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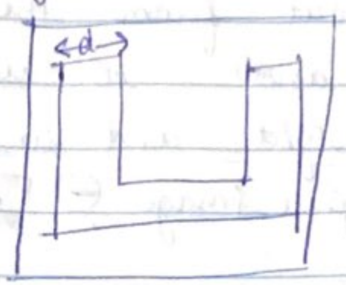
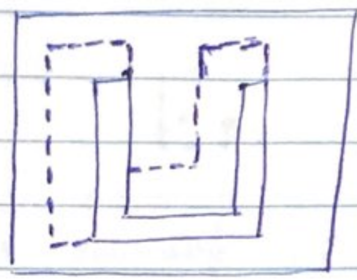
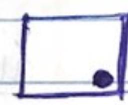
CVIP HW-3.

Given image





To obtain (a) as the output, I would carry out 'erosion' on my original image

Structuring element: Square kernel 
with width less than 'd'.

Origin point: Bottom-right corner of the structuring element.

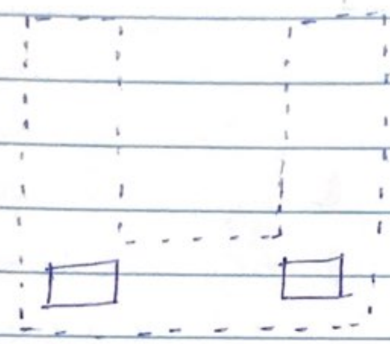
Starting position: Starting position will be the top-left corner of the image.

<u>Process</u>: I will take my square kernel and erode my original image using it.
The origin point at the bottom right corner will ensure that ~~my~~ the output (a) is produced

Erosion will start from the top-left corner of the image and it will traverse from left to right. and so on.

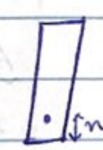
OPERATION: $\boxed{\text{original\_image} \ominus \boxed{\cdot} = \text{resultant\_image}}$

17b.

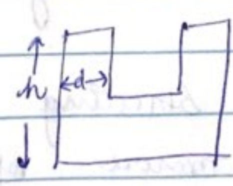


To obtain (b), I would carry out 'erosion' on my original image.

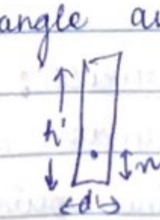
Structuring element: vertical rectangle.



Let h be the height of the rectangle in given image and d be the width of the image



Let h' be the height of the rectangle and 'd'' be its width such that,

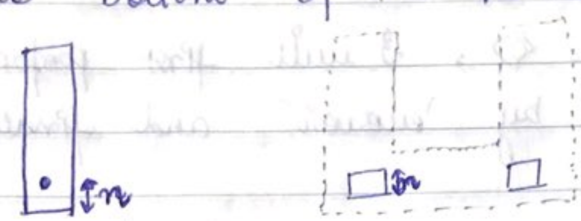


~~h' < h~~

d' < d

h' is slightly lesser than h and
d' is lesser than d.

Origin point: It is going to be slightly above (n distance) from the bottom of the round.



n is basically equal to the size of the final image ~~po~~ patches formed.

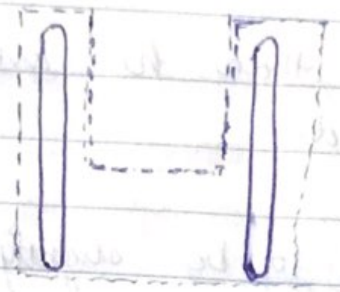
Starting Point: Starting position will be the top-left corner of the original image

Process: Erosion would be carried from top-left corner ~~to of~~ and shall further be traversed from there. (left to right).
The aim of taking a vertical rectangle is such that its origin at bottom retains only that small bottom part of the original image and negates the rest of the image.

IMP Operations:

original_image ⊖ [•] = resultant_image

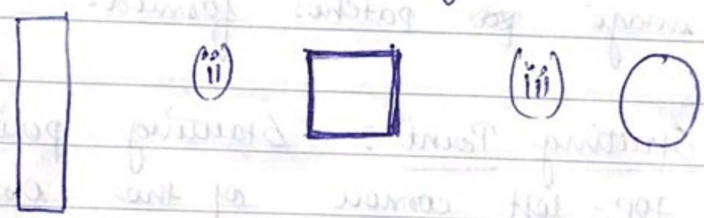
1c)

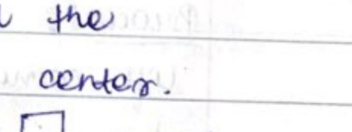


Operations:
i) (original_image) ∘ ▯ = Img1
ii) Img1 ⊖ □ = Img2
iii) Img2 ∘ ○ = resultant_image

To obtain (c), I will first perform 'opening' followed by 'erosion' and finally 'opening' again.

Structuring elements: I am using 3 structuring elements to carry out these operations

i)  (ii) (iii)

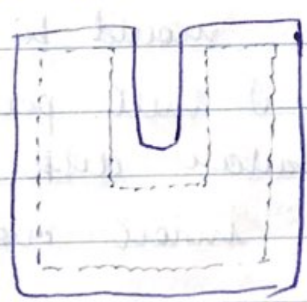
Origin point: Origin point for all the structuring elements is the center. of all the structuring elements i) ii) iii) 

Starting point: Starting position of the image is the top-left corner of the original image

Process: I will start with the first structuring element - i.e. vertical rectangle. This structuring element will be used to perform the opening operation. The size of the kernel will be equal to the height of the original image so that the bridge in the original image can be broken. and the two vertical blocks can be retained.

After this bridge in the image has been broken, we want to decrease the size of the remaining image and then we also have to smooth the corners which we will perform using opening again. For erosion, I am using a small squared kernel to get the desired output image and for opening, I will take a small disk-shaped circle to smoother the corners.

(d)



To obtain (d), I will first perform dialation and then closing.

Structuring element : I am using 1 structuring elements

Origin point : Origin point for all the structuring elements is the center of all the structuring element.

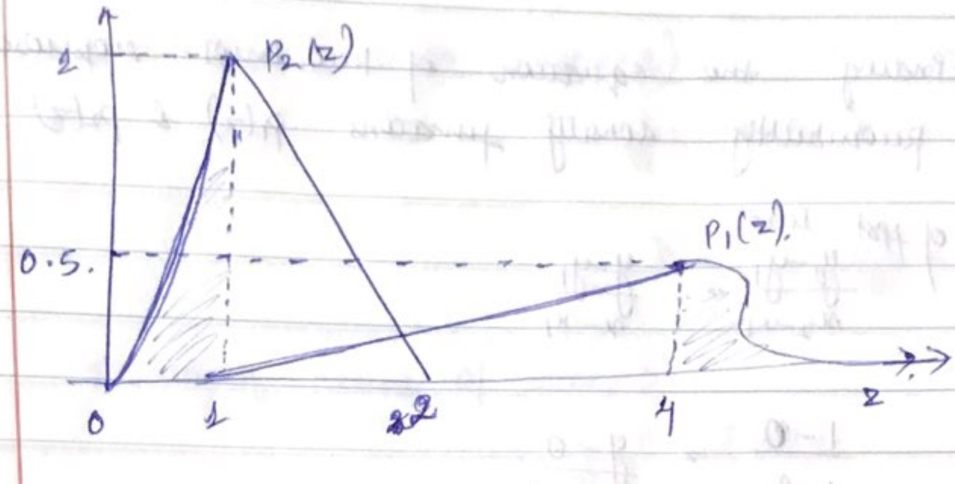
Starting point : Starting position of the image is the top left corner of the original image.

Process : The first step is to dilate the image. I will carry out the dilation using a small circular disk. This will also result in smoothening the corners of the image since we are using a circular disk as the structuring element.

The second operation would be to carry out closing. I will perform closing using the same circular disk to smoothen out the inner corner of the image.

OPERATIONS : i) Original_Image ⊕ ◯ = Image1
ii) Image 1 • ◯ = resultant_Image

Soln 2



P1 = probability of occurrence of object (foreground)
P2 = probability of occurrence of background

Segmentation requires us to find the threshold value such that the background can be segregated from the object (foreground).

If we find the area under the curves, it will give us probabilities P_1 and P_2. The threshold will lie near the intersection of $P_1(z)$ and $P_2(z)$. Therefore, ignoring the shaded regions of the curves and only considering the area of the two triangles

~~Area of~~ $P_2(z) \Rightarrow (x_1, y_1) = (2, 0)$
$(x_2, y_2) = (1, 1)$

$P_1(z) \Rightarrow (x_1, y_1) = (1, 0)$
$(x_2, y_2) = (4, 0.5)$

Finding the equation of two lines representing probability density functions $p_1(z)$ & $p_2(z)$

Equation of first line

$$\frac{y_2-y_1}{x_2-x_1} = \frac{y-y_1}{x-x_1}$$

$$\frac{1-0}{1-2} = \frac{y-0}{x-2}$$

$$x-2 = -1(y)$$

$$\Rightarrow \boxed{y = 2-x} \quad \text{(I)}$$

{ representing $p_2(z)$

Equation of second line

$$\frac{y_2-y_1}{x_2-x_1} = \frac{y-y_1}{x-x_1}$$

$$\frac{0.5-0}{4-1} = \frac{y-0}{x-1}$$

$$\frac{0.5}{3} = \frac{y}{x-1}$$

$$0.5x - 0.5 = 3y$$

$$\frac{x}{2} - \frac{1}{2} = 3y$$

$$x - 1 = 6y$$

$$\Rightarrow \boxed{y = \frac{x-1}{6}} \quad \text{(II)}$$

Finding P_1 (area of first Δ)

$$= \frac{1}{2} \times (4-1) \times (0.5-0)$$

$$= \frac{3(0.5)}{2} = \frac{1.5}{2} = 0.75$$

Finding P_2 (area of second Δ)

$$= \frac{1}{2}(1-0)(2-1)$$

$$= 0.5.$$

Threshold equation is given by:

$$P_1 \, p_1(t) = P_2 \, p_2(t).$$

$$0.75 \left[\frac{x-1}{6}\right] = 0.5\left[2-x\right].$$

$$\Rightarrow 1.5x - 1.5 = -6x + 12$$

$$\Rightarrow 7.5x = 13.5$$

$$\Rightarrow \boxed{x = 1.8}$$

$\therefore$ Therefore, threshold $(t) = 1.8$.

Solⁿ 3 (i) a Given the eqⁿ of the line as :

$$y = x - 2.$$

$\Rightarrow x - y = 2$ — Eqⁿ 1

Coefficient of x and y $\Rightarrow$ 1 and -1 respectively.

Let $a = 1$, $b = -1$.

$\sqrt{a^2+b^2} = \sqrt{1+1} = \sqrt{2}$.

Dividing eqⁿ (1) by $\sqrt{a^2+b^2}$

$$\Rightarrow \frac{x}{\sqrt{a^2+b^2}} - \frac{y}{\sqrt{a^2+b^2}} = \frac{2}{\sqrt{a^2+b^2}}$$

$$\Rightarrow \frac{x}{\sqrt{2}} - \frac{y}{\sqrt{2}} = \frac{2}{\sqrt{2}}$$

$$\Rightarrow \frac{x}{\sqrt{2}} - \frac{y}{\sqrt{2}} = \sqrt{2} \quad \text{— Eqⁿ (ii)}$$

Comparing eqⁿ (ii) with the normal eqⁿ
$x\cos\theta + y\sin\theta = p$. — Eqⁿ (iii)

From (ii) and (iii), we get
$\cos\theta = 1/\sqrt{2}$, $\sin\theta = -1/2$, $p = \sqrt{2}$.

As seen from the values of $\cos\theta$ and $\sin\theta$, ~~as~~ we find that the value of θ will be in the fourth quadrant since values, $\cos\theta$ is positive and value of $\sin\theta$ is negative.

Hence, θ will lie in the fourth quadrant.

$$\theta = 270^\circ + 45^\circ = 315^\circ$$

$$\left[\, 45^\circ, \text{ since } \cos\theta = 1/\sqrt{2} \Rightarrow \theta = 45^\circ \,\right]$$

Therefore, the final eqn comes out to be:

$$\boxed{x \cos(315^\circ) + y \sin(315^\circ) = \sqrt{2}}$$

This is polar form eqn.

i) b Given equation : $y = 1 - \frac{x}{2}$

$$\Rightarrow \frac{x}{2} + y = 1 \quad \text{—— eq}^n(1)$$

Coefficient of x and y $\Rightarrow$ $\frac{1}{2}$ and 1 respectively

Let $a = 1/2$ and $b = 1$

$$\sqrt{a^2+b^2} = \sqrt{1/4+1} = \sqrt{\frac{5}{4}} = \frac{\sqrt{5}}{2}$$

Dividing eqn (I) by $\sqrt{a^2+b^2}$

$$\Rightarrow \frac{x}{2\sqrt{a^2+b^2}} + \frac{y}{\sqrt{a^2+b^2}} = 1$$

$$\Rightarrow \frac{x}{2\times\frac{\sqrt{5}}{2}} + \frac{y}{\frac{\sqrt{5}}{2}} = \frac{1}{\frac{\sqrt{5}}{2}}$$

$$\Rightarrow \frac{x}{\sqrt{5}} + \frac{2y}{\sqrt{5}} = \frac{2}{\sqrt{5}}. \quad \text{— eqn (II)}$$

$x \cos\theta + y \sin\theta = p$. — eqn (III)

From eqn (II) and eqn (III)

$$\cos\theta = \frac{1}{\sqrt{5}}, \ \sin\theta = \frac{2}{\sqrt{5}}, \ p = \frac{2}{\sqrt{5}}.$$

Hence, $\cos\theta$ and $\sin\theta$ are positive values.
Therefore, value of θ will be in the first quadrant.

Hence, $\theta = 63°$ $\left\{ \theta = \cos^{-1}\left(1/\sqrt{5}\right) \right\}$

The final polar form eq^n can therefore be written as

$$\boxed{x\cos 63^\circ + y\sin 63^\circ = \frac{2}{\sqrt{5}}}$$

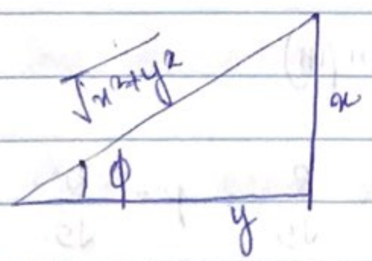
3(ii) Given,

$$\boxed{x\cos\theta + y\sin\theta = p}$$

Dividing the given equation by $\sqrt{x^2+y^2}$, we get,

$$\frac{x}{\sqrt{x^2+y^2}}\cos\theta + \frac{y}{\sqrt{x^2+y^2}}\sin\theta = \frac{p}{\sqrt{x^2+y^2}} \quad (1)$$

Let's assume there is a triangle with $\angle\phi$, it can be drawn as.



Therefore, $\cos\phi = \dfrac{y}{\sqrt{x^2+y^2}}$

$\sin\phi = \dfrac{x}{\sqrt{x^2+y^2}}$ (ii)

From (I) and (II)

$$\sin\phi \cos\theta + \cos\phi \sin\theta = \frac{p}{\sqrt{x^2+y^2}}$$

$$\sin(\theta+\phi) = \frac{p}{\sqrt{x^2+y^2}}$$

$$\boxed{p = \sqrt{x^2+y^2} \cdot \sin(\theta+\phi)} \quad \text{—(III)}$$

Eqⁿ (III) indicates that there is a sinusoidal varying.

From eqⁿ (II),

Amplitude $A = \sqrt{x^2+y^2}$

Phase $\phi = \cos^{-1}\left(\frac{y}{\sqrt{x^2+y^2}}\right)$

or $\phi = \sin^{-1}\left(\frac{x}{\sqrt{x^2+y^2}}\right)$.

$\because \theta = 2\pi ft = \omega t$. —(IV)

$\therefore \boxed{A \sin(\omega t + \phi) = p}$ — {From (III) and (IV)}.

b)

The period (or frequency) of the sinusoid does not vary with the image point.