# Digital Image Processing
## EE368

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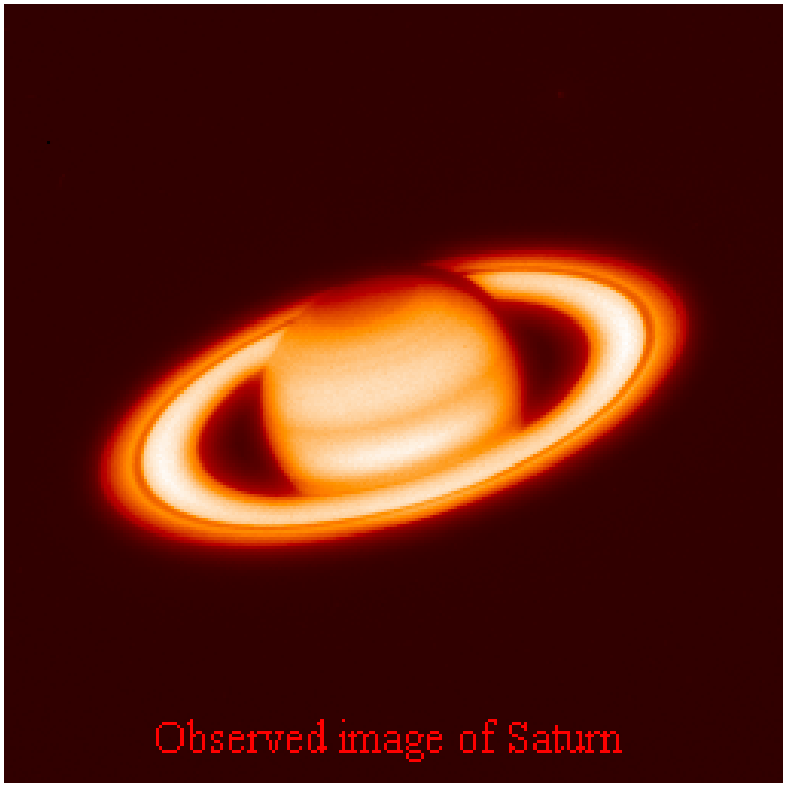
Spring 2006/07

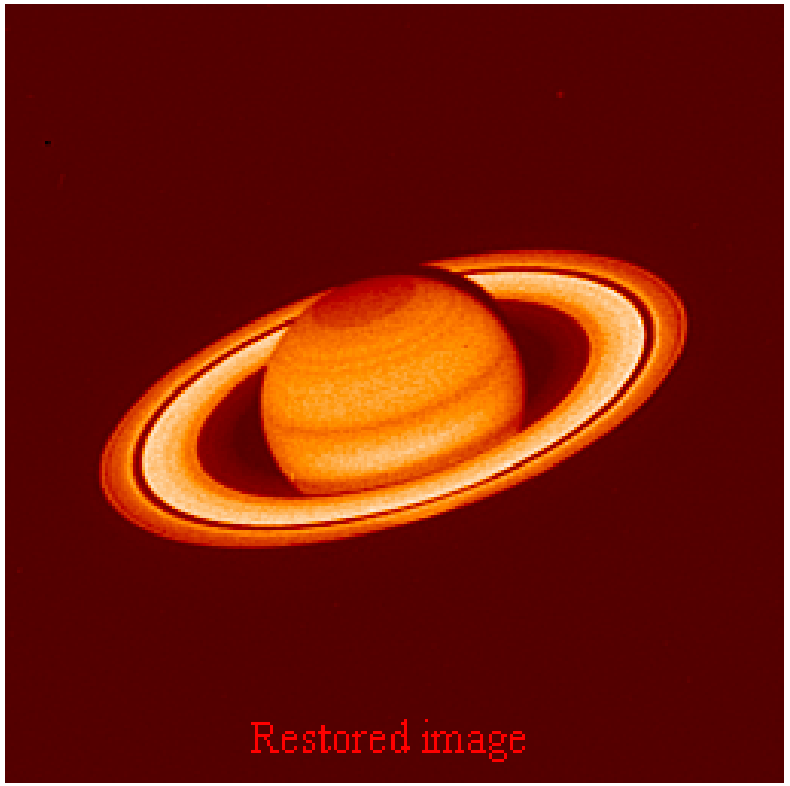
# Why do we process images?

- 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

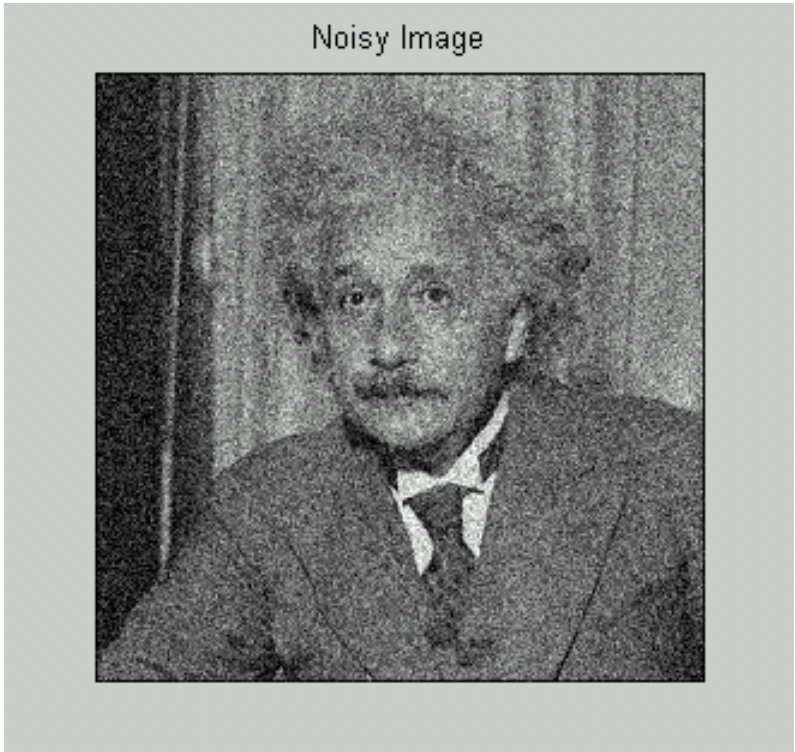
Original

Automatic Enhancement

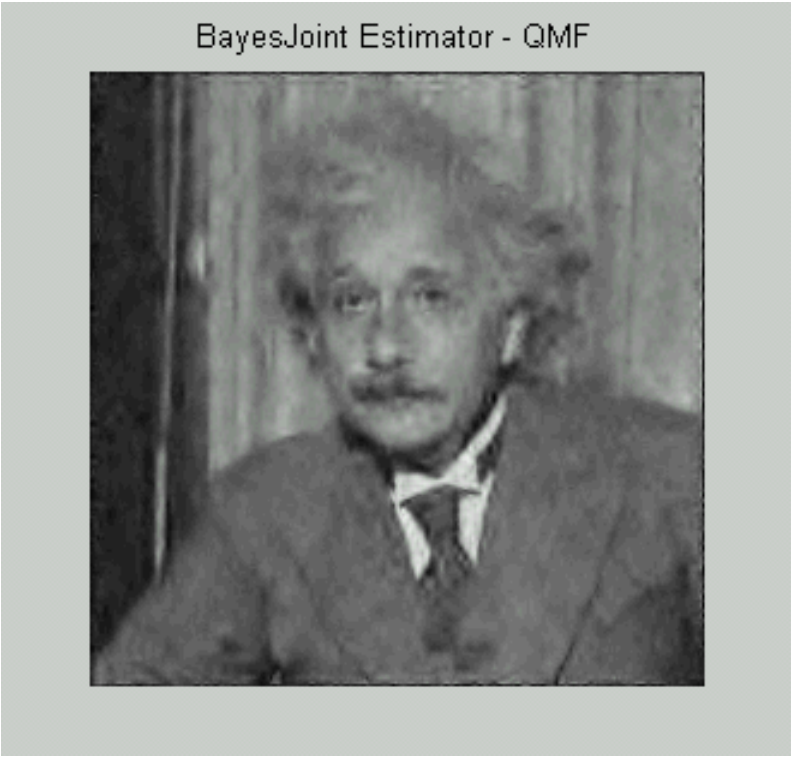
Software: Picture Project 1.5, 2005, Nikon Corporation

# 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

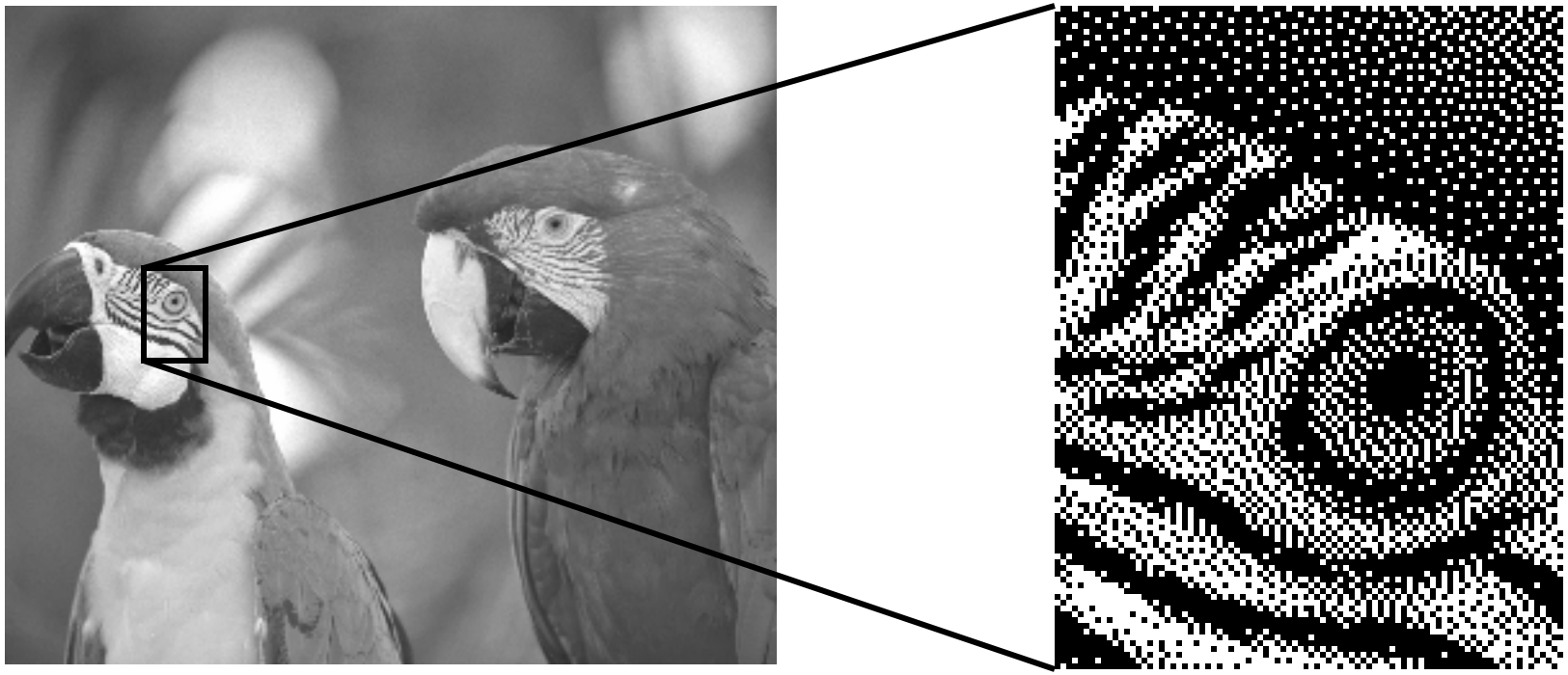
Simulated
color pencils

Simulated
oil painting

source: Feng Xiao, EE368 class project, spring 2000.

