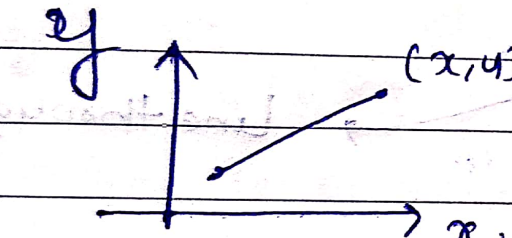
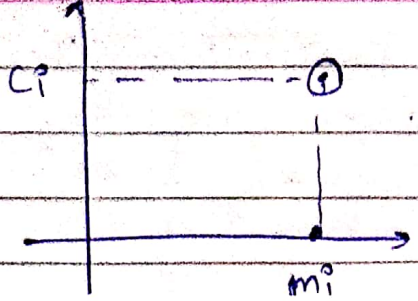
Global Processing

Hough Transform :- Transformation from spatial domain. Parameter space (m, c) plane.

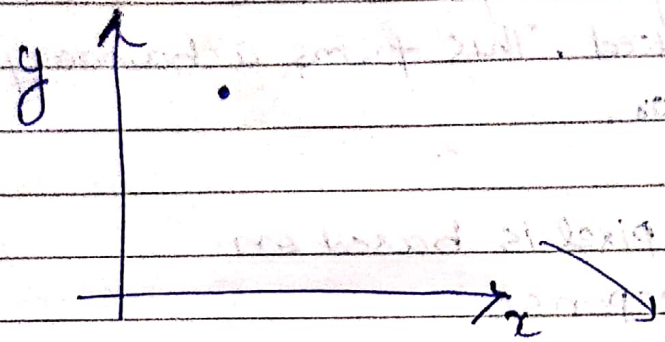


$y = m_i x + c_i$

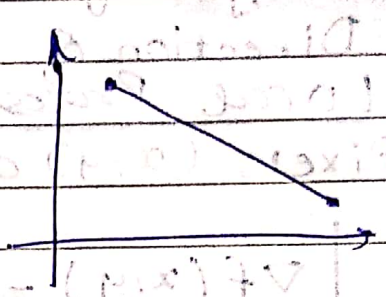
$y = mx + c$

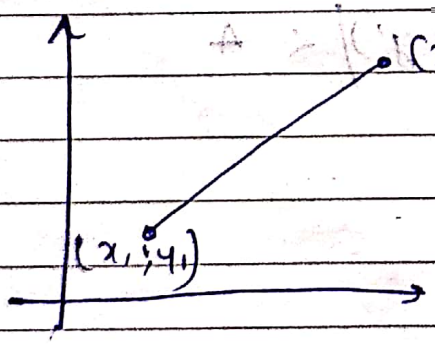


$c = -(mx+y)$

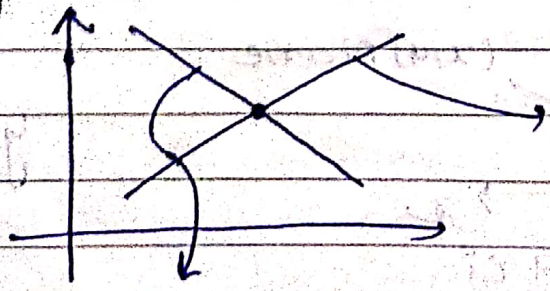


A dot in x-y plane will be represented as a line in (m-c) plane.

