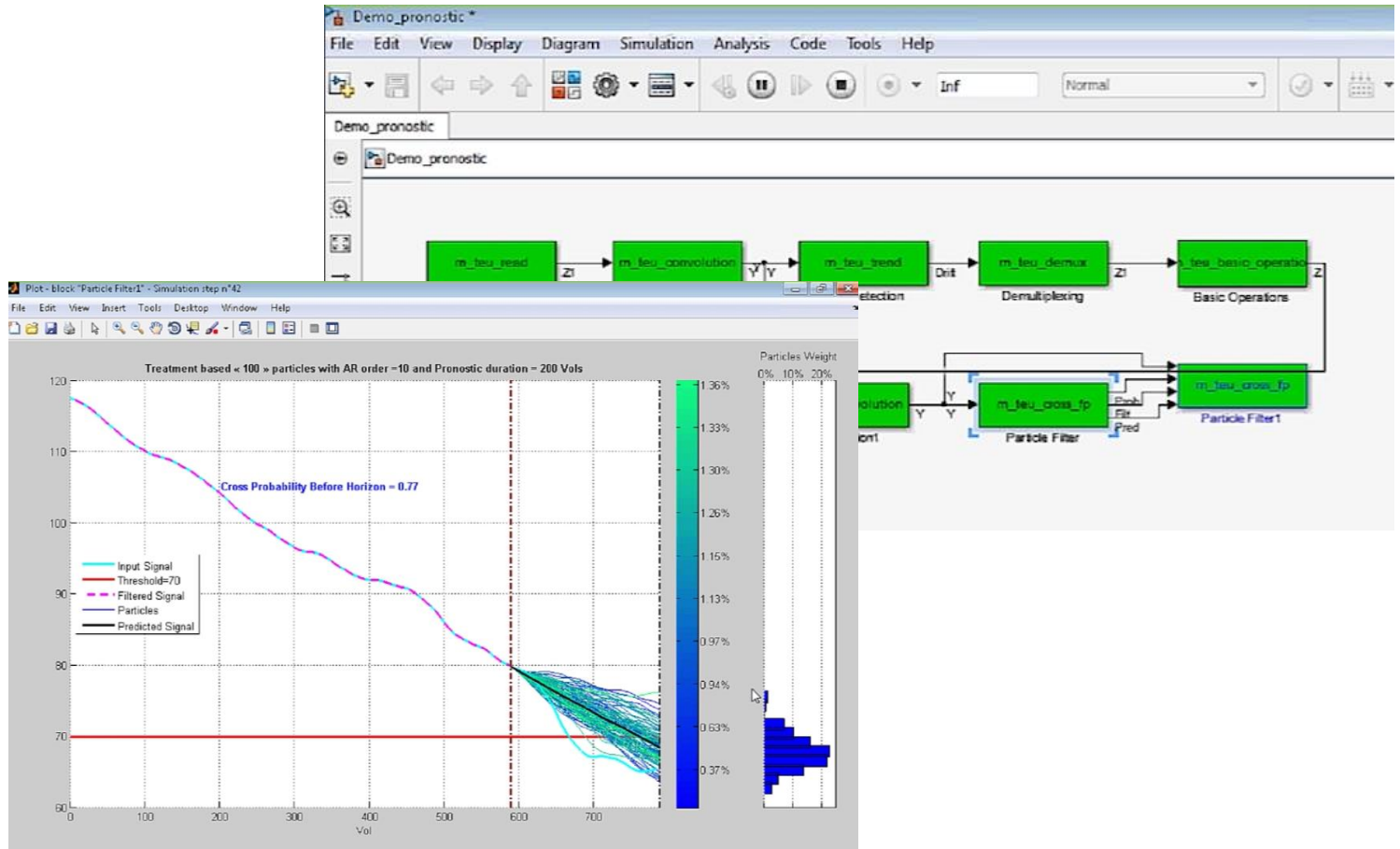
Monitor Closely



Maintenance Needed

What are the best predictors?

- Data
- Models



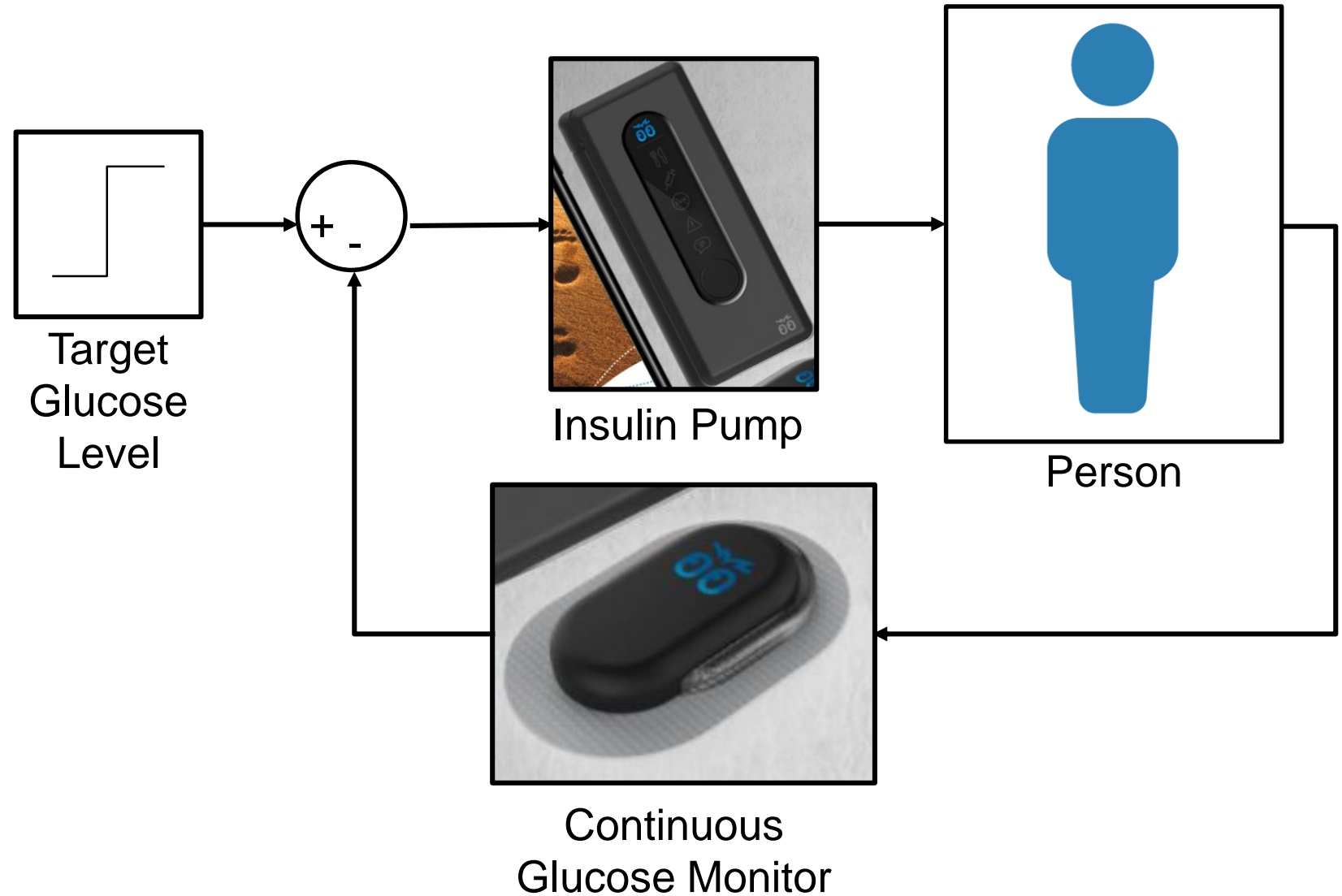
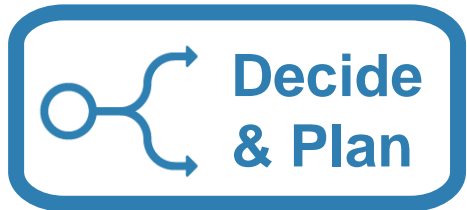
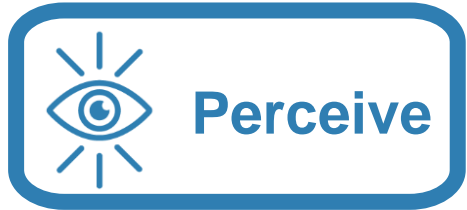
Jet Engine Monitoring