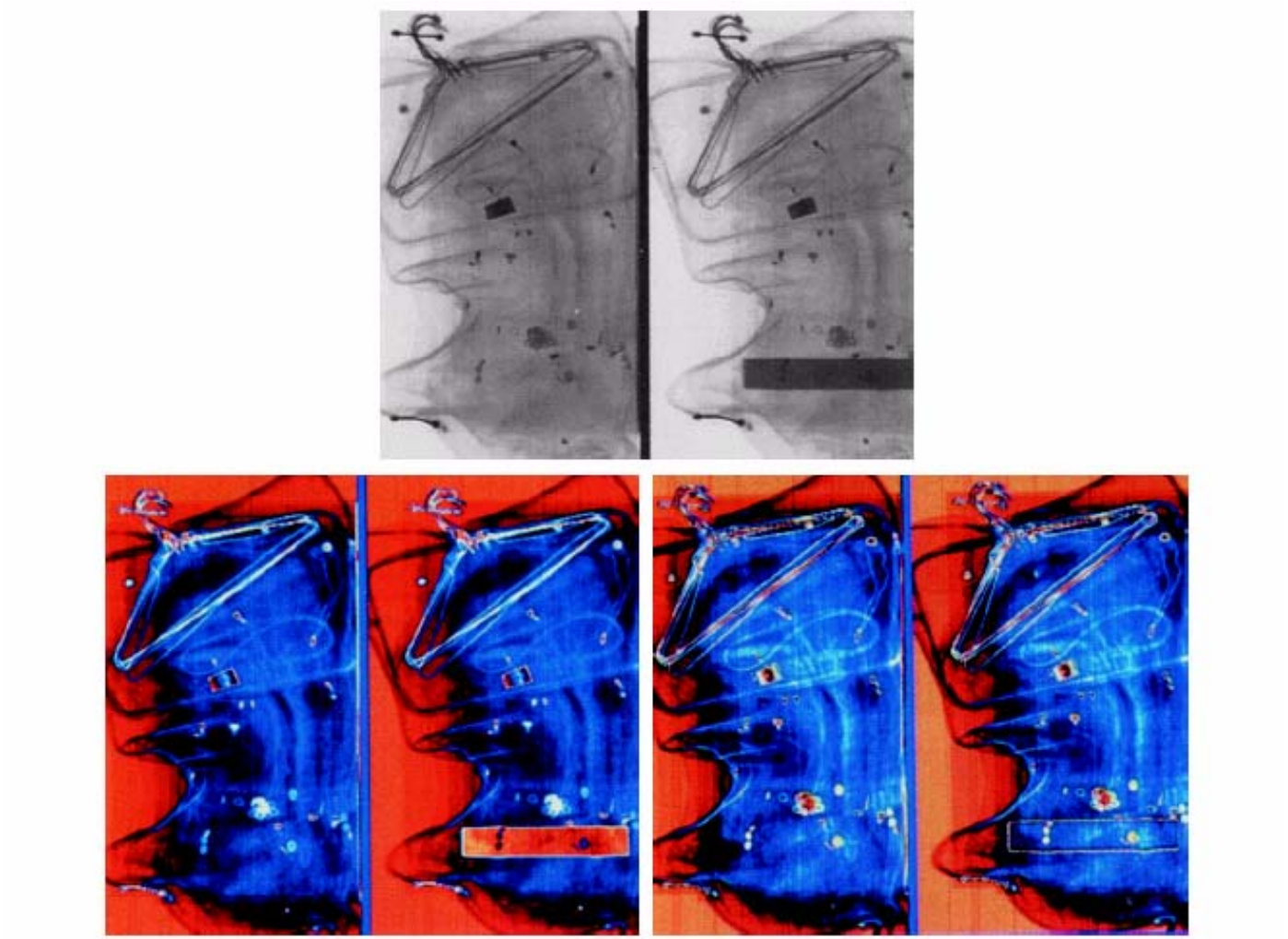
# Image Processing Examples

## 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

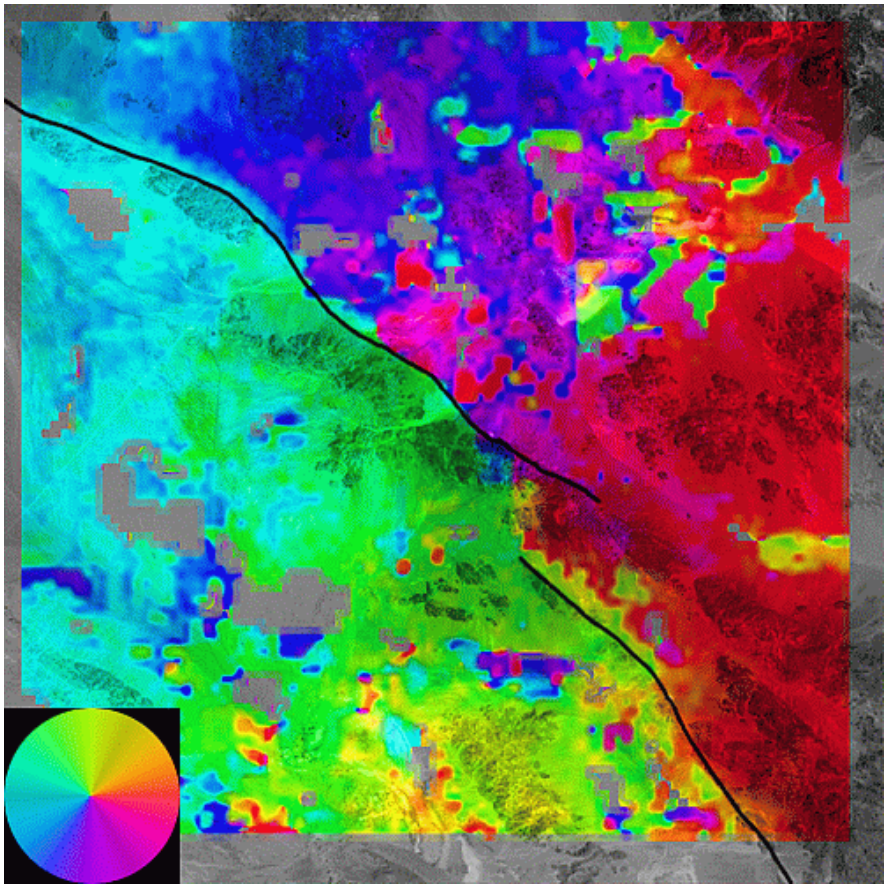
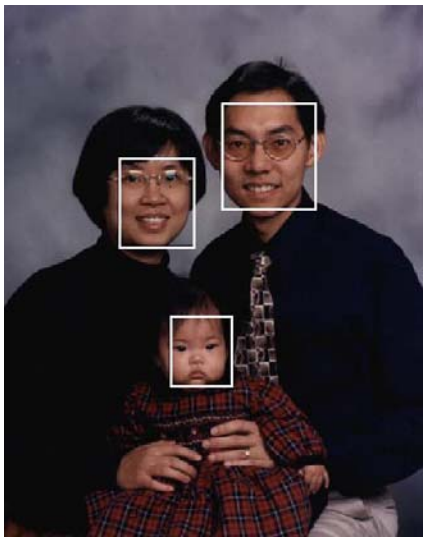


