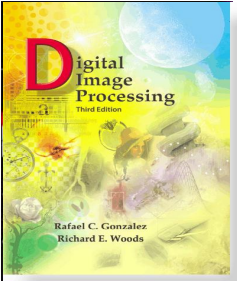
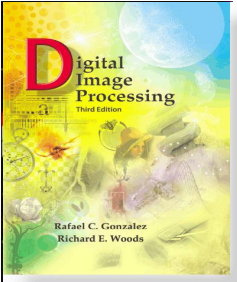



## Introduction

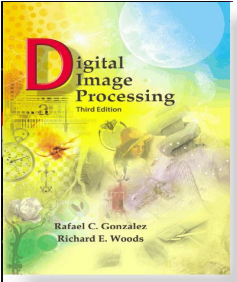
# Digital Image Processing (DIP)
# 25-157

Lecturer: E. Fatemizadeh



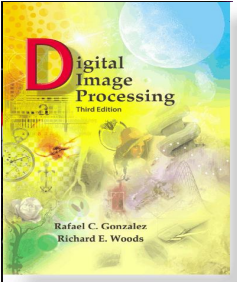

## Introduction

- Course Information:
  - Type: Graduated
  - Credits: 3
  - Prerequisites: **D**igital **S**ignal **P**rocessing (25155)
    - Convolution
    - DFT/FFT
    - Filtering



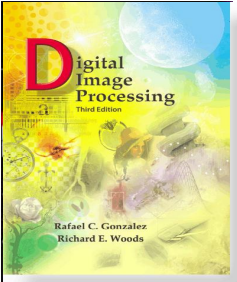

## Introduction

- Reference(s):
  - ***Digital Image Processing****, by: R. C. Gonzalez and R. E. Woods, 3rd Ed., 2008, Prentice Hall.
  - ***Fundamentals of Digital Image Processing,*** by: A. K. Jain, 1989, Prentice Hall.
  - ***The Image Processing Handbook***, by: J. C. Russ, 4th Edition, 2002, CRC Press.



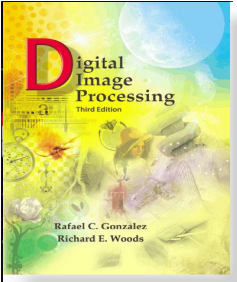

## Introduction

- Evaluation:
  - Middle: 40%
  - Final: 40%
  - Homework: 10% (Paper and Compute Based)
  - Research Project: 10%
    - In depth paper (one) study (Simulation and Judgment)
    - Experiments on real data



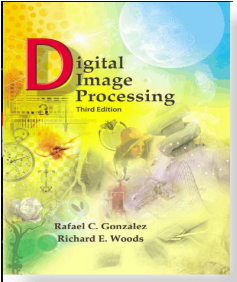

## Introduction

- **Journals**:
  - IEEE Trans. on Image Processing
  - IEEE Trans. on Medical Imaging
  - Signal Processing, Image Communication (Elsevier Science)
  - IEEE Trans. on Visualization and Computer Graphics
  - IEEE Trans. on Pattern Analysis and Machine Intelligence
  - Pattern Recognition, (Pergamon-Elsevier)
  - Pattern Recognition Letters ( Elsevier)
  - IEEE Trans. on Biomedical Engineering
  - IEEE Trans. on Information Technology in Biomedicine
  - IEEE Trans. on Signal Processing
  - Signal Processing (Elsevier Science)




## Introduction

- Course Contacts and Links:
  - URL: http:/ee.sharif.edu/~dip
    - Course Lecture Notes
  - Course Email: dip@ee.sharif.edu
  - Electronic Homework submission (NOT .rar)!
  - Submission rule:
    - Subject: DIP*n*:*stdnum*
  - My email: fatemizadeh@{sharif.edu, gmail.com}

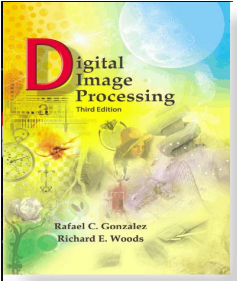



## Introduction

- Digital Image Processing:
  - First Q's:

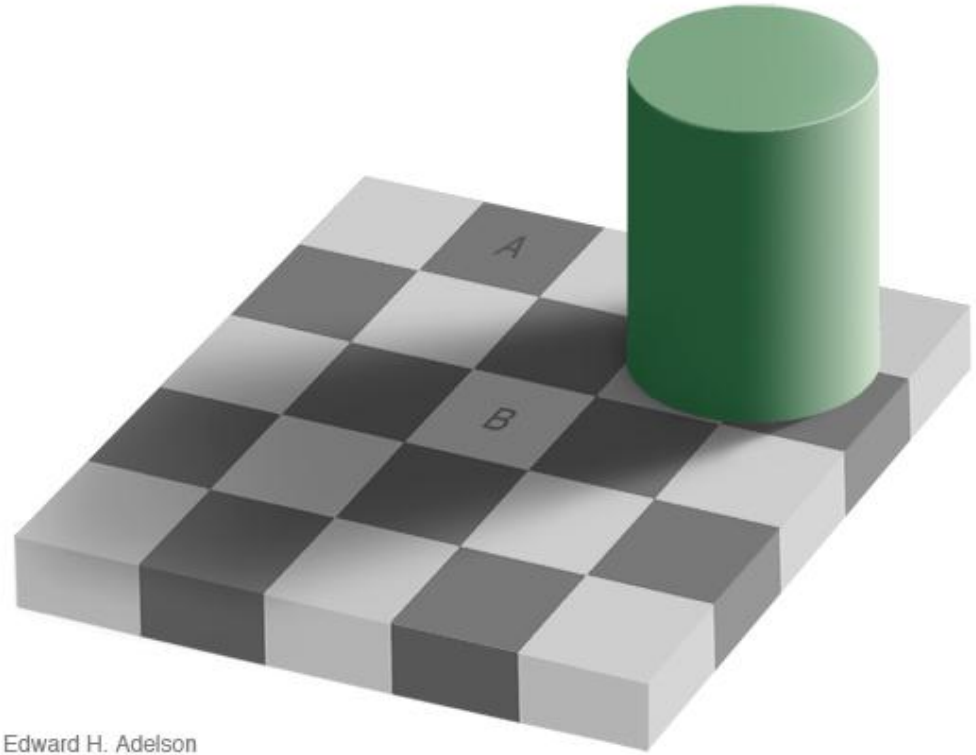
    Is it a Two Dimensional Signal Processing?
  - Answer:

    Not Exactly!
  - An Images is completely different from 2D Signal.
    - Human Vision/Perception/Intelligibility
      - Quantization
      - Eye illusion



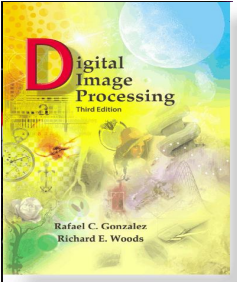

## Introduction

# Eye illusion



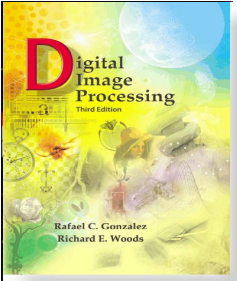

Edward H. Adelson

The squares marked A and B are the same shade of gray.