Autonomous Glucose Level Management



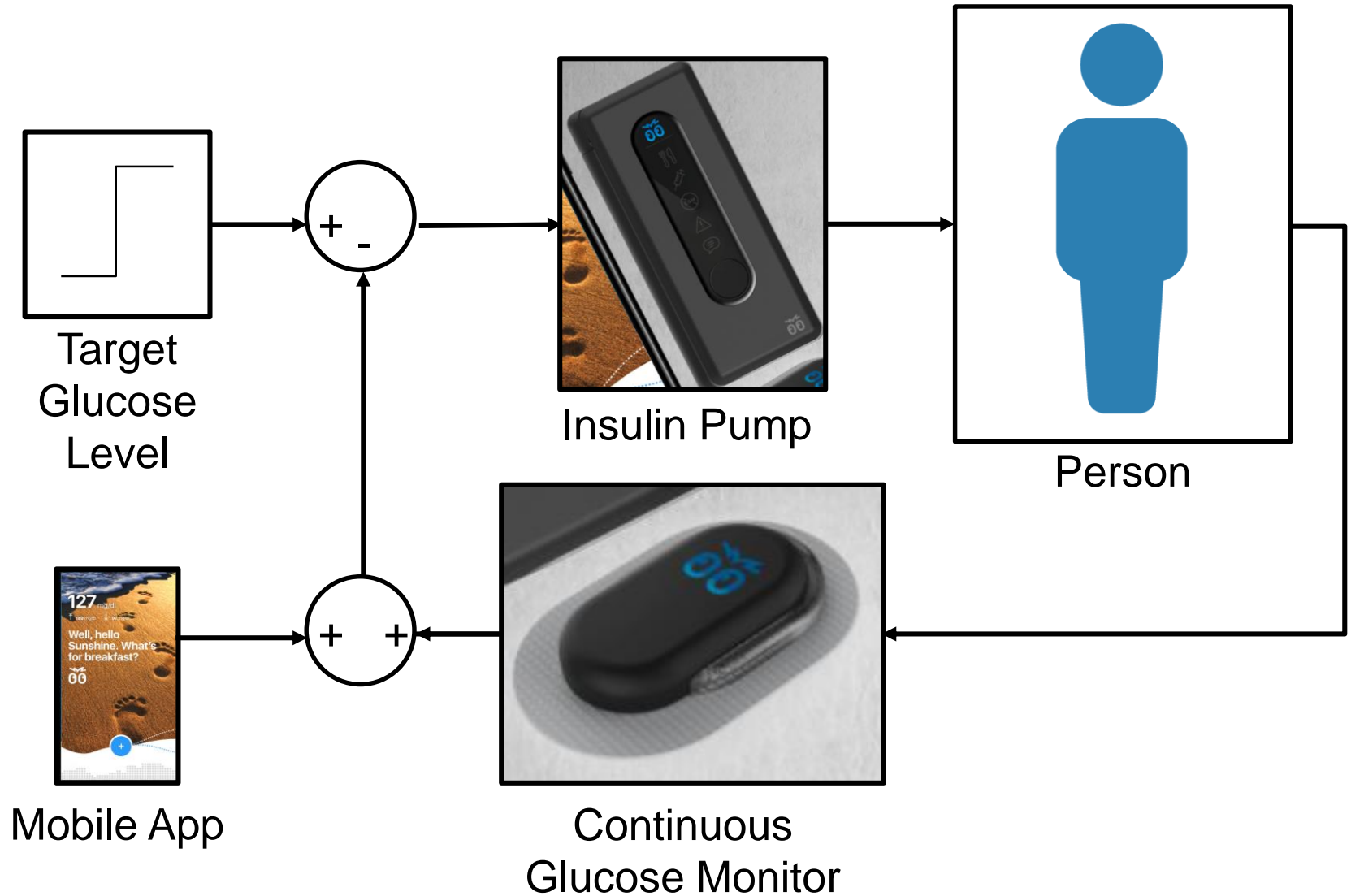
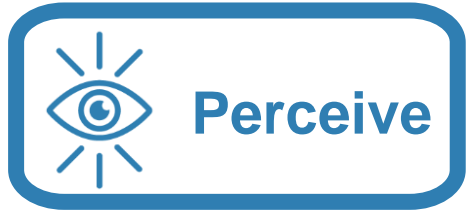
Autonomous Glucose Level Management

