Incorporating Machine Vision into an Industrial Robotics Course

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Overview

- The presentation will illustrate how machine vision may be incorporated into a traditional industrial robotics university course of study.
- The presenters will provide curriculum, sample exercises, and Youtube video modules to assist faculty interested in modernizing their robotics course through the incorporation of machine vision.

NEED

- Today's applied engineering students need to be exposed to industrial robots outfitted with modern machine vision technology.
- Controls/automation engineers will rely on these technologies as they automate our manufacturing processes in order to compete in the global marketplace.

Industrial Robots and Robotic Vision

According to the Association for Advancing Automation's Annual report for 2017

- North American had sales of $1.9 billion
- Machine vision grew 14% to $2.6 billion
- 2018 sales are expected to grow

https://global.epson.com/newsroom/2018/news_20180522_2.html

https://www.a3automate.org/robotics-vision-motion-control-industries-set-new-growth-records-2017/

Active vs. Passive Compliance

Passive - The robot end effector will move to a predetermined position every time.

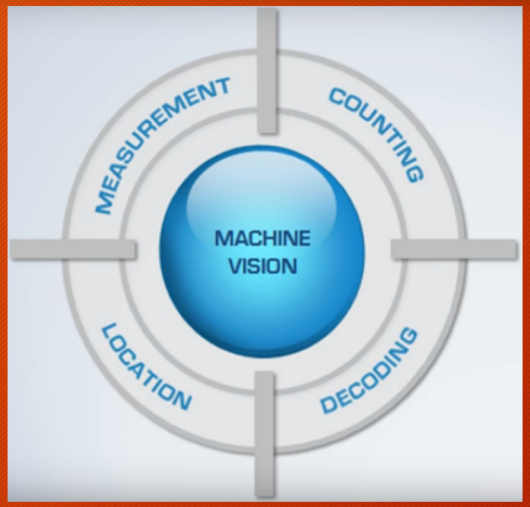
https://www.youtube.com/watch?v=oXQxM8fE3c0

Active - The robot end effector will move to a different position every time based on the parts location.

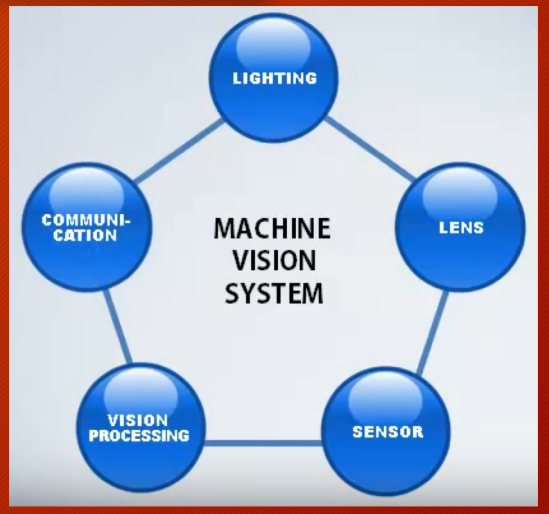
https://www.youtube.com/watch?v=aK2kXyfMPtY

New Machine Vision Curriculum

- Machine Vision
  - Programming Techniques
  - Measurement
  - Counting
  - Decoding
  - Location
- Benefits
  - Reduce defects
  - Increase yield
  - Track and trace
  - Comply with regulations
- Fundamental of Lighting
  - Illumination Principles
  - Types/Sources of lighting
  - Lighting variants and accessories



