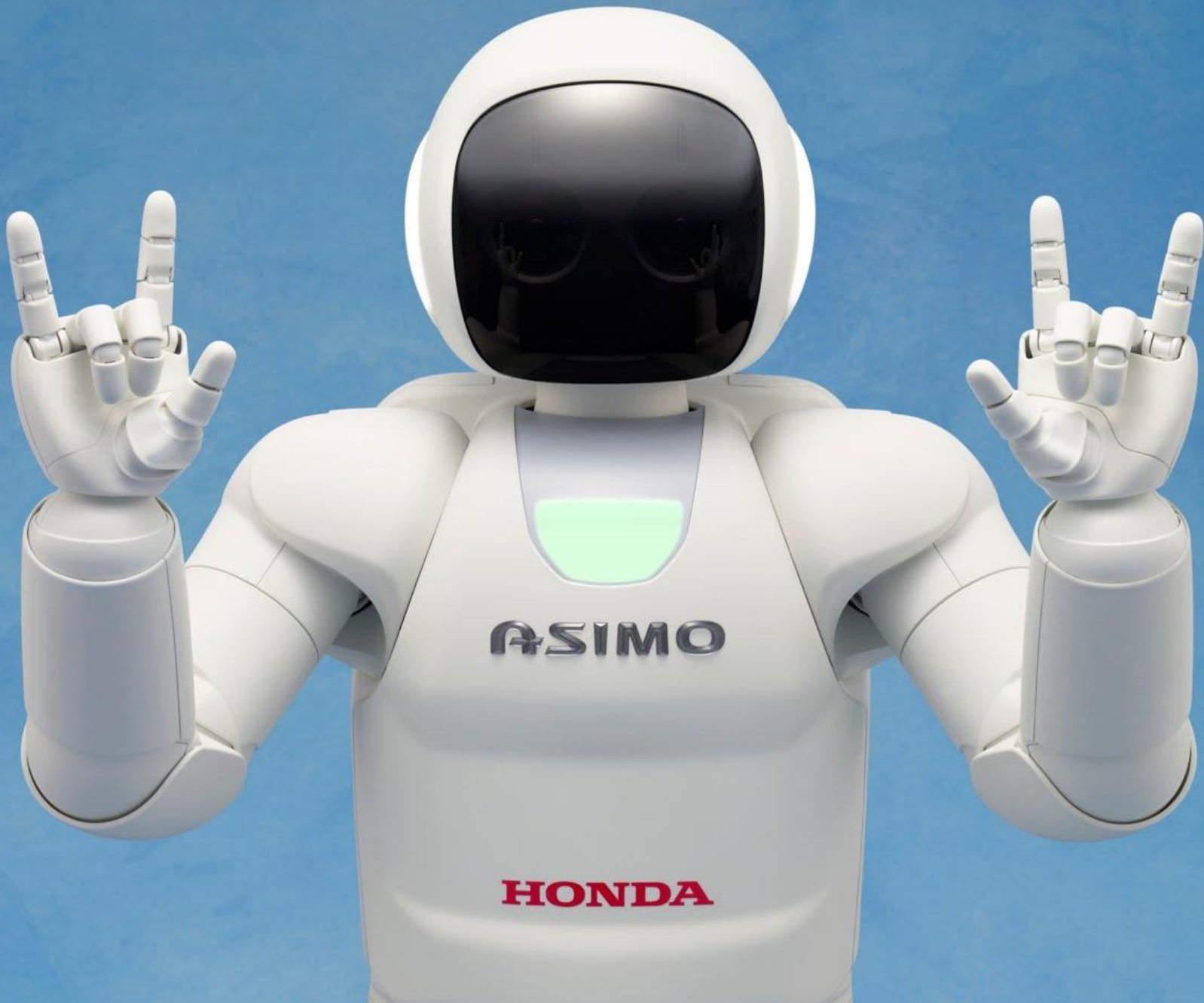


MATLAB EXPO 2017

How to build an **autonomous** anything

Jim Tung
jim@mathworks.com

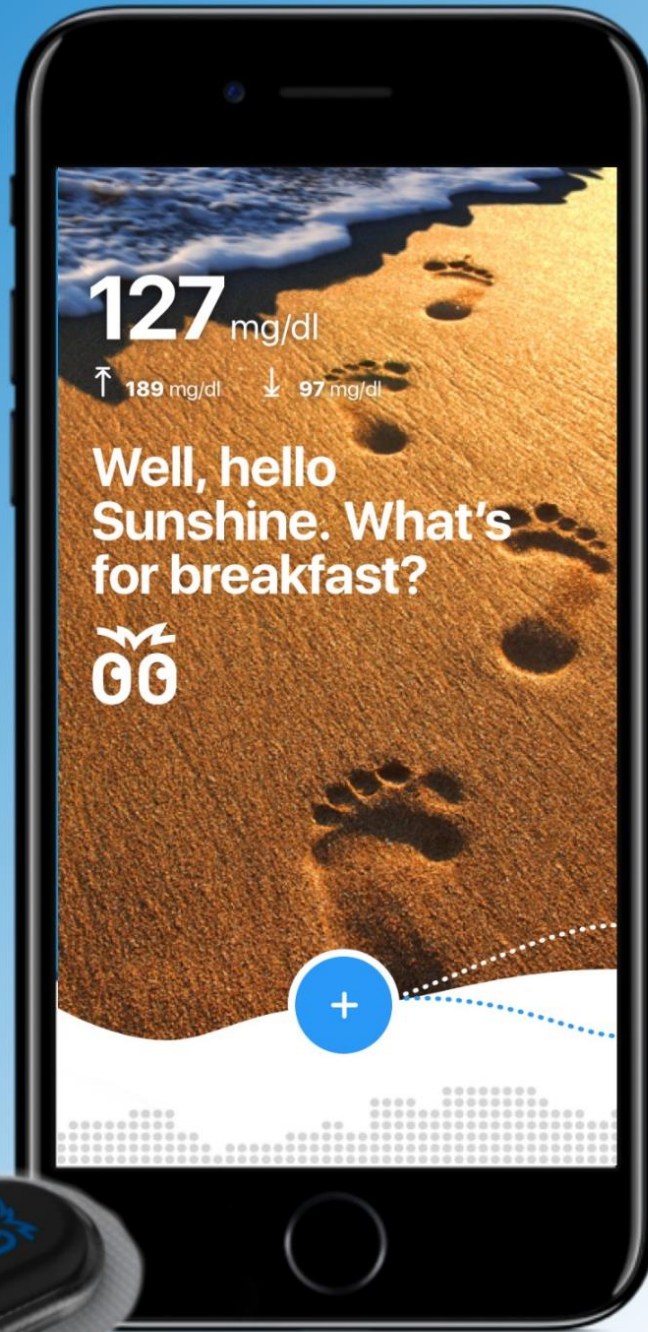












Autonomous Technology

Autonomy

Having the power for self-governance

Autonomous Technology

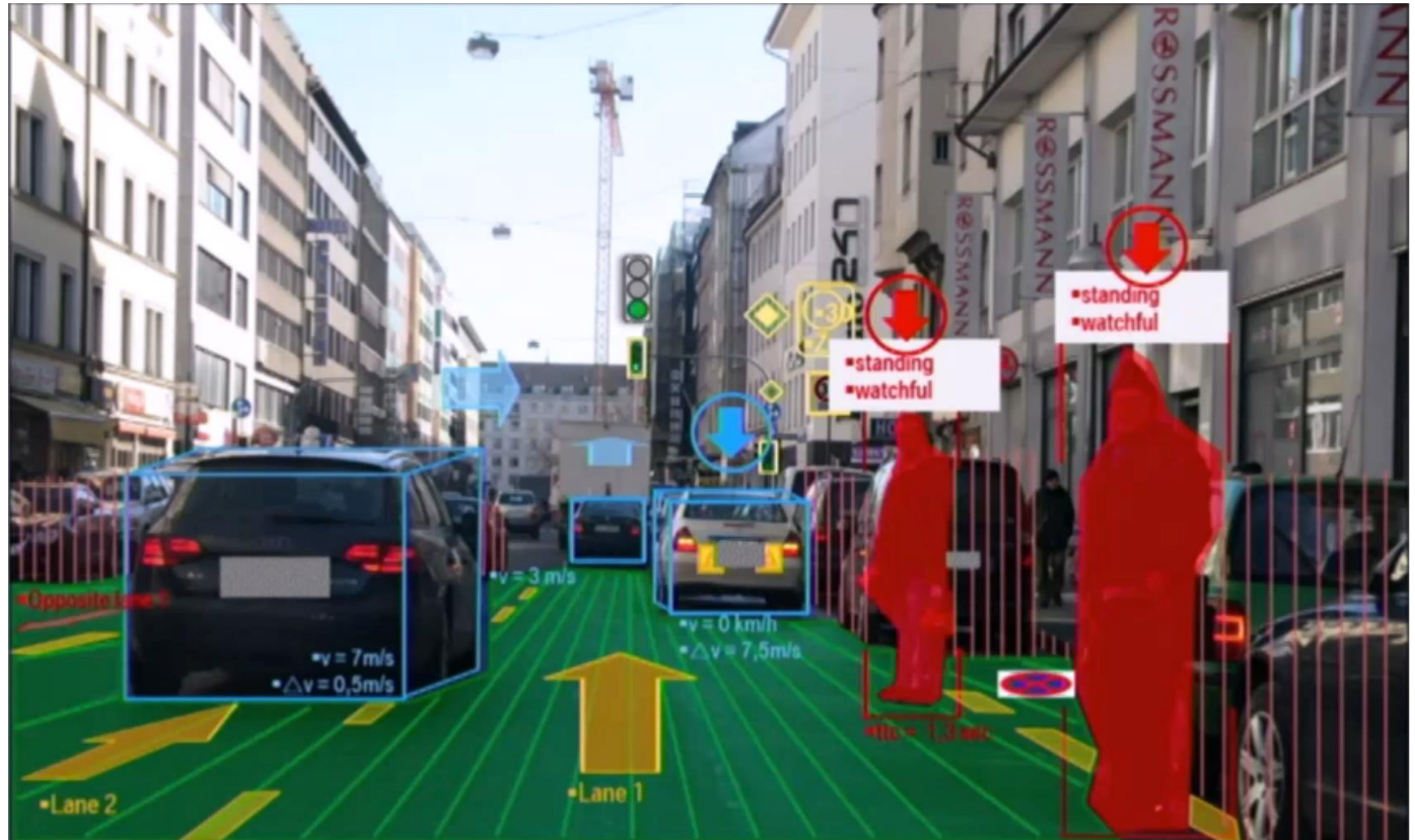
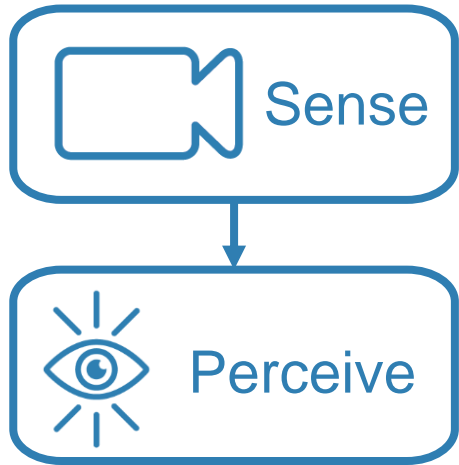
*Provides the ability of a system to act **independently** of direct human control under **unrehearsed** conditions*



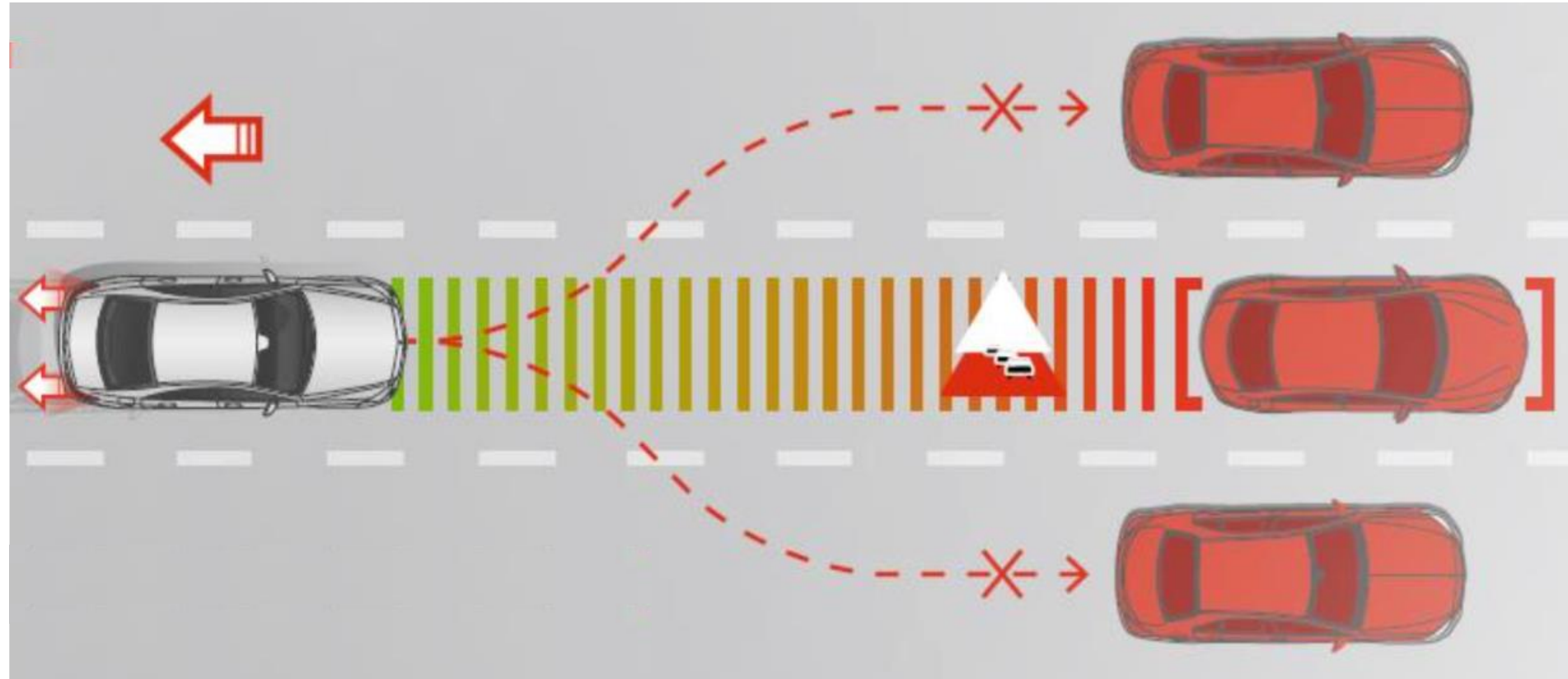
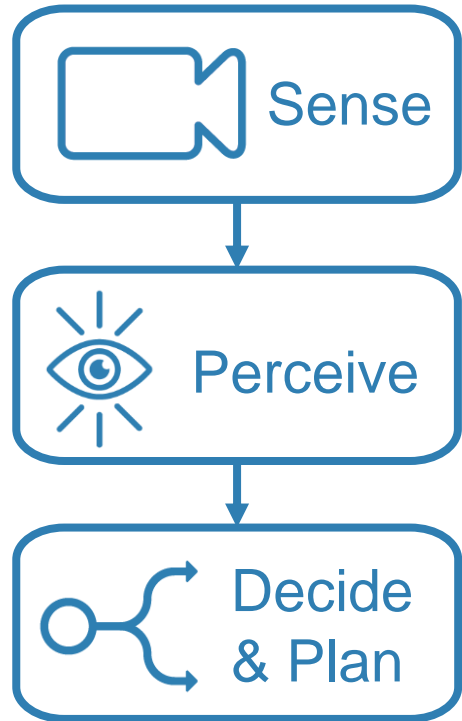
Capabilities of an Autonomous System



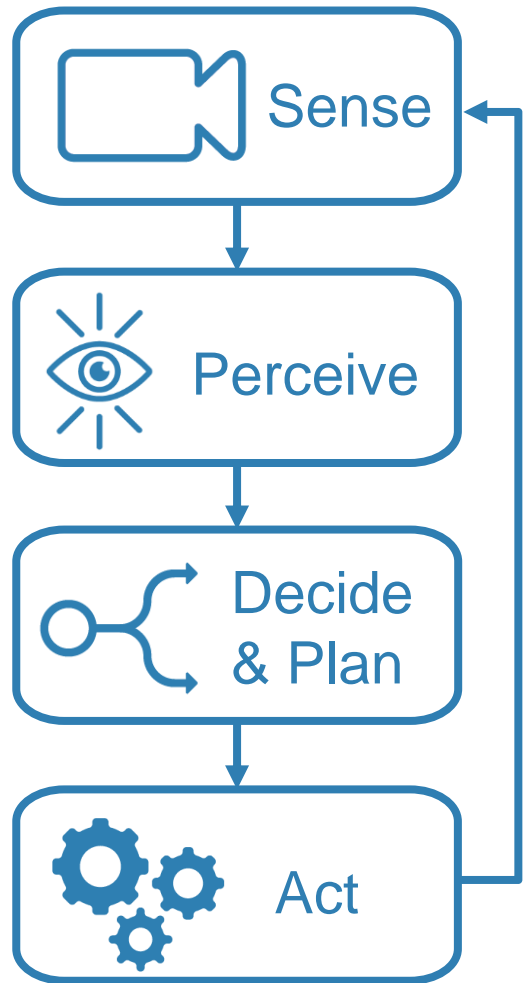
Capabilities of an Autonomous System



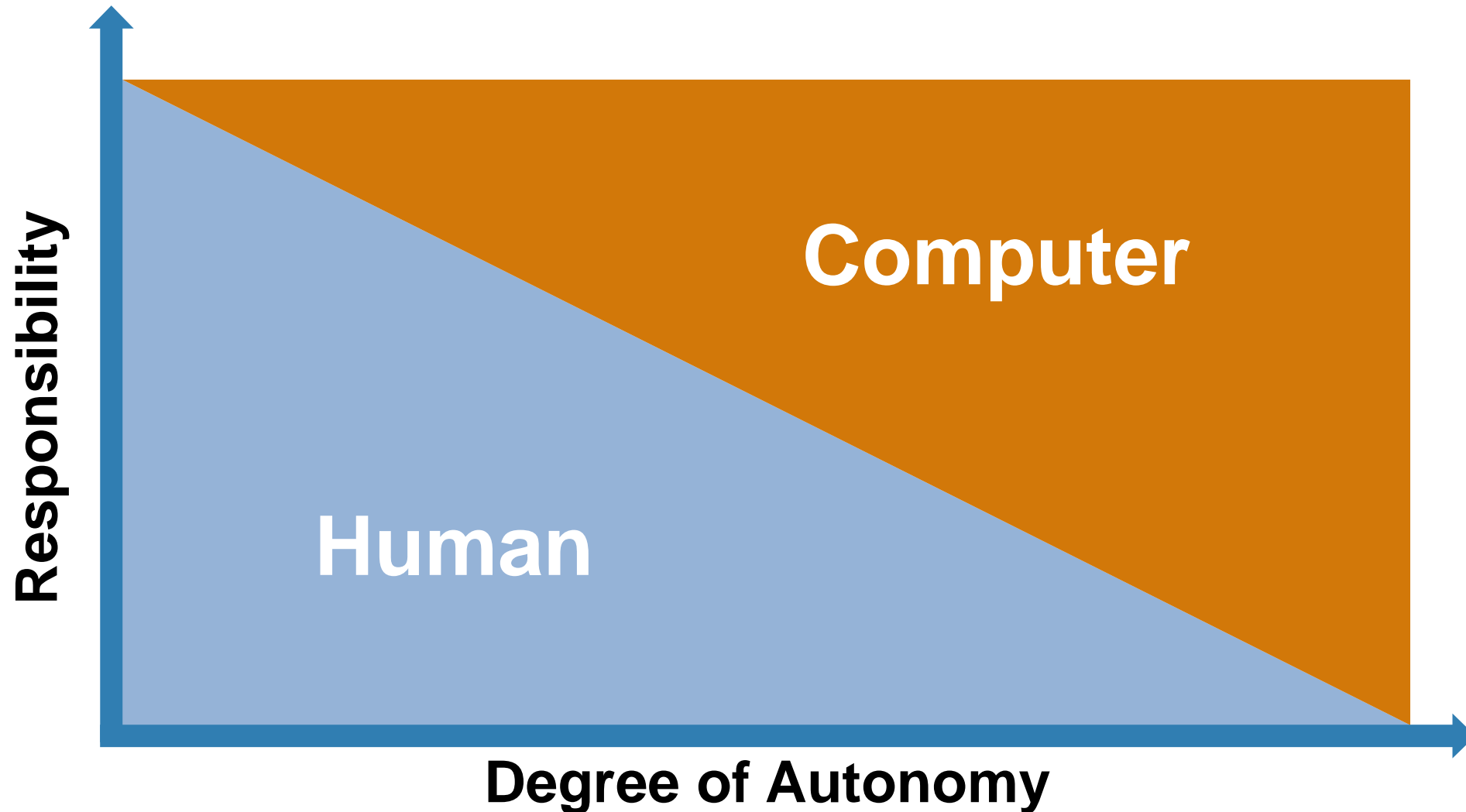
Capabilities of an Autonomous System

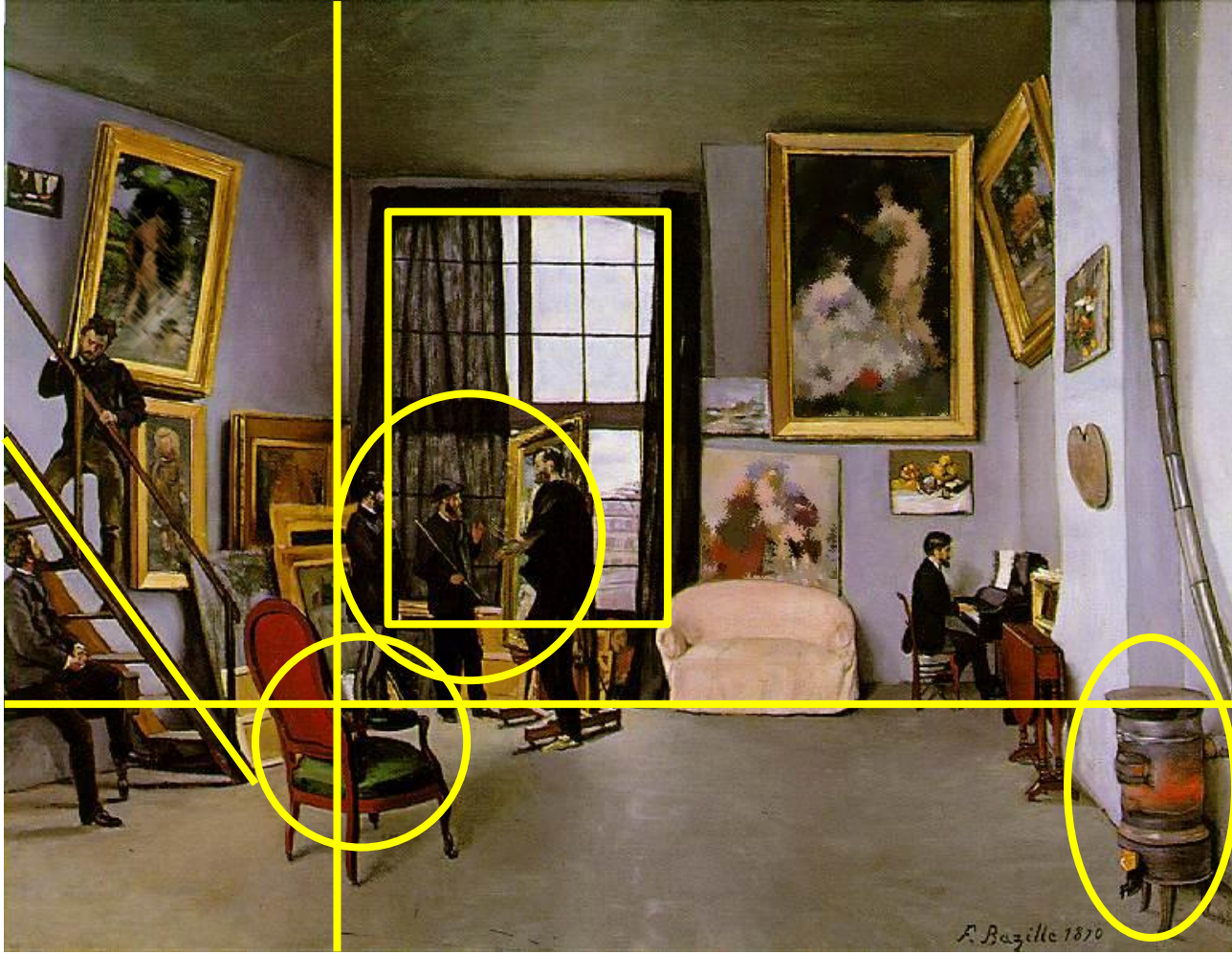


Capabilities of an Autonomous System

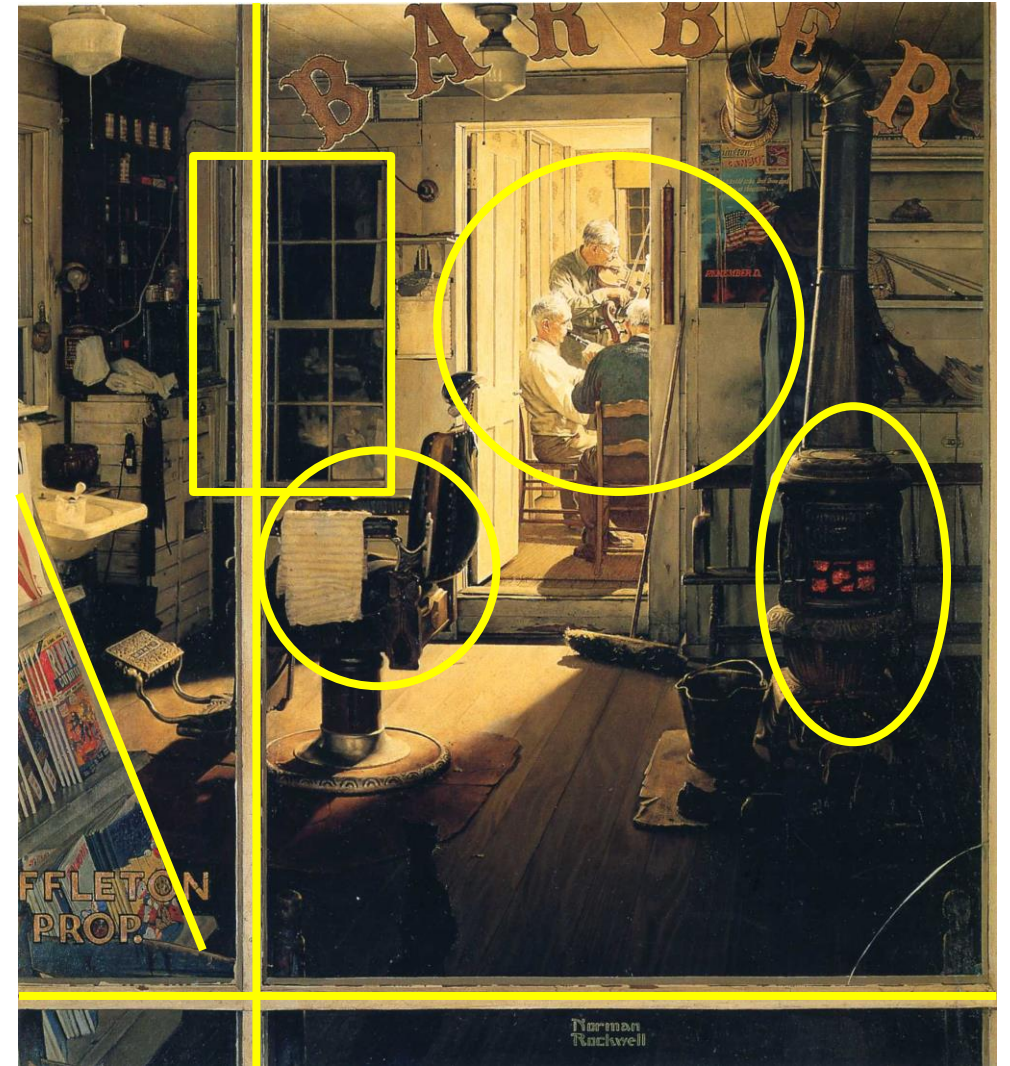


Autonomous Technology Transfers Responsibility to Computers

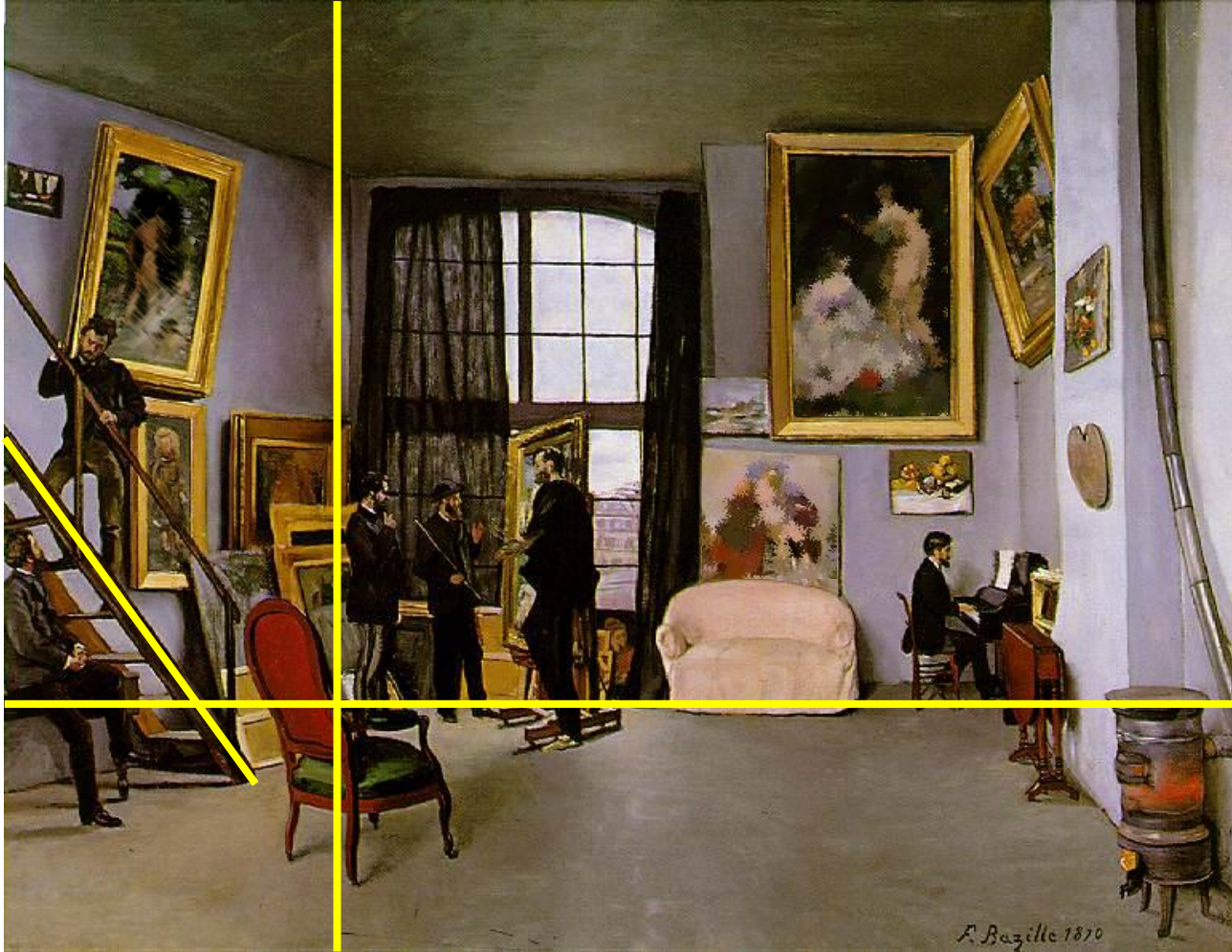




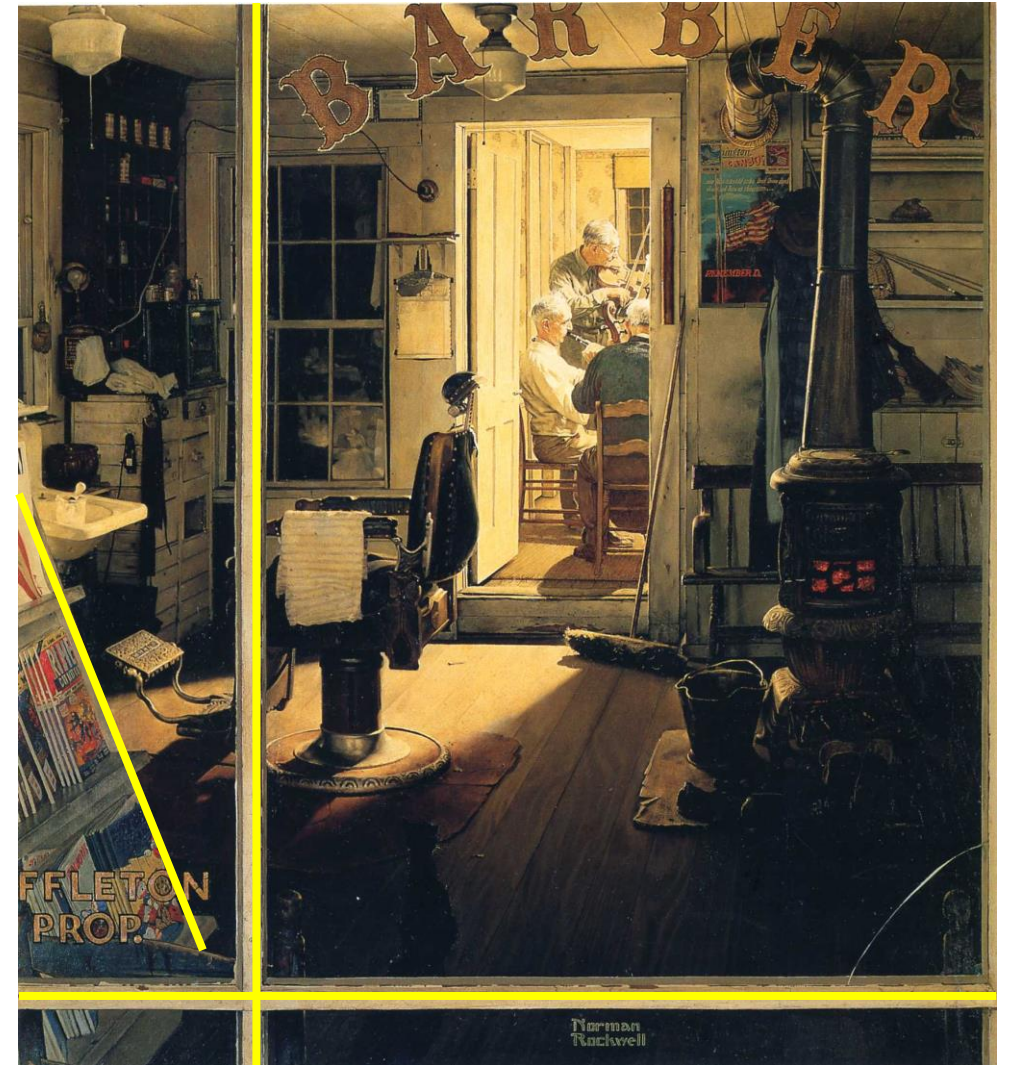
Bazille's Studio
 Frederic Bazille (Paris, 1870)



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

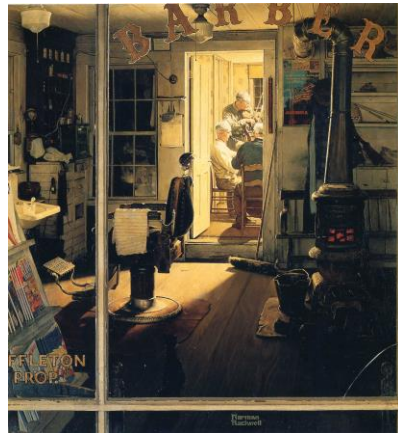
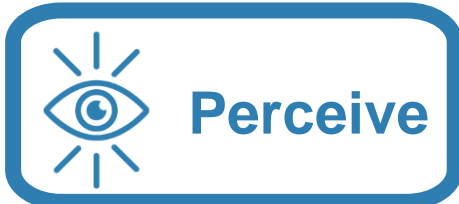
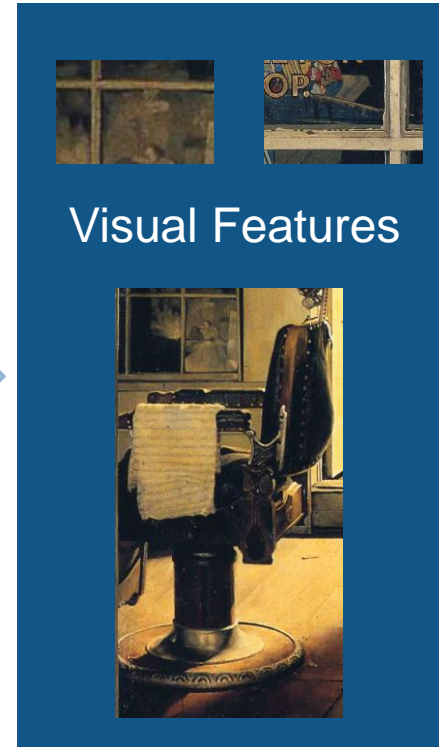


Image
Feature
Extraction



Machine
Learning
Classification



Style:
Regionalism



Genre:
Interior



Artist:
Rockwell

Where to add autonomy with perception?

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

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Introduction

- ▶ Even in this machine era, manual inspection of products (products like sea food, grains, products at end of line etc.) in processing industries is widely practiced
