Introduction to Machine Vision for New Users

Part 1 of a 3-part webinar series: *Introduction to Machine Vision*
About your Instructors

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Today’s Objectives

By the end of this Webinar, you will know:

- What is Machine Vision
- How Machine Vision can be used in different applications
- What makes a Machine Vision system
Today’s Topics

Today we will discuss:

- What is Machine Vision?
- Why Use Machine Vision?
- Parts of a Machine Vision system
What is Machine Vision?

Automatic extraction of information from digital images.

The most popular Machine Vision applications include:

1. **Measure**: measure a part and check to tolerances.
2. **Decode**: 1D codes, 2D symbols, and OCR reading.
3. **Count**: find the number of parts or features on a part.
4. **Locate**: report the position and orientation of a part.

*It’s not magic!*

Arthur C. Clarke’s Third Law:
Any sufficiently advanced technology is indistinguishable from magic.
1. Measure

Automated measurement, and then check to specified tolerances.

Measuring a spark plug for proper gap tolerance
2. Decode

Decode 1D or 2D Symbologies, read OCR.

- Record information for historical data
- Use information for immediate action
- Validate the data for correctness

OCR on cans used to identify contents

1D and 2D symbols

DPM Data Matrix
3. Count

Find a number of parts or features on a part.
- Missing parts/proper assembly
- Presence: is it there or not?
- Identify quantity

Count the number of sodas in an 8-pack

Counting the holes drilled in a machined block of aluminum
4. Locate

Report the position and orientation of a part.

- Locate position and orientation then check to specified tolerances
- Report information to another device for guidance
- Use for alignment of other Machine Vision tools
- Find a unique pattern to identify the part

Search for a pattern to identify a product

Locate tools can align images for other tools
Why Use Machine Vision?

- Reduce Defects
- Track WIP
- Increase Yield
- Comply with Regulations
- Machines don’t get tired
Parts of a Machine Vision System

1. Lighting
   The most critical piece, illuminates the part

2. Lens
   Delivers image to the sensor

3. Sensor
   Captures light and converts it to a digital image

4. Vision Processing
   Looks at the picture to extract features

5. Communicate
   Report the results to the world, can be data or discrete I/O

Example component system

Examples of integrated systems

2D imagers use the same parts as a Machine Vision system
1. Lighting and the part

Proper lighting is essential to a successful Machine Vision application.

- Why is lighting so important?
- Select the right light and geometry:
  - Reveal the part’s features
  - Minimize everything else

If the feature cannot be seen, it cannot be measured
2. Lens

Delivers the image to the sensor.

- Determines the Field of View, Depth of Focus, and Focal Point
- Interchangeable: C-mount
- Fixed: auto-focus

12mm: larger Field of View
25mm: magnified image
3. Sensor

Captures light and converts it to a digital image.
4. Vision Processing

Extracting useful information from images

- **Acquire image**: Collect the image that was captured by the sensor/lens
- **Image Pre-processing**: Modify the image to make features stand out
- **Image Analysis**: Extract features from the image
- **Geometry & Tolerance**: Measure features and compare to specification
- **Results**: Communicate Pass/Fail

- Counting PCB pads using blobs
- Measure using edge tools
- Locate a part by searching for unique features
5. Communicate

Report the inspection results.

- **Discrete I/O**: Trigger inspection, drive indicator lights, PLCs, diverters
- **Data**: send data over RS-232, Ethernet, Ethernet/IP…

A PLC can collect data and discrete I/O signals

Integrated systems have I/O built in

Electrical signals can be sent to a diverter to remove faulty items, and to a stack light to warn operators

HMI screens can display Machine Vision inspection status
Parts of a Machine Vision System

**Putting it together:** Check fill level and cap installation

1. Trigger the inspection (Communicate)
2. Illuminate the bottle (Lighting)
3. Capture the image (Lens and Sensor)
4. Run Machine Vision tools (Vision Processing)
5. Show results to an HMI (Communicate)
6. Send a signal to a reject device (Communicate)
Conclusion

- Machine Vision can be used to automate manual tasks
  - Measure
  - Count
  - Decode
  - Locate

- There are five key components to a vision system:
  - **Part/Lighting**: the features to be extracted must stand out consistently
  - **Lens**: select the proper lens combination to deliver best Field of View and Depth of Focus to the sensor
  - **Sensor**: the sensor type and number of pixels is important to acquire a good image
  - **Vision Processing**: extract useful information from an image
  - **Communicate**: send the results in a way that is useful
Choosing the Right Machine Vision Applications

- Successful Machine Vision Applications
- Questionable Machine Vision Applications
- Machine Vision Hardware Platforms

Introduction to Machine Vision Webinar series:
Today: Introduction to Machine Vision for New Users
December 10: Choosing the Right Machine Vision Applications
December 17: Machine Vision Tools for Solving Auto ID Applications