Bigfoot Biomedical



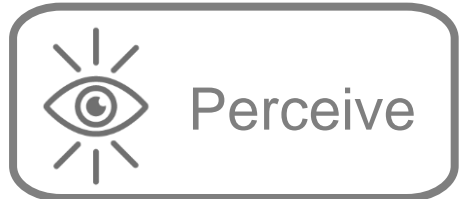
Autonomous Glucose Level Management

Bigfoot Biomedical

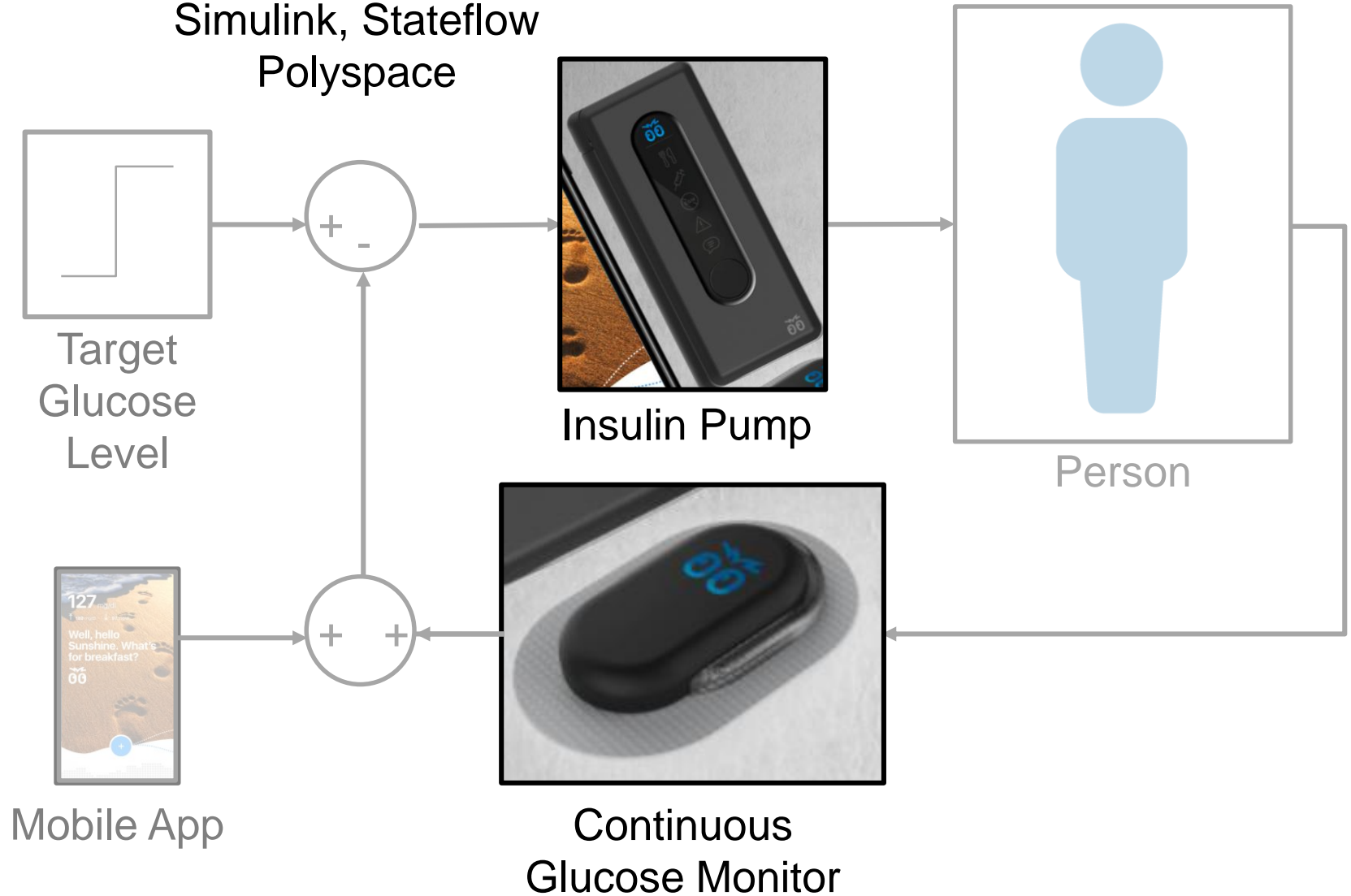


Autonomous Glucose Level Management

Bigfoot Biomedical

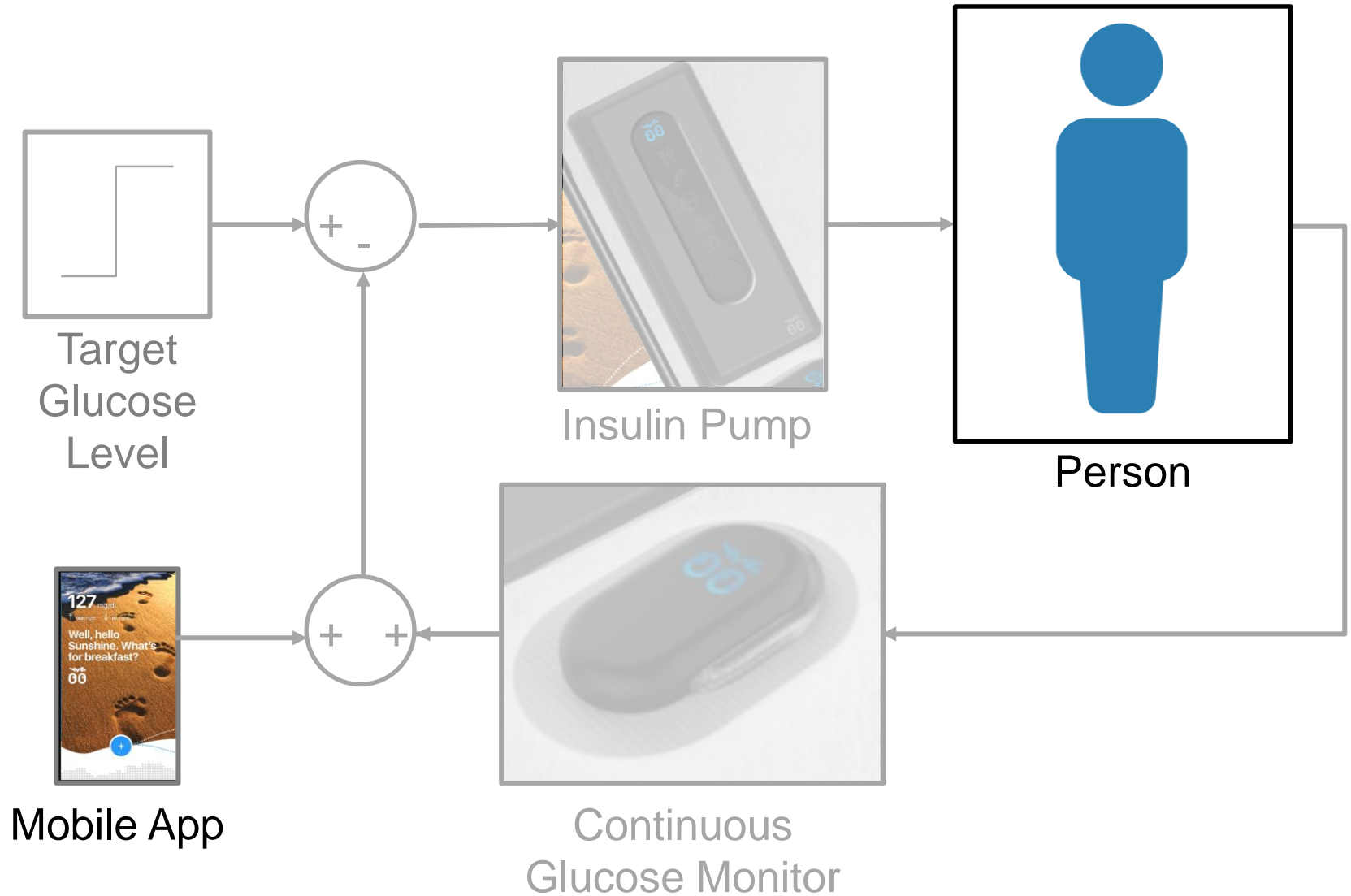
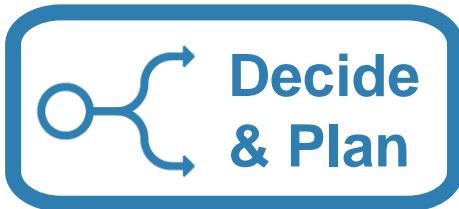
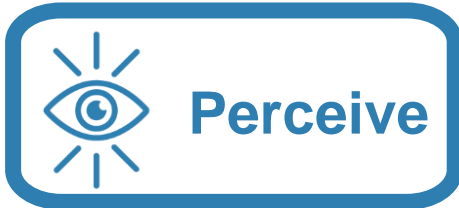


Virtual Lab
Simulink, Stateflow
Polyspace



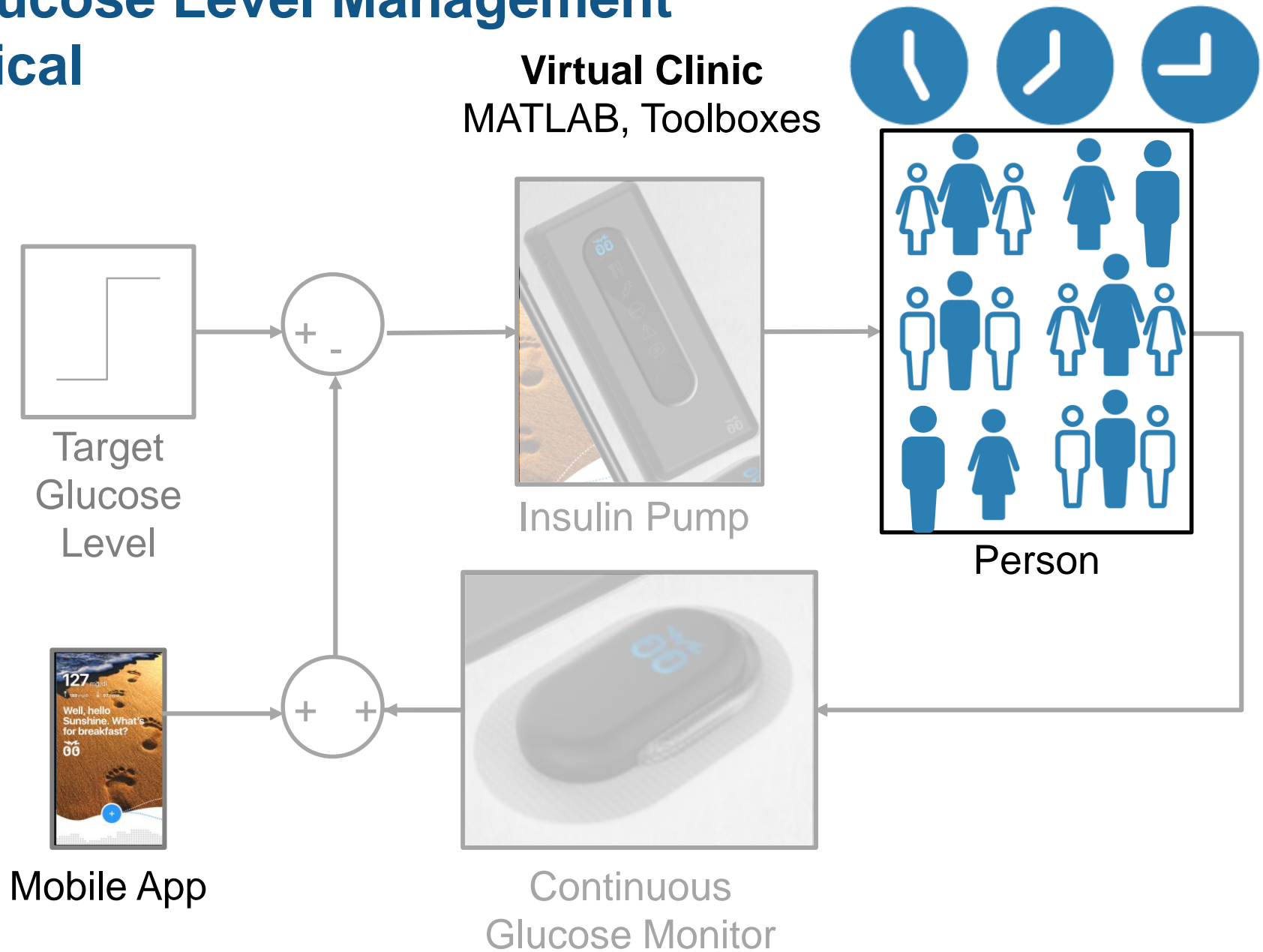
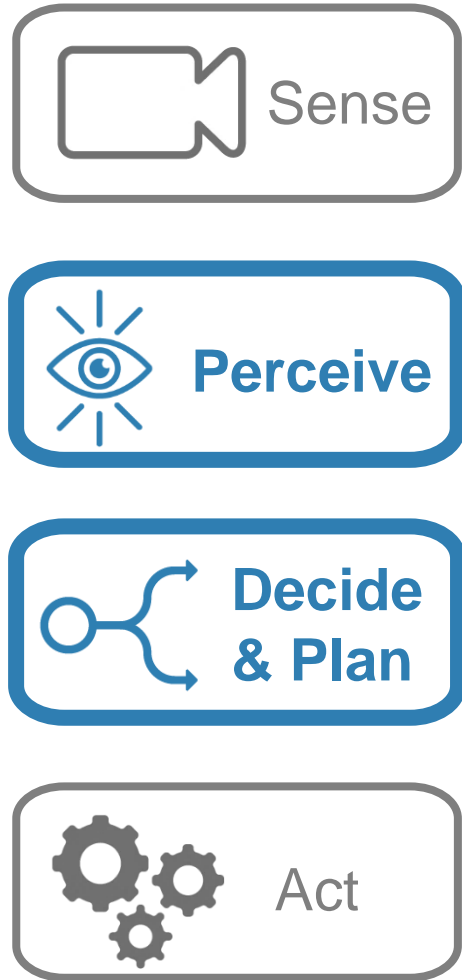
Autonomous Glucose Level Management