- ▶ Large variance in appearance within a class and small inter class variance make the automation of visual quality inspection complex, thereby demanding manual inspection

Where to add autonomy with perception?

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

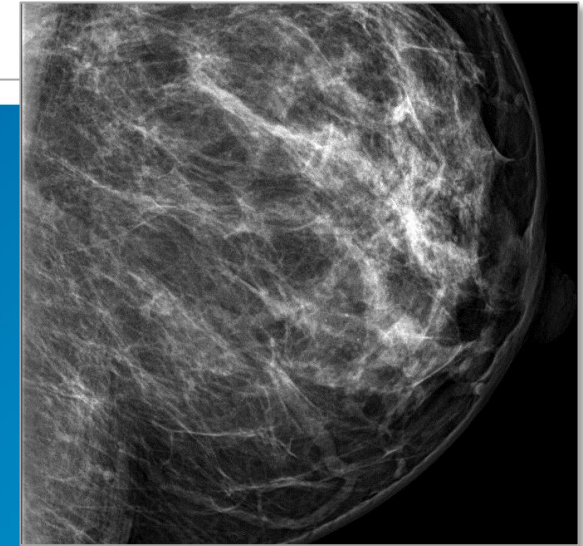
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Spectral Imaging:
Breast Density Measurement
Using Matlab Coder

Abha Ramesh Chandra
Sr. Technical Specialist
Philips India Limited, Bangalore
January 15, 2017

innovation  you

PHILIPS



Cost of rig: >\$1M
Repair cost: \$100,000
Cost of valve: \$200



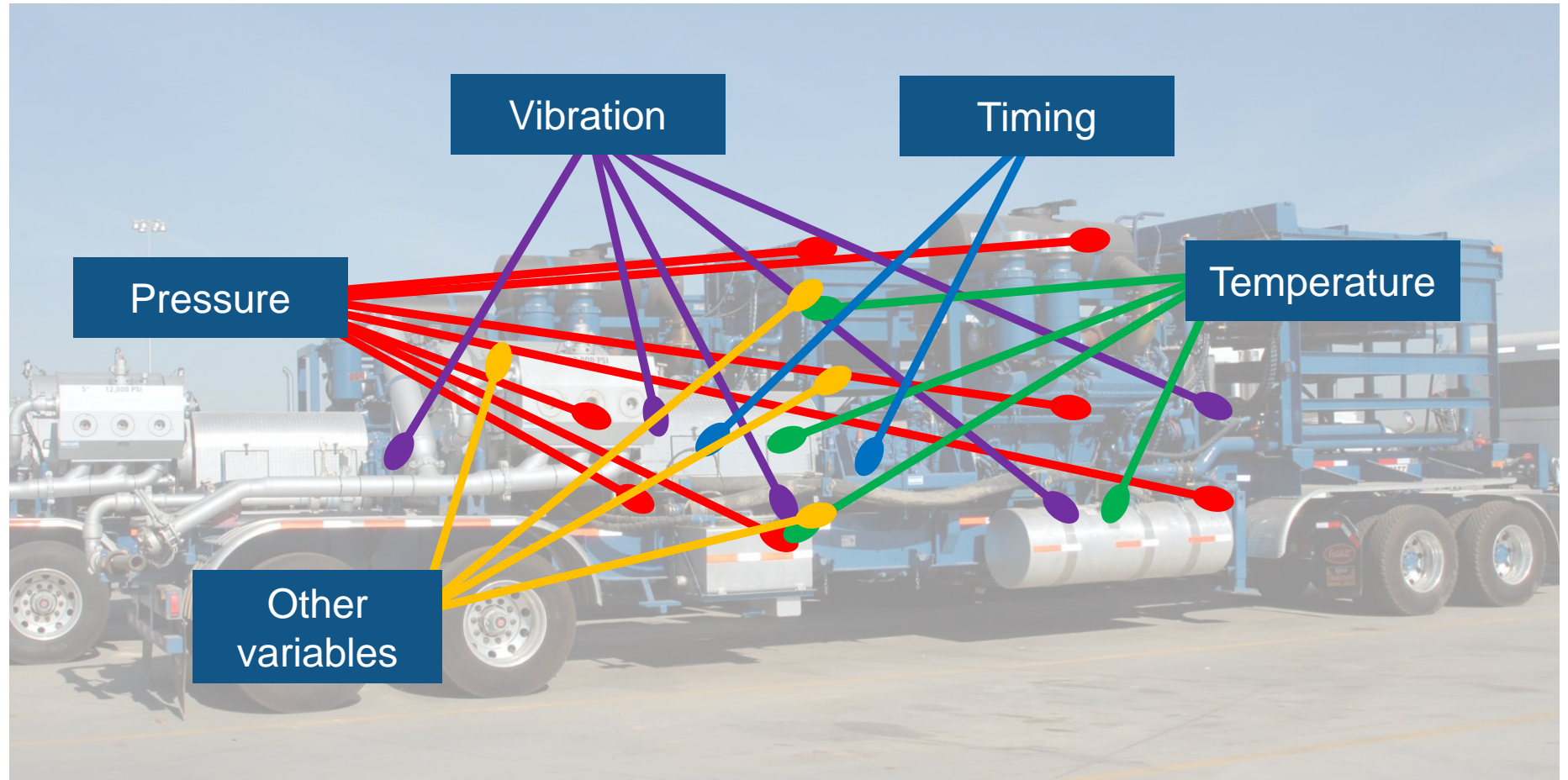
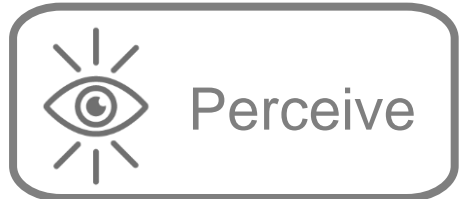




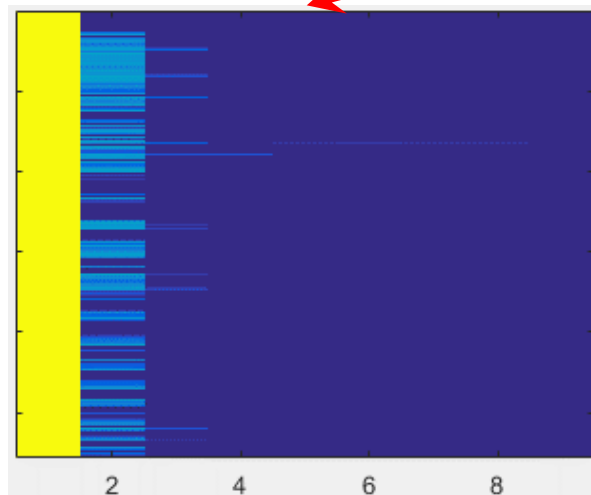
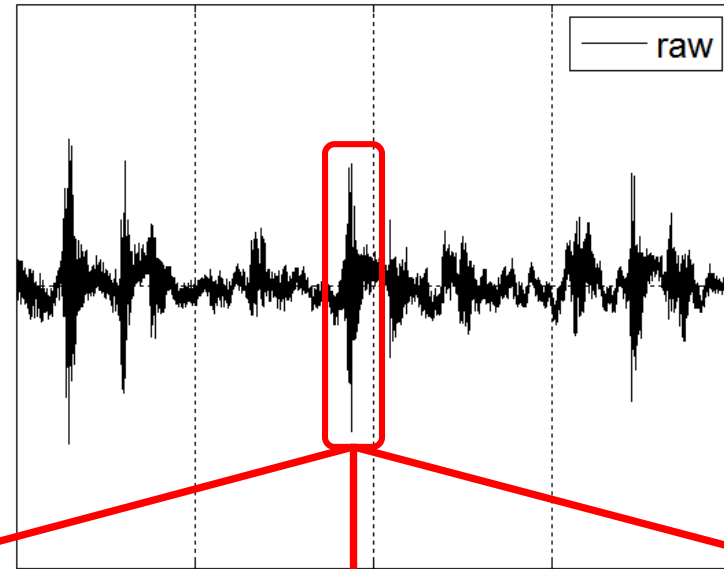
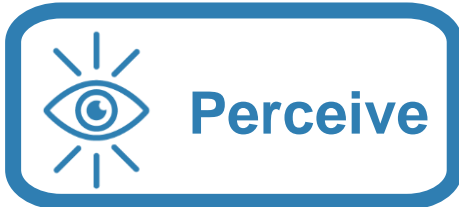


Autonomous Service for Predictive Maintenance

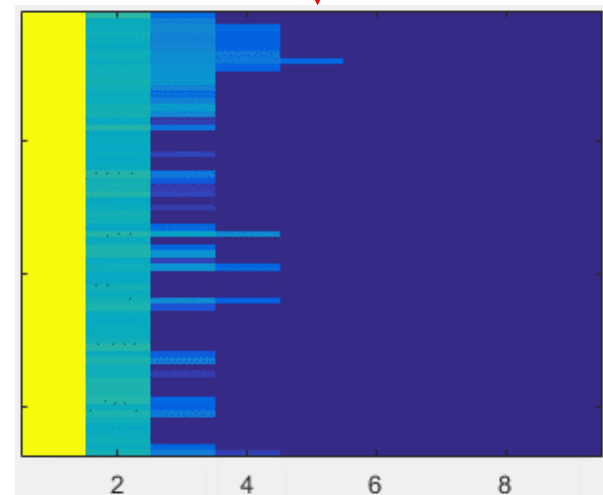
Which sensor values should they use?



