Ch-1 Introduction

1.1 What is digital image processing?

- An image may be defined as a 2-D function $f(x, y)$ where x and y are spatial coordinates, and the amplitude of f at any pair of co-ordinates (x, y) is called the intensity or gray level of the image at that point.
- When x, y and f are all finite, discrete quantities, we call an image a digital image.
- Human eye is limited to visual band of the electromagnetic spectrum, but imaging machines cover almost the entire EM spectrum, ranging from gamma rays to radio waves.
  Eg ultrasound, electron microscopy, computer generated images.
- 3 levels of computerized processes are - low level, mid-level & high level processing.

Low-level processing: involves primitive operations such as image pre-processing to reduce noise, contrast enhancement, image sharpening.
- Both inputs and outputs are images.

Mid-level processing: involves tasks such as segmentation, description of those objects to reduce them to a suitable form suitable for computer processing, and classification.
- Inputs are generally images but its outputs are attributes extracted from those images (like edges, contours, and the identity of objects)

Higher-level processing: involves "making sense" of an ensemble of recognized objects, as in image analysis, and at far end of the continuum, performing cognitive functions normally associated with human vision.

1.2 Applications of DIP

① GAMMA-RAY IMAGING: includes nuclear medicine and astronomical observations.

- In nuclear medicine, the approach is to inject a patient with a radioactive isotope that emits gamma rays as it decays.
- Images are produced from the emissions collected by gamma-ray detectors.

② X-RAY IMAGING

- medical diagnostics
- X-rays for medical & industrial imaging are generated using X-ray tube, i.e. a vacuum tube with cathode & anode.

③ Imaging in Ultraviolet Band

④ Imaging in the visible & infrared Bands

- satallite based images.

⑤ Imaging in the microwave band.

- Using radars.

⑥ Radio Band

- Used in Magnetic Resonance Imaging (MRI)

1.3 Fundamental Steps in Digital Image Processing

1) Image Acquisition:

- First process
- Acquisition could be as simple as being given an image already in digital form.
- Generally involves preprocessing, such as scaling.

2) Image Enhancement:

- Process of manipulating an image so the result is more suitable than the original for a specific application.
- Enhancement techniques are problem oriented.

3) Image Restoration :

- Deals with improving the appearance of image.
- Unlike enhancement, which is subjective, this is objective.
- These techniques tend to be based on mathematical or probabilistic models of image degradation.

4) Colour image processing :

gaining importance because of significant increase in the use of digital images over internet.

5) Wavelets :

- Foundation for representing images in various degrees of resolution.
- Used for data compression and for pyramidal representation, in which images are sub-divided successively into smaller regions.

6) Compression :

- Reducing the storage space required to save an image or the bandwidth required to transmit it.
- JPEG ("Joint Photographic Experts Group) – image compression standard.

7) Morphological Processing :

- Deals with tools for extracting image components that are useful in the representation & description of shape.
- Transition from processes that output images to processes that output image attributes.

8) Segmentation :

- Partitions an image into its constituent parts or objects.
- Autonomous segmentation is one of the most difficult tasks in DIP.

9) Feature Extraction :

- Almost always follows segmentation stage, which usually is raw pixel data, consisting either boundary of a region or all points in the region itself.

- It consists of feature detection and feature description.

10) Image Pattern Classification:

Process that assigns a label to an object based on its feature descriptors.

1.4 COMPONENTS OF AN IMAGE PROCESSING SYSTEM

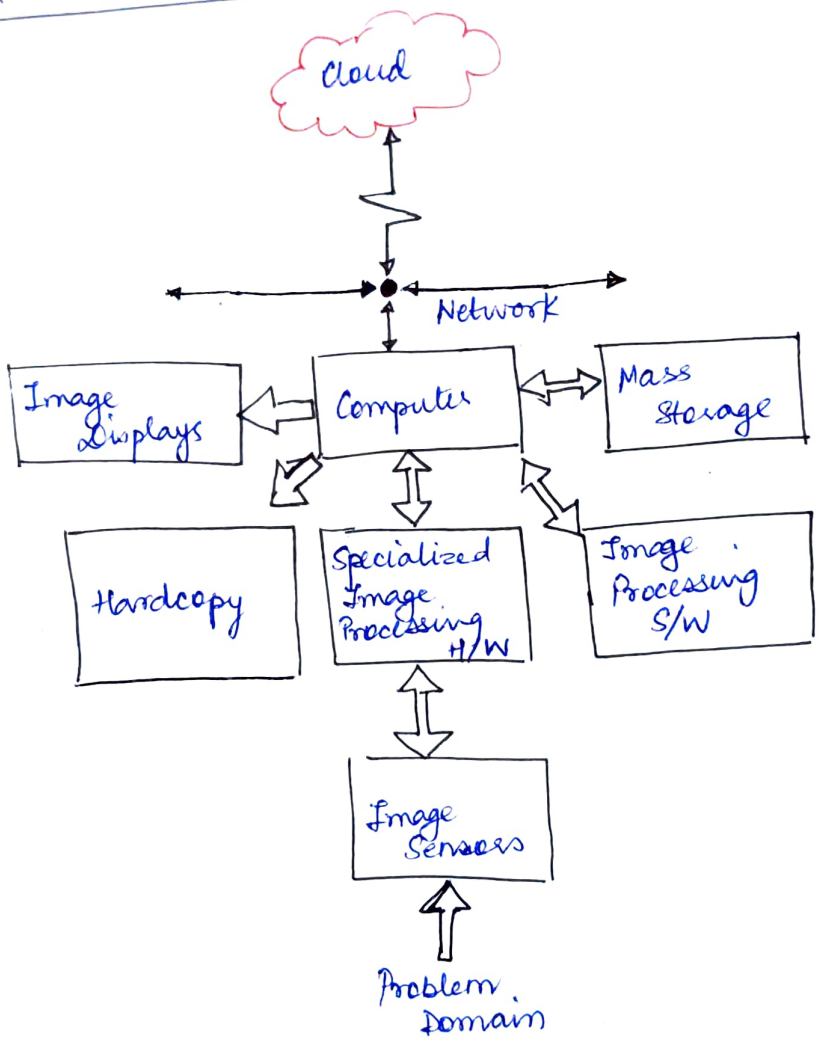

Image Sensors:

2 subsystems are required to capture image

1→ Physical sensors that respond to the energy radiated by object we wish to image

2→ Digitizer - converts the output of physical sensing device into digital form.

Specialized Image Processing H/W:

usually consists of a digitizer mentioned above, plus hardware that performs other primitive operations like ALU, GPU.

Computer

is a general-purpose computer and can range from a PC to super computer

Software:

- specialized modules that perform specific tasks.
- A well designed package also includes capability for the user to write code that utilizes specialized modules.

Eg MATLAB.

Mass storage:

Must.

1 MB storage for 1024 x 1024 sized 8-bit intensity of pixels.

Image Displays: Color, flat screen monitors.

Monitors are driven by the outputs of image and graphics display cards.

Hardcopy: Laser printers, film cameras, heat sensitive devices, etc.

Networking & cloud: