MATLAB EXPO 2017
How to build an autonomous anything

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Application Engineering
MathWorks
Well, hello Sunshine. What’s for breakfast?
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

Sense
Perceive
Capabilities of an Autonomous System

- Sense
- Perceive
- Decide & Plan
Capabilities of an Autonomous System

Sense

Perceive

Decide & Plan

Act
Autonomous Technology Transfers Responsibility to Computers

Responsibility vs. Degree of Autonomy

Human

Computer
Bazille’s Studio
Bazille 1870

Shuffleton’s Barbershop
Rockwell 1950
Autonomous Artistic Style Classification
Rutgers University

Sense

Perceive

Decide & Plan

Act

Machine Learning Classification

Style Classifier (SVM)

Genre Classifier (SVM)

Artist Classifier (SVM)

Style: Regionalism

Genre: Interior

Artist: Rockwell

Image Feature Extraction

Visual Features
Where to add autonomy with perception?

- Analyze more data
- Reduce bias
- Reduce variability
- Save time
- Improve performance
Where to add autonomy with perception?

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

Determine Loudspeaker Quality

Virtual Semiconductor Manufacturing Calibration

Find out more:
Talk Name
Name of Presenter
Time and Location
Autonomous Service for Predictive Maintenance

Which sensor values should they use?

Sense

Perceive

Decide & Plan

Act

Vibration

Timing

Pressure

Temperature

Other variables
Autonomous Service for Predictive Maintenance

Sense
Perceive
Decide & Plan
Act

Normal Operation
Monitor Closely
Maintenance Needed
What are the best predictors?

- Data
- Models
What are the best predictors?

- Data
- Models

Find out more:
Techniques for Predictive Maintenance

Name of Presenter
Time and Location
Autonomous Glucose Level Management
Autonomous Glucose Level Management
Bigfoot Biomedical

Sense

Perceive

Decide & Plan

Act

Target Glucose Level

Insulin Pump

Continuous Glucose Monitor

Person
Autonomous Glucose Level Management
Bigfoot Biomedical

Sense
Perceive
Decide & Plan
Act

Target Glucose Level
Mobile App
Continuous Glucose Monitor
Insulin Pump
Person
Autonomous Glucose Level Management
Bigfoot Biomedical

Virtual Lab
Simulink, Stateflow
Polyspace

Sense

Perceive

Decide & Plan

Act

Person

Target Glucose Level

Mobile App

Insulin Pump

Continuous Glucose Monitor

Sense
Perceive
Decide & Plan
Act
Autonomous Glucose Level Management
Bigfoot Biomedical

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Mobile App

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Person
Autonomous Glucose Level Management
Bigfoot Biomedical

Sense

Perceive

Decide & Plan

Act

Virtual Clinic
MATLAB, Toolboxes

Target Glucose Level

Mobile App

Insulin Pump

Continuous Glucose Monitor

Person

Sense

Perceive

Decide & Plan

Act

Virtual Clinic
MATLAB, Toolboxes

Target Glucose Level

Mobile App

Insulin Pump

Continuous Glucose Monitor

Person
Virtual Clinic
Generating data through simulation
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)
Where will you get your data?

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

Find out more:
Talk Title

Name of Presenter
Time and Location
CNH Develops Intelligent Filling System for Forage Harvesters
Autonomous Trailer Filling

 Sense

 Perceive

 Decide & Plan

 Act
Autonomous Trailer Filling

Sense

Perceive

Decide & Plan

Act

Computer Vision Algorithms

Control Algorithms

3D Camera Image

3D Scene Simulator

Control outputs
Autonomous Trailer Filling

- **Sense**
- **Perceive**
- **Decide & Plan**
- **Act**

Computer vision and controls algorithms

Embedded Platform
MPC5121e

- User Input
- Visualization

CAN

Actuators

ECU
Autonomous Trailer Filling

Sense

Perceive

Decide & Plan

Act

3D Camera

Embedded Coder

Embedded Platform
MPC5121e

- User Input
- Visualization
- Computer Vision
- Controls

Actuators

Monitoring

CAN

ECU
How will you put it into production?

- Embedded Systems
- IT Systems
- Desktop Apps
How will you put it into production?

- Embedded Systems
- IT Systems
- Desktop Apps

Find out more: Techniques for Predictive Maintenance

Name of Presenter
Time and Location
How to build an autonomous anything

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<tr>
<th>Focus on Perception</th>
<th>Use the Best Predictors</th>
<th>Get the Right Data</th>
<th>Flow to Production</th>
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<tbody>
<tr>
<td>Look for autonomy in creative places</td>
<td>Data-driven</td>
<td>Reduce to actionable data</td>
<td>Address the architecture</td>
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<tr>
<td>Do more than manually possible</td>
<td>Model-driven</td>
<td>Take advantage of Big Data</td>
<td>Leverage Model-Based Design for embedded</td>
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<td></td>
<td></td>
<td>Use simulation to supplement available data</td>
<td>Automate integration with enterprise IT systems</td>
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What is *your* autonomous anything?