ECE 468 / CS 519
Digital Image Processing

Introduction

Prof. Sinisa Todorovic

sinisa@eecs.oregonstate.edu

OSU Oregon State University

ECE 468: Digital Image Processing

- Instructor:

  Sinisa Todorovic

  sinisa@oregonstate.edu

- Office:

  2107 Kelley Engineering Center

- Office Hours:

  Tuesday 2:30-3PM, or by appointment

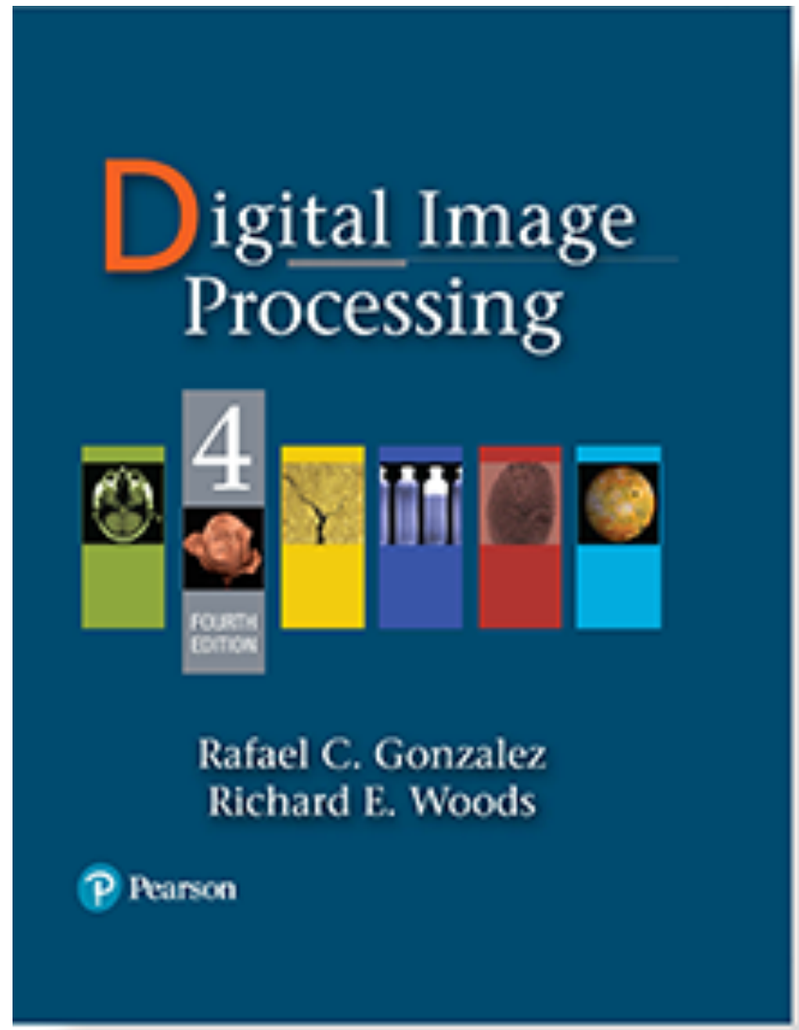
- Classes:

  MWF 2-2:50pm, BAT 144

- Class website:

  http://web.engr.oregonstate.edu/~sinisa/courses/OSU/ECE468/ECE468.html

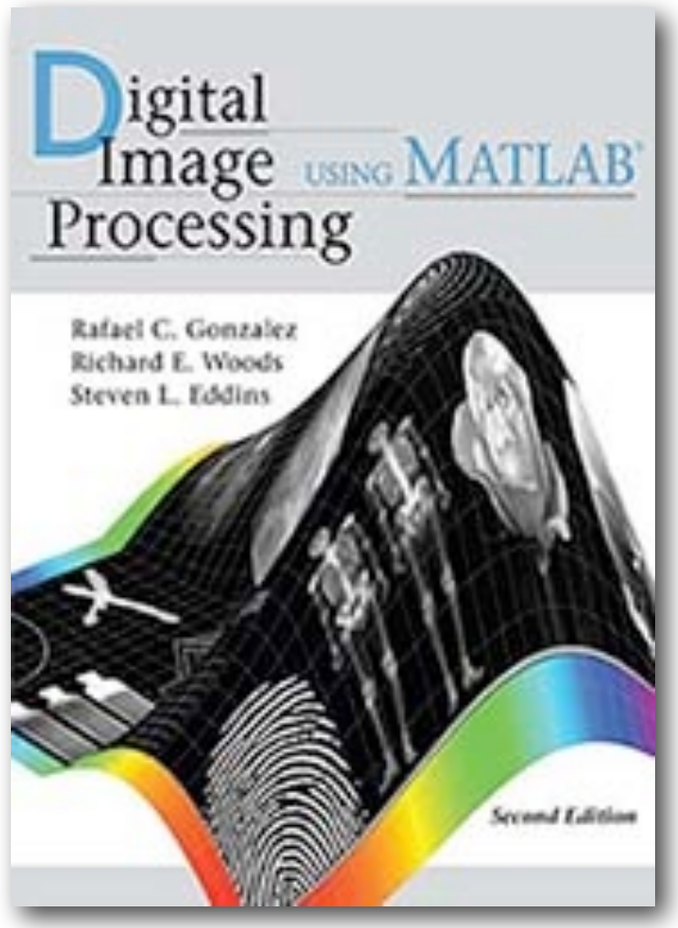
Recommended Textbook



- "Digital Image Processing" by R.C. Gonzalez and R.E. Woods, 4th edition, Pearson Prentice Hall, 2018

- Additional readings on the class website

Suggested Readings



- “Digital Image Processing Using MATLAB,” by R.C. Gonzalez, R.E. Woods, and S. Eddins, 2nd edition, Pearson Prentice Hall, 2009

Course Objectives

- Cover basic theory and algorithms widely used in image processing
- Develop hands-on experience in processing images
- Familiarize with MATLAB Image Processing Toolbox
- Develop critical thinking about the state of the art

Prerequisites

- Signals and systems: ECE 351 and ECE 352
- Linear algebra
  - Matrices, Matrix Operations
  - Determinants, Systems of Linear Equations
  - Eigenvalues, Eigenvectors
- Statistics and probability
  - Probability density function, Probability distribution
  - Mean, variance, co-variance, correlation
  - Priors, Posteriors, Likelihoods
  - Gaussian distribution
- Good programming skills

Requirements

- Homework
  - **Turn-in a hard copy**
  - Homework = Mini-project **must** be implemented in MATLAB
  - Homework should be an individual effort
  - **Late homework will not be accepted** without prior approval
- Graduate students will be given approximately 20% greater amount of work for homework assignments

Requirements

Exams will be closed-book.

