Problems

→ **Histogram Equalisation** :

$$\boxed{P(r_k) = \frac{n_k}{N}}$$

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

$P(0) = \frac{5}{25} = 0.2$

$P(1) = \frac{5}{25} = 0.2$

$P(2) = \frac{4}{25} = 0.16$

$P(3) = \frac{4}{25} = 0.16$

$P(4) = \frac{2}{25} = 0.08$ , $P(5) = \frac{2}{25} = 0.08$ $P(6) = \frac{2}{25} = 0$

$P(7) = \frac{1}{25} = 0.04$

Cumulative Probability :-



$P(0) = 0.2$ $P(1) = P(0) + C.P(1) = 0.4$

$P(2) = 0.56$ $P(3) = 0.72$ $P(4) = 0.8$

$P(5) = 0.88$ $P(6) = 0.96$ $P(7) = 1$

Now construct Histogram Equali

$$\begin{bmatrix} 0.2 & 0.4 & 0.72 & 0.8 & 1 \\ 0.56 & 0.72 & 0.4 & 0.2 & 0.56 \\ 0.8 & 0.88 & 0.96 & 0.2 & 0.4 \\ 0.72 & 0.4 & 0.2 & 0.56 & 0.72 \\ 0.88 & 0.96 & 0.56 & 0.2 & 0.4 \end{bmatrix}$$

NOTES

MARCH 2024

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| | | | | 1 | 2 | 3 |
| 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | 29 | 30 | 31 |

Now, multiply the Histogram Equalisation Matrix with the max. number of initial Matrix, (i.e) 7

$$\begin{bmatrix} 1.4 & 2.8 & 5.04 & 5.6 & 7 \\ 3.92 & 5.04 & 2.8 & 1.4 & 3.92 \\ 5.6 & 6.16 & 6.72 & 1.4 & 2.8 \\ 5.04 & 2.8 & 1.4 & 3.92 & 5.04 \\ 6.16 & 6.72 & 3.92 & 1.4 & 2.8 \end{bmatrix}$$

Round off the output

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

∴ Equalised Histogram Equalisation.

→ Point Detection :- (Values/Matrix needs to be remembered)

~~Horizontal~~

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

NOTES

$$\begin{bmatrix} 1 & 1 & 1 \\ 1 & -8 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

APRIL 2024

| M | T | W | T | F | S | S |
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→ Line Detection

Horizontal
$$\begin{bmatrix} -1 & -1 & -1 \\ 2 & 2 & 2 \\ -1 & -1 & -1 \end{bmatrix}$$

45°
$$\begin{bmatrix} 2 & -1 & -1 \\ -1 & 2 & -1 \\ -1 & -1 & 2 \end{bmatrix}$$

Vertical
$$\begin{bmatrix} -1 & 2 & -1 \\ -1 & 2 & -1 \\ -1 & 2 & -1 \end{bmatrix}$$

-45°
$$\begin{bmatrix} -1 & -1 & 2 \\ -1 & 2 & -1 \\ 2 & -1 & -1 \end{bmatrix}$$

→ Robert Operator

$$gx = \frac{\delta f}{\delta x} = (z9 - z5)$$

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$gy = \frac{\delta f}{\delta y} = (z8 - z6)$$

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & -1 \\ 0 & 1 & 0 \end{bmatrix}$$

→ Prewitt Operator :-

$$g_x = (z_7 + z_8 + z_9) - (z_1 + z_2 + z_3)$$

$$\begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix}$$

$$g_y = (z_3 + z_6 + z_9) - (z_1 + z_4 + z_7)$$

$$\begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

→ Sobel Operator :-

$$g_x = (z_7 + 2z_8 + z_9) - (z_1 + 2z_2 + z_3)$$

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

NOTES

$$g_y = (z_3 + 2z_6 + z_9) - (z_1 + 2z_4 + z_7)$$

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

⇒ Average Filter / Box Filter

$$\frac{1}{9} \times \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

similarly for Max, min & Median Filter

⇒ Weighted Average Filter

$$\frac{1}{16} \times \begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$$

Max weight to the center then to the Horizontal and Vertical component and then remaining (diagonal)

⇒ Marr Hildreth Edge Detection

1). Filter the input image with Gaussian Low pass filter kernel to obtain the enhanced image

$$G(x,y) = e^{-\frac{x^2+y^2}{2\sigma^2}}$$

⇒ Computing the Laplacian of the image resulting in Step ①.

$$\nabla^2 G(x,y) = \frac{\delta^2 G(x,y)}{\delta x^2} + \frac{\delta^2 G(x,y)}{\delta y^2}$$

Laplacian of Gaussian (LOG)

$$\nabla^2 G(x,y) = \left(\frac{x^2+y^2-2\sigma^2}{\sigma^4}\right) e^{-\frac{x^2+y^2}{2\sigma^2}}$$

⇒ HSI, RGB conversion

HSI needed to be ~~found~~ calculated from the given RGB

$$\text{Intensity} = \frac{R+G+B}{3}$$

$$\text{Saturation} = 1 - \frac{3}{R+G+B}(\min(R,G,B))$$

$$\text{Hue} = \cos^{-1}\left[\frac{\frac{1}{2}[(R-G)+(R-B)]}{\sqrt{(R-G)^2+(R-B)*(G-B)}}\right]$$

HSI Given, Find RGB

$$B = I(1-S)$$

$$R = I\left(1+\frac{S\cos H}{\cos(60°-H)}\right)$$

NOTES

$$G = 3I - (R+B)$$

⇒ Opening and closing Morphological Operations

For opening operations

1). Take the Original Matrix
2). Apply Erosion ⇒ Min operation
3). Apply the Dilation for the eroded resultant Matrix

For closing operations

1). Take the Original Matrix
2). Apply Dilation
3). Apply the Erosion to the dilated resulted Matrix.

⇒ Convex Hull :-

→ Method by enclosing all the points inside / on the circumference with the closed boundary.



Steps are present to structure the convex Hull

⇒



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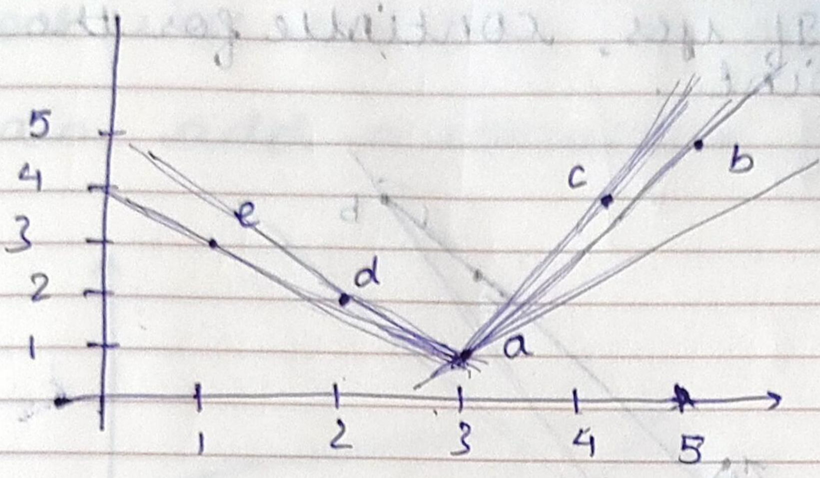
NOTES

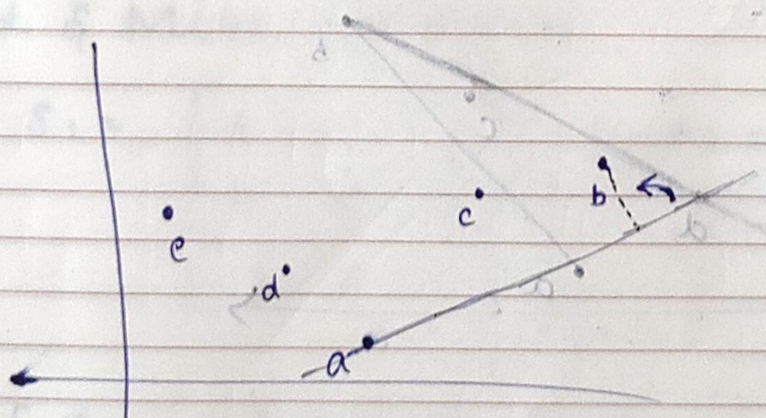
CIA Qn (2,2), (4,4), (1,3), (3,1), (5,5)




step 1, Find the lowest point and ~~name~~ label the points

Step 2 :- draw the ~~horizontal~~ Normal line that passes through the point a and check the closest point.

step 3 :- check the point and make a connection with Normal line




NOTES

check the angles acuting is in anti clockwise direction

| APRIL | | | | | | 2024 |
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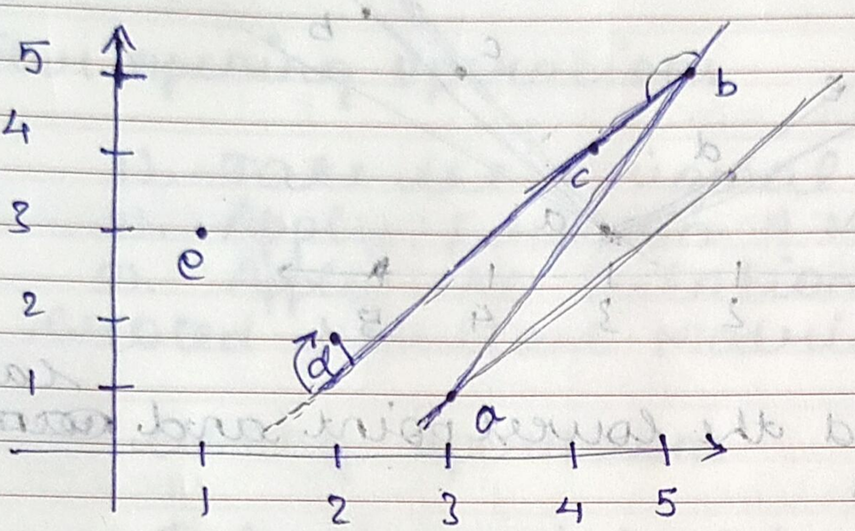
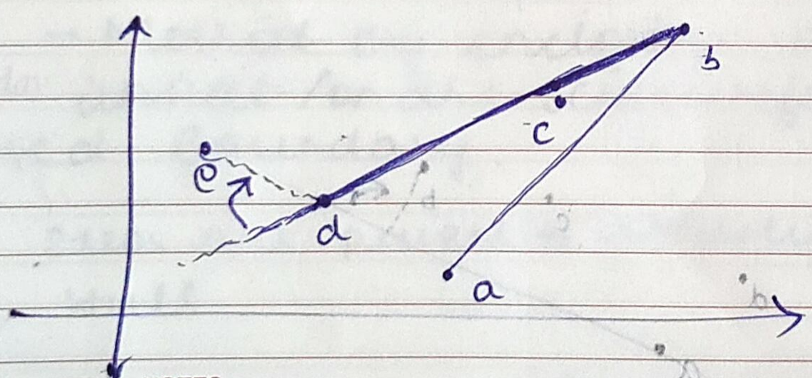
Step 5 :- If yes, continue for the next point.




Here, when we are connecting the point d from the c, we are getting acute at clockwise, so pop c, Now, connect the point d from c

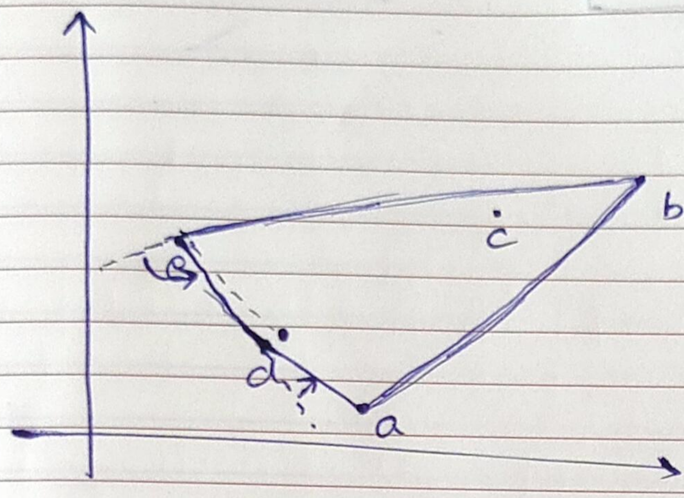





NOTES

Now, when we connect from d to e, we are getting a clock wise rotating, so pop d.

Again, add a connection from b to e




Area should be maximum, circum should be minimum

Here,

So, the convex hull co-ordinates are
(3,1), (5,5), (1,3)

⇒ Hit & Miss problem

$$S_1 = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 0 & 0 \\ 1 & 0 & 1 \end{bmatrix} \qquad S_2 = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 1 & 1 \\ 0 & 1 & 0 \end{bmatrix}$$

NOTES

$$(A - S_1) \cap (A' - S_2)$$

APRIL 2024

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Focal length

$$\boxed{\frac{1}{f} = \frac{1}{u} + \frac{1}{v}}$$