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Image enhancement in Spatial domain

Consider the image given below.

3 bits are used to represent a pixel.

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

255
8 bits.

a) **Show Negation of Image**

→ Assum. the image to be 3-bit. (because in matrix maximum value we can see is 6.)

So we have $2^3 = 8$ levels. (Grey level)

$\therefore L = 8$ ✓

$$S = (L-1) - r$$

or. $$g(x,y) = (L-1) - f(x,y) \quad \text{--- ①}$$

Now $L - 1 = 8 - 1 = 7$.

Thus eq^n ① becomes

$$g(x,y) = 7 - f(x,y)$$

Now do bit substraction on give matrix. we will get ⟹

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

(b) Apply bit-plane slicing.

→ Image is broken into bits and then converted into **LSB, MSB,** etc..

∴ As the given image is **3-bit**, we will convert every pixel value in 3-bit binary, we get

100	011	010	001
011	001	010	100
101	001	110	010
010	011	101	110

→ Now we will break this to get planes.

MSB Plane — left most bits
center plane — central bits
LSB plane — Right most bits.

MSB

1	0	0	0
0	0	0	1
1	0	1	0
0	0	1	1

MSB plane

center

0	1	1	0
1	0	1	0
0	0	1	1
1	1	0	1

center-bit plane

LSB

0	1	0	1
1	1	0	0
1	1	0	0
0	1	1	0

LSB-plane

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(c) Perform contrast stretching on given image.

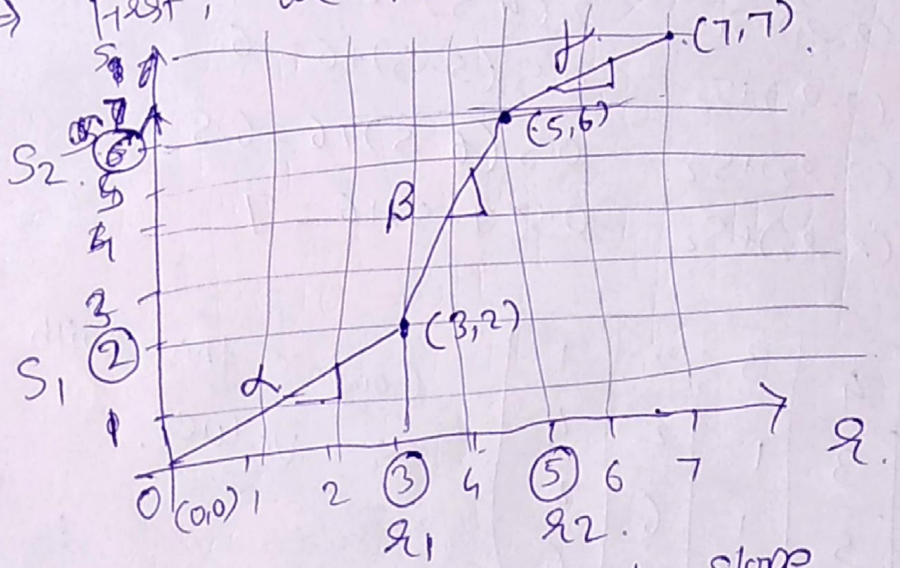
Given $r_1 = 3$ $\quad r_2 = 5$

$s_1 = 2$ $\quad s_2 = 6$ and

Image $f(x,y) =$

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

→ First, we have to plot a graph r and s



Now we will find out slope.

$$\alpha \text{ (alpha)} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{2-0}{3-0} = \frac{2}{3} = 0.66$$

$$\beta \text{ (beta)} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{6-2}{5-3} = \frac{4}{2} = 2$$

$$\gamma \text{ (gamma)} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{7-6}{7-5} = \frac{1}{2} = 0.5$$

Formulas

$$\hookrightarrow S = \begin{cases} \alpha \cdot r & 0 \leq r < 3 \\ \beta \cdot (r - r_1) + S_1 & 3 \leq r < 5 \\ \gamma \cdot (r - r_2) + S_2 & 5 \leq r \leq 7 \end{cases}$$

r	S	
0	$S = \alpha \cdot r$	$0.66 \times 0 = 0$
1	$S = \alpha \cdot r$	$0.66 \times 1 = 0.66$
2	$S = \alpha \cdot r$	$0.66 \times 2 = 1.32$
3	$S = \beta(r - r_1) + S_1$	$2(3-3)+2 = 2$
4	$S = \beta(r - r_1) + S_1$	$2(4-3)+2 = 4$
5	$S = \gamma(r - r_2) + S_2$	$0.5(5-5)+6 = 6$
6	$S = \gamma(r - r_2) + S_2$	$0.5(6-5)+6 = 6.5$
7	$S = r(r - r_2) + S_2$	$0.5(7-5)+6 = 7$

$f(x,y) =$

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

Compare this with r values.

