Digital Image Processing
EE368

Bernd Girod
Information Systems Laboratory
Department of Electrical Engineering
Stanford University

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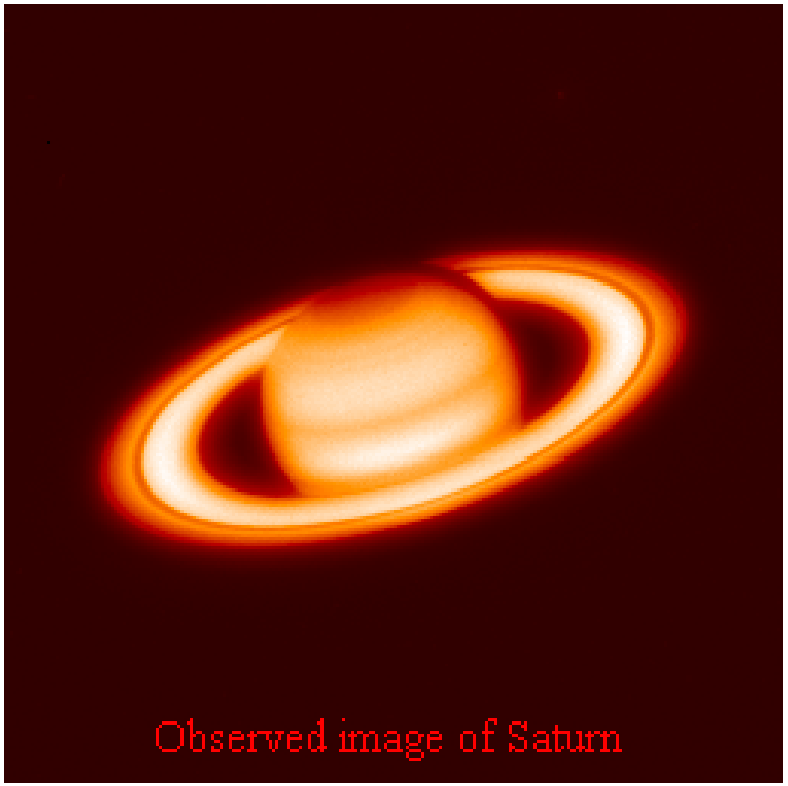
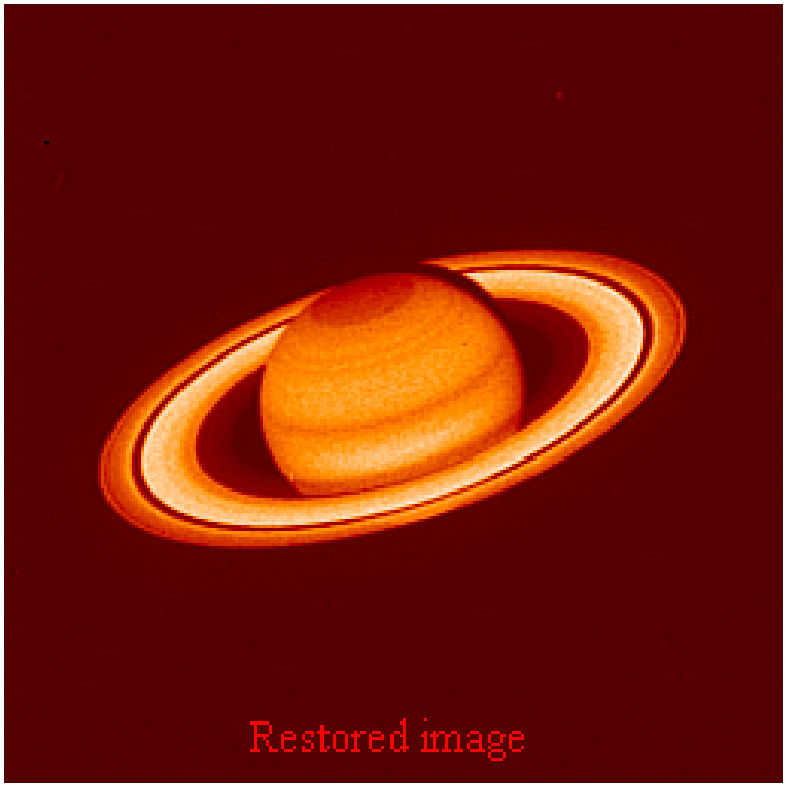
Why do we process images?

- 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 polution from aerial images*