https://www.youtube.com/watch?v=TTnho9-i6dI



https://www.youtube.com/watch?v=aq4EHRHVOdc

http://sites.millersville.edu/jwright/425%20Syllabus%20sp%202018.pdf

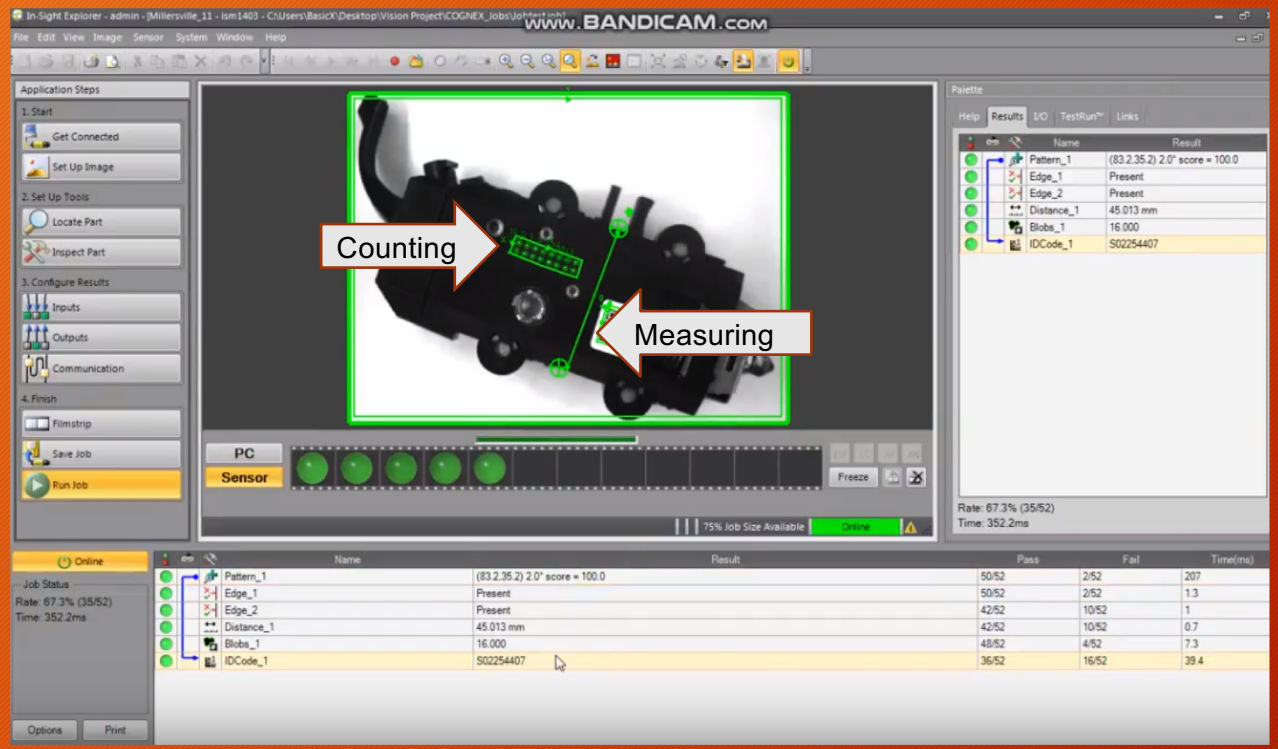
MU's Industrial Robotics - Laboratory Exercises

- Lab 1 – MELFA-Basic V. Programming Basics (Teaching Points & Manipulating Speed)
- Lab 2 – MELFA-Basic V. Programming Basics (Linear and Circular Motion Interpolation)
- Lab 3 – MELFA-Basic V. Programming Basics (Gripper Control, For/Next Loops, Subroutines)
- Lab 4 – MELFA-Basic V. Programming Basics (Palletizing)
- Lab 5 – End-of-Arm Tooling (Classifications, Gripper Force Calculations, & Applications)
  - Machine Vision YouTube Overview Tutorial
- Lab 6 – Cognex In-Sight (Measurement & Counting Tools)
- Lab 7 – Cognex In-Sight (Decoding & Location Tools)
  - Mitsubishi/Cognex Interface YouTube and Written Tutorials
- Lab 8 – Cognex & Mitsubishi Interface (Object Recognition & Moves)
- Lab 9 – Object Tracking (Active Compliance)
- Lab 10 – Cost Justification (Payback Period, ROI, FV & NPW)

MITSUBISHI

COGNEX

Measurement & Counting Lab



Machine Vision
Lab 6 – Cognex In-Sight (Measurement & Counting Tools)
ITEC 425, Industrial Robotic Systems
Mr. Michael Wiles, December 2017
Edited by Dr. John Wright, January 2018
Department of Applied Engineering, Safety & Technology

Objectives:

Upon conclusion of this activity each student will be able to:

1. Identify the advantages and disadvantages of the *measurement* and *counting* methods associated with using COGNEX In-Sight Micro-Vision System for quality control applications.
2. Test an actual part by moving it within the camera's view and observe the *pass* or *fail* status as the camera image is compared against the running Job file.

Questions:

1. Define the function of *measurement tools*.
2. Define the function of *counting tools*.
3. For each technique list two possible applications where they may be used.
4. Compare and contrast *measurement* and *counting tool* functions.

Measurement & Counting Lab

PART 1 (Measurement Tools)

This activity introduces basic measurement tools utilized by the *COGNEX In-Sight EasyBuilder* software. *Measurement tools* are used to measure distances, diameters, angles and area of features in the image.

Directions:

Using the skills developed in the introductory vision activity select an available object that fits within the camera view for identification. After receiving instructor approval, create a basic Job locating the part and then, using one of the *measurement tools*, inspect a distinct feature of the object. Reposition the object into different orientations and observe when the Job recognizes a *pass* or *fail*.

