

Sug 1

Aeff

Introduction

Digital Image processing (DIP)

DIP is used with deal with processing and analyzing digital Images and videos. DIP involves the manipulation of digital Images to improve their quality or extract useful information from them.

Pattern Recognition:

It is the process of identifying patterns in data and making predictions based on patterns.

Image processing means editing Images. It is a process

which takes an image input and generates a modified image output

Computer vision: is a version which concerned with the automatic extraction, analysis and understanding of useful information from a single image or sequence of images.

Image compression: process of encoding or converting an image file in such a way that it consumes less space than the original file.

Application of Digital Image processing (DIP)

Medical - X-ray & MRI

CT scan

Remote sensing - flood, disaster area mapping
Crop monitor.

Security - face recognition
motion detection.

Telecommunication - video text
video calls

Process control, Scientific analysis, Military guidance
printing & graphics cards

outflow of the process generally
are being

7 Fundamental Steps in Digital

Image Processing

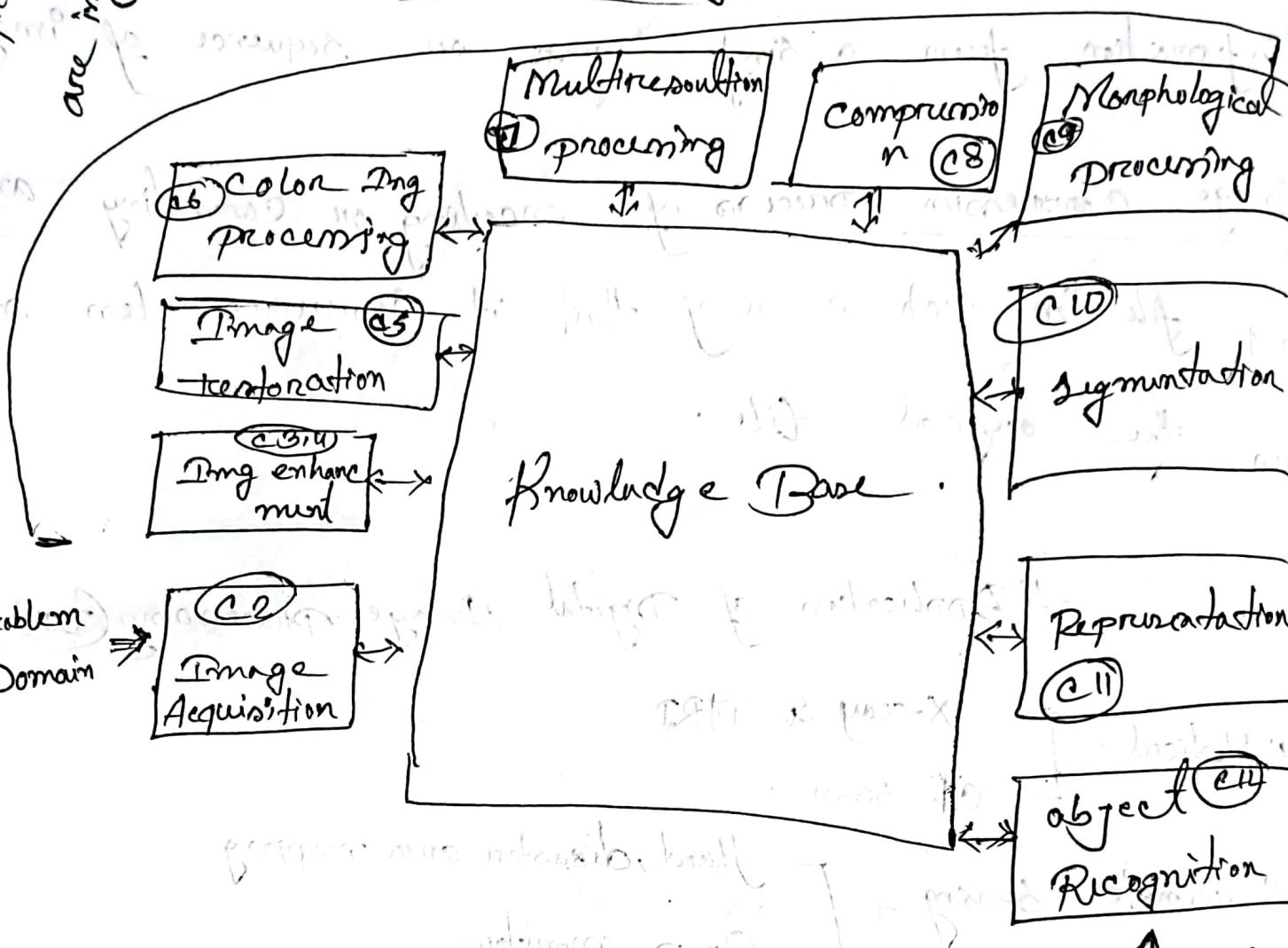


Image Acquisition

using Camera, Scanners.

Image Enhancement: It's improve quality of the image

by adjusting the brightness, contrast,

color, contrast, etc.

Image Restoration: The process of recovering the original image from a corrupted image.

Image from a corrupted Image:

Color Image processing: It helps to understand color models and extract useful features from images.

Multiresolution processing: It helps represent images at different resolutions and breaking images into smaller parts.

Compression: Reduces image file size for easier storage and faster transmission.

Morphological processing: It uses tools to extract shapes from images.

Segmentation: It divides an image into parts or objects accurate segmentation key of successful recognition.

Representation: Convert segmented image data into useful features, focused internal shape and region.

Object Recognition: Identifying a specific object in a digital image.

* Levels of DP

Low Level

Image → Image [Noise removal, Img sharpening]

Mid Level

Image → Attributes. [Object recognition, Segmentation]

High Level

Attributes → understanding [Scene understanding]

Goal of DP

visualization (Enhancement, 3D display)

Quantification (Measurement)

Automation. (Minimize human intervention)

Computer: High performance computer that runs ~~the~~ ^{fast} program.

Image processing software: Tools and programs that help process, edit & analyze img.

Mass Storage: used to save img, includes short-term (RAM) fast access (hard-drives), long-term storage (disks)

Image Display: Monitors for visualizing processed image

Handcopy Devices: printers, film cameras, or CD for producing physical copies of images.

Network: Share images between system or user, needing fast Internet or local connection, requires high bandwidth for image transmission.

Abstraction: abstract wifj, local connection, network, etc.
more and more stand additional to each other at last
expands to the Internet

Color is a visual perceptual property (cuando usas)

Imager & Video

Imager

- * processing one frame
- * It is 2 dimensional representations of object or scenes.
- * one moment in time
- * JPG, PNG

Video

- * processing Many frames
- * sequence of frames
- * It is a sequence of images played in quick succession
- * Captures motion over time
- * AVI, MOV, MP4.

⑩ Image (camera) vs Human eye

Img (camera)

- * It is mechanical.
- * Limited dynamic range
- * fixed focus and zoom
- * No depth perception

Human eye

- * Eye physical
- * wide dynamic range
- * Can auto focus & adjust
- * See in 3D

Similarity → Camera & Eye

- * Camera and Eye need light to see & capture anything
- * Camera and Eye need light to see & capture anything
 - ↳ Dark room struggle inc.
- * Both use lens to focus light for C/n Image
- * Both adjust to brightness.
- * Both used to understand the world visually.
 - ↳ Camera with I_{so}, eye with pupil size
 - ↳ Driving car men for see the road
 - ↳ Human use eyes to drive

Color TV Scheme:

① Involved 3 Color (R & B) By moving different intensities of these 3 color wide range c/n produced appear on Computer, television, monitors.

Types of color inc. RGB basic color

CE & CRT

Gray Image:

- It is represented by black & white shades on combinations of levels. For 8 bit gray image total $2^8 = 256$ levels from black & white.

Binary Image:

A binary image has only two values for each pixel 0, 1 corresponding to black & white.

* pseudocolor imaging processing:

It maps each of the gray and white image into an assigned color which identifies certain features easier. for the operation. So feature extraction is done.

* Aspect Ratio

It is the proportionality between width & height.

Seg 2

Analog vs Digital Image

- has no discrete colors & should be balanced by

A analog Img represented by continuous variation

in tone such as photograph

A Digital Img is a numeric representation (binary)

of a two dimensional Image (Mobile pictures)

analog

Digital

• Continuous Data

(Pixel has infinite range)

• Discrete Data

(represent specific pixel, off

• Easier for human

Easier to store & Edit

viewing

Matrix of pixels and

III Cont process analog Img directly to Digital

• Input & Output required
Conversion needed (Edit, filtering).

Acquisition & Devices

This is the process of capturing an image from the real world and converting it into a form that a computer can use as digital image.

Types of Acquisition:

- Single Sensor → one detection (flatbed scanner)
- Line Sensor (or Scan Sensor) → one row of Sensors (fax machine)
- Array Sensor → capture whole img fast once (cameraphn)

Spatial & Amplitude Quantization

This step convert analog to digital (grid) image

Spatial Sampling

- Divides the img onto grid.
- Each cell of grid becomes pixel.
- Determine img resolution (more pixels \rightarrow more detail)

* Amplitude Quantization

- Each pixel's brightness is rounded to the nearest from a set.
- This defines gray scale (levels) \rightarrow 0-black 255-white in 8 bit.

How to Convert analog to digital img.

- Sampling - It is measure the amplitude of signal at equal interval. (divide small part using grid)
- Quantization - It is the process of rounding off the signal to the nearest finite level of the code word generation. By using binary code (0,1) measure brightness.

So that real world pic can be converted onto digital pic

[Digitizing the coordinate \rightarrow Sampling]
[the amplitude value \rightarrow quantization]

pixels

- Picture element
- represented by a grid of small squares, each with specific color or intensity values.
- pixel determines the level of details that can be captured in the img.

Each pixel

- grayscale (0-255)
- color (R, G, B)

Resolution

It tells how detailed the image is.

2 types

Spatial Resolution:

- Number of pixels per unit area. (DPI)
- High DPI = High Clarity.

Intensity Resolution:

Number of brightness (gray) Levels.

$$8 \text{ bit} = 256 \text{ lvl}$$

$$16 \text{ bit} = 65536 \text{ lvl}$$

High res = better quality.

* Difference monocular vs Binocular Vision

Binocular

Monocular

Two eyes front of the face.

• Eyes point same way

• Create one img

• Have a depth perception

• Common in human

• Eyes of opposite sides

of the heads.

• Eyes point opposite direction

(e.g. Wrens, larks)

• Create 2 img

(e.g. pigeons)

• Lack of depth perception

• Common in birds, fishes

(e.g. pigeons, fish) (e.g. penguins, seals)

• Pigeon depth = ERF depth

• visual field = retinal field

• 1st see - field

• second = field

Aspect Ratio = $\frac{\text{width}}{\text{height}}$. [Used in tv, display].

* Maintain Constant aspect Ratio avoids img distortion.

Gray Level

- represent brightness in an Image.

Range depend on bit depth.

$$1 \text{ bit} = 2^1 \text{ lvls}$$

$$8 \text{ bit} = 256 \text{ lvls}$$

$$16 \text{ bit} = 65536 \text{ (Medical use.)}$$

More gray levels smoother shading in Img.

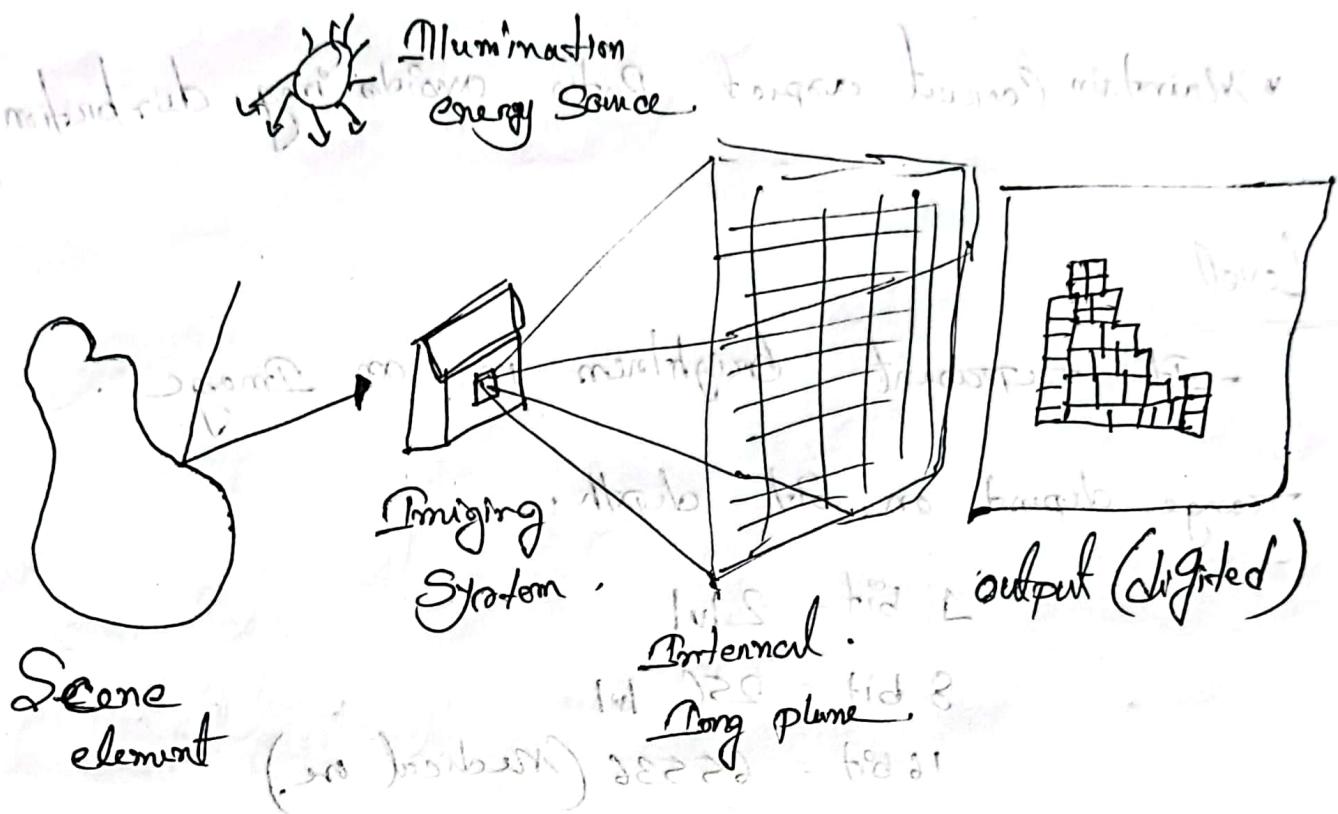
III Convert color to gray.

$$\text{Gray} = 0.2989 \times R + 0.5870 \times G + 0.1140 \times B$$

human eye sensitive in green

* Gray scale is a clr img where 3 value represent R,G,B Combination.

④ Example. Of digital Image acquisition:



④ find resolution (PPD) of 15" monitor with 640×480

$$\Rightarrow \text{Aspect Ratio} = \frac{\text{width}}{\text{height}} = \frac{640}{480} = 4:3$$

$$20 \text{ (in)} + (3\pi) = 15 \times 82.0 + 8 \times 82.0 = 177.0$$

angle which $25m = 225^\circ$

$$\text{length} = 4/n = 4 \times 3 = 12$$

resolution $= \frac{640}{12} = 53.3 \text{ PPI}$

PPI = Total pixels ÷ size of inches.

$$PPI = \frac{\sqrt{(\text{width})^2 + (\text{height})^2}}{\text{diagonal size}}$$

Monitor 20" @ value or
20" width

Good eye resolution at 15" = 600 dpi

Q4 calculate resolution 14" x 9" photo.

$$\rightarrow \text{resolution} = \frac{\text{width}}{\text{height}} \text{ in inch} \times \text{DPI (in pixel)}$$

$$14 \times 600 = 8400$$
$$9 \times 600 = 5400$$

Find ppi 15" monitor working 800 x 600

$$PPI_{\text{mon}} = \frac{\sqrt{800^2 + 600^2}}{15}$$

width + height
diagonal size

$$= 66.67 \text{ PPI}$$

Light & Electromagnetic Spectrum

Visible light has a range of colors, from violet (shortest wavelength) to red (longest wavelength).

- The visible light is just tiny part of the electromagnetic spectrum.
- One side of spectrum is radio waves, which have wavelength billions of times longer than visible light.
- On the other side are gamma rays, which have wavelength millions of times smaller than visible light.

How Img Sensors Work

Both CCD & CMOS sensors detect light using photo sensitive elements. They convert light into analog signals, which turned into digital data. the digital data create an image.

Color Model

HDI / HSB

Hue = the actual color, measured in degree

Saturation = The purity of the color measured in percentage 0% (gray) to 100% (pure)

Brightness / Intensity = The bright/darkness of clr. Measured in percentage 0% (black) to 100% (white)