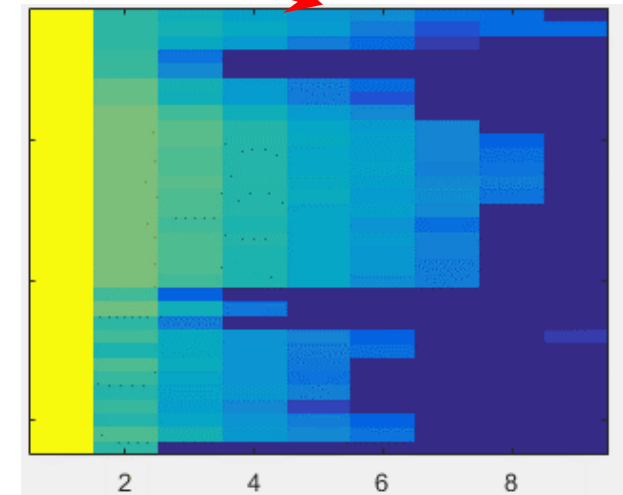
Autonomous Service for Predictive Maintenance



Normal Operation



Monitor Closely

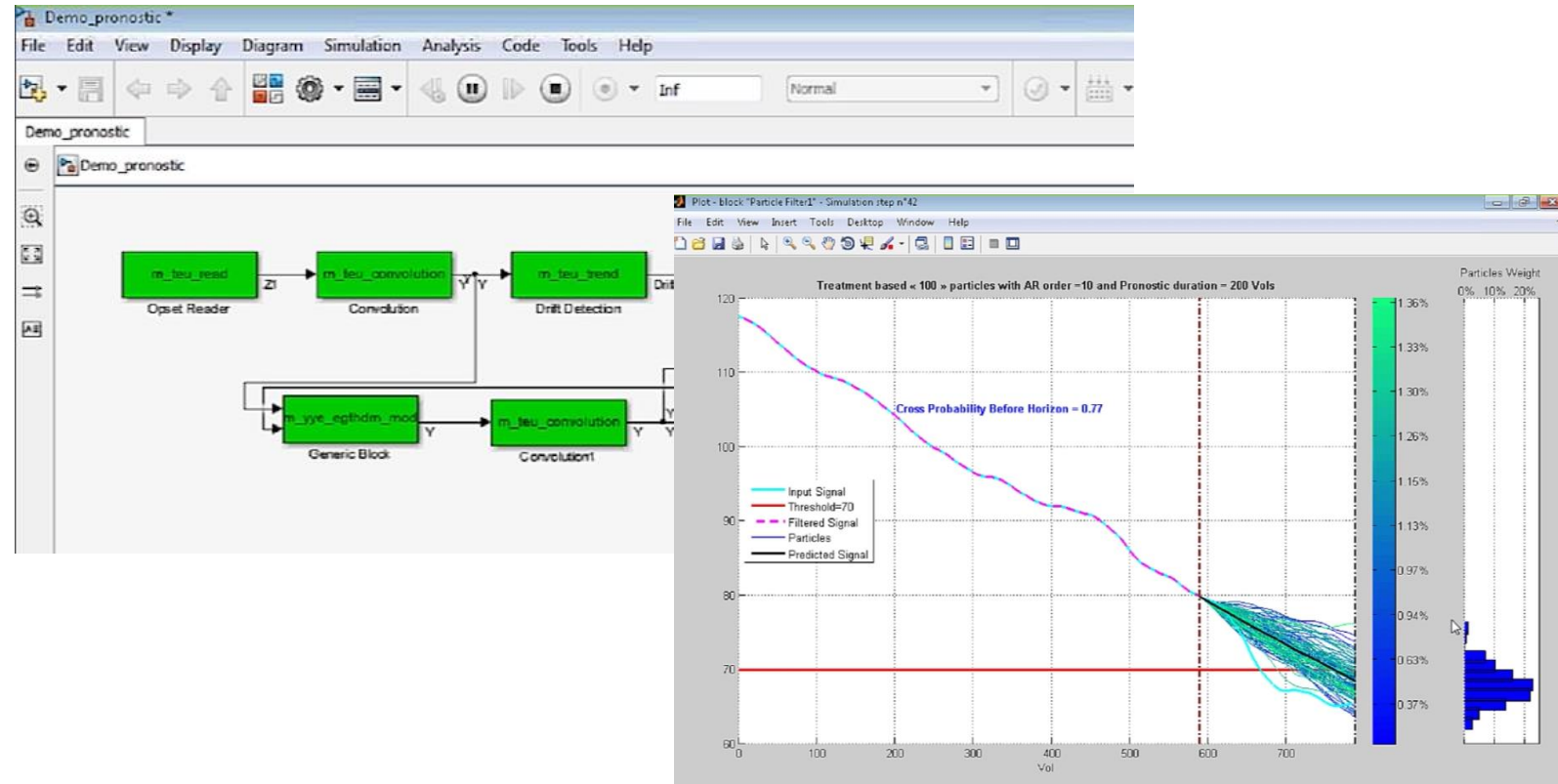


Maintenance Needed

What are the best predictors?

- Data-driven
- Model-driven

Jet Engine Monitoring

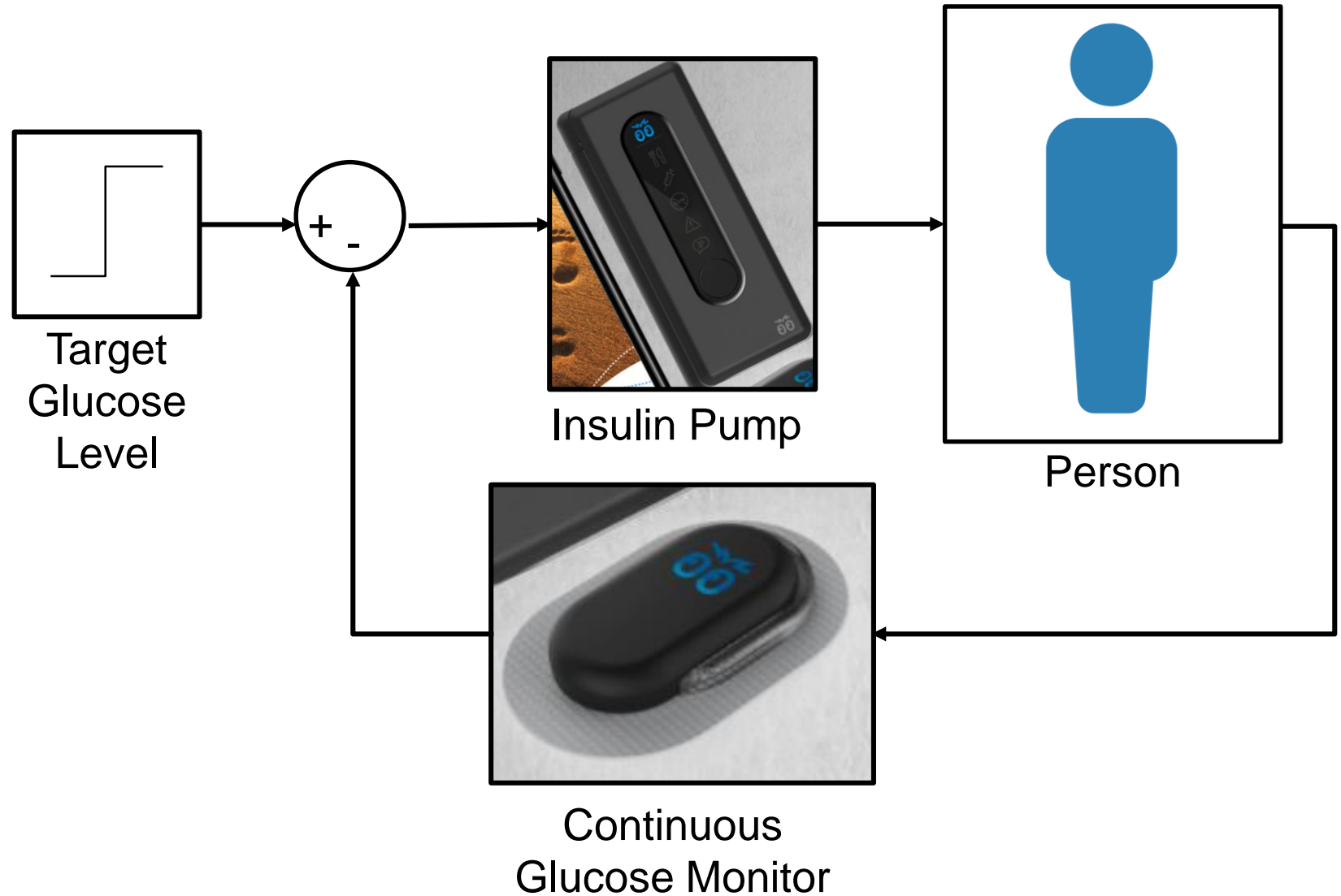
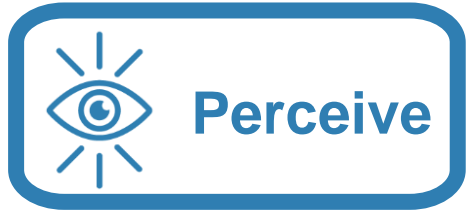


Autonomous Glucose Level Management



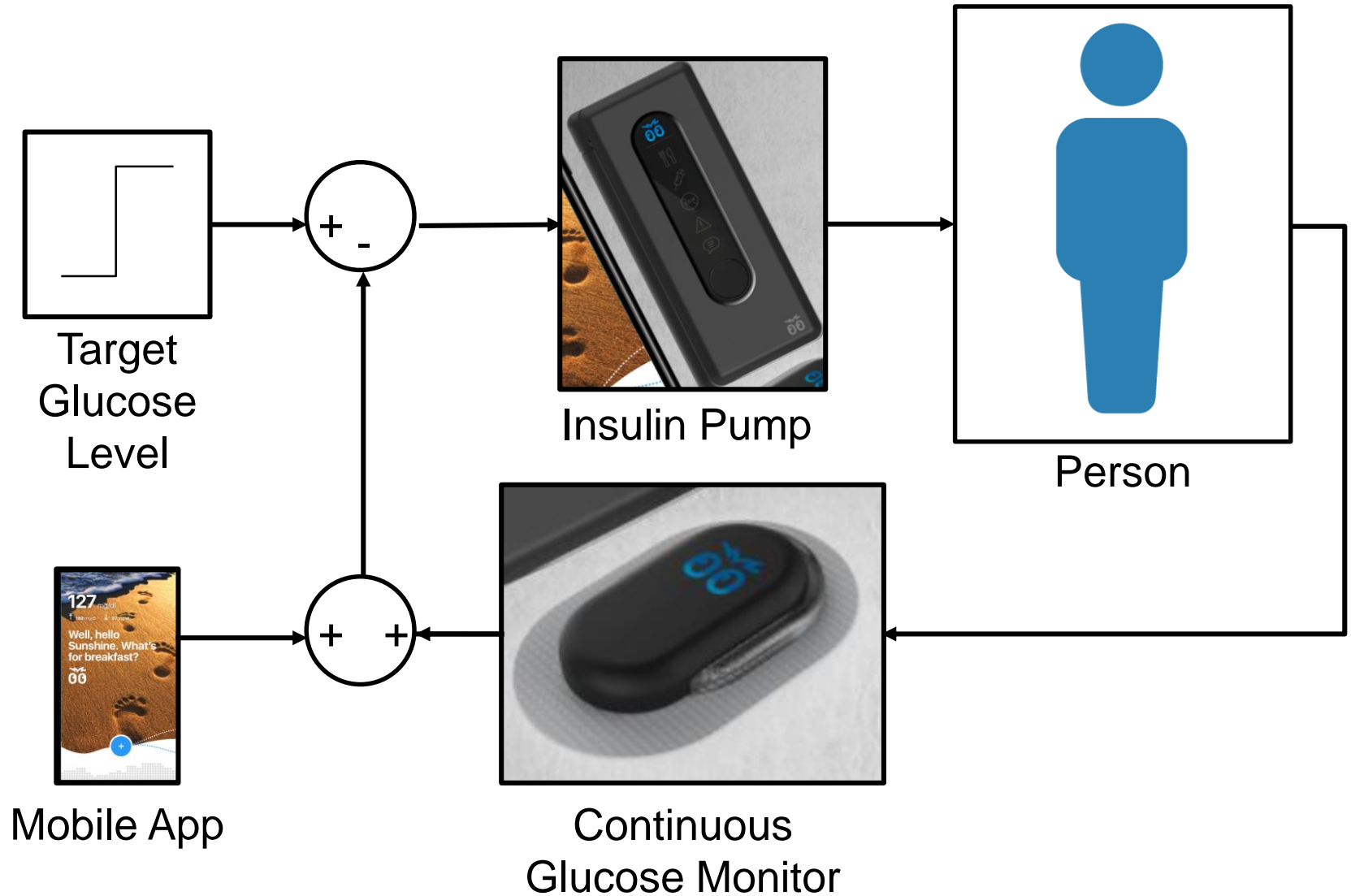
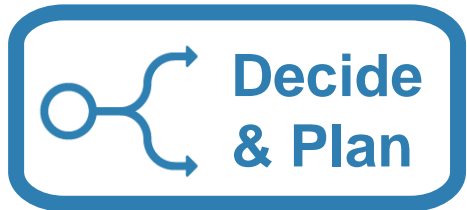
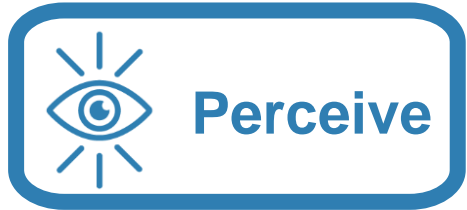
Autonomous Glucose Level Management

