

1 Introduction

1.1 What is Digital Image Processing

Image

- A 2D function $f(x, y)$, where x and y are spatial coordinates;
- Amplitude of f is called **intensity** or **gray level**.

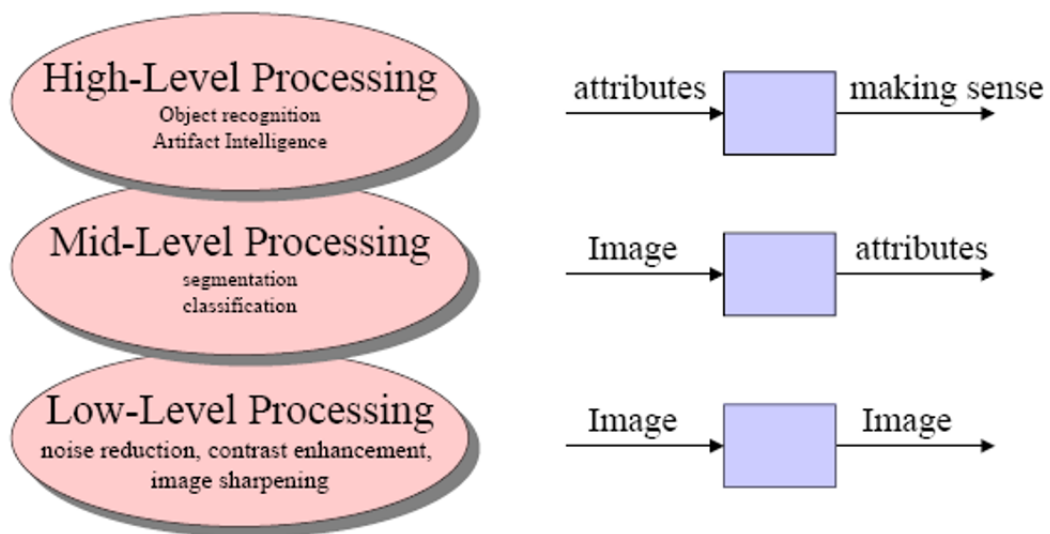
Digital image

- x , y and $f(x, y)$ are finite and discrete;
- The digital image is composed of a finite number of elements called picture elements / image elements / pels / pixels.

Digital Image Processing

- Processing of digital images on a digital computer;
- Not just limited to the visual band of the electromagnetic spectrum.

▪ *Image processing to computer vision*



1.2 The Origins of Digital Image Processing

The first computers powerful enough to carry out meaningful image processing tasks appeared in the early 1960s.

In the late 1960s and early 1970s, image processings are used in medical imaging & astronomy & remote earth resource observations.

From 1960s to present, image processings are used in a broad range of applications.

- Contrast enhancement or code the intensity to color;
- **Image enhancement and restoration;**
- Astronomy, biology, nuclear medicine, law enforcement, defense, industrial applications.

1.3 Examples of Fields that Use Digital Image Processing

Principle energy source for images

- Electromagnetic Spectrum

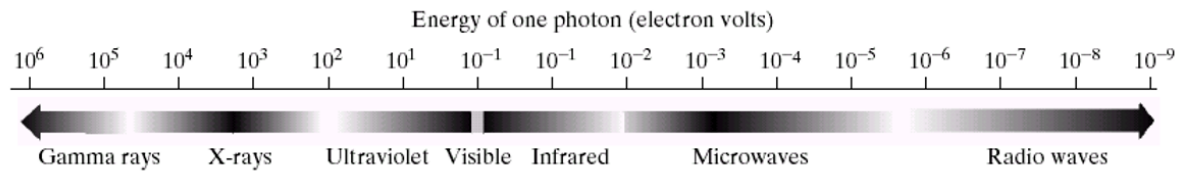


FIGURE 1.5 The electromagnetic spectrum arranged according to energy per photon.

Applications:

- *Gamma-ray imaging*: nuclear medicine; astronomy.
- *X-ray imaging*: medicine (胸部 X 光、血管造影法、电脑断层扫描) ; industry.
- *Ultraviolet band*: lithography 平面印刷术, industrial inspection, fluorescence microscopy 荧光显微镜, lasers, biological imaging, astronomical observations.
- *Visible and Infrared bands*: light microscopy 光学显微镜, astronomy, remote sensing 遥感, industry, law enforcement.
- *Microwave band*: radar image.
- *Radio band*: medicine, astronomy.
- Acoustic

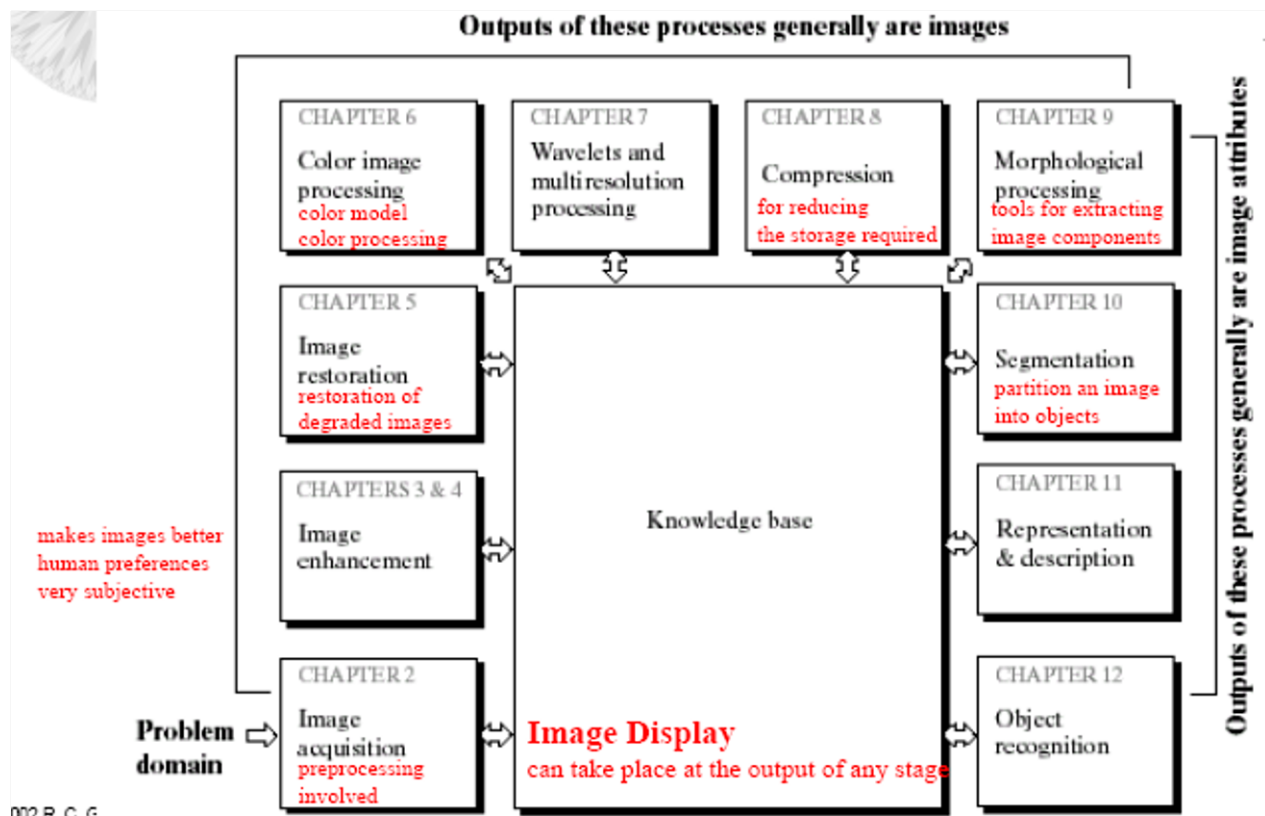
Applications: geological exploration (hundreds of Hertz), industry and medicine (million of Hertz, ultrasound).
- Ultrasonic

Applications: mineral or oil exploration, medicine.
- Electronic

Applications: electron microscopy 电子显微镜 (EM, TEM/SEM).
- Synthetic imaging

Applications: fractal 分形;

1.4 Fundamental Steps in DIP



1.5 Components of an Image Processing System

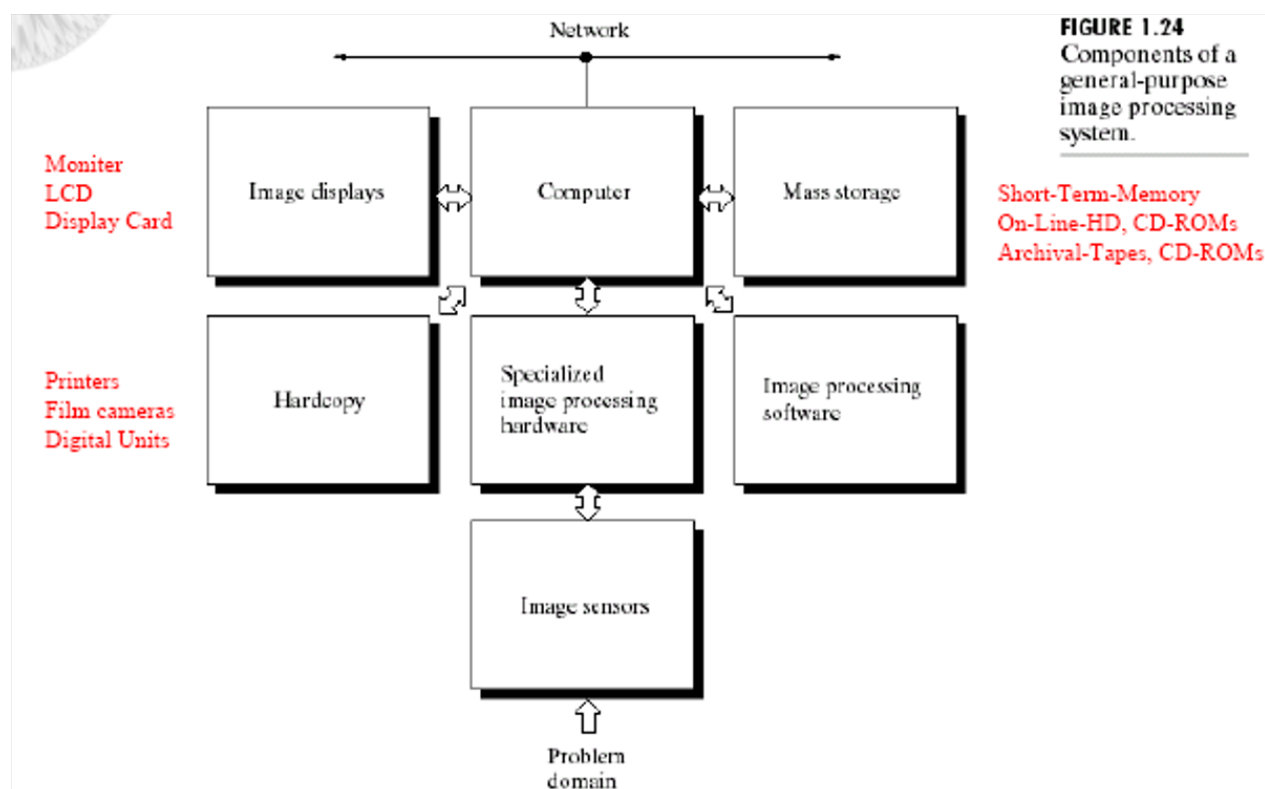


FIGURE 1.24
Components of a general-purpose image processing system.