- Midterm on November 6, 2-2:50pm, BAT 144
- Final on December 5, 12-1:30pm, BAT 144

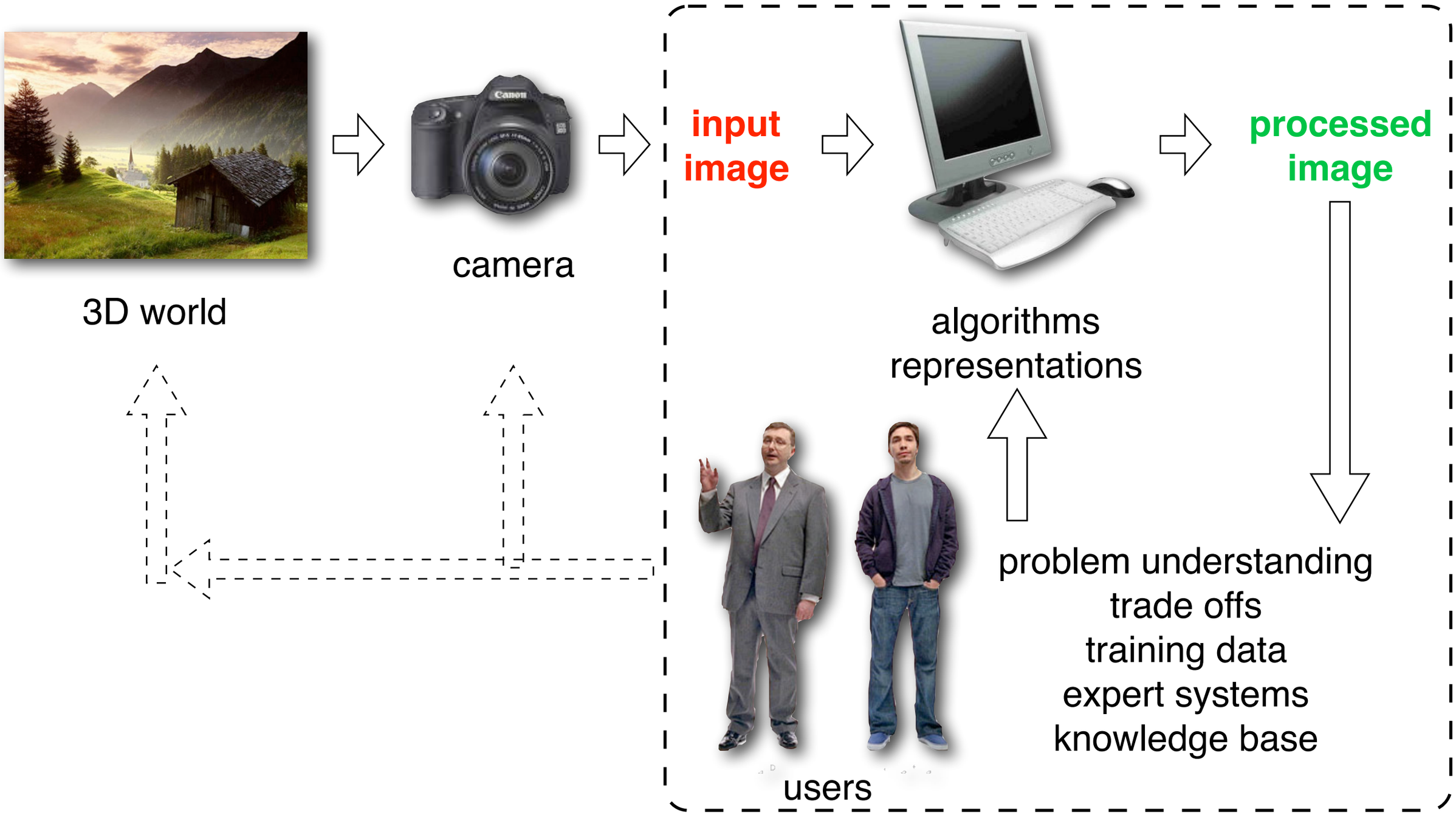
Grading Policy

- Homework = 20%
- Midterm Exam = 35%
- Final Exam = 45%

Academic Honesty -- Examples of Cheating

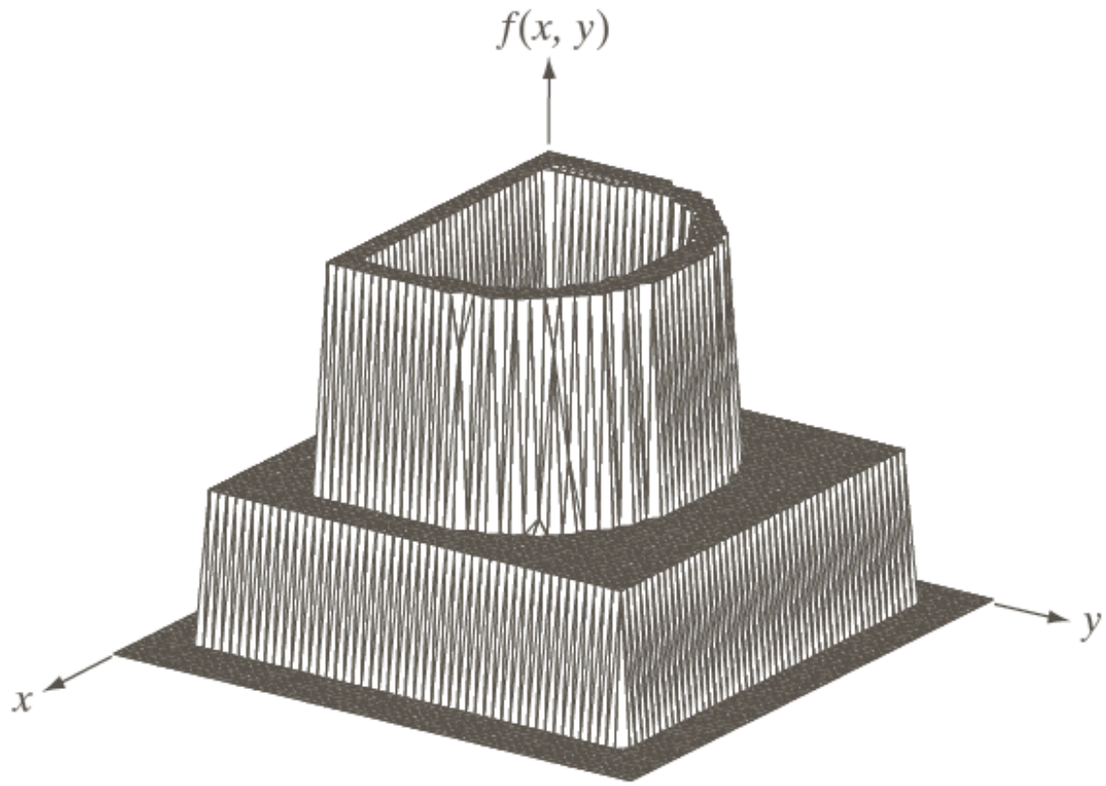
- Bringing forbidden material or devices to the examination
- Working on the exam before or after the official time allowed
- Requesting a re-grade of work altered after the initial grading
- Submitting a homework that is not your own work

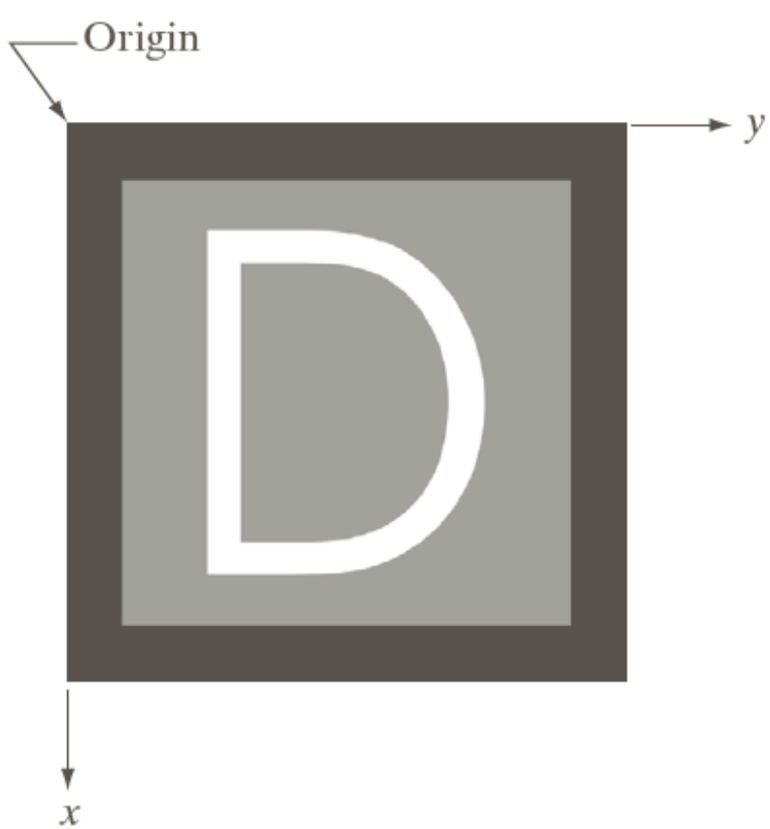
A Typical Digital Image Processing System



What is a Digital Image?