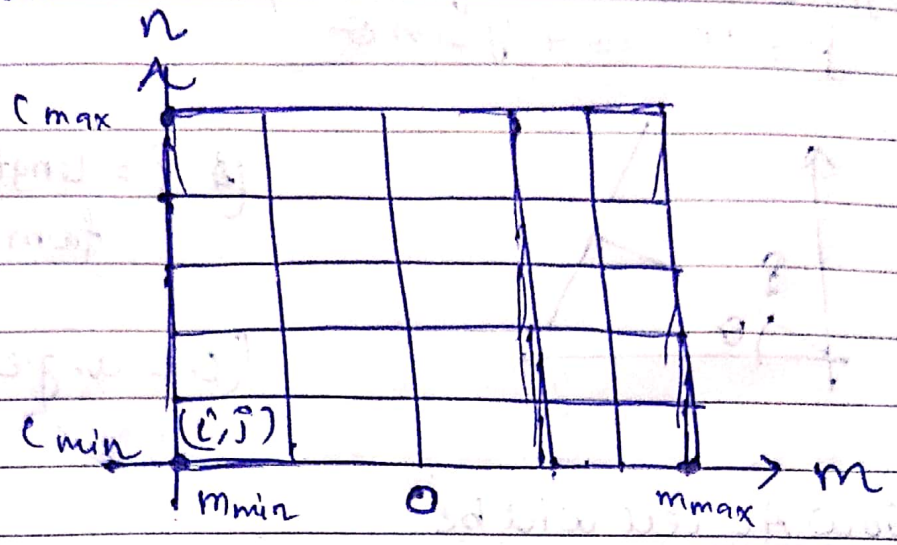




There is a line whose slope & intercept is same, thus line of (x_1, y_1) and (x_2, y_2) in m-c plane will be intersecting in nature.



MC plane is divided into no. of accumulator cells.



A (i,j) :- Accumulated cell where Mi is slope and Cj is intercept.

(1) Initialize all cell values with zero.

At point (x_k, y_k) in spatial domain,

$C = -(m x_k + y_k)$ in parameter domain.

Now we take boundary pt. say (x_k, y_k) in spatial plane, In m-C plane.

$C = -m x_k + y_k$

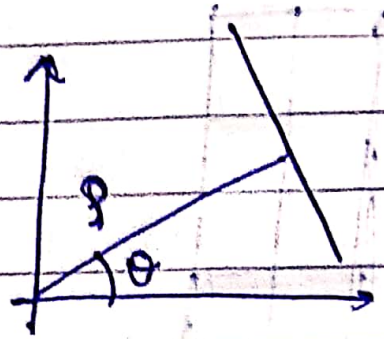
Assume every possible value of m and find the corresponding value of C. Value of C has to be rounded off to the nearest allowed value of C. Suppose $mp \rightarrow cq$, then corresponding accumulator cell value is incremented by 1.

$A(p,q) = A(p,q) + 1$

This has to be done for all boundary points. At the end A(i,j) contains q. q = No. of points on straight line $y = m x_i + c_j$

Problem comes when line is vertical and $m = \infty$.
To solve this, we use normal representation of straigth line instead of m-c plane.

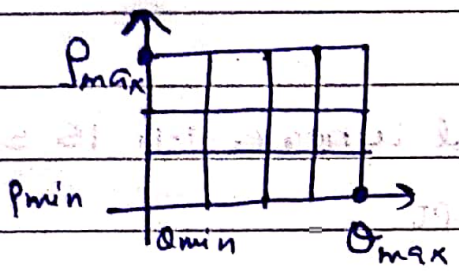
$$\rho = x\cos\theta + y\sin\theta$$



(ρ = length of ⊥ on line from Origin)

(θ = angle)

So, Now AC cell will be



So, max value of θ can be $(\pm 90^\circ)$ and max value of range of 'ρ' is $\sqrt{M^2+N^2}$
$M \times N$ is the image size.

A Particular point in xy-plane is represented as sinosidual wave in ρ-θ plane. So 'q' no. of points will have q - sinosidual waves intersecting at a point.