Image Processing Examples

Restoration of image from Hubble Space Telescope





Source: IVPL Northwestern University, Chicago

Image Processing Examples

Color photo enhancement

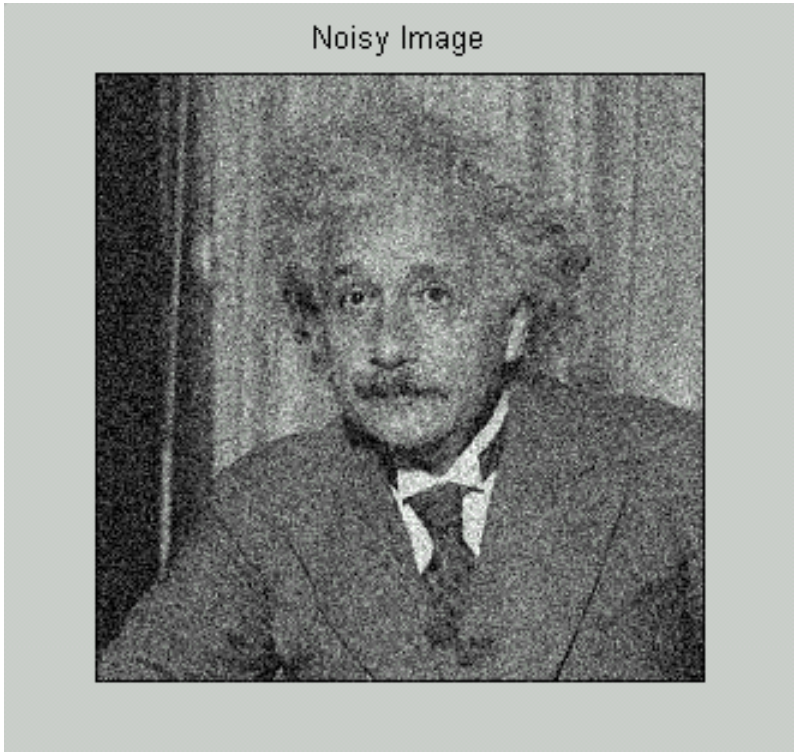
Original

Automatic Enhancement

