ME5405 Machine Vision

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Course Mechanics

- Lecture: Wednesday (6:10 pm - 8:45 pm): LT 1
- Class info, lecture slides, notes and tutorials can be found in IVLE.
- IVLE Discussion Forum
  - Collaborative tool – comments and questions for discussion will be posted
  - Example Matlab codes for image processing
  - Peer-to-peer learning

Main Text

Digital Image Processing: International Version, 3/e

Author : Gonzalez

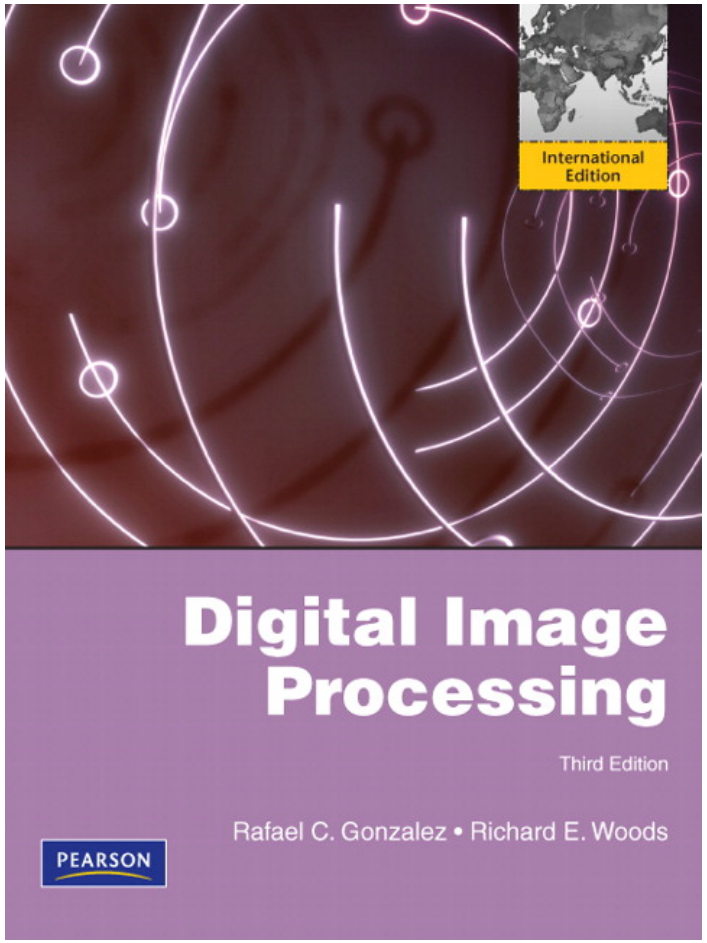
Woods

Publisher : Pearson

ISBN : 9780132345637

Available at NUS Co-op @ Forum !

http://www.imageprocessingplace.com/



Main Text (Continue)

- M Sonka, V Hlavac, R Boyle, “Image Processing, Analysis and Machine Vision”, Thomson Learning, 2008, ISBN 10:0-495-08252-X, ISBN 13:978-0-495-08252-1
  - Image Processing, Analysis, and Machine Vision – A MATLAB Companion (http://visionbook.felk.cvut.cz/)

- Other references will be announced in class or via IVLE Discussion Forum.

