Digital Image Processing

About the class

Tentative Syllabus

- Prerequisites

- Objectives

- Textbook

- Grade

About Instructor

Dr. Behnam Kiani Kalejahi

PhD in Biomedical Engineering

Area of Research Interest

- Biomedical Image Processing
- Cyber Security

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Consultation hours(Tentative): Monday–Thursday 15:00 to 17:00

Office: Room # A – 257

Prerequisites of This Course

This is a computer science course

- It will involve a fair amount of math
  - calculus, linear algebra, geometry
  - probability
  - analog/digital signal processing
  - graph theory etc.

- It will involve the modeling and design of a real system
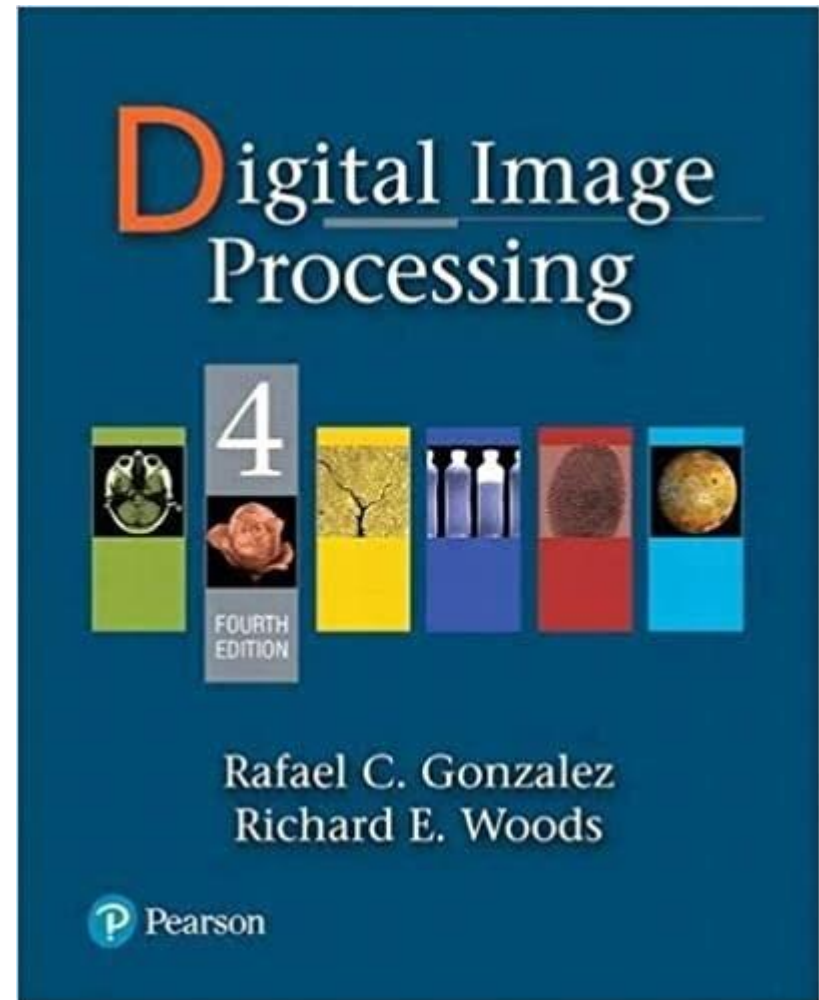 - Programming skills with matlab, Python, or C++

Textbook

Required:

Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods, 4th Edition, Pearson

We will cover many topics in this text book

We will also include special topics on recent progresses on image processing

Grading policy

Internship	10%
Mid-term, written exam.	20%
Final, written exam	50%
Continuous assessment	10%

Mid term

- Mid-term will be taken totally on paper.
- Mid may include

  - Understanding of the concepts.

  - Exercises

  - Basic python codes to solve the problems.