(*) SIMILARITY BASED IMAGE SEGMENTATION

(*) Region Growing

All points belonging to an Image form a set R. It partitions R into number of sub-regions like R_1, R_2 ... R_n. Some properties it should follow :-

(1) If we take union of R_i, then $\bigcup_{i=1}^{n} R_i = R$

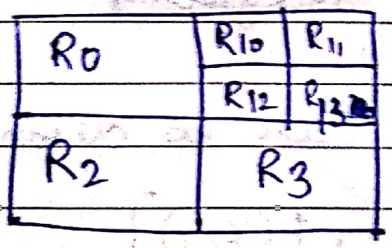
(2) R_i must be connected i.e. If we select any two points, we should be able to identify a path b/w them.

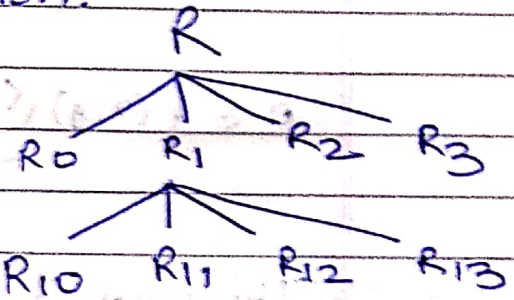
(3) $R_i \cap R_j = \phi$ for $i \neq j$

(4) If we define predicate 'P' over R, it should be true.

(*) Region Splitting / Merging

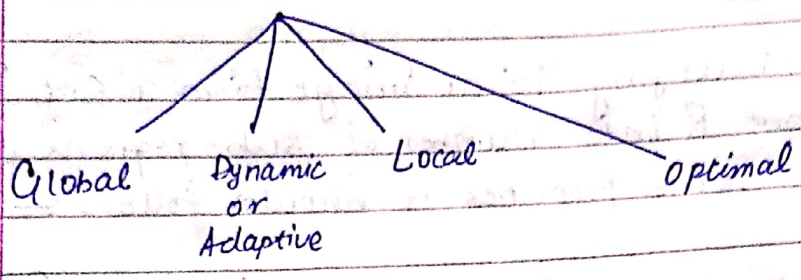
If we have an image say 'R', first try to find if intensity values are similar or not. If not, then break Image imgge into partition and check again for each partition.





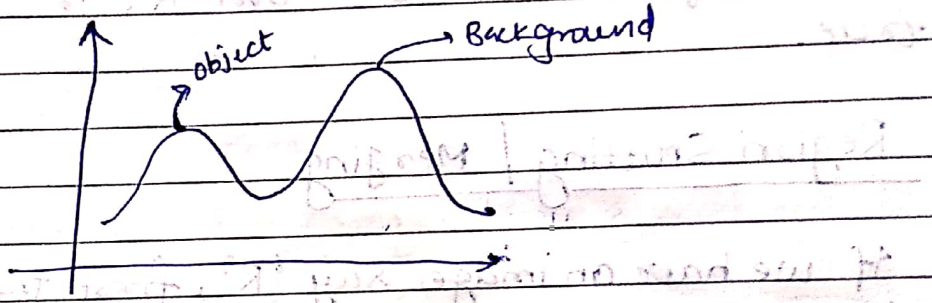
Stop if no more partition can be done, select adjacent partitions, if similar, MERGE them.

(*) THRESHOLDING



Bi-modal Histogram

Two Peaks : Dark object
Light Background



$0 \leq f(x,y) \leq T$
↳ object

$0 \leq f(x,y) \leq 255$
↳ Background

Thresholding func^n can be defined as:

$$T\left[(x,y), f(x,y), P(x,y)\right]$$

x, y = Location of Pixels
$f(x,y)$ = Intensity value of (x,y)
$P(x,y)$ = Local property of neighborhood centered at (x,y)

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T [f(x,y)] → Global

T [f(x,y) p(x,y)] → Local

T [(x,y), f(x,y), p(x,y)] → Dynamic

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(*) DISSIMILARITY BASED SEGMENTATION

(•) Point detection

-1	-1	-1
-1	8	-1
-1	-1	-1

Mask

If $|R| > T$

Apply mask on pt (x,y) say it is $R(x,y)$.
If $|R| > T$ (Threshold) then (x,y) is considered as a point.

