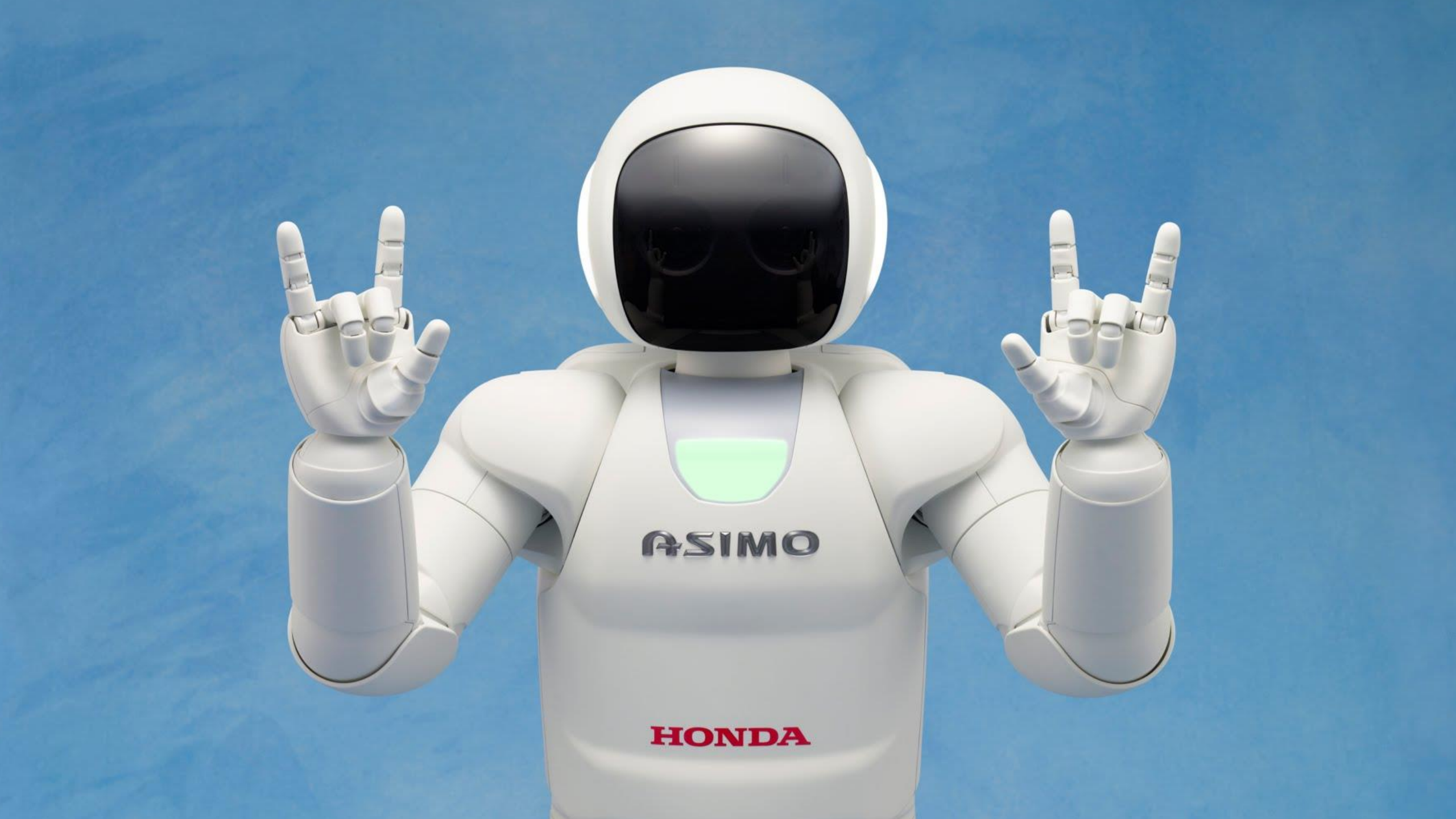
MathWorks

MODEL-BASED DESIGN CONFERENCE 2017

How to Build an Autonomous Anything

Chris Hayhurst


ASIMO
HONDA

amazon

5" 12,000 PSI
5" 12,000 PSI
BAKER HUGHES

127 mg/dl
189 mg/dl
97 mg/dl
Well, hello Sunshine. What's for breakfast?
CGM

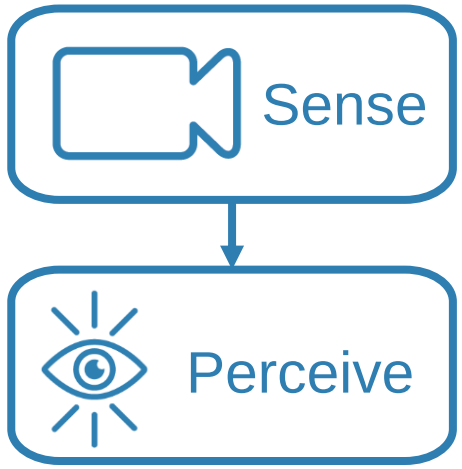
Autonomous Technology

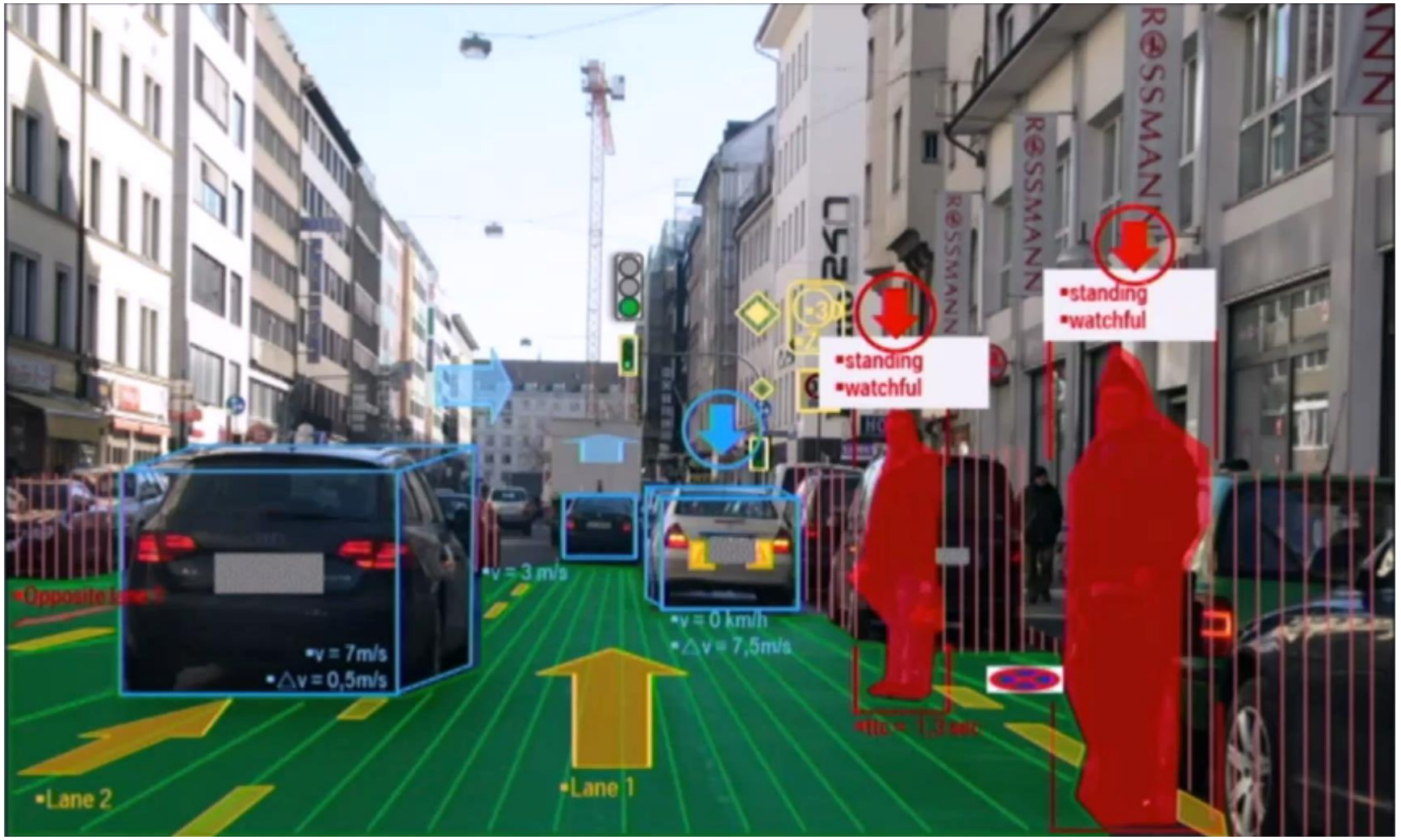
Provides the ability of a system to act independently of direct human control under unrehearsed conditions

