CVIP HW 3

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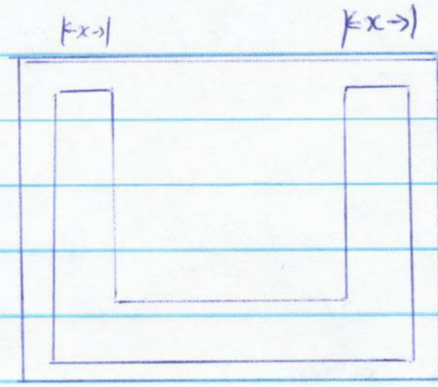
1.a) Given image:

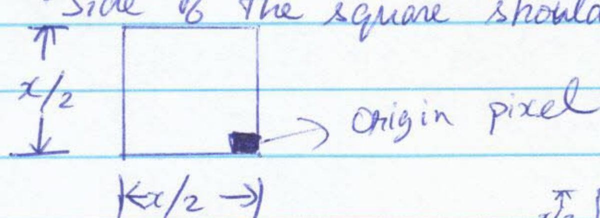


A

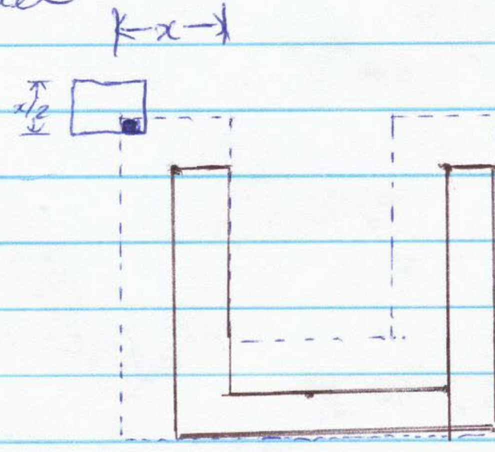
Operation: Erosion:

Structuring element:

- We have to take a square structuring element
- Since there is a shift towards the bottom right side in the given output image from the input image, the origin of the structuring element should be in the bottom right corner.
- Side of the square should be of size $x/2$.



B



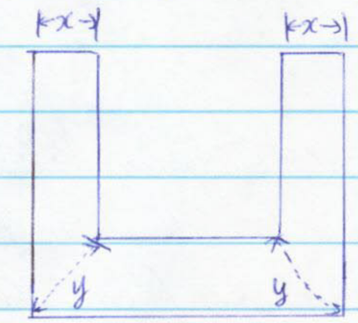
A ! B

1. b) Step 1: Erosion

Structural element: Circle with the origin in center

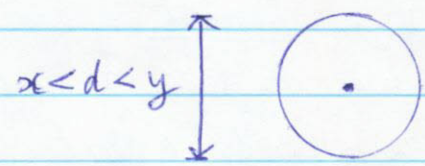
- The diameter of the circle should be greater than the distance 'x' and also lesser than the distance 'y' so that we will get few pixels remaining after erosion.

Given image:

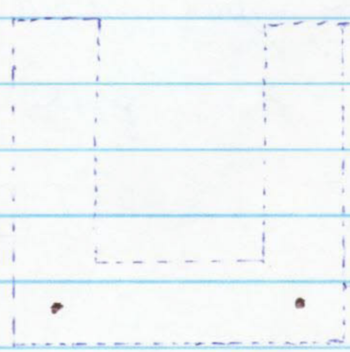


A

Structural element:



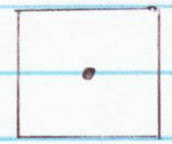
B



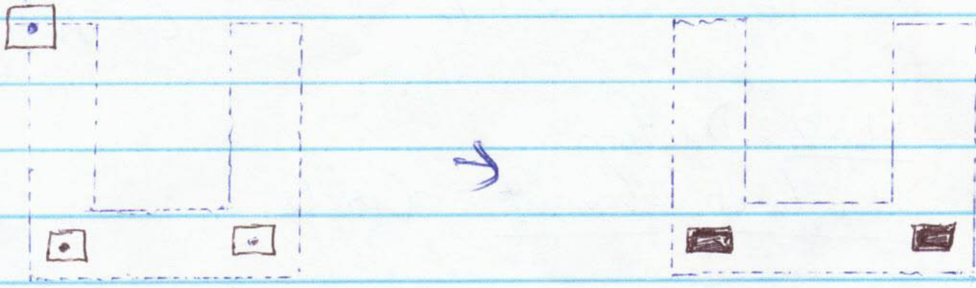
$C = A ! B$

Step 2: Dilation

Structural element: Rectangular with origin at center.



D



placing structural element at various points

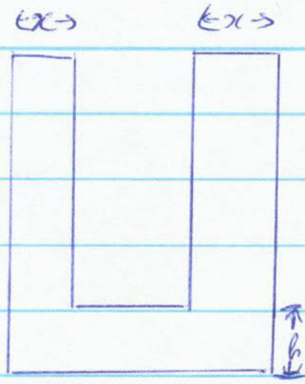
$C \oplus D$

1.(c) Step 1: Erosion

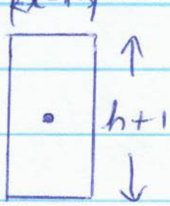
Structural element: Rectangle

- The width of the rectangle should be lesser than 'x', let us say "x-1" pixel which is the maximum possible width of the rectangle to get only a single vertical line of pixel after erosion in both the sides

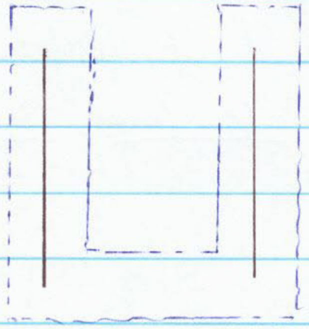
- Similarly, the height of the rectangle should be greater than the distance 'h' marked in the given image, let us say 'h+1' pixel which is greater than 'h' and it is the minimum possible height, in order to obtain <u>no</u> horizontal line after erosion.



A



B

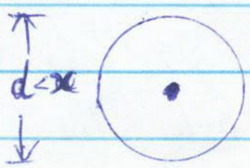


C = A ! B

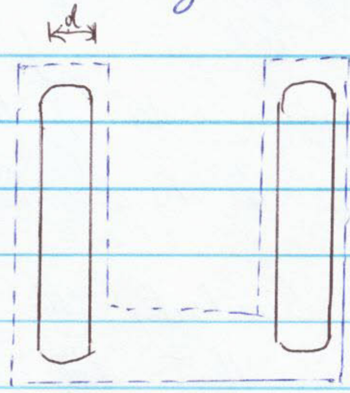
Step 2: Dilation
Structural element: Circle

• Since, there is a curve in the output image it is clear that we have to use the circle to get that after dilation.

• ~~B~~ Based on the thickness we need in the output image we can take the diameter of the circle. We can clearly see that it is not greater than "x"



D



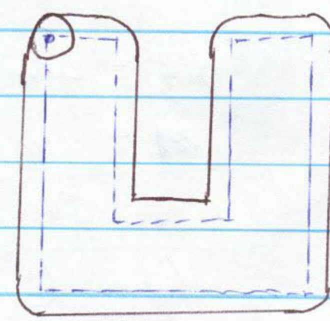
$C \oplus D$

1.d) Step 1: Dilation

Structural element: Circle

• The first step is clearly a dilation with circle with origin at center

B

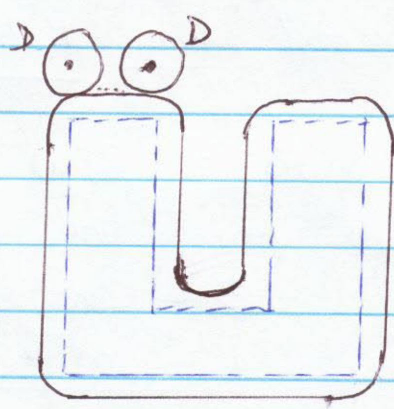


$C = A \oplus B$

Step 2: Closing operation

Structural element: Circle with origin at center.