Pixel Values





Origin

$$
\begin{array}{ccccccccccccccccccccc}
0 & 0 & 0 & 0 & 0 & 0 & 0 & \cdots & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & & & & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & & & & & & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & & \vdots & & & & & & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & \cdots & .5 & .5 & .5 & \cdots & & & & & 0 & 0 & 0 \\
0 & 0 & 0 & & .5 & .5 & & & & & & & 0 & 0 & 0 \\
\vdots & & & & .5 & & \ddots & & & & & & & & \vdots \\
\vdots & & & & \vdots & & & 1 & 1 & 1 & \cdots & & & & \vdots \\
\vdots & & & & & & & 1 & 1 & & & & & & \vdots \\
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0 & 0 & 0 & & & & & \vdots & & & & & 0 & 0 & 0 \\
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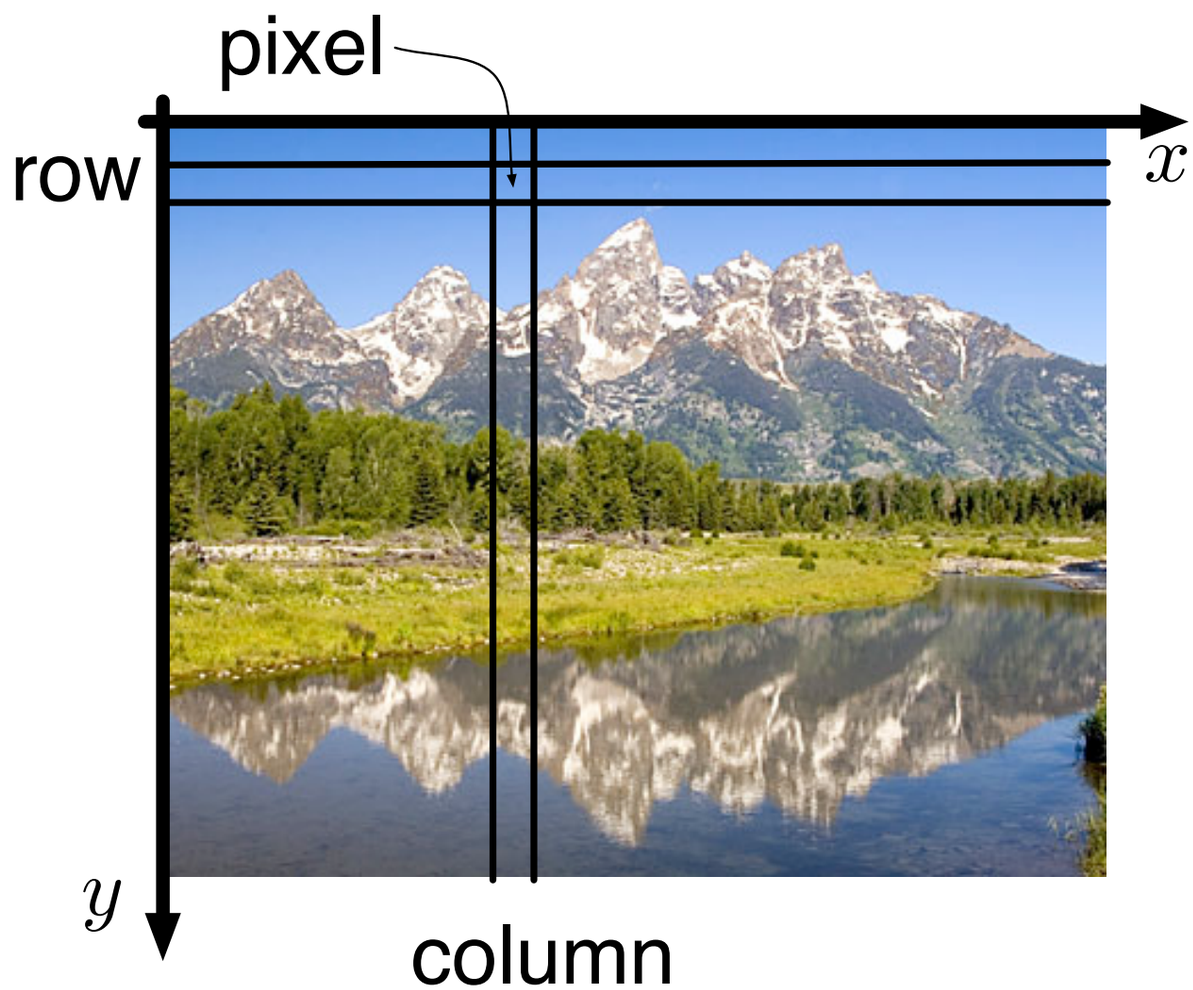
0 & 0 & 0 & 0 & 0 & 0 & 0 & \cdots & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{array}
$$

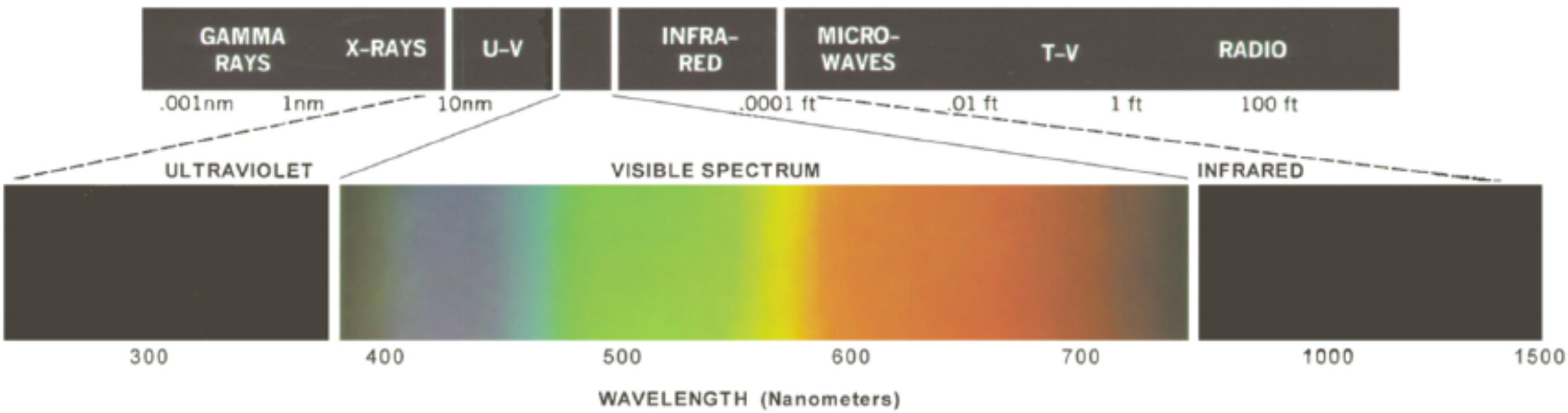
Source: DIP/3e

What is a Digital Image?



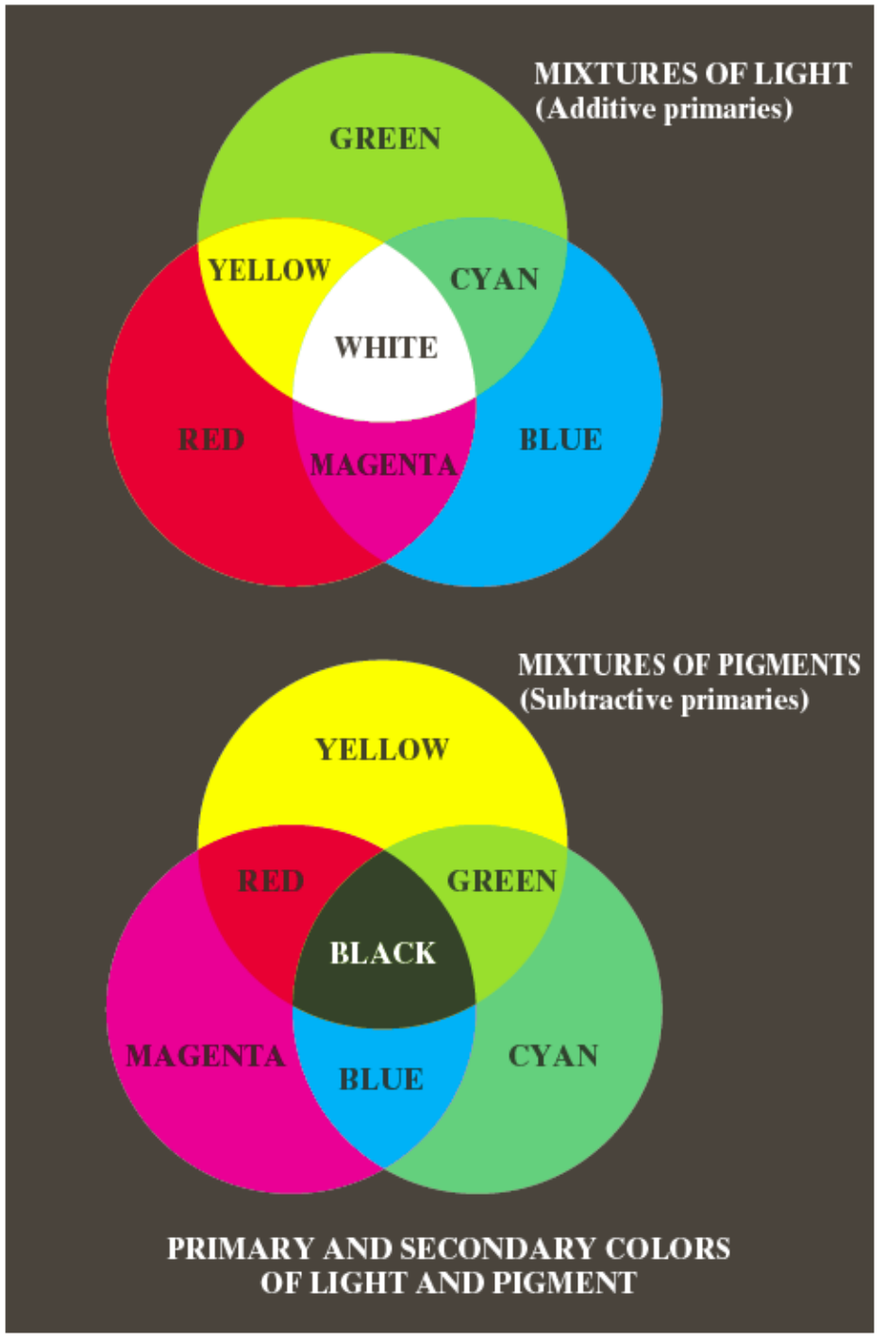
- Two-dimensional function *f(x,y)* or matrix
- *x, y, f(x,y)* are discrete and finite
- Image size = max_x x max_y -- e.g. 640x480
- Pixel intensity value $f(x,y) \in [0, 255]$

Visible Spectrum of EM



Based on Psychophysical Studies

- Cones in the human eye
  - red (R) 65%
  - green (G) 33%
  - blue (B) 2%

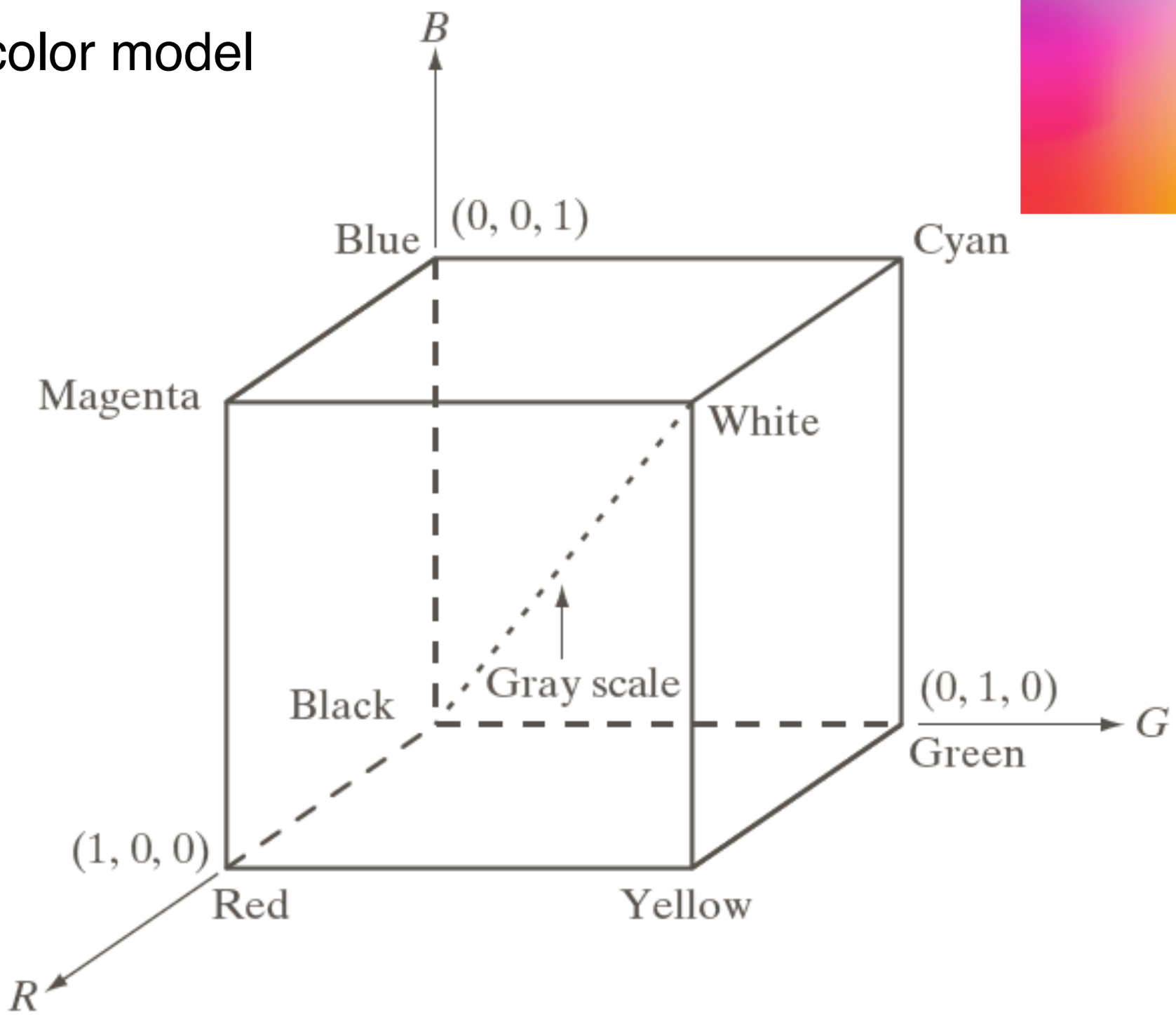


- R = 700nm
- G = 546.1nm
- B = 435.8nm

- Color = combination of primary colors R, G, B

Color Model = Color System = Color Space

- Purpose: To facilitate specification of colors
- RGB color model



Sources of Energy for Image Formation

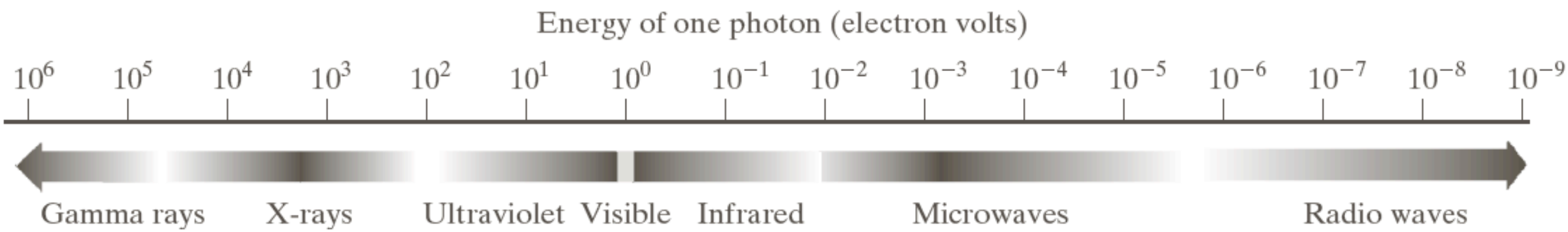
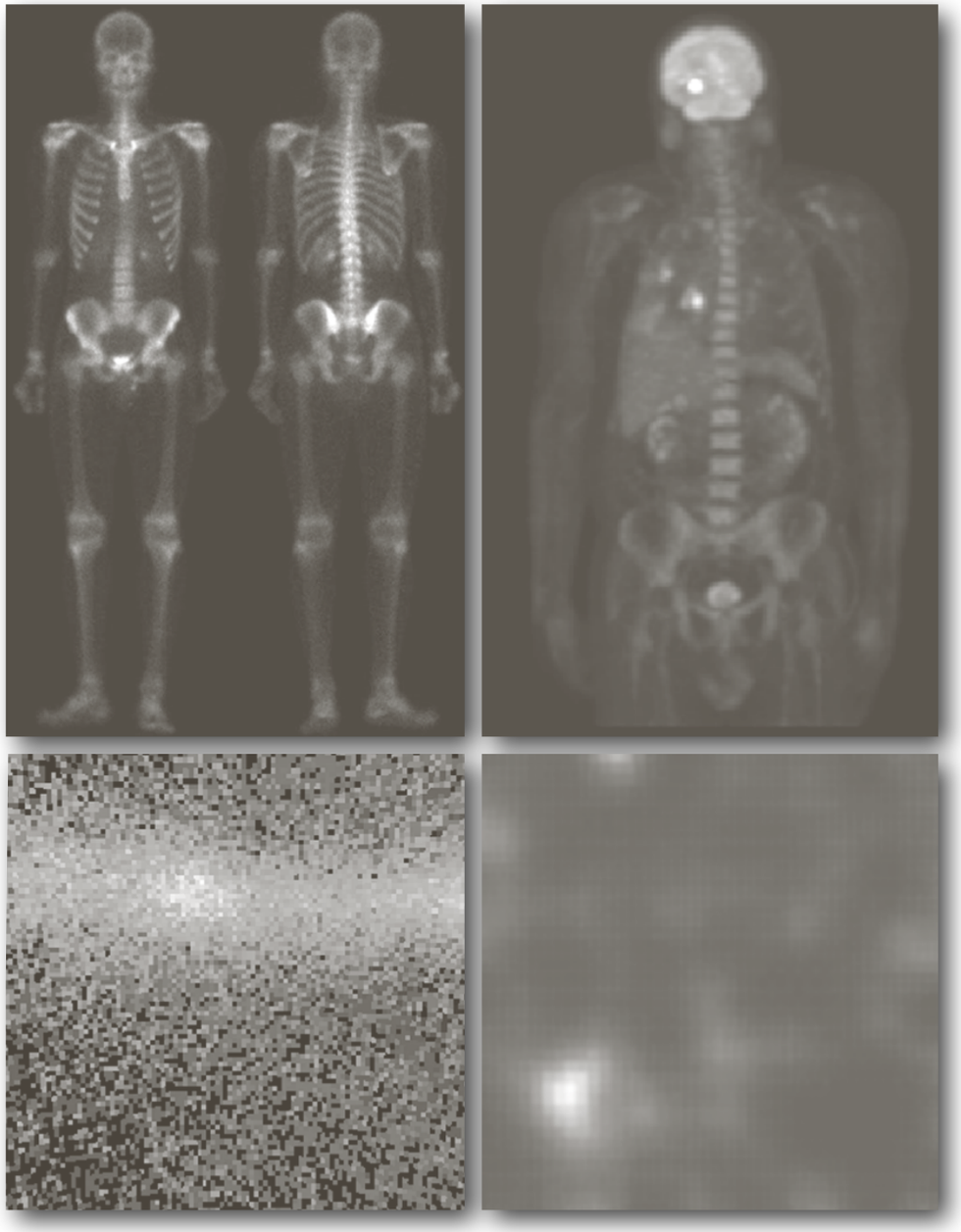


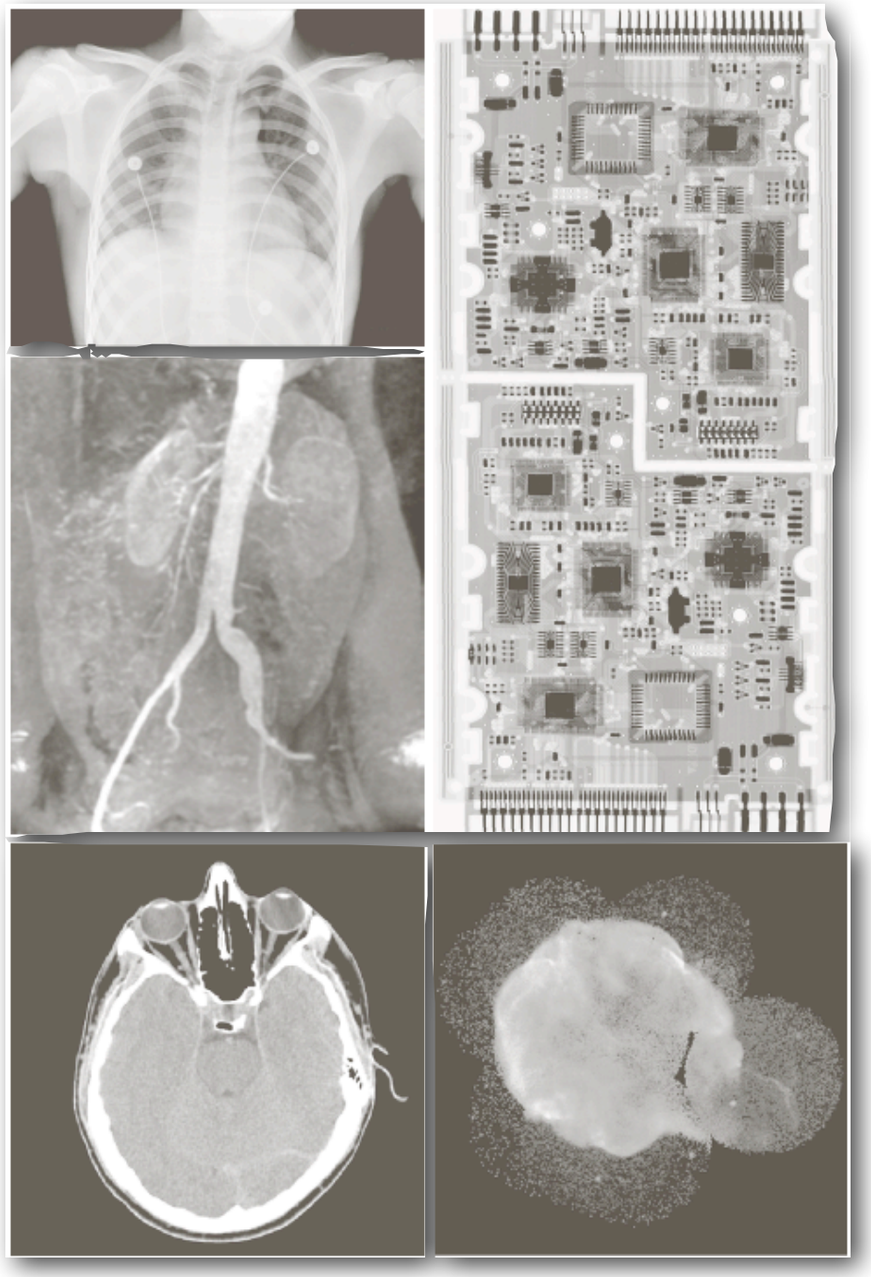
FIGURE 1.5 The electromagnetic spectrum arranged according to energy per photon.