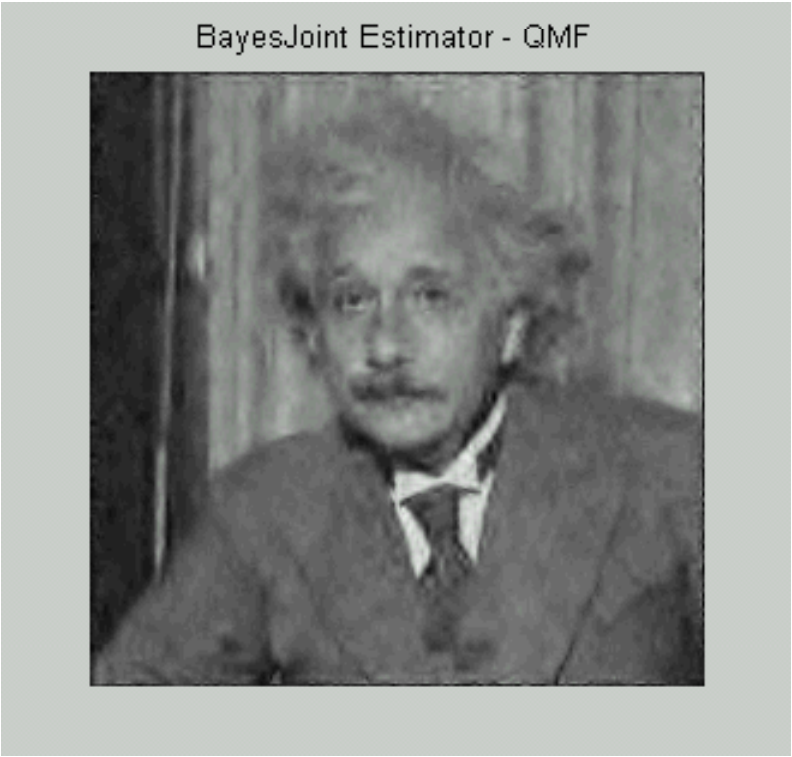
Software: Picture Project 1.5, 2005, Nikon Corporation

Image Processing Examples

Noise reduction



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

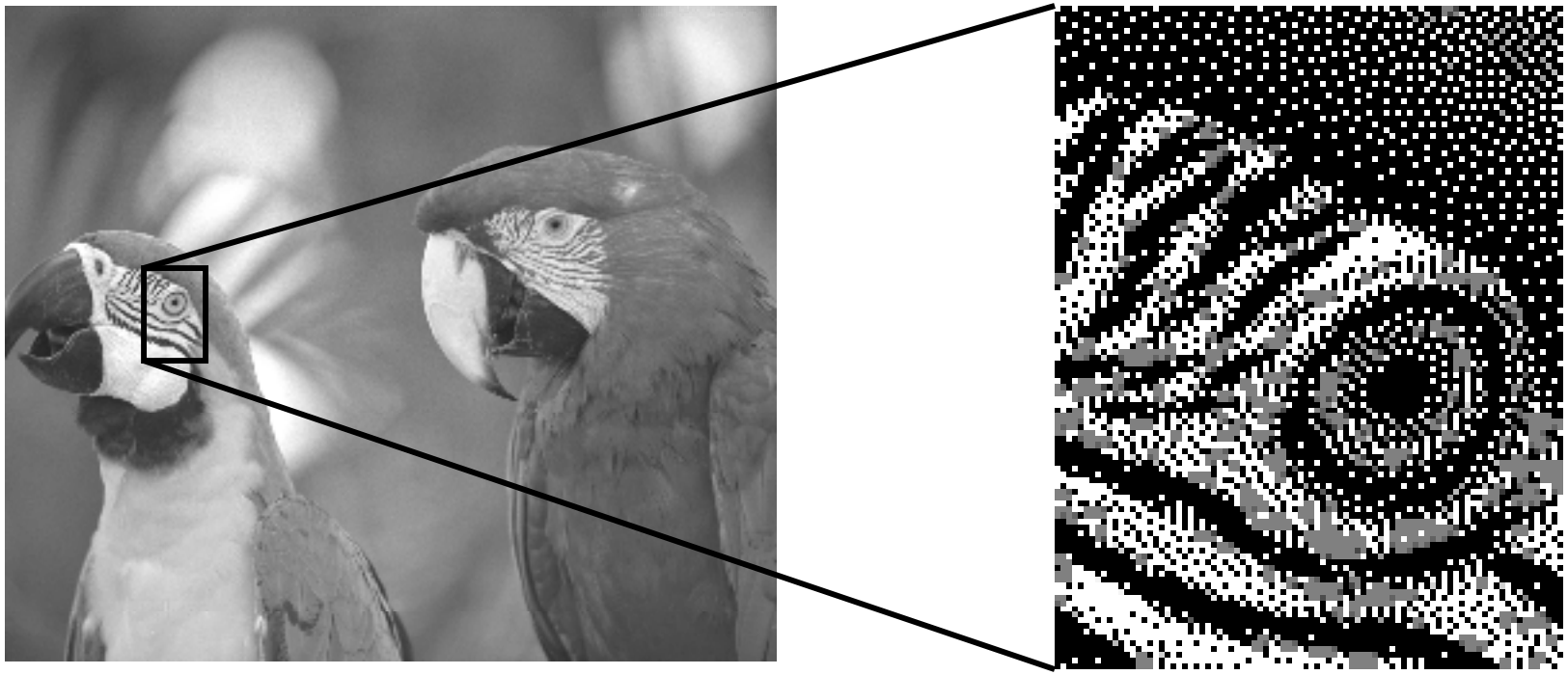
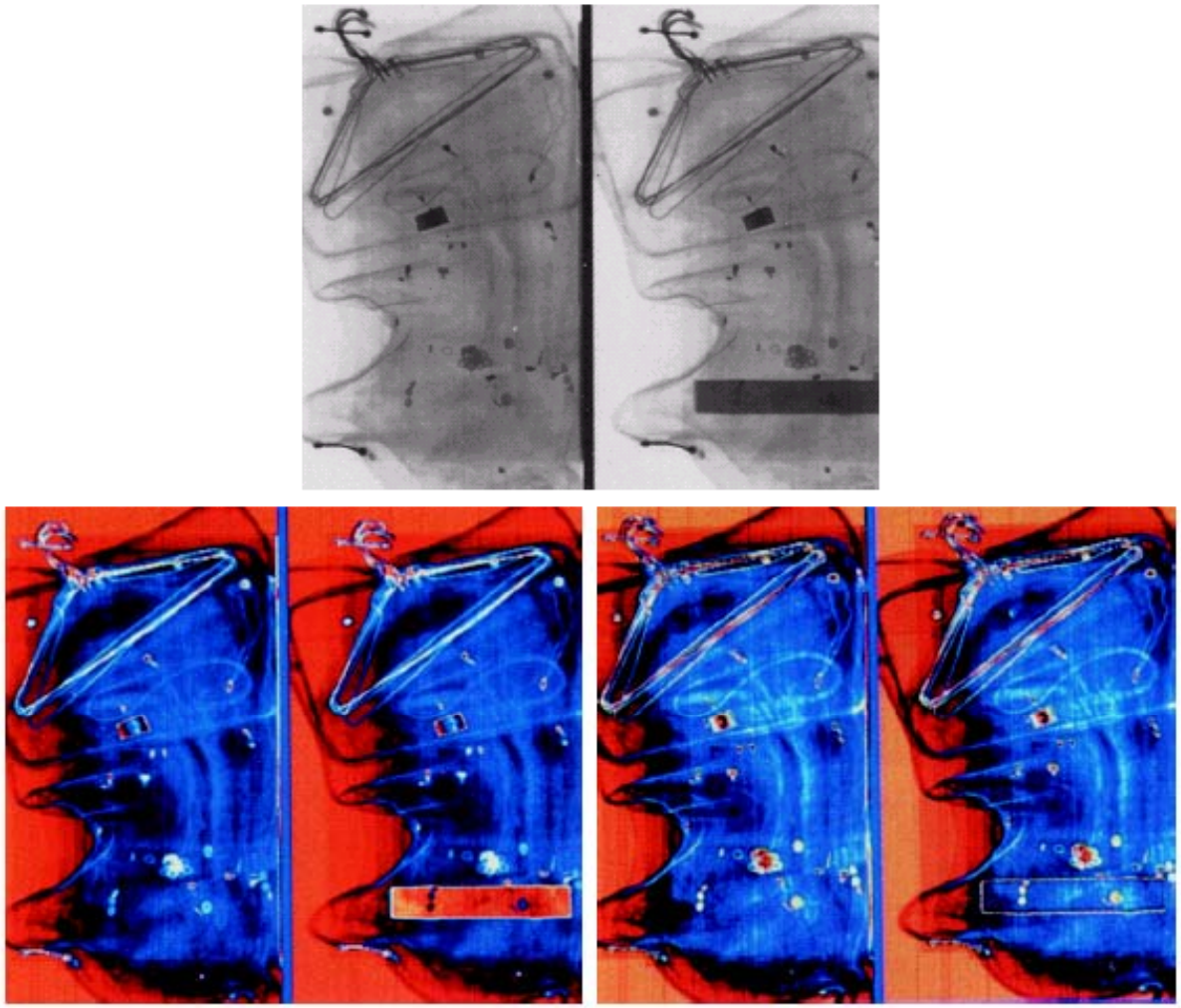


