Seg 1 AE77

Introduction

Digital Image processing (DIP)

DIP is ~~a used with~~ deal with processing and analyzing digital Images and vedios. 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 identify images. It is a process. which takes an images input and generates a modified image output

Computer version: 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 img file in such a way that it consumes less space than the orginal file.

Application of Digital Image processing (DIP)

\# Medical
- X-ray & MRI
- CT scan.

\# Remote Sensing
- flood, disaster area mapping
- Crop monitor.

\# Security
- face Recognation
- motion detection.

\# Telecominication
- Video text
- vedio Calles

Process control, Scientific analysis, Military guidance printing & graphics arts.

Fundamental Steps in Digital Image processing.

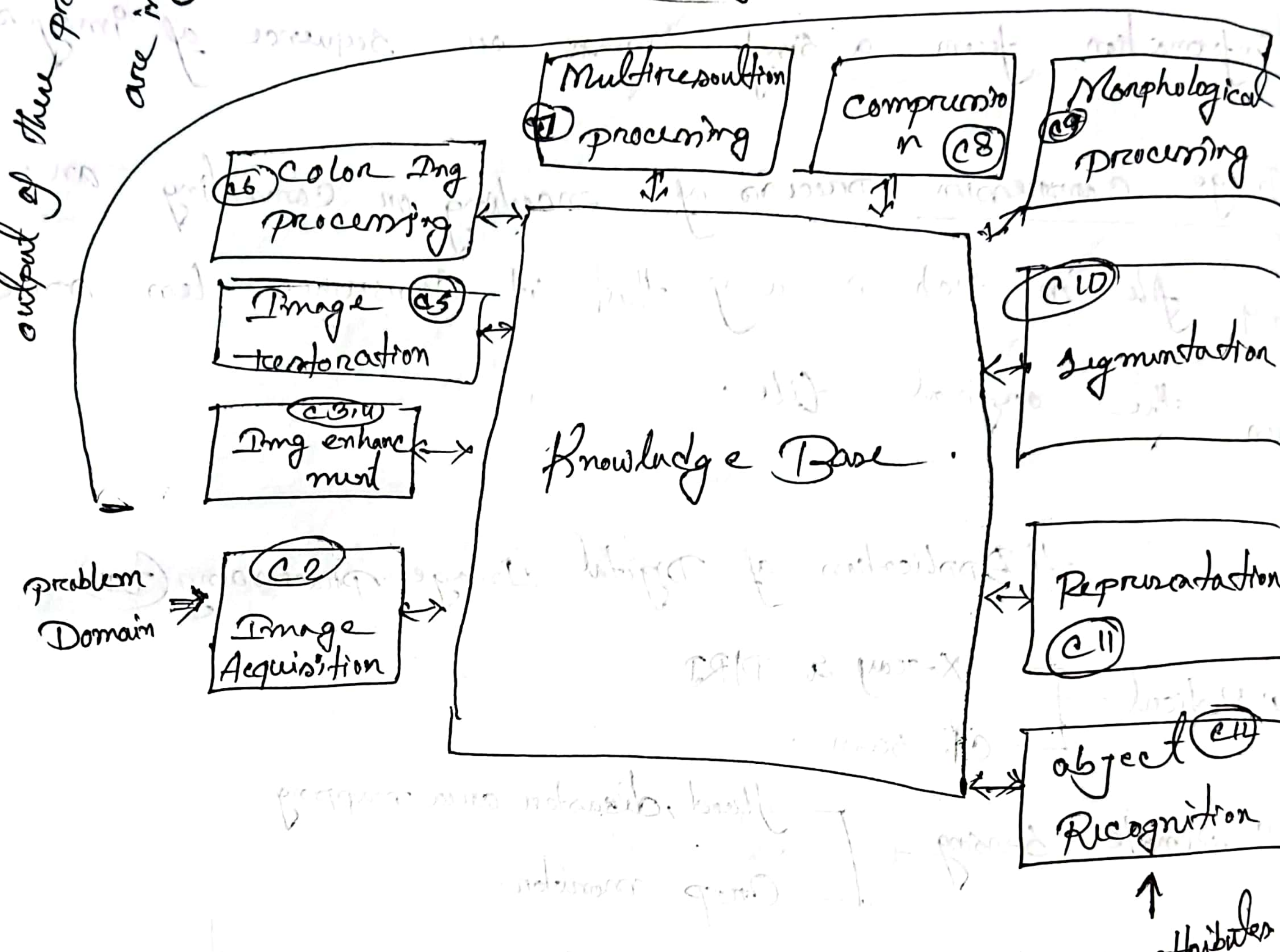


Image Acquisition: process of acquiring digital Img. using Camera, Scanners.

Image Enhancement: It's improve quality of the image by adjusting the brightness, contrast.

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

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

Multiresolution processing: It help represent Images at different resolutions and breaking images into smaller parts

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

Morphological processing: It uses tools to extract shapes from Img

Segmentation: It divides an img into parts or objects
accurate Segmentation key of successfull recognition

Representation: Convert Segmented Img data into useful features, focused internal shape and region.

Object Recognition: Identifying a Specific object in a Digital Image.