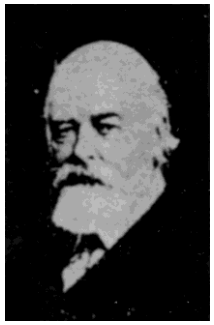

## Introduction

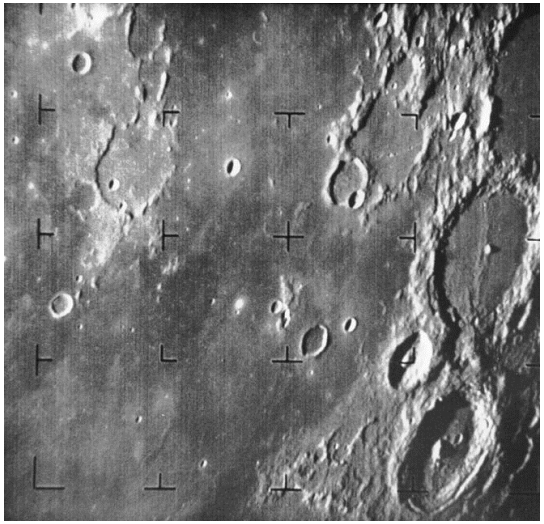
- Digital Image Processing:
  - DSP
  - Human Vision
  - Other forms of mathematics (i.e. Morphology)
  - Art
  - Heuristic Inference
  - Pattern Recognition

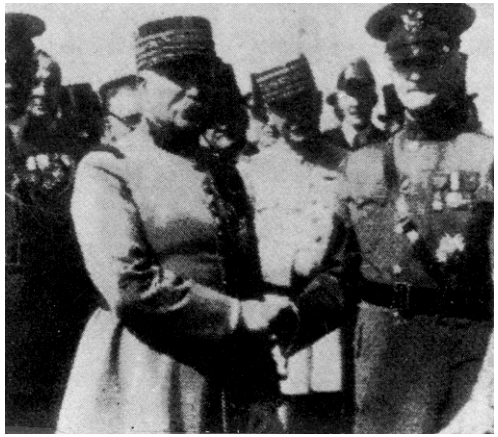


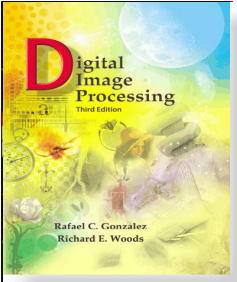

## Introduction

- Old and Historical Digital Images



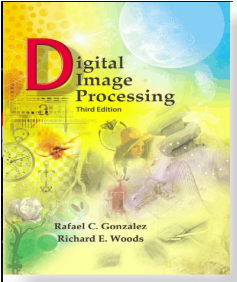






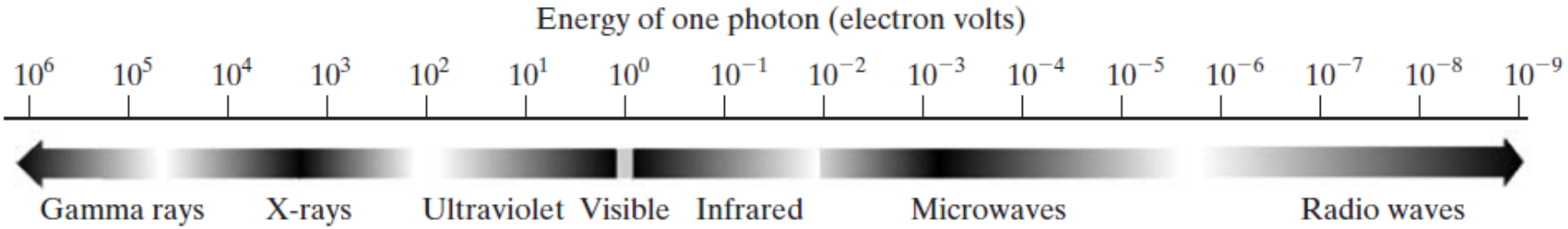

## Introduction

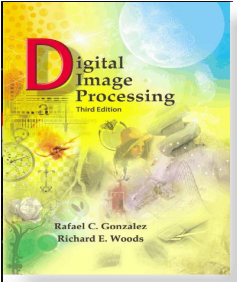
- Our General Definition of image:
  - A physical property(ies) of an object.
    - Not necessarily visible.
- Main Physical Property:
  - Electromagnetic Radiation:
    - From Radio Waves to Cosmic rays
- A categorization:
  - Single Channel
  - Multi Channels




## Introduction

- Electromagnetic Spectrum:

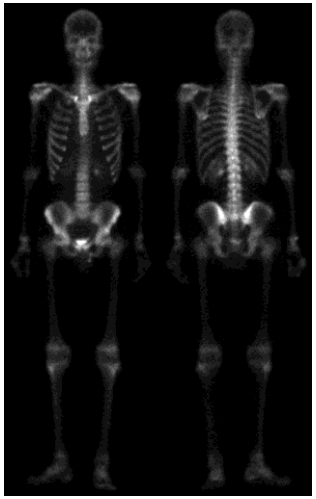





## Introduction

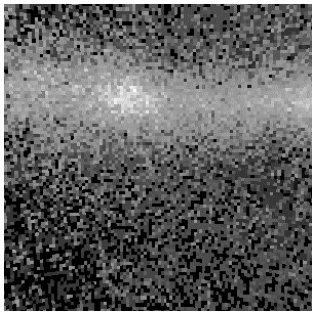
- Some Physical Properties (Gamma Ray):

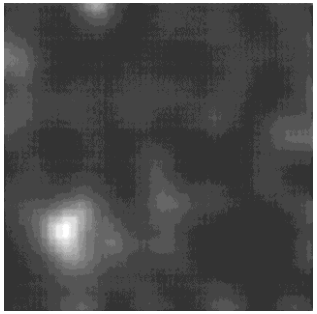
**Bone Scan**



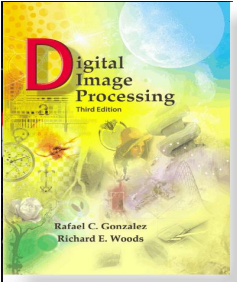
**PET**

**Cygnus Loop**





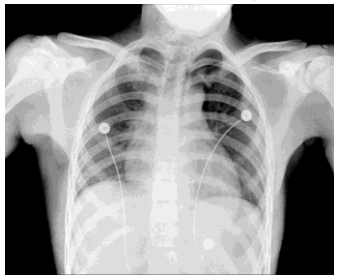
**Gamma Radiation from reactor valve**




## Introduction

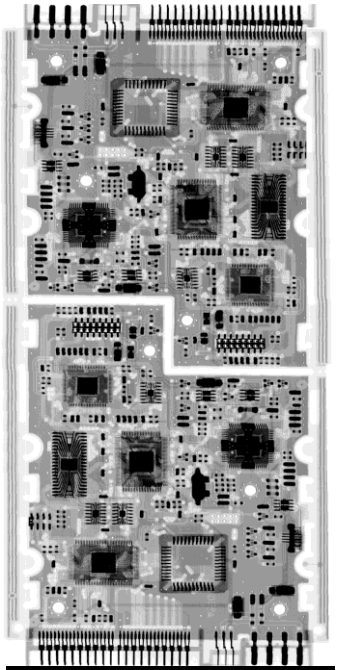
- Some Physical Properties (X-Ray):