Bigfoot Biomedical



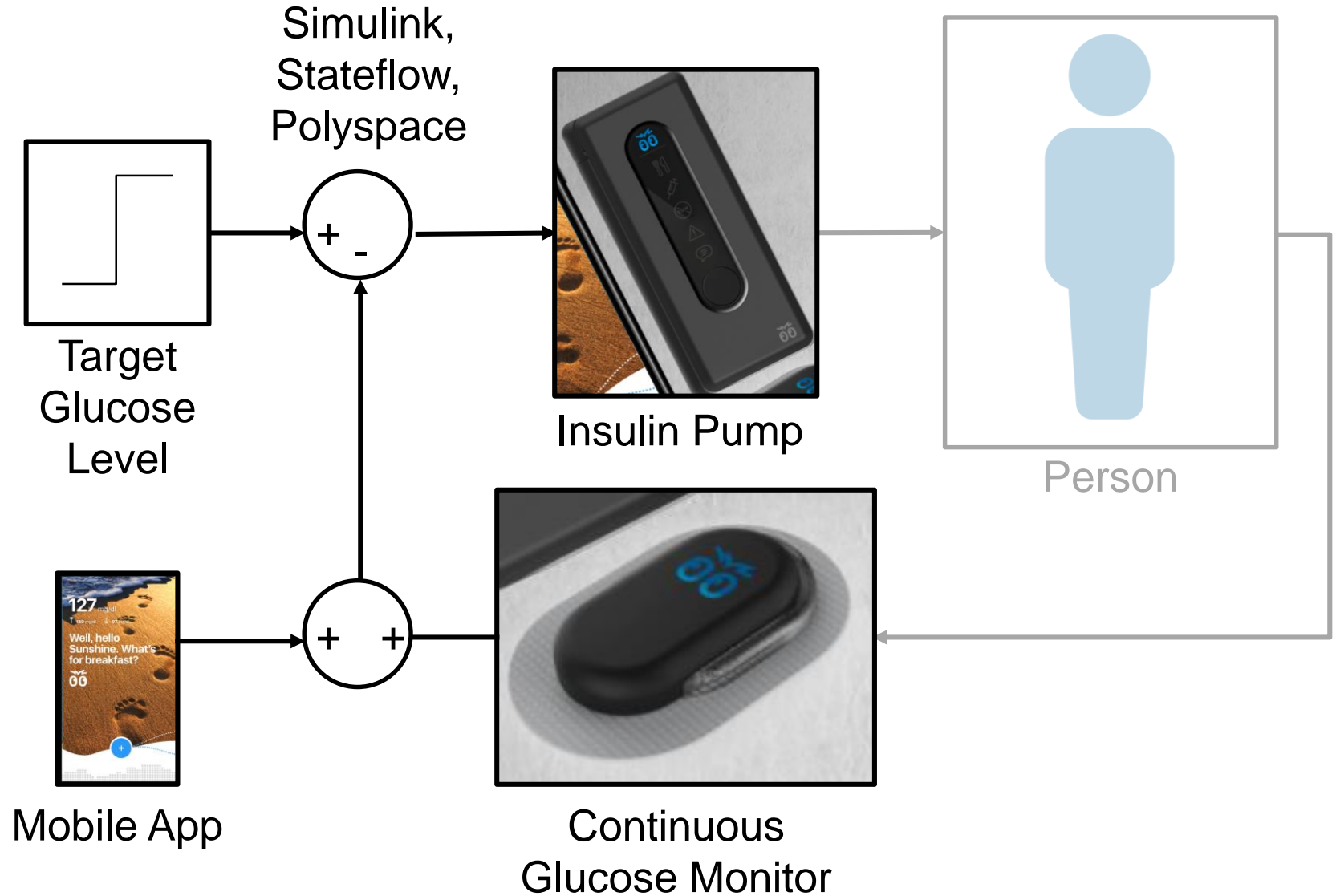
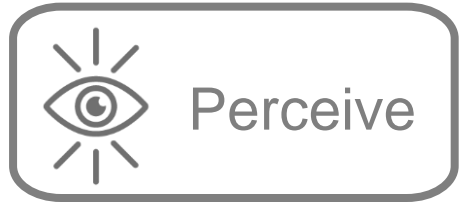
Autonomous Glucose Level Management

Bigfoot Biomedical



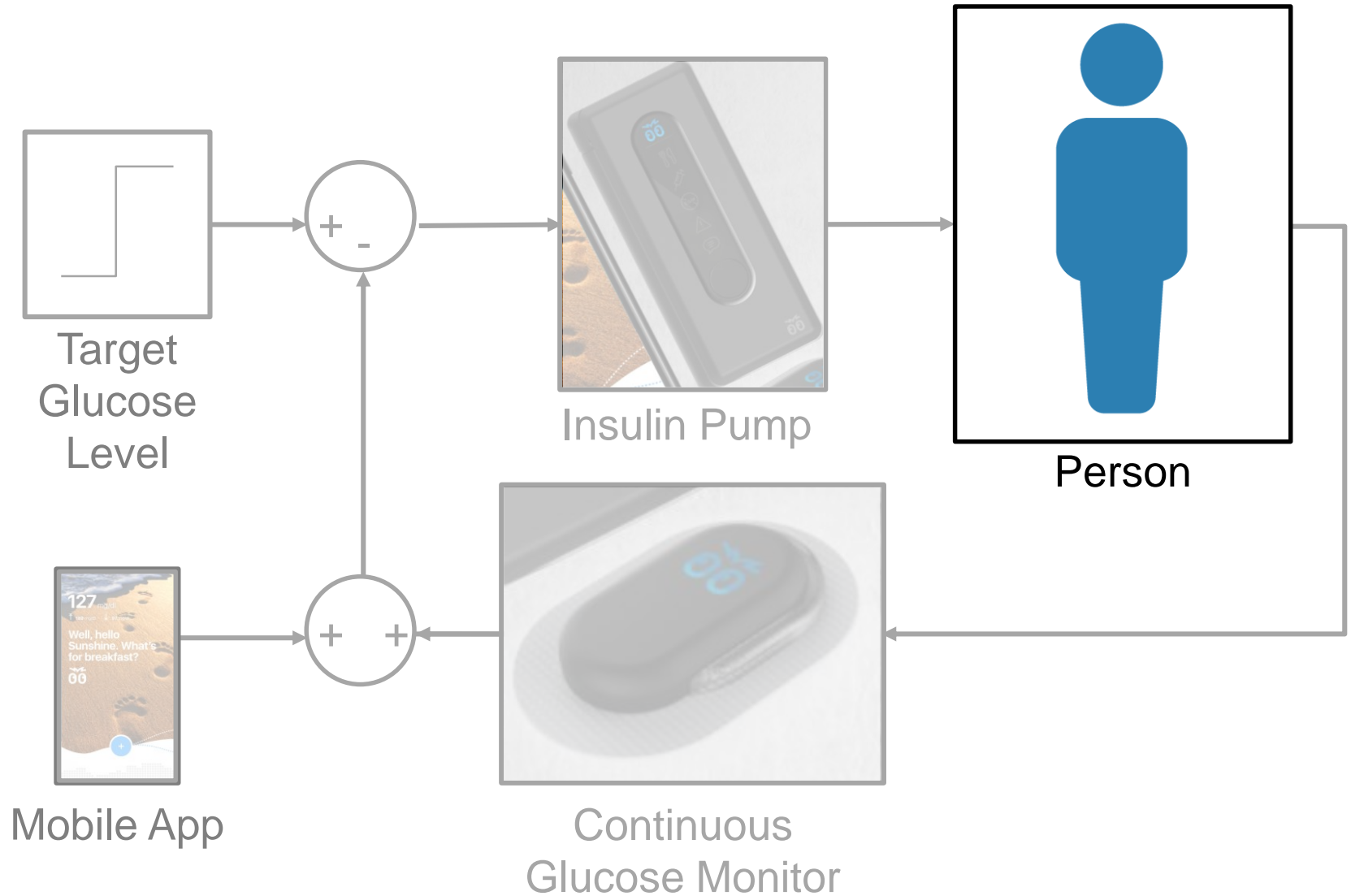
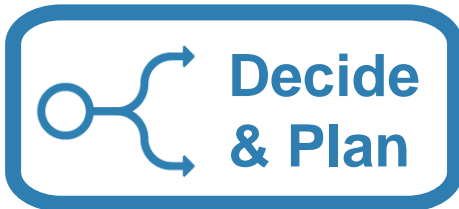
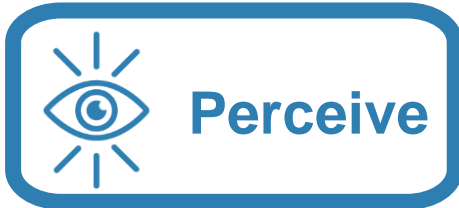
Autonomous Glucose Level Management

Bigfoot Biomedical



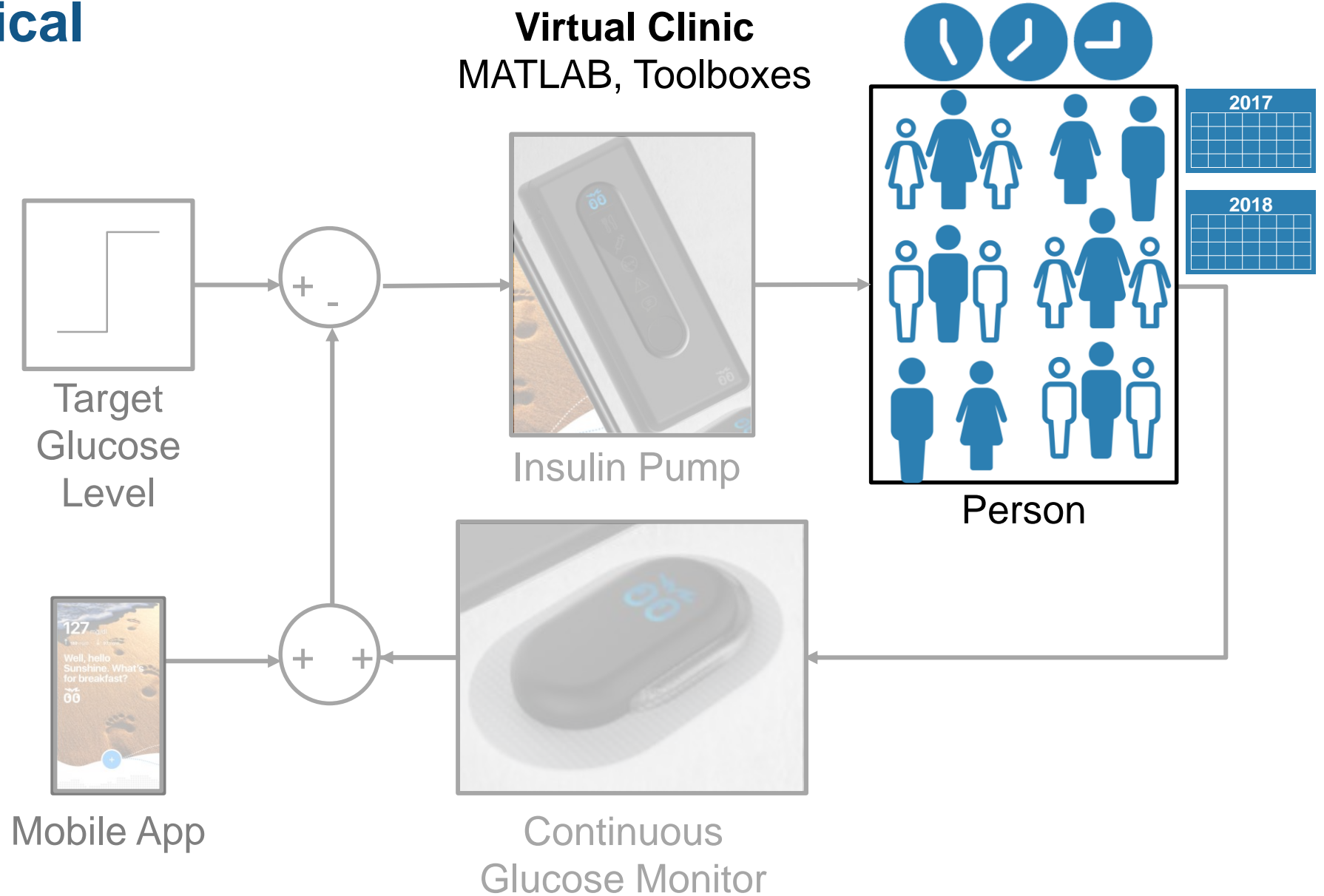
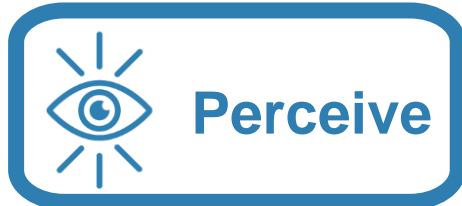
Autonomous Glucose Level Management

Bigfoot Biomedical



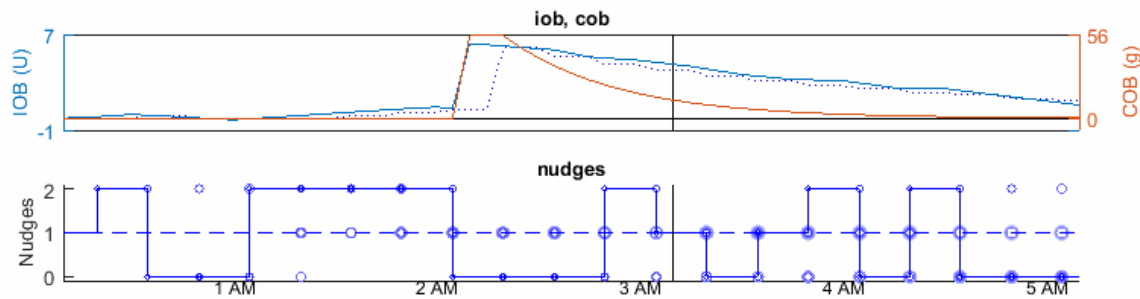
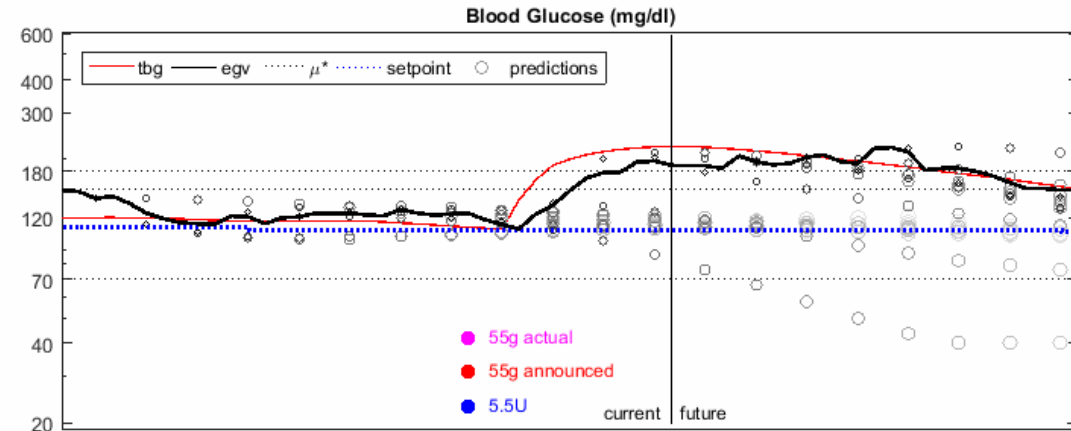
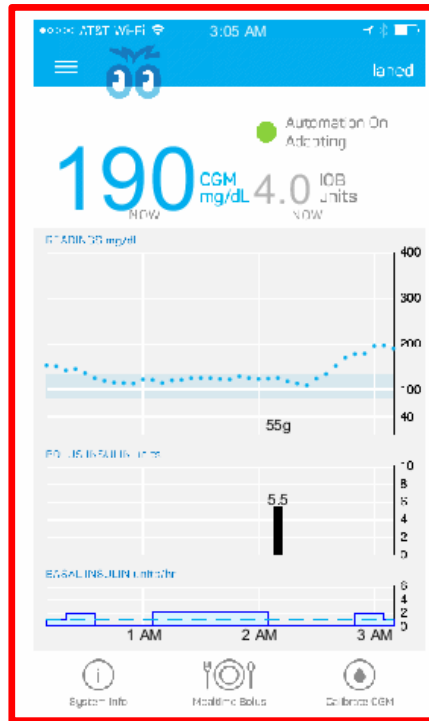
Autonomous Glucose Level Management