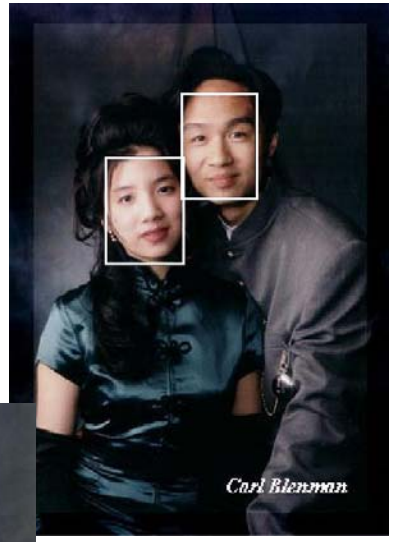
Image shows the ground displacement due to Landers earthquake in CA, 1992

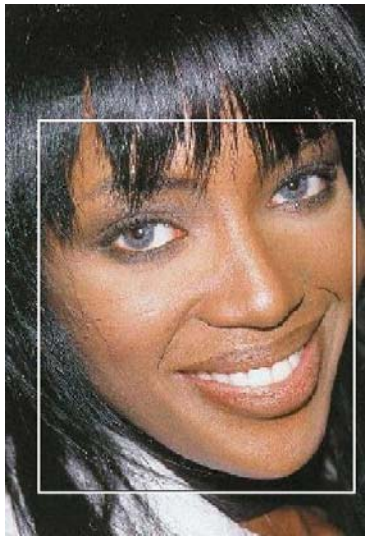
Source: JPL, Pasadena, QUAKEFINDER project

