08/01/2024
Monday

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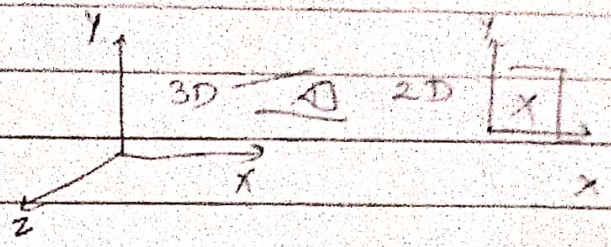
Subject Code - CS233

Digital Image Processing (DIP)

Analog Digital

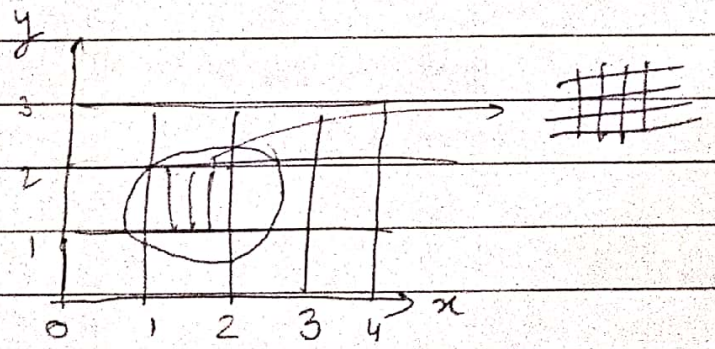


After Process Analog Image become Digital

0011010

Visualize Portion → Analog

For Processing, Analog → Digital & then process..



$f(x, y)$

□ pixel

8 bits (major) 99.99% 16 bits 32 bits

$2^k = 256$

(0-255) → CSS

Camera

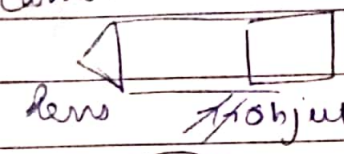
		I/P	O/P
Processing	Low level Processing	Image	Image
	Mid level Processing	Image	Info
	High level Processing (Please unlock thumb)	Image	Scene
Knowledgable Image		Knowledge	

→ Google lens

Scanned with CamScanner

1. Image Acquisition
2. Image storing
3. Image processing
4. Display
5. Transmission

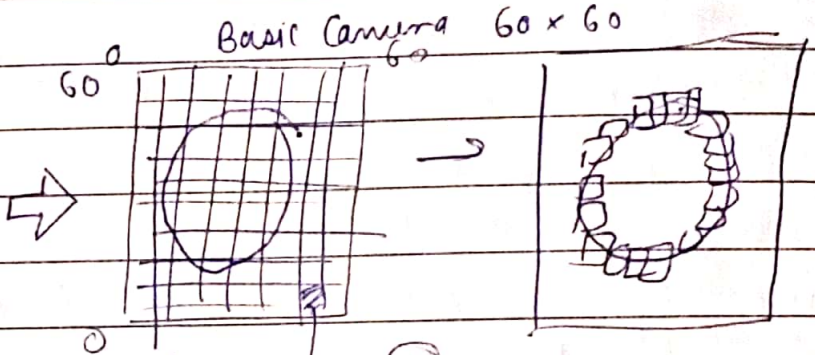
Camera



light on obj.

1

Basic Camera 60 × 60



Digital Image is stored

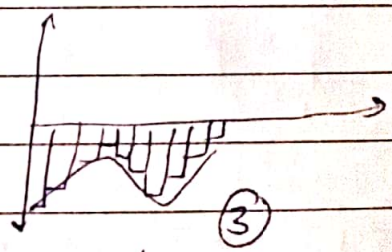
2

Grey Scale

K = 8 255 pixel.

0 - 255

Sampling & Quantization



3

Digital photo को digitalized करती (Removable display)

A × B × C × D

A → Height, B → Width, C → intensity of pixel, D → No. of images

(Display driver)
Digitizer cannot convert digital image

VGA
SD 720
HD 1080
4K 2048
8K 4096
12K

By charu pillowing & Crying

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Types of Images:

① Binary Image :- 0/1 → 0 White, 1 Black
Monochrome image, bitimage

② Gray Scale Image :- (8 bit image) = 1 byte
$2^k \rightarrow 8$
0 - 255
B, LB, DG, G, LG, DW

③ Colour :- (24 bit image) = 3 bytes
RBG {0 - $2^8 - 1$ each intensity}
8 + 8 + 8 = 24 bits

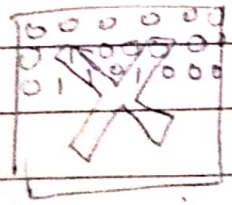
④ Half Toned Image
Each dot has its own intensity
1 Pixel / several dots.

Different file image format :-

① jpg (or jpeg) - Joint Photographic Experts Group ✓
② png - Portable Network Graphics — internet, bg removal
③ GIF - Graphical Interchange format ✓
* ④ TIFF - Tagged Image File — tag position of image, Lossless compression
* ⑤ PDF - Portable Document Format
* ⑥ EPS - Encapsulated Post script — vector format for high design
⑦ RAW - Raw Image Format-
vector
Raster / pixels

jpg - joint pitture group

⑧ bmp - Bitmap — Zero (0) / One (1)
Empty / Dark / Color



proper arrays of 0 & 1

while (t-3) while (true)
gif { } } Boomerang
1 to 9 & 9 to 1

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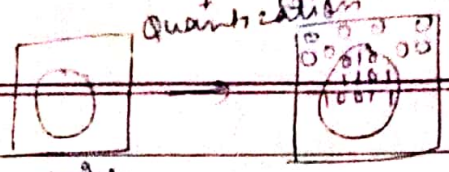
15.01.2024
Monday

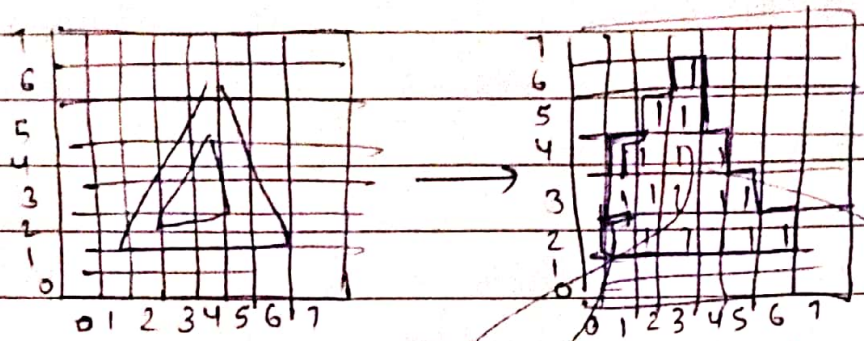
Sampling + Quantization

Sampling -

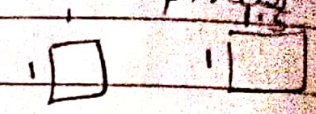


~~Analog~~ Analog Digital

Stretching of image
↓
Change of pixels



Analog Digital



5 or 6 or 9 → Black

Each value has intensity (Greyscale level) 0 - 255

V big resolution → 255

250 or 245

$2^8 = 2^k$ Black to white

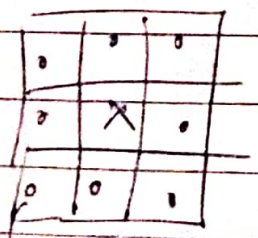
Digital → digitizer → Analog ∆ Quantization

Freehand ~~at~~ Digital (Discrete) Image draw ~~ka~~ → Show it in analog.

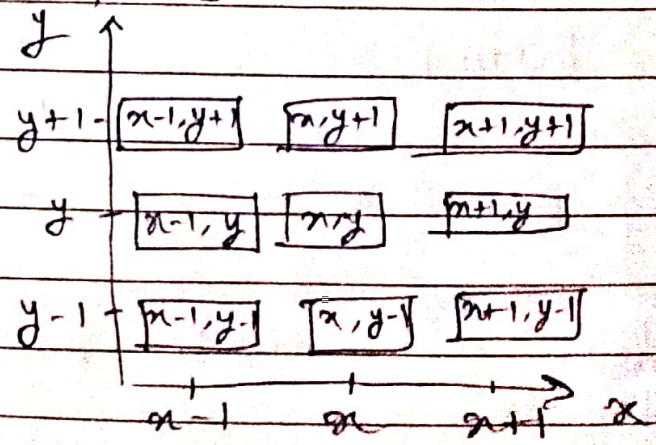
X → Single Image → Different filters

Camera or Sensor

Relationship ~~with~~ b/w pixels.



Neighbouring Pixels



Scanned with CamScanner

③ दोनों path जरूरी not exists.

① & ② use formula even if path Full white or black image में Euclidean दोनों

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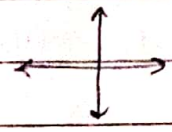
Relationship betn pixels.

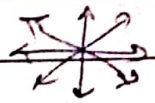
① $N_4(P)$: (V+H)



(x,y)

② $N_D(P)$: (Diagonal)

③ $N_{mixed}(P)$: $N_m(P)$:



or $N_8(P)$

$$\frac{N_m(P)}{8} = \frac{N_4(P)}{4} + \frac{N_D(P)}{4}$$

$\therefore N_8(P)$

Adjacency of pixels :-

① Adjacency ($N_4(P)$) $= |x-s| + |y-t|$

↳ Pixel

↳ Relationship

(Dest.) (s,t) $(0,0)$

1	3	2
1	2	3
3	2	1 (x,y) (Src) $(2,2)$

$V = \{1,2\}$

↳ you can take only these

$Adj(N_4(P)) = |2-0| + |2-0|$

$Adj(N_4(P)) = 4$

② Adjacency ($N_c(P)$)

Chess adjacency =

$= \min(|x-s|, |y-t|)$

↳ consider it as rounded

$= \min(|4-0|, |4-0|)$

$= 4$

(0,0)

1	2	3	1	2
2	1	2	2	1
2	1	1	3	2
2	3	3	1	1
1	3	2	3	1

$\min(1, 1) = 1$

③ $N_{DM}(P)$ Adjacency

If possible $N_4(P)$ then do that If not do $N_D(P)$

(x,y)

1	2	1
1	3	2
3	2	1 (s,t)

4

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16.01.2024
Tuesday

Q) $P(0,0)$

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

$q(4,4)$

$V = \{2, 3\}$

Sol: ① $N_4(P) = 8$
② $N_D(P) = 4$

③ $N_m(P)$:
src = (0,0) = 2
dest = (4,4) = 6 not in V
No Path

④ $V = \{2, 6\}$ $N_m(P) =$ No Path

Q) src (0,0)

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

(3,3)

$V = \{1, 2\}$ dest

Sol: ① $N_4(P) = |3-0| + |3-0| = 6$
② $N_D(P) = \min(|3-0|, |3-0|) = 3$
③ $N_m(P) = 6$

Operations b/w pixels:- (points)

① Arithmetic $+, *, -, /$

$0 - 255$ $2^k = 2^8 = 256$

① Roundoff $10.6 = 11$ → $10.5 = 10$
② val > 255 then 255
③ val < 0 then 0
④ val = ∞ then 0

$$\underset{A}{\begin{bmatrix} 50 & 10 & 15 \\ 6 & 9 & 7 \\ 8 & 12 & 13 \end{bmatrix}} + \underset{B}{\begin{bmatrix} 10 & 5 & 15 \\ 7 & 8 & 9 \\ 12 & 13 & 12 \end{bmatrix}} = \begin{bmatrix} 60 & 15 & 30 \\ 13 & 17 & 16 \\ 20 & 25 & 25 \end{bmatrix}$$

$$A - B = \begin{bmatrix} 40 & 5 & 0 \\ \cancel{-1} \to 0 & 1 & \cancel{-1} \to 0 \\ 0^* & 0^* & 1 \end{bmatrix}$$

$$A * B = \begin{bmatrix} \overset{255}{\cancel{500}} & 50 & 225 \\ 42 & 72 & 63 \\ 96 & 156 & 156 \end{bmatrix}$$

→ use for removing ~~noise from the~~ picture

$$A / B = \begin{bmatrix} 5 & 2 & 1 \\ 2 & 1 & * \\ * & * & 1 \end{bmatrix}$$

layer of colour (color shade) changes on org.

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17.01.2024
W2 Lec 2 Day.

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② Logical Operators

AND ~~OR~~ OR NOT

X	Y	And	Or	~~Not~~	A	Not A
0	0	0	0		0	1
0	1	0	1		1	0
1	0	0	1			
1	1	1	1			

Brightness & Contrast improvement is performed using ~~AND and OR~~ operation

$$\underset{A}{\begin{bmatrix} 0 & 1 & 0 \\ 1 & 1 & 1 \\ 1 & 0 & 0 \end{bmatrix}} \text{ AND } \underset{B}{\begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 1 & 0 \end{bmatrix}} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{bmatrix}$$

$$A \text{ OR } B = \begin{bmatrix} 0 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 0 \end{bmatrix}$$

$$\text{NOT } A = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 0 & 0 \\ 0 & 1 & 1 \end{bmatrix}$$

① Negative / (-ve)

$$\underset{\substack{R \text{ or } r \\ \text{Real Image} \\ \text{I/P image}}}{\begin{bmatrix} 6 & 5 & 3 \\ 2 & 7 & 1 \\ 3 & 4 & 0 \end{bmatrix}} \xrightarrow[\text{operation}]{T} \underset{\substack{S \\ \text{o/p image}}}{\begin{bmatrix} 1 & 2 & 4 \\ 5 & 0 & 6 \\ 4 & 3 & 7 \end{bmatrix}}$$

1M

$S = T(r)$

$S = (L-1) - r$

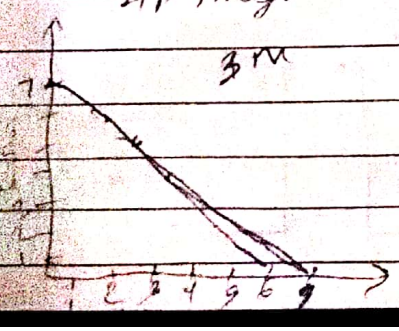
highest bit of image

7 से बड़ी 2 का power

$8 = 2^3$ ∴ $L = 8$

3 bits to store intensity of pixels.

3M



2M

$S = (8-1) - r$

$\Rightarrow S = 7 - r$

$r = 0 \Rightarrow S = 7$

$r = 1 \Rightarrow S = 6$

⋮

$r = 7 \Rightarrow S = 0$

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Q) Find img threshold for T = 4, 5, 6
Three imgs & compare it

Assignment

Q)
$$\begin{bmatrix} 4 & 16 & 17 & 22 \\ 25 & 11 & 10 & 9 \\ 0 & 31 & 23 & 8 \\ 7 & 6 & 5 & 4 \end{bmatrix} \; r$$

$31 < 2^5 (= 32)$

$S = (L-1) - r$

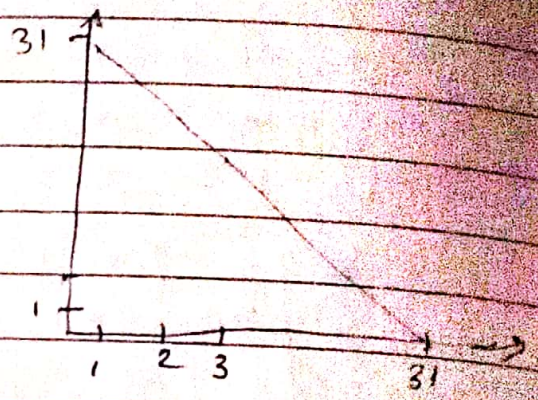
$= (32-1) - r$

$S = 31 - r$

$\downarrow T$

$$\begin{bmatrix} 27 & 15 & 14 & 9 \\ 6 & 20 & 21 & 22 \\ 31 & 0 & 8 & 23 \\ 24 & 25 & 26 & 27 \end{bmatrix} \; S$$

r	S
0	
1	
2	
⋮	
31	



(2)

Q) Image Threshold with T = 4

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

Negative Image.

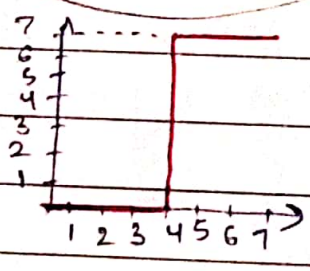
$$S = \begin{cases} r >= 4 \Rightarrow S = 7 \\ r < 4 \Rightarrow S = 0 \end{cases}$$

$\downarrow T$

$$S = \begin{cases} 7, & r \geq 4 \\ 0, & r < 4 \end{cases}$$

$$\begin{bmatrix} 7 & 7 & 0 \\ 0 & 0 & 7 \\ 0 & 7 & 0 \end{bmatrix}$$

Graph



r	S
0, 1, 2, 3	0
4, 5, 6, 7	7

(3)

Q) Image Clipping with $r_1 = 2$ & $r_2 = 5$
↳ Screenshot of image

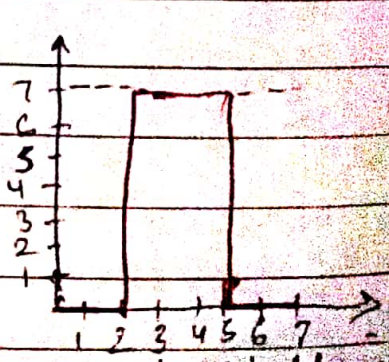
$$S = \begin{cases} 2 <= r <= 5 \Rightarrow S = 7 \\ \text{otherwise} \Rightarrow S = 0 \end{cases}$$

$r = \{2, 3, 4, 5\}$ $S = 7$

$r = \{0, 1, 6, 7\}$ $S = 0$

$$\begin{bmatrix} 6 & 5 & 1 \\ 2 & 2 & 4 \\ 3 & 5 & 3 \end{bmatrix} \xrightarrow{T} \begin{bmatrix} 0 & 7 & 0 \\ 7 & 7 & 7 \\ 7 & 7 & 7 \end{bmatrix}$$

Finding coordinates, when clipping is done, then do other operation to get clipped image



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25 Jan 2024 Thursday

(4) BIT Plane Slicing

0	000
1	001
2	010
3	011
4	100
5	101
6	110
7	111

BIT → MSB, Current bit, LSB

$$\underset{(r)}{\begin{bmatrix} 6 & 5 & 1 \\ 2 & 2 & 4 \\ 3 & 5 & 3 \end{bmatrix}} \xrightarrow{T} \underset{(s)}{\begin{bmatrix} 110 & 101 & 001 \\ 010 & 010 & 100 \\ 011 & 101 & 011 \end{bmatrix}}$$

[$n=3$ ines for max 6 $L=8$. → 3 bit binary in S]

Q) How to perform operation on image.

$$S = \begin{cases} 3 <= r <= 5 & \text{Change intensity of OR } n \text{ of in this region.} \\ \cancel{0 <=} \; r<03 \;\&\; r>5 & r \; \cancel{\text{AND } n} \end{cases}$$

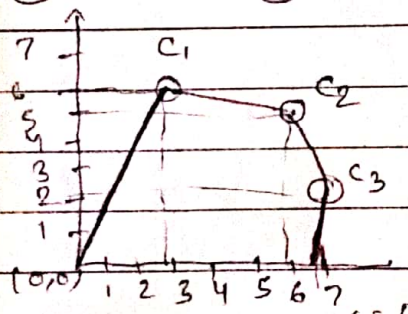
(5)

#CONTRAST STRETCHING with

$r_1 = 3$, $s_1 = 6$ $\quad r_2 = 6$, $s_2 = 5$ $\quad r_3 = 7$, $s_3 = 2$

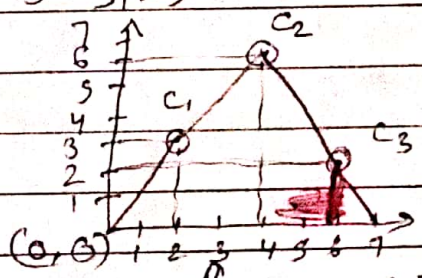
$$\underset{(r)}{\begin{bmatrix} 4 & 6 \\ 7 & 3 \end{bmatrix}} \xrightarrow{T} \underset{(s)}{\begin{bmatrix} 4 & 5 \\ 2 & 6 \end{bmatrix}}$$

(r,s) present in question then change that else leave the same bit of r in S



$r=0, s=0$

Q) $r_1 = 2$, $s_1 = 3$ $\quad r_2 = 4$, $s_2 = 6$ $\quad r_3 = 6$, $s_3 = 2$



Q) $\begin{bmatrix} 1 & 3 & 7 & 6 \\ 2 & 4 & 6 & 6 \\ 1 & 5 & 7 & 3 \\ 3 & 4 & 4 & 5 \end{bmatrix}$

$r_1 = 3$, $s_1 = 2$ $\quad r_3 = 7$, $s_3 = 7$

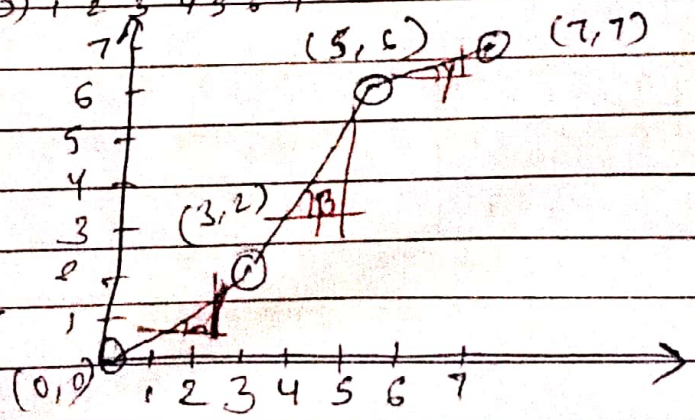
$r_2 = 5$, $s_2 = 6$

~~S = 7~~

Slope $\alpha = 2/3$

$\beta = \frac{6-2}{5-3} = \frac{4}{2} = 2$

$\gamma = \frac{7-6}{7-5} = \frac{1}{2}$ } Slope



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upper pt in graph

$$S \begin{cases} R<3 & r * \alpha \\ R>=3 \text{ and } R<=5 & ((r-r_1)\beta + s_1) \\ R>5 & (r-r_2)\gamma + s_2) \end{cases}$$

$\alpha = 0.66 \rightarrow$ (I)

$\beta = 2 \rightarrow$ (II)

$\gamma = 1/2 \rightarrow$ (III)

$\beta = \frac{r_2 - r}{s_2 - s}$

r			S
0	$0.66 \times 0 = 0.66$	(I)	0
1	0.66		1
2	1.32		1
3	$(3-3) \times 2 + 2 = 6$	(II)	6
4	$(4-3) \times 2 + 2 = 4$		4
5	$(5-5) \times 2 + 2 = 2$		2
6	$(7-6) * 1/2 + 6 = 6.5$	(III)	7
7	$(7-7) * \frac{1}{2} + 6 = 6$		6

$$S = \begin{cases} r<3 & (r-0) * \alpha = r\alpha \\ r>=3 \ \& \ r<=5 & ((r-r_1)\beta + s_1) \\ r>5 & ((r-r_2)\gamma + s_2) \end{cases}$$

$\alpha = 0.66$

$\beta = 2 \quad (r-3) * 2 + 2$

$\gamma = 1/2 \quad (r-5) * 1/2 + 6$

$(r-3)$

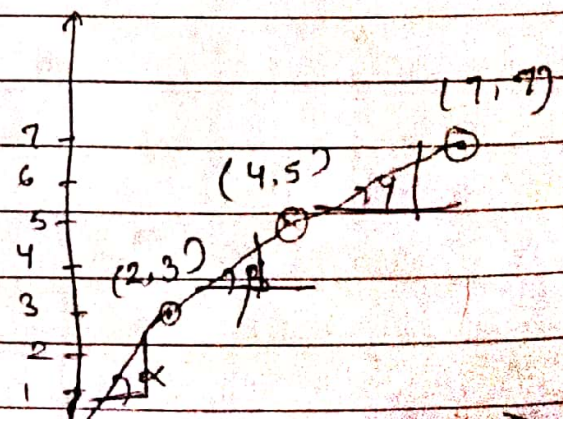
$3, 2$
$r_1 \ s_1$

r			S (round off)
0	0.66×0	0	0
1	0.66×1	0.66	1
2	0.66×2	1.32	1
3	$0 + 2$	2	2
4		4	4
5		6	6
6		6	6
7		6.5	7

8) $\begin{bmatrix} 7 & 6 & 5 \\ 2 & 0 & 1 \\ 3 & 5 & 4 \end{bmatrix}$

$r_1 = 2 \quad s_1 = 3$

$r_2 = 4 \quad s_2 = 5$



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04.01.2024 Wednesday

$\alpha = 3/2$ $\quad \cancel{\beta =}$

$$S \begin{cases} r < 2 \\ r >= 2 \;\&\; r <= 4 \\ r > 4 \end{cases}$$

$\alpha = 3/2$

$\beta = (5-3)/(4-2) = 1$

$\gamma = (7-5)/(7-4) = 2/3$

$(r-0)\alpha + 0 = r\alpha = \frac{3}{2}r$

$(r-2)1 + 3 = r+1$

$(r-4)\frac{2}{3} + 5 = r + \frac{7}{3}$

r		S
0	0	0
1	1.5	2
2	3	3
3	4	4
4	5	5
5	22/3 = 7.33	7
6	25/3 = 8.33	8
7	28/3 = 9.33	9

(6)

INTENSITY LEVEL SLICING WITH BACKGROUND AND WITHOUT BACKGROUND

$r_1 = 2 \qquad r_2 = 5$

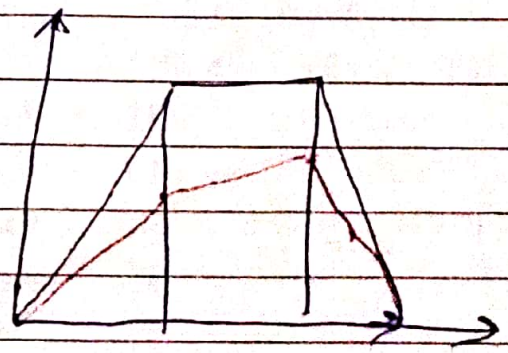
clipping

$$\begin{bmatrix} 7 & 6 & 5 \\ 4 & 3 & 2 \\ 1 & 2 & 0 \end{bmatrix} \longrightarrow S = \begin{cases} r >= 2 \;\&\; r <= 5 & S = 7 \\ \{2, 3, 4, 5\} & \\ \text{otherwise } \{0, 1, 6, 7\} & S = r \end{cases}$$

change.