Capabilities of an Autonomous System

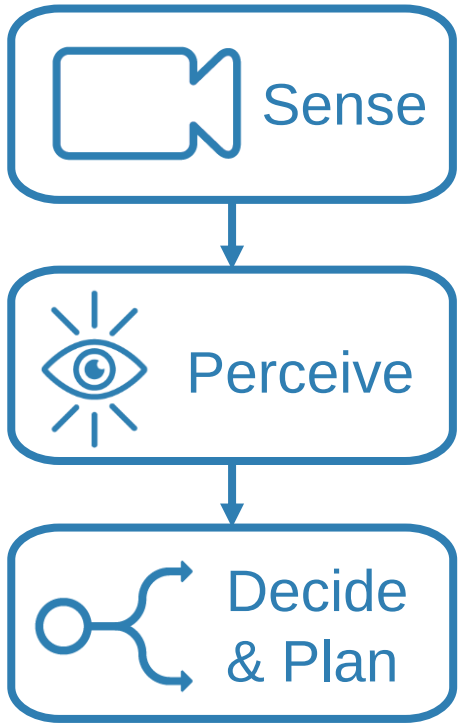
Sense

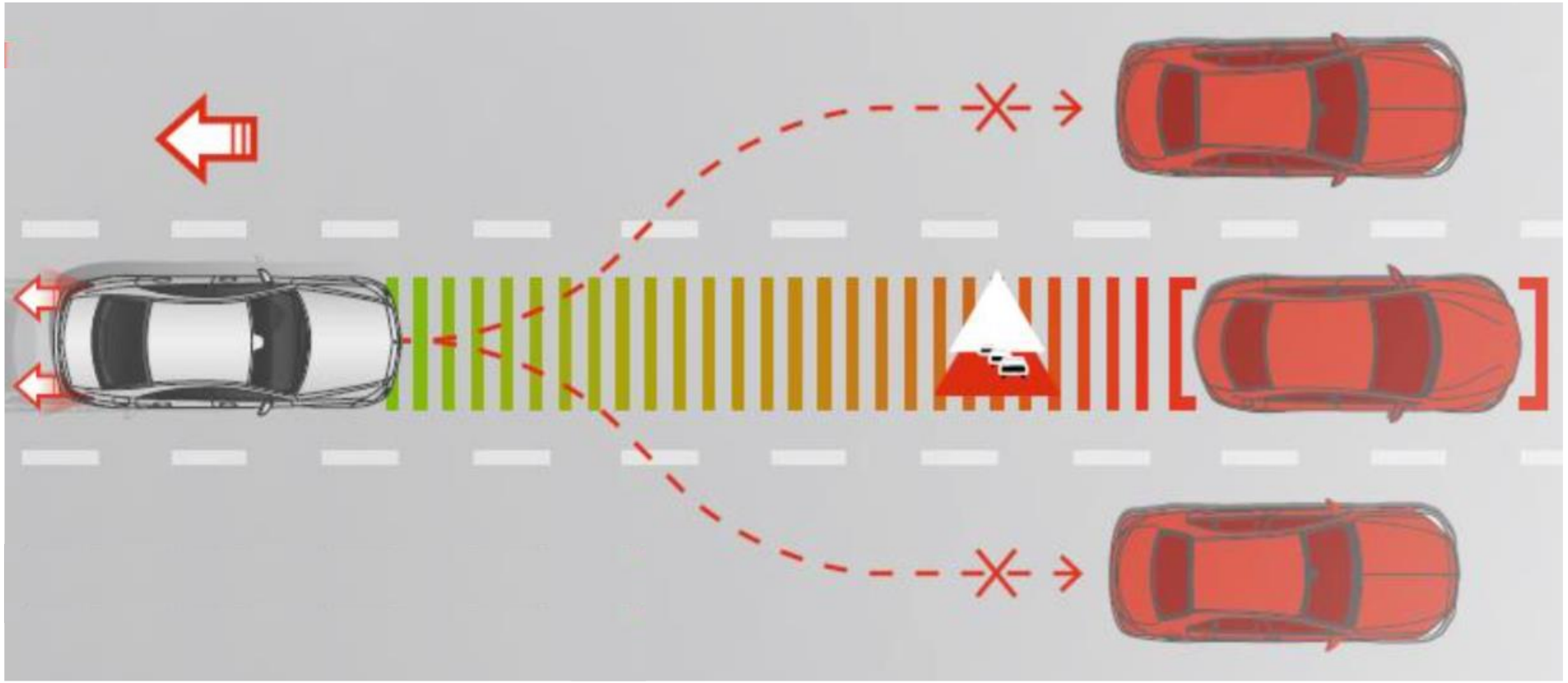
Capabilities of an Autonomous System



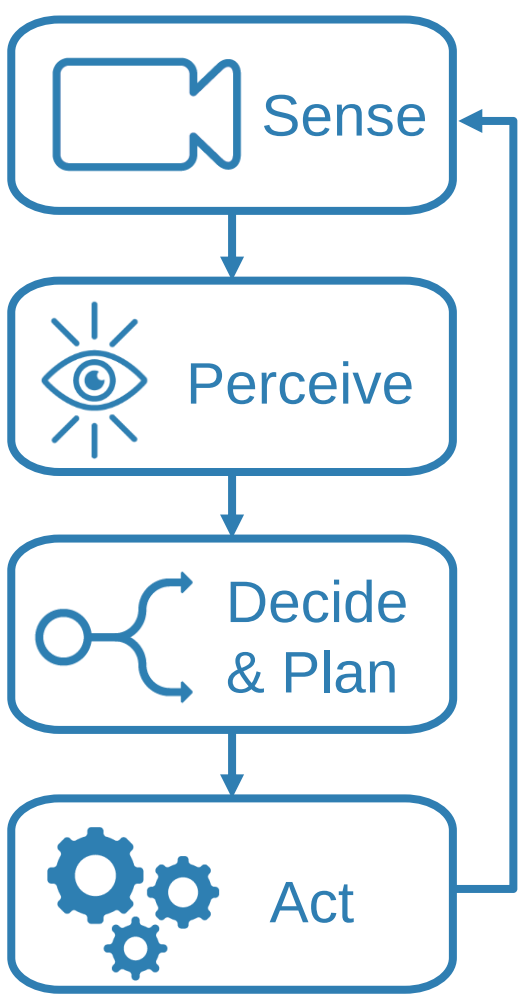


Capabilities of an Autonomous System

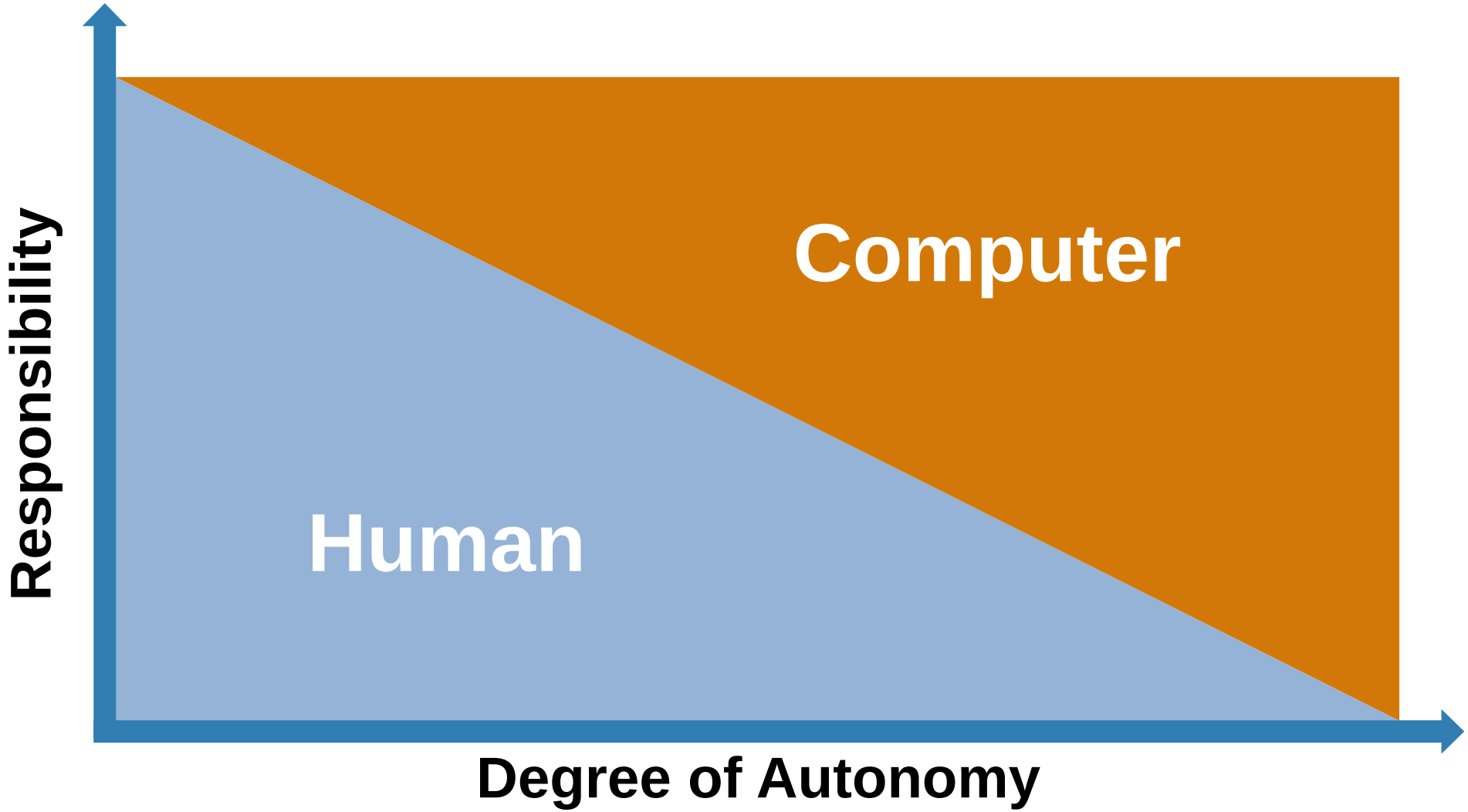


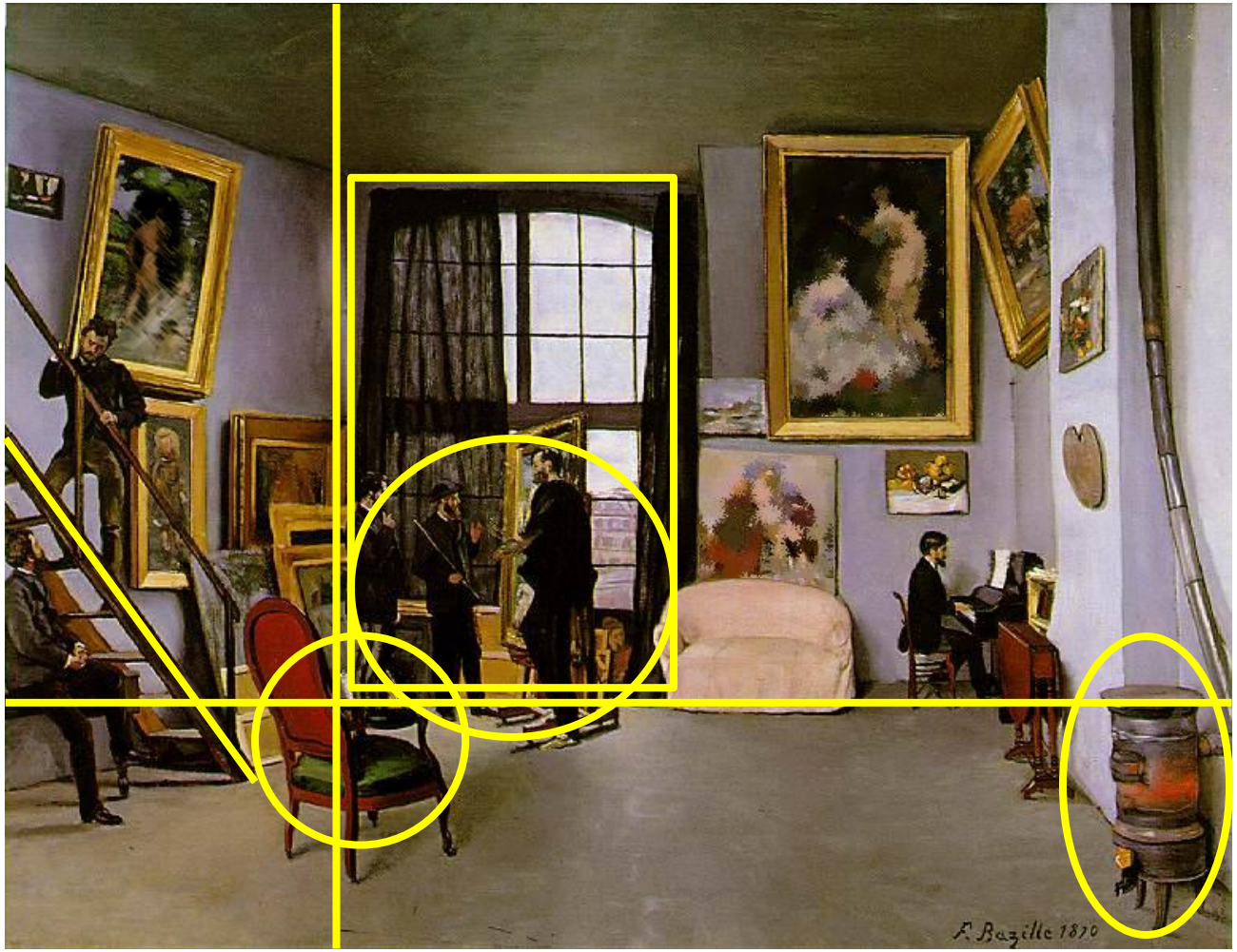


Capabilities of an Autonomous System



Autonomous Technology Transfers Responsibility to Computers





Bazille's Studio