Bigfoot Biomedical



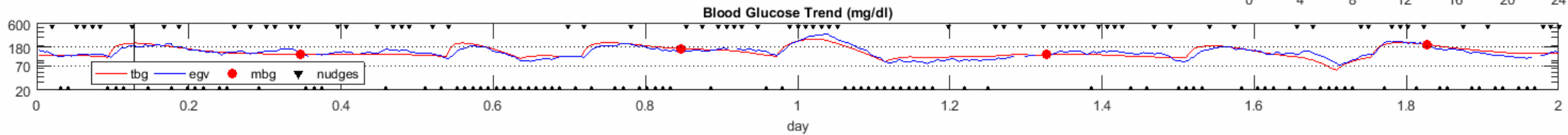
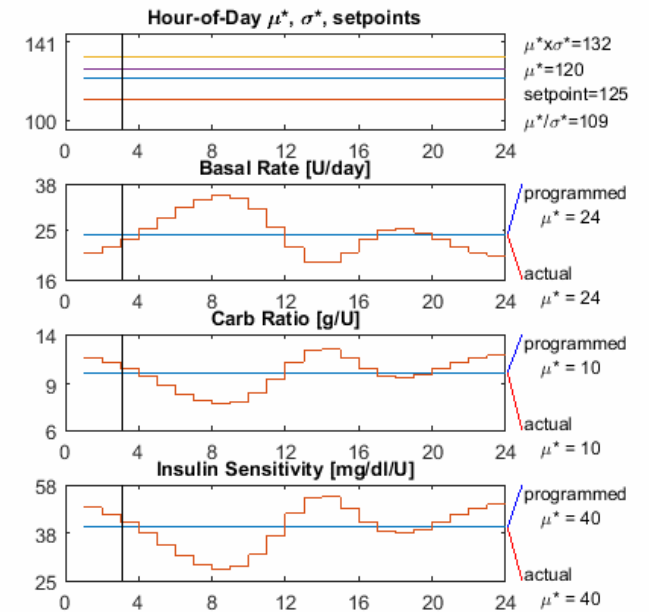
Virtual Clinic

Generating data through simulation



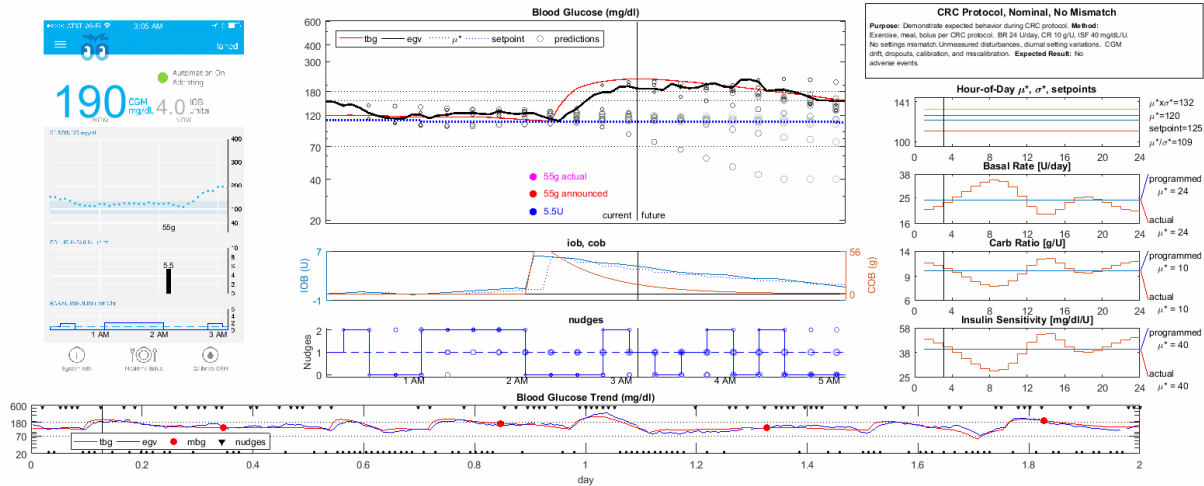
CRC Protocol, Nominal, No Mismatch

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



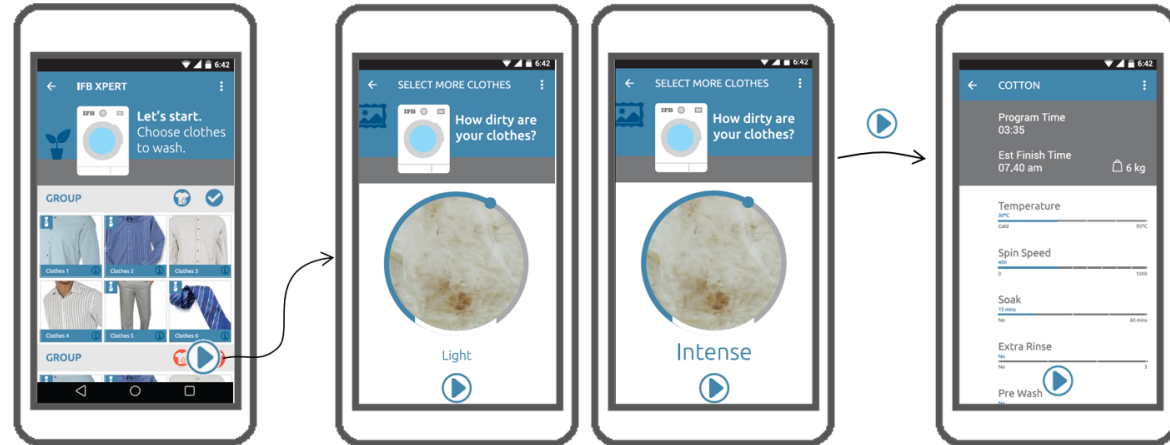


Development of decision support system for connected washing machine

Results Achieved



- The idea conceived during concept phase was successfully refined and transcended to Android and iOS app.



- Customer response from pilot launch of the app:

“We can use it for special clothes, which should not get damaged.”

“the app feels like it is designed for me.”

“I didn't use the application yet before. Now I will use this application. Highlight is machine prescribes the program according to the clothes type and dirt level.”

Where will you get your data?

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

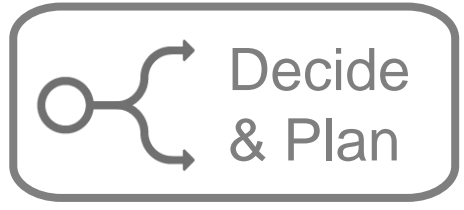
The collage illustrates various data sources:

- Simulation:** Mobile health app interface showing a glucose reading of 190 mg/dL and a line graph of glucose levels over time.
- Public repositories:** Line graphs showing blood glucose (mg/dl) and insulin (U) over time, with data points for 55g actual, 55g announced, and 5.5U.
- In the lab:** A large aerial photograph of a busy construction site with many trucks and equipment.
- In the field:** A grid of various art and portrait images, including a portrait of a man, a painting of a woman, a painting of a landscape, and a painting of a group of people.
- Internet of Things (IoT):** A small inset graph showing a glucose reading of 190 mg/dL and a line graph of glucose levels over time.