$$\begin{bmatrix} 7 & 6 & 7 \\ 7 & 7 & 7 \\ 1 & 7 & 0 \end{bmatrix}$$

↳ without



If $r_1 = 2$
$S_1 = 4$
$r_2 = 5$
$S_2 = 5$

Scanned with CamScanner

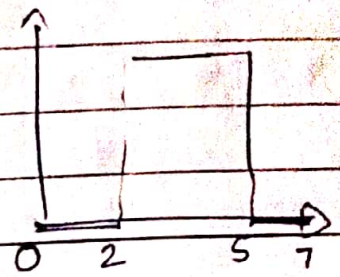
Q)

$$A = \begin{bmatrix} 1 & 3 & 7 \\ 4 & 5 & 6 \\ 2 & 3 & 4 \end{bmatrix}$$

Without BG → Clipping

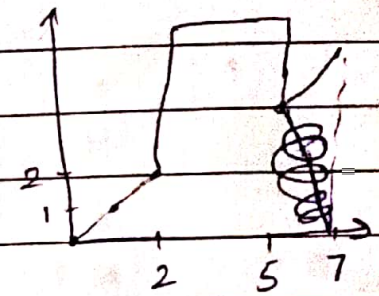
$r_1 = 2$, $r_2 = 5$

$$S \begin{cases} r >= 2,\ r <= 5 \Rightarrow S = 7 \\ \text{Otherwise} \quad S = 0 \end{cases}$$



With BG

$$S \begin{cases} r >= 2,\ r <= 5 \quad S = 7 \\ \text{Otherwise} \quad S = r \end{cases}$$



$$S(A) \text{ without BG} = \begin{bmatrix} 0 & 7 & 0 \\ 7 & 7 & 0 \\ 7 & 7 & 7 \end{bmatrix} \qquad S(A) \text{ with BG} = \begin{bmatrix} 1 & 7 & 7 \\ 7 & 7 & 6 \\ 7 & 7 & 7 \end{bmatrix}$$

7 *

~~LOG TR~~ LOG TRANSFORMATION :-

$$\boxed{S = C + (\log_{10}(r+1))}$$

1. Number constant value (+ve, -ve)
2. log constant value $\dfrac{L}{\log_{10}(L+1)}$

Q) $r = \begin{bmatrix} 100 & 98 & 97 \\ 95 & 94 & 95 \\ 96 & 97 & 100 \end{bmatrix}$ given $C = 1$ (can be any)

Sol: 1 $L = 2^7 = 128 > 100 \rightarrow$ Number constant value

r	S
100	$1 \times \log_{10}(100+1) = 2.004 = 2$
98	$\log_{10}(99) = 1.9956 = 2$
97	$\log_{10}(98) = 1.991 = 2$
95	$\log_{10}(96) = 1.98 = 2$
96	$\log_{10}(97) = 1.986 = 2$

$$S = \begin{bmatrix} 2 & 2 & 2 \\ 2 & 2 & 2 \\ 2 & 2 & 2 \end{bmatrix}$$

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Log constant value

② $\frac{L}{\log_{10}(L+1)} = \frac{128}{\log_{10}(129)} = 60.64 \approx 60.5$ Take 60.64 only

$C = 60.5$

r	s	
100	$C \times \log_{10}(r+1)$	121 → 121
98	120.7	→ 120
97	120.45	→ 120
95	119.7	→ 120
96	120.19	→ 120

$$S = \begin{bmatrix} 121 & 121 & 120 \\ 120 & 120 & 120 \\ 120 & 120 & 121 \end{bmatrix}$$

③

POWER LOW TRANSFORMATION

(not so imp)

$$\boxed{S = r \times C^{\gamma}}$$

$\gamma \to \frac{1}{4}, \frac{9}{20}$

Q) $r = \begin{bmatrix} 1 & 3 & 5 \\ 9 & 7 & 15 \\ 14 & 12 & 6 \end{bmatrix}$ $C = 1.2$, $\gamma = 1.5$

Sol: $C^{\gamma} = 1.3145$

$$\begin{bmatrix} 2.3145 & 4.3145 & 6.3145 \\ 10.3145 & 8.3145 & 16.3145 \\ 15.3145 & 13.3145 & 7.3145 \end{bmatrix} = \begin{bmatrix} 2 & 4 & 6 \\ 10 & 8 & 16 \\ 15 & 13 & 7 \end{bmatrix}$$

$$\begin{bmatrix} 1.3145 & 3.9435 & 6.5725 \\ 11.8305 & 9.201 & 19.8715 \\ 18.403 & 15.774 & 7.887 \end{bmatrix} = \begin{bmatrix} 1 & 4 & 7 \\ 12 & 9 & \cancel{19}\ 20 \\ 18 & 16 & 8 \end{bmatrix}$$

~~IMAGE ENLARGEMENT ENHA.~~

$r \to s$

IMAGE ENHANCEMENT

① Spatial

② Frequency

③ Comb^n ① + ②

$r \to$ opr $\to s$

$r \to$ modify $\to$ opr (operation) $\to s$ +

← Ans

① Spatial

Ⓘ

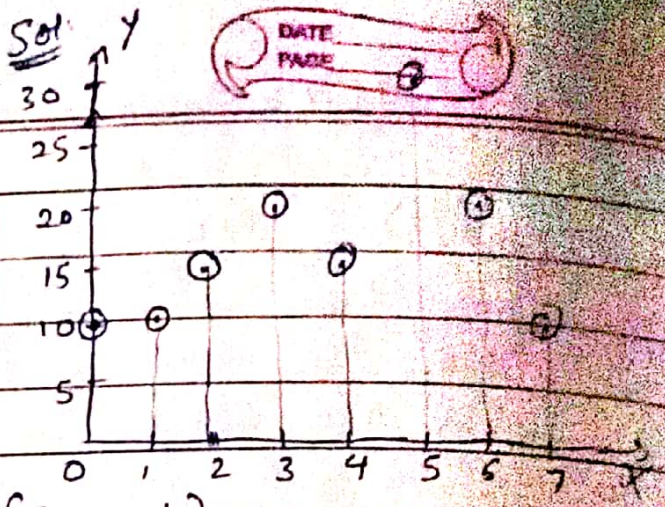
29.01.20 Monday
TAV

Sol

(I) Histogram

Q

Gray level	0	1	2	3	4	5	6	7
No. of pixels	10	10	15	20	15	30	20	10



Say if sum of No. of pixels = 16

Image can be 4×4, 2×8,

(Type-1)

Q) Draw the sol^n for image enhancement in below table
{ कुछ नहीं दिया हो तो जो आता है वो use कर लो }

Grayscale	0	1	2	3	4	5	6	7
No. of pixels (freq)	9	8	11	4	10	15	4	3

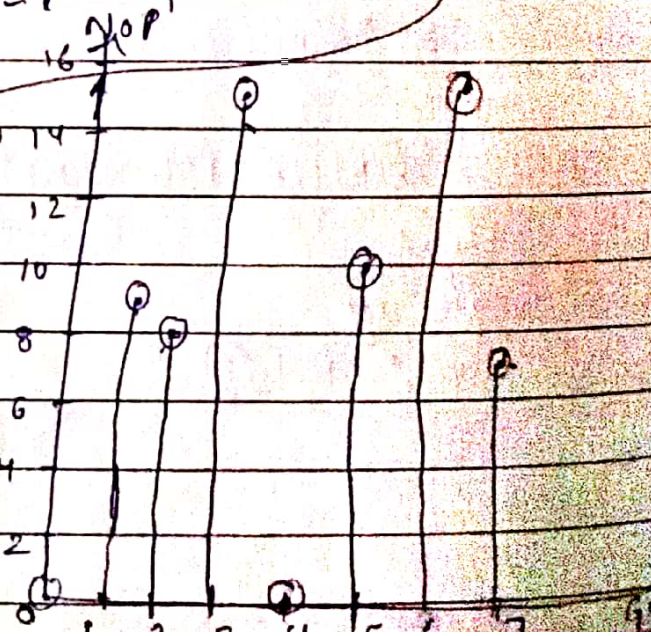
Sq. Grayscale (rk)	No. of pixel (freq.) (nk)	(nk)/Σnk	(Sk)	Sk*7 (No. of pixels)	Nearly value
0	9	0.1406	0.1406	0.9842	1
1	8	0.125	0.2656	1.8592	2
2	11	0.1718	0.4374	3.0618	3
3	4	0.0625	0.4999	3.4993	3
4	10	0.1562	0.6561	4.5927	5
5	15	~~0.7968~~ 0.2343	0.8904	6.2328	6
6	4	0.0625	0.9529	6.6703	7
7	3	0.0468	0.9997 ≈ 1	7	7

Σnk = 64 {Probability}

1 - corresponding sum of zero (0)

(11+4) (4+3)

GS	0	1	2	3	4	5	6	7
No. of pixels	0	9	8	15	0	10	15	7



pdf = (nk)/Σnk probability distribution factor

(Sk) = cdf = cumulative distribution factor

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Q)

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

Digital Image

Sol: Chart

No. of 1's in matrix

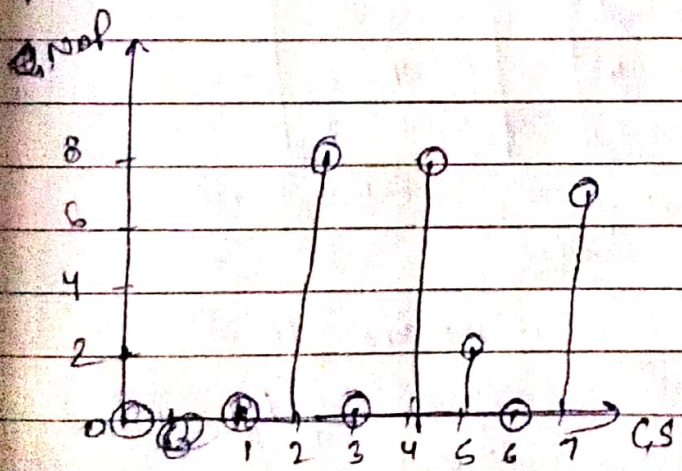
GS	0	1	2	3	4	5	6	7
No of	0	8	8	2	0	7	0	0

Gray scale (r_k)	No. of pixels (n_k)	$\frac{n_k}{\Sigma n_k}$	SK	SK × 7	Nearby value
0	0	0	0	0	0
1	8	0.32	0.32	2.24	2
2	8	0.32	0.64	4.48	4
3	2	0.08	0.72	5.04	5
4	0	0	0.72	5.04	5
5	7	0.28	1.00	7	7
6	0	0	1	7	7
7	0	0	1	7	7

$\Sigma n_k = 25$

(2+0) (7+0+0)

GS	0	1	2	3	4	5	6	7
No. of pixels	0	0	8	0	8	2	0	7



Q)

$$\begin{bmatrix} \begin{matrix} 1 & 1 \\ 1 & 1 \end{matrix} & \begin{matrix} 2 & 2 \\ 2 & 2 \end{matrix} & \begin{matrix} 5 & 5 \\ 5 & 5 \end{matrix} \\ \begin{matrix} 6 & 6 \\ 6 & 6 \end{matrix} & \begin{matrix} 7 & 7 \\ 7 & 7 \end{matrix} & \begin{matrix} 1 & 1 \\ 1 & 1 \end{matrix} \\ \begin{matrix} 3 & 3 \\ 3 & 3 \end{matrix} & \begin{matrix} 4 & 4 \\ 4 & 4 \end{matrix} & \begin{matrix} 6 & 6 \\ 6 & 6 \end{matrix} \end{bmatrix}$$

2X Image zoom

$$\begin{bmatrix} 1 & 2 & 5 \\ 6 & 7 & 1 \\ 3 & 4 & 6 \end{bmatrix}$$

Real image {Perform operation on this}

zoom 3x image

$$\begin{matrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{matrix}$$

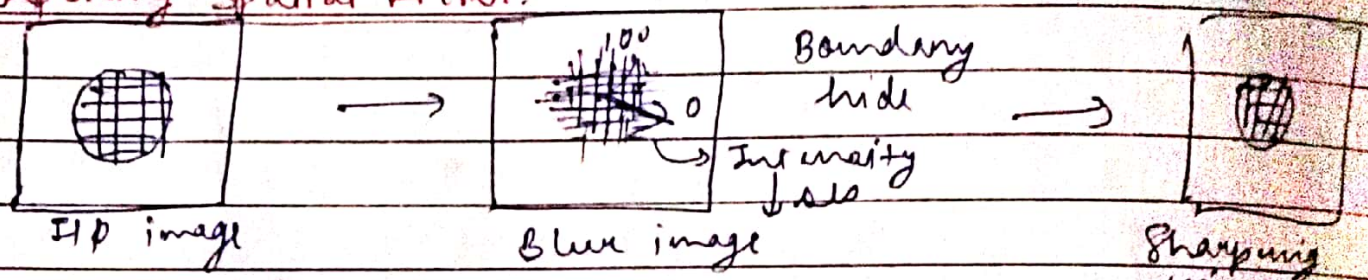
05.02.2024
Monday

Q) $\begin{bmatrix} 1 & 1 & 2 & 2 & 5 & 5 \\ 1 & 1 & 2 & 2 & 5 & 5 \\ 6 & 6 & 7 & 7 & 1 & 1 \\ 6 & 6 & 7 & 7 & 1 & 1 \\ 3 & 3 & 4 & 4 & 6 & 6 \\ 3 & 3 & 4 & 4 & 6 & 5 \end{bmatrix}$ → But this is not 2 x

यो 5 है। सब 6 नहीं है।

'All are not same.'

