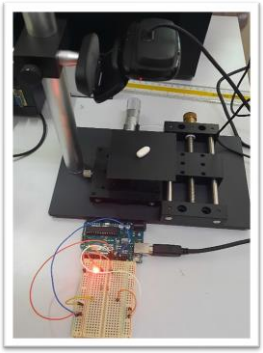
Training Workshop on

MACHINE VISION (LIGHTING, OPTICS & CAMERAS)



by

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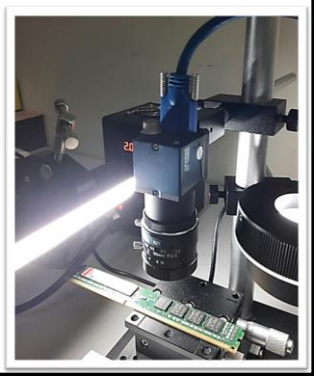
MMR Training and Consulting



Course outcomes

- Simplify machine vision solutions by exploiting and/or imposing constraints
- Select correct lighting type for a range of applications
- Determine pulse width required in high-intensity strobe lighting
- Assess consistency and uniformity of machine vision lighting
- Understand various camera and imaging parameters
- Select suitable camera sensor resolution
- Determine maximum exposure to prevent motion blur
- Select suitable lens for optimum magnification and image quality
- Investigate effect of f-number on depth-of-field and image quality
- Determine spatial resolution of imaging system
- Determine data transfer rate for high-speed application
- Understand various camera interface types and applications
- Select suitable camera interface type for given application

Course content

Part 1 - Scene constraints

- The generic machine vision model
- Principal aims of scene constraints
- Exploited vs. imposed constraints
- Methods of exploitation of constraints
- Methods of imposition of constraints
- *Activity 1* : Human as the ultimate machine vision system
- *Activity 2* : Simplify the machine vision problem
- *Activity 3a,b,c,d,e* : Identify the constraints that can be exploited and/or imposed
- *Activity 4* : Suggest improvements to an existing machine vision system
- *Activity 5* : Simplify machine vision problem

Part 2 - Machine Vision Lighting

- Aims of machine vision lighting
- Types of machine vision lighting and applications
- Spectral content of vision illumination source
- Lighting for multispectral and hyperspectral imaging
- Factors affecting lighting selection
- Factors affecting consistency of lighting
- *Activity 6* : Identify machine vision lighting types
- *Activity 7* : Match lighting type with image
- *Activity 8 (P)* : Effect of lighting type on object features
- *Activity 9* : Determine pulse width required in strobe lighting
- *Activity 10* : Select lighting using scene characteristics
- *Activity 11a (P)* : Determine consistency of lighting
- *Activity 11b (P)* : Determine uniformity of lighting

Part 3 - Machine Vision Optics

- Common imaging terms
- Lens mount types vs. sensor size
- Focal length and magnification vs. sensor dimensions
- f-number and numerical aperture vs. depth of focus
- Depth of field vs. depth of focus
- Resolving power of lens vs. sensor resolution
- Basics of image formation
- Telecentric lenses and their uses
- *Activity 12*: Determine focal length and select lens
- *Activity 13 :* Increase magnification using extension tube
- *Activity 14* : Effect of *f*-number and gain on image quality
- *Activity 15 (P)*: Capture image of IC chip to fill 90% sensor area

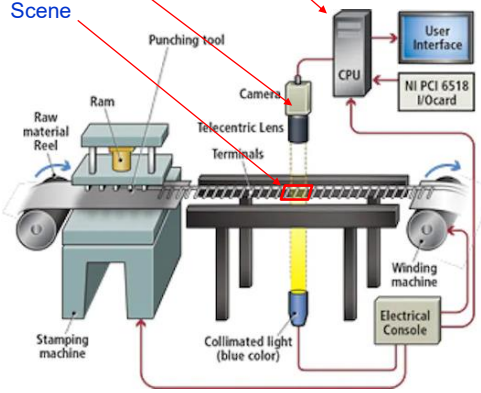
Part 4 - Machine Vision Cameras

- Camera selection process
  - color vs. monochrome
  - sensor resolution
  - frame rate, shutter speed vs. exposure time
  - global vs. rolling shutter
  - data transfer rate & camera interface
  - spectral response of sensor
- Sampling vs. quantization
- Interlace vs. progressive scan
- CCD vs. CMOS sensors
- Sensor format and dimensions
- *Activity 16* : Minimum camera sensor resolution needed
- *Activity 17* : Minimum exposure time to freeze motion
- *Activity 18*: Determine number of uncompressed images that can be stored on 32 GB SD card
- *Activity 19*: Determine the data transfer rate and camera interface
- *Activity 20* : Design a machine vision solution (*Open-ended group*)