Chest X-Ray



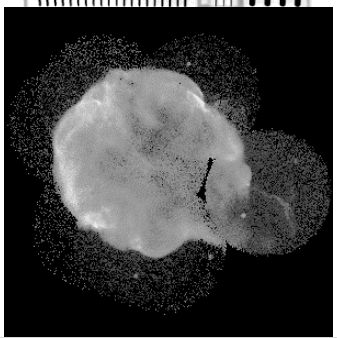
Angiography

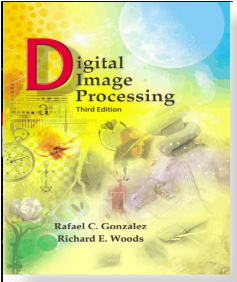
CT



Circuit Board

Cygnus Loop

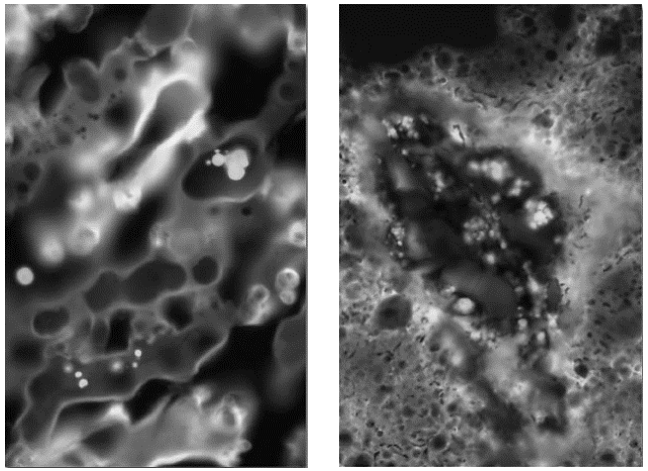





## Introduction

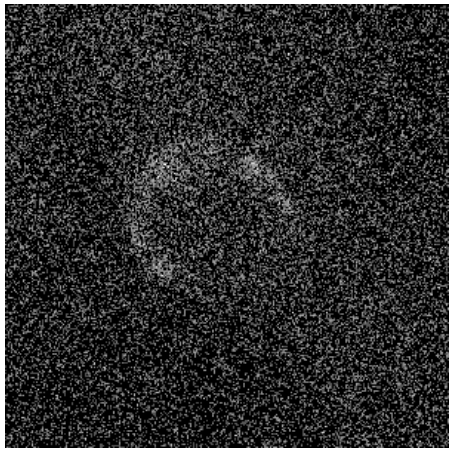
- Some Physical Properties (Ultraviolet):

**Normal Corn**

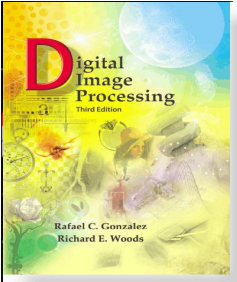


**Smut Corn**

**UV imaging**



**Cygnus Loop**

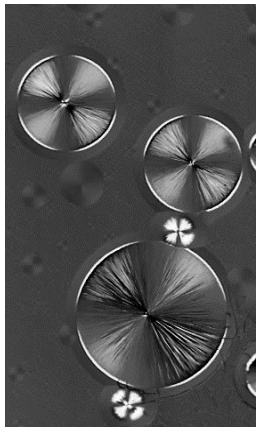


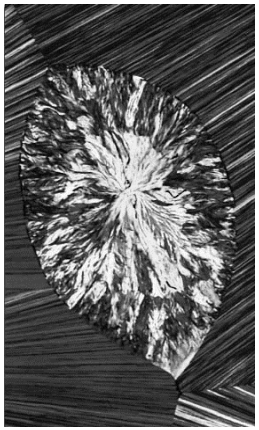

## Introduction

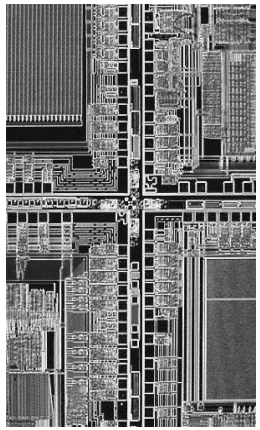
- Microscopy (Visible Light):

Cholesterol

Taxon (Anti cancer)

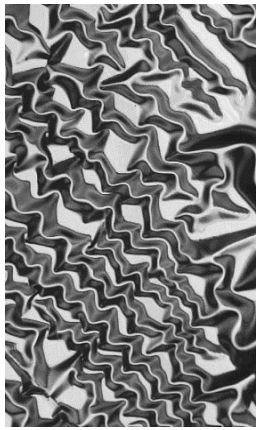


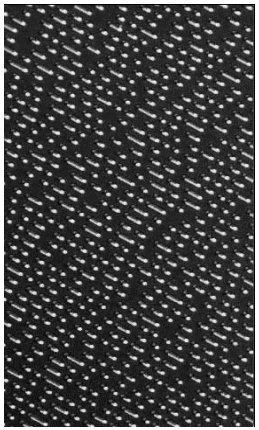




Microprocessor

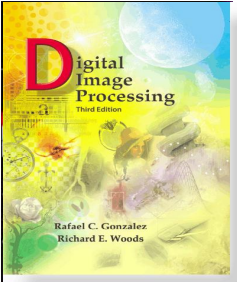
Nickel Oxide Thin Film





Superconductor

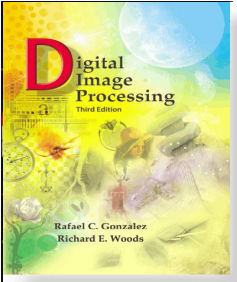
CD Surface




## Introduction

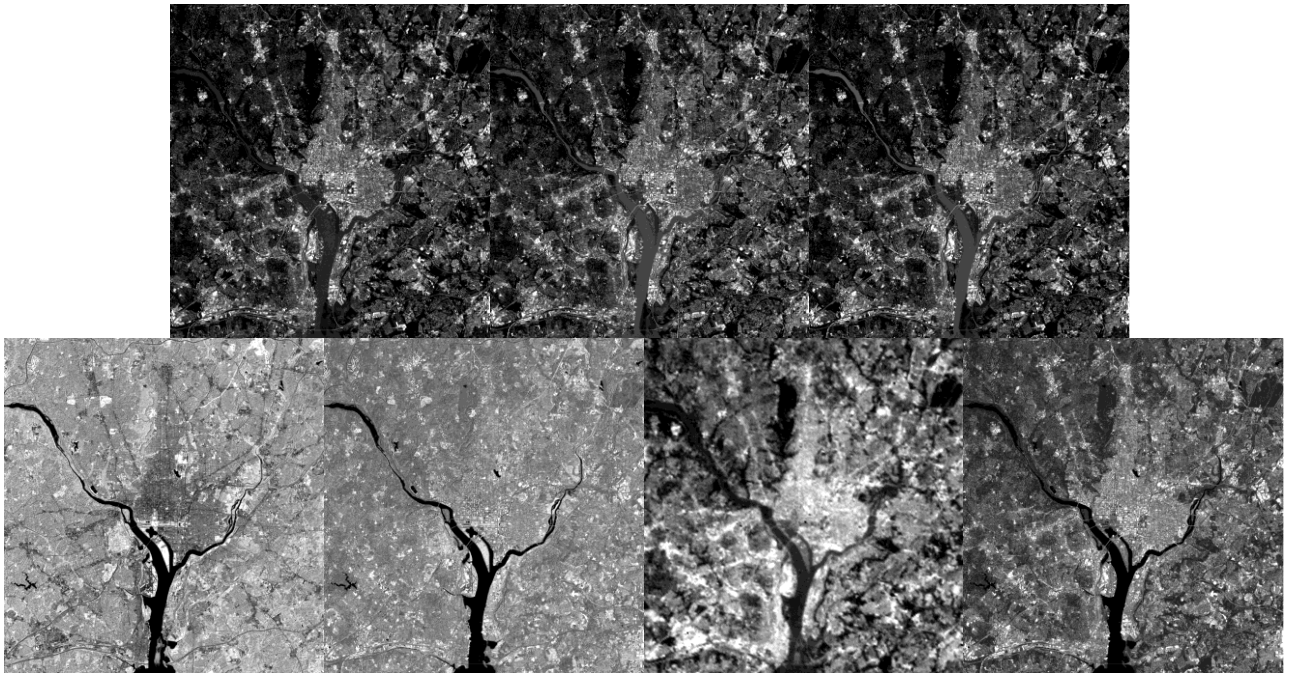
- A Sample of Multi Channels imaging:
  - Satellite imaging (NASA LANDSAT)