Bazille 1870

Shuffleton's Barbershop
Rockwell 1950

Autonomous Artistic Style Classification
Rutgers University

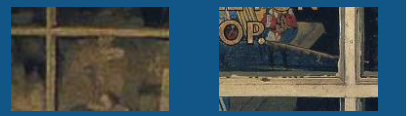
Sense

Perceive

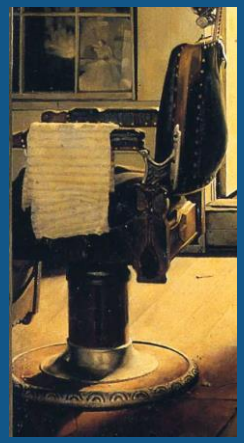
Decide & Plan

Act

Image Feature Extraction



Visual Features



Machine Learning Classification

Style Classifier (SVM)

Style: Regionalism

Genre Classifier (SVM)

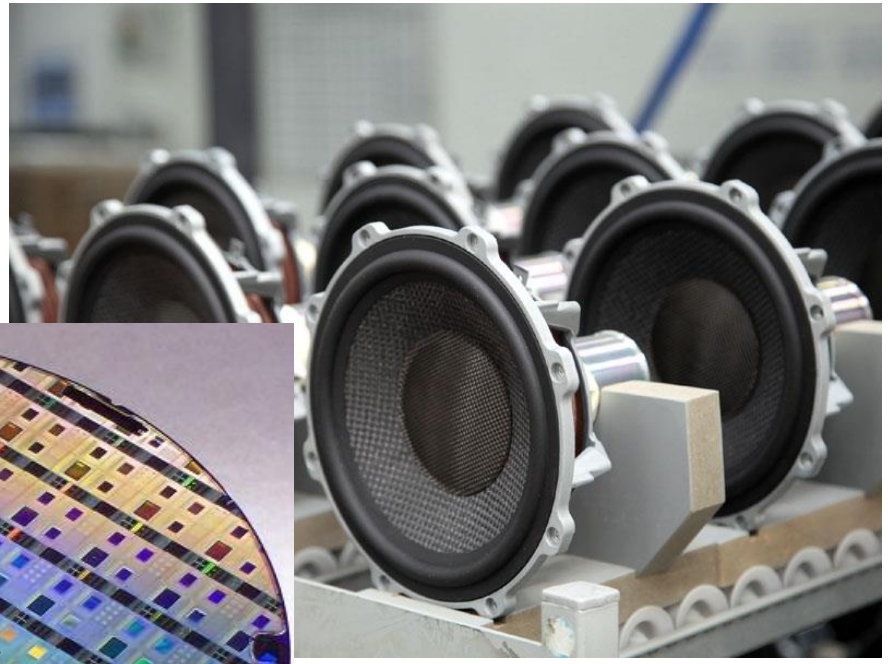
Genre: Interior

Artist Classifier (SVM)