**Refer to "http://sites.millersville.edu/jwright/" for video tutorial "Machine Vision – Measurement" for assistance.*

Sketch the object and features used.

Instructor Initials

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PART 2 (Counting Tools)

This exercise introduces basic *counting tools* utilized by the COGNEX In-Sight EasyBuilder software. *Counting tools* are used to count types of features in the image.

Directions:

Using the skills developed in the introductory vision activity select an available object that fits within the camera view for identification. After receiving instructor approval, create a basic Job locating the part and then, using one of the *counting tools*, inspect a distinct feature of the object. Reposition the object into different orientations and observe when the Job recognizes a *pass* or *fail*.

**Refer to "http://sites.millersville.edu/jwright/" for video tutorial "Machine Vision – Counting" for assistance.*

Sketch the object and features used.

Instructor Initials

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Barcode Decoding & Location Lab

https://www.youtube.com/watch?v=dC_kCNZLVwU

Machine Vision
Lab 7 – Cognex In-Sight (Decoding & Location Tools)
ITEC 425, Industrial Robotic Systems
Mr. Michael Wiles, December 2017
Edited by Dr. John Wright, January 2018
Department of Applied Engineering, Safety & Technology

Upon conclusion of this activity each student will be able to:

1. Identify the advantages and disadvantages of the *decoding* and *location* methods associated with using COGNEX In-Sight Micro-Vision System for quality control applications.
2. Test an actual part by moving it within the camera's view and observe the *pass* or *fail* status as the camera image is compared against the running Job file.

Questions:

1. Define the function of *identification (decoding) tools*.
2. Define the function of *presence/absence (location) tools*.
3. For each technique list two possible applications where they may be used.
4. Compare and contrast *identification (decoding)* and *presence/absence (location) tool* functions.

Barcode Decoding & Location Lab

PART 1 (Decoding Tools)

This laboratory experiment introduces basic *decoding tools* utilized by the *COGNEX In-Sight EasyBuilder* software. *Decoding tools* are used to identify and verify one-dimensional (1D) and two-dimensional (2D) codes and symbols, alphanumeric text, pattern features and colors in the image.

Directions:

Using the skills developed in the introductory vision activity select an available object that fits within the camera view for identification. After receiving instructor approval, create a basic Job locating the part and then, using one of the *Identification/Decoding* tools, inspect a distinct feature of the object. Reposition the object into different orientations and observe when the Job recognizes a *pass* or *fail*.

**Refer to "http://sites.millersville.edu/jwright/" for video tutorial "Machine Vision – Decoding" for assistance.*

Sketch the object and features used.

Instructor Initials

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PART 2 (Location Tools)

This laboratory experiment introduces basic *location* tools utilized by the *COGNEX In-Sight EasyBuilder* software. *Location tools* are used to qualify whether or not there is a feature, in a particular relative orientation, present in the image.

Directions:

Using the skills developed in the introductory vision activity select an available object that fits within the camera view for identification. After receiving instructor approval, create a basic Job locating the part and then, using one of the *location tools*, inspect a distinct feature of the object. Reposition the object into different orientations and observe when the Job recognizes a *pass* or *fail*.

**Refer to "http://sites.millersville.edu/jwright/" for video tutorial "Machine Vision – Location" for assistance.*

Sketch the object and features used.

Instructor Initials

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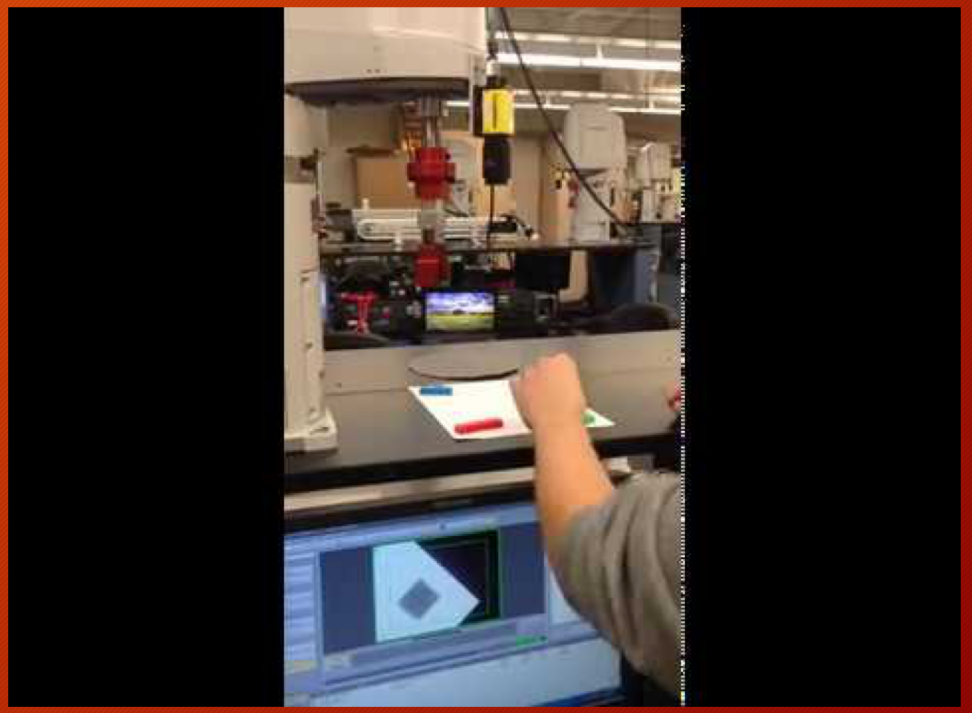
https://www.youtube.com/watch?v=dC_kCNZLVwU