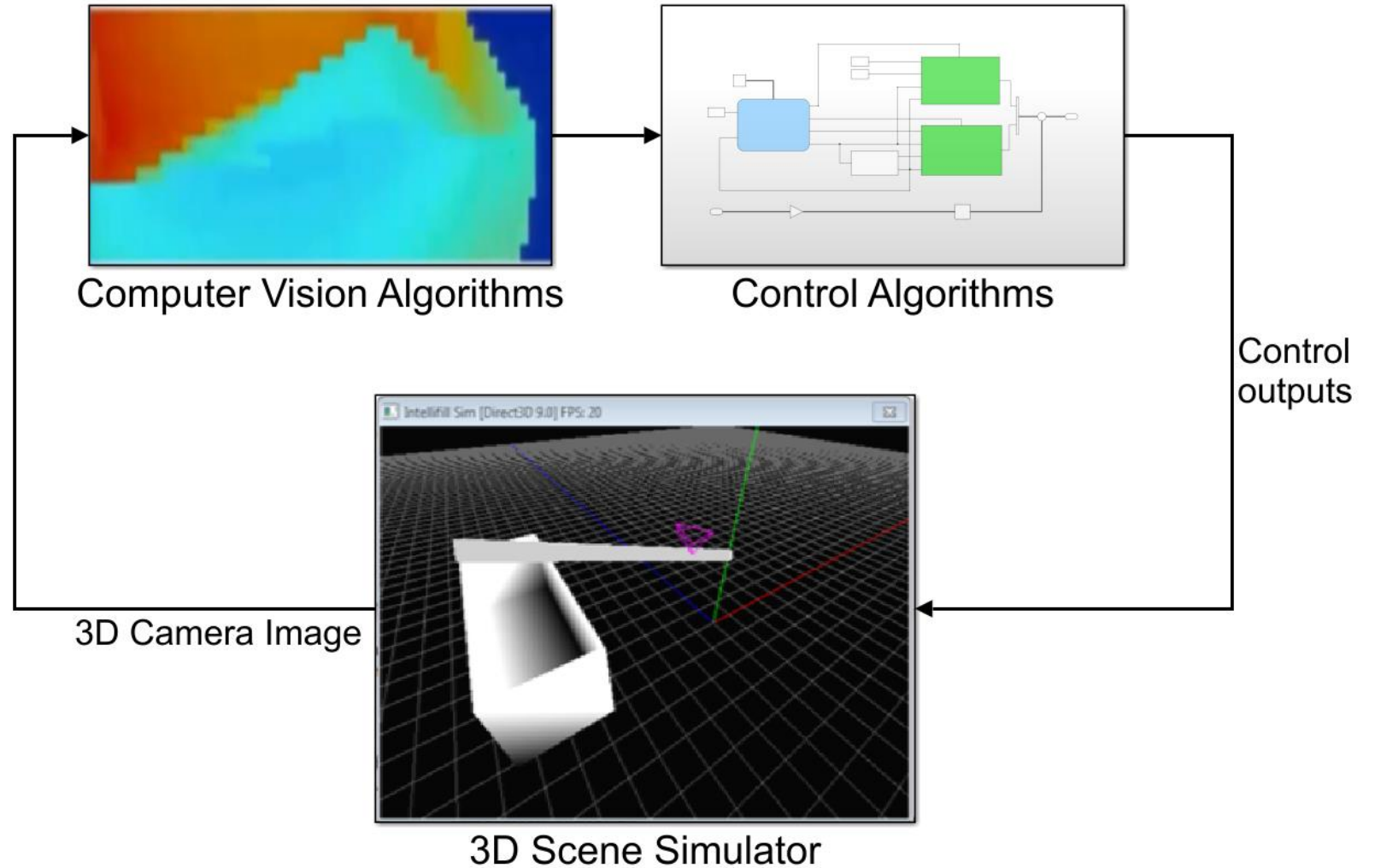


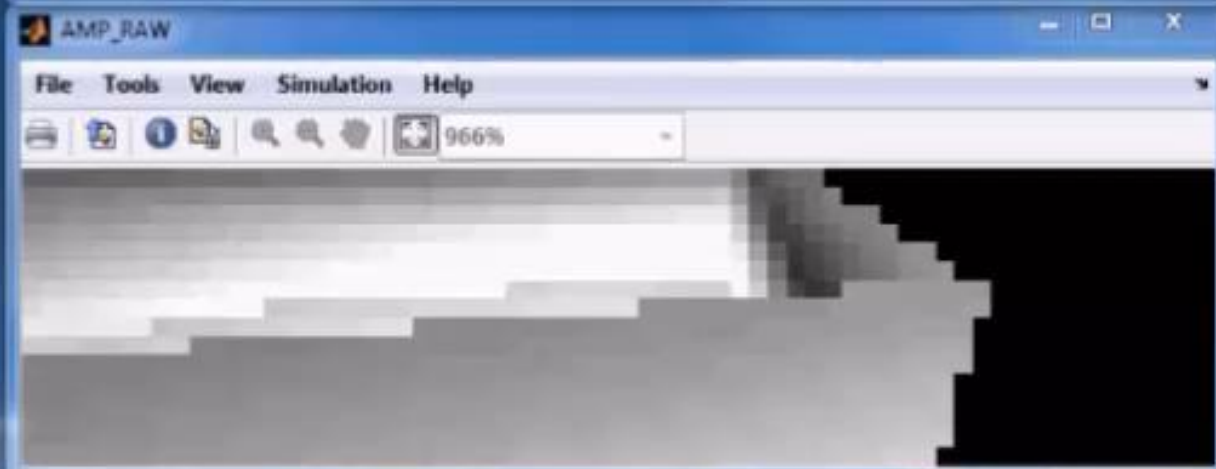
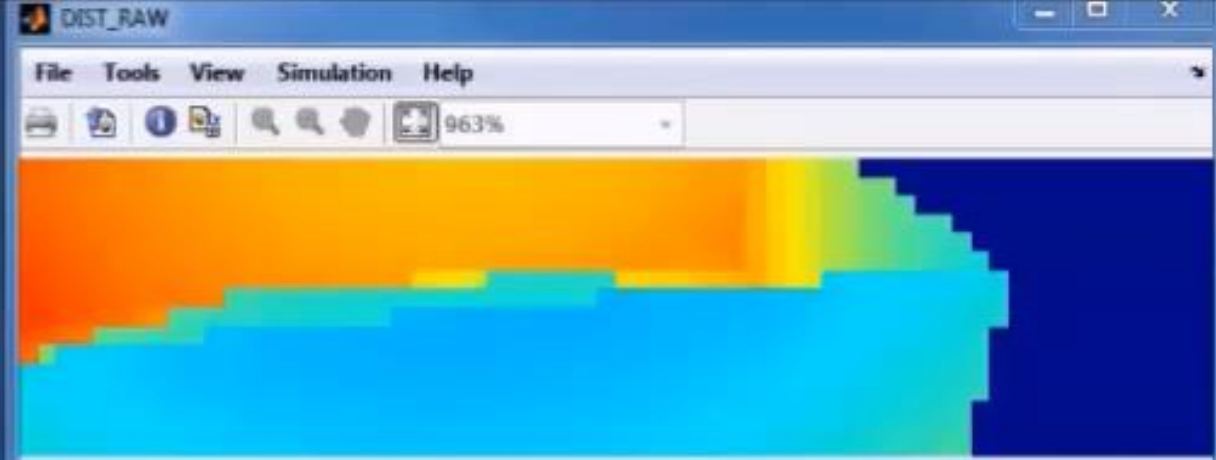
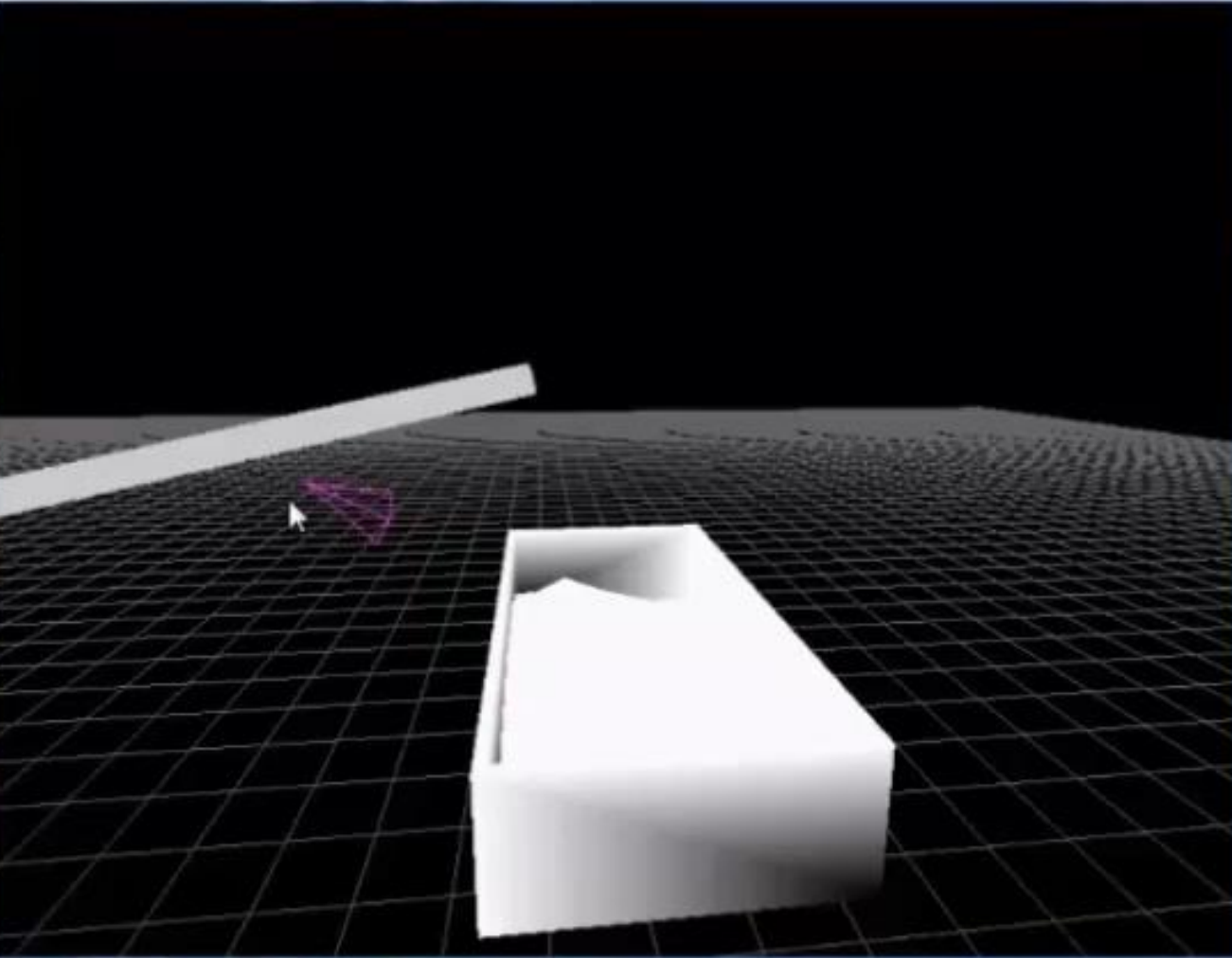


Autonomous Trailer Filling

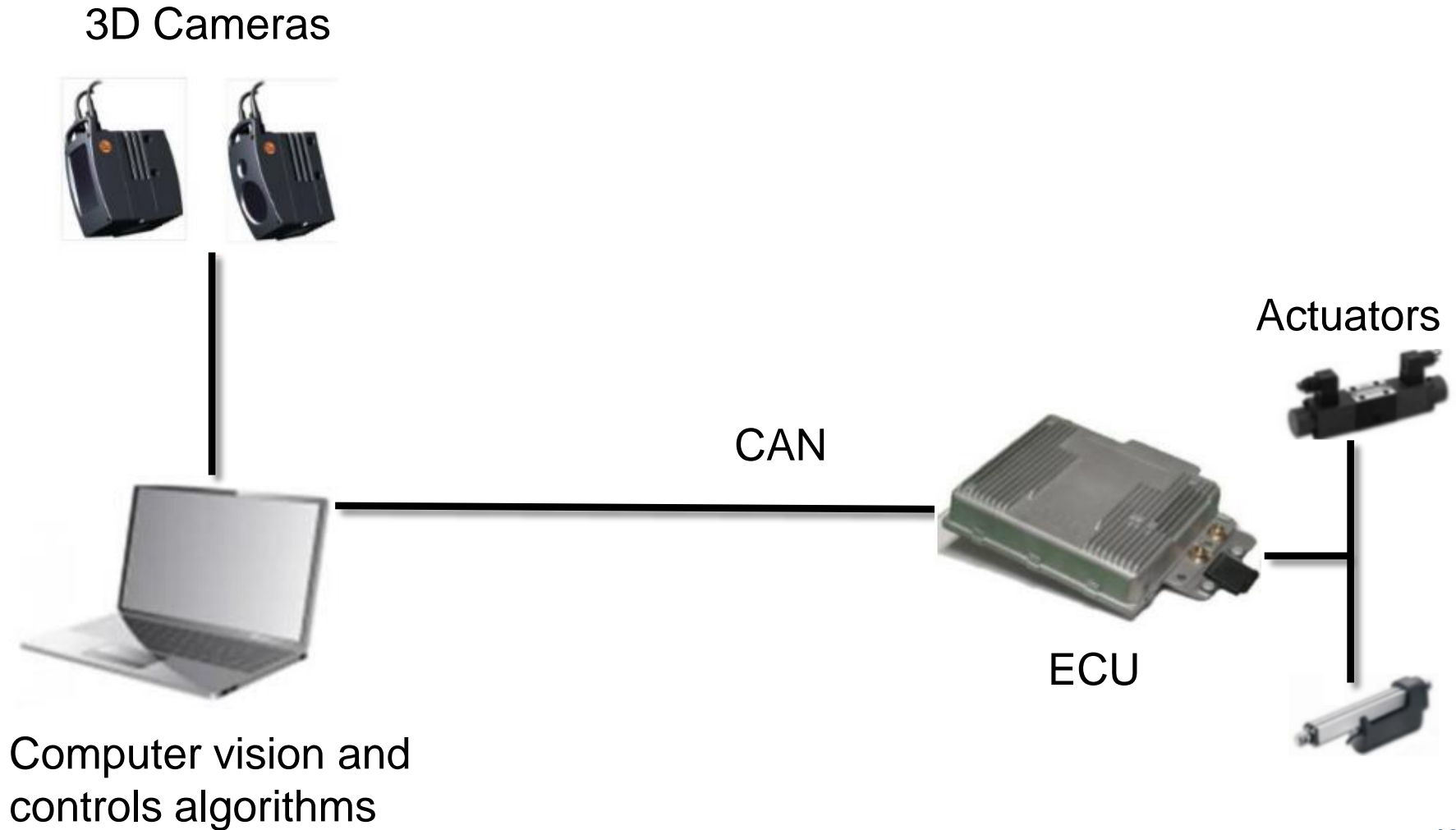
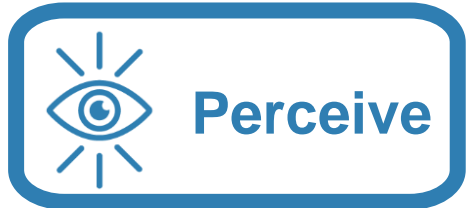


Autonomous Trailer Filling

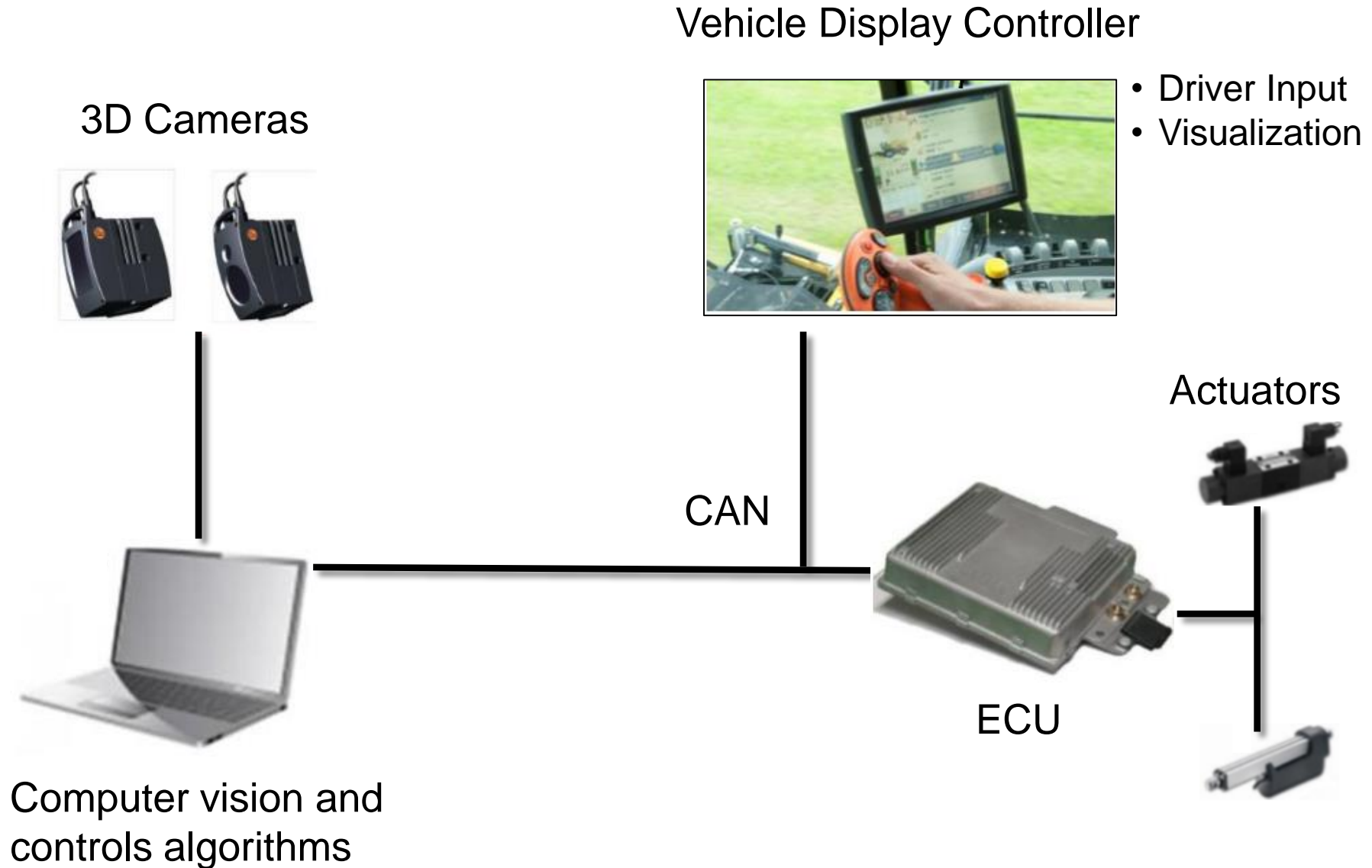
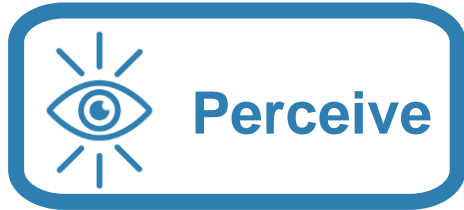




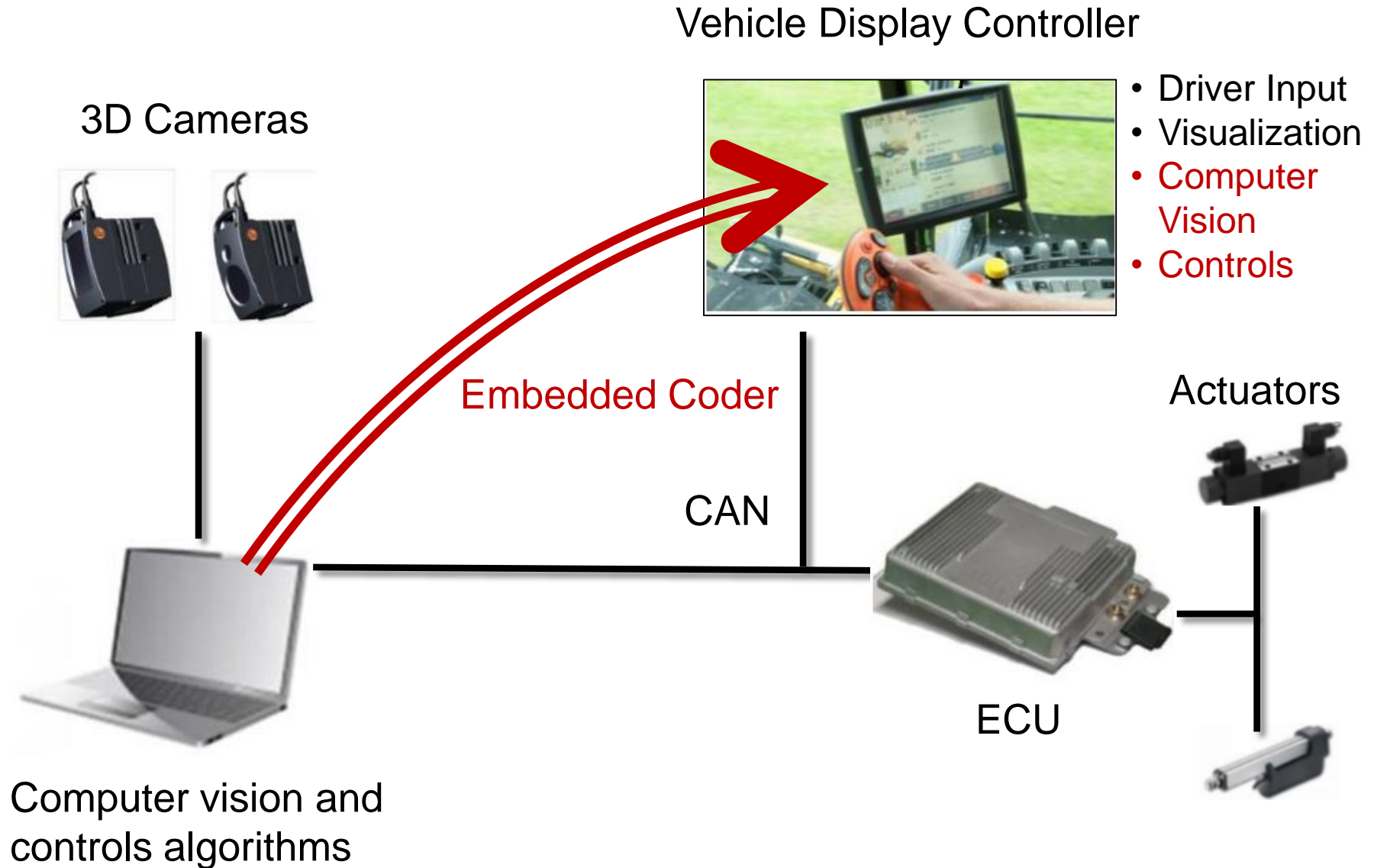
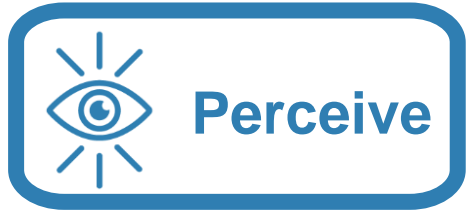
Autonomous Trailer Filling



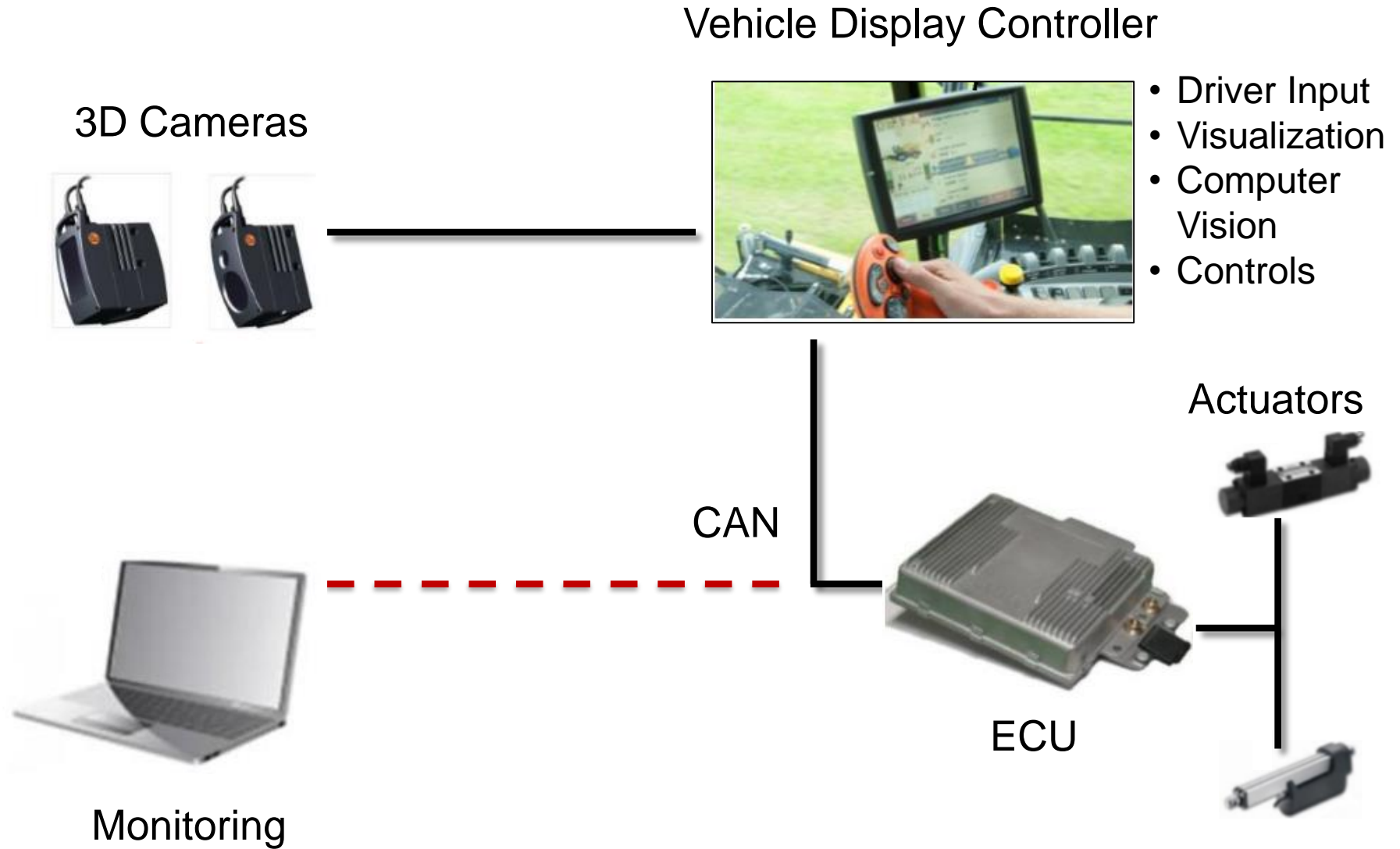
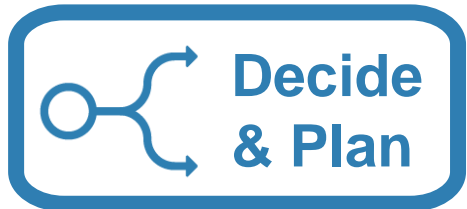
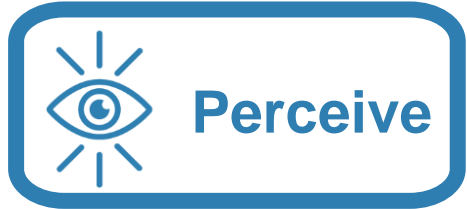
Autonomous Trailer Filling



Autonomous Trailer Filling



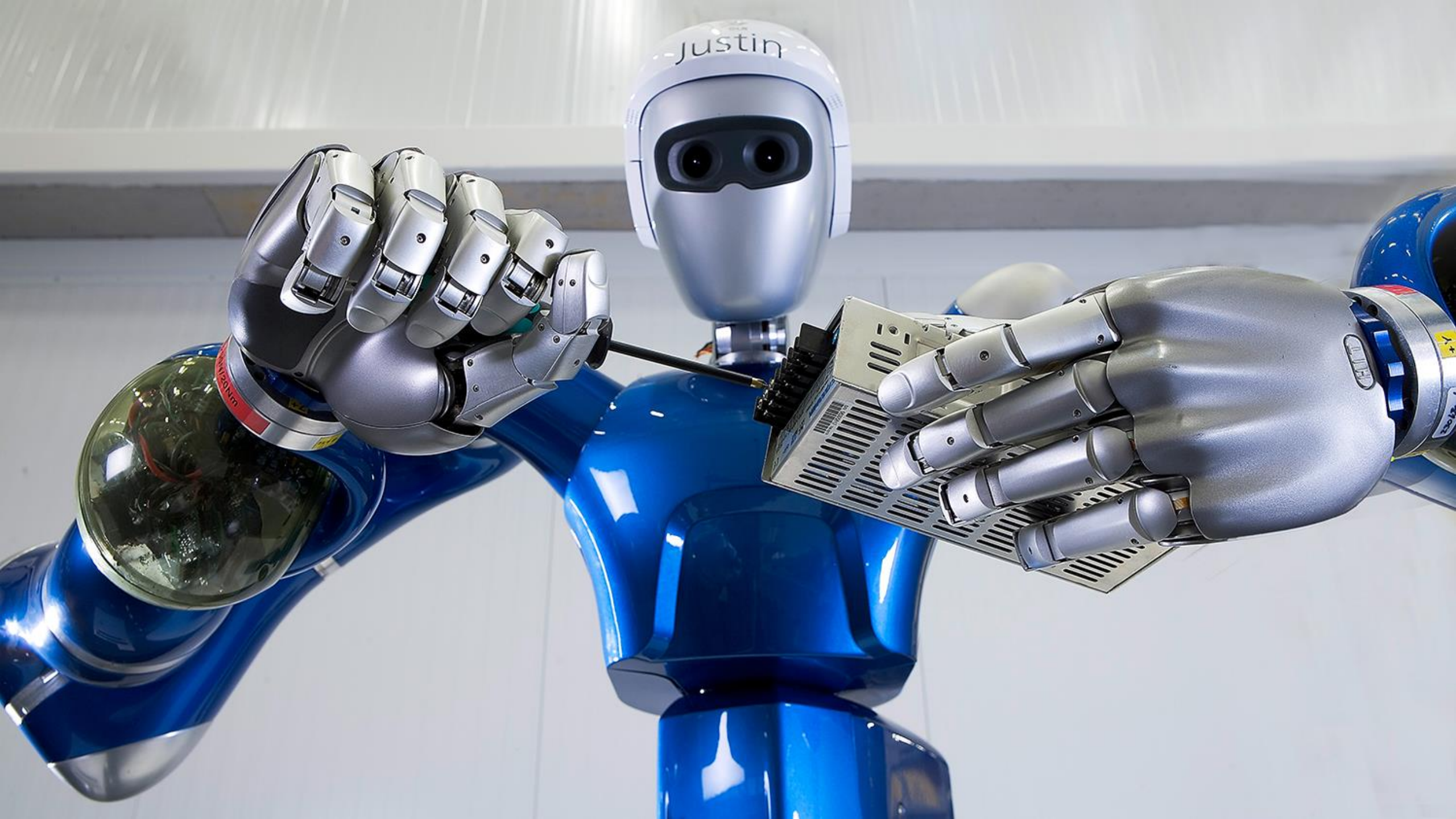
Autonomous Trailer Filling



How will you put it into production?

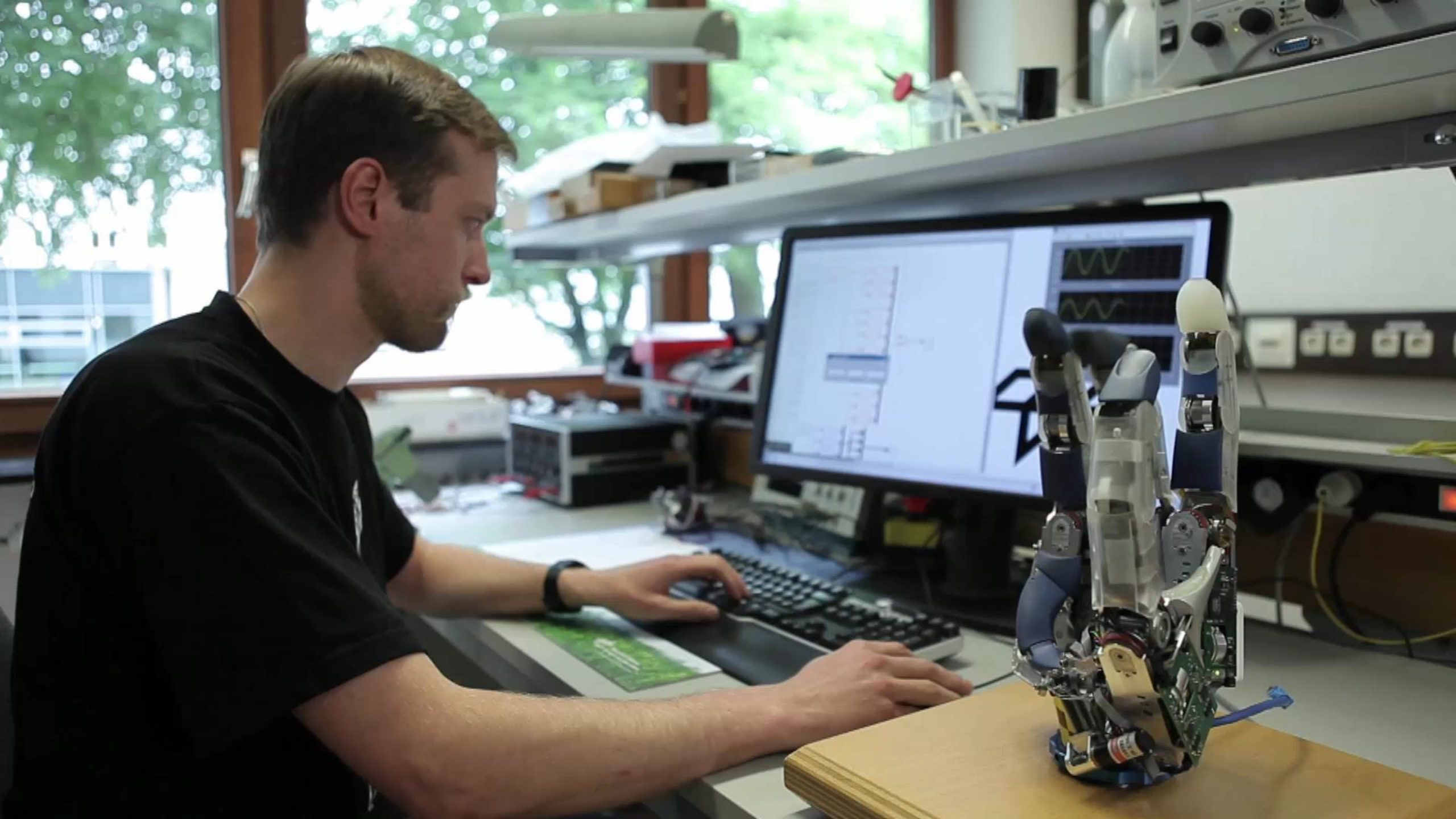
- System Architecture
- Embedded systems
- Enterprise systems
- HMIs





Justin





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
-

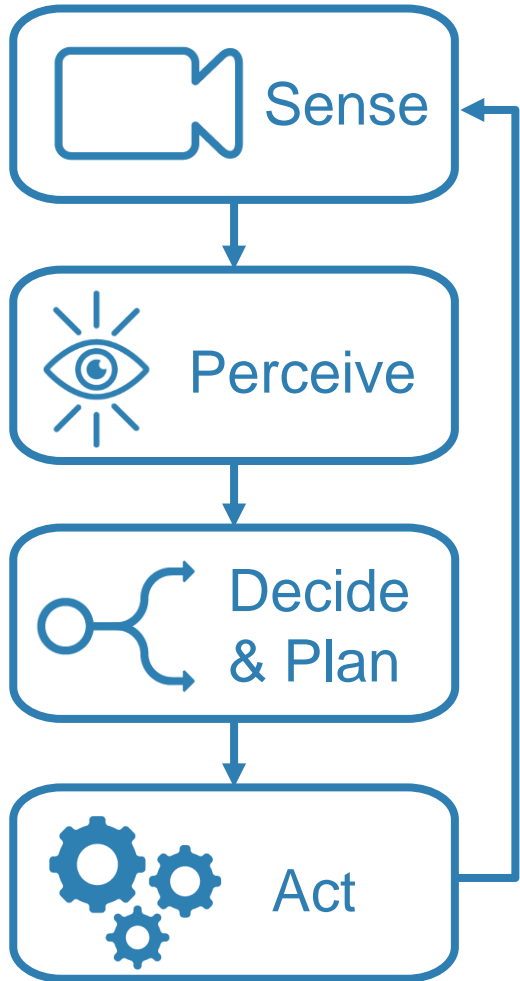
Get the Right Data

- 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

How to build an autonomous anything



Rise^{PRIZE} Driverless Car Challenge



What is *your*
autonomous anything?