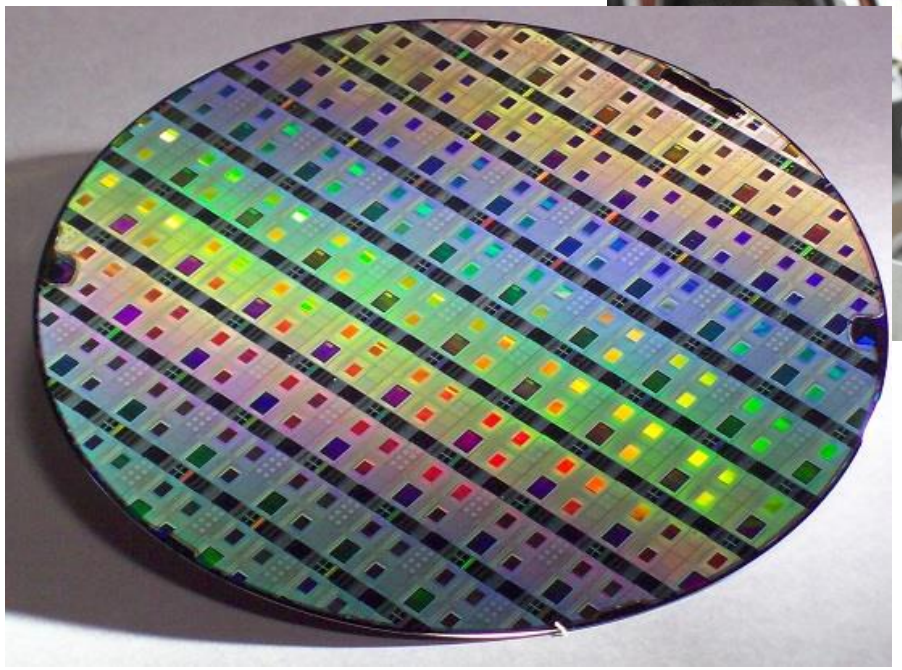
Artist: Rockwell

Where to add autonomy with perception?

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



Determine Loudspeaker Quality



Virtual Semiconductor Manufacturing Calibration

5" 12,000 PSI
5" 12,000 PSI
BAKER HUGHES

Autonomous Service for Predictive Maintenance

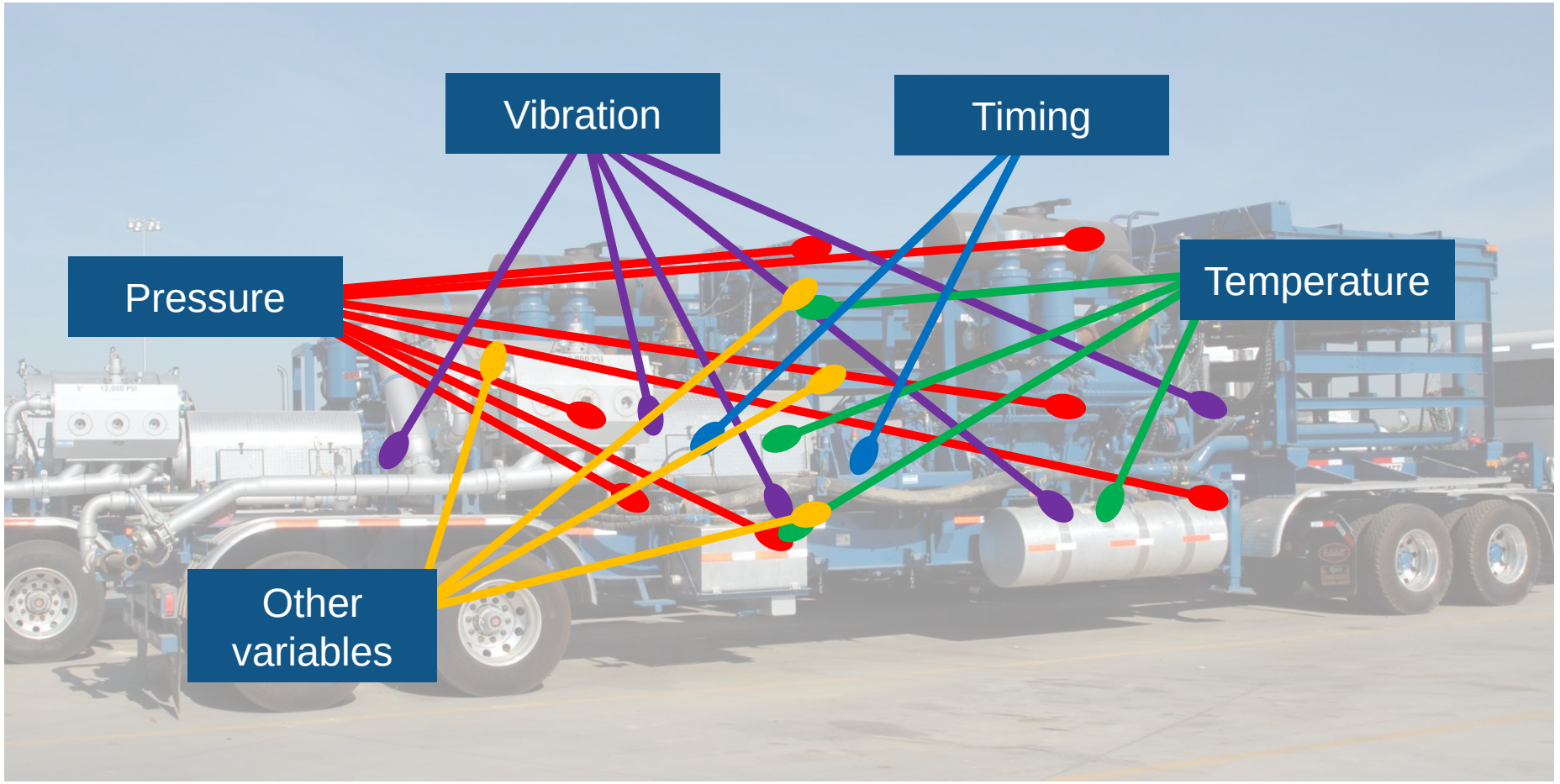
Sense

Perceive

Decide & Plan

Act

Which sensor values should they use?



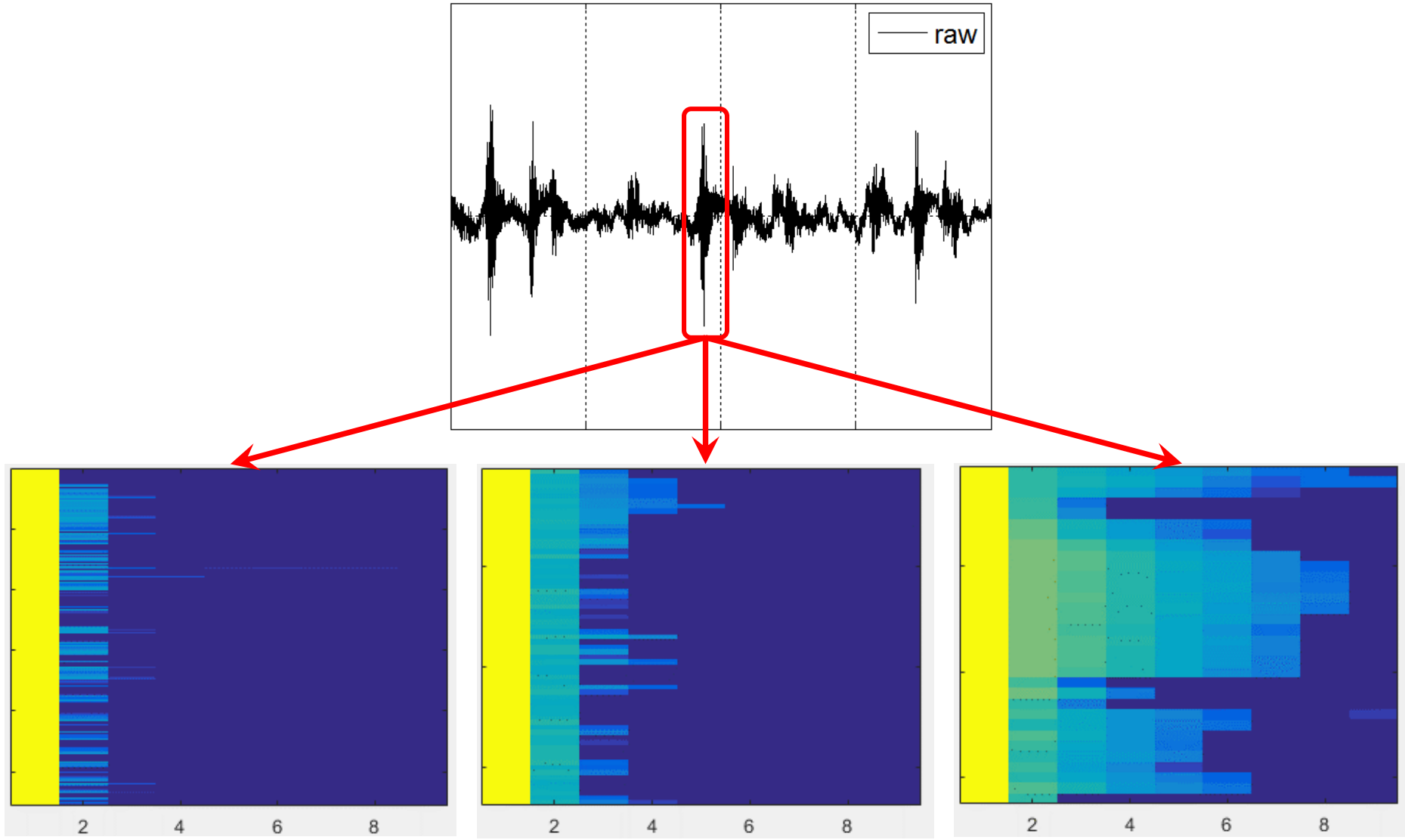
Autonomous Service for Predictive Maintenance