(•) Line detection

Horizontal

-1	-1	-1
2	2	2
-1	-1	-1

$\longrightarrow$

45^0 Rotation

-1	-1	2
-1	2	-1
2	-1	-1

Vertical

-1	2	-1
-1	2	-1
-1	2	-1

$\longrightarrow$

(45^0 Rotation)

2	-1	-1
-1	2	-1
-1	-1	2

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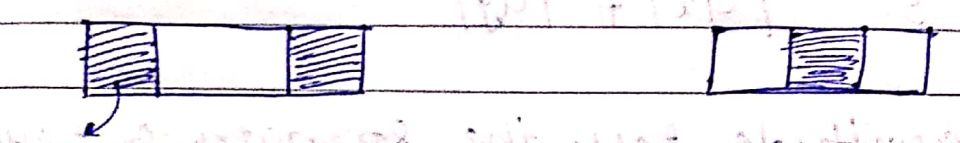
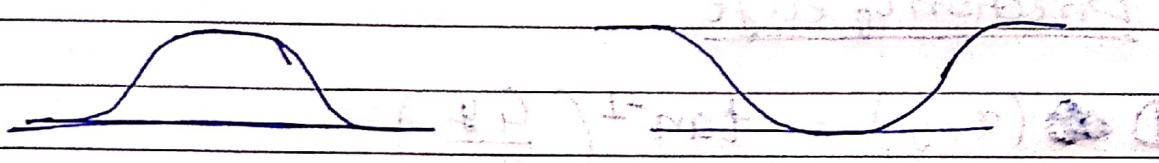
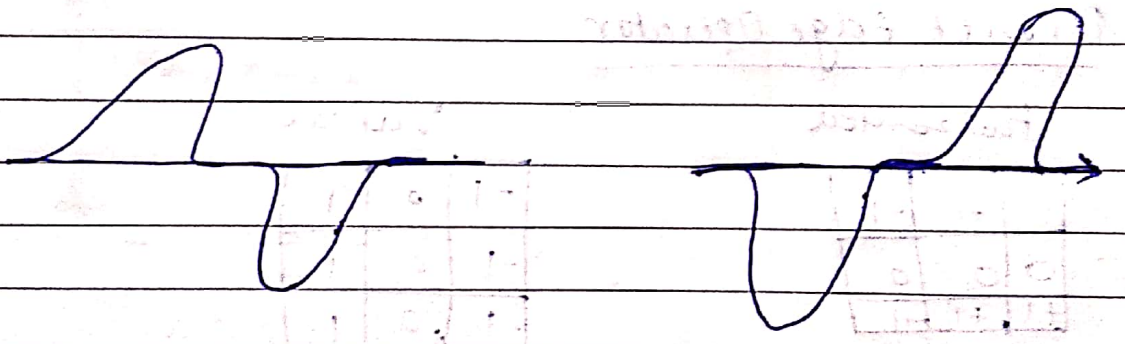
We apply all 4 masks on an image. For two diff. masks i and j, $i \neq j$ and. If $R_i > R_j$, then it means corresponding point lies in the direction of mask i, rather than j.

(*) Edge Detection

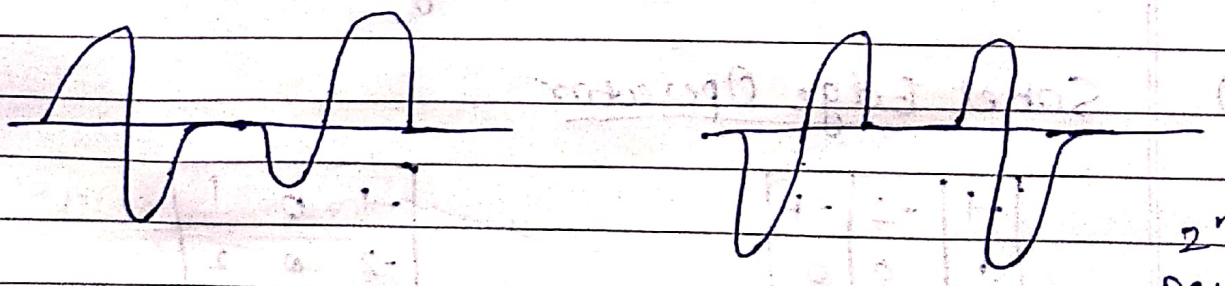


dark (0)





1st Derivative



2nd Derivative

We use 1'st derivative for edge detection, 2nd derivative is very sensitive.

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We use gradient operator :-

$$\vec{\nabla} f = \begin{bmatrix} G_x \\ G_y \end{bmatrix} = \begin{bmatrix} \partial f / \partial x \\ \partial f / \partial y \end{bmatrix}$$

$$\vec{\nabla} f = \sqrt{G_x^2 + G_y^2}$$

$$\simeq |G_x| + |G_y|$$

The magnitude tells the strength of edge at (x, y)

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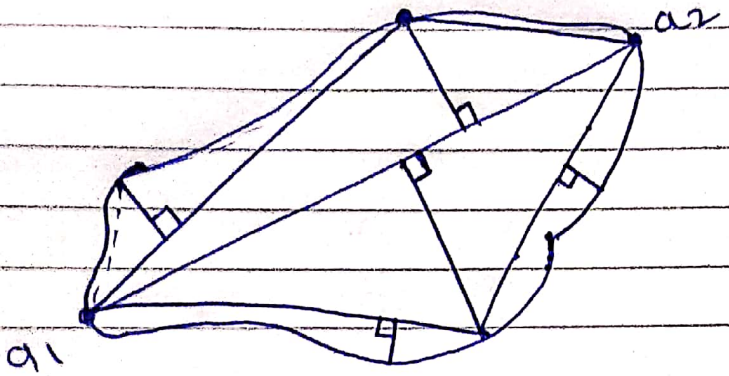
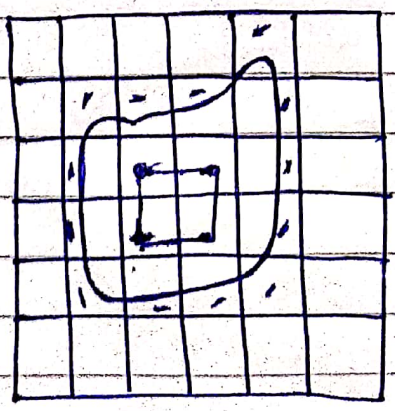
(4) POLYGON APPROXIMATION TECHNIQUES

(1) Polygon Splitting and Merging

(i) Choose two farthest pt.
(ii) Draw a line
(iii) Draw the perpendicular (max) from the line.
(iv) If $\perp r$ < Threshold, stop process



(2) Minimum Perimeter Polygon



Represents the shape in a given boundary using fewest no. of possible sequences.
The cells (inner) that are not touched by the polygon connects and represent the shape's boundary.

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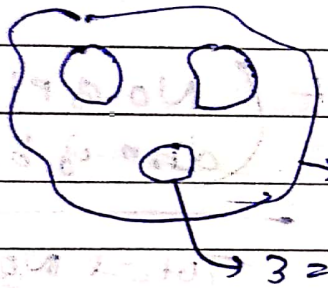
(*) REGION BASED SHAPE DESCRIPTORS