Image Processing Examples

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

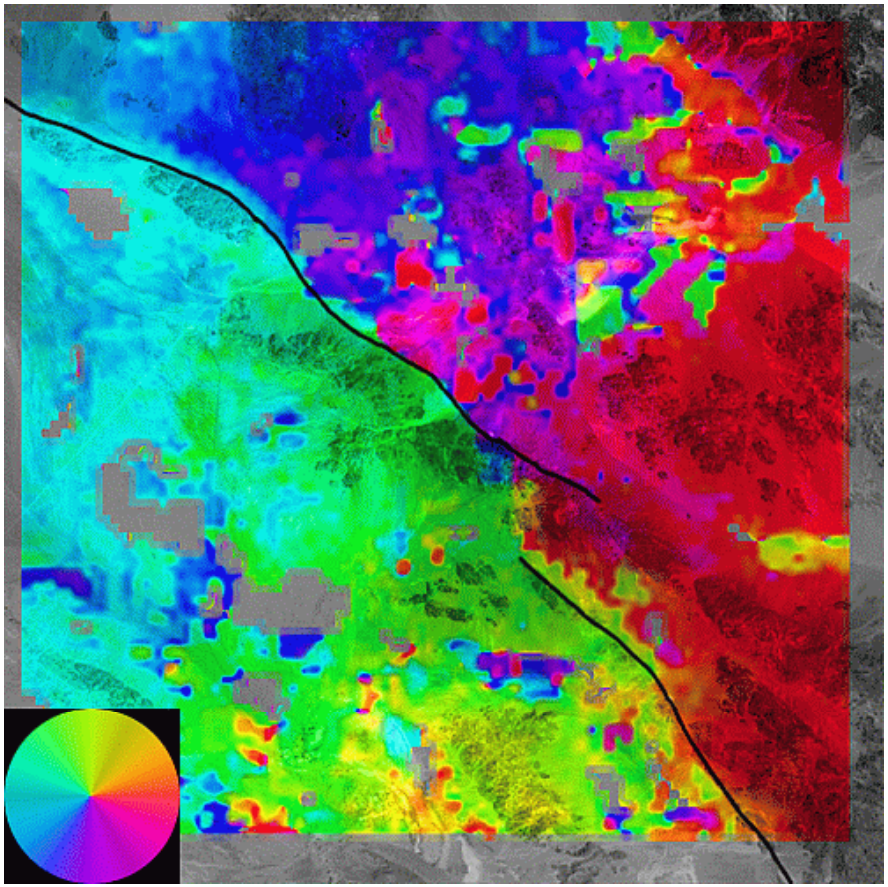
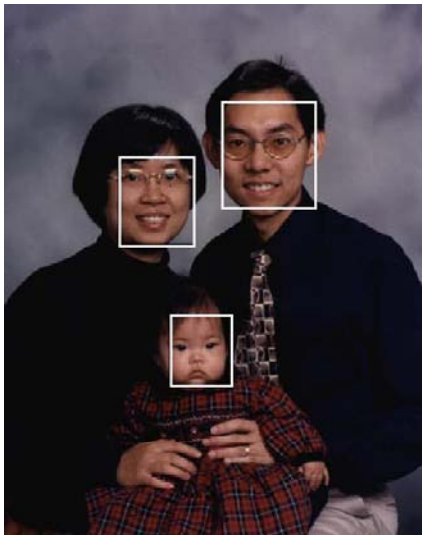


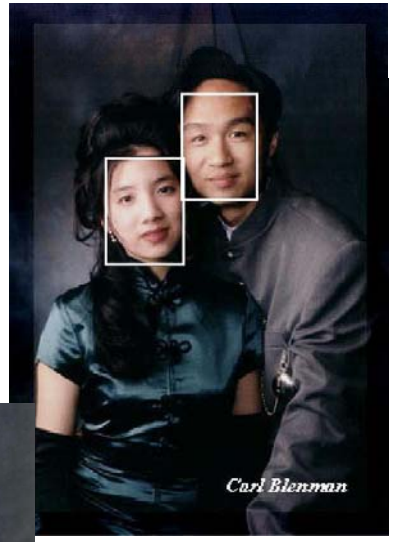
Image shows the ground displacement due to Landers earthquake in CA, 1992