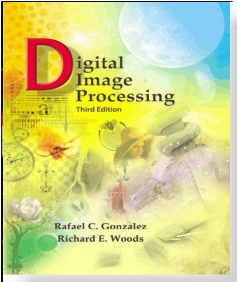
| Band No. | Name | Wavelength (μm) | Characteristics and Uses |
|---|---|---|---|
| 1 | Visible blue | 0.45–0.52 | Maximum water penetration |
| 2 | Visible green | 0.52–0.60 | Good for measuring plant vigor |
| 3 | Visible red | 0.63–0.69 | Vegetation discrimination |
| 4 | Near infrared | 0.76–0.90 | Biomass and shoreline mapping |
| 5 | Middle infrared | 1.55–1.75 | Moisture content of soil and vegetation |
| 6 | Thermal infrared | 10.4–12.5 | Soil moisture; thermal mapping |
| 7 | Middle infrared | 2.08–2.35 | Mineral mapping |




## Introduction

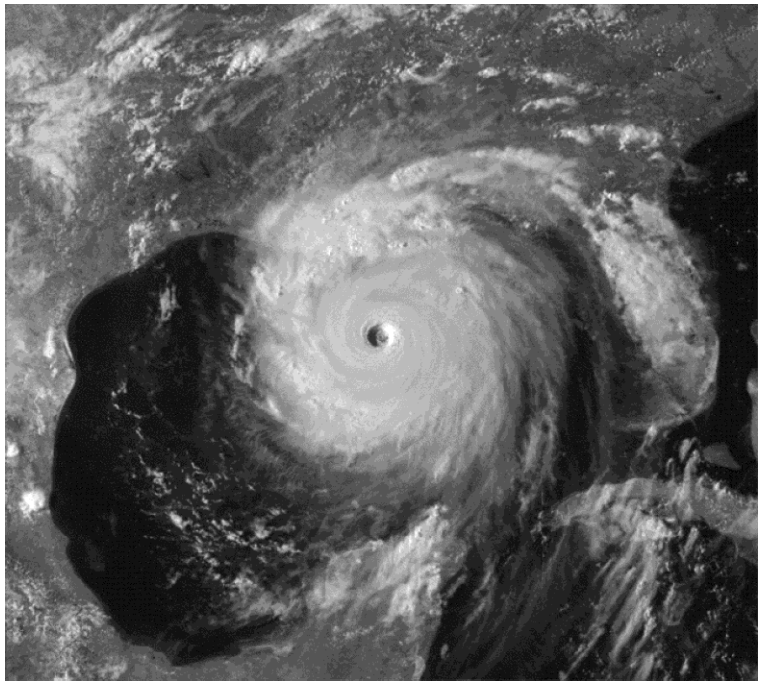
- A Sample of Multi Channels imaging:
  - Satellite imaging

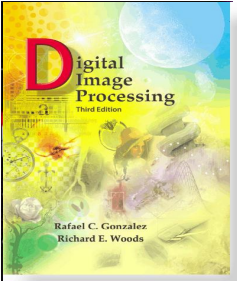





## Introduction

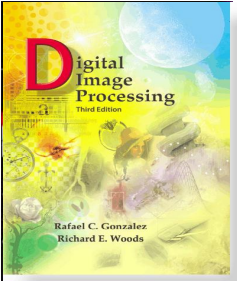
- Multispectral image of Hurricane Andrew:





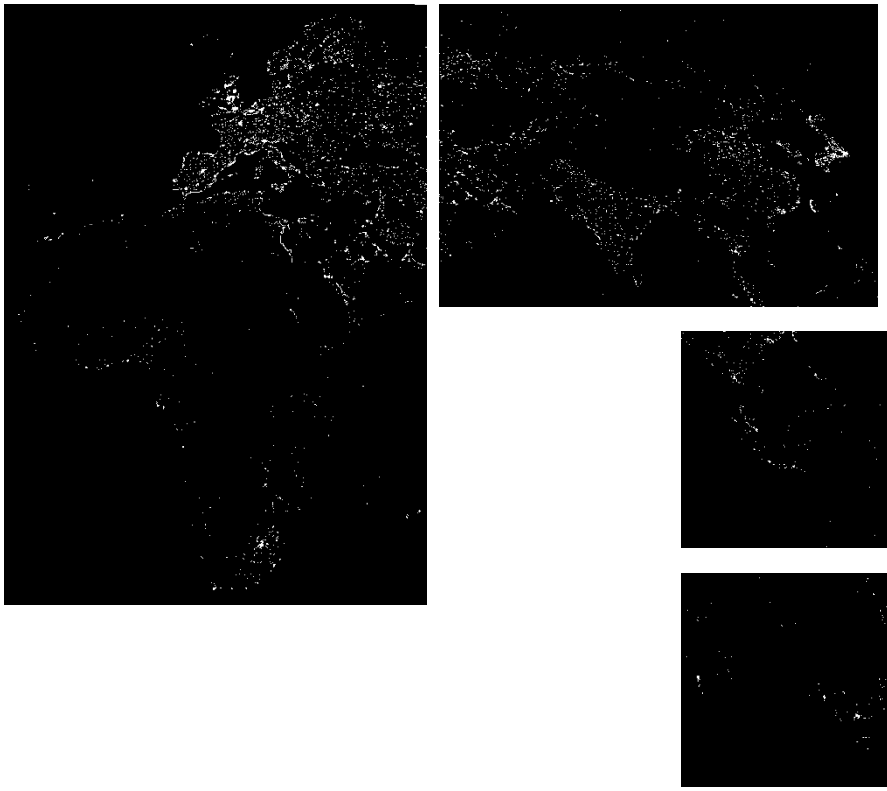

## Introduction

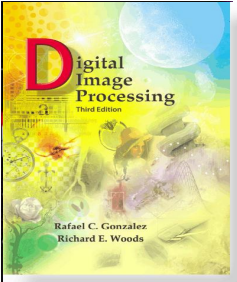
- Geographical infrared images (1):