Sense

Perceive

Decide & Plan

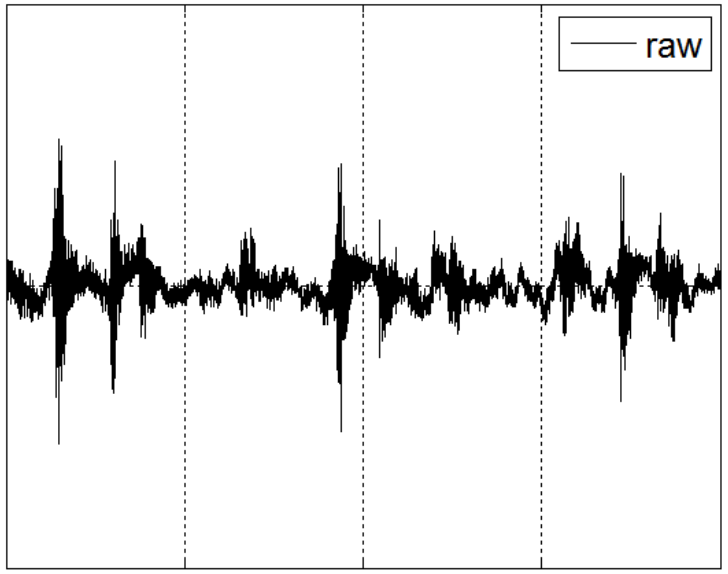
Act



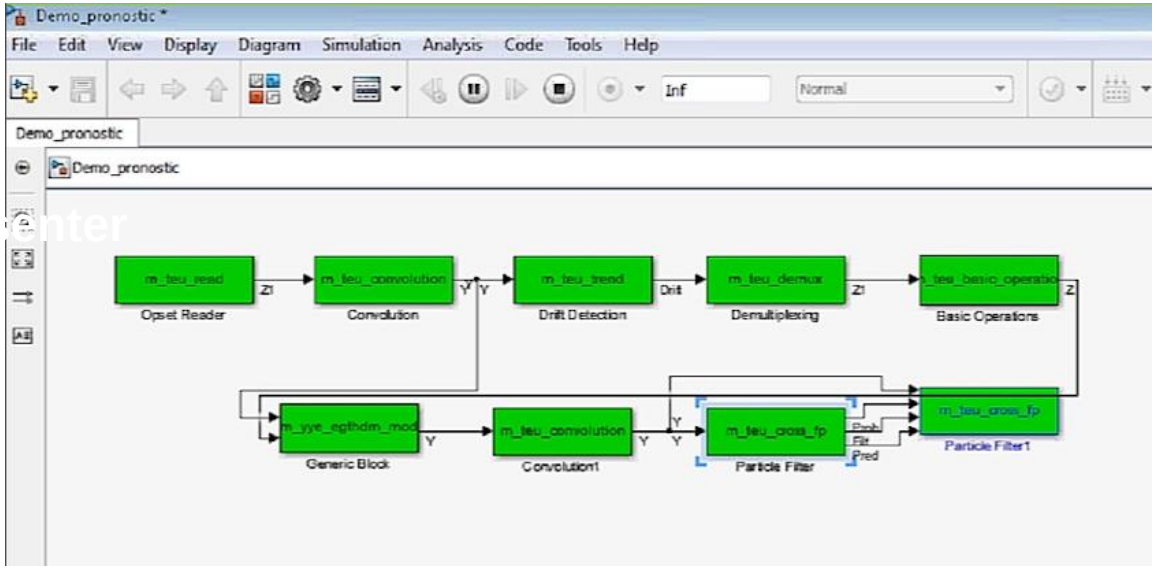
Normal Operation | Monitor Closely | Maintenance Needed

What are the best predictors?