(1) Translation Invariant]
(2) Rotational "] ↘ [AREA]
(3) Scaling "] ↗

(1) Euler No = S − N
S → CONNECTED COMPONENTS
N → No. of Holes



⇒ V = S − N
V = 1 − 3
= −2

(Translation, Rotation, Scaling) ↗

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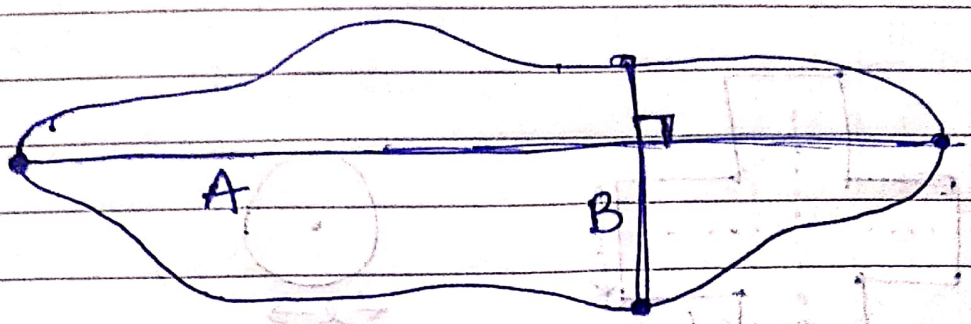
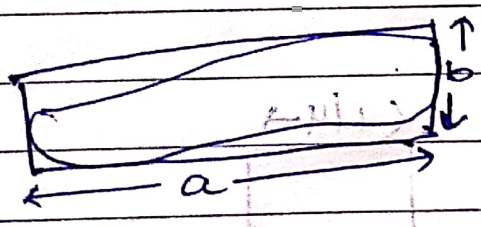
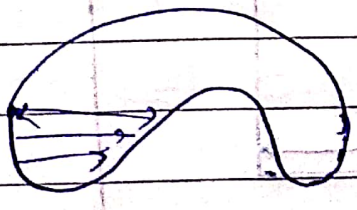
(3) Eccentricity :-



$$\frac{len(A)}{len(B)} = \varepsilon$$

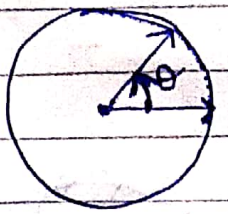
(4) Elongatedness $= \frac{a}{b}$

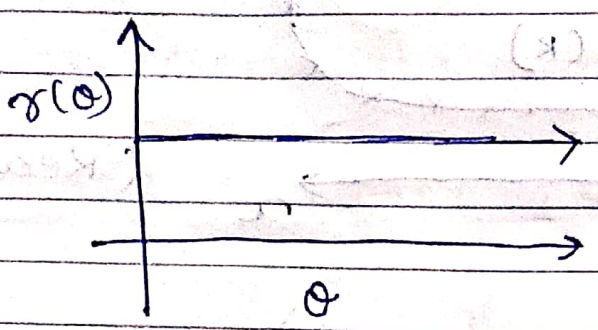




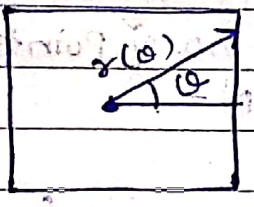
$\frac{area}{(thickness)^2}$ → No. of erosions to erode it to a NULL set.

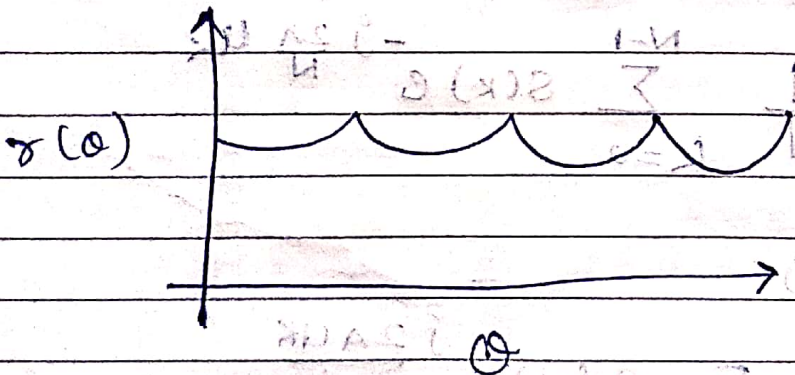
(3) Signature :- 1-D mapping of boundary.