Sharpening Spatial Filter:-



HP image → Blur image → Sharpening image

$$\nabla^2 = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}$$

$$\frac{\partial^2 f}{\partial x^2} = f(x+1, y) + f(x-1, y) - 2f(x,y)$$

$$\frac{\partial^2 f}{\partial y^2} = f(x, y-1) + f(x, y+1) - 2f(x,y)$$

$$\therefore \nabla^2 = f(x+1,y) + f(x-1,y-1) + f(x-1,y) + f(x,y+1) - 4f(x,y)$$

$$\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} \qquad y \uparrow \begin{bmatrix} f(x-1,y+1) & f(x,y+1) & f(x+1,y+1) \\ f(x-1,y) & f(x,y) & f(x+1,y) \\ f(x-1,y-1) & f(x,y-1) & f(x+1,y-1) \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$$

→ x

write coeff. of ∇^2 terms

Filter/Mask

Blurring image $\xrightarrow{\text{mask}}$ Sharp image

(Reverse of smoothing image)

Laplace transform

Q) $[x] * [y] = [z]$

Sol: $[y] = [z] / [x]$

bit by bit divide

mask $\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix} \equiv \begin{bmatrix} 1 & 1 & 1 \\ 1 & -8 & 1 \\ 1 & 1 & 1 \end{bmatrix}$

Balanced one

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Filter = $\frac{\text{o/p image}}{\text{i/p image}}$ (bit by bit to write the filter then)

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Apply laplace filter on the Image:- (Sharpening और तकनीक)

→ same sol^n

$$\text{I/P image} = \begin{bmatrix} 4 & 6 & 5 \\ 3 & 2 & 8 \\ 6 & 4 & 3 \end{bmatrix} \times \begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix} = \begin{bmatrix} 4 & 6 & 5 \\ 3 & 13 & 8 \\ 6 & 4 & 3 \end{bmatrix}$$

i/p image Filter / mask o/p

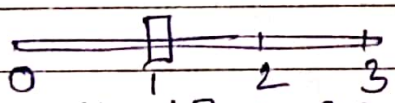
$6 + 3 + 8 + 4 - 4 \times 2$
$= 22 - 8 = 13$

Laplace filtering effect on the image

$$\boxed{\text{Portrait filter} = \text{Box Mean (Blur.)} + \text{Laplace filter (O/P) Sharpening}}$$

→ areas को boundary identify करती है।

Use mask = $\begin{bmatrix} 1 & 1 & 1 \\ 1 & -8 & 1 \\ 1 & 1 & 1 \end{bmatrix}$ then o/p = $\begin{bmatrix} 4 & 6 & 5 \\ 3 & 23 & 8 \\ 6 & 4 & 3 \end{bmatrix}$

Sharp 

Levels type

$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$ $\begin{bmatrix} 1 & 1 & 1 \\ 1 & 8 & 1 \\ 1 & 1 & 1 \end{bmatrix}$ $\begin{bmatrix} 0 & 2 & 0 \\ 2 & -8 & 2 \\ 0 & 2 & 0 \end{bmatrix}$ → sum of all values in each = 0

↳ divide by 2 get laplace filter

Sharpening से boundary identify करते है।

Enhanced laplace filter (only increase -1 bit)

$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix} \longrightarrow \begin{bmatrix} 0 & 1 & 0 \\ 1 & -5 & 1 \\ 0 & 1 & 0 \end{bmatrix}$ $\begin{bmatrix} 1 & 1 & 1 \\ 1 & -8 & 1 \\ 1 & 1 & 1 \end{bmatrix} \rightarrow \begin{bmatrix} 1 & 1 & 1 \\ 1 & -9 & 1 \\ 1 & 1 & 1 \end{bmatrix}$

laplace filter Enhanced laplace filter LF ELF

3) $\begin{bmatrix} 6 & 7 & 5 \\ 3 & 2 & 4 \\ 3 & 5 & 0 \end{bmatrix}$ Apply ELF $\times \begin{bmatrix} 0 & 1 & 0 \\ 1 & -5 & 1 \\ 0 & 1 & 0 \end{bmatrix}$ (ELF) $= \begin{bmatrix} 6 & 7 & 5 \\ 3 & 9 & 4 \\ 3 & 5 & 0 \end{bmatrix}$

↳ $\begin{pmatrix} 0 & 1 & 0 \\ 1 & -9 & 1 \\ 0 & 1 & 0 \end{pmatrix} = \begin{pmatrix} 6 & 7 & 5 \\ 3 & 11 & 4 \\ 3 & 5 & 0 \end{pmatrix}$

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orig. image $\begin{bmatrix} 50 & 100 \\ 100 & 50 \end{bmatrix}$

Q)

$$\begin{bmatrix} a & a & a & & & & \\ a & 50 & 50 & 50 & 100 & 100 & 100 \\ a & 50 & 50 & 50 & 100 & 100 & 100 \\ & 50 & 50 & 50 & 100 & 100 & 100 \\ & 100 & 100 & 100 & 50 & 50 & 50 \\ & 100 & 100 & 100 & 50 & 50 & 50 \\ & 100 & 100 & 100 & 50 & 50 & 50 \end{bmatrix}$$

Clearly 3 × zoom

sudden color change is here ∴ we apply refine

Apply LF $\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$

Corner kite पर लगाते हैं।

If zero padding then a = 0

else a = 50 (NOT zero Padding का मतलब कुछ नहीं है।

↳ Neighbouring से replace करो)

$$\begin{bmatrix} 50 & 50 & 50 & 50 & 100 & 100 & 100 & 100 \\ 50 & 50 & 50 & 50 & 100 & 100 & 100 & 100 \\ 50 & 50 & 50 & 50 & 100 & 100 & 100 & 100 \\ 50 & 50 & 50 & 50 & 100 & 100 & 100 & 100 \\ 100 & 100 & 100 & 100 & 50 & 50 & 50 & 50 \\ 100 & 100 & 100 & 100 & 50 & 50 & 50 & 50 \\ 100 & 100 & 100 & 100 & 50 & 50 & 50 & 50 \\ 100 & 100 & 100 & 100 & 50 & 50 & 50 & 50 \end{bmatrix}$$

-ve को Replace with 0

$$\begin{bmatrix} 0 & 0 & 50 & -50 & 0 & 0 \\ 0 & 0 & 50 & -50 & 0 & 0 \\ 50 & 50 & 100 & -100 & -50 & -50 \\ -50 & -50 & -100 & 100 & 50 & 50 \\ 0 & 0 & -50 & 50 & 0 & 0 \\ 0 & 0 & -50 & 50 & 0 & 0 \end{bmatrix} \xrightarrow{-ve \to 0} \begin{bmatrix} 0 & 0 & 50 & 0 & 0 & 0 \\ 0 & 0 & 50 & 0 & 0 & 0 \\ 50 & 50 & 100 & 0 & 0 & 0 \\ 0 & 0 & 0 & 100 & 50 & 50 \\ 0 & 0 & 0 & 50 & 0 & 0 \\ 0 & 0 & 0 & 50 & 0 & 0 \end{bmatrix}$$

current mirror image of upper part

Object और bg को अलग करते हैं (Laplace)

Photo boundary अलग करने का काम।

~~Update in the same & find value~~

0 0 50 -50 0 0

50	50	50	50	100	100	100	100
50	50	50	50	100	100	100	100
50	-50	-150	-150	-400	-600	-800	100
50	50	50	50	100	100	100	100
100	100	100	100	50	50	50	50
100	100	100	100	50	50	50	50
100	100	100	100	50	50	50	50
100	100	100	100	50	50	50	50

↳ Nearly all value = 0 High intensity पर आता है।

Q) ~~(Imp)~~ Apply mean/Average wt. filter & scanner it & find whether they are equal.