## Introduction

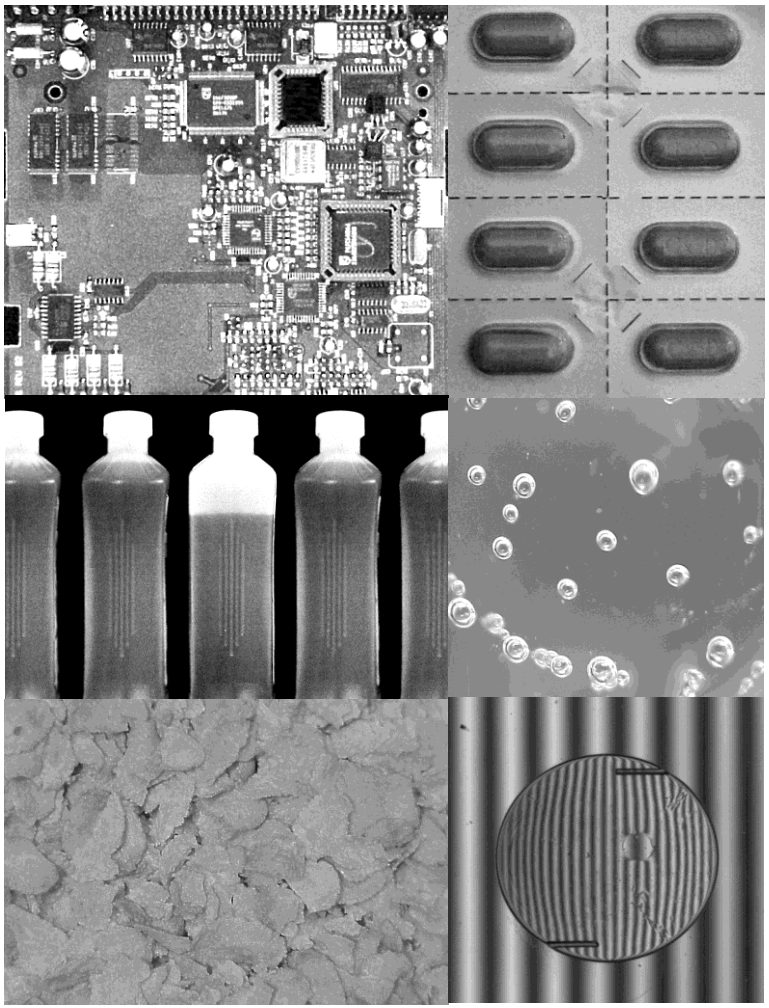
- Geographical infrared images (2):

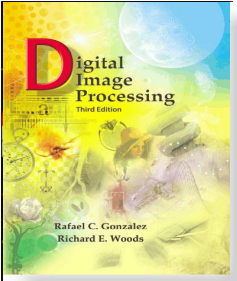





## Introduction

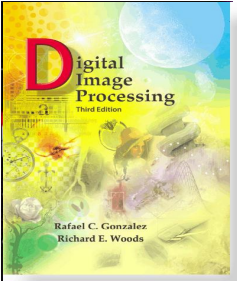
- Visual Spectrum:
  - Inspection





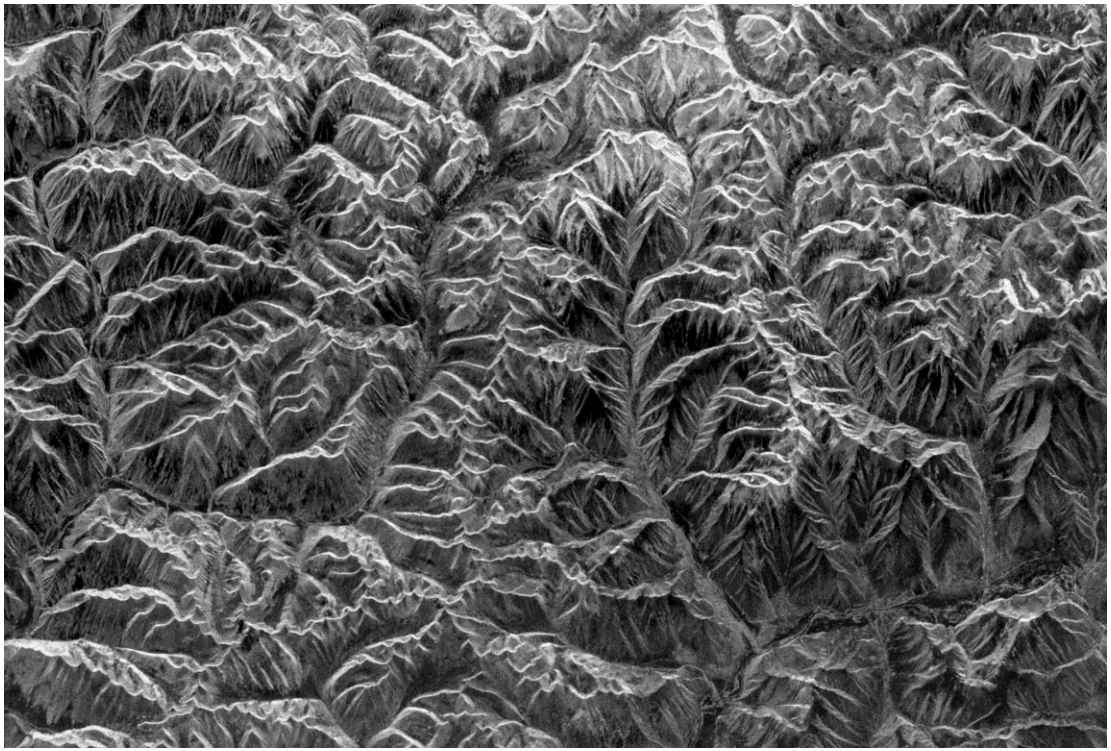

## Introduction

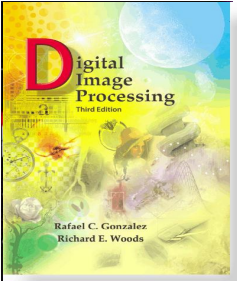
- Visual Spectrum:
  - Biometrics
  - OCR




## Introduction

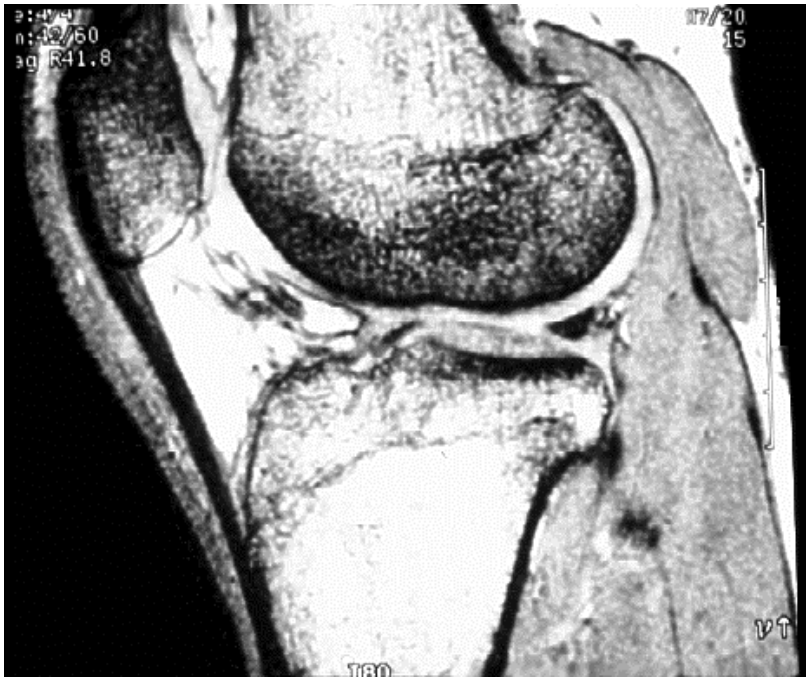
- Radar Image of Mountain (Microwave Band):