Object Recognition & Moves Lab

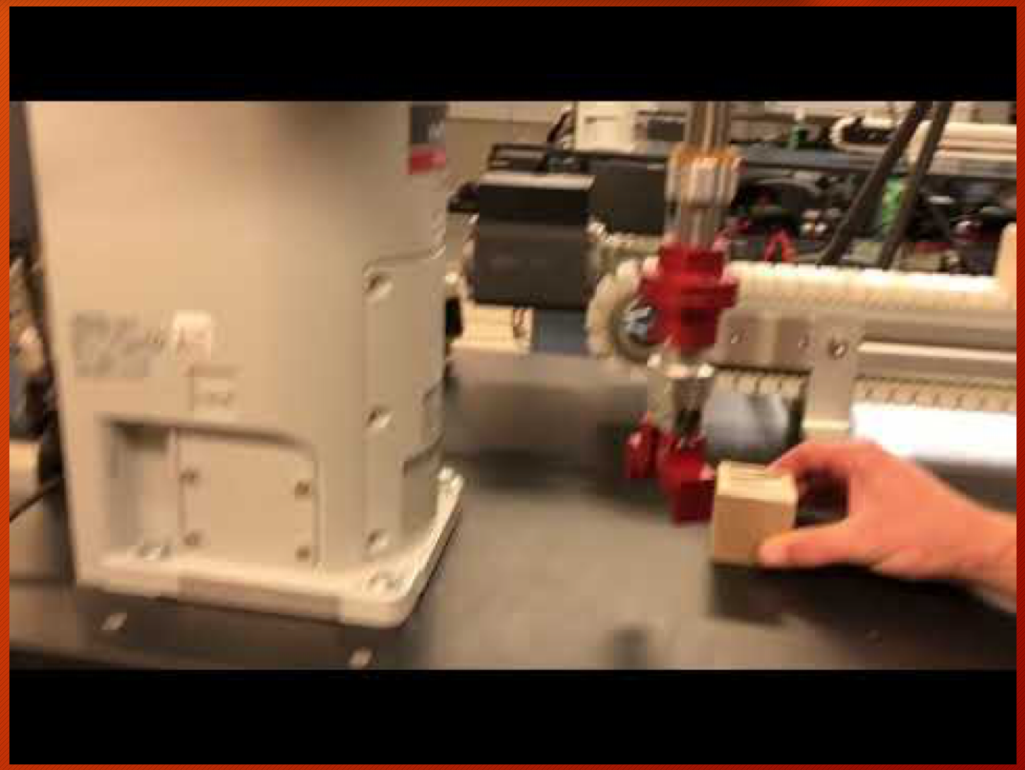
https://www.youtube.com/watch?v=0vptdy6UgKE



https://www.youtube.com/watch?v=rjqi5ffOeY0

Object Tracking Lab

- Active compliance object tracking
- Active pick
- Passive place



https://www.youtube.com/watch?v=faTmwMiJNao

Results & Recommendations

- Experience as a Student
  - Ups and Downs
  - Learning the language
  - Networking the Devices
  - Computer Science vs Real World

Summary

- Today's applied engineering students need to be exposed to industrial robots outfitted with modern machine vision technology.
- Controls/automation engineers will rely on these technologies as they automate our manufacturing processes in order to compete in the global marketplace.
- Once students master the setup/networking of the devices, they quickly grasp and enjoy the use of machine vision technology which now allows them to design much more intelligent automated cells.

Contact Information

All presentations can be found on

- http://sites.millersville.edu/jwright/

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