- Data



- Models



Autonomous Glucose Level Management

Autonomous Glucose Level Management
Bigfoot Biomedical

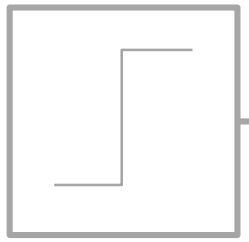
Sense

Perceive

Decide & Plan

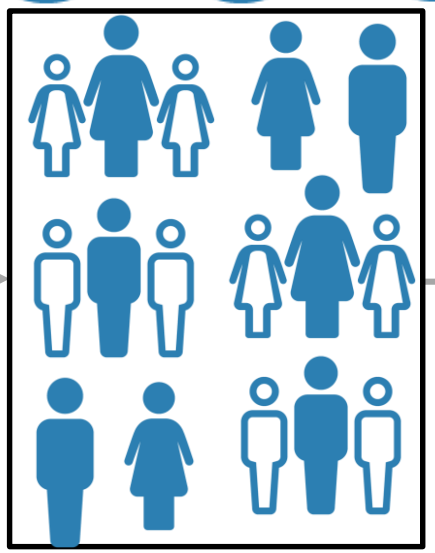
Act

Virtual Clinic
MATLAB, Toolboxes

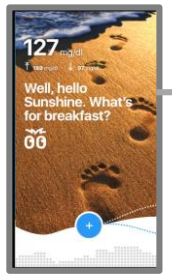


Target Glucose Level

Insulin Pump



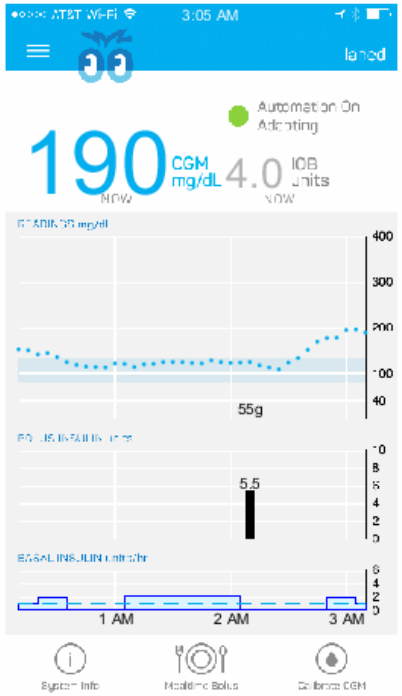
Person

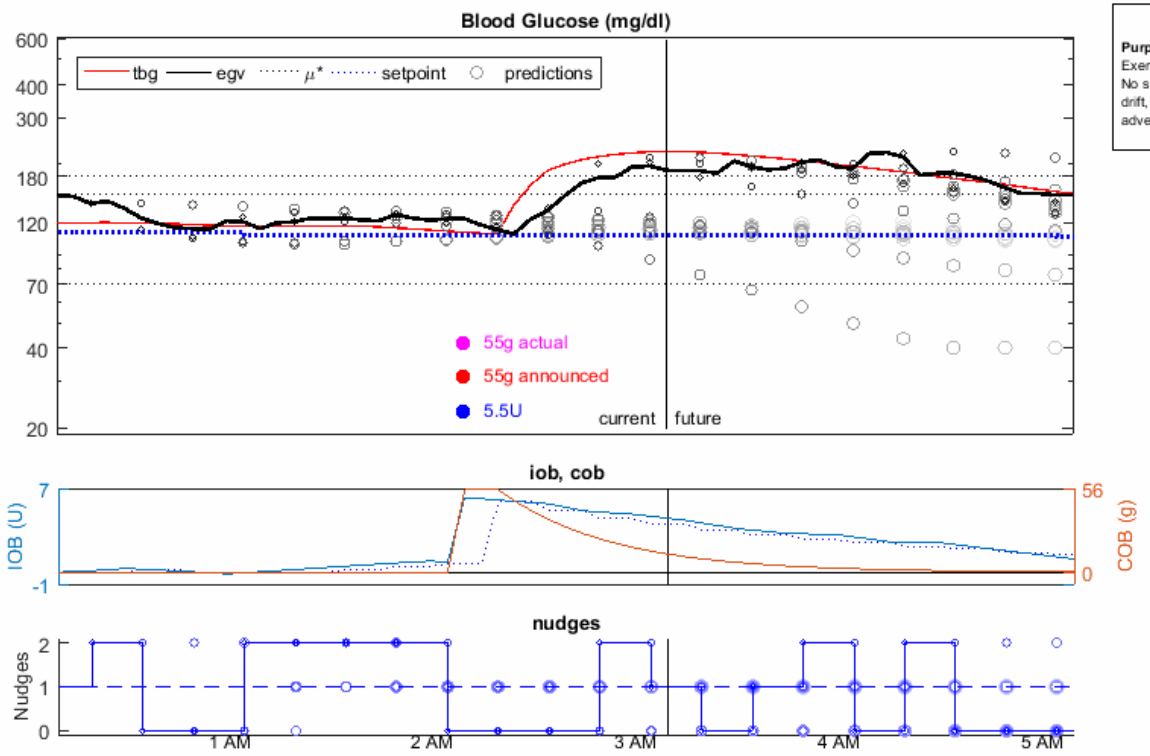


Mobile App

Continuous Glucose Monitor

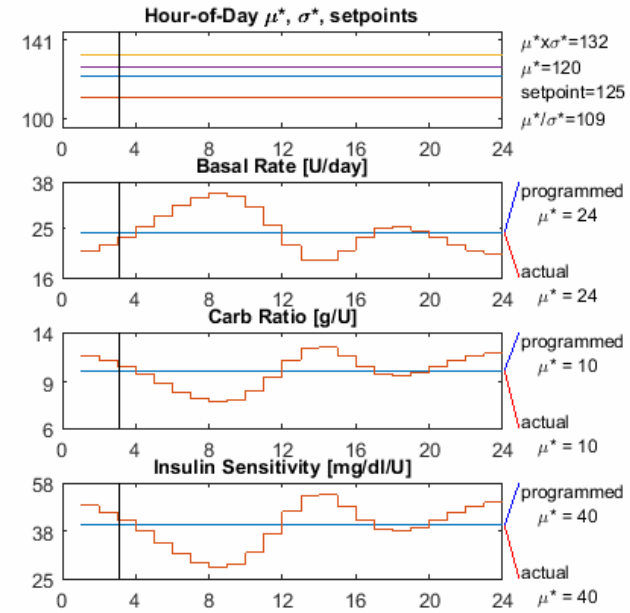
Virtual Clinic
Generating data through simulation