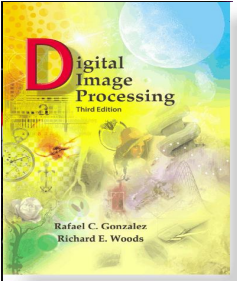





## Introduction

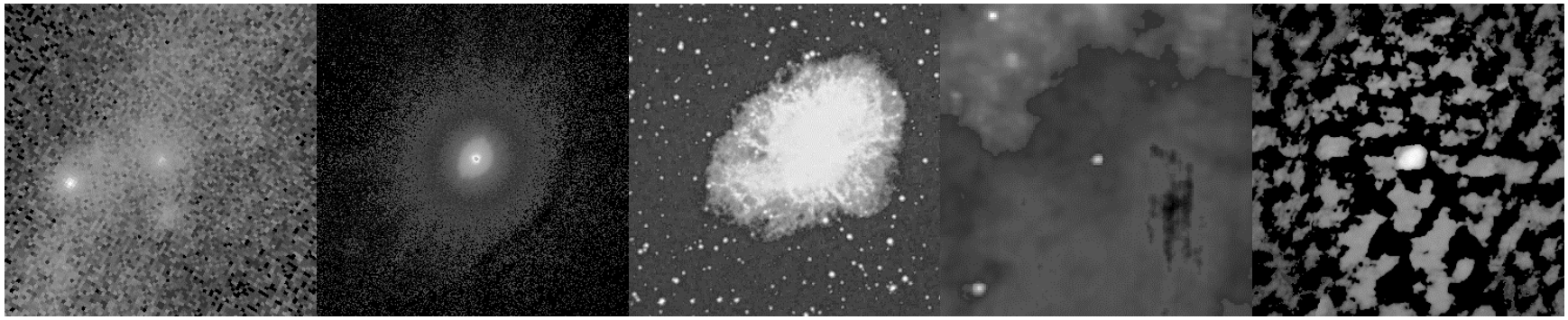
- Magnetic Resonance Imaging – MRI (RF):

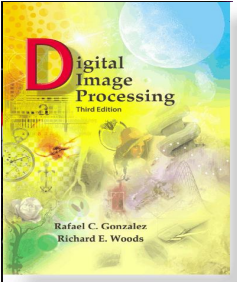





## Introduction

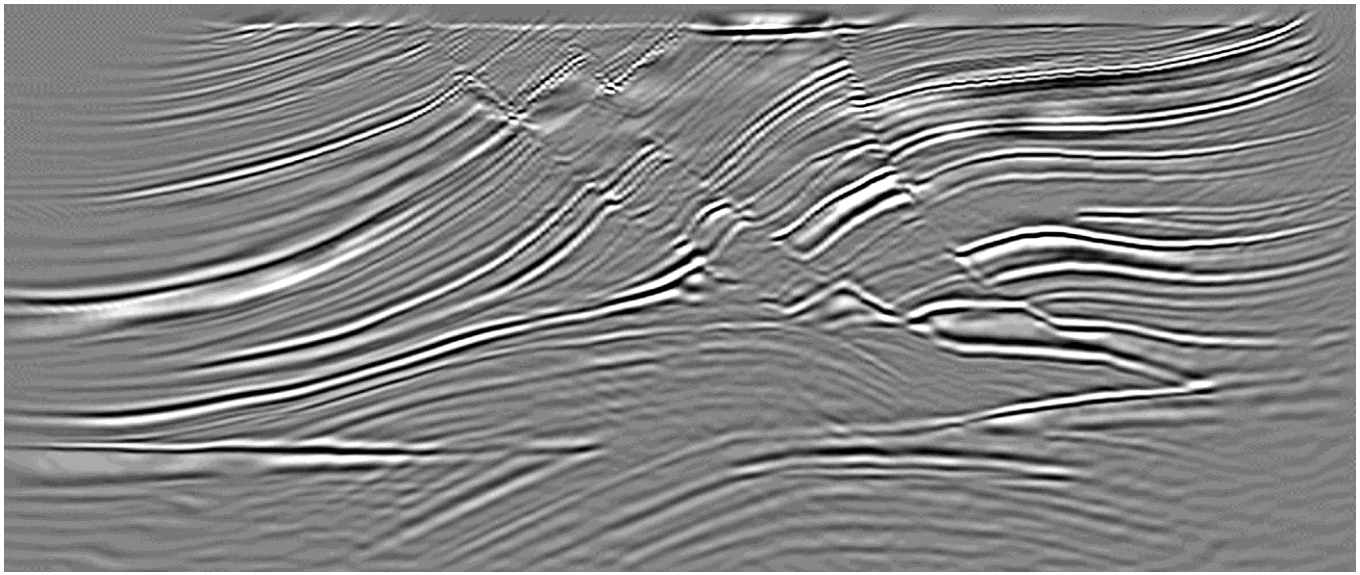
- Multichannel Pulsar Images:
  - Gamma, X-Ray, Optical, Infrared, and Radio

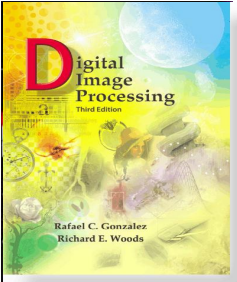





## Introduction

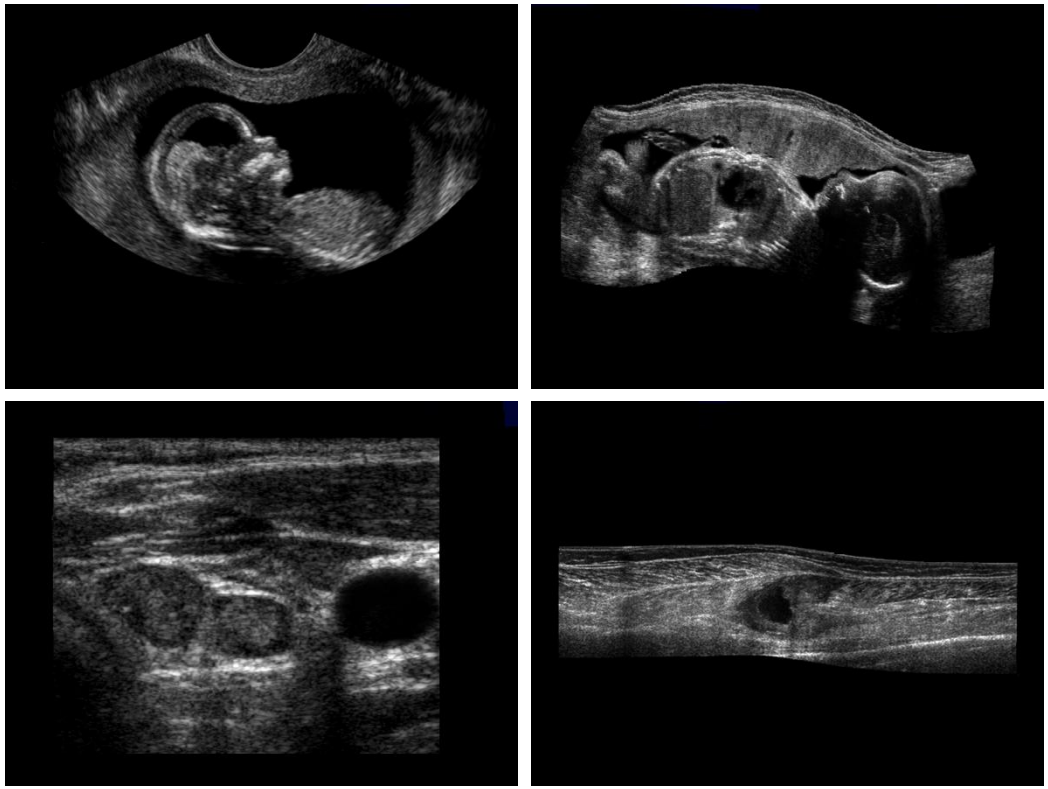
- Ultrasonic Images (Seismic):
  - Oil/Gas/Water trap