Chapter 1 - Introduction

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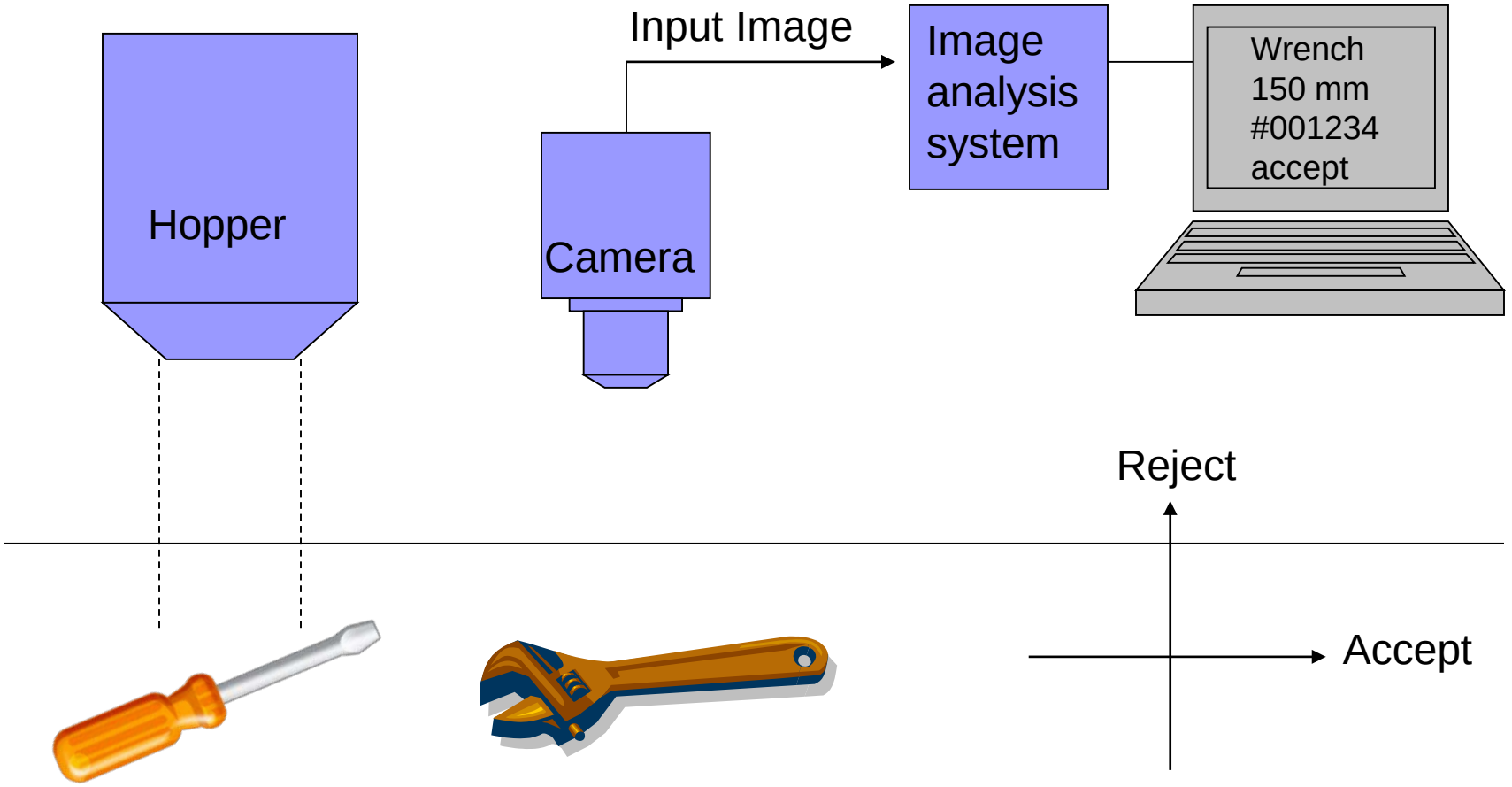
Human Vision, Computer Vision and Machine Vision

- Human Vision: allows humans to perceive and understand the world around him
- Computer Vision: aims to duplicate the effect of human vision by electronically perceiving and understanding an image
- Machine Vision: is the application of computer vision to industries including media and healthcare, and manufacturing.
  - A subfield of engineering that encompasses mechanical engineering, optics, computer science and automation.

Examples of Machine Vision

- Industrial vision – inspection of manufactured goods such as semiconductor chips, automobile components, tools, food and pharmaceuticals
  - Uses digital cameras, smart cameras and image processing software
  - Smart camera is an integrated machine vision system that comprises of image capture circuitry and a microprocessor to extract and process information from images. It normally has an interface device to make results available to other devices.

Examples of Machine Vision (Continue)

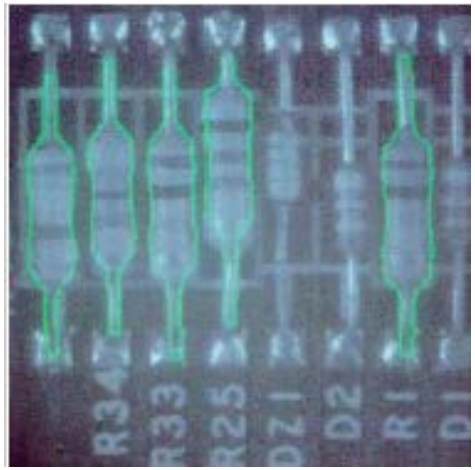


Examples of Machine Vision (Continue)

- X-ray for health screening
- Satellite maps for battle planning
- Photoshop to prepare photographs
- Face detection
- Capture an image from moon, and then transmit the image to Earth

Machine Vision for Quality Control

- Machine Vision allows manufacturing industry to
  - Detect defects
  - Calibrate and control the manufacturing process
  - Optimize the use of resources
- Leading to
  - Result repeatability
  - Product reliability
  - 100% high speed inspection
  - Consumer confidence and satisfaction



Source: British Machine Vision Association and Society for Pattern Recognition

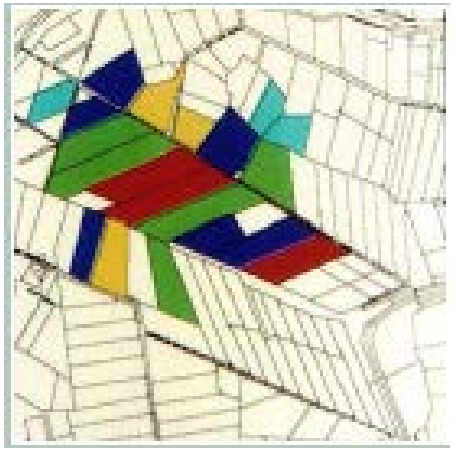
Machine Vision for Security and Surveillance

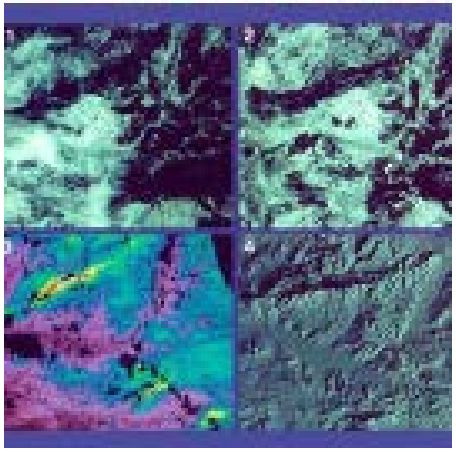
- Machine vision provides the abilities to
  - Track objects and people in 3D
  - Recognize and register specific and generic objects
  - Model and identify gestures, actions and behavior
  - Perform biometric measurements
- Leading to
  - Safer environment
  - Efficient non-obstructive monitoring
  - Reduce crime rates

Source: British Machine Vision Association and Society for Pattern Recognition

Machine Vision for Environment

- Machine vision can be used to
  - Monitor pollution from refuse sites
  - Map and monitor the condition of gas pipelines and railways
  - Police the pollution of the seas
  - Monitor the spread of disease in crops
- Leading to
  - Cleaner environment
  - Greater safety
  - Better planning and use of resources





Source: British Machine Vision Association and Society for Pattern Recognition

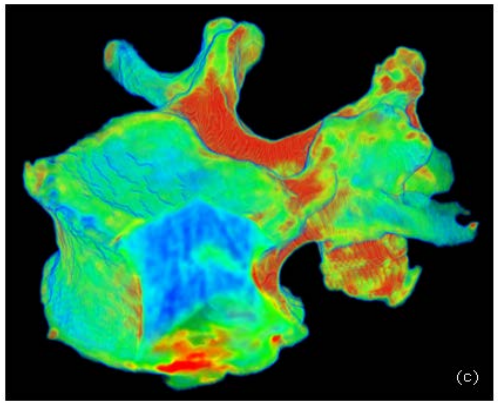
Machine Vision for Entertainment

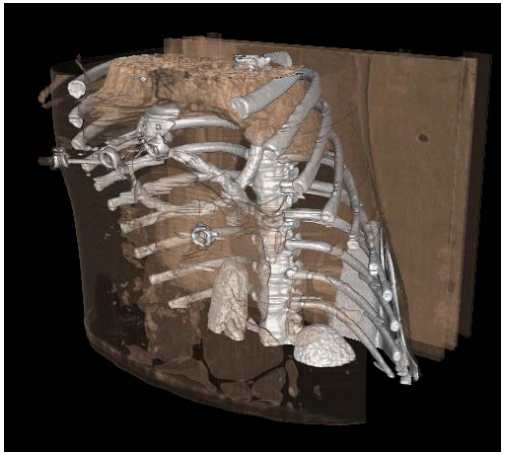
- Machine vision allows
  - Searching of image databases and video libraries by content
  - Efficient image compression
  - Multiview scenes creation
  - Realistic models of objects generation
- Leading to
  - Greater realism
  - Lower cost
  - Wider accessibility

Source: British Machine Vision Association and Society for Pattern Recognition

Machine Vision for Medicine

- Machine vision empowers the clinician with
  - 3D/4D visualization
  - 3D texture analysis
  - 3D and 2D image registration
  - Virtual object manipulation
- Leading to
  - Objectivity in measurement and estimation
  - Result repeatability
  - Decision consistency





Why is Computer/Machine Vision Difficult?

- Loss of information in 3D to 2D
  - Pinhole model and single available view - the projective transformation sees a small object close to the camera in the same way as a big object remote from the camera.

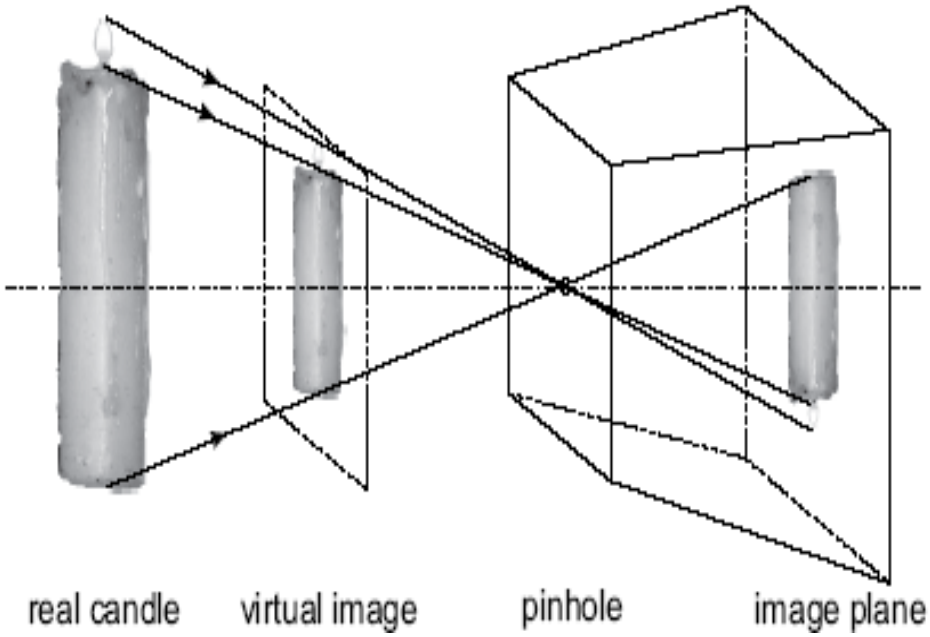


Figure 1.4: The pinhole model of imaging geometry does not distinguish size of objects.

Why is Computer/Machine Vision Difficult? (Continue)

- Interpretation
  - A human uses previous knowledge and experience to understand an image currently under observation.
- Noise
  - Inherently present in every measurement in the real world.

Why is Computer/Machine Vision Difficult? (Continue)

- Too much data
  - An A4 sheet of paper scanned at 300 dots per inch (dpi) at 8 bits per pixel (grayscale) = 8.5 MB
- Brightness measured
  - The brightness or radiance is dependent on the irradiance (light source type, position and intensity), the observer's position, the surface local geometry, and the surface reflectance properties.

Scope of ME5405

- Introductory graduate-level vision and image processing class
- Emphasis on general principles, systems and applications

Contents of ME5405

- Introduction (LKB)
- Digital Image Fundamentals and Programming (CCK)
- Image Acquisition (CCK)
- Binary Machine Vision (LKB)
- Image Enhancement (LKB)
- Image Segmentation (LKB)

Contents of ME5405 (Continue)

- Color Image Processing (LKB)
- Image Geometry (CCK)
- Noise and Filtering in Frequency Domain (CCK)
- Machine Vision Application and Design (CCK)

Assignment

Computing Project

- 30% of the final grade
- Computing project – group of 2 or 3
- Codes written in Matlab or clones (http://www.dspguru.com/dsp/links/matlab-clones)

Computing Project (Continue)

- **Image: Characters**
  - You are given two set of images of characters.
  - For each image,
    - Threshold the image and convert it into binary image
    - Display the original image on screen
    - Determine the outline(s)
    - Segment the image to separate and highlight the different characters
    - Rotate the characters about their own respective centroids by 90 degrees clockwise and then 30 degrees counterclockwise
    - Determine a one-pixel thin image of the characters
    - Scale and display the characters in each image according to specified patterns

Computing Project (Continue)

- Report
  - An introduction to the problem
  - A description of your algorithm and a flow chart
  - Screen dumps of every stage of the image processing
  - An explanation of the method and why you choose the method employed in your project
  - A conclusion including on how your codes can be improved in the future
- Softcopy of your program and data file (with readme.txt on how to execute the codes)
  - Upload onto IVLE – Workbin - Student Submission
- Due: about one week before ME5405 final exam