CS 556: Computer Vision

Lecture 1

Prof. Sinisa Todorovic

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CS 556: Computer Vision

• Instructor:
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• Office:
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• Office Hours:
  Wed 3-3:30pm, or by appointment

• Classes:
  Tue 2-4pm, Thu 2-3pm STAG 262

• Class website:
  http://web.engr.oregonstate.edu/~sinisa/courses/OSU/CS556/CS556.html
Recommended Textbooks


• “Multiple View Geometry in Computer Vision,” by R. Hartley and A. Zisserman, Academic Press, 2nd ed, 2004

• “Learning OpenCV: Computer Vision with the OpenCV Library,” by Gary Bradski, Adrian Kaehler

• Additional readings on the class website
Prerequisites

• Undergraduate-level knowledge of:
  • Linear algebra
    • Matrices, Matrix Operations
    • Determinants, Systems of Linear Equations
    • Eigenvalues, Eigenvectors
  • Statistics and probability
    • Probability density function, Probability distribution
    • Priors, Posteriors, Likelihoods
    • Gaussian distribution
  • Some programming skills
    • MATLAB, C, C++
Requirements and Grading Policy

- Homework assignments (35%)
  - HW1 (5%) — Jan 21
  - HW2 (10%) — Feb 04
  - HW3 (10%) — Feb 18
  - HW4 (10%) — Mar 3
- Exam 1 (30%) — Feb 11
- Exam 2 (35%) — Mar 10
- Bonus HW5 (10%) — Mar 17
Grading Policy

Late policy:

Zero tolerance without prior approval
Homework

• Mini projects using MATLAB 2015b

• http://is.oregonstate.edu/accounts-support/software/software-list/matlab

• Must have:
  • Computer Vision Toolbox
  • Neural Network Toolbox

• Individual work, but collaboration is allowed

• Use any helpful source code that is available online

• Turn in homework online via TEACH
“...Understanding vision is a key to understanding intelligence...”

T. Poggio
What is Computer Vision?

Develop
- representations,
- learning and inference algorithms,
for interpretation of images and video in terms of
- recognition,
- detection,
- segmentation, etc.,
of
- objects (parts), surfaces,
- human activities, events, etc.,
and their 3D spatiotemporal relations, e.g.,
- depth, occlusion, 3D orientation, supported-by,
- followed-by, cause, effect
A Typical Computer Vision System

3D world: objects, scenes, events

camera

algorithms representations

problem understanding, trade offs, training data

users

image interpretation
Applications: Face Detection

Automatic adjustment of camera focus, aperture, and shutter speed based on face detection
Applications: Object Recognition

http://www.kickstarter.com/projects/visionai/vmx-project-computer-vision-for-everyone
Applications: Monitoring Driver’s Behavior

Source: P. Smith, M. Shah, and N.V. Lobo
Applications: Navigating UAVs

Flight stability and control of Micro Air Vehicles

Source: M. Nechyba
Applications: Navigating UAVs

Flight stability and control of Micro Air Vehicles

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Image Features
Image Structure

- Pixels, 4-adjacency, 8-adjacency, m-adjacency

4-adjacency
Image Structure

- Path -- directed, undirected, loop
Image Structure

- Edge = Connected pixels with high gradient values
Image Structure

- T-junctions
Image Structure

- T-junctions
Image Structure

- T-junctions
Image Structure

- Interest points = corners, textured patches
Image Structure

• Specularity = Highlights
Image Structure

- Lambertian surface = isotropic reflectance
- Specular surface = zero reflectance except at an angle
Image Structure

- Region = Connected set of pixels
- Region boundary, inner and outer contour
Image Structure

• Texture
Image Structure

• Dynamic texture
Image Structure

- Foreground - Background
From Image Formation to Image Interpretation
Image interpretation is usually defined in terms of

- Objects, scenes, activities, events
- Spatiotemporal relations between objects, scenes, ...
From Image Formation to Image Interpretation

Image properties depend on:

• Imaging conditions

• Visual properties of the 3D world
From Image Formation to Image Interpretation

- Image acquisition parameters:
  - Camera distance, viewpoint, motion
  - Camera intrinsic parameters (e.g., lens)
  - Illumination or Brightness
  - Occlusion and Clutter