* Levels of DIP

Low level

Image → Image [Noise removal, Img sharpening]

Mid Level

Image → Attributes. [Object recognation, segmentation]

High level.

Attributes → understanding [Scene understanding)

Goal of IP.

visualization (Enhancement, 3D display)

↓

Quantification (Measurement)

↓

Automation. (Minimize human intervention)

Computer: High performance Computer that Runs Img processing program.

Image processing ~~Hardw~~ Software: Tools and program that help process edit & analyze img.

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

Image Display: Monitors for visualizing processed image

Hardcopy Devices: printers, flim Cameras, & CD for producing Physical copies of images.

Network: Share images between system or user, needing for Internet or Local Connections, requires high bandwidth for img transmission.

Color is a visual perceptual property (দেখার অনুভূতি)

Images & Vedio

Images	Vedio
* processing one frame	• processing Many frame.
• It is 2 dimensional representations of object on scenes.	• It is a sequence of Img played in quick succession
• one moment in time	• Captures motion over time
• JPG, PNG	• AVI, MOV, Mp4.

Image (Camera) v/s Human eye

Img (Camera)	Human eye
• It is machanical.	• Eye physical.
• Limited dynamic Range	• Wide dynamic Range.
• fixed focous and Zoom	• Can auto focous & adjust.
• No depth perception	• See in 3D

Similarity → Camra & Eye

* Camra and Eye need light to see & Capture anything.
  ↳ Dark room struggle ine

* Both use Lens to focous Light for C/n Image

* Both adjust to brightness.
  ↳ Camra with ISO, eye with pupil size.

* Both used to understand the work visualy.
  ↳ Driving car uses camra for see the road
  human use eyes to drive.

Coloor tv Scheme:

It involves 3 Color (R G B) By maxing different intensities of these 3 Color wide range C/n produced, basis Computer, television, monitors.

Gray image:

- It represented by black & white shades on com-
-binations of levels. for 8 bit gray image total $2^8=256$
level from black & white.

Binary image:

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

* pseudocolor img processing:

It maps each of the gray levels of a black
and white img into an assigned clr. which identify
certain features easier for the observer & further.

* aspect Ration

It is the proportional between width & height

Seg2

Analog & Digital Image

A analog Img represented by Continuous variation in tone such as photograph.

A Digital Img is a numarcle representation (binary) of a two dimensional Image. (Mobile pictures)

analog	Digital
• Continuous Data (pixel has infinite range)	• Discreate data (represent specific pixel, clr)
• Easier for human viewing	• Easier store & Edit
	• Matrix of pixels used.

If Can't process analog img directly, Digital 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 img.

Types of Acquisition :

- Single Sensor → one detector (flatbed scanners)
- Linear ~~scan~~ Sensor → one row of Sensors (fax machine)
- Array Sensor → capture whole img at once (smartphn)

Spatial & Amplitude Quantization

this step convert analog to digital (grid) image

Spatial Sampling

- Divides the img into grid.
- Each cell of grid becomes pixel.
- Determine img resolution (more pixel → more detail)

• Amplitude Quantization

• Each pixel's brightness is rounded to the nearest number from a set.

• This defines gray scale (levels) → 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 of the singnal to the nearest finite lvl

Code word generation: By using binary code (0, 1) measure Brightness.

So that real world pic can be trained into digital pic

[Digitizing the coordinate → Sampling
" the amplitude value → 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

Its tells how detailed the image is.

2 types

Spatial Resolution:

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

Intensity Resolution:

Number of brightness (gray) Levels.

8 bit = 256 lvl
16 " = 65536 "

Hig res = better quality.

* Diffrnce monoculer vs Binoculer vision.

Binoculer	Monoculer
Two eyes front of the face.	• Eyes of oppsite sides of the heads.
• Eyes point same way	• Eyes point opposite direction.
• Crate one img	• Create 2 img.
• Has a depth perception	• Lacks of depth perception.
• Comon in human	• Common in birds, fish.

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

* Maintain Correct aspect Ratio, avoids img distortion.

Gray Level

- It represent brightness in an Image.

range depend on bit depth.

1 bit = 2 lvl

8 bit = 256 lvl

16 bit = 65536 (medical use)

More gray Lvl smoother shading in Img.