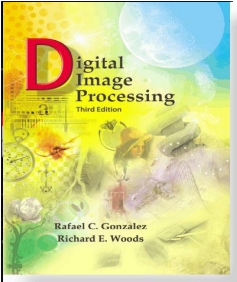





## Introduction

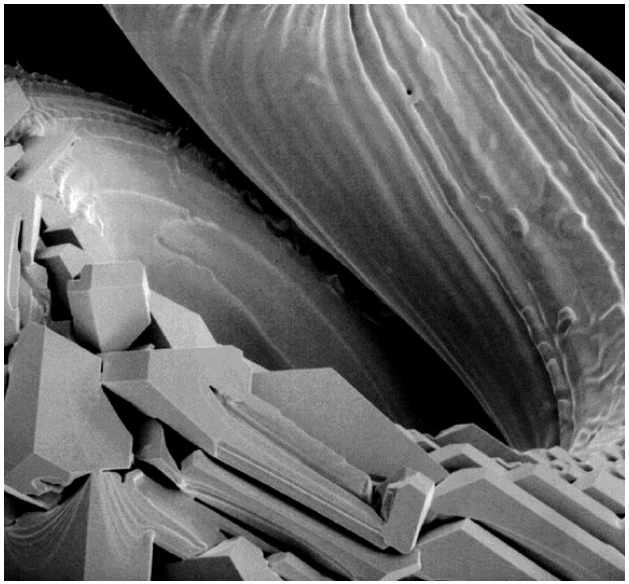
- Ultrasonic Images (Medical):
  - Infants, Thyroid, Muscle

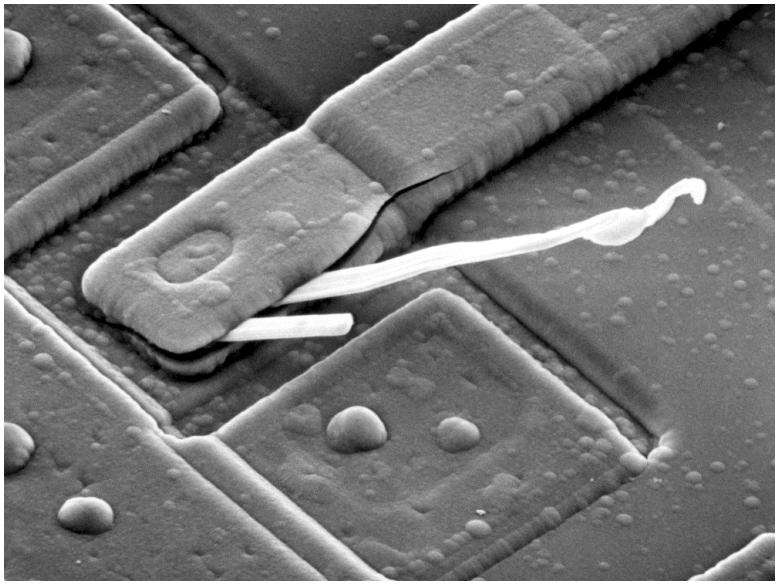


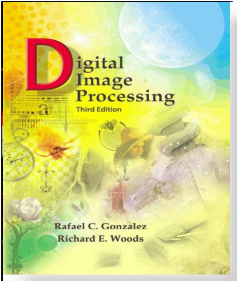



## Introduction

- Scanning Electron Microscope (SEM):

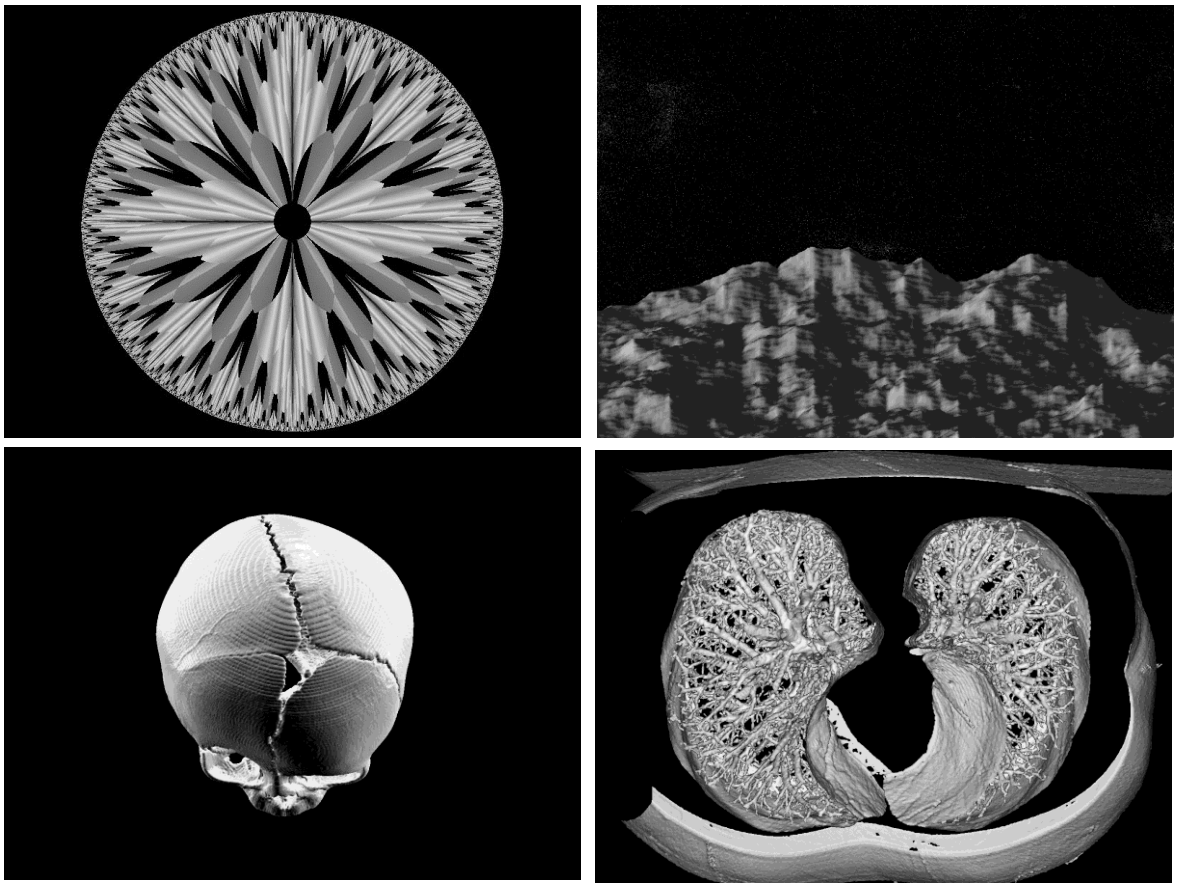


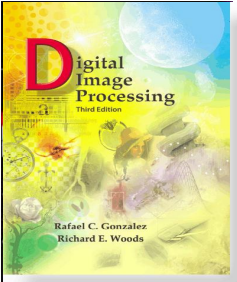





## Introduction

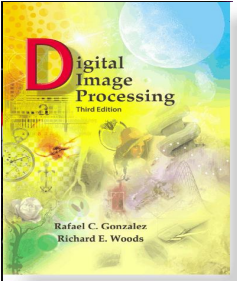
- Synthetic Images:





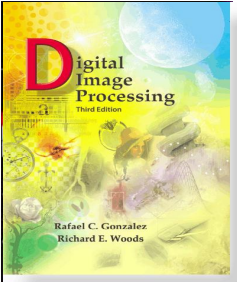

## Introduction

- DIP applications (1):
  - Image Recovering:
    - Reconstruction and Restoration
  - Image Quality Enrichment:
    - Enhancement and Denoising.
  - Data Redundancy Reduction:
    - Image Compression (tiff, jpg, png, jp2, …)
  - Automatic Detection and Recognition:
    - OCR, Medical/Industrial CAD, …
  - Authentication:
    - Face, Signature, Fingerprint, Palm, Gesture, Retina Iris.