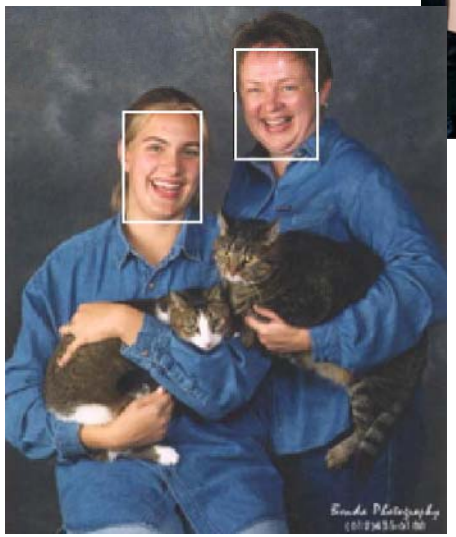
Source: JPL, Pasadena, QUAKEFINDER project

Image Processing Examples

Face Detection

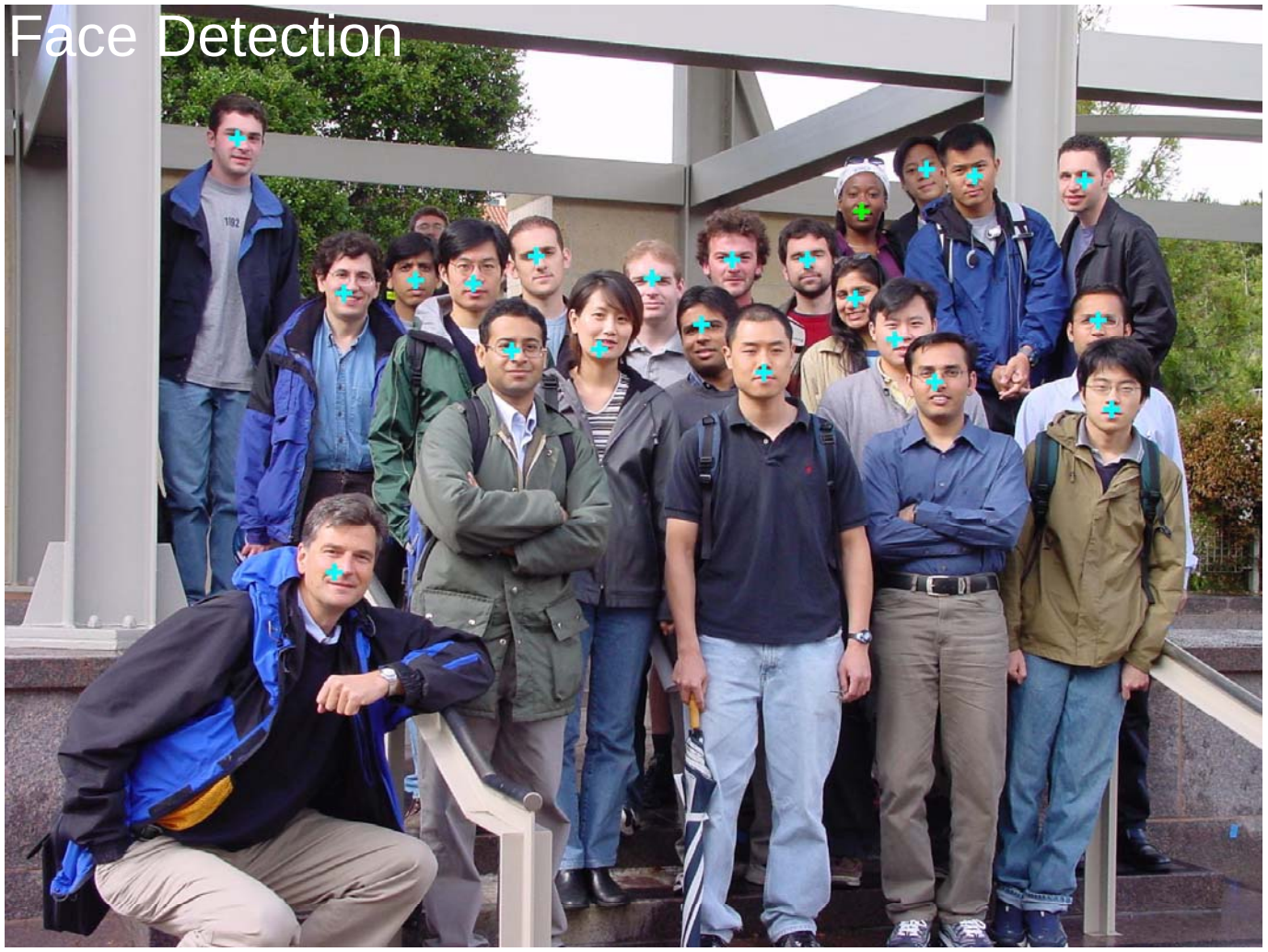






source: Henry Chang, Ulises Robles, EE368 class project, spring 2000

Image Processing Examples



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

Image Segmentation

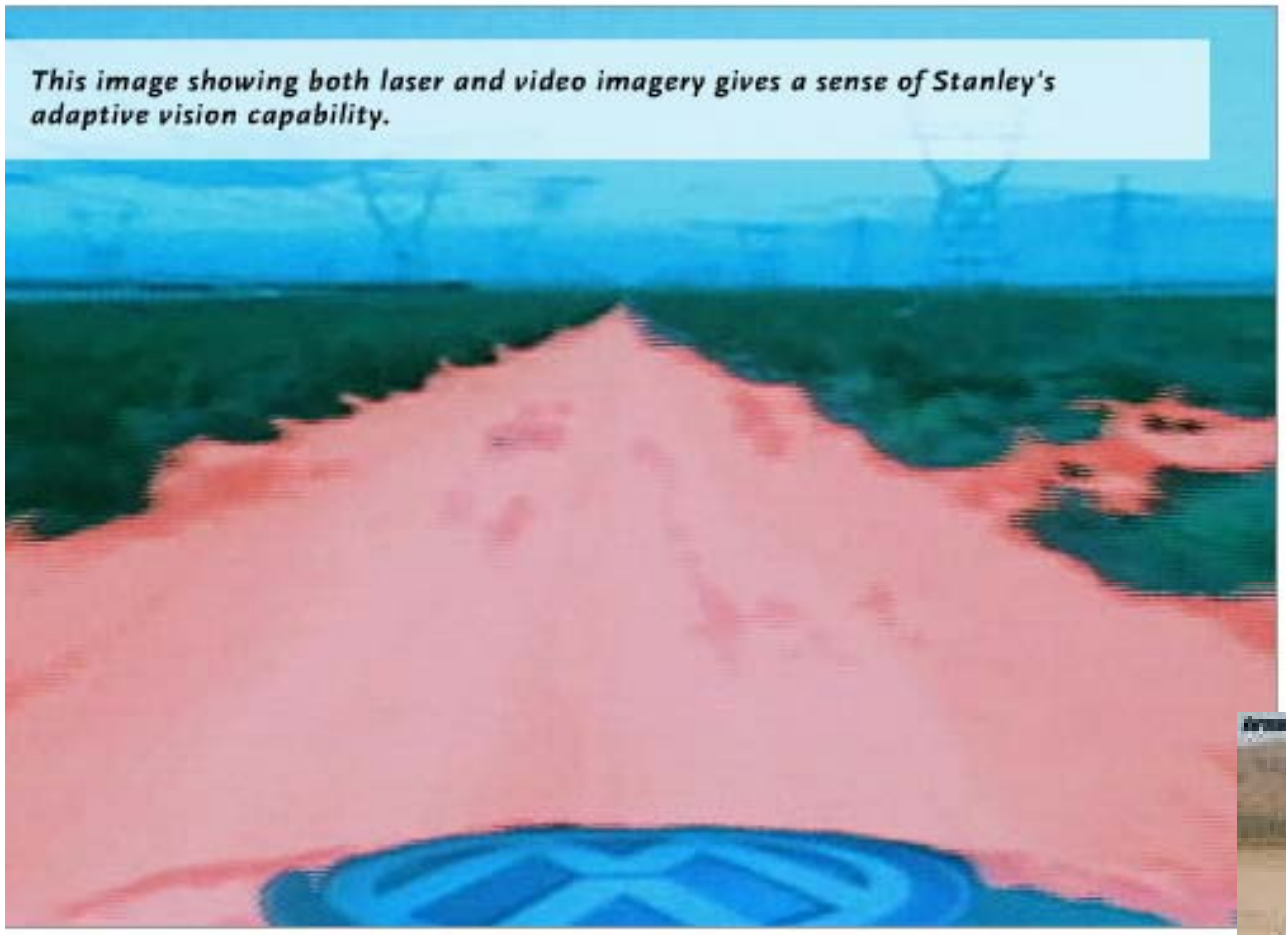
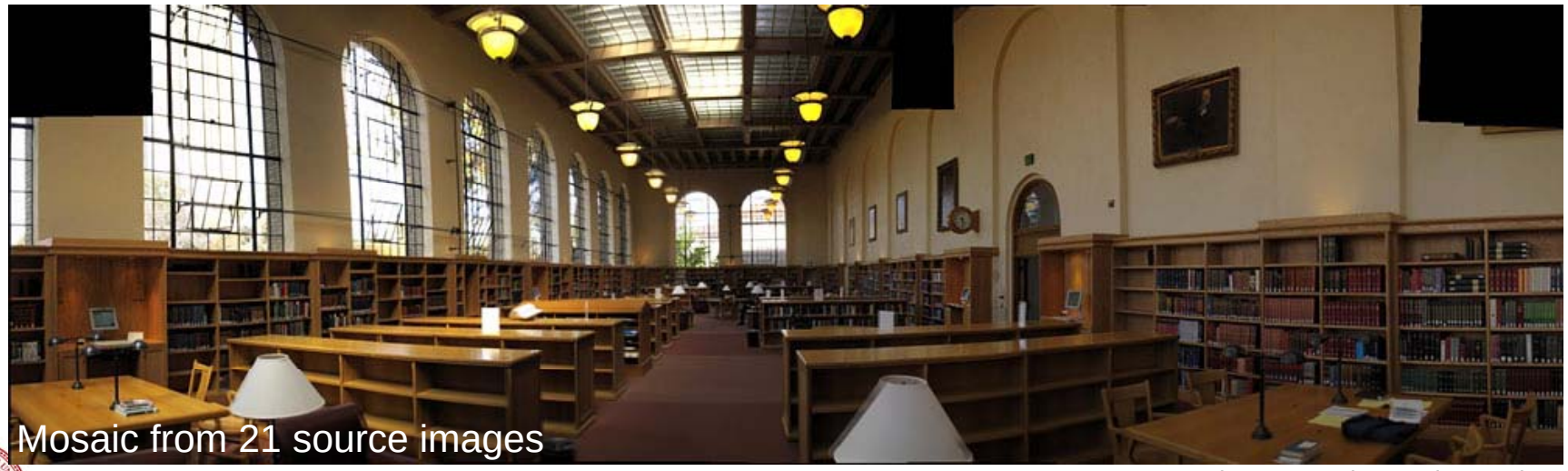