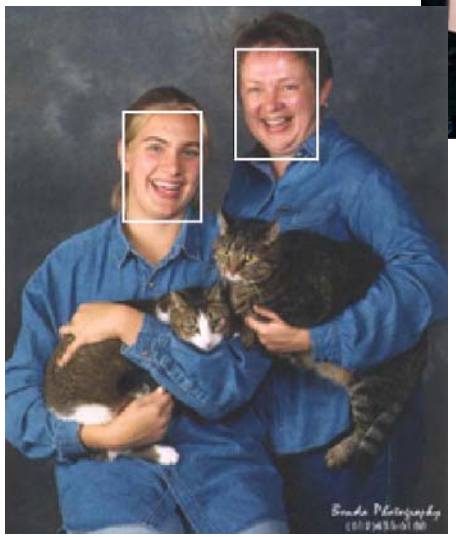
# Image Processing Examples

## Face Detection



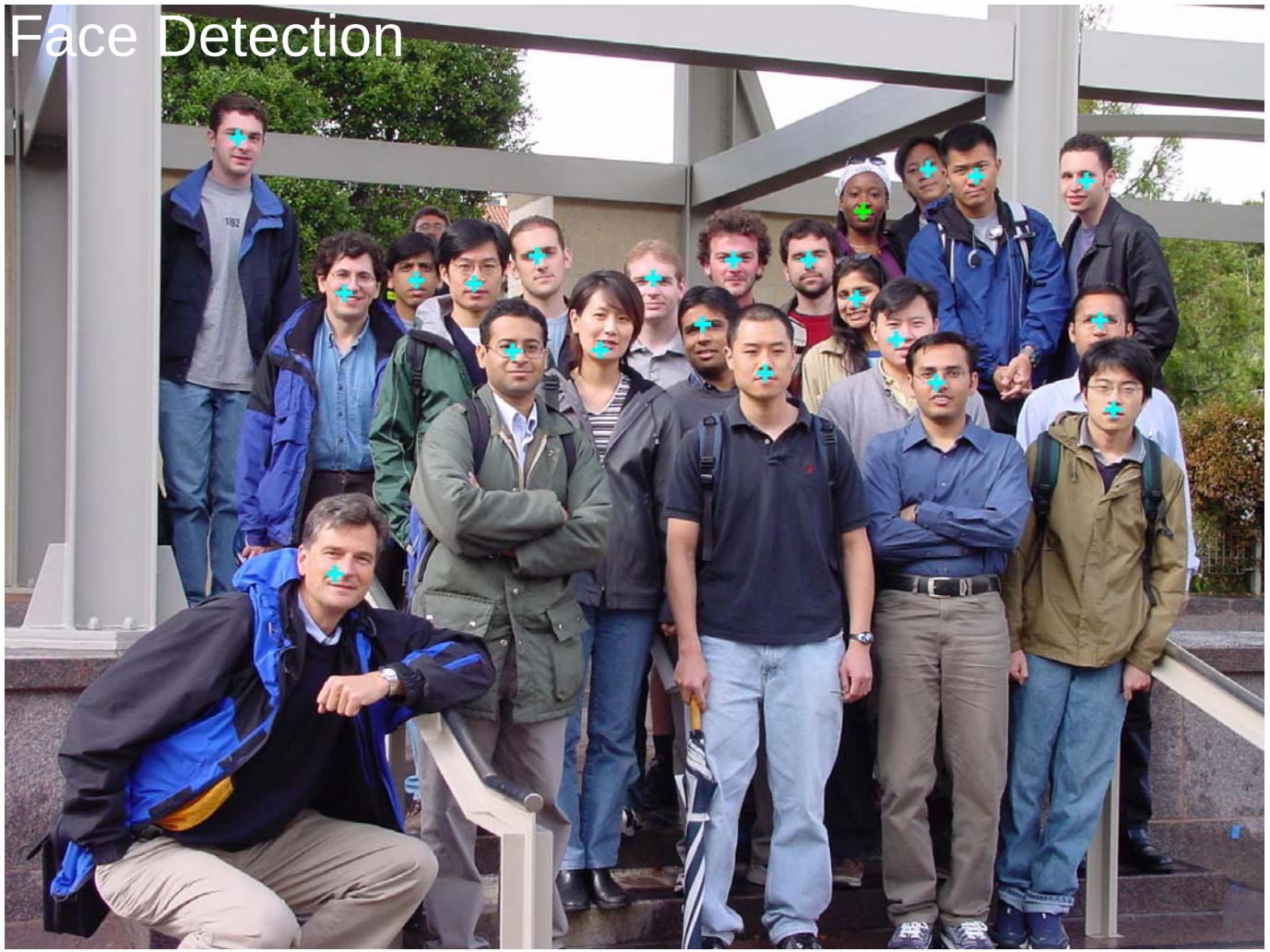




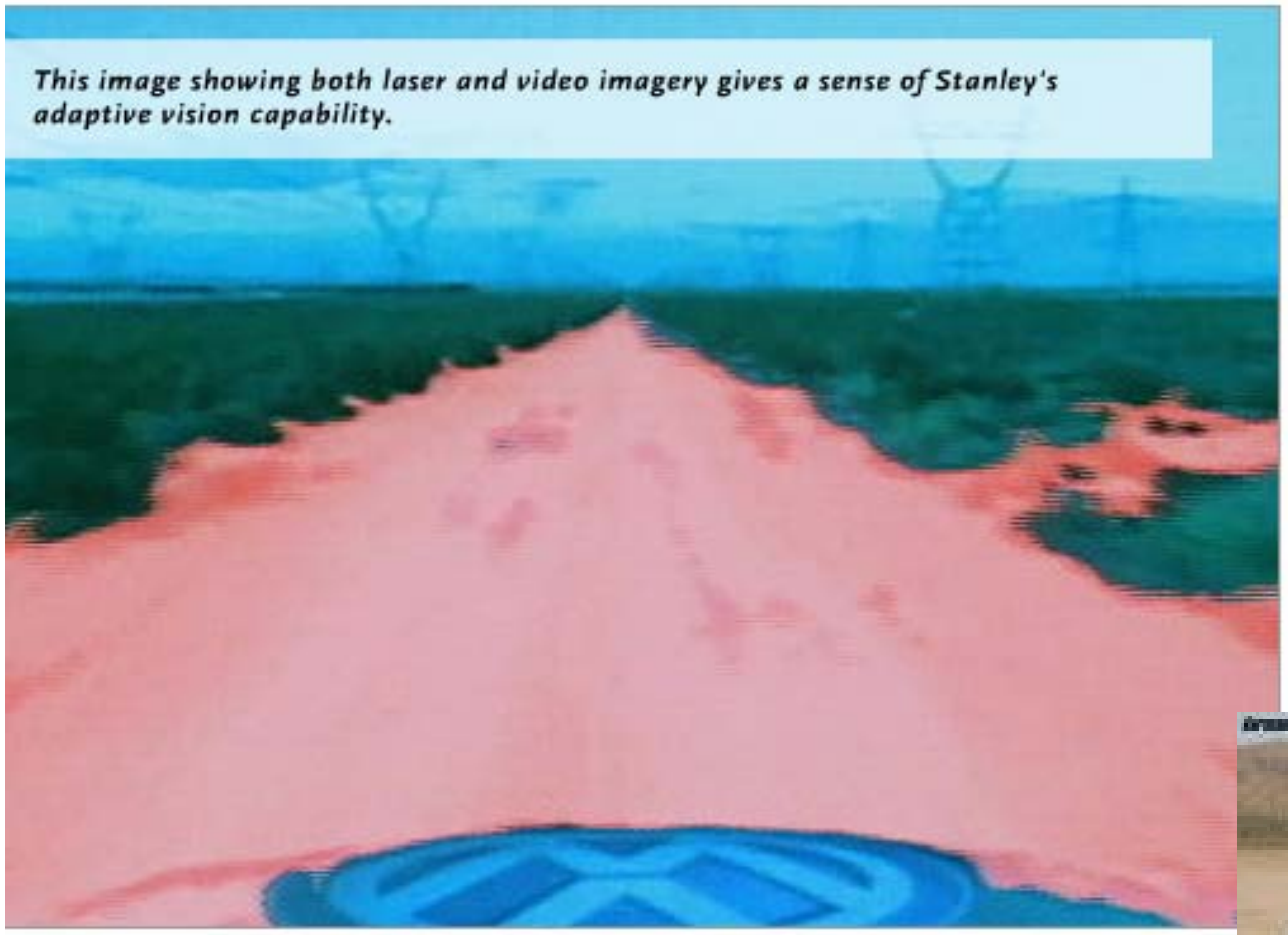
source: Henry Chang, Ulises Robles, EE368 class project, spring 2000.

# Image Processing Examples

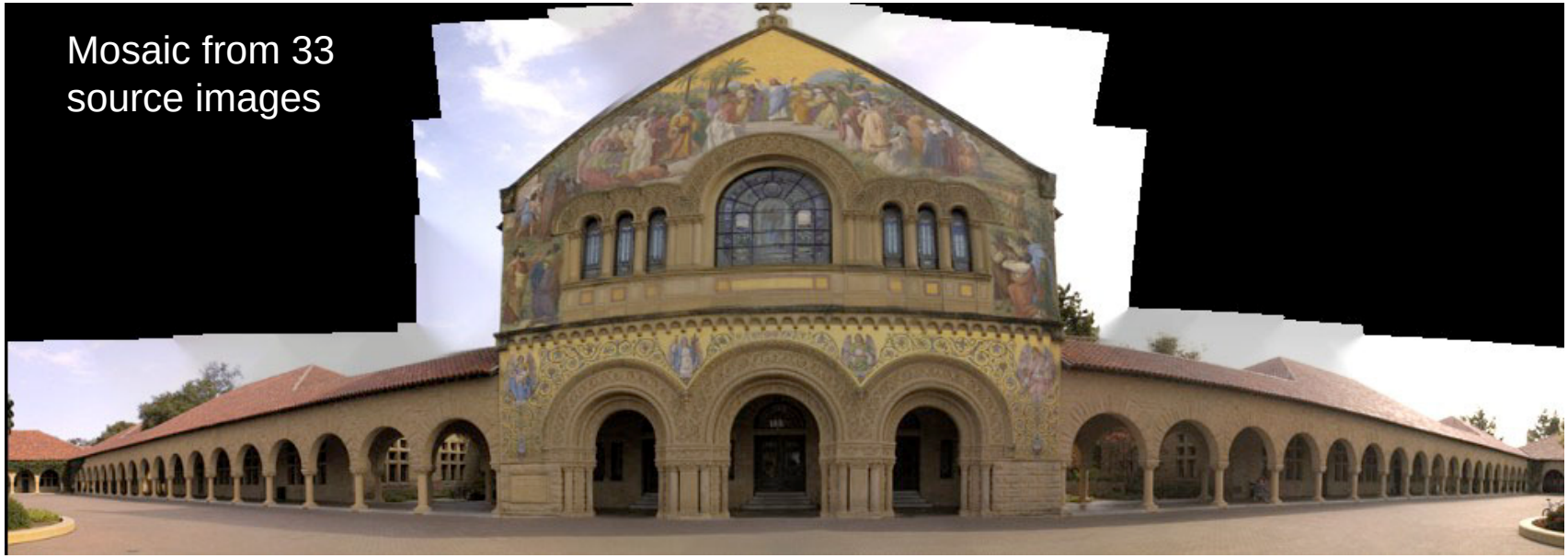



source: Michael Bax, Chunlei Liu, and Ping Li, EE368 class project, spring 2003.

# Image Segmentation




# Image Processing Examples

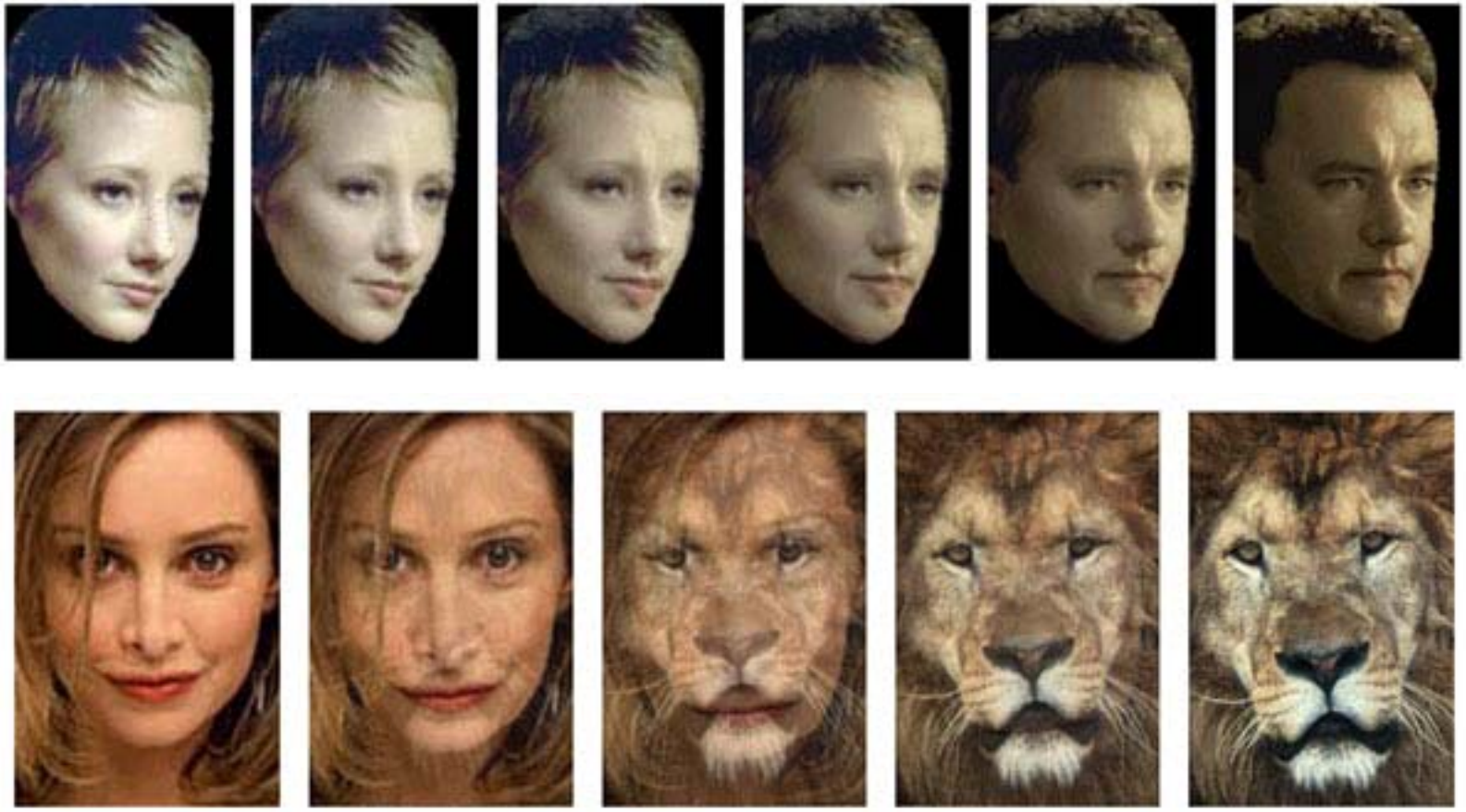




source: M. Borgmann, L. Meunier, EE368 class project, spring 2000.