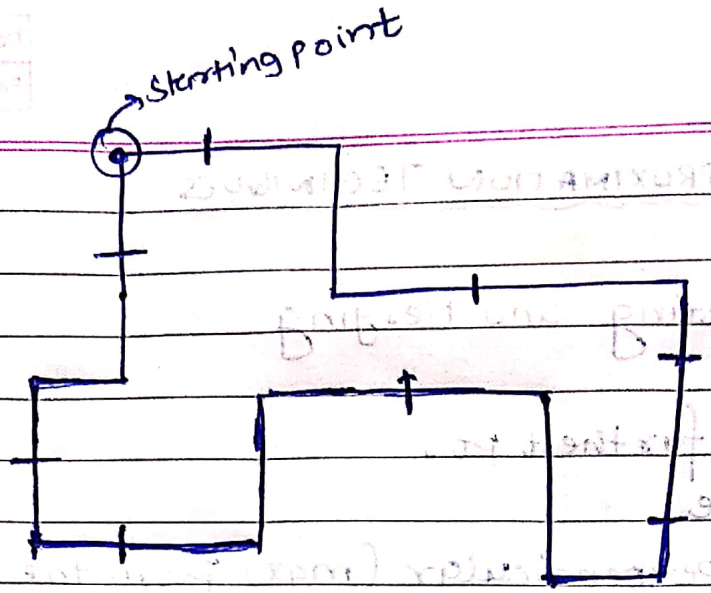
(Circle Signature)



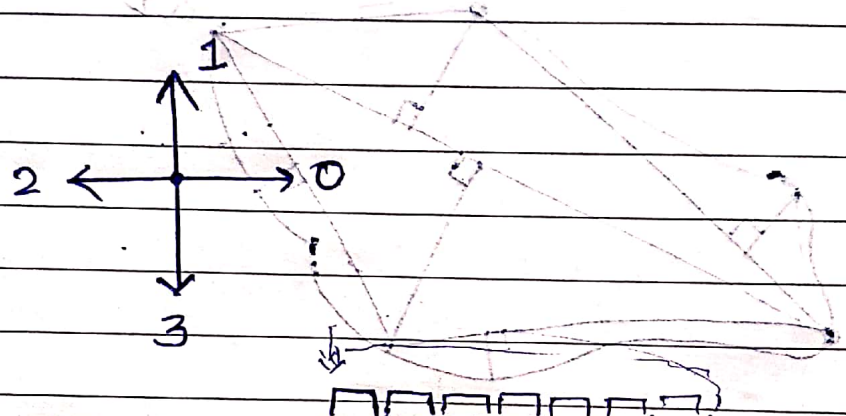


(Sq/Rect Signature)

The Signature is formed on the basis of angle difference from the centroid of the shape.



Assuming the start point to top left (not given in question)



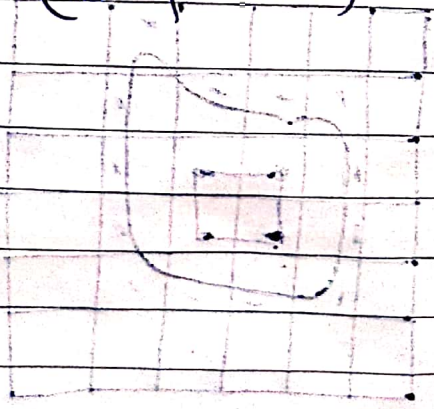
4-D

Chain-code = 00332211

Circular 1st Difference = 03030303

Normalized CD = 03030303

(Shape No.)



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To make chain code independent of starting point we use normalized chain code.