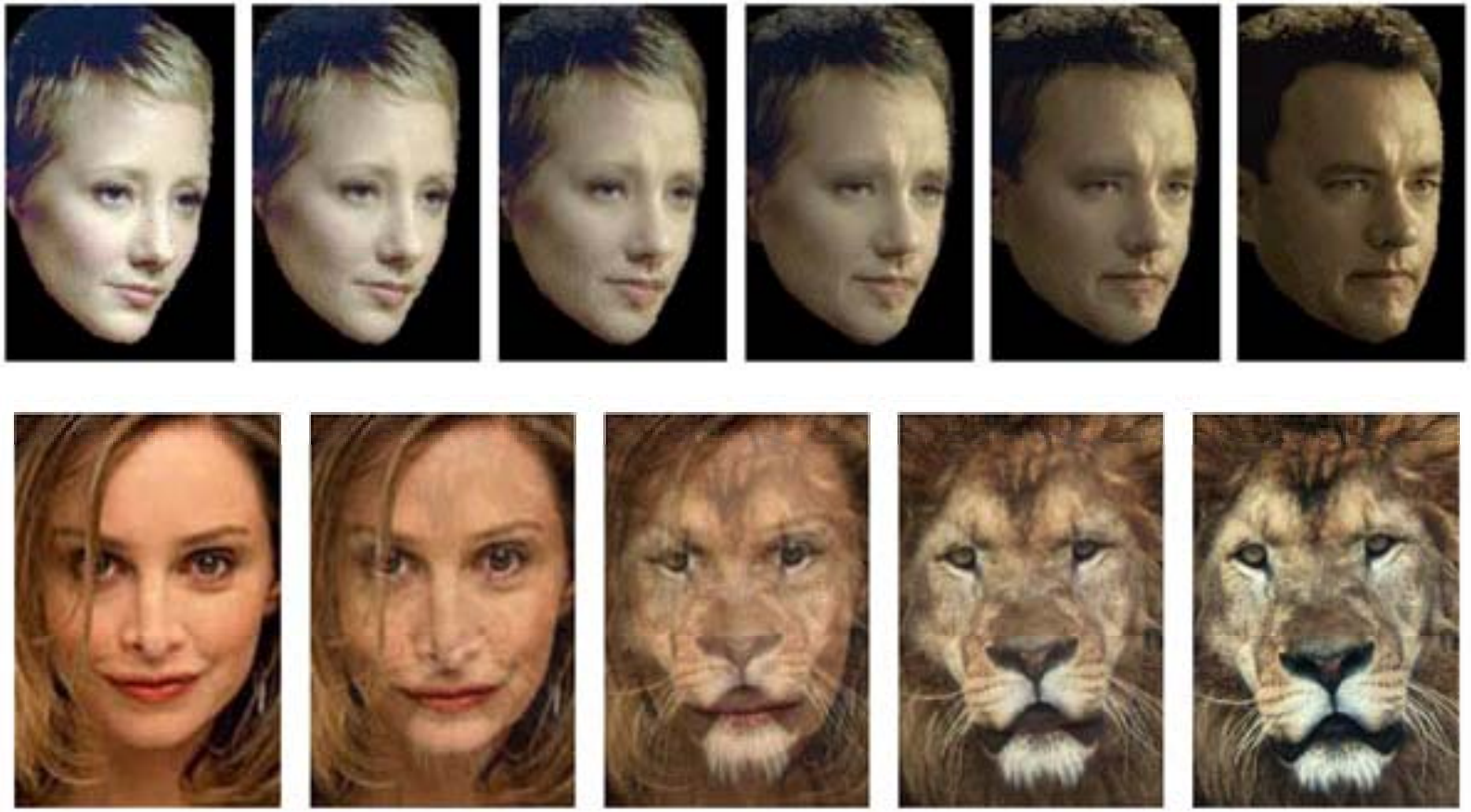
Image Processing Examples



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

Image Processing Examples

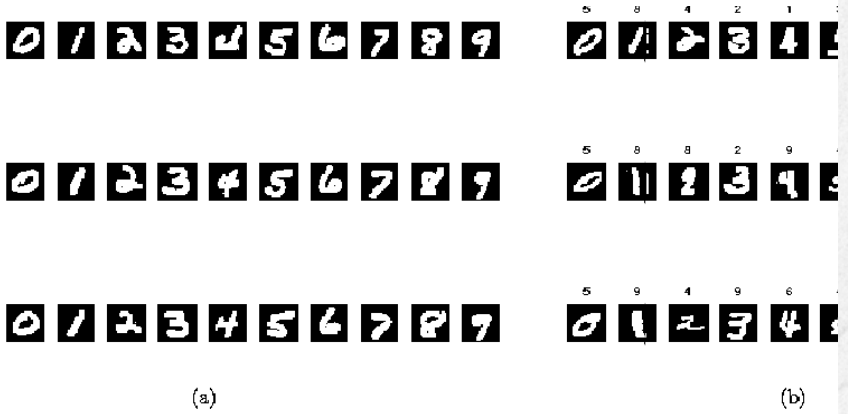
Face morphing



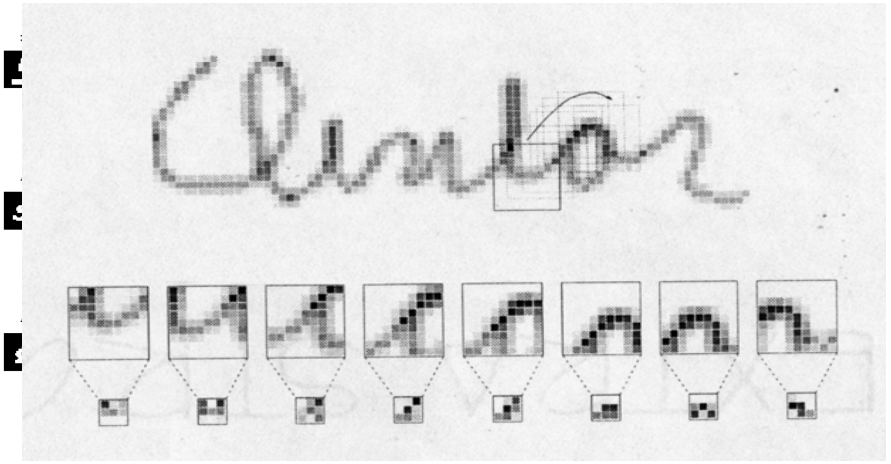
Source: Yi-Wen Liu and Yu-Li Hsueh, EE368 class project, spring 2000.

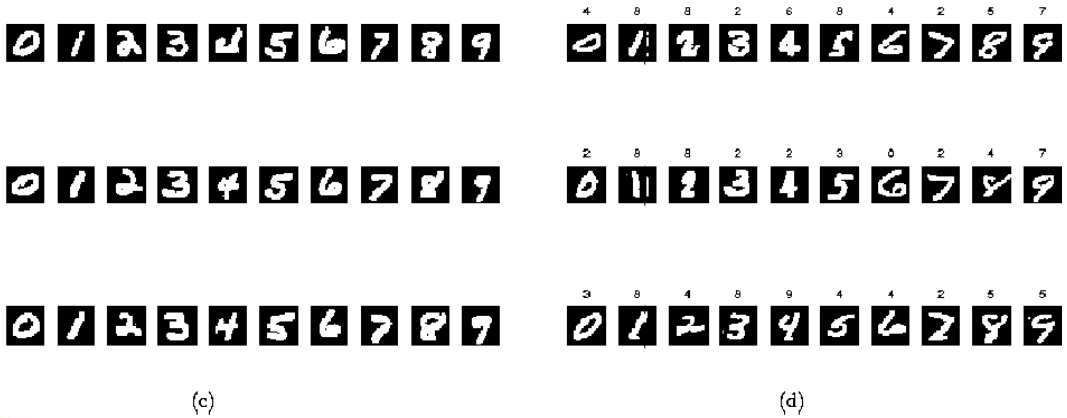
Image Processing Examples

- Handwriting recognition



(a) (b)





(c) (d)

Image Processing Examples

Biometrics: Fingerprint recognition

FBI's Integrated Automated Fingerprint Identification System

IAFIS

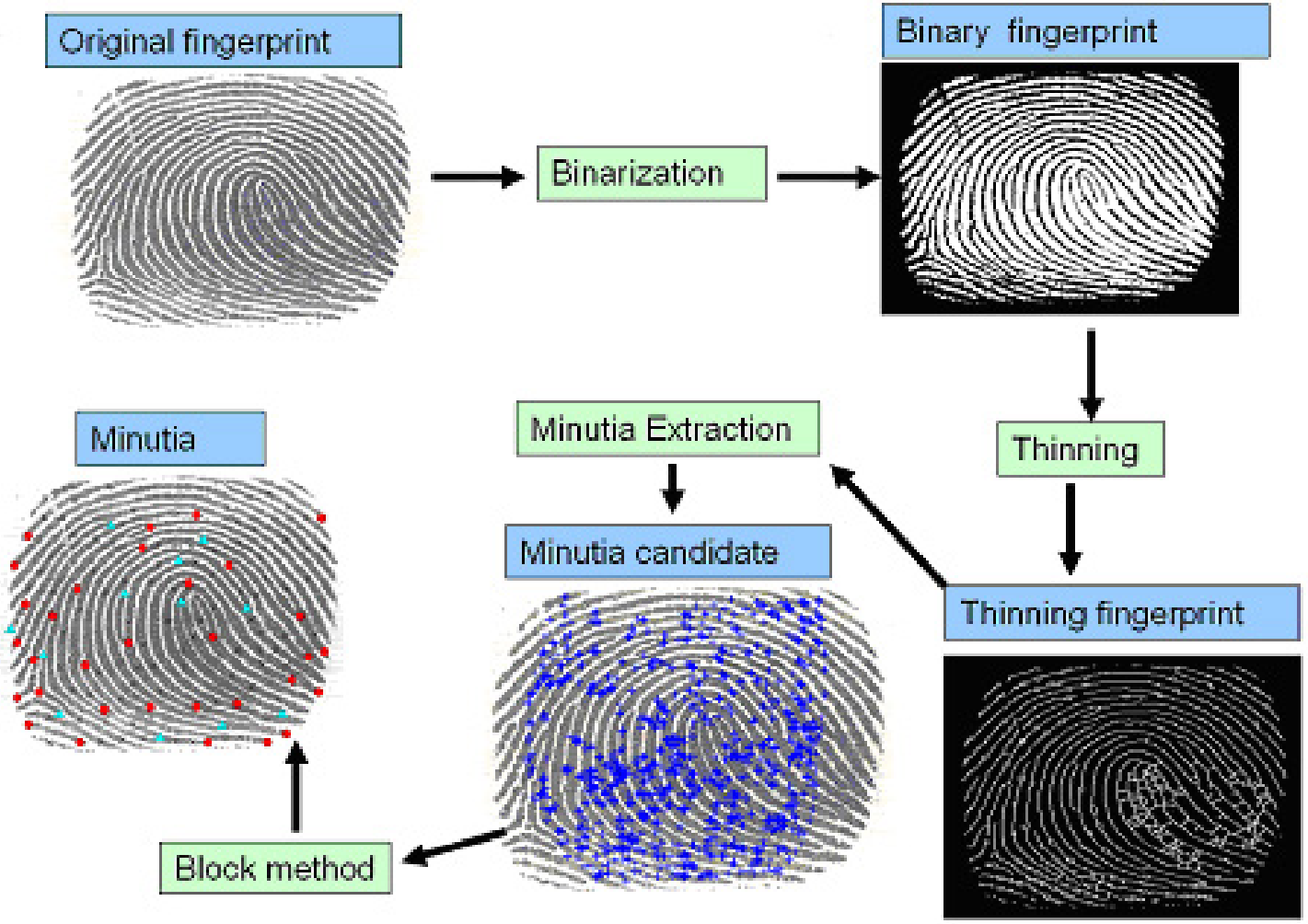
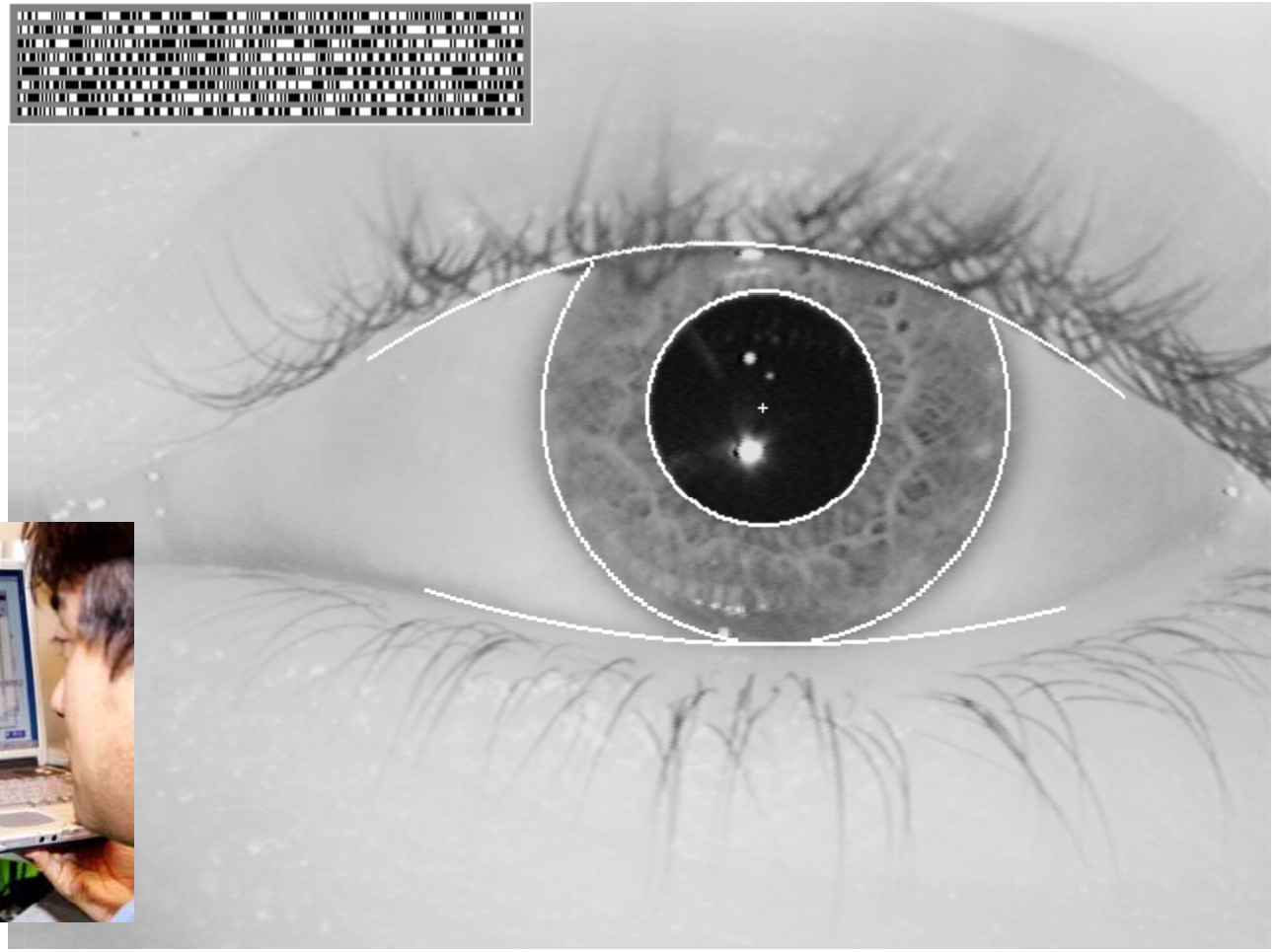