Source: DIP/3e

Some Applications -- Medical Diagnostics



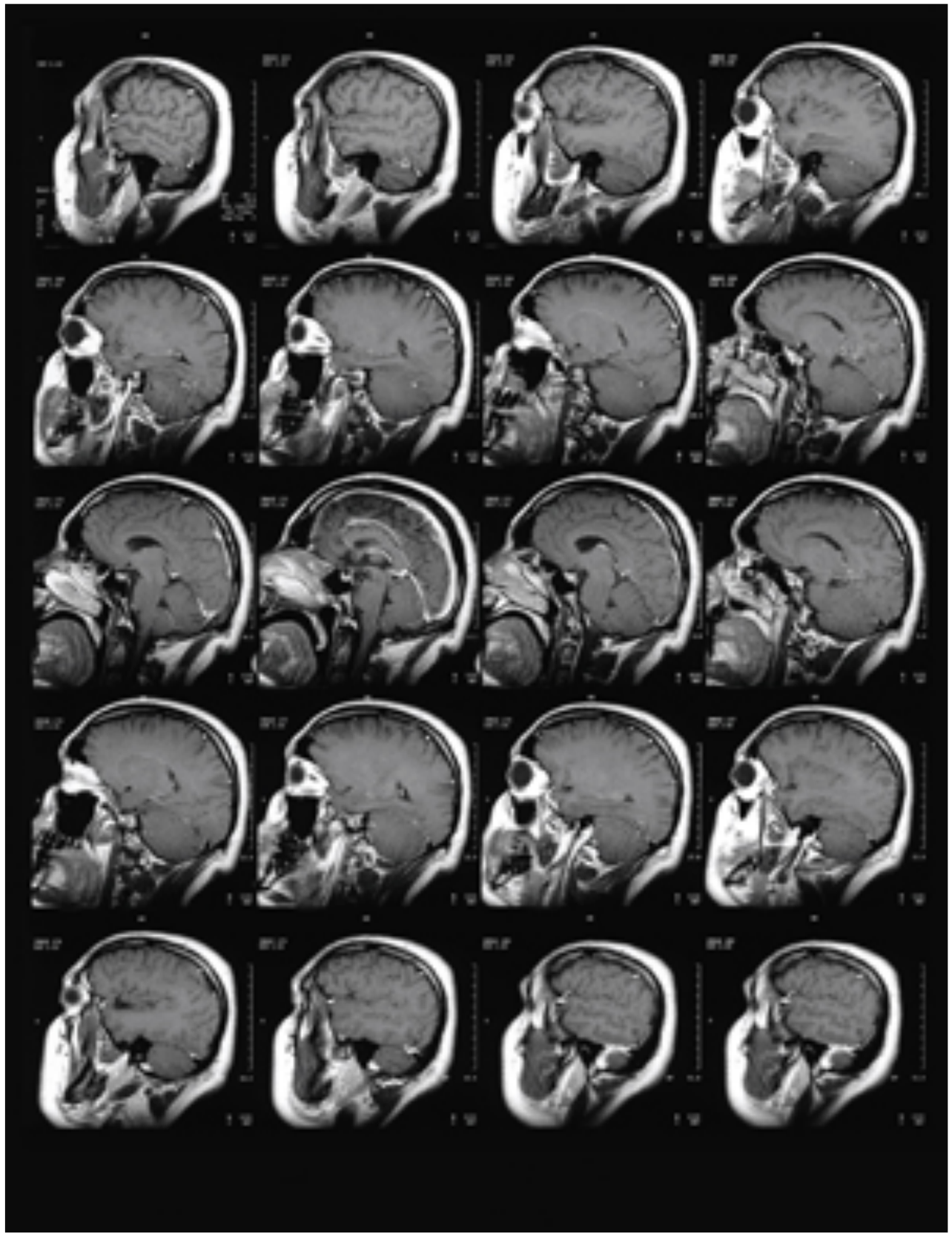
Gamma-ray imaging



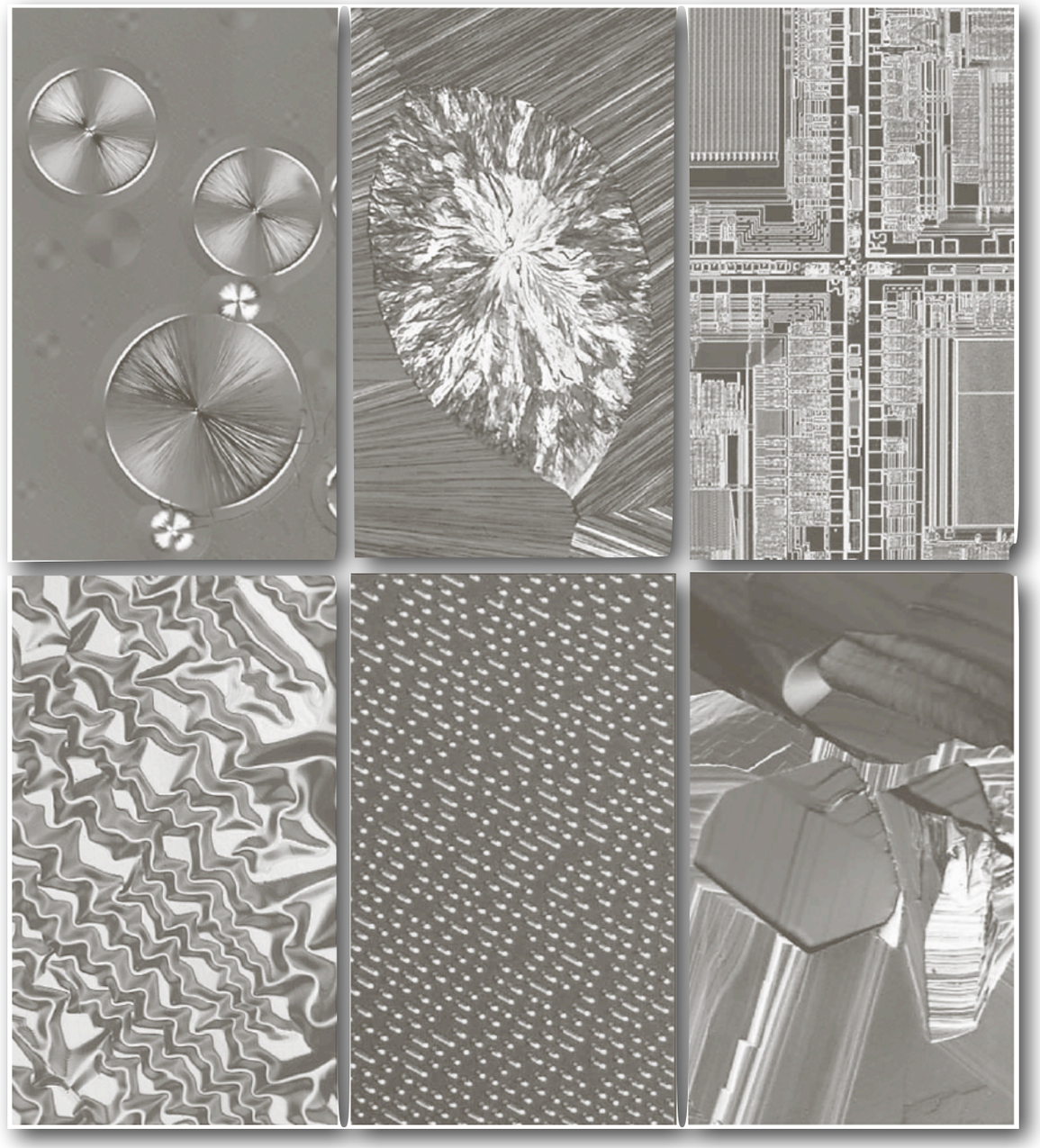
X-ray imaging

Source: DIP/3e

Some Applications -- Magnetic Resonance Imaging



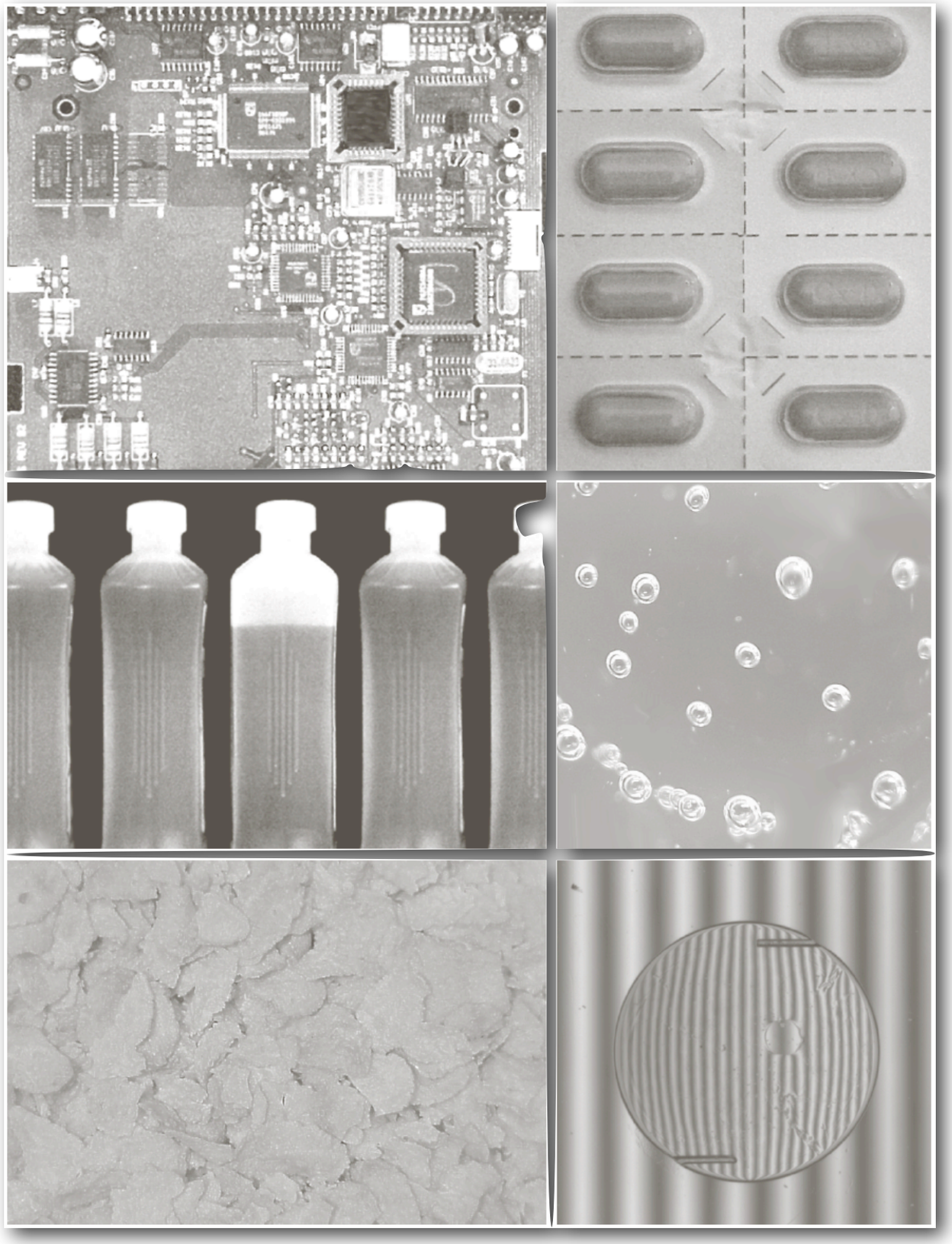
Some Applications -- Microscopy



Visible-light microscopy imaging

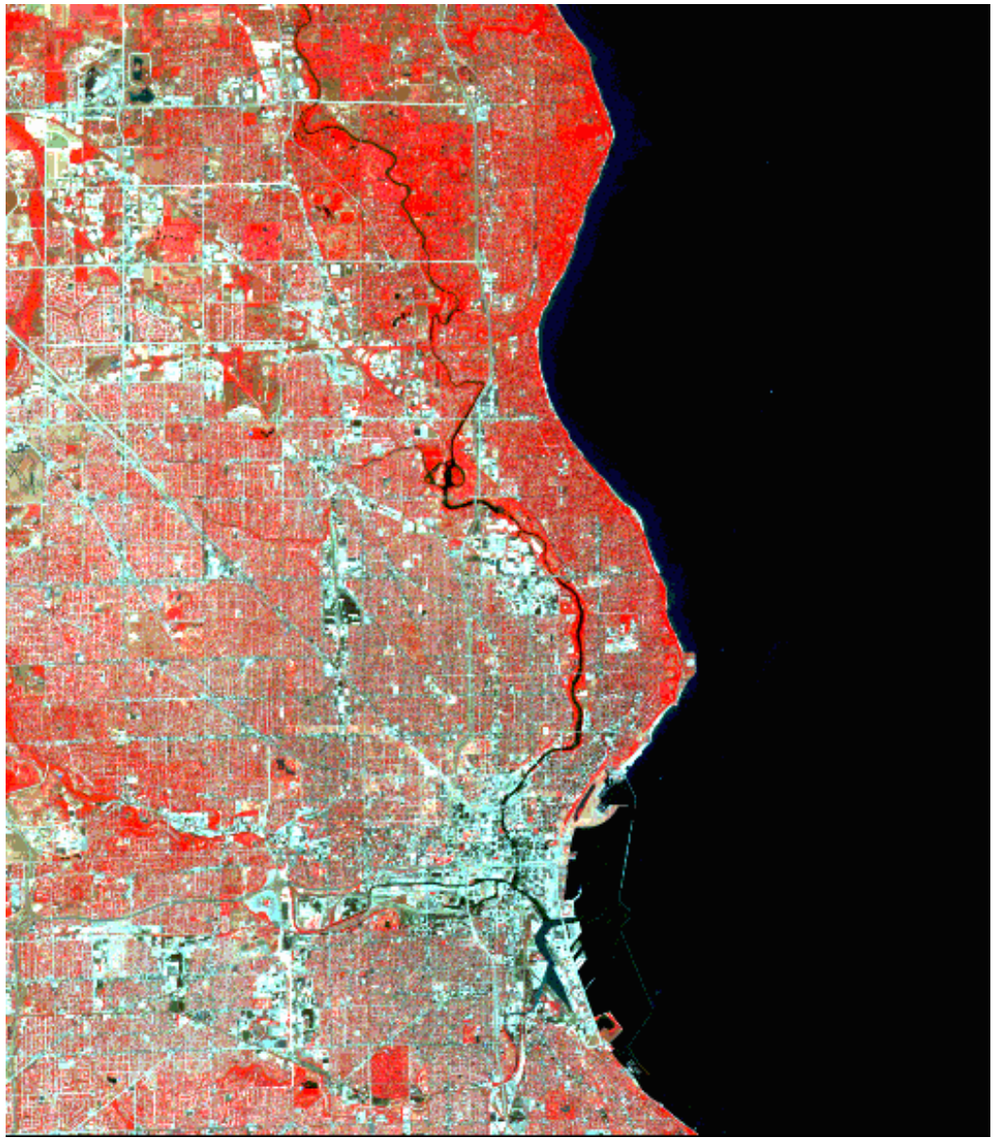
