MET-1340: INTRODUCTION TO INDUSTRY 4.0 VISION SYSTEMS

Cuyahoga Community College

Viewing: MET-1340 : Introduction to Industry 4.0 Vision Systems

Board of Trustees:
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Academic Term:
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Subject Code
MET - Mech Eng/Manuf Ind Eng Tech

Course Number:
1340

Title:
Introduction to Industry 4.0 Vision Systems

Catalog Description:
The students learn the concepts of Smart manufacturing, (Industry 4.0) ; theories behind the factory of future, lean concepts, maximizing efficiency, recognizing and eliminating waste. Vision system components, programming, error recovery, and inspection process; introduction to Human-Machine Interface (HMI), manufacturing execution system (MES), RFID, barcoding, vision inspection. Prepares students for Fanuc Vision System Certification.

Credit Hour(s):
4

Lecture Hour(s):
2

Lab Hour(s):
6

Requisites

Prerequisite and Corequisite
MET-1120 Computer Applications and Programming.

Outcomes

Course Outcome(s):
Apply knowledge of manufacturing principles.

Objective(s):

a. Explain the relationship between process, design, and material in manufacturing.
b. Use the taxonomy of manufacturing processes to locate and describe manufacturing processes.
c. Analyze product features to identify manufacturing processes that may have been used.
d. Describe examples of how different manufacturing processes can be used to produce the same product.
e. Suggest manufacturing processes required to make a product design from an engineering drawing and explain why the recommended suggestions were made.
f. Describe and interpret manufacturing process data (including materials, machines, and process parameters) in reference manuals.
g. Read measuring and inspection tools used in the machine shop.
h. Measure, inspect parts, features characteristics using steel rule, vernier high gage and gage block, micrometers, calipers, divider, center-punches and scribers.

Course Outcome(s):

Explain the basic concept of smart manufacturing and identify the components of industry 4.0 and how it differs from traditional manufacturing.

Objective(s):

a. Discuss theories behind the factory of the future.
b. Explain lean concepts and how it maximizes efficiency and eliminates waste.
c. Identify and explain Vision system components, programming, error recovery, and inspection process.
d. Describe the Human-Machine Interface (HMI).
e. Describe the Manufacturing Execution System (MES), Radio Frequency Identification (RFID), barcoding, vision inspection-learn PLC operation and their roles in controlling processes.

Course Outcome(s):

Describe Smart manufacturing/industry 4.0 and evaluate and understand automation and vision system in modern manufacturing environments.

Objective(s):

a. Discuss concepts of industry 4.0/ smart manufacturing.
b. Identify operations and components of factory of the future/Industry 4.0.
c. Describe the use of vision system in automating different types of equipment.

Course Outcome(s):

Establish robot-to-computer communication.

Objective(s):

a. Identify all components involving robot to computer communication.
b. View and/or change parameters in the robot and computer to facilitate communication.
c. Test communication.
d. Access the robot's web page in order to setup vision.
e. Check and/or change the robot IP address.
f. Check and/or change the computer IP address.
g. Ping devices to ensure good communication.
h. Access robot web page.
i. Use robot web page to access vision setup screen.

Course Outcome(s):

Perform error recovery.

Objective(s):

a. Check for impediments to servo power-up.
b. Remove impediments to servo power-up.

Course Outcome(s):

Create a frame.

Objective(s):

a. Create tool frame for robot applicator.
b. Create user frames necessary for use with vision system.
c. Program and use a tool frame.
d. Program a user frame to use as an offset frame.
e. Program a user frame using the calibration grid.

Course Outcome(s):

Set up an inspection process.

Objective(s):

a. Setup the camera.
b. Train the vision system to recognize the part.
c. Program the robot for vision interface and part handling.
d. Setup the criteria upon which judgement will be made.

Course Outcome(s):

Setup 2D or 3D single view process (Class Dependent).

Objective(s):

a. Setup the camera.
b. Calibrate the camera.
c. Setup the vision process.
d. Program the robot to respond to vision results.