Image Processing Examples

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
  - Morphological image processing
  - Linear processing, filtering
  - Image transforms, multiresolution image processing
  - Feature detection
  - Image registration
- Image compression: EE398A - Winter 2010/11

EE368 Organisation

- Assistants
  - Course assistant: David Chen
  - Administrative assistant: Kelly Yilmaz
- Office hours
  - Bernd Girod: Fr 10:15-11:45, Packard 373
  - David Chen, We 6:15-8:15 p.m., Packard 104
- Class home page:

  http://www.stanford.edu/class/ee368

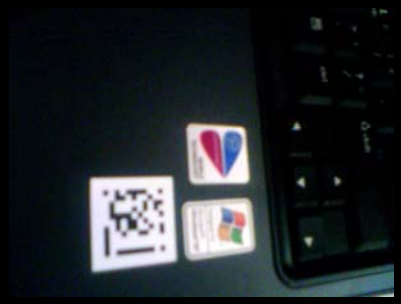
EE368 Organisation (cont.)

- Homeworks
  - Weekly assignments until midterm, require computer + Matlab
  - Handed out Fridays, due one week later, solve individually
  - First handed out on April 2
- Late Midterm
  - 24-hour take-home exam
  - 3 slots, **May 19-22**
- Final project
  - Individual or group project, plan for about 50-60 hours per person
  - Develop, implement and test/demonstrate an image processing algorithm
  - Project proposal due: **April 30**
  - Project presentation: Poster session, **June 7, 5-7:30 p.m.**
  - Submission of written report and source code: June 7
- Grading
  - Homeworks: 20%
  - (Late) mid-term exam: 30%
  - Final project: 50%
  - No final exam.

Spring 2006 Project:
Visual Code Marker Recognition

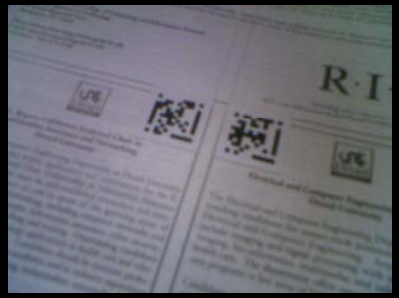













Spring 2007 Project:
Painting Recognition


1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3


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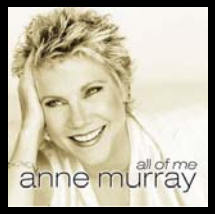
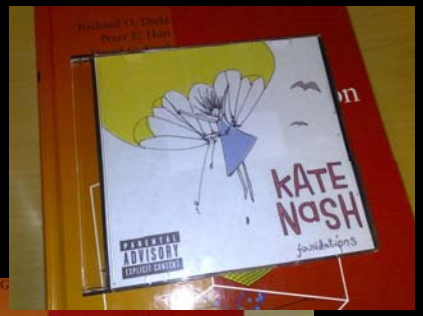
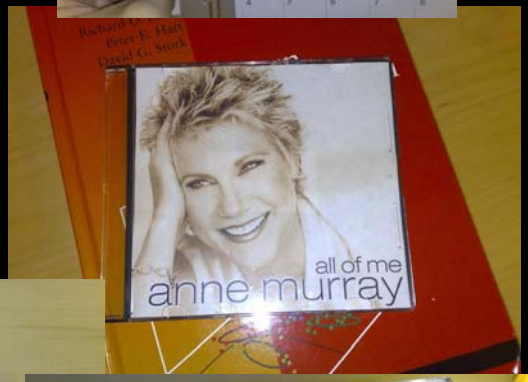
10

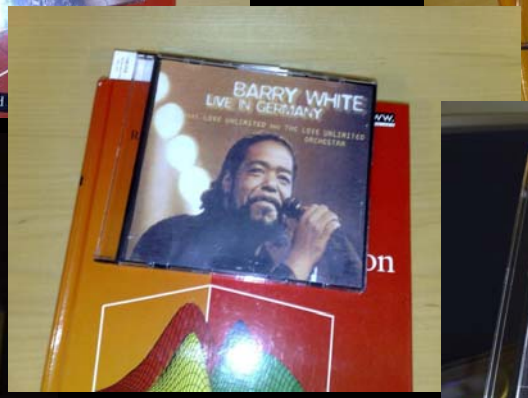
Spring 2007 Project:
Painting Recognition

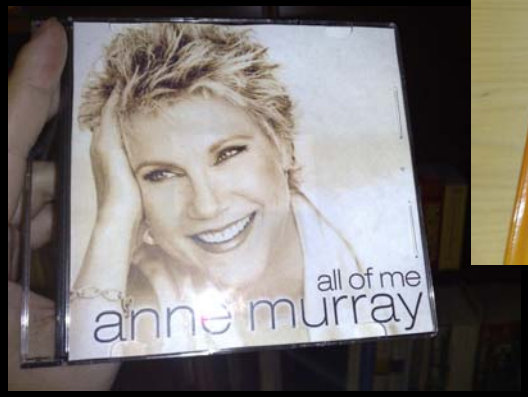
Spring 2008 Project:
CD Cover Recognition











CD Cover Recognition on Cameraphone

SCIEN laboratory

- 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
- SCIEN = Stanford Center for Image Systems Engineering (http://scien.stanford.edu)
- SCIEN lab equipment grants from Hewlett-Packard, Xerox, and Intel

Mobile Image Processing

- Google gift: 40 Motorola DROID cameraphones
- Available for EE368 projects (must be returned after, sorry)
- Image processing on phones will be reviewed April 20-23
- Android development environment on your own computer or in SCIEN lab
- Programming in Java

Further reading

- Slides available as hand-outs and as pdf files on the web
- Recommended book (but not required):
  - R. C. Gonzalez, R. E. Woods, „Digital Image Processing,“ 3rd edition, Prentice-Hall, 2008, $159.00.
- Additional books:
  - R. C. Gonzalez, R. E. Woods, S. L. Eddins, „Digital Image Processing using Matlab,“ 2nd edition, Pearson-Prentice-Hall, 2009, ca. $ 140.--.
  - A. K. Jain, „Fundamentals of Digital Image Processing,“ Prentice-Hall, Addison-Wesley, 1989, $156.00.
  - Al Bovik (ed.), “The Essential Guide to Image Processing,“ Academic Press, 2009. $ 89.95
  - J. S. Lim, „Two-dimensional Signal and Image Processing,“ Prentice-Hall, 1990. $94.-.
  - M. Petrou, P. Bosdogianni, „Image Processing, The Fundamentals,“ Wiley, 1999, $73.50.