Final

- You may be provided with a problem that will require some algorithm to use.
- You maybe provided the before and after effects of an algorithm and will be asked the type of algorithm used in the process.
- Some exercises.
- Python source codes for some simple unseen algorithms

Major Topics Covered in Class

- Image acquisition and digital image representation

- Image enhancement

- Image restoration

- Color image processing Image

- Compression Image

- Segmentation

- Morphological image processing

- Special topics on recent progresses on digital image processing

Human Perception VS Machine Vision

- Limited vs entire EM spectrum

THE ELECTRO MAGNETIC SPECTRUM

Image Processing → Image Analysis

Low
level

Image acquisition

Image enhancement

Image compression

**Image
processing**

Mid level

Image segmentation

Object recognition

High
level

Scene understanding

Semantics

Image analysis
(Computer vision,
Pattern recognition,
etc.)
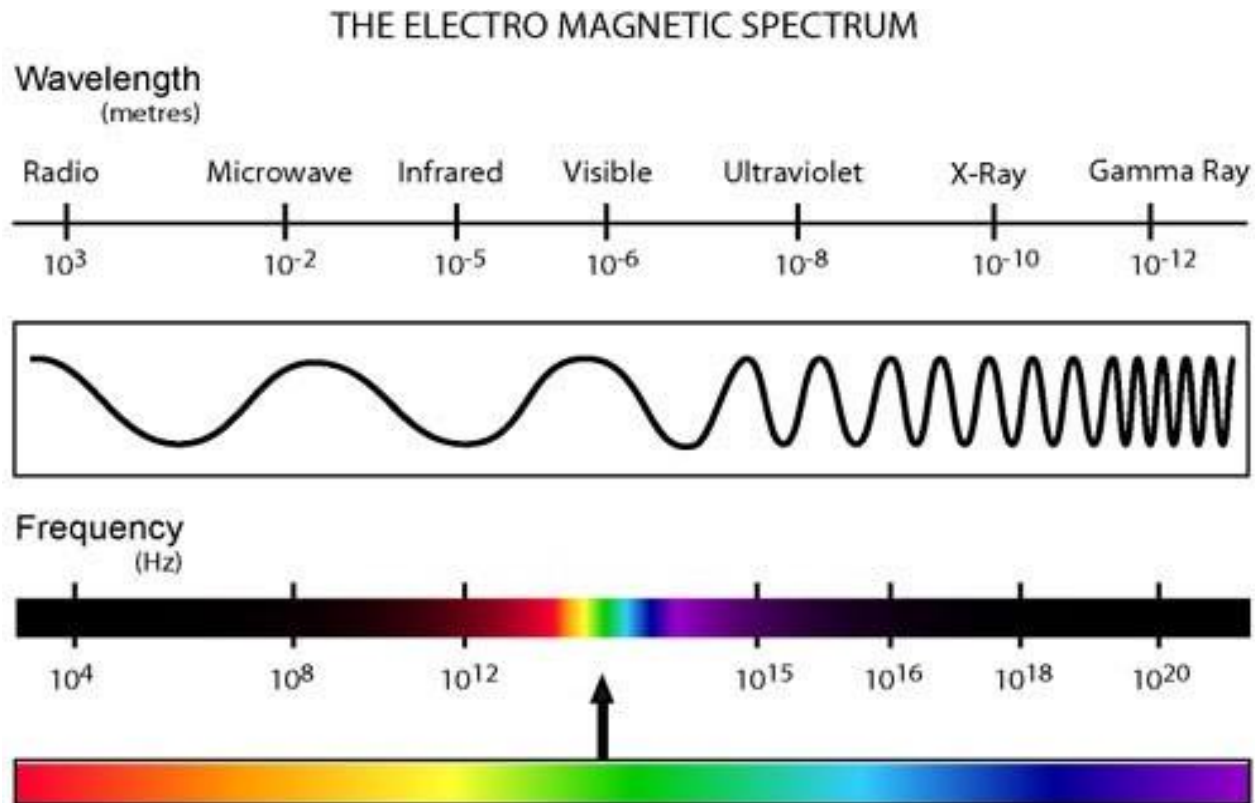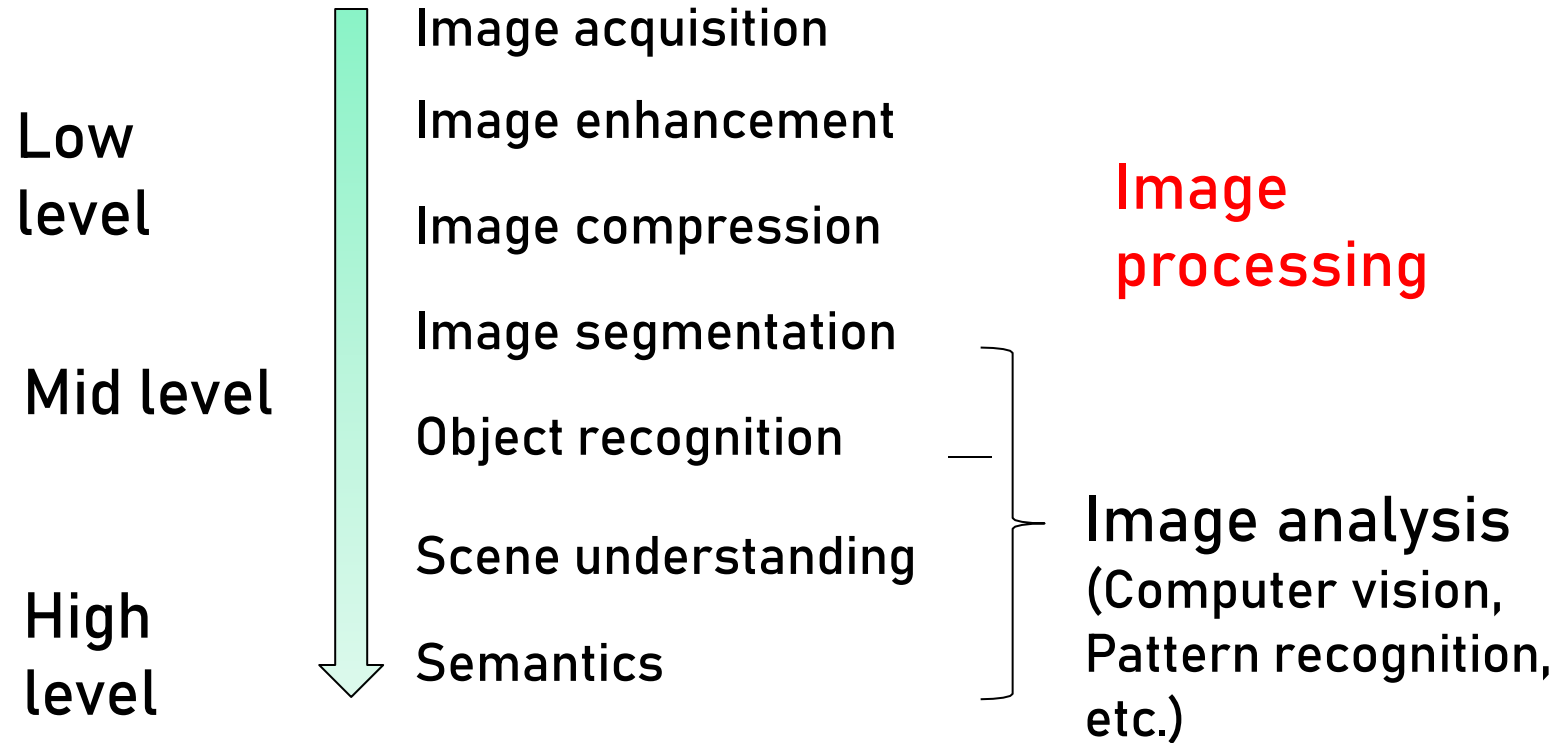
Image Acquisition and Representation
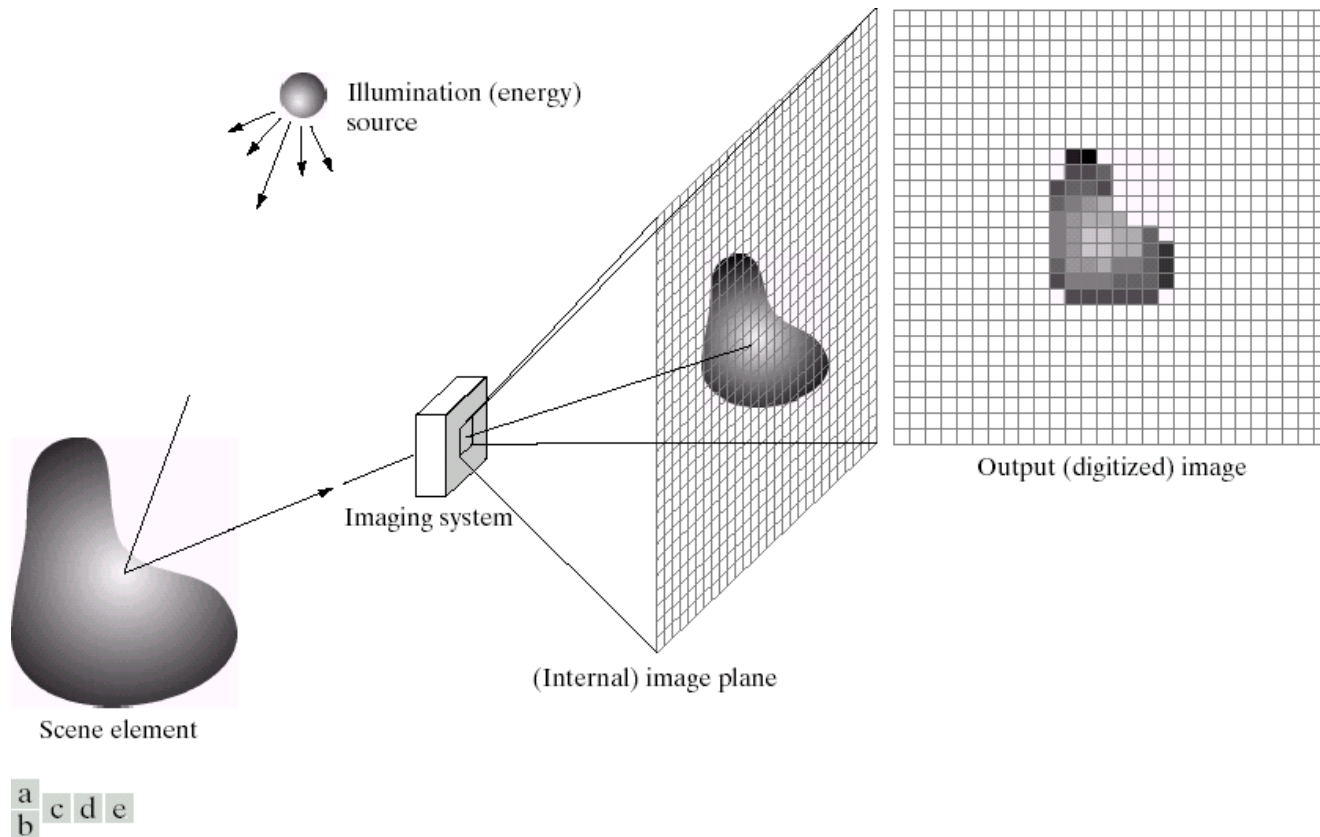
FIGURE 2.15 An example of the digital image acquisition process. (a) Energy ("illumination") source. (b) An element of a scene. (c) Imaging system. (d) Projection of the scene onto the image plane. (e) Digitized image.