D



$C \bullet D = (C \oplus D) ! D$

• Since, the inward pointing corners are rounded from the first step to the ~~op~~ output image given, we have to use the closing operation with circle.

2. Lets take the points from the given data,

$P_1 = (4, 0.5)$

$P_2 = (1, 0)$

Lets form the line equation in form $y = mx + c$

$$0.5 = 4m + c \rightarrow (1)$$
$$0 = m + c \rightarrow (2)$$
$$0.5 = 3m$$

By solving (1) & (2) we get

$m = 1/6$ & $c = -1/6$

$\therefore P_1(z)\,(\text{line}) = \frac{1}{6}z - \frac{1}{6}$

<u>Second line</u> <u>$P_2(z)$</u> :

Points $= (2, 0)$ & $(1, 1)$

Lets form the equations of form $y = mx + c$

$$0 = 2m + c$$
$$1 = m + c$$
$$-1 = m \quad , \quad c = 2$$

By solving we get,

$P_2(z) = -z + 2$

Now, let us find the area under the curve for both the lines:

~~Area~~ Area under $P_1(z)$:

$P_1(z)$ lies between $z=1$ and $z=4$

$$\boxed{\text{Area under } P_1(z) = \frac{3}{4}}$$

~~Area~~ For $P_2(z)$, it lies between $z=1$ and $z=2$

$$\boxed{\text{Area under } P_2(z) = \frac{1}{2}}$$

Optimal probability of error

$$E(T) = P_2\, E_1(T) + P_1\, E_2(T)$$

In order to minimize the error, we are going to differentiate with respect to T and let the result ~~= 0~~. equal to zero.

$$\frac{dE(T)}{dT} = \frac{d\left(P_2\left(E_1(T)\right) + P_1\, E_2(T)\right)}{dT} = 0$$

Find T which makes $P_1\, p_1(T) = P_2\, p_2(T)$

$$\frac{3p_1(T)}{4} = \frac{p_2(T)}{2}$$

$$\frac{3}{2} p_1(T) = p_2(T)$$

$$3 p_1(T) = 2 p_2(T)$$

$$\frac{3 \cdot T - 3}{6} = -2T + 4$$

$$\frac{3T}{6} + 2T = 4 + \frac{3}{6}$$

$$\frac{15T}{6} = \frac{27}{6}$$

$$T = \frac{27}{15}$$

$$\boxed{T = 1.8}$$

Optimal threshold, $\boxed{T = 1.8}$

3.a) $y = x - 2 \rightarrow ①$

$y = 1 - \frac{x}{2} \rightarrow ②$

We know,

$x = r\cos\theta$

$y = r\sin\theta$

$r = \sqrt{x^2 + y^2}$

To write in (r, θ) form:

(i) $y = x - 2$

$x - y = 2$

$r\cos\theta - r\sin\theta = 2$

$$\boxed{\therefore r = \frac{2}{\cos\theta - \sin\theta}}$$

(ii) $y = 1 - \frac{x}{2}$

$x + 2y = 2$

$r\cos\theta + 2r\sin\theta = 2$

$$\boxed{r = \frac{2}{\cos\theta + 2\sin\theta}}$$

3.b) Let us consider one sample point (x, y) and plot it in graph of (ρ, θ) plane.
Let us assume $(2, 2)$, it turns out to be a sinosoidal curve.
On calculating for other points as well we get a sinosoidal curve.
A unique sin curve for every point

Relation ships:

Amplitude:

Amplitude $\propto$ Distance of the origin.
(Directly propotional)

Period:

The Frequency of the curve does not vary with the point (x, y)

Phase:

Phase also varies with point (x, y).

Phase $\propto$ Distance from the origin

(Directly propotional)