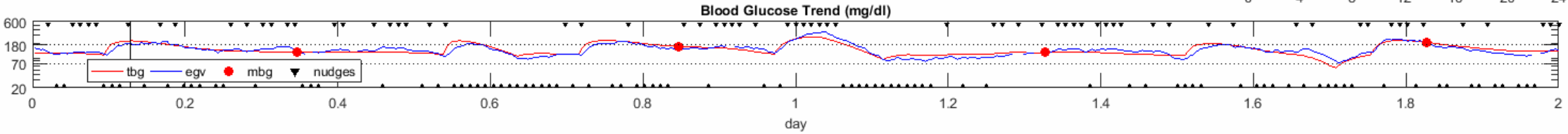




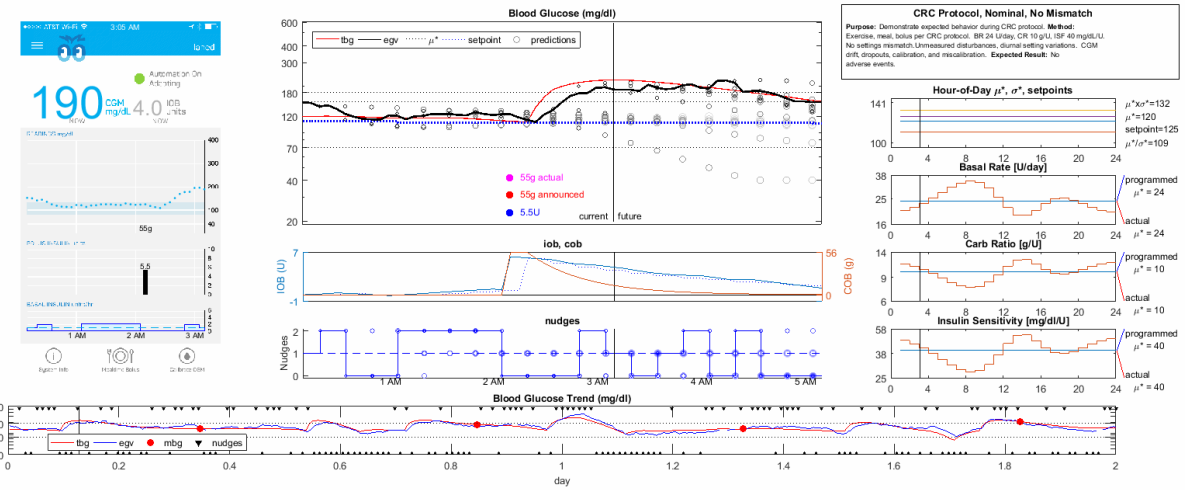
CRC Protocol, Nominal, No Mismatch

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

Sense

Perceive

Decide & Plan

Act

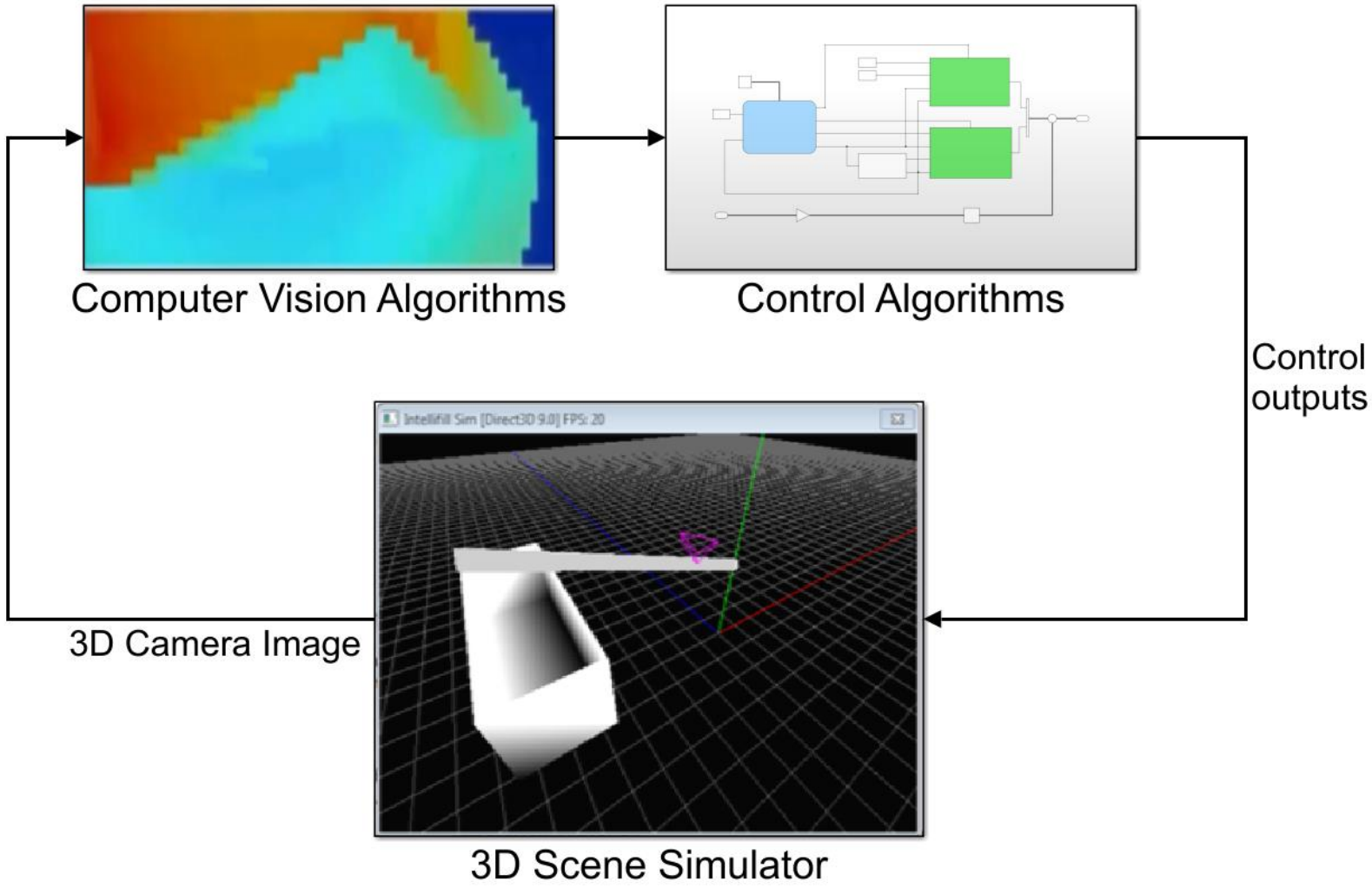
Autonomous Trailer Filling

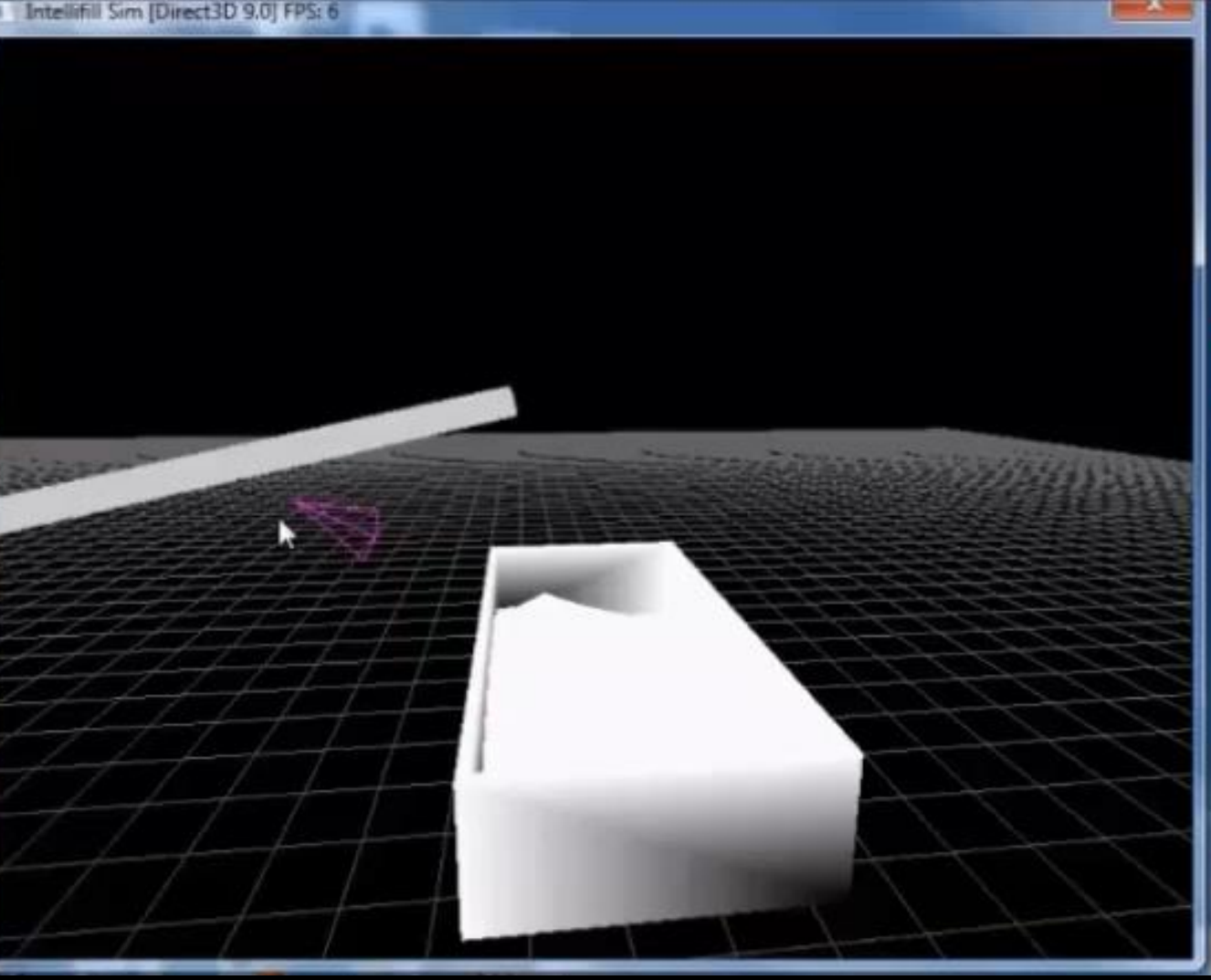
Sense

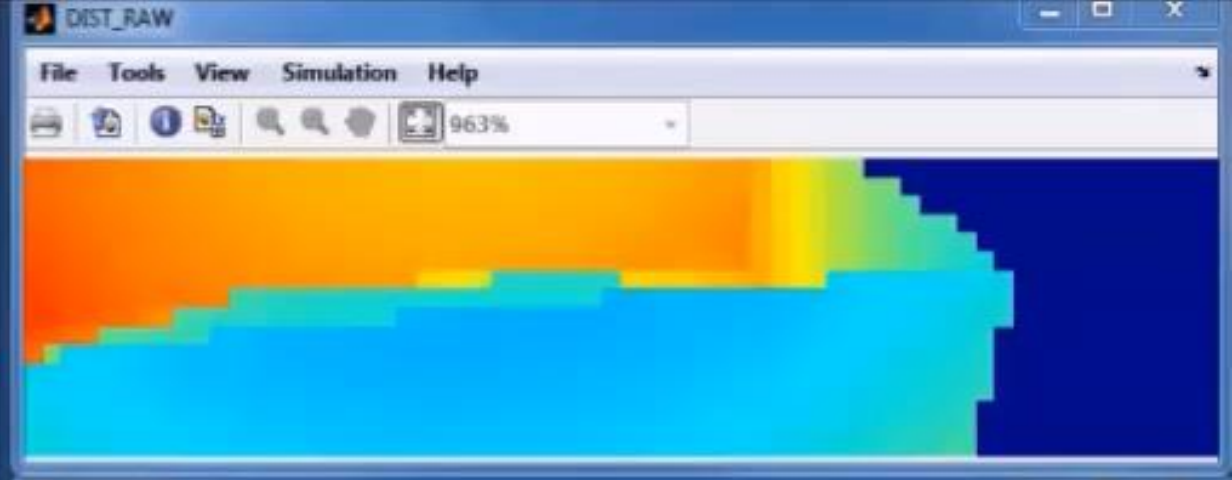
Perceive

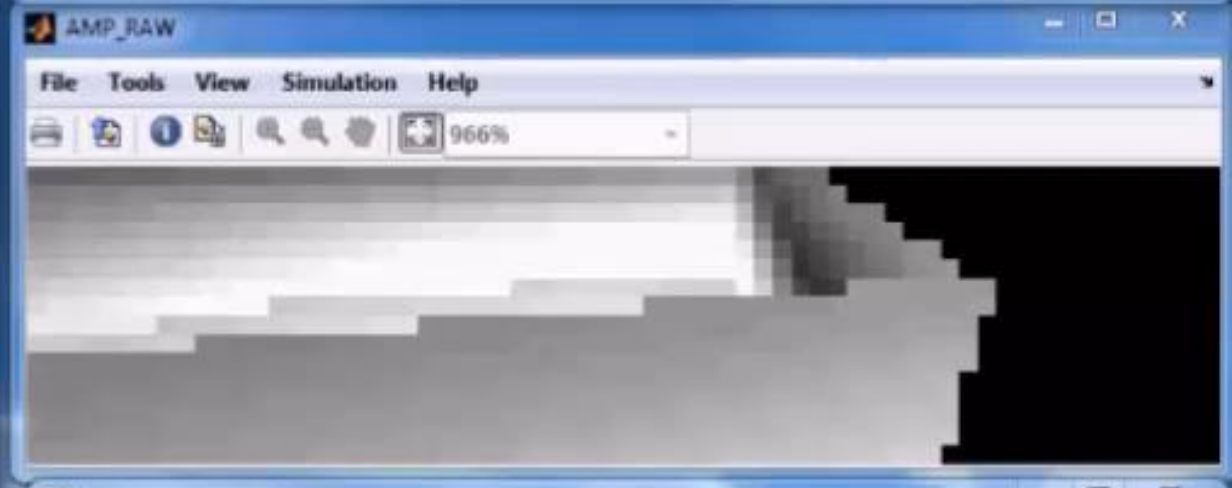
Decide & Plan

Act




Intellifill Sim [Direct3D 9.0] FPS: 6


DIST_RAW
File Tools View Simulation Help
963%


AMP_RAW
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0133
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Autonomous Trailer Filling

