SMJE 4293 Industrial Automation

Machine Vision Systems

PROF MADYA DR. MOHD FAUZI OTHMAN

Electronic System Engineering Department (ESE), Malaysia-Japan International Institute of Technology, Universiti Teknologi Malaysia, Kuala Lumpur.

Centre for Artificial Intelligence and Robotics, Universiti Teknologi Malaysia, Kuala Lumpur.

Phone: +60197120085 (mobile) +60322031530 (office)
Room: 05.27.01 MJIIT Lecturer Room
Email: mdfauzi@utm.my fauzi@fke.utm.my
Website: http://www.fauziothman.com

Expertise: Artificial Intelligence, Soft Computing, Intelligent Control System, Power System Stability, Fault detection and Accommodation, Power System Generation Scheduling, Biomedical Image/Signal Processing

Previous Lecture
Fieldbus

- Definition
- Types of fieldbus loop, devices and software
- Design of a basic fieldbus; control solution
- Configuration of a fieldbus installation
- Troubleshoot and repair of various installation problems
- Specify instrumentation and equipment for a fieldbus solution

Outline

- Vision System Operation
- Charge Couple Device
- Charge Injection Device
- Vision System Integration
- Programming a Vision System

Vision System Operation

- Camera –
  - Device that records images –still or moving
  - consists of an enclosed hollow with an opening (aperture) at one end for light to enter, and a recording or viewing surface for capturing the light at the other end.
  - majority of cameras have a lens positioned in front of the camera's opening to gather the incoming light and focus all or part of the image on the recording surface. The diameter of the aperture is often controlled by a diaphragm mechanism, but some cameras have a fixed-size aperture

Vision System Operation

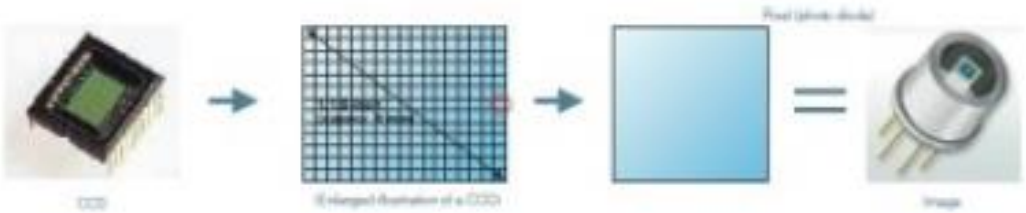
- Traditional Camera:
  - capture light onto photographic film or photographic plate.
  - The lens of a camera captures the light from the subject and brings it to a focus on the film or detector. The design and manufacture of the lens is critical to the quality of the photograph being taken

Vision System Operation

- Digital Camera
  - takes video or still photographs, or both, digitally by recording images via an electronic image sensor
  - Able to:
    - connect directly to a computer to transfer data
    - Image editing
    - displaying images on a screen immediately after they are recorded,
    - recording video with sound,
    - Many more!

CHARGE-COUPLED DEVICE (CCD)

- CCD: a semiconductor element that converts images into digital signals.
- is approx. 1 cm in both height and width, and consists of small pixels aligned like a grid.
- When taking a picture with a camera, the light reflected from the target is transmitted through the lens, forming an image on the CCD. When a pixel on the CCD receives the light, an electric charge corresponding to the light intensity is generated. The electric charge is converted into an electric signal to obtain the light intensity (concentration value) received by each pixel.
- This means that each pixel is a sensor that can detect light intensity (photo diode) and a 2 million-pixel CCD is a collection of 2-million photo diodes.
- A photoelectric sensor can detect presence/absence of a target of a specified size in a specified location.
- A single sensor, however, is not effective for more complicated applications such as detecting targets in varying positions, detecting and measuring targets of varying shapes, or performing overall position and dimension measurements.



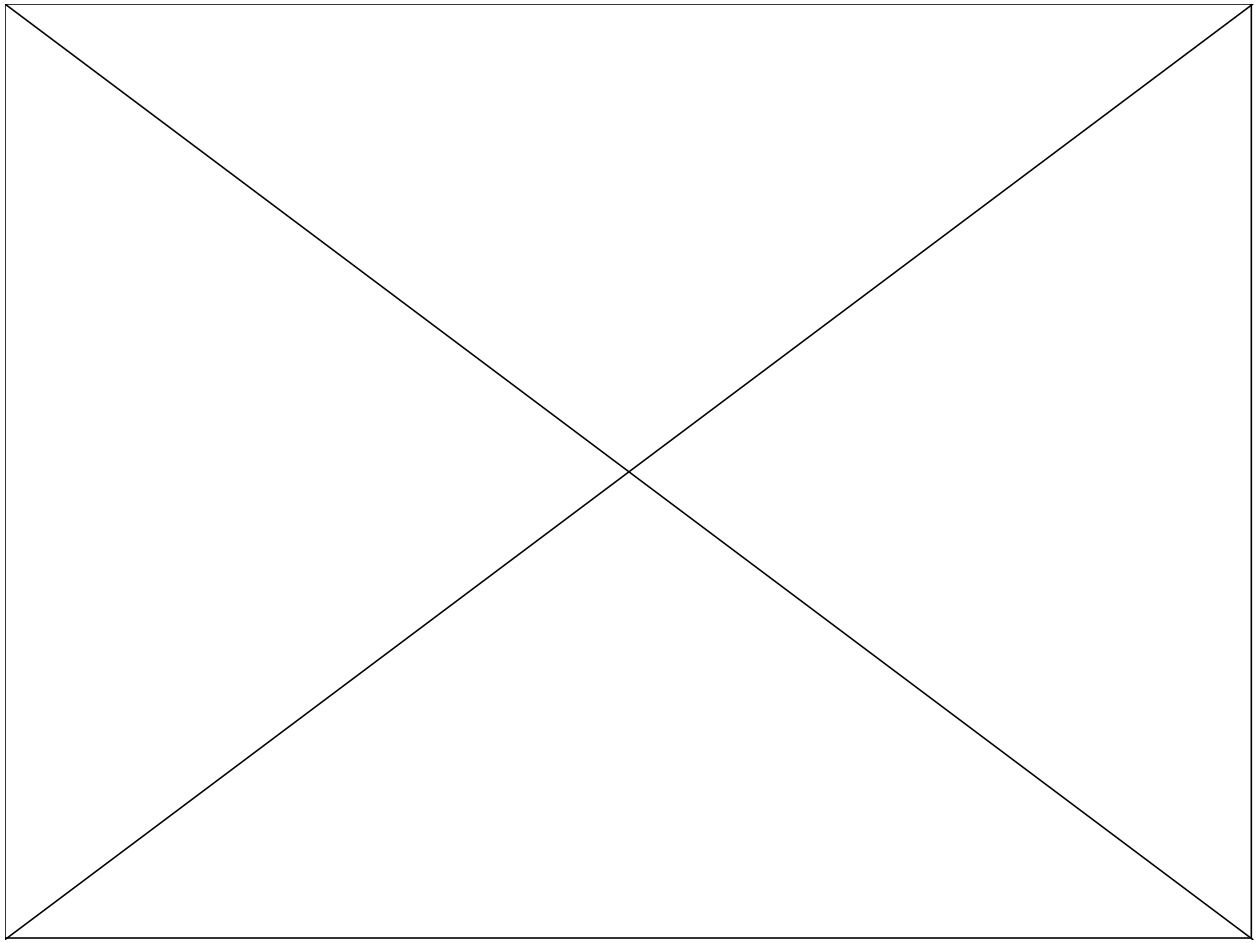
CHARGE-COUPLED DEVICE (CCD)

Complementary metal–oxide–semiconductor (CMOS)

- CMOS (Complimentary Metal Oxide Semiconductor) chips use transistors at each pixel to move the charge through traditional wires. This offers flexibility because each pixel is treated individually. Traditional manufacturing processes are used to make CMOS. It's the same as creating microchips. Because they're easier to produce, CMOS sensors are cheaper than CCD sensors.
- Because CMOS technology came after CCD sensors and are cheaper to manufacture, CMOS sensors are the reason that digital cameras have dropped in price.

CCD vs CMOS

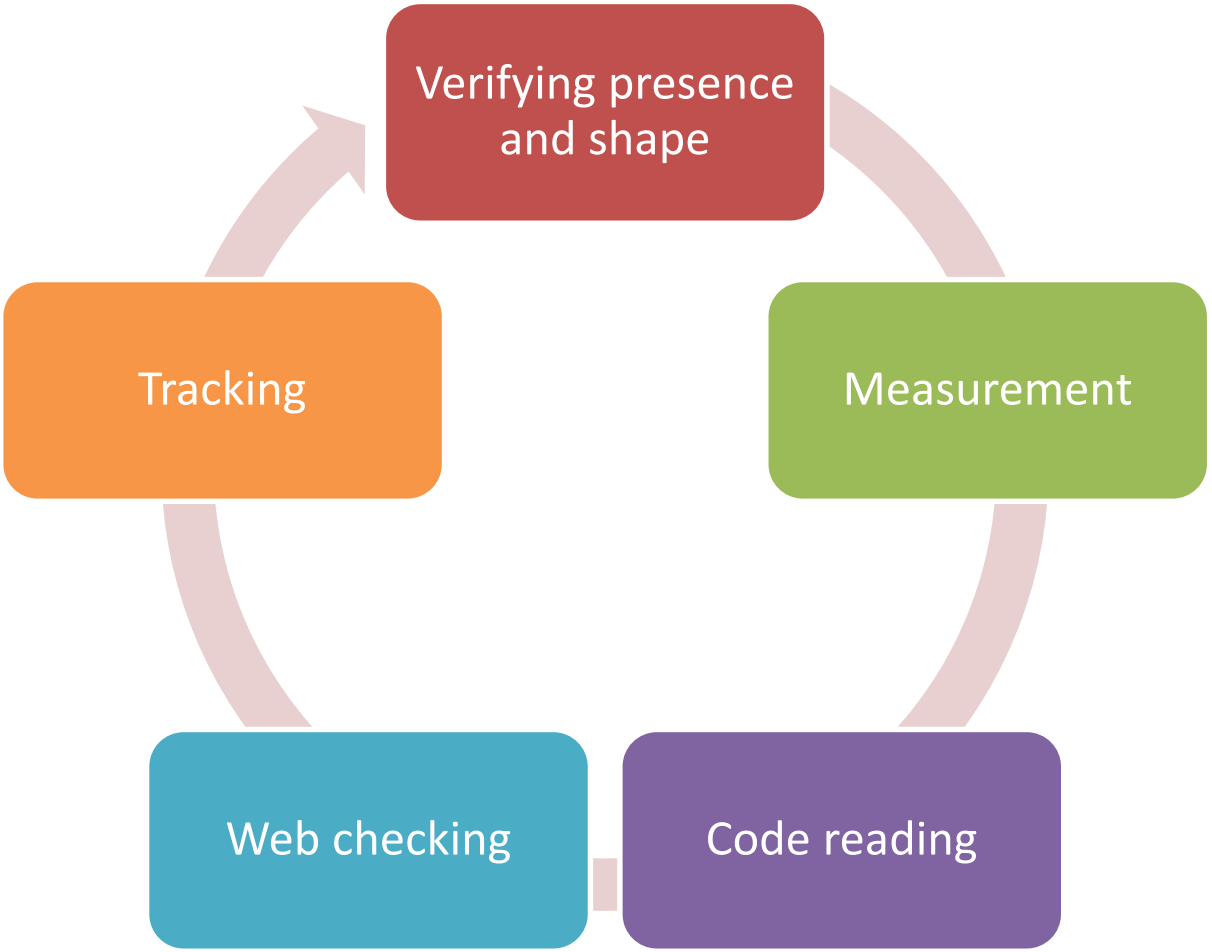
- Reading Assignment
  - CCD vs. CMOS



VISION SYSTEM INTEGRATION

- Applications of Machine Vision
  - Large-scale industrial manufacture
  - Short-run unique object manufacture
  - Safety systems in industrial environments
  - Inspection of pre-manufactured objects (e.g. quality control, failure investigation)
  - Visual stock control and management systems (counting, barcode reading, store interfaces for digital systems)
  - Control of Automated Guided Vehicles (AGVs)
  - Quality control and refinement of food products
  - Retail automation

Categories of Industrial Applications



Categories of Industrial Applications

Verifying presence and shape

- Label on a product? Must be correct.
- Product correct in a container? Correct before closure and distribution.
- Parts assembled correctly in a product? For instance, are all the rollers in a bearing?
- Product closure correct? For instance, a bottle top?
- Natural product OK and not contaminated? For instance, poultry inspection.
- Product looks good? For instance, chocolate bar color.

Categories of Industrial Applications

Measurement

- Parts on a conveyor or feeder are located so they can be handled.
- The position of part is determined so subsequent operations are OK. For instance, the position of a circuit board.
- Size and shape of a manufactured product measured. For instance, the shape of a contact lens.
- Measure the dimensions of a natural product. For instance, the shape of a person for custom tailoring of clothes.
- A critical dimension measured in a continuous product. For instance, diameter of glass fibers.

Categories of Industrial Applications

Code reading

- Read a fingerprint or eye iris pattern for security purposes.
- Read an intended code. For instance, bar codes, 2D codes, package sorting.
- Text reading. For instance, license plates.

Web checking

- Defects in a fabric. For instance, from airbag fabric to material for sheets.
- Photographic film inspection.

Tracking

- Landmarks for vehicle guidance.
- Track end of a robot arm.
- Missile guidance

- https://www.youtube.com/watch?v=qq6--4jtj7s.

VISION SYSTEM INTEGRATION

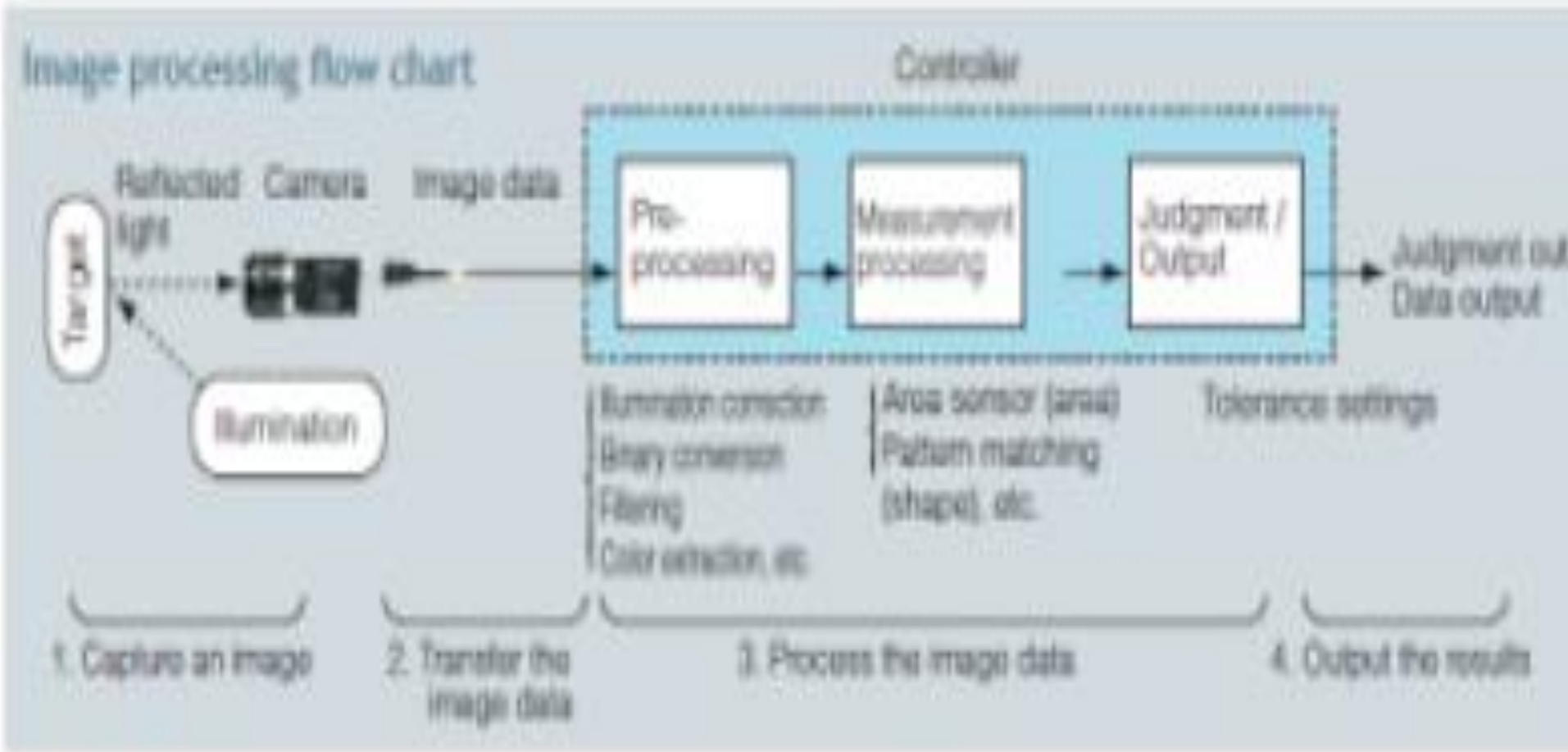
- An industrial vision system is a complex sensor, just like a photo-eye or linear encoder.
- As such it must communicate with the controller of a machine, a cell, or a production line through PLC discrete I/O for serial communications . Difficulty:
  - Number of different systems in use
  - rapid changes in the technology.

VISION SYSTEM INTEGRATION

- Latency (low delays) in communication
  - a critical feature of communication system in production facilities
  - For many messages, the low delay is more important than data rates measured in bits per second. the data rates associated with all of these standards would normally be adequate and the choice would depend on maximum delays in sending messages.
  - An exception are those cases where for some reason, real-time or large numbers of images need to be transmitted. Then the higher data rates of Ethernet or Firewire become important.

PROGRAMMING A VISION SYSTEM

- Steps to image processing:
  - Capture an image



PROGRAMMING A VISION SYSTEM

image processing operations:

- Euclidean geometry transformations such as enlargement, reduction, and rotation
- Color corrections such as brightness and contrast adjustments
- Digital compositing or optical compositing (combination of two or more images). Used in film-making to make a "matte"
- Interpolation, demosaicing, and recovery of a full image from a raw image format using a Bayer filter pattern

PROGRAMMING A VISION SYSTEM

image processing operations:

- Image registration, the alignment of two or more images
- Image differencing and morphing
- Image recognition, for example, extract the text from the image by using optical character recognition
- Image segmentation
- High dynamic range imaging by combining multiple images
- Geometric hashing for 2-D object recognition with affine invariance

Example of Application

Example of Application