# Image Processing Examples

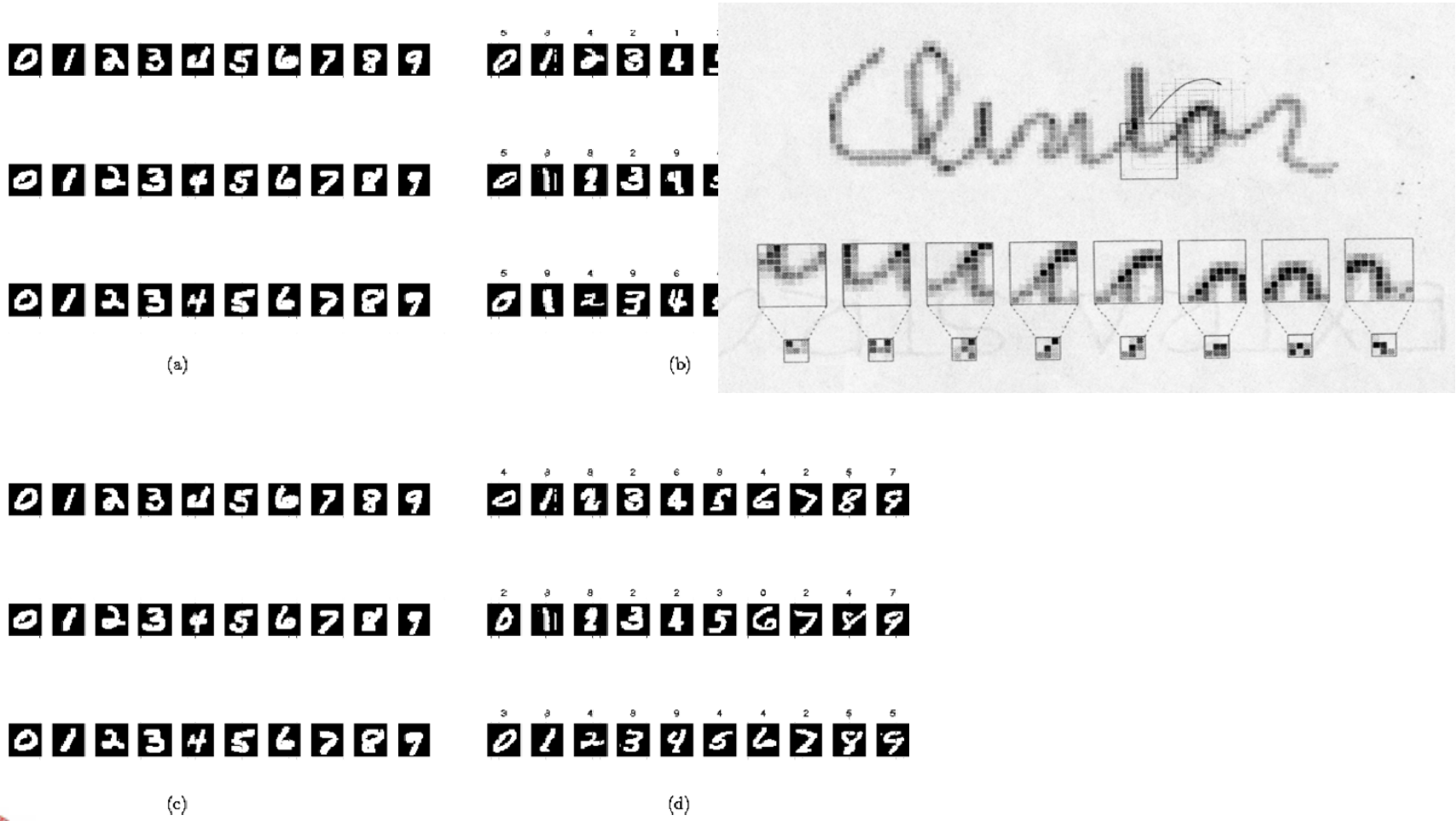
## Face morphing



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

# Image Processing Examples

- Handwriting recognition

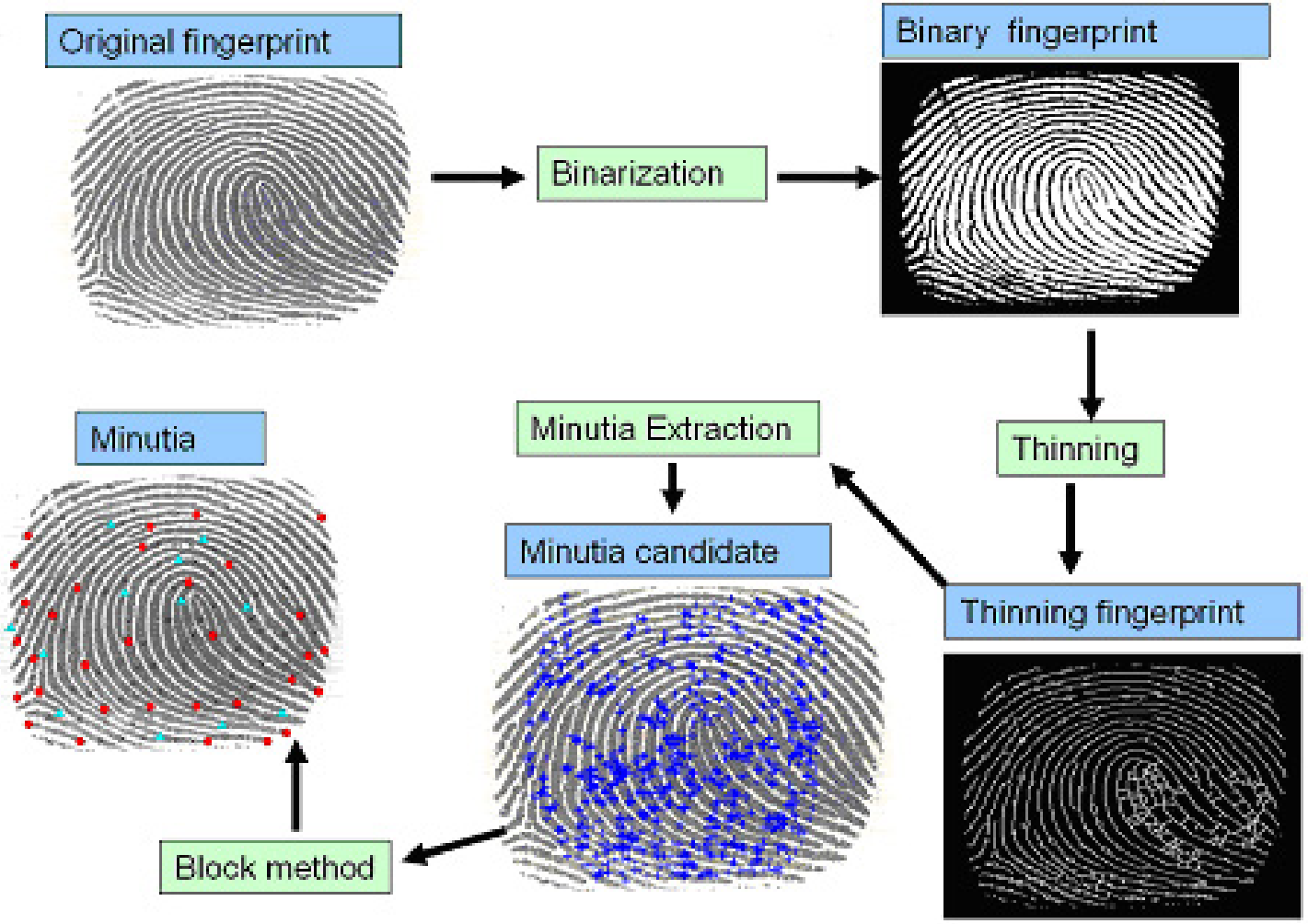


# Image Processing Examples

## Biometrics: Fingerprint recognition

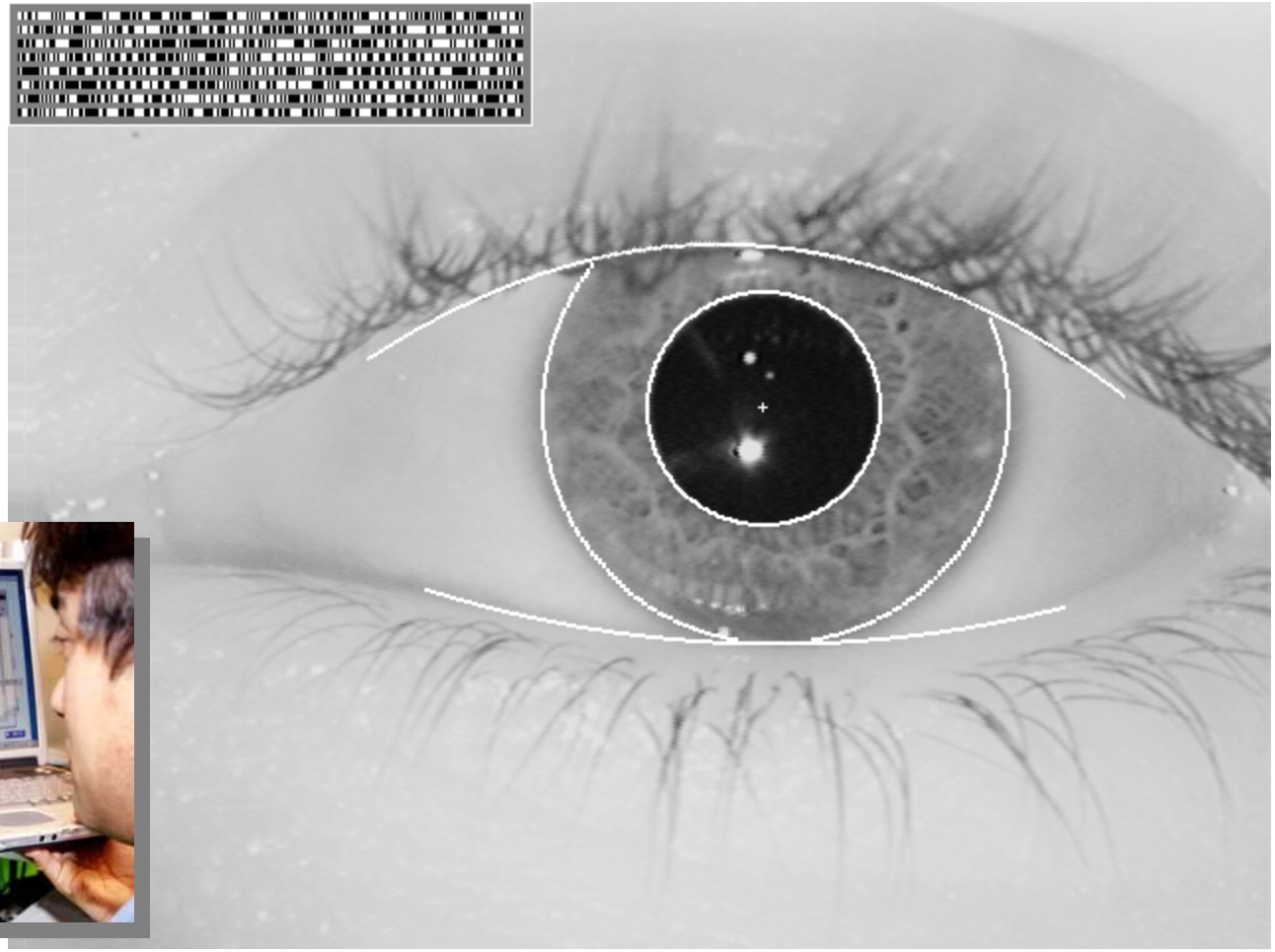
FBI's Integrated Automated Fingerprint Identification System

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
  - 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*

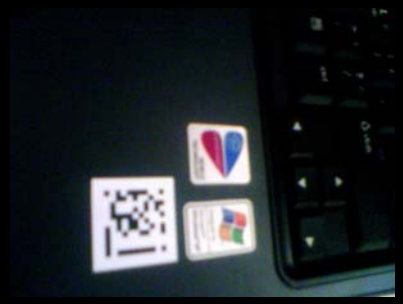
# EE368 Organisation (cont.)

- 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

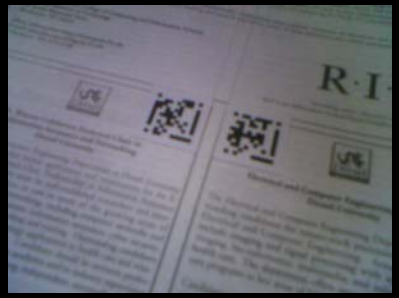













# SCIEN laboratory

- 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:
  - R. C. Gonzalez, R. E. Woods, „Digital Image Processing,“ 2nd edition, Prentice-Hall, 2002, $116.00.
  - A.K. Jain, „Fundamentals of Digital Image Processing,“ Prentice-Hall, Addison-Wesley, 1989, $115.00.
- Additional books:
  - R. C. Gonzalez, R. E. Woods, S. L. Eddins, „Digital Image Processing using Matlab,“ Pearson-Prentice-Hall, 2004, $ 116.--.
  - Al Bovik (ed.), „Handbook of Image and Video Processing,“ Academic Press, 2000, $ 110.--
  - 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.
  - B. Jähne, „Practical Handbook on Image Processing for Scientific Applications,“ CRC Press, 1997. $139.95.

# Voluntary Reading Assignment

- Gonzalez + Woods:
  - Chapter 1
  - Chapter 2