Sense

Perceive

Decide & Plan

Act

Embedded Platform MPC5121e

3D Camera

- User Input
- Visualization
- Computer Vision
- Controls

Embedded Coder

CAN

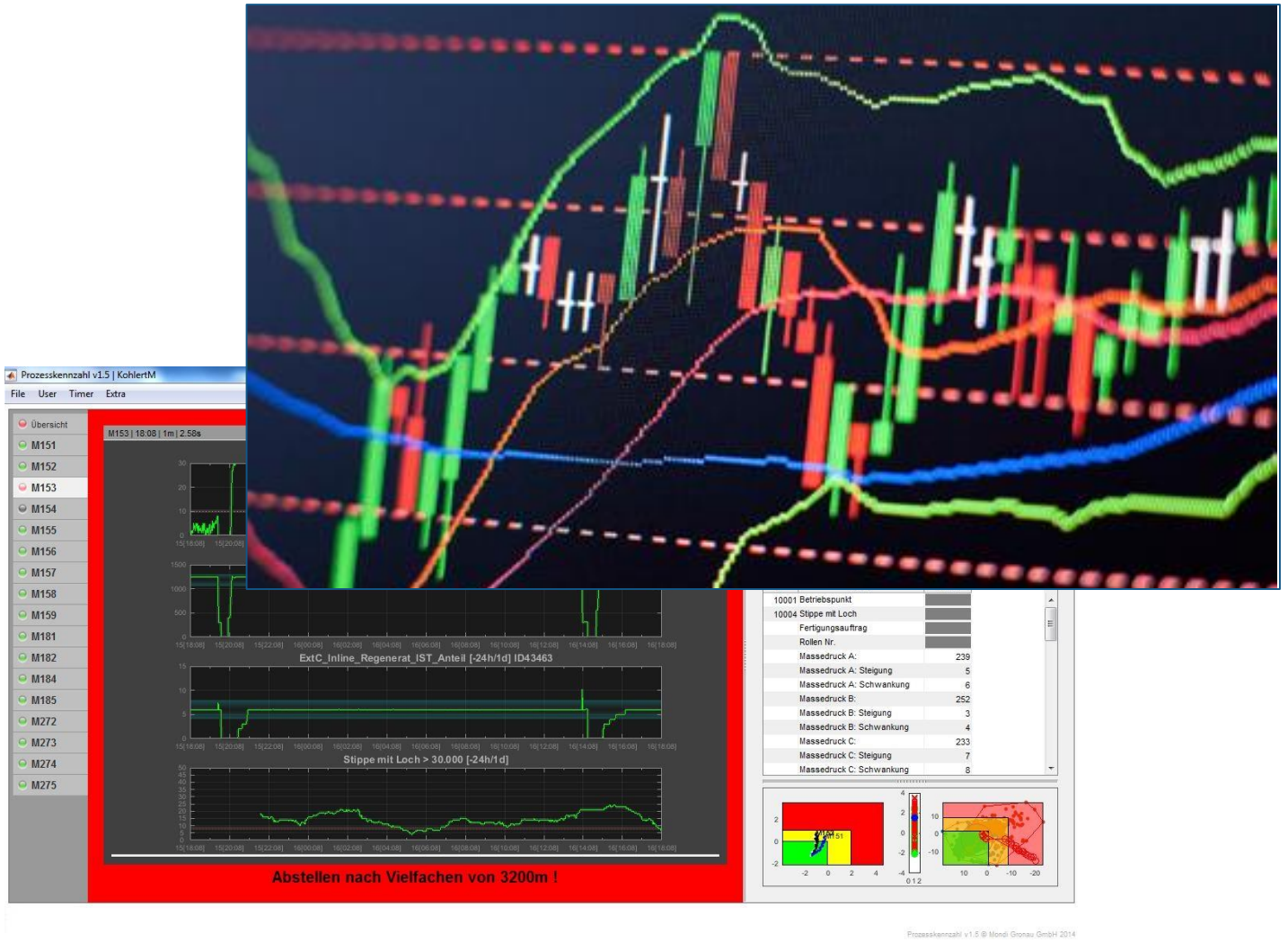
Actuators

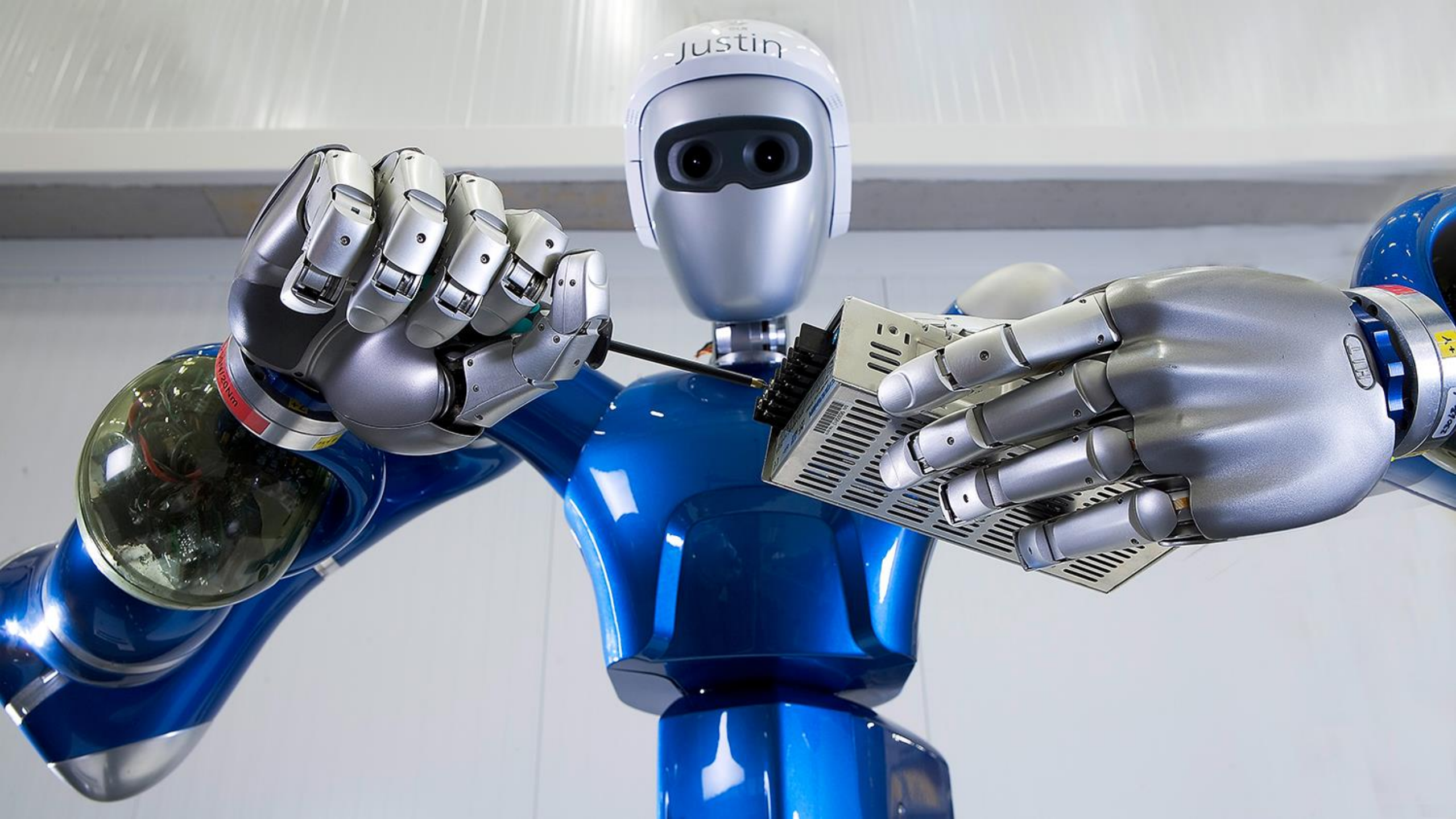
ECU

Monitoring

How will you put it into production?

- Embedded Systems
- IT Systems
- Desktop Apps




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

What is ***your***
autonomous anything?