Examples
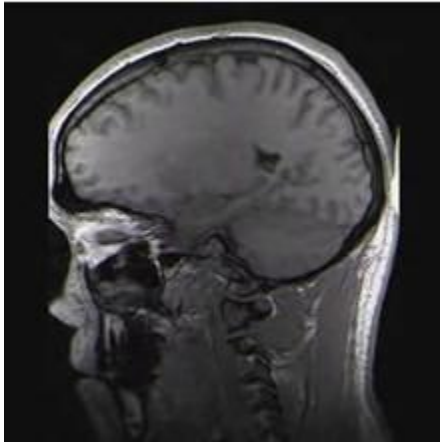
1. Brain MRI
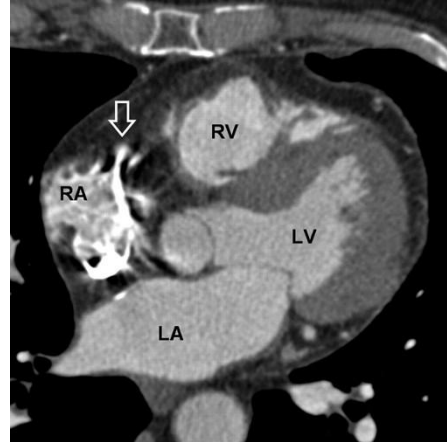
2. Cardiac CT

