MATLAB TOUR 2017

How to build an autonomous anything

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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
Bazille’s Studio
Bazille 1870

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

Image Feature Extraction

Machine Learning Classification

Visual Features

Style Classifier (SVM)
- Style: Regionalism

Genre Classifier (SVM)
- Genre: Interior

Artist Classifier (SVM)
- Artist: Rockwell

Machine Learning Classification

Sense

Perceive

Decide & Plan

Act

Sense

Perceive

Decide & Plan

Act
Where to add autonomy with perception?

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

Determine Loudspeaker Quality

Virtual Semiconductor Manufacturing Calibration
Autonomous Service for Predictive Maintenance

Which sensor values should they use?

Sense

Perceive

Decide & Plan

Act

Pressure

Vibration

Timing

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
Autonomous Glucose Level Management
Autonomous Glucose Level Management
Bigfoot Biomedical

Virtual Clinic
MATLAB, Toolboxes

Target Glucose Level

Mobile App

Continuous Glucose Monitor

Insulin Pump

Person

Sense
Perceive
Decide & Plan
Act
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)
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**

### Embedded Platform
MPC5121e
- User Input
- Visualization
- Computer Vision
- Controls

- **3D Camera**
- **Embedded Coder**
- **CAN**
- **ECU**
- **Actuators**

**Monitoring**
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?