4.	2	1.32	0.66
2	0.66	1.32	4
6	0.66	6.5	1.32
1.32	2	6	6.5

Round off. $\Longrightarrow$

4	2	1	1
2	1	1	4
6	1	7	1
1	2	6	7

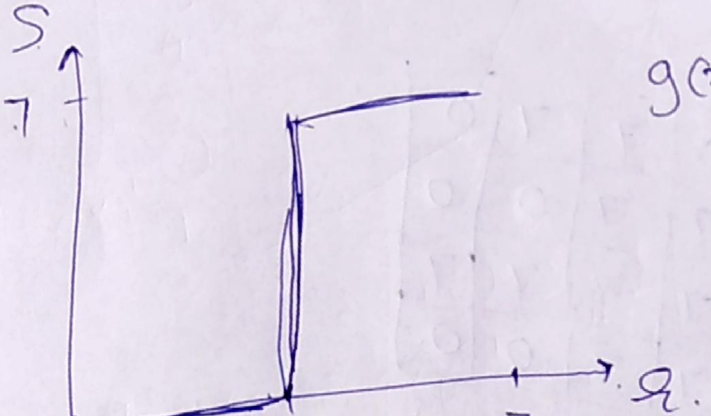
Q. For the image given below apply thresholding with $T = 4$

$f(x,y) =$

1	2	3	0
2	4	6	7
5	2	4	3
3	2	6	1

→ Assuming 3-bit image, $2^3 = 8$ levels.

$$L - 1 = 8 - 1 = 7$$



$$g(x,y) = \begin{cases} 0 & \text{if } f(x,y) < 4 \\ 1 & \text{if } f(x,y) \geq 4. \end{cases}$$

$g(x,y) =$

0	0	0	0
0	7	7	7
7	0	7	0
0	0	7	0

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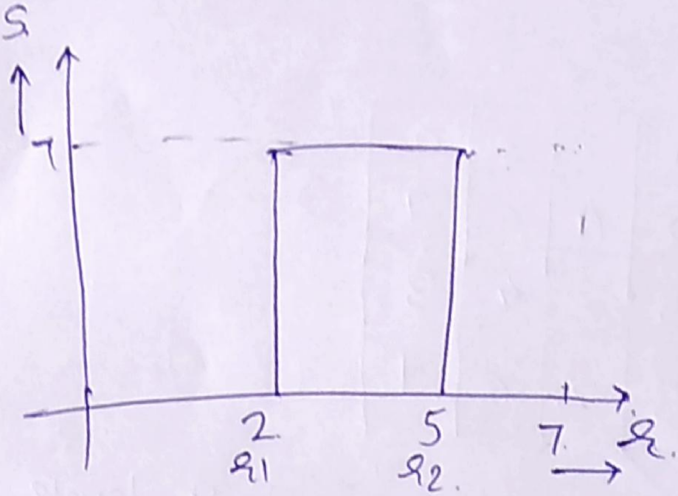
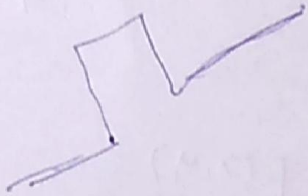
Q. Apply clipping with $r_1 = 2$ and $r_2 = 5$.

$\Rightarrow$





$$g(x,y) = \begin{cases} 7 \text{ or } (L-1) & \text{if } \overset{r_1}{2} \le f(x,y) \le \overset{r_2}{5} \\ 0 & \end{cases}$$

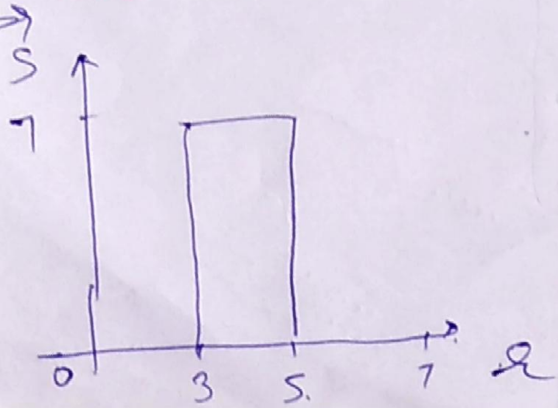
$\therefore$ $g(x,y) =$

0	7	7	0
7	7	0	0
7	7	7	7
7	7	0	0.

Q. Apply Intensity level slicing with $r_1 = 3$ and $r_2 = 5$. with out background.

$\Rightarrow$

$$g(x,y) = \begin{cases} 7 & 3 \le r \le 5 \\ 0 & \text{otherwise.} \end{cases}$$



0	0	7	0
0	7	0	0
7	0	7	7
7	0	0	0