3. Fetus Ultrasound
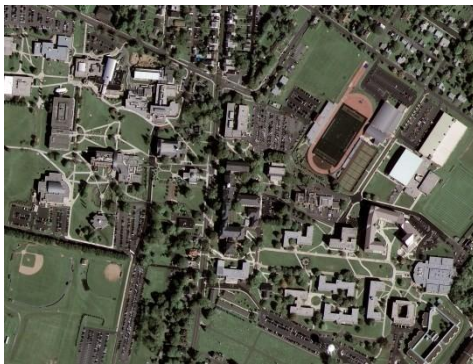
4. Satellite image

5. IR image

Image Acquisition

Camera + Scanner → Digital Camera: Get images into computer
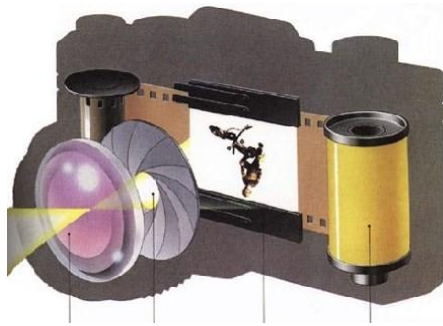
lens aperture shutter film

Image Representation

Discrete representation of images

- we'll carve up image into a rectangular grid of pixels $P[x,y]$
- each pixel p will store an intensity value in [0 1]
- 0 → black; 1 → white; in-between → gray
- Image size mxn → (mn) pixels
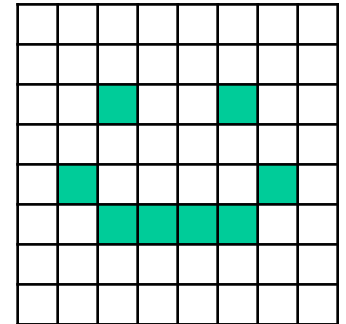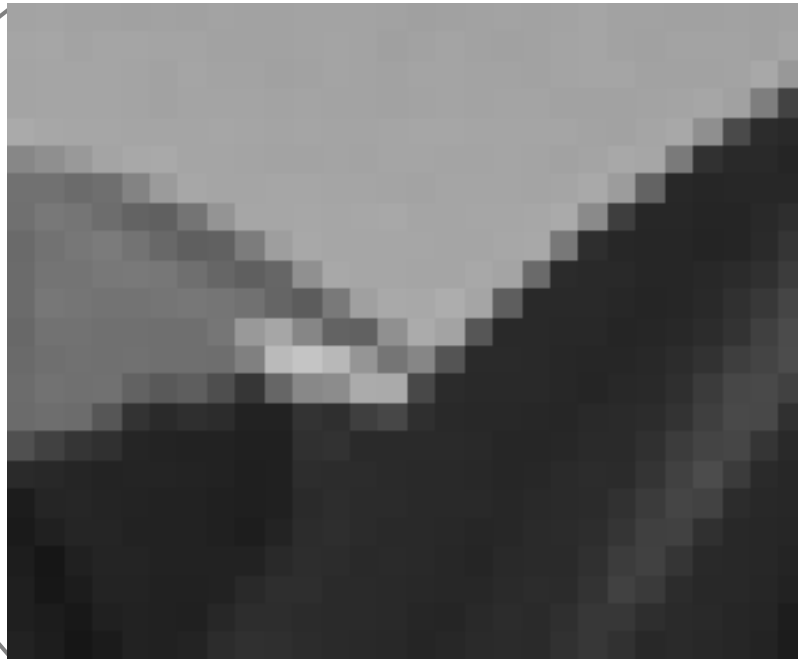
Color Image

Red
(1,0,0)
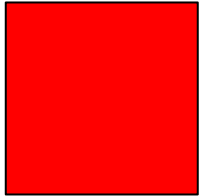
Green
(0,1,0)
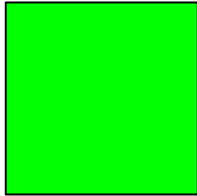
Blue
(0,0,1)

0.6

0.0

0.8

+

0   Colors along Red axis   1
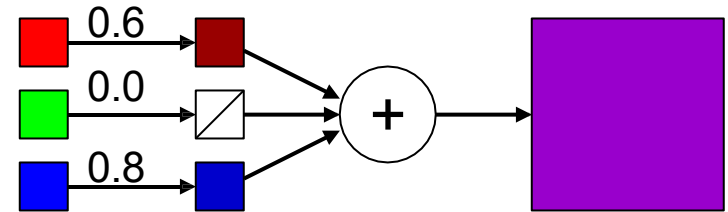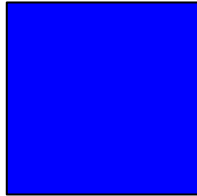
RGB
channels

Video: Frame by Frame

30 frames/second

Image Enhancement

Image Restoration

Image Compression

100% fidelity — Image is 725kB | 90% — 250kB | 10% — 37kB | 1% — 20kB

→ **Video compression**

Image Processing → Image Analysis

Low level — Image acquisition, Image enhancement, Image compression → Image processing