Source: DIP/3e

Some Applications -- Industrial Inspection



Some Applications -- Remote Sensing

Aerial images



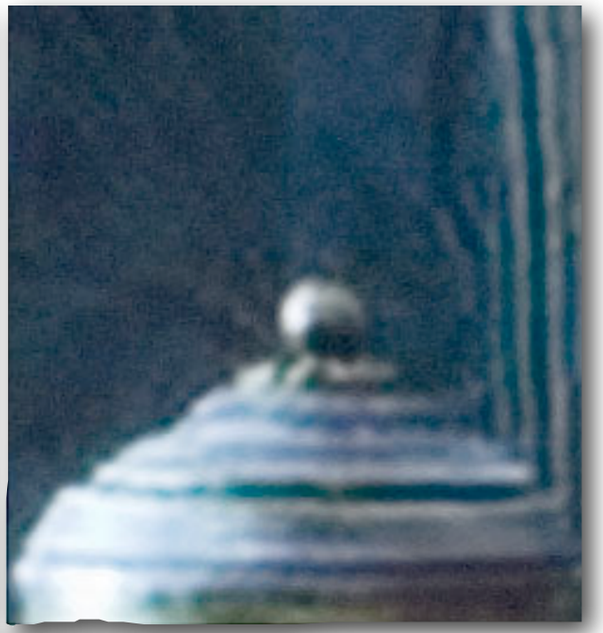
Satellite images

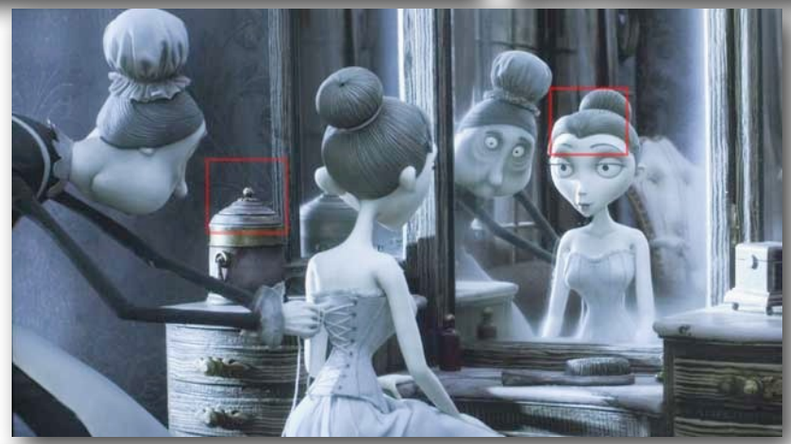
Some Applications -- Infrared Satellite Images

Source: DIP/3e

Some Applications -- Storing Images

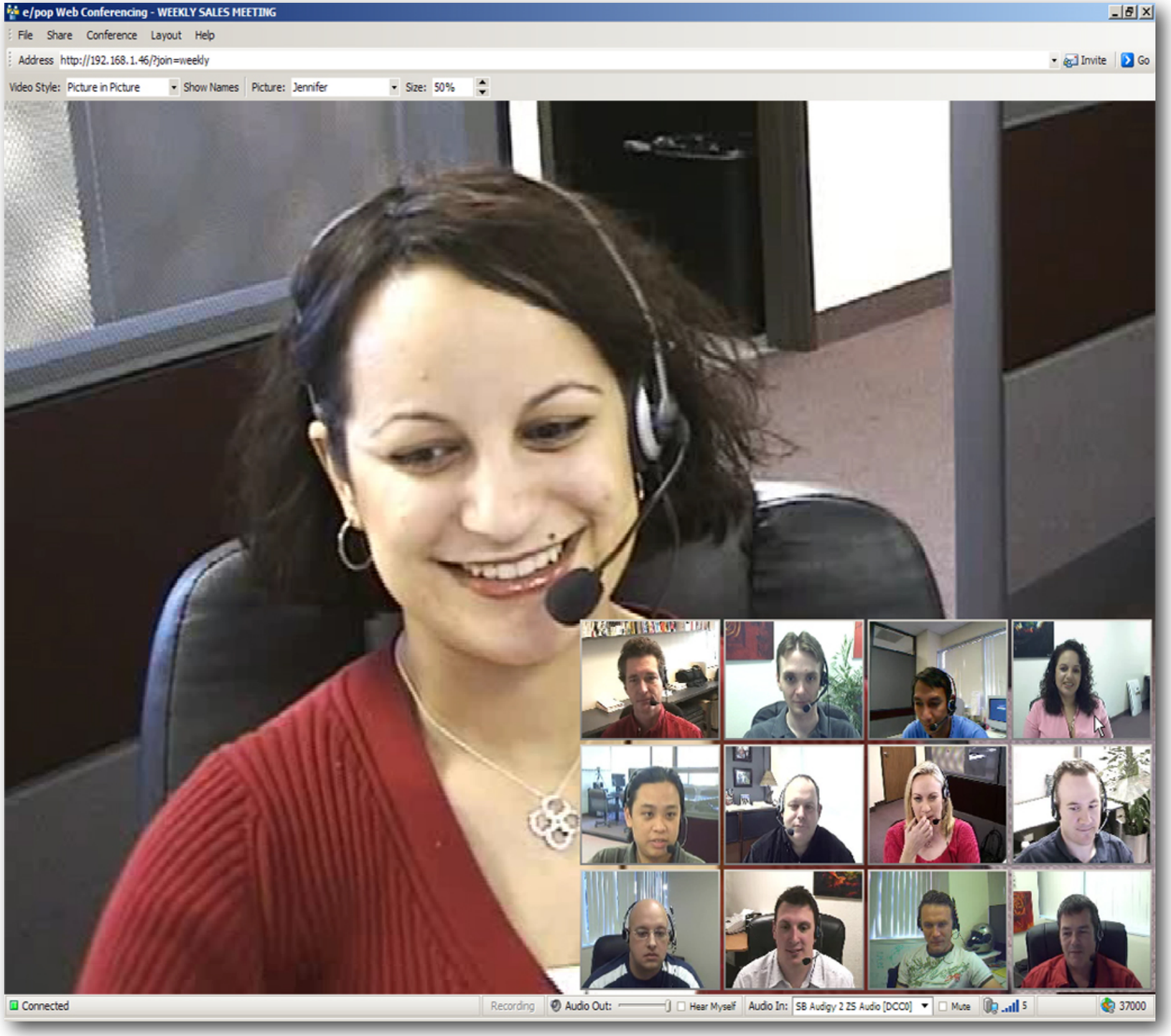
Standard DVD





Blue-ray DVD

Some Applications -- Transmitting Images



Video conferencing

Some Applications -- Image Forensics

Fundamental Steps in Digital Image Processing

Fundamental Steps in Digital Image Processing

- Acquisition
- Spatial and frequency transforms
- Enhancement (subjective)
- Restoration (objective)
- Color processing
- Multi-resolution processing
- Compression
- Morphological processing
- Segmentation