$\begin{bmatrix} 6 & 3 & 2 \\ 4 & 5 & 4 \\ 3 & 2 & 5 \end{bmatrix}$ → mean filter / Box filter → o/p → Laplace filter → o/p image

$\begin{bmatrix} A \\ B \\ C \end{bmatrix}$

→ $\frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$ → $\begin{bmatrix} 6 & 3 & 2 \\ 4 & 4 & 4 \\ 3 & 2 & 5 \end{bmatrix}$

$\begin{bmatrix} 1 & 1 & 1 \\ 1 & -8 & 1 \\ 1 & 1 & 1 \end{bmatrix}$ → $\begin{bmatrix} 6 & 3 & 2 \\ 4 & -3 & 4 \\ 3 & 2 & 5 \end{bmatrix}$ → Can be Enhanced Laplace filter

Sol. No they are not equal. 3.27 = 4

Q) Apply avg. weight filter & calculate the pixel intensity & check its scanner by enhanced Laplace transformation, is equal or not.

Sol. $\begin{bmatrix} 8 & 5 & 4 \\ 0 & 6 & 2 \\ 1 & 3 & 7 \end{bmatrix}$

$\frac{1}{16}\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$ → Box filter ↳ $\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$ $\begin{bmatrix} 8 & 5 & 4 \\ 0 & 4 & 2 \\ 1 & 3 & 7 \end{bmatrix}$ → $\begin{bmatrix} 1 & 1 & 1 \\ 1 & -9 & 1 \\ 1 & 1 & 1 \end{bmatrix}$ → $\begin{bmatrix} 8 & 5 & 4 \\ 0 & -6 & 2 \\ 1 & 3 & 7 \end{bmatrix}$

5 2+1 Reduction / Pixel intensity ↳ NOT equal

Value of scanner ve -ve ∴ 0

06.02.2024
Tuesday

Printing media ~~Sri Adhan~~ It Use

DATE
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UNSHARPEN IMAGE AND HIGHBOOSTING IMAGE :-

$$\boxed{f_s(x,y) = f_0(x,y) - \bar{F}(x,y)} \rightarrow \text{I}$$

or $F_B(x,y)$ or F'

or Sharpen Image = Original Image − Blur Image

[f_s : output image f_0 or f : Original Image]

complement is a blur image.

$$\Rightarrow \boxed{f_{HB}(x,y) = A\,F(x,y) - \bar{F}(x,y) \quad \text{where } A \geq 1} \rightarrow \text{II}$$

$A == 1 \Rightarrow F(x,y)$ = Original Image

$\Rightarrow f_{HB}$ = sharpened image

From I & II : $\{\bar{F}(x,y)\}$

$$f_s(x,y) = f_0(x,y) + f_{HB}(x,y) - A f_0(x,y)$$

$$\Rightarrow f_s(x,y) = (1-A) f_0(x,y) + f_{HB}(x,y)$$

$$\Rightarrow f_{HB}(x,y) = (A-1) f_0(x,y) + f_s(x,y)$$

$$f_{HB}(x,y) = A f(x,y) - (f(x,y) - f_s(x,y))$$

$$= A f(x,y) - f(x,y) - f_s(x,y)$$

$$\Rightarrow f_{HB}(x,y) = (A-1) f_0(x,y) - f_s(x,y)$$

↓ Laplace

Two macro

$$\begin{bmatrix} 0 & -1 & 0 \\ -1 & \boxed{A+4} & -1 \\ 0 & -1 & 0 \end{bmatrix} \qquad \begin{bmatrix} -1 & -1 & -1 \\ -1 & \boxed{A+8} & -1 \\ -1 & -1 & -1 \end{bmatrix}$$

Scanned with CamScanner

Highboosting: जब Print करने Bhaiya करते हैं तो its quality is not good. Then highboost is used.
(Printing capabilities ↑ से)

Any Pick/

→ Apply HB on center bit → No padding is required

Q) $\begin{bmatrix} 1 & 2 & 3 \\ 4 & \boxed{5} & 6 \\ 7 & 8 & 9 \end{bmatrix}$

Sol: $(1.8+8)5 - (\text{sum of remain})$
$= 9 + 40 - 40$
$= 9$

mask $= \begin{bmatrix} -1 & -1 & -1 \\ -1 & A+8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$

with $A = 1.8$

↳ o/p $\begin{bmatrix} 1 & 2 & 3 \\ 4 & \boxed{9} & 6 \\ 7 & 8 & 9 \end{bmatrix}$

A : coefficient factor of HB Image.

Q) $\begin{bmatrix} 4 & 3 & 7 & 5 \\ 4 & 3 & 2 & 1 \\ 3 & 5 & 7 & 2 \\ 4 & 6 & 3 & 9 \end{bmatrix}$ Apply HB on this image.

Sol: Padding.

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 4 & 3 & 7 & 5 & 0 \\ 0 & 4 & 3 & 2 & 1 & 0 \\ 0 & 3 & 5 & 7 & 2 & 0 \\ 0 & 4 & 6 & 3 & 9 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} * \begin{bmatrix} 0 & -1 & 0 \\ -1 & (A+4) & -1 \\ 0 & -1 & 0 \end{bmatrix} = \begin{bmatrix} 15 & 2.5 & 28.5 \\ 12 & & \end{bmatrix}$$

5.5 ; $-7 + 22$

$5.5 \times 3 - 14$ $\quad A+4 = 1.5 + 4 = 5.5$

$$\begin{bmatrix} 15 & 2.5 & 28.5 & 19.5 \\ 12 & 2.5 & -7 & -3.5 \\ 3.5 & 8.5 & 26.5 & -6 \\ 13 & 21 & -5.5 & 44.5 \end{bmatrix} \longrightarrow \begin{bmatrix} 15 & 3 & 29 & 20 \\ 12 & 3 & 0 & 0 \\ 4 & 9 & 27 & 0 \\ 13 & 21 & 0 & 45 \end{bmatrix}$$

Scanned with CamScanner