Mid level — Image segmentation, Object recognition

High level — Scene understanding, Semantics

Image analysis (Computer vision, Pattern recognition, etc.)
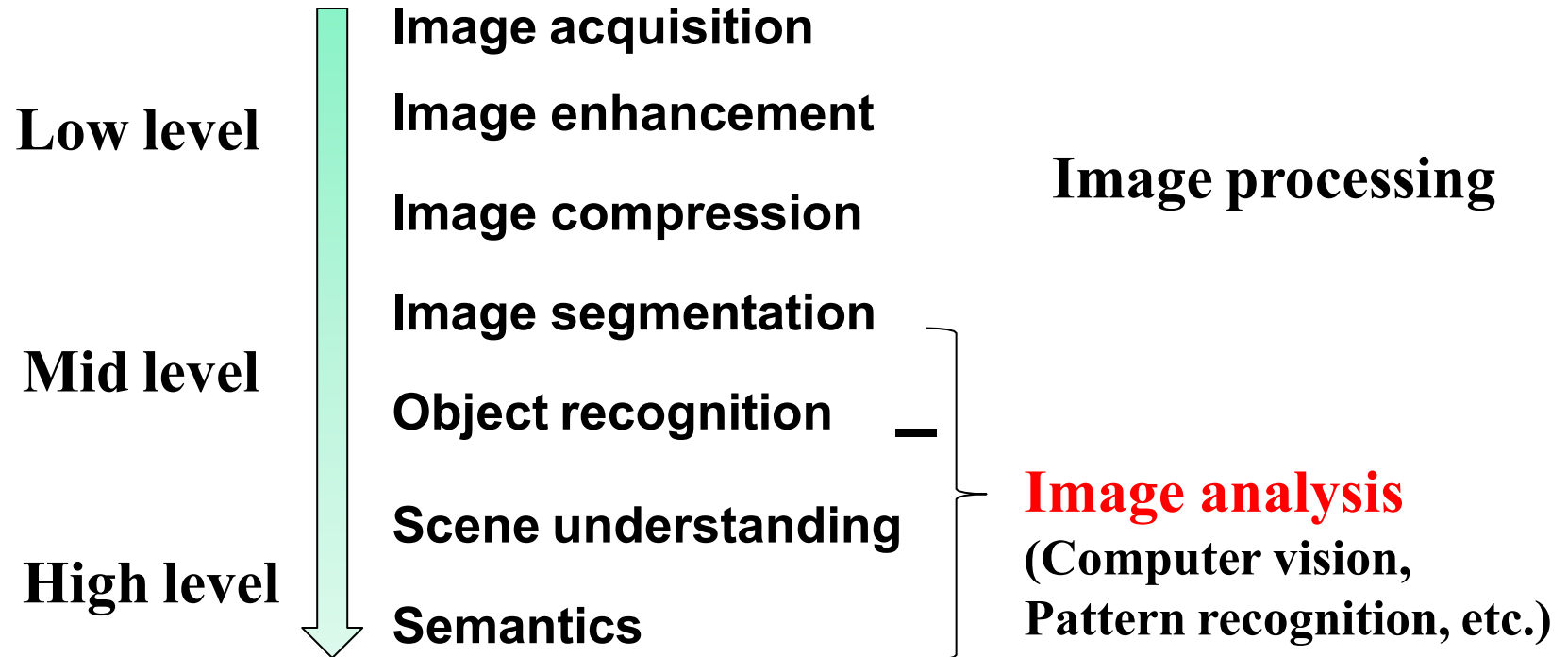
Image Segmentation
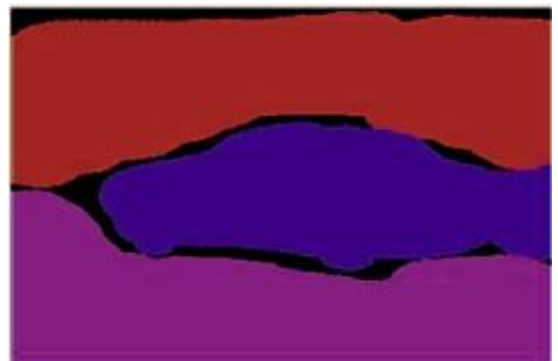
Microsoft multiclass segmentation data set