Methods of Evaluation:

a. Quizzes
b. Text assignments
c. Tests
d. Laboratory assignments
e. Participation
f. Instructor observation/evaluation of student lab exercise performance
g. Certification exam

Course Content Outline:

a. Manufacturing principles and processes
    i. Traditional manufacturing principles and processes
    ii. Contemporary manufacturing principles and processes
    iii. Measuring techniques
    iv. Inspection techniques
b. Factory of the future
    i. New technologies are profoundly changing industrial production
    ii. What will the factory of the future be like?
    iii. How revolutionary technologies meet an adaptable and digitally minded engineering workforce to create incredible solutions to the problems of tomorrow
c. Lean concepts
    i. DMAIC method
        1. Define
        2. Measure
        3. Analyze
        4. Improve
        5. Control
    ii. Defining value
    iii. Mapping the value stream
    iv. Waste elimination
    v. Create flow
    vi. Using pull system
    vii. Pursuing perfection
d. HMI and MES

i. Human Machine Interface
ii. HMI basics
iii. HMI & operator interface in automation process

e. Vision system in industry setting
i. Setup the camera.
ii. Train the vision system to recognize the part.
iii. Program the robot for vision interface and part handling.
iv. Setup the criteria upon which judgement will be made

f. Robot safety
i. Keeping people safe
ii. Using safety-enhancing devices
iii. Setting up a safe work cell
iv. Safety during automatic operation

g. Setup an inspection process
i. Single view inspection process
ii. 2-D multi-view vision process
iii. 3-D inspection process
iv. Setup the camera
1. Lens
2. Camera cable
3. Multiplexor
4. Communication cable
5. Calibration grid
6. Laser vision sensor
7. 3D Multiplexer
v. Train the vision system to recognize the part
vi. Program the robot for vision interface and part handling
vii. Camera properties
1. Focal Length
2. CCD (Charge Coupled Device) width
3. Standoff
4. Field of view
viii. Setup 2D or 3DL single view process
1. Calibration screens for 2D vision
2. Calibration procedure for 2D vision
3. Height variations
4. Perspective calibration
5. Orthogonal calibration
6. Process screens for 2D vision
7. Single view process setup procedure for 2D
8. Program the robot to respond to vision results

h. Robot to computer communication
i. Components
ii. Robot and computer parameters for communication
iii. How to test communication
iv. How to access the robot web page in order to setup vision
1. Access vision set up screen
2. Perform setup of vision
v. How to check and/or change the robot IP address
vi. How to check and/or change the computer IP address
vii. How to ping devices to ensure good communication
viii. How to access robot web page
ix. Use robot web page to access vision setup screen

i. Perform error recovery
i. How to check for impediments to servo power-up
ii. How to remove impediments to servo power-up

j. Tool frames

i. Tool frame overview
ii. Tool frames for vision
iii. Tool frame for robot applicator
iv. User frames necessary for use with vision system
v. Use a tool frame
vi. Offset user frame
vii. Teaching the calibration grid frame
    1. Using the four point method
    2. Using the five point method

Resources

Andrew Kelleher, Adam Kelleher. *Applied Machine Learning for Data Scientists and Software Engineers: Framing--The First Steps Toward Successful Execution*. 1st. 2018.

Batchelor, Bruce G. *Machine Vision Handbook*. 1. 2012.

E. R. Davies. *Computer Vision*. 5th. Academic Press, 2017.

Manuela Chessa, Fabio Solari and Silvio P. Sabatini. *Human-Centric Machine Vision*. 1st. Intech, 2012.

Karabegovi, Isak. *Handbook of Research on Integrating Industry 4.0 in Business and Manufacturing (Advances in Business Information Systems and Analytics (Abisa)*. Hershey, PA: IGI Global, 2020.

Koc, Muammer and Tugrul Ozel. *Modern Manufacturing Processes*. Wiley, 2019.

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