Pre-processing
Segmentation
Feature extraction
Classification /interpretation

Image acquisition

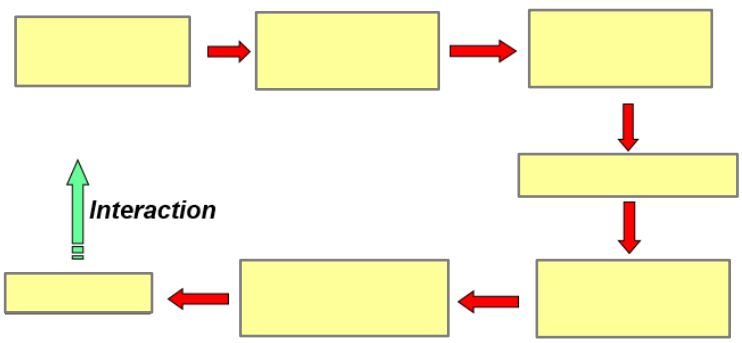
Scene



High speed vision system inspects stamped terminals | Vision Systems Design (vision-systems.com)

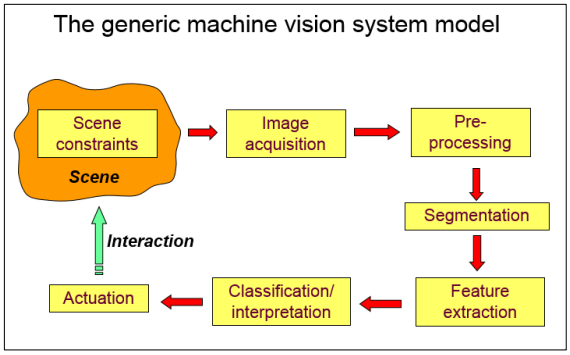
LEARNING POINT 1

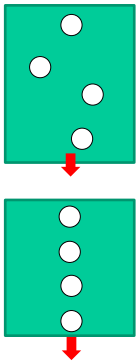
Name the seven elements of a generic vision system model. Which of these involve hardware?



1.1 What are scene constraints?

- Restrictions available in the scene or applied onto the scene to simplify subsequent stages in the machine vision system development





1.2 Aim of scene constraints

- Principal aims of scene constraints:

  i) Maximize use of prior knowledge about the scene

  ii) Make the problem of image analysis as simple as possible

  - Reduce unnecessary image processing stages
  - Shorten software development time
  - _____
  - _____
  - _____
  - _____

Activity 3a – Identify the constraints that are exploited and/or imposed in the following application. What simplification is made in each case?

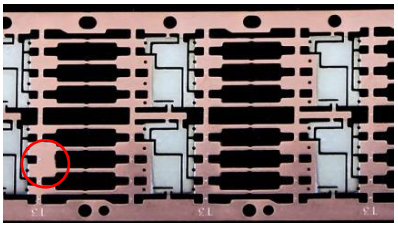
Aim: Read label for sorting cookies

Understand your application!

Exploited constraints	Imposed constraints	Simplification made

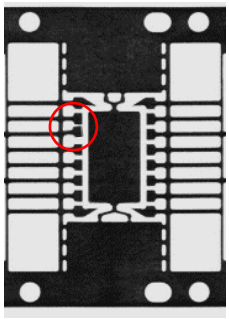
Activity 3b – Identify the constraints you can exploit or impose in the following application. Explain what simplification is made

Aim: Detect stamping defect in a cut leadframe

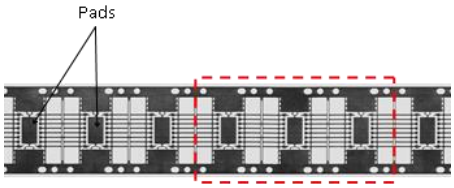


Exploited constraints	Imposed constraints	Simplification made

Activity 3c – Identify the constraints you can exploit or impose in the following application. What simplification is made in each case?

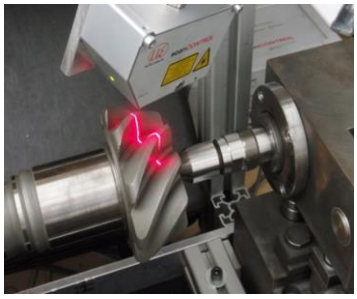


Aim: Detect bent leads



Exploited constraints	Imposed constraints	Simplification made

Activity 3d – Identify the constraints you can exploit or impose in the following application. Explain what simplification is made



Aim: Detect defects on gear

Exploited constraints	Imposed constraints	Simplification made

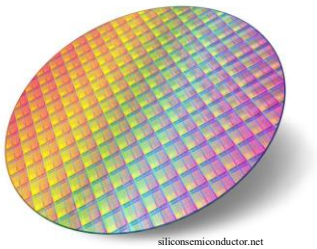
Example 2: Detect scratch marks on a CD

What constraint can be exploited?

What constraint can be imposed?

How is the problem of image analysis made simpler?

Example 4: Detection of defects on patterned wafer



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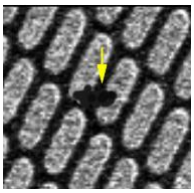

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What is the exploited constraint?

What is the imposed constraint?

How is the problem of image analysis made simpler?