Image Completion

Interactively select objects. Remove them and automatically fill with similar background (from the same image)

I. Drori, D. Cohen-Or, H. Yeshurun, SIGGRPAH'03

More Examples

Morphological Image Processing
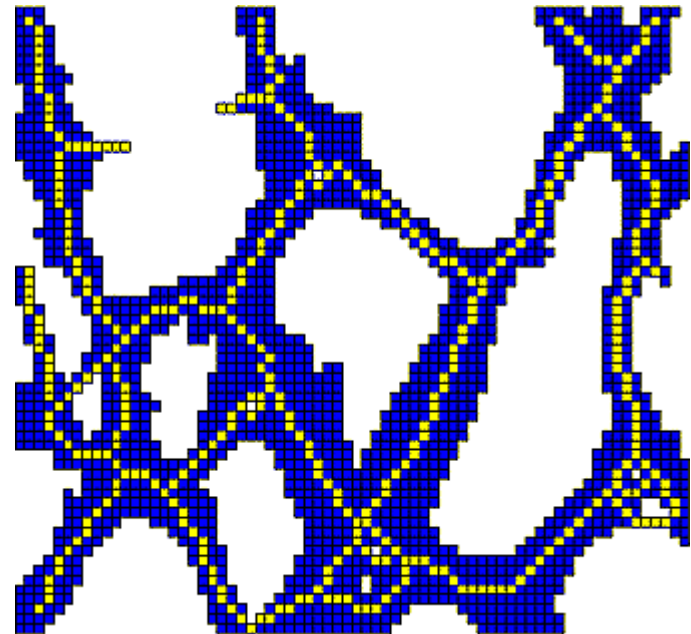
Object Detection / Recognition
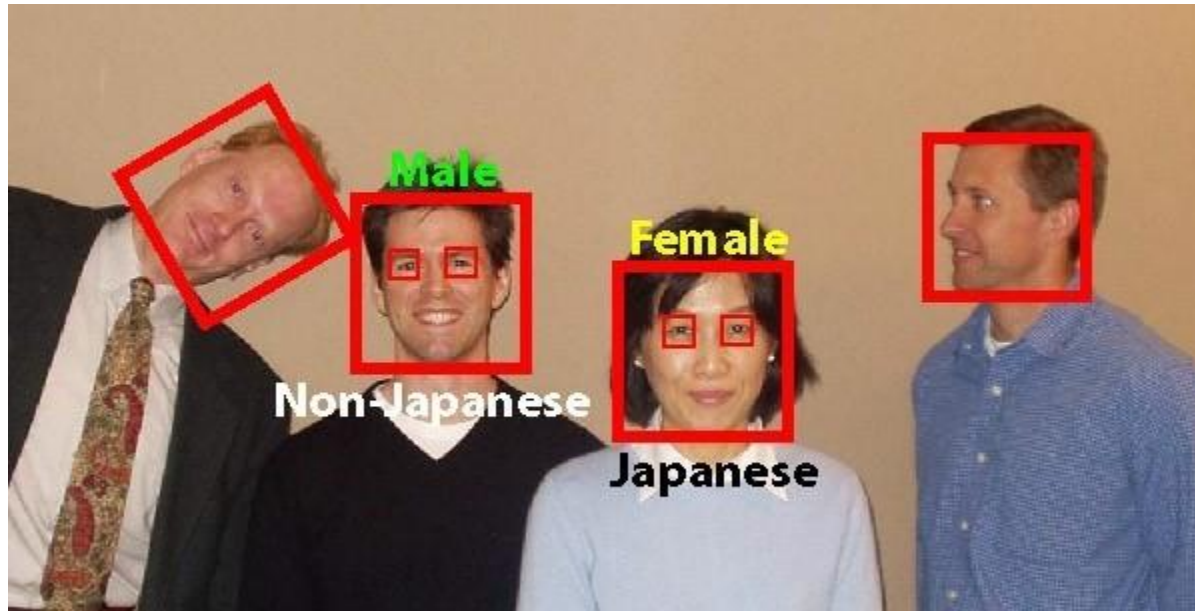
Content-Based Image Retrieval

Biometrics

crossover

core

bifurcation

ridge ending

island

delta

pore

Super-Resolution

Applications of Digital Image Processing

Digital camera

Photoshop

Human computer interaction

Medical imaging for diagnosis and treatment

Surveillance

Automatic driving

…

Fast-growing market!