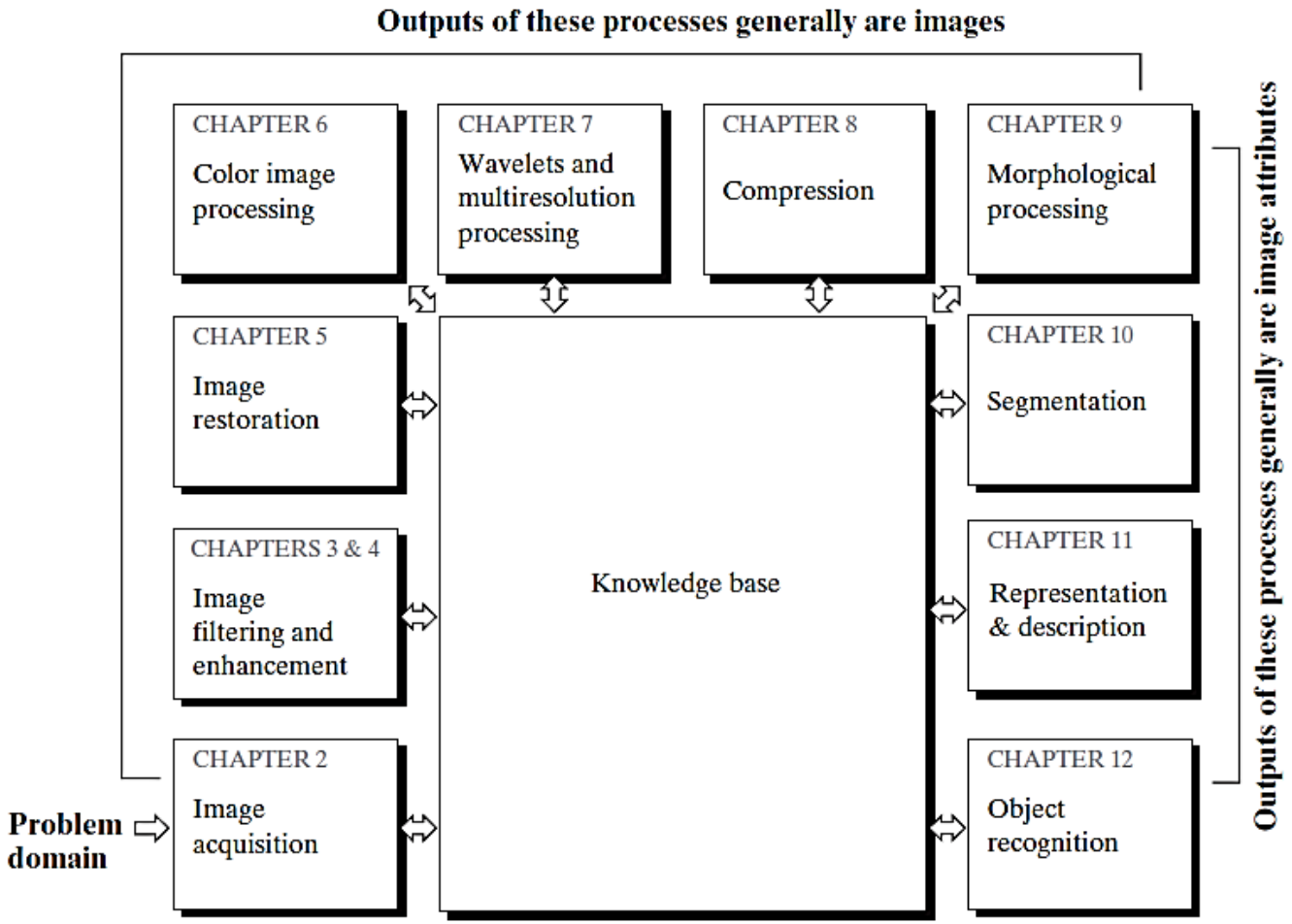

## Introduction

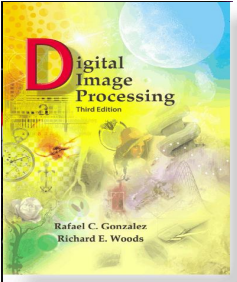
- DIP applications (2):
  - Machine Vision
  - Machine Recognition/Verification




## Introduction

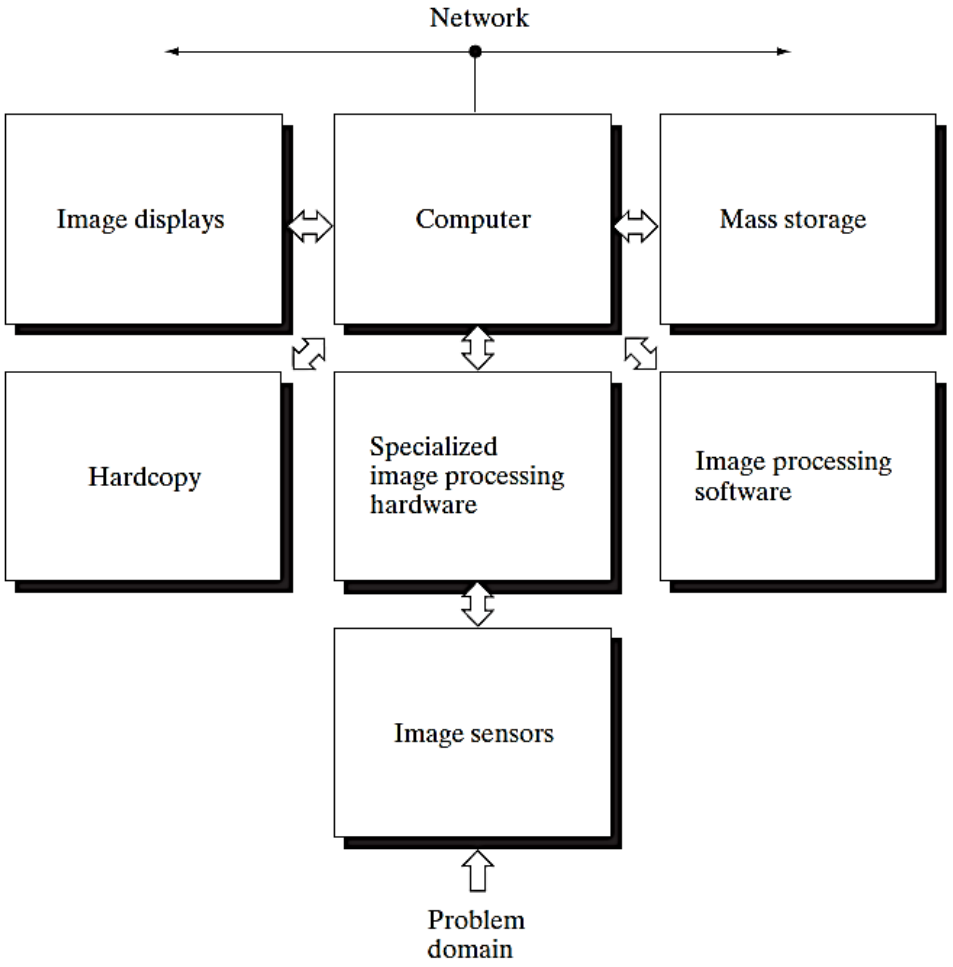
- Fundamental Steps in Image Processing:

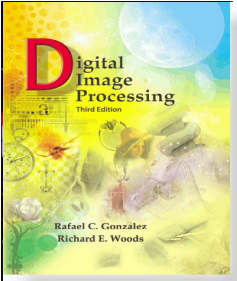





## Introduction

- Components of an Image Processing System:






## Introduction

- An Example of Image Processing Results: