Machine Vision

Lecture Set – 01

Introduction

Huei-Yung Lin

Robot Vision Lab

Instructor

- Instructor
  - Huei-Yung Lin
- Class Time and Place
  - Tu. 9:10 – 10:00, Th. 10:10 – 12:00
  - 六教426
- Office Hours
  - W.: 8:00 am – 12:00pm
- Course Materials
  - Announcements will be posted on i-study
  - Homework assignments will be given by the TAs via email and Google Drive

Textbooks

- Required:
  - "Machine Vision", Jain, Kasturi, and Schunck, McGraw-Hill
  - The textbook can be obtained from the web (licensed), (http://www.cse.usf.edu/~r1k/MachineVisionBook/MachineVision.pdf)
- References:
  - "Machine Vision: Theory, Algorithms, Practicalities", E. R. Davies, Morgan Kaufmann
  - "Robot Vision", B.K.P. Horn, The MIT Press
  - "Machine Vision", W. E. Snyder and H. Qi, Cambridge University Press

Grading

- Exam – 40%
  - 20% for midterm exam
  - 20% for final exam
- Homework – 60%
  - 60% each, four homework assignments
  - Most of them will be computer homework (using C/C++)
  - Due in two weeks
- All weights are approximate and subject to change

Schedule

- 3/23: Homework #1 due (assigned 3/9)
- 4/6: Homework #2 due (assigned 3/23)
- 4/20: Homework #3 due (assigned 4/6)
- 4/20: Midterm Exam
- 5/11: Homework #4 due (assigned 4/27)
- 5/25: Homework #5 due (assigned 5/11)
- 6/8: Homework #6 due (assigned 5/25)
- 6/15: Final Exam

Questions?

- Grading?
- Homework, exams?
- Project?
  - (If you are interested in working on a project instead of homework assignments.)

- Who should take this course?
  - People interested in extracting information from images (termed also computer or robot vision)
  - Students taking “intelligent system project”

Course Topics

- Digital Image Fundamentals
- Binary Image Processing
- Regions
- Image Filtering
- Edge Detection
- Contours
- Texture
- Optics
- Color
- Depth

What is Machine Vision?

- Vision for Machine …
- A machine automatically processes an image and reports “what is in the image”
  - Recognize the content of the image
  - Locate and inspect the objects in the image
  - e.g., ATR (automatic target recognition), industrial inspection
- Also termed “computer vision”, “image understanding”, “robot vision”
  - Recent deep learning approaches can also be adopted for machine vision algorithms, but they will not be introduced in this course

What is Machine Vision?

- Machine vision includes two components
  - Measurement of features
  - Pattern classification based on those features
- Measurement of features focuses on processing the image pixels and extract sets of measurements
- Pattern classification is the process of making a decision about a measurement
- For example, how to distinguish different kind of fish or machine parts?

Vision = Geometry + Measurement + Interpretation

Machine Vision vs. Image Processing

- "Image processing" tries to make images look better, the output of an image processing system is an image
- The output of a "machine vision" system is information about the content of the image
- Some image processing tasks:
  - Enhancement
  - Restoration
  - Reconstruction
  - Coding and Compression
- They are not the main concerns of vision algorithms

2/23/2023

Grading

- Exam – 50%
  - 25% for midterm exam
  - 25% for final exam
- Homework – 50%
  - 10% each, five homework assignments
  - Most of them will be computer homework (using C/C++)
  - Due in two weeks
- All weights are approximate and subject to change

Schedule

- 3/23: Homework #1 due (assigned 3/9)
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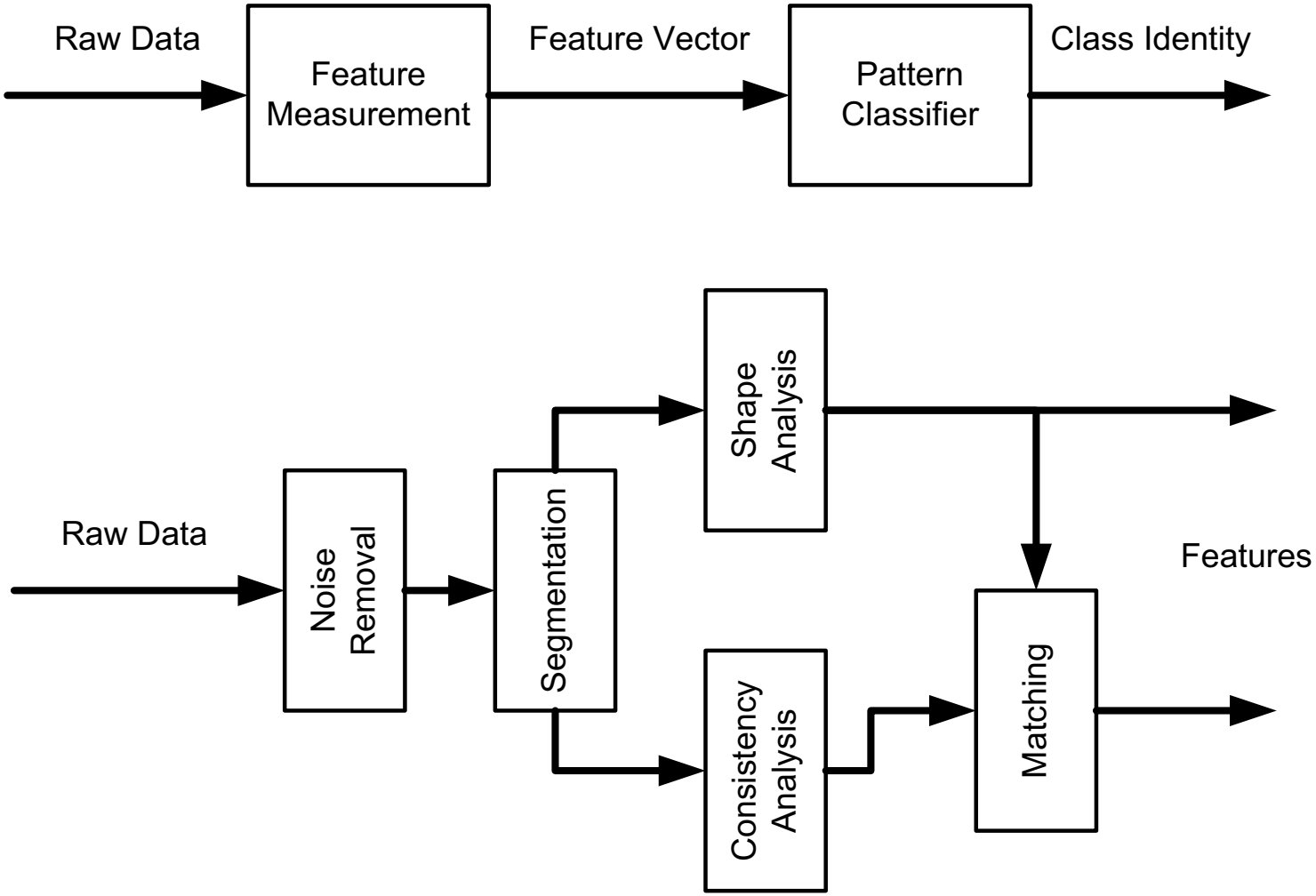
- 6/15: Final Exam
- Subject to change!

Machine Vision System Organization



Some Examples

- Shape (and motion) recovery

  "What is the 3D shape of what I see?"
- Segmentation

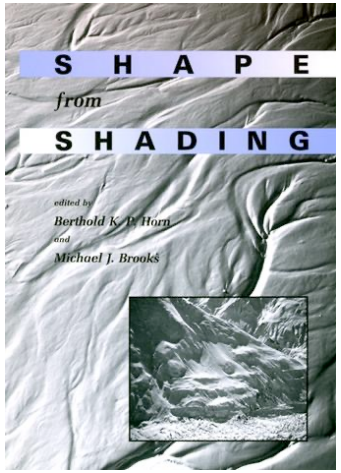
  "What belongs together?"
- Tracking

  "Where does something go?"
- Recognition

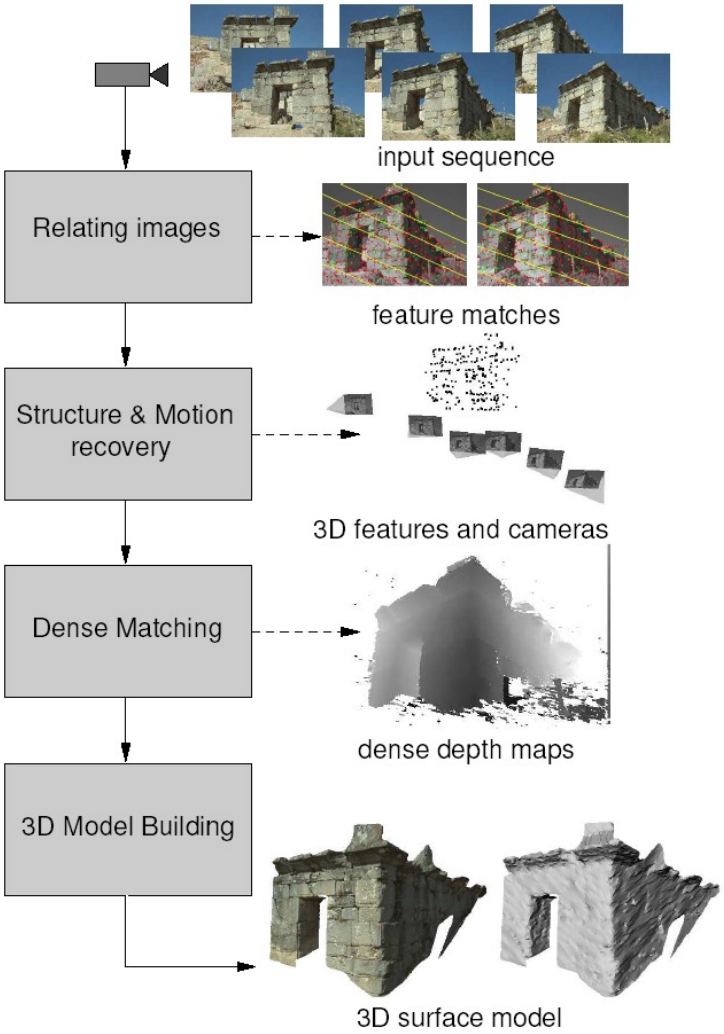
  "What is it that I see?"

