Digital Image Processing
EE368

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Why do we process images?

- Acquire an image
  - *Correct aperture and color balance*
  - *Reconstruct image from projections*
- Prepare for display or printing
  - *Adjust image size*
  - *Halftoning*
- Facilitate picture storage and transmission
  - *Efficiently store an image in a digital camera*
  - *Send an image from Mars to Earth*
- Enhance and restore images
  - *Remove scratches from an old movie*
  - *Improve visibility of tumor in a radiograph*
- Extract information from images
  - *Read the ZIP code on a letter*
  - *Measure water pollution from aerial images*
Image Processing Examples

Restoration of image from Hubble Space Telescope

Source: IVPL Northwestern University, Chicago
Image Processing Examples

Color photo enhancement

Original

Automatic Enhancement

Software: Picture Project 1.5, 2005, Nikon Corporation
Image Processing Examples

Noise reduction

Noisy Image

BayesJoint Estimator - QMF

Degraded image

Noise-reduced image

Source: Jungwon Lee, EE 368 class project, Spring 2000
Image Processing Examples

Special Effects

Photo  Simulated color pencils  Simulated oil painting

source: Feng Xiao, EE368 class project, spring 2000.
Image Processing Examples

Halftoning
Image Processing Examples

Pseudocolor enhancement for security screening

Source: Gonzalez+Woods, Fig. 6.24
Image Processing Examples

Extraction of settlement area from an aerial image

source: INRIA, Sophia-Antipolis, France
Image Processing Examples

Earthquake Analysis from Space

Image shows the ground displacement due to Landers earthquake in CA, 1992

Source: JPL, Pasadena, QUAKEFINDER project
Image Processing Examples

Face Detection

source: Henry Chang, Ulises Robles, EE368 class project, spring 2000.
Image Processing Examples

Face Detection

source: Michael Bax, Chunlei Liu, and Ping Li, EE368 class project, spring 2003.
Image Segmentation

This image showing both laser and video imagery gives a sense of Stanley's adaptive vision capability.
Image Processing Examples

Mosaic from 33 source images

Mosaic from 21 source images

source: M. Borgmann, L. Meunier, EE368 class project, spring 2000.
Image Processing Examples

Face morphing

Source: Yi-Wen Liu and Yu-Li Hsueh, EE368 class project, spring 2000.
Image Processing Examples

- Handwriting recognition

![Handwriting examples with digits and a handwritten name](image-url)
Biometrics: Fingerprint recognition

FBI’s Integrated Automated Fingerprint Identification System (IAFIS)
Image Processing Examples

Biometrics: Iris recognition

Source: J. Daugman, U. Cambridge
Image Processing Examples

Mugshot retrieval

Source: MIT Media Lab
Scope of EE368

- Introductory graduate-level digital image processing class
- Prerequisites: EE261, EE278 or equivalent
- Emphasis on general principles, signals & systems angle
- Topics
  - Continuous-tone images, point operations, color
  - Image segmentation
  - General linear image processing
  - Linear processing, 2-d signals and systems, sampling, filtering
  - Feature detection
  - Morphological image processing
  - Image transforms, multiresolution image processing
  - Image registration
- Image compression: EE398 - Winter 2007/08
EE368 Organisation

- Assistants
  - TAs: Aditya Mavlankar (general), Gabriel Takasz (project)
  - SCIEN lab TA: Shantanu Rane
  - Course assistant: Kelly Yilmaz

- Office hours
  - Bernd Girod: Fr 1:30-3:00, Packard 373
  - Aditya Mavlankar We 5-7, room t.b.a.

- Email hours: Tu, Th 5:30-7:30 p.m.

- Regularly check class home page:
  
  http://www.stanford.edu/class/ee368
Homeworks
- 4-5 assignments, require computer + Matlab
- Handed out Fridays, due one week later, solve individually
- First handed out on April 13

Late Midterm
- 24-hour take-home exam
- 3 slots, May 23-26

Final project
- Individual or group project, plan for about 50-60 hours per person
- Develop, implement and test an image processing algorithm
- Task to be announced around May 1
- Submission of Matlab implementation and report on June 1
- Performance will be tested for the same data set for all algorithms

Grading
- Homeworks: 20%
- (Late) mid-term exam: 30%
- Final project: 50%
- No final exam.
Last year’s project:
Visual Code Marker Recognition
SCIEN laboratory

- Created by equipment grants from Hewlett-Packard, Xerox, and Intel
- Exclusively a teaching laboratory
- Location: Packard room 021
- 20 Linux PCs, 2 Windows PCs, scanners, printers etc.
- Access:
  - door combination for lab entry will be provided by TA
  - Account on ise machine will be provided to all enrolled in class
Further reading

- Slides available as hand-outs and as pdf files on the web
- Recommended books:
- Additional books:
  - J. S. Lim, „Two-dimensional Signal and Image Processing,“ Prentice-Hall, 1990. $94.-.
Voluntary Reading Assignment

- Gonzalez + Woods:
  - Chapter 1
  - Chapter 2