Bigfoot Biomedical



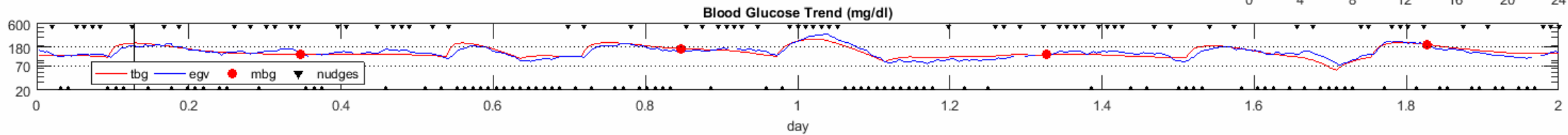
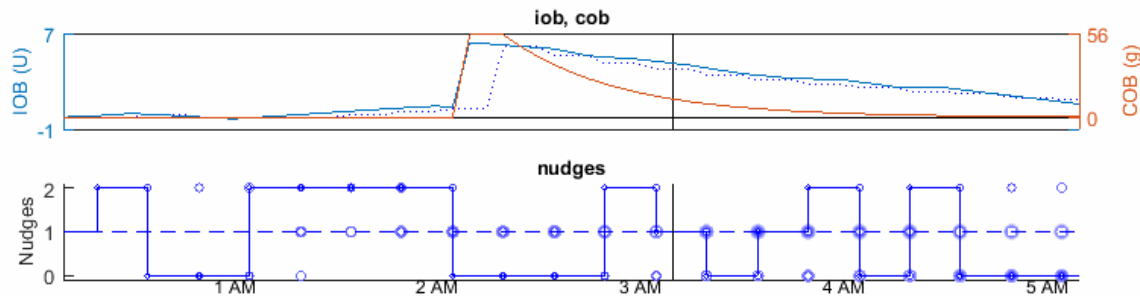
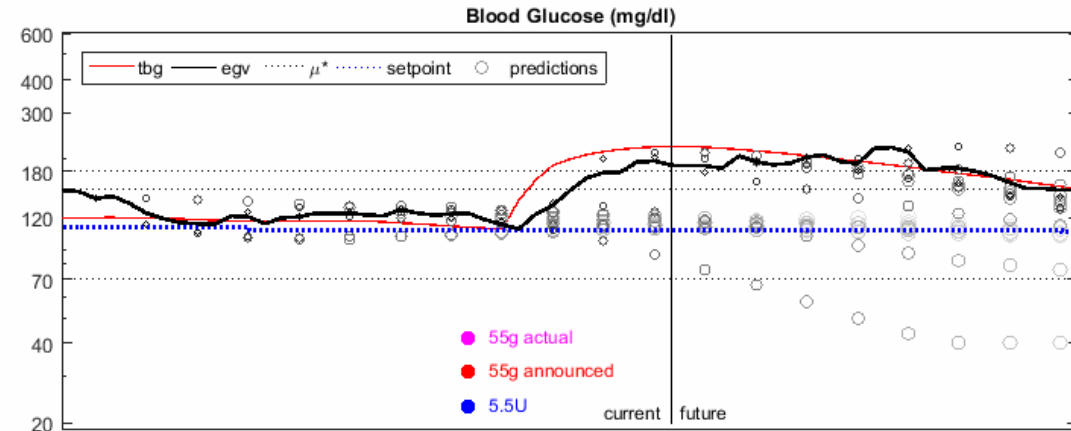
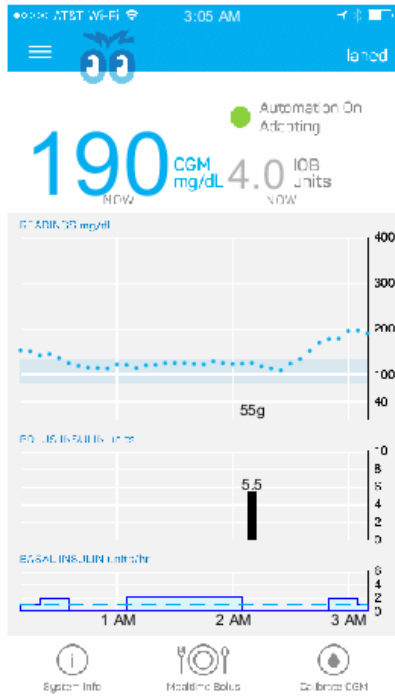
Autonomous Glucose Level Management

