Digital Image Processing

Contents

- Image Processing Fields
- Computerized Processes Types
- Digital Image Definition
- Fundamental steps in Digital Image

Image Processing Fields

- **Computer Graphics:** The creation of images
- **Image Processing:** Enhancement or other manipulation of the image
- **Computer Vision:** Analysis of the image content

Image Processing Fields

Input / Output	Image	Description
Image	Image Processing	Computer Vision
Description	Computer Graphics	AI

Sometimes, Image Processing is defined as "a discipline in which both the input and output of a process are images

But, according to this classification, trivial tasks of computing the average intensity of an image would not be considered an image processing operation

Computerized Processes Types

- **Low-Level Processes:**
  - **Input** and **output** are images
  - **Tasks:** Primitive operations, such as, image processing to reduce noise, contrast enhancement and image sharpening

Computerized Processes Types

- **Mid-Level Processes:**
  - **Inputs**, generally, are images. **Outputs** are attributes extracted from those images (edges, contours, identity of individual objects)
  - **Tasks:**
    - Segmentation (partitioning an image into regions or objects)
    - Description of those objects to reduce them to a form suitable for computer processing
    - Classifications (recognition) of objects

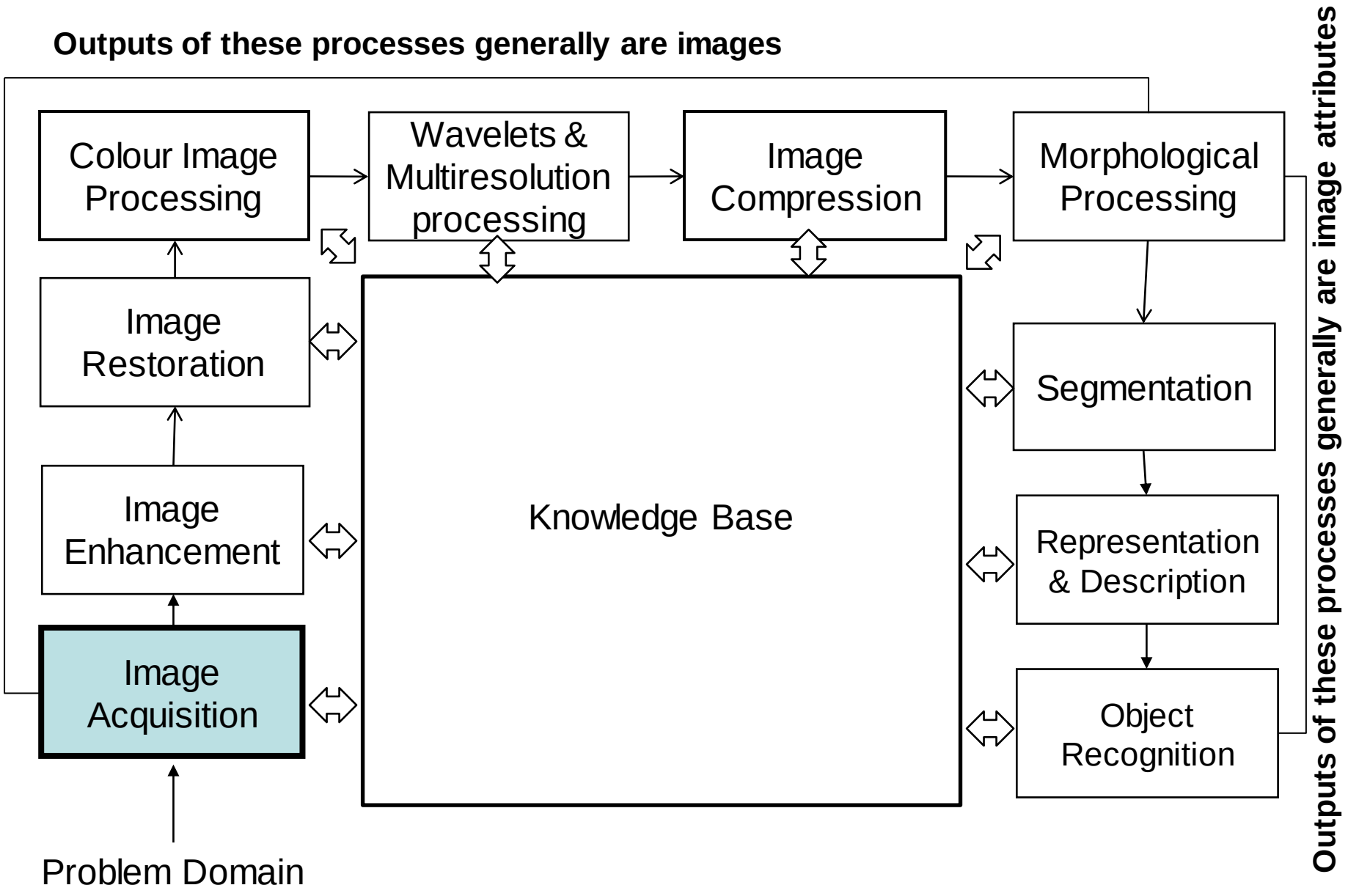
Computerized Processes Types

- **High-Level Processes:**
  - Image analysis and computer vision

Digital Image Definition

- An image can be defined as a two-dimensional function f(x,y)
- x,y: Spatial coordinate
- F: the amplitude of any pair of coordinate x,y, which is called the intensity or gray level of the image at that point.
- X,y and f, are all finite and discrete quantities.

Fundamental Steps in Digital Image Processing:



Fundamental Steps in DIP: (Description)

Step 1: Image Acquisition

The image is captured by a sensor (eg. Camera), and digitized if the output of the camera or sensor is not already in digital form, using analogue-to-digital convertor

Fundamental Steps in DIP: (Description)

Step 2: Image Enhancement

The process of manipulating an image so that the result is more suitable than the original for specific applications.

The idea behind enhancement techniques is to bring out details that are hidden, or simple to highlight certain features of interest in an image.

Fundamental Steps in DIP: (Description)

Step 3: Image Restoration

- Improving the appearance of an image

- Tend to be mathematical or probabilistic models. Enhancement, on the other hand, is based on human subjective preferences regarding what constitutes a “good” enhancement result.

Fundamental Steps in DIP: (Description)

Step 4: Colour Image Processing

Use the colour of the image to extract features of interest in an image

Fundamental Steps in DIP: (Description)

Step 5: Wavelets

Are the foundation of representing images in various degrees of resolution. It is used for image data compression.

Fundamental Steps in DIP: (Description)

Step 6: Compression

Techniques for reducing the storage required to save an image or the bandwidth required to transmit it.

Fundamental Steps in DIP: (Description)

Step 7: Morphological Processing

Tools for extracting image components that are useful in the representation and description of shape.

In this step, there would be a transition from processes that output images, to processes that output image attributes.

Fundamental Steps in DIP: (Description)

Step 8: Image Segmentation

Segmentation procedures partition an image into its constituent parts or objects.

Important Tip: The more accurate the segmentation, the more likely recognition is to succeed.

Fundamental Steps in DIP: (Description)

Step 9: Representation and Description

- **Representation:** Make a decision whether the data should be represented as a boundary or as a complete region. It is almost always follows the output of a segmentation stage.
  - **Boundary Representation:** Focus on external shape characteristics, such as corners and inflections (انحناءات)
  - **Region Representation:** Focus on internal properties, such as texture or skeleton (هيكلية) shape

Fundamental Steps in DIP: (Description)

Step 9: Representation and Description

- Choosing a representation is only part of the solution for transforming raw data into a form suitable for subsequent computer processing (mainly recognition)

- **Description:** also called, ***feature selection***, deals with extracting attributes that result in some information of interest.

Fundamental Steps in DIP: (Description)

Step 9: Recognition and Interpretation

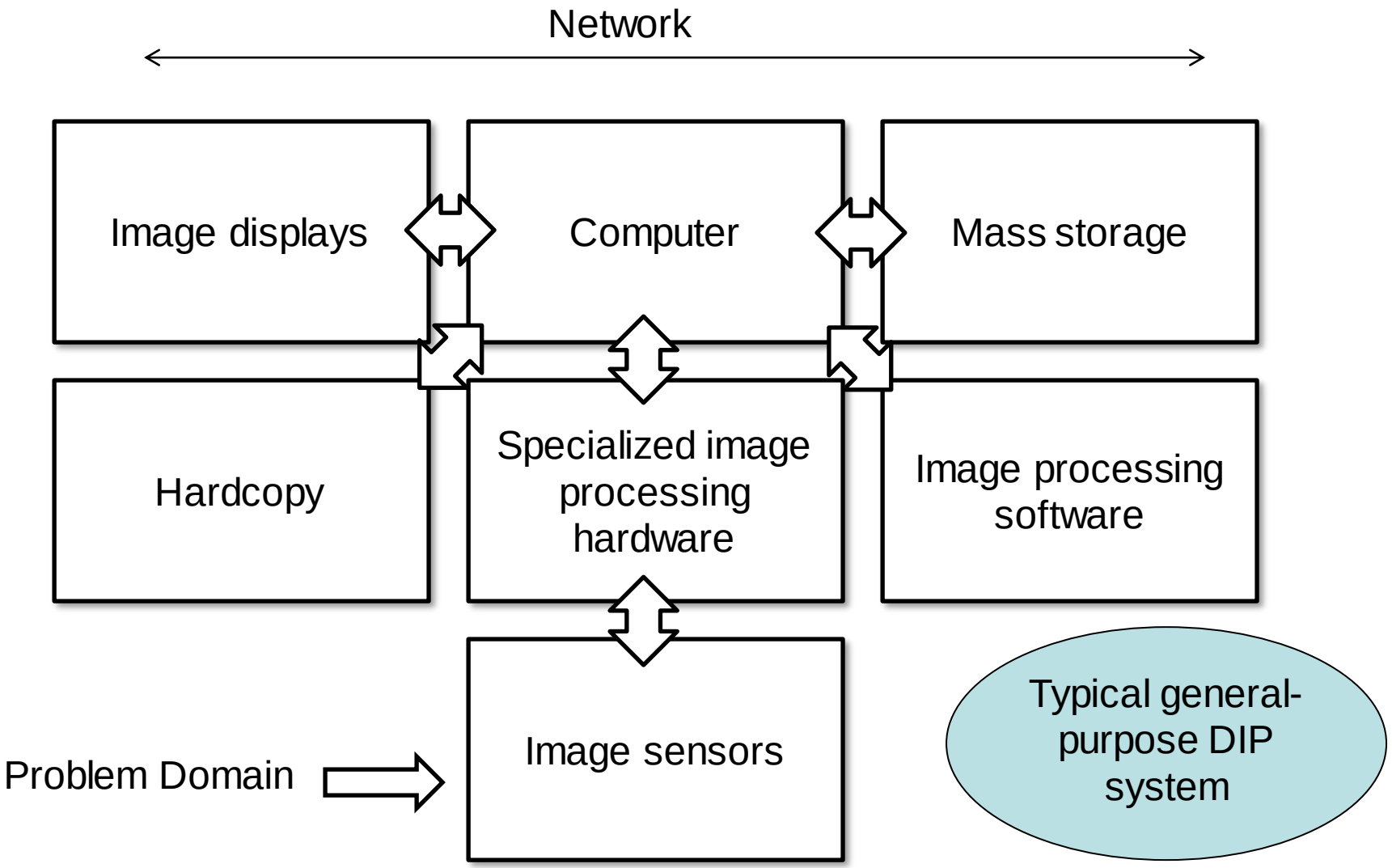
Recognition: the process that assigns label to an object based on the information provided by its description.

Fundamental Steps in DIP: (Description)

Step 10: Knowledge Base

Knowledge about a problem domain is coded into an image processing system in the form of a knowledge database.

Components of an Image Processing System



Components of an Image Processing System

1. **Image Sensors**

   Two elements are required to acquire digital images. The first is the physical device that is sensitive to the energy radiated by the object we wish to image (*Sensor*). The second, called a *digitizer*, is a device for converting the output of the physical sensing device into digital form.

Components of an Image Processing System

2. Specialized Image Processing Hardware

Usually consists of the digitizer, mentioned before, plus hardware that performs other primitive operations, such as an arithmetic logic unit (ALU), which performs arithmetic and logical operations in parallel on entire images.

This type of hardware sometimes is called a front-end subsystem, and its most distinguishing characteristic is speed. In other words, this unit performs functions that require fast data throughputs that the typical main computer cannot handle.

Components of an Image Processing System

3. Computer

The computer in an image processing system is a general-purpose computer and can range from a PC to a supercomputer. In dedicated applications, sometimes specially designed computers are used to achieve a required level of performance.

Components of an Image Processing System

4. Image Processing Software

Software for image processing consists of specialized modules that perform specific tasks. A well-designed package also includes the capability for the user to write code that, as a minimum, utilizes the specialized modules.

Components of an Image Processing System

5. Mass Storage Capability

Mass storage capability is a must in a image processing applications. And image of sized 1024 * 1024 pixels requires one megabyte of storage space if the image is not compressed.

Digital storage for image processing applications falls into three principal categories:

1. Short-term storage for use during processing.
2. on line storage for relatively fast recall
3. Archival storage, characterized by infrequent access

Components of an Image Processing System

5. Mass Storage Capability

One method of providing short-term storage is computer memory. Another is by specialized boards, called frame buffers, that store one or more images and can be accessed rapidly.

The on-line storage method, allows virtually instantaneous image zoom, as well as scroll (vertical shifts) and pan (horizontal shifts). On-line storage generally takes the form of magnetic disks and optical-media storage. The key factor characterizing on-line storage is frequent access to the stored data.

Finally, archival storage is characterized by massive storage requirements but infrequent need for access.

Components of an Image Processing System

6. Image Displays

The displays in use today are mainly color (preferably flat screen) TV monitors. Monitors are driven by the outputs of the image and graphics display cards that are an integral part of a computer system.

Components of an Image Processing System

7. Hardcopy devices

Used for recording images, include laser printers, film cameras, heat-sensitive devices, inkjet units and digital units, such as optical and CD-Rom disks.

Components of an Image Processing System

8. Networking

Is almost a default function in any computer system, in use today. Because of the large amount of data inherent in image processing applications the key consideration in image transmission is bandwidth.

In dedicated networks, this typically is not a problem, but communications with remote sites via the internet are not always as efficient.