Shape from ...

- Many different approaches/cues
  - Shape from stereo
  - Shape from shading
  - Shape from texture
  - Shape from motion
  - Shape from focus/defocus
  - Shape from silhouettes
  - Shape from photometric stereo

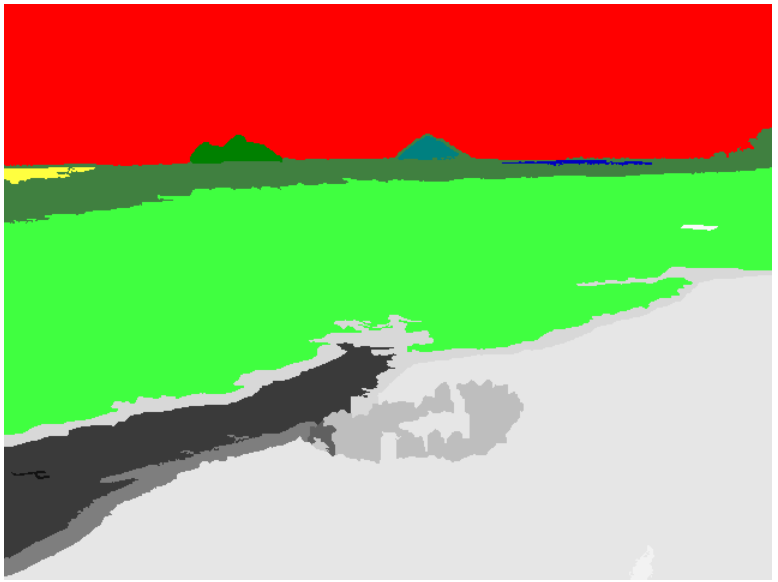


Structure from Motion



Segmentation

- Which image components “belong together”?
- Cues:
  - Similar color, similar texture
  - Form a suggestive shape when assembled



Tracking

Tracking and HCI

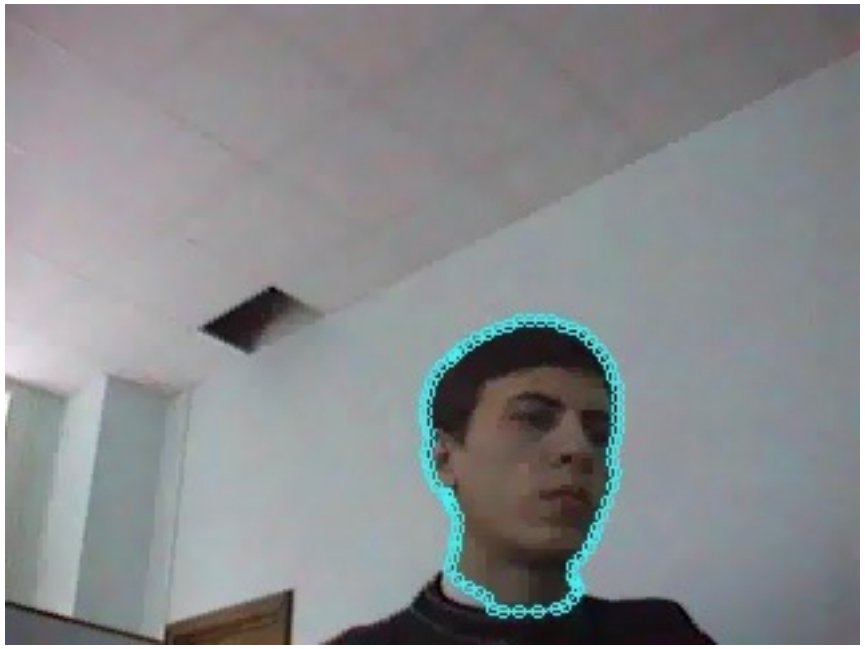
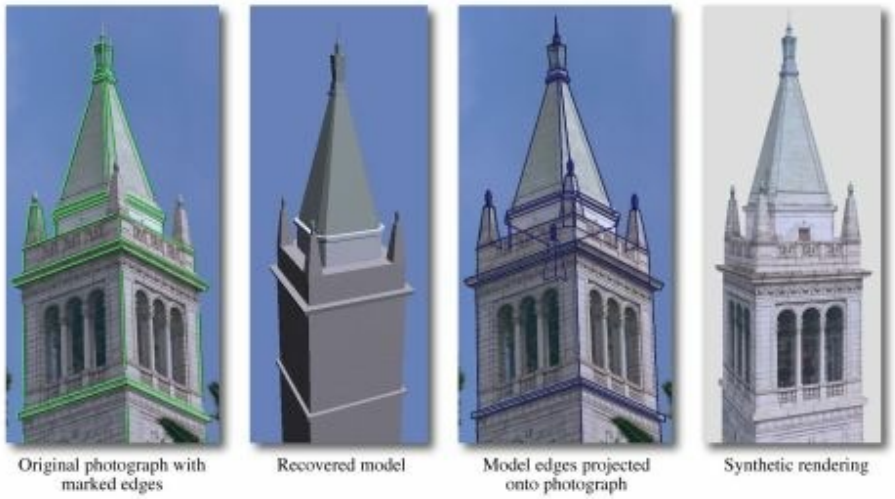


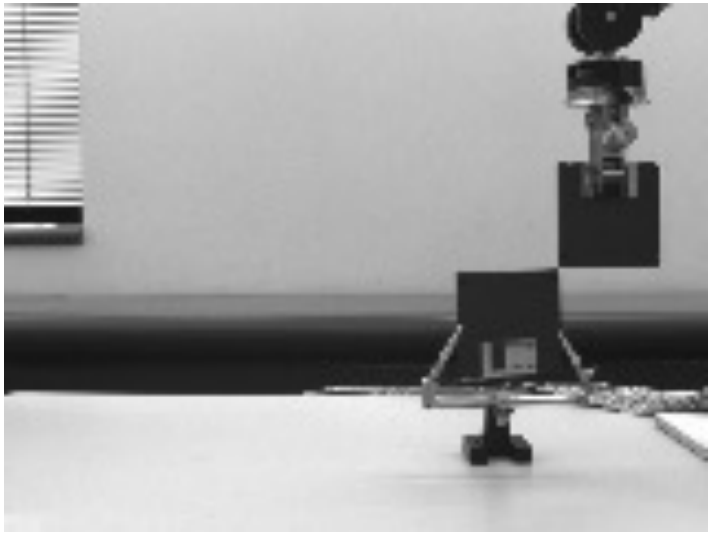
Image-Based Recognition

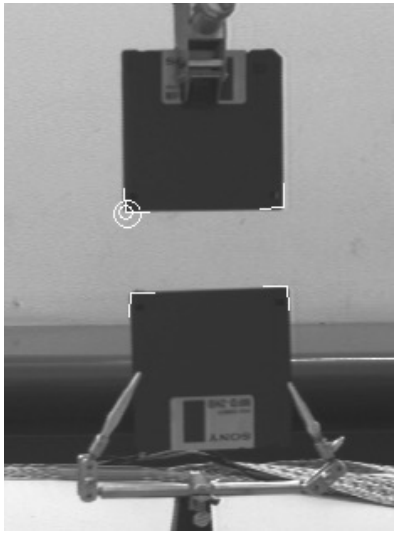
Vision for 3D Reconstruction



Original photograph with marked edges | Recovered model | Model edges projected onto photograph | Synthetic rendering

Vision for Control





Opportunities for Vision Study

- Thanks to Moore's law – desktop machine have gotten faster and cheaper – many already come equipped with cameras

- Vision as the input device of the future – your computer will be able to:
  - Recognize you by sigh
  - Watch what you do and respond accordingly
  - Build model of the world from image data

Related Fields

- Image Processing
  - Consider image properties, image-to-image transformation
  - Image processing algorithms are useful in early stages of vision tasks
- Computer Graphics
- Artificial Intelligence
- Pattern Recognition
- Photogrammetry
- Robotics

Application Areas

- Industrial inspection and quality control
- Reverse engineering
- Surveillance and security
- Face recognition
- Gesture recognition
- Autonomous vehicles
- Road monitoring
- Hand-eye robotics systems
- Medical image analysis (MRI, CT, X-rays, sonar scan)
- Image databases
- Virtual reality, tele-applications
- Space & Military
- Image based graphics