Bigfoot Biomedical



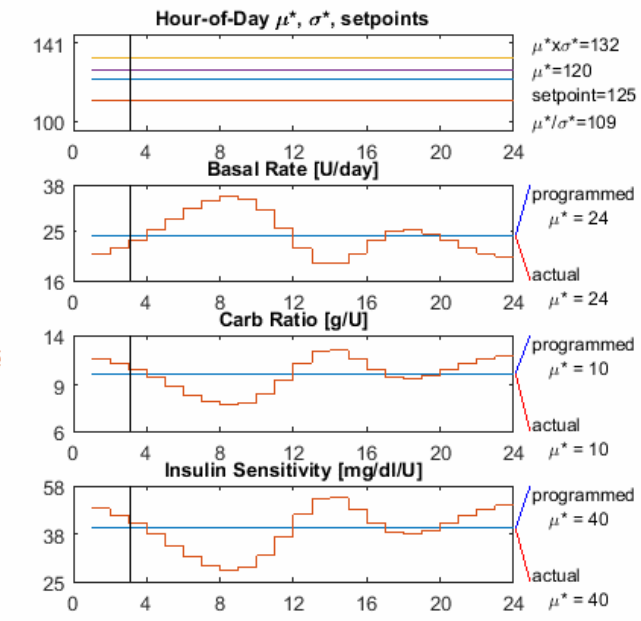
Virtual Clinic

Generating data through simulation



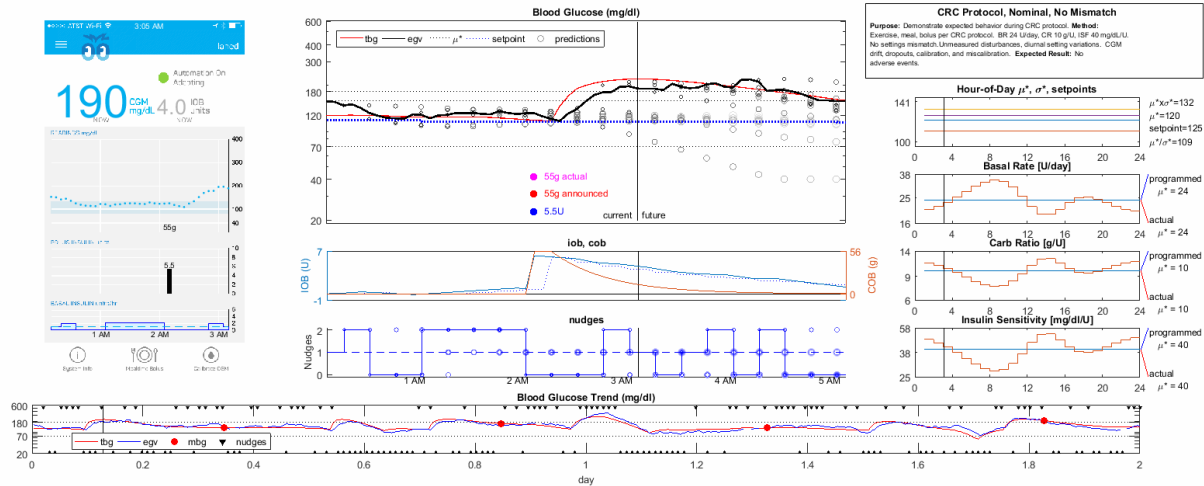
CRC Protocol, Nominal, No Mismatch

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.



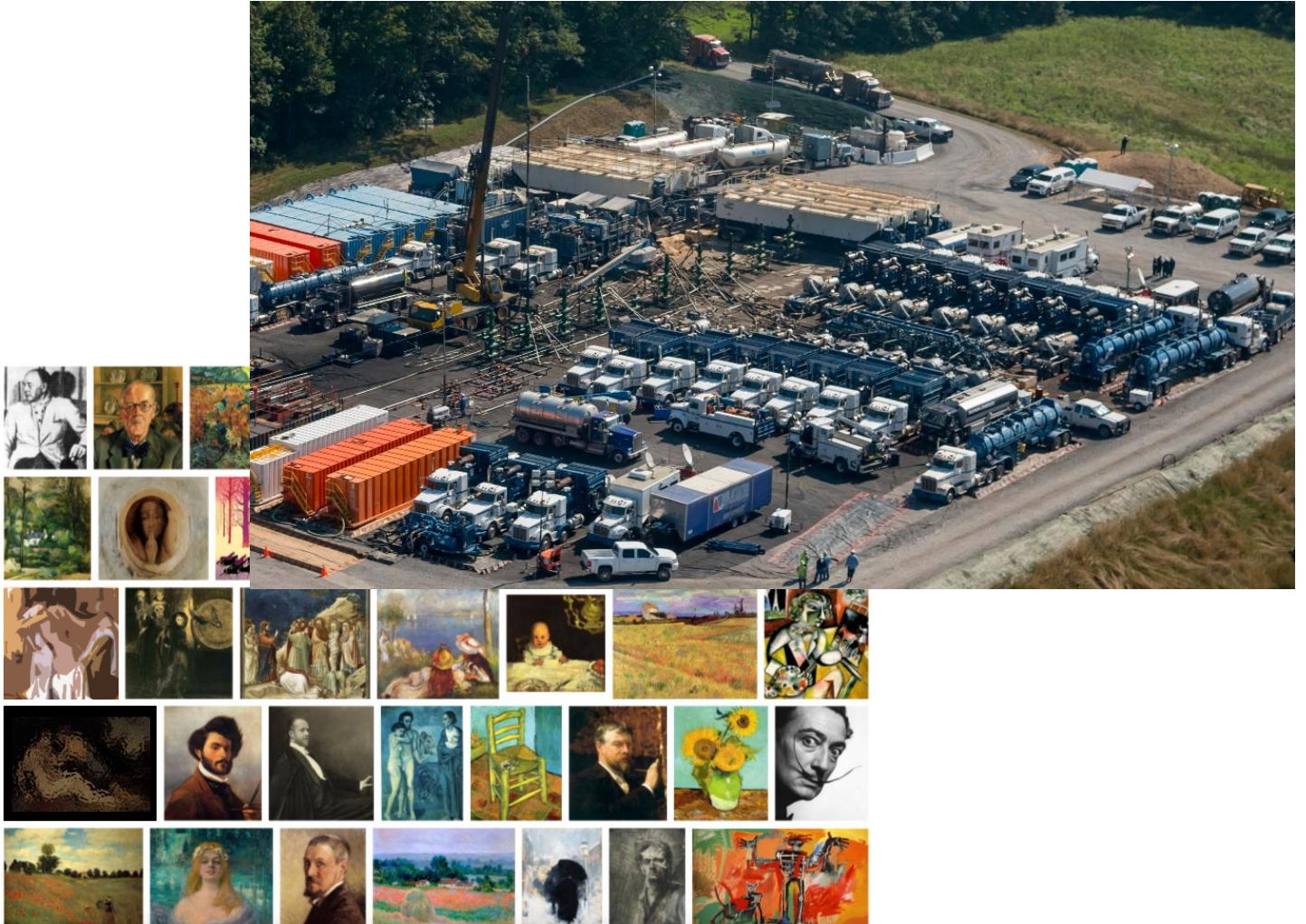
Virtual Clinic

Scaling computations to simulate 50 million patients a day



Where will you get your data?

- Simulation
- Public repositories
- In the lab
- In the field
- Internet of Things (IoT)