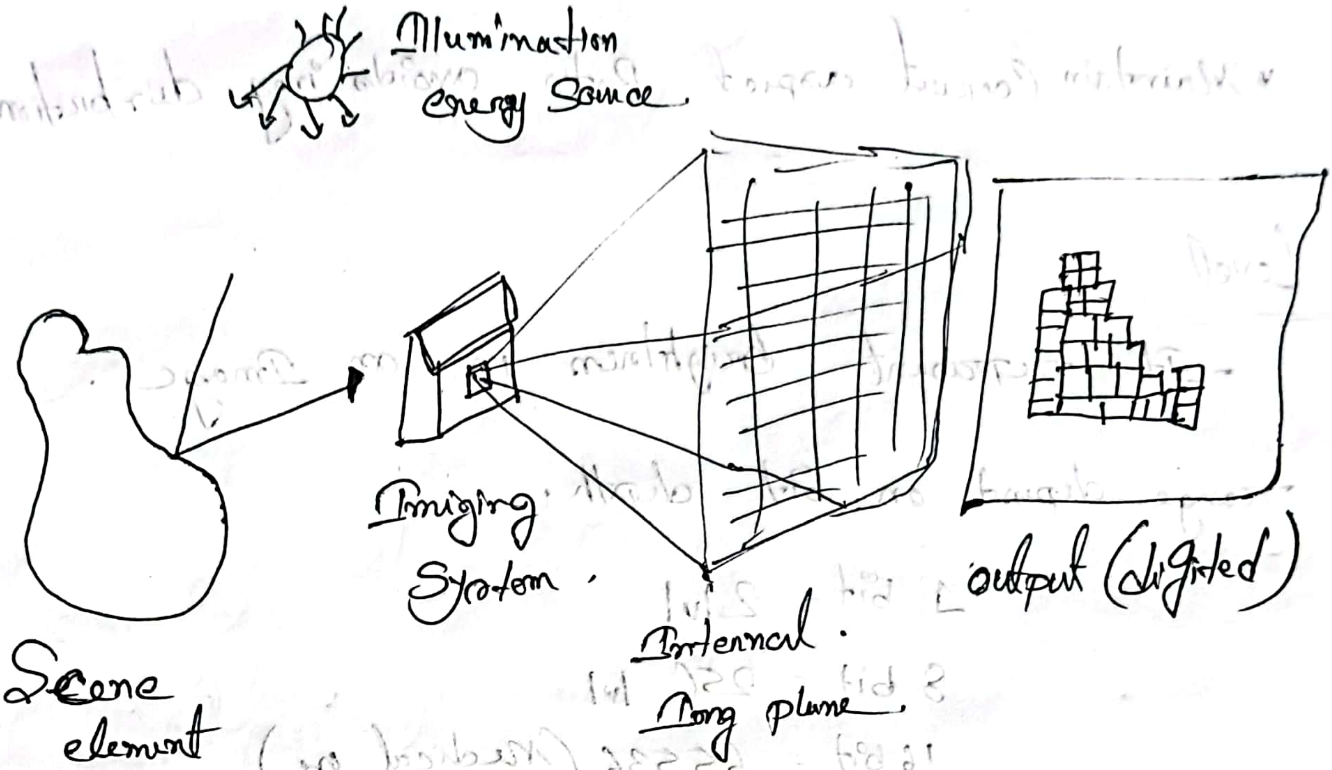
III Convert color to gray.

Gray = 0.2989 * R + 0.5870 × G + 0.1140 × B

human eye sensitive in gre

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

④ Example of digital Image acquisition:



④ find resolution (PPI) of 15" monitor worn 640×480

$\Rightarrow$ Aspect Ratio = $\dfrac{\text{width}}{\text{hieght}} = \dfrac{640^{4}}{480_{3}} = 4:3$

So $(4x)^2 + (3x)^2 = 15^2$

$25x^2 = 225$

$\therefore x = 3$

Length $= 4x = 4 \times 3 = 12$ | resolution $= \dfrac{640}{12}$

$= 53.3$ PPI

PPI = Total pixels ÷ size of inches.

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

diagonal size → monitor 20" or value to

Good eye resolution at 15" = 600 dpi

Q4 calculate resolution 14" × 9" photo.

→ Resolution = width / highth in inch × DPI (in pixel)

$14 \times 600 = 8400$ [15" @ 600 DPI)

$9 \times 600 = 5400$

(#) find ppi 15" monitor working 800 × 600

$$PPI = \frac{\sqrt{800^2 + 600^2}}{15}$$

$\sqrt{width^2 + hieght^2}$

diagonal size

= 66.67 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 other side gamma rays, which have wavelength millions of times Smaller than visible light

How Img Sensors Work

Both CCD & CMOS Sensors detect light using photosensitive elements. They convert light into analog Signals. which turned into digital data. the digital data ~~to~~ Create an Image.

Colon Model

HSI / 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)

Segment 3

Image Enhancement

For processing 2 methods use

Spital Domain processing.

processing image directly is called spatral domain processing.

Image $\xrightarrow{\text{processing fun}}$ Img with modified Pixel values

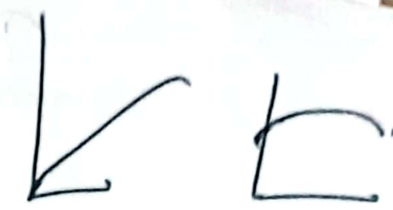
Frequency Domain processing:

Don't change it directly but transfrom.

Img $\xrightarrow{\text{fourier transfrom}}$ F.T of Img $\xrightarrow{\text{Processing function}}$ Modified fourier tranfrom img $\xrightarrow{\text{inverse fourier tranfrom}}$ Img with modifed Pixel

Spatial

Spatial domain methods:



$$g(x,y) = T[f(x,y)]$$

processed img output

operation on f

input (original Img)

Types of operation.

Point: output at a pixel depends only on that pixel's input value.

Local: Output at a pixel depends on nearby pixel values.

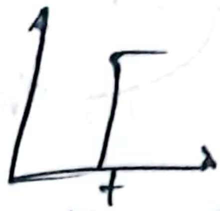
Global: output at a pixels depends on whole img.

Spatial Domain	Frequency processing
works directly on img pixel	works on the frequency (
works by applying function like addition, Subtraction.	use fourier transform to process img
smoothing, sharpening, edge detection	Noise reduction, filtering, Compression.

Threshold

operation to convert an img into two levels.

Single threshold (Global)



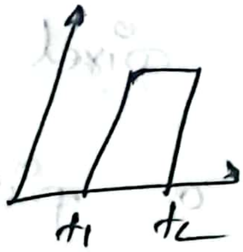
$$T(x,y) = \begin{cases} 255 & \text{if } I(x,y) > T \\ 0 & \text{if } I(x,y) \leq T \end{cases}$$

threshold value

coordinate pixel img

Dual threshold

2 values T_1 t_2

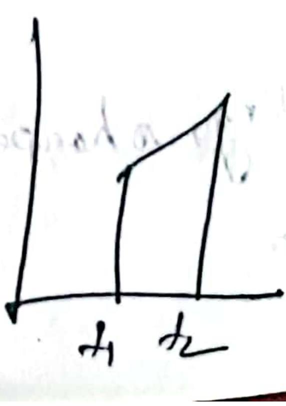


$$I'(x,y) = \begin{cases} 255 & \text{if } I(x,y) > T_2 \\ I(x,y) & \text{if } T_1 \leq I(x,y) \leq T_2 \\ 0 & \text{if } I(x,y) < T_1 \end{cases}$$

Grayscale threshold:

Instead of binary (blk, white), retain grayscale

$$I'(x,y) = \begin{cases} I(x,y) & x,y > T \\ 0 & \text{if } (x,y) \leq T \end{cases}$$



~~Contrast~~

Contrast stretching

- Aim to increase dynamic range of an img
- It transform gray level ~~img~~ in {0,1 ... L-1} by piecewise linear function.
- Its making dark areas darker, light area lighter

Gray level slicing

Highlight a specific range of gray lvl in an img

It extract specific gray lvl (intensity) from an img

works 2 method

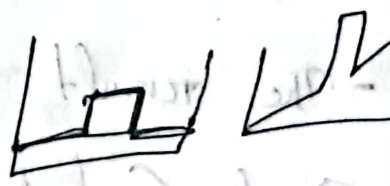
- Highlight a range, keep others unchanged.
- only pixel in a selected range are shown. others are black (set 0).

255 তে (user)

Ex

range (100-150)

$$\begin{bmatrix} 90 & 150 & 20 \\ 40 & 200 & 30 \\ 10 & 2 & 120 \end{bmatrix} \longrightarrow \begin{bmatrix} 0 & 255 & 0 \\ 0 & 255 & 0 \\ & & \end{bmatrix}$$



Temporal processing

processing involve more then one image

if 2 frame — dyadic processing.

addition $g(x,y) = f_1(x,y) + f_2(x,y) \cdot k$

Signal Averaging : $1/n\,(f_1(x,y) + f_2(x,y) + \dots f_n(x,y))$

multipication, OR, And, XOR.

Spital Filtering

also mask, kernel, template

used to proces an image by looking at small parts of it. (neighborhoods)

what it does.

- Takes a small window (3x3, 5x5)
- Applies mathimatical operation on the pixels inside the window.
- The result become the new value of center pixel (output img).

Types of spatial filtering

Linear spatial filtering

Smoothing filter: Reduce noise and blur by averaging pixel values (Gaussian, mean filter)

Linear

Sharpening filters: Enhance edges and fine details by increasing intensity variations. (Laplacian, Sobel)

Linear

Edge Direction: Detect rapid intensity changes to highlight edges & boundaries. (~~pre~~ prewitt, Roberts filter)

Linear

Noise reduction filter: remove noise like Salt and paper noise. (median filter)

Non linear

Osfu thresholding

Convert grayscale image to monochrom

Devide img foreground and background

Math

find optimal threshold ostu method

$$\begin{bmatrix} 0 & 1 & 4 & 0 \\ 0 & 2 & 1 & 2 \\ 2 & 1 & 4 & 4 \\ 0 & 2 & 3 & 1 \end{bmatrix}$$

steps

find fuqumey

(i)	f(i)
0	4 times.
1	4 "
2	4 "
3	1 "
4	3 "

$\sum f(i)\, N = 4 + 4 + 4 + 1 + 3 = 16$

$\therefore N = 16$

S2 probability

$$P(i) = \frac{f(i)}{N}$$

(i)	f(i)	P(i)	
0	4	0.25	$\frac{4}{16}$
1	4	0.25	
2	4	0.25	
3	1	0.0625	$\frac{1}{16}$
4	3	0.1875	3/16

S4 Mean (μ) find.

$$\mu_T = \sum (i) \times P(i)$$

$$= (0 \times 0.25) + (1 \times 0.25) + (2 \times 0.25) + (3 \times 0.0625) + (4 \times 0.1875)$$

$$= 1.6875$$

S5 Threshold (Let T=0)

So Background (ω_1): $P(0) = 0.25$

foreground (ω_2): $1 - \omega_1 = 0.75$

Background mean $\mu_1 = \dfrac{\text{grey lvl (i)} \times \text{No of Pixel P(i)}}{\text{total No of Pixl } \Sigma Pi}$

$$\mu_1 = \frac{0 \times 0.25}{0.25} = 0$$

foreground mean $\mu_2 = \dfrac{1 \times 0.25 + 2 \times 0.25 + 3 \times 0.0625 + 4 \times 0.1875}{0.75}$

বাকী 8 টার
0 বাদে, নিতে

(4টার pi যোগ করে)

$$= 2.25$$

Between cls variance

$$\sigma_B^2 = \omega_1 \omega_2 (\mu_1 - \mu_2)^2$$

$$= 0.25 \times 0.75 (0 - 2.25)^2 = 0.9492.$$

Now $T = 1$

আগেরটা সহ যোগ করে

Background $\omega_1 = P(0) + P_1 = 0.25 + 0.25 = 0.5$

foreground $\omega_2 = 1 - 0.5 = 0.5$

Bacg mean $\mu_1 = \dfrac{0.25 \times 0 + 0.25 \times 1}{0.5} = 0.5$

forg mean $\mu_2 = \dfrac{2 \times 0.25 + 3 \times .0625 + 4 \times 0.1875}{0.5}$

$$= 2.75$$

Between cls variance

$$\sigma^2_B = \omega_1 \omega_2 (\mu_1 - \mu_2)^2$$
$$= (0.5 \cdot 0.5)(0.5 - 2.75)^2 = 1.2656.$$

$T_0 = 2$ then

$$\omega_1 = P_0 + P_1 + P_2 = 0.75$$

$$\omega_2 = 0.25$$

$$\mu_1 = \frac{0 \times 0.25 + 1 \times 0.25 + 2 \times 0.25}{0.75} = 1$$

$$\mu_2 = \frac{3 \times 0.0625 + 4 \times 0.1875}{0.25} = 3.6$$

$$\sigma^2_B = (0.75 \times 0.25)(1 - 3.6)^2 = 1.2656$$

তাহার মান σ^2_B hiegest এইটার optimal threshold

Ans 1.2656.

Low pass filter

Given 4×4 original img 3 bits/pixel.

0	0	0	0	0	0
0	1	3	3	0	0
0	0	6	4	2	0
0	2	6	3	4	0
0	1	3	3	0	0
0	0	0	0	0	0

[used 0 padding]

formula $R = \frac{1}{9} \sum_{i=1}^{9} z_i$ $\Big[\frac{z_i}{9}$ সবগুলা all.

Kernel sliding

9 টা নেও. then 1st. 3 টা ফেলে দাও 9 টা

$$\begin{matrix} 0 & 0 & 0 \\ 0 & 1 & 3 \\ 0 & 0 & 6 \end{matrix} = \frac{0+0+0+0+1+3+6}{9} = \frac{10}{9} \cong 1.$$

2nd pixel

$$\begin{matrix} 0 & 0 & 0 \\ 1 & 3 & 3 \\ 0 & 6 & 4 \end{matrix} = \frac{0+0+0+1+3+3+0+6+4}{9} = \frac{17}{9} \cong 2$$

Same way all.

(iii) $\dfrac{3+3+6+4+2}{9} = 2$

(iv) $\dfrac{3+4+2}{9} = 1$

(v) $3+2+6+6/9 = 1.89$ — 1 ঘ. Clm [illegible]

(vi) $(1+3+3+6+4+2+6+5)/9 = 3.33$

(vii) $3+3+6+4+2+6+5+4/9 = 3.67$

(8) $(3+4+2+5+4)/9 = 2$

(9) $6+2+6+1+3/9 = 2$

(10) $(6+4+2+6+5+1+3+2)/9 = 3.33$

(11) $(6+4+2+6+5+4+3+3)/9 = 3.67$

(12) $(4+2+5+4)/9 = 1.67$

(13) $2+6+1+3/9 = 2.22$

(14) $2+6+5+1+3+3/9 = 2.44$

15\. $6+5+4+3+3/9 = 2.33$

$16 = 5+4+3/9 = 1.33 = 1.33$

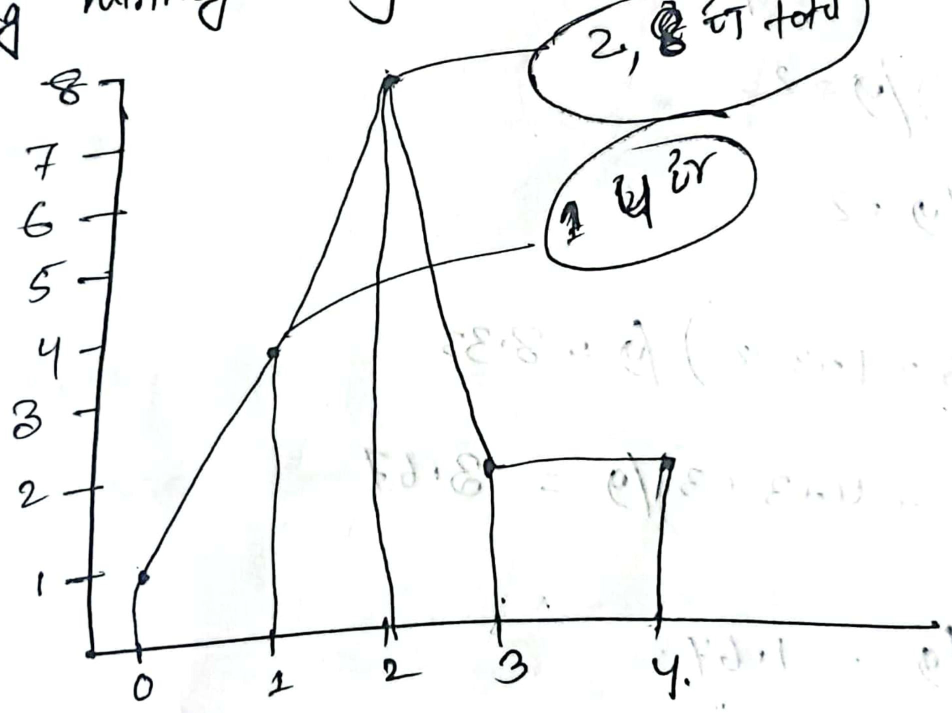
Update img after low pass

1.11	1.89	2	1
1.89	3.3	3.6	2
2	3.3	3.67	1.67
1.3	2.2	2.3	1.3

$\rightarrow$

1	2	2	1
2	3	4	2
2	3	4	2
1	2	2	1

plotting histrogram for low pass filter img



2.22 → 2
2.95 — 3

.5 → upor
.5 → Lower

বাদ দেয়া

$$\begin{bmatrix} 1 & 3 & 3 & 0 \\ 0 & 6 & 4 & 2 \\ 2 & 6 & 5 & 4 \\ 1 & 3 & 3 & 0 \end{bmatrix}$$

⇒ Q1 0 padding

$$\begin{matrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 3 & 3 & 0 & 0 \\ 0 & 0 & 6 & 4 & 2 & 0 \\ 0 & 2 & 6 & 5 & 4 & 0 \\ 0 & 1 & 3 & 3 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{matrix}$$

Q2 kernel shadding (Sort wise [illegible] middle value ko pick) [illegible]

(1) 0 0 0 0 0 0 1 3 6 = 0
median

(2) 0 0 0 0 1 3 3 6 4 = 1
mid

(3) 0 0 0 0 2 3 3 4 6 = 2
M

(4) 0 0 0 0 0 0 2 3 4 = 0

(5) 0 0 0 0 1 2 3 6 6 = 1

(6) 0 1 2 3 3 4 5 6 6 = 3

(7) 0 2 3 3 4 4 5 6 6 = 4

(9) 0 0 0 0 1 2 3 6 6 = 1

(8) 0 0 0 0 2 3 4 5 5 = 2

(10) 0 1 2 3 3 4 5 6 6 = 3

(11) 0 2 3 3 4 4 5 6 6 = 4

(12) 0 0 0 0 2 3 4 4 5 = 2

(13) 0 0 0 0 0 1 2 3 6 = 0

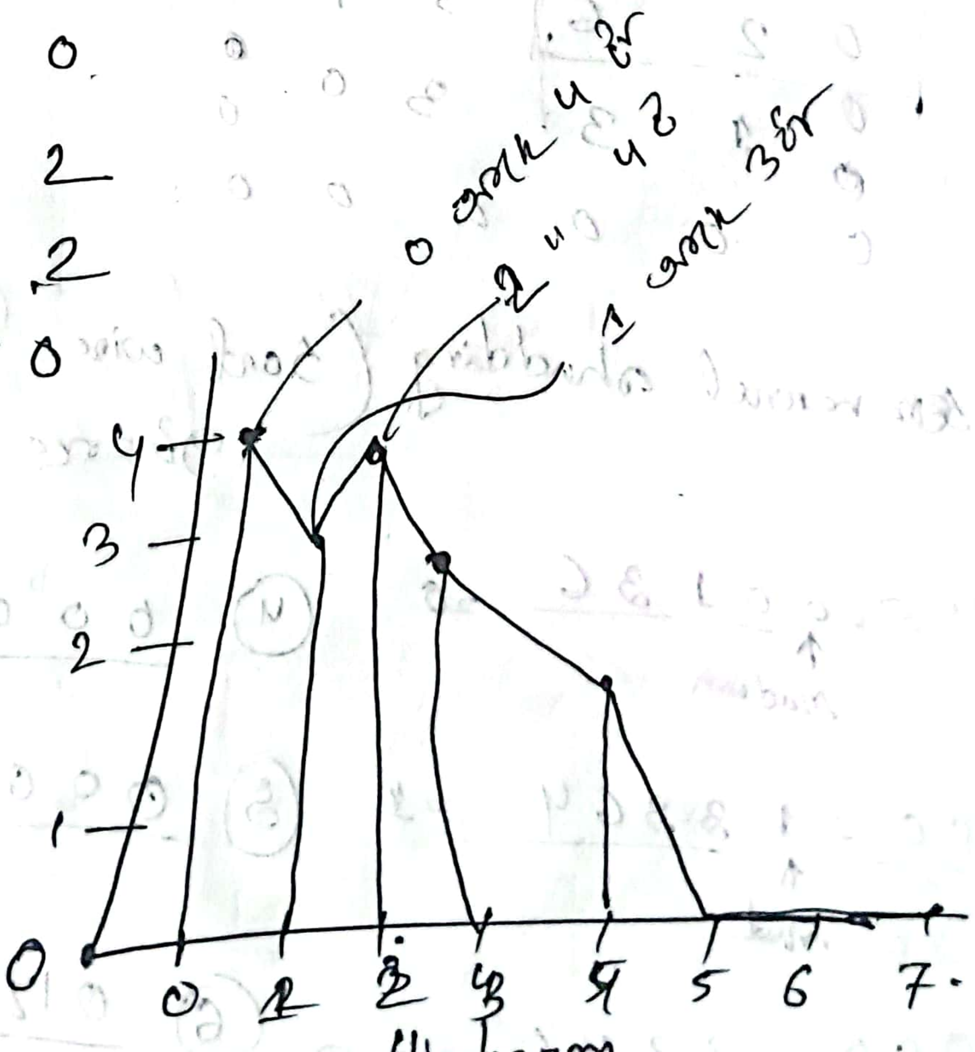
(14) 0 0 0 1 2 3 3 5 6 = 2

(15) 0 0 0 0 3 3 4 5 6 = 3

(16) 0 0 0 0 0 0 3 4 5 = 0

update after median filter

0	1	2	0
1	3	4	2
1	3	4	2
0	2	3	0



Histogram

High pass filter

4×4 original Img given 3 bits/pixel.

* edge & sharp details store

1	3	3	0
0	6	4	2
2	6	5	4
1	3	3	0

Cned
$$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$$
kernel (Laplacian)

Step 1 0 padding

0	0	0	0	0	0
0	1	3	3	0	0
0	0	6	4	2	0
0	2	6	5	4	0
0	1	3	3	3	0
0	0	0	0	0	0

St 2 kernel shadding

1st kernel
$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 1 & 3 \\ 0 & 0 & 6 \end{pmatrix} \times \begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$$

$= 0\times-1 + 0\times-1 + 0\times-1 + 0\times-1 + 1\times8 + 3\times-1 + 0\times-1 + 0\times-1 + 6\times-1$

$= -1.$

2nd Kernel.

$$\begin{matrix} 0 & 0 & 0 \\ 1 & 3 & 3 \\ 0 & 6 & 4 \end{matrix} \times \text{kernel (Laplacian} \quad \begin{matrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{matrix}$$

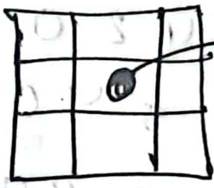
0 কয়ে লাগবেনা যে ultimately 0 হবে.

$= -1 + 24 - 0 - 6 - 4 = 10$

3nd

$$\begin{matrix} 0 & 0 & 0 \\ 3 & 3 & 0 \\ 6 & 4 & 2 \end{matrix} = -3 + 24 - 6 - 4 - 2$$

$= 9$

[Ninja teecnique  এইটার গুণ করে বাকী সব গুলো (−) আগে 0 হোক So middle × 8 করে সব(−) করলে শেষ.

update After high filter

$$\begin{bmatrix} -1 & 10 & 9 & -8 \\ 5 & 18 & 9 & -6 \\ 4 & 11 & 3 & -8 \\ -1 & 5 & 0 & -9 \end{bmatrix}$$

neg value আসলে normalize করতে হবে [0 - 255) পর্যন্ত

Normalization process :

$$\text{New value} = \frac{\text{Pixel} - \text{Min}}{\text{Max} - \text{min}} \times 255 \qquad \left[\begin{array}{l} \text{Max} = 18 \\ \text{Min} = -9 \end{array} \right)$$

এর value গুলো

বসা লাগবে

$$(-1) \text{ pixel} = \frac{-1 - -9}{18 - -9} \times 255 \cong 76$$

$$(10) \quad '' \quad = \frac{10 - -9}{18 - -9} \times 255 \cong 179$$

$$(-6) \quad '' \quad = \frac{-6 - -9}{18 - -9} \times 255 \cong 170.$$

Same way সে সব বের করলাম

$$\begin{bmatrix} 76 & 179 & 170 & 28 \\ 132 & 255 & 170 & 28 \\ 123 & 188 & 113 & 38 \\ 76 & 132 & 85 & 0 \end{bmatrix}$$

Histogram

$$N(g) = \max\left\{0,\ \text{round}\left(\frac{2^{l} \cdot c(g)}{n}\right) - 1\right\}$$

no of gray lvl.

(*) Histogram is a graphical representation that shows how the intensity values (gray lvl) are distributed on image.

Histogram plots x → intensity (0-255)

y → No of pixel (each intensity lvl)

if img dark → Histogram higher values on left side (0-50)

if " brigh → histogram will peak Right side (200-255).

Histogram Equalization is a process spreads out the pixel intensities to improve the contrast of an img, mainly for dark img.

Math

5x5 pixel img

15	12	8	9	14
12	12	12	14	11
13	13	10	9	10
15	12	10	12	11
13	14	13	13	14

(c) Apply histogram equalization by rounding resulting img pixel to integer.

⇒ here max value 15

$2^n = 2^4 = 16 > 15$

L = total no of pixel = 16

interval (0-15) so $2^L = 15$ [no of gray level]

Histogram equalization

$$N(g) = \max\left\{0, \text{round}\left(\frac{2^L \times C(g)}{n}\right) - 1\right\}$$

$n = \Sigma f = 25$ [ইত আগের total chart find করে]

new gray level

grey level g	frequency f	Cumulative pixel count C [illegible] type	$N(g)$	New frequency
0	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	1 বার	1	0	1
9	2 বার	3	1	2
10	3 বার	6	3	3
11	2	8	4	2
12	6	14	7	6
13	5	19	10	5
14	4	23	13	4
15	2	25	14	2

frequency copy করে বসাও

$\sum f = 25$

M total no of pixel.

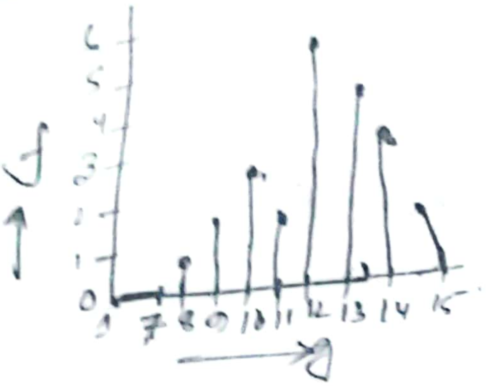
Sample

$$\boxed{\frac{15 \times 1}{25} - 1 \quad (0.6 - 0.4)}$$

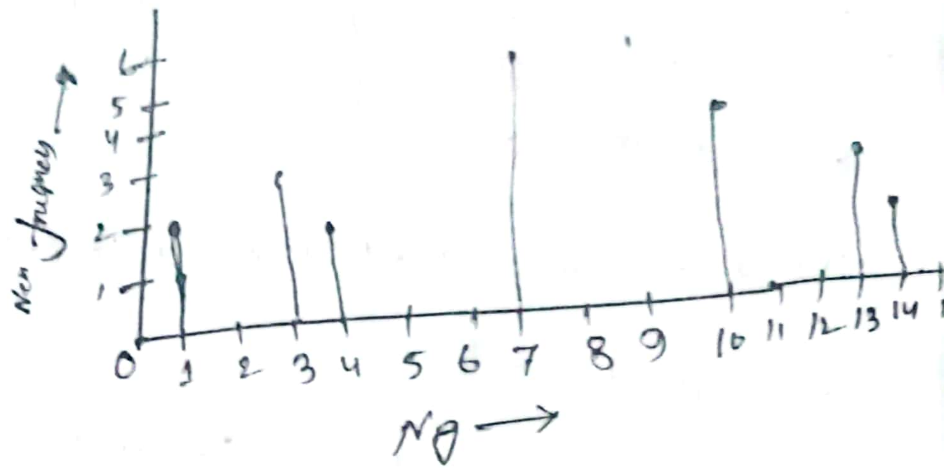
max 0. round figure

(ii) Sketch the histogram original & Equalized img.

original img



After equalization



Prewitt & Sobel operator

use original img 3bits/pixel.

1	3	4	0
0	7	4	2
2	6	7	4
1	2	8	1

10	9	9	4	0
0	6	6	2	2
5	9	8	4	3
7	5	5	4	3
8	1	8	5	0

(i) perform prewitt & SOBEL operator. on the img (use padd

⇒ prewitte edge detection kernel x, y

x direction		
-1	0	1
-1	0	1
-1	0	1

y direction		
1	1	1
0	0	0
-1	-1	-1

with x direction

$$\begin{matrix} 10 & 9 & 9 & 4 & 0 \\ 0 & 6 & 6 & 2 & 2 \\ 5 & 9 & 8 & 4 & 3 \\ 7 & 5 & 5 & 4 & 3 \\ 8 & 10 & 8 & 5 & 0 \end{matrix} \times \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

$= 10\times -1 + 9\times 0 + 9\times 1 + 0\times -1 + 6\times 0 + 6\times 1 + 5\times -1$

$9\times 0 + 8\times 1 = 8$

Same [illegible] kernel [illegible]

[illegible] kernel

$$\begin{bmatrix} 8 & -14 & -18 \\ 7 & -10 & -11 \\ 1 & -11 & -15 \end{bmatrix} = I_x$$

with y direction. Same way [illegible] kernel [illegible]

$$\begin{bmatrix} 6 & 1 & -2 \\ -5 & 0 & -2 \\ -4 & -2 & 2 \end{bmatrix} = I_y$$

magnitude = Lx . Ly =

10	14	18
9	10	11
4	11	15

$\sqrt{Lx^2 + Ly^2}$
$= 8^2 + 6^2 = \sqrt{100}$
$= 10$

Lx, Ly আগের ans এ আছে

$\boxed{\text{round figure korbo}}$

threshold $= (10+14+18+9+10+11+4+11+15)/9$
$= 11$ (threshold value).

$x > 11 = 1$ হবে
$x \leq 11 = 0$ হবে

0	1	1
0	0	0
0	0	1

— x —

Sobel Edge detection

Same way kernel ব্যবহার

$$\begin{matrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{matrix}$$ x direction

$$\begin{matrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{matrix}$$ y direction

Same process
pura prewitt
step.

$$\left[\begin{matrix} x > \text{threshold} = 1 \\ x \leq \text{threshold} = 0 \end{matrix}\right]$$