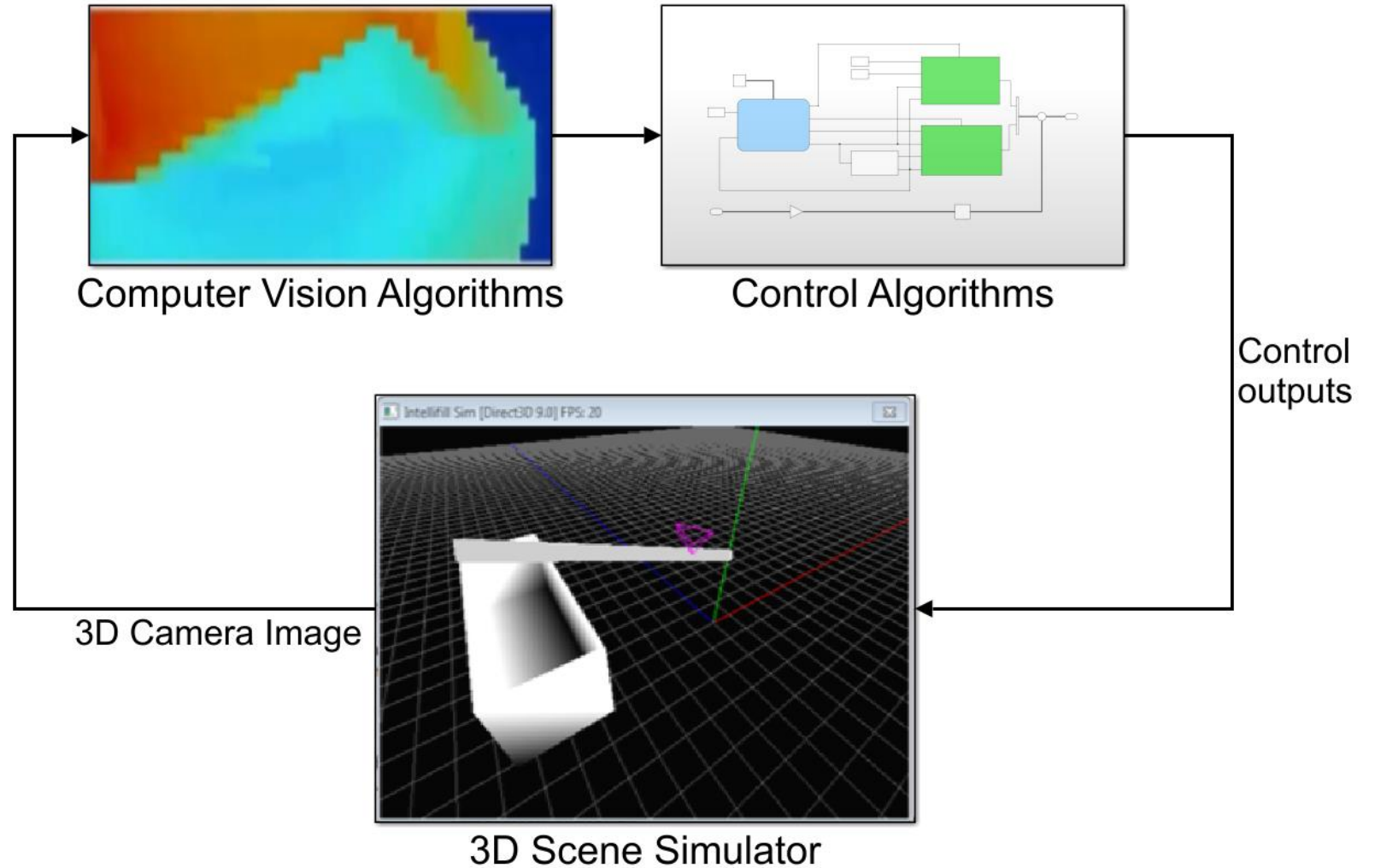


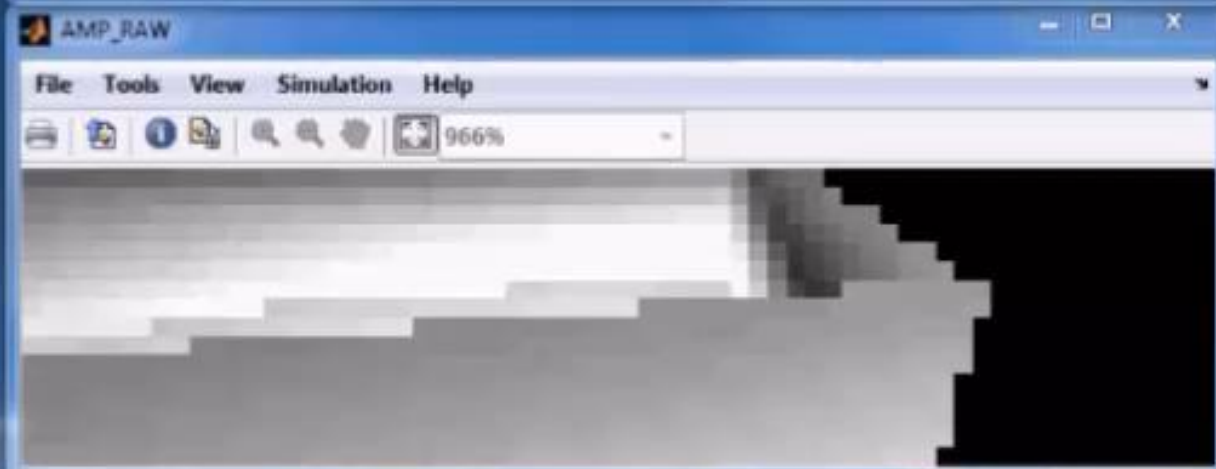
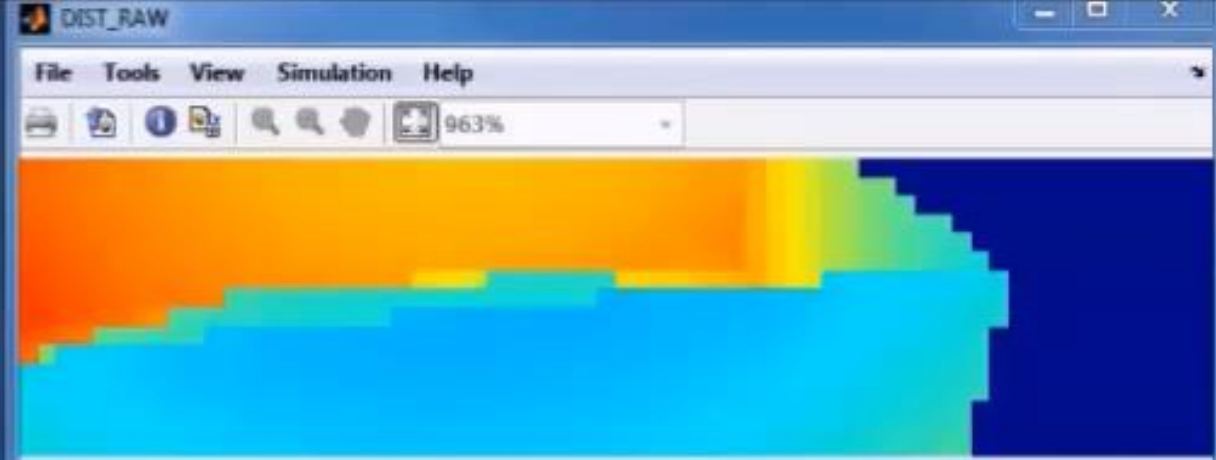
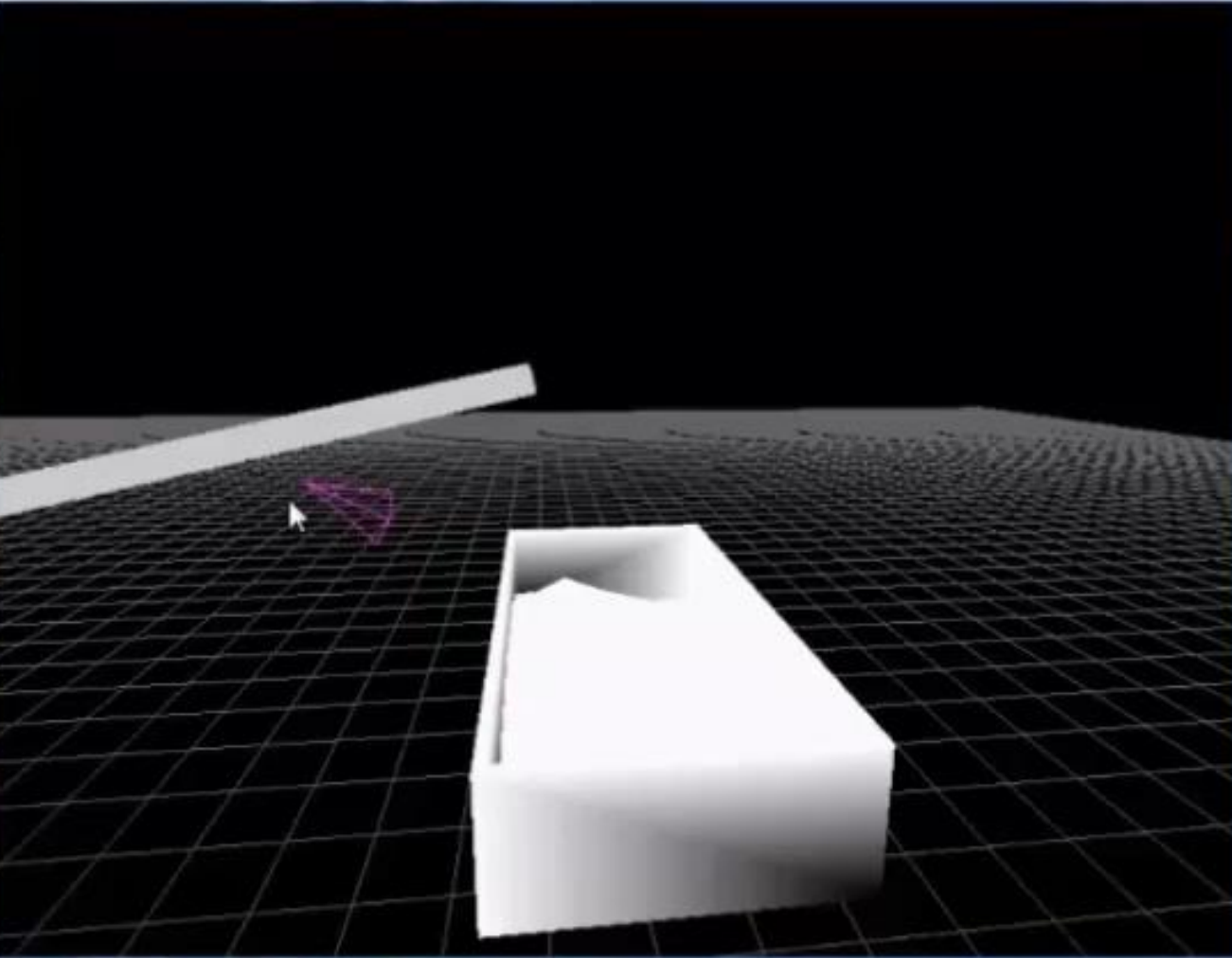


Autonomous Trailer Filling

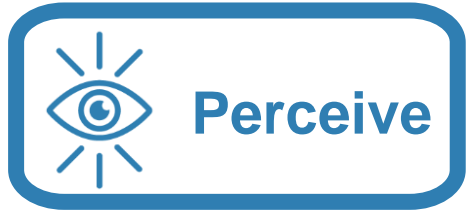


Autonomous Trailer Filling





Autonomous Trailer Filling



3D Camera



Computer vision and controls algorithms

Embedded Platform
MPC5121e



- User Input
- Visualization

CAN

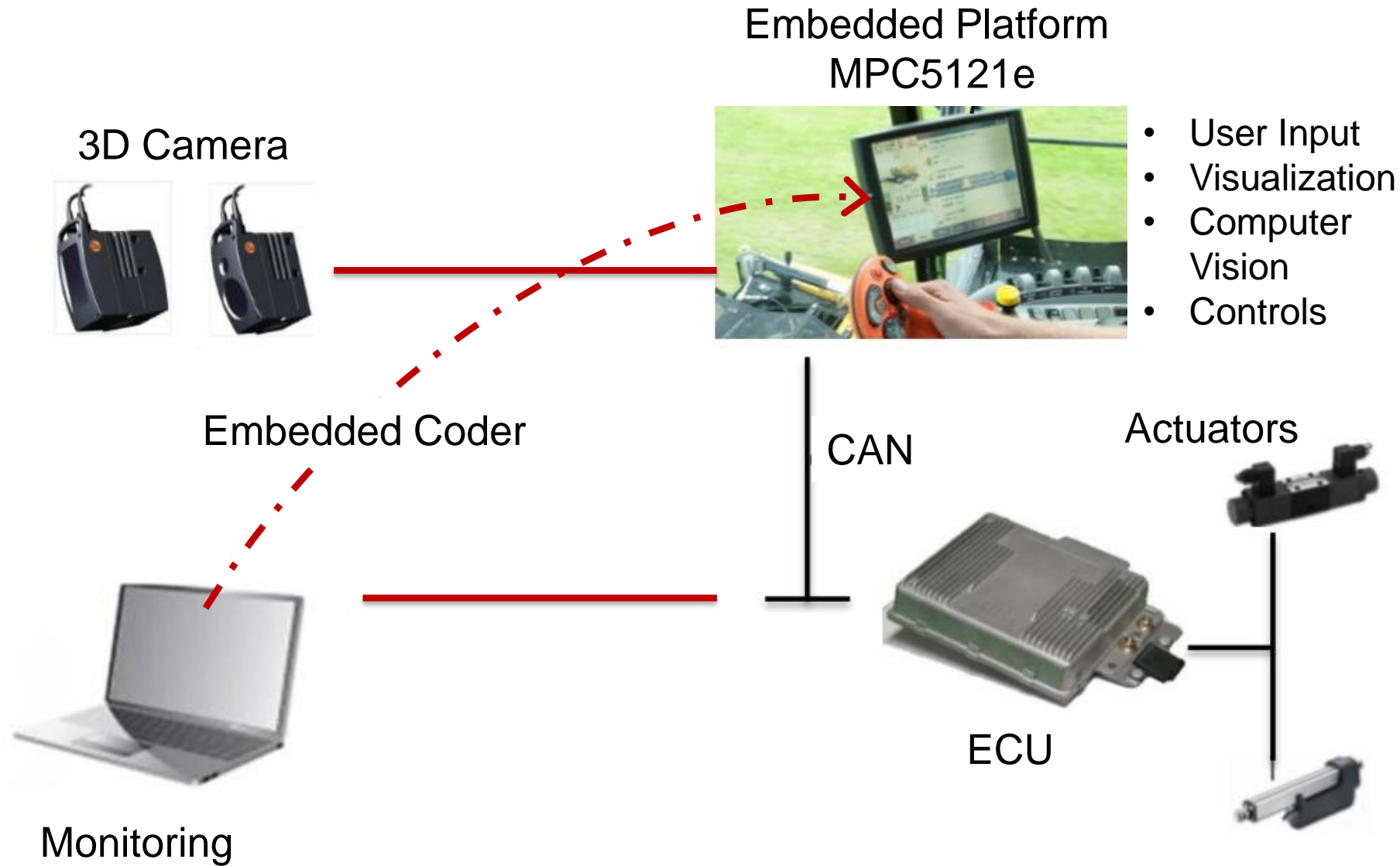
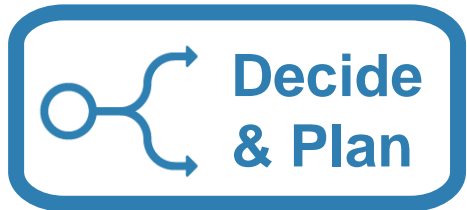
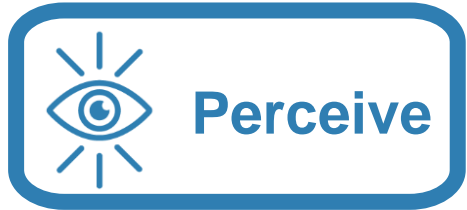
Actuators



ECU

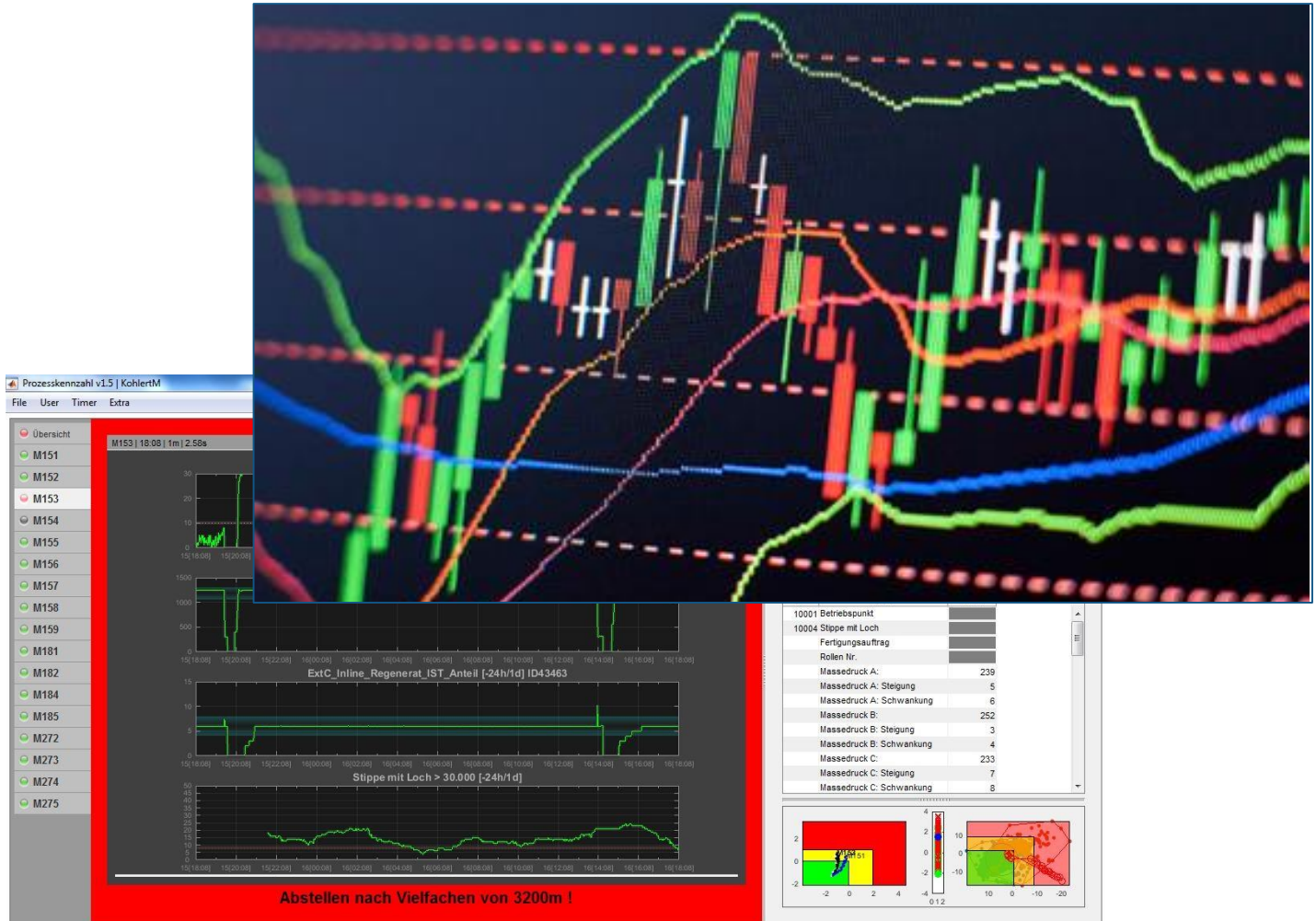


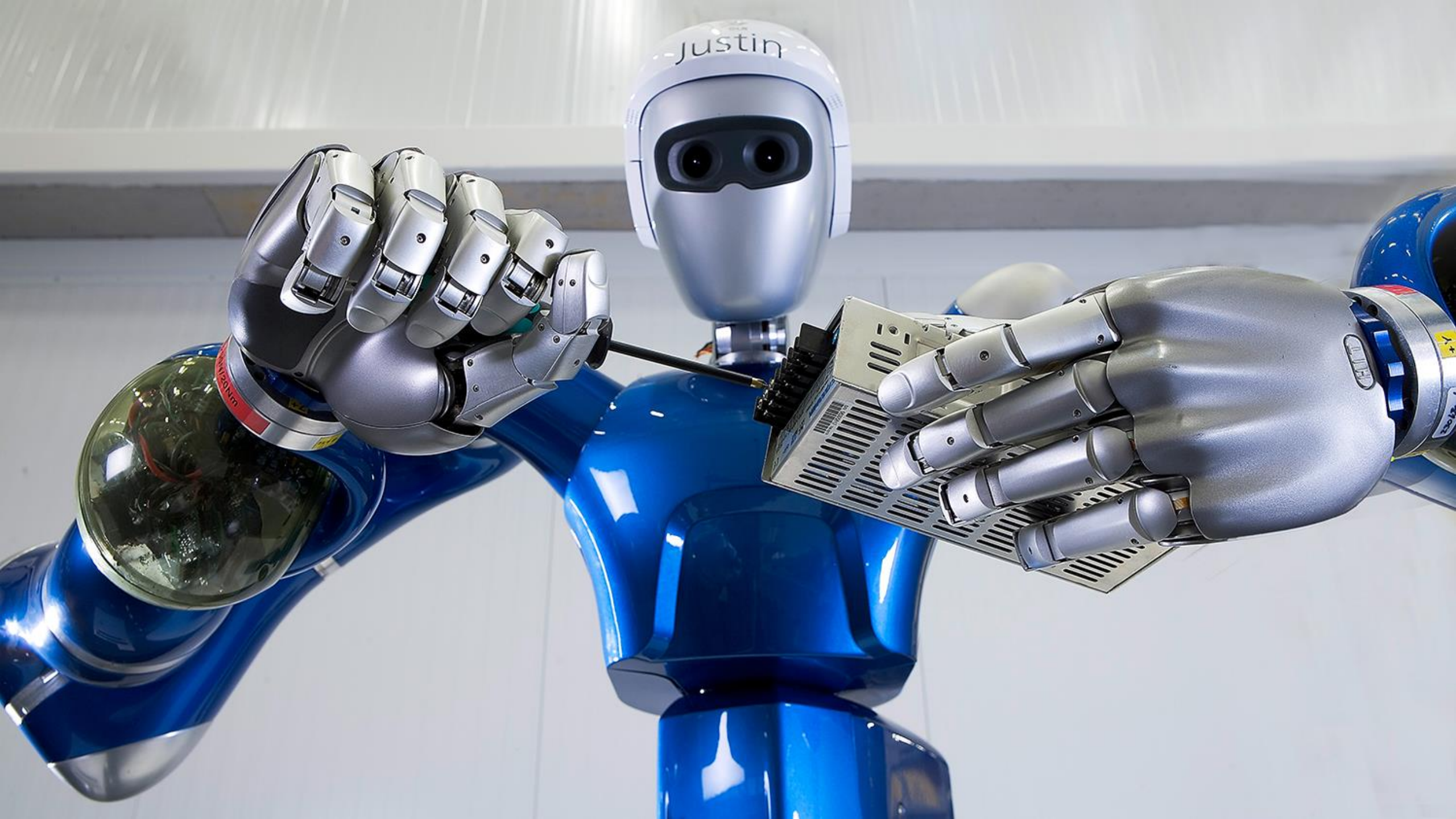
Autonomous Trailer Filling



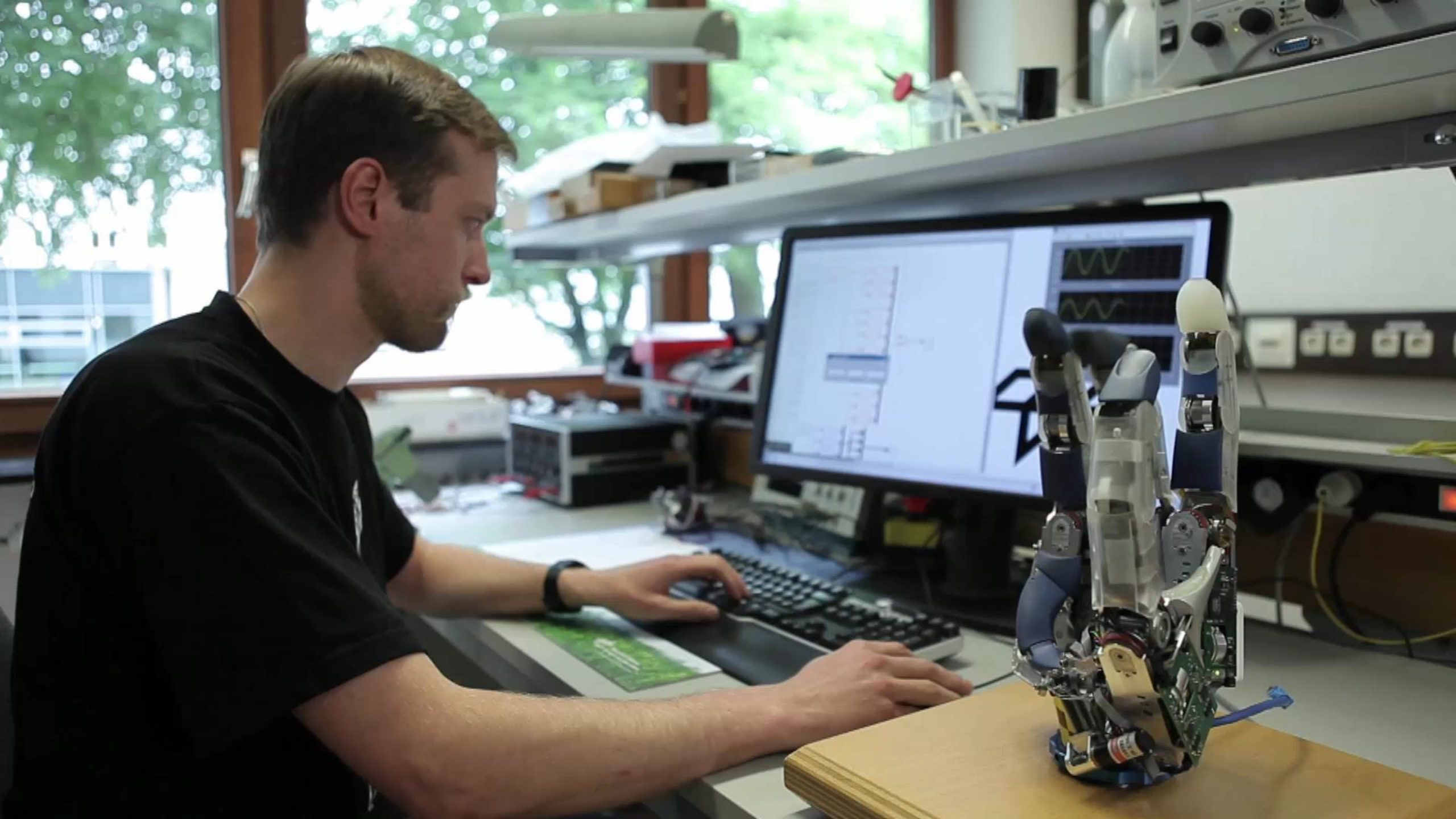
How will you put it into production?

- Embedded Systems
- IT Systems
- Desktop Apps









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
-

Flow to Production

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

What is *your*
autonomous anything?