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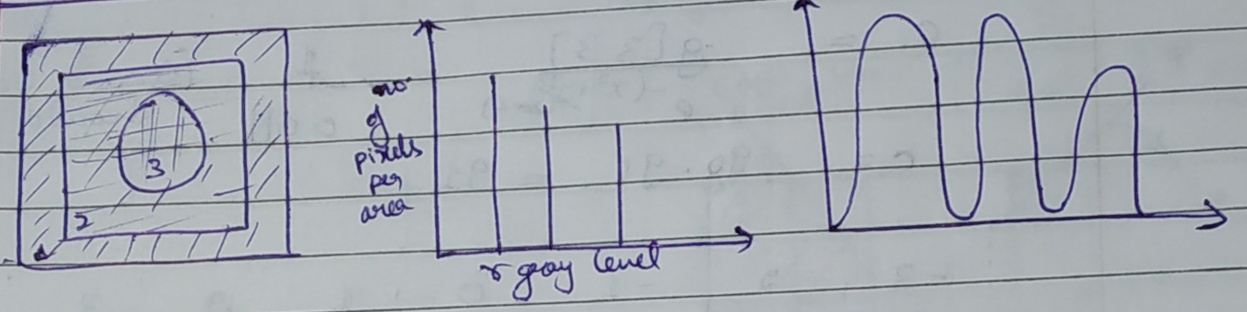
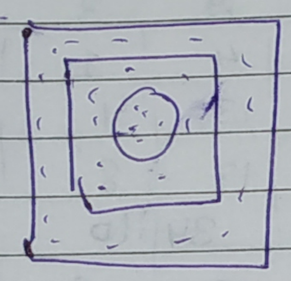
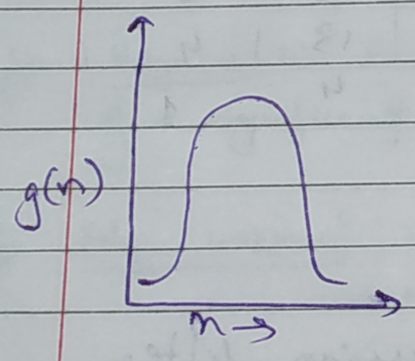
Gaussian Noise:







$g(n) = e^{\frac{-n^2}{2\sigma^2}}$

PDF of gaussian random variable

$g[x,y] = c\, e^{\frac{-(x^2+y^2)}{2\sigma^2}}$

Discrete gaussian distribution ↖ normalizing constant

Gaussian Filter / Smoothing ~~Filter~~

For $\sigma^2 = 2$, $n = 7$

	-3	-2	-1	0	1	2	3
-3	0.011	0.038	0.082	0.105	0.082	0.038	0.011
-2	0.038	0135	0.286	0.368	0.286	0.135	0.038
-1	0.082	0.286	0.606	0.779	0.606	0.286	0.082
0	0.105	0.368	0.779	1	0.779	0.368	0.105
1	0.082	0.286	0606	0.779	0.606	0.286	0.082
2	0.038	0.135	0.286	0.368	0.286	0.135	0.038
3	0.011	0.038	0.082	0.105	0.082	0.038	0.011

Mask Kernel → OR Gaussian Kernel

get exact

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$$g\underline{[3,3]} = e^{-\frac{(x^2+y^2)}{2\sigma^2}}$$

$$c = \frac{g[3,3]}{e^{-(x^2+y^2)/(2\sigma^2)}} = \frac{1}{0.011}$$ [Corner values should be 1]

$$c = 90.91 = 91$$

Gaussian filter

Scaling value

	-3	-2	-1	0	1	2	3
-3	1	3	4	8	10	8	4	1
-2	4	13	27	34	27	13	4	
-1	8	13	56	71	56	13	8	
0	10	34	71	91	71	34	10	
1	8	13	56	71	56	13	8	
2	4	13	27	34	27	13	4	
3	1	4	8	10	8	4	1	

* This filter smoothens image.
* Scaling ~~filter~~ function = sum of gaussian filter = 1086 (1115)
* To retain uniform intensity.
* Averaging filter → blur image
  Gaussian filter → ~~sharp~~ image

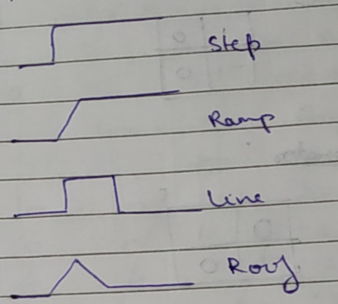
Ques For $n=5$, $\sigma^2 = 1$

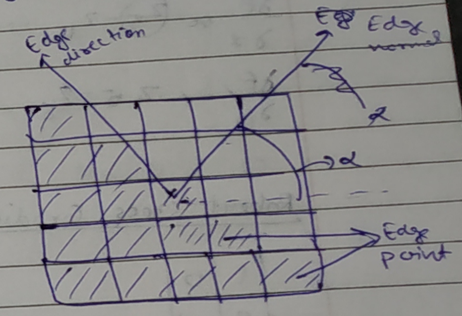
	-2	-1	0	1	2
-2	1	4	5	8	5	1
-1	5	21	34	21	5
0	8	34	55	34	8
1	5	21	34	21	5
2	1	5	8	5	1

Edge Detection:

Edge: Significant local change in intensity

Types:



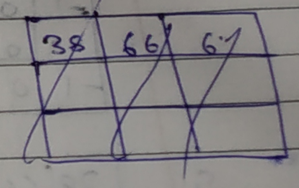


Edge point: Point with coordinates [i, j] at a location of a significant local intensity change.

Edge normal: Unit vector in the direction of maximum intensity change

Edge direction: Perpendicular to the edge normal

Gradient:
Measure of change



$$G[f(x,y)] = \begin{bmatrix} G_x \\ G_y \end{bmatrix} = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{bmatrix}$$

Gradient Measure $\propto |G_x| + |G_y|$

Direction of gradient: $\alpha(x,y) = \tan^{-1}\left(\frac{G_y}{G_x}\right)$

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Derivative Filter:

reference point

$\frac{\partial f}{\partial x} = z_5 - z_6$

$\frac{\partial f}{\partial y} = z_5 - z_8$

1	-1
0	0

1	0
-1	0

z_1	z_2	z_3
z_4	z_5	z_6
z_7	z_8	z_9

Robert cross Gradient Operator:

1	0
0	-1

0	1
-1	0

Prewitt operator:

-1	0	1
-1	0	1
-1	0	1

-1	-1	-1
0	0	0
1	1	1

Sobel operator:

-1	0	1
-2	0	2
-1	0	1

-1	-2	-1
0	0	0
1	2	1

Eg

38	66	65
14	35	64
12	15	42

Use prewitt operator, to calculate α.
Using pixel ~~rate~~ 35

$G_x = 107$

$G_y = -100$

$\alpha = \tan^{-1}\left(\frac{-100}{107}\right) = -43°$

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Eg

10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0

$G_x = -30$, $G_y = 0$, $\tan^{-1} 0 = 0$

0	0	-30	30	0
0	0	-30	-30	0
0	0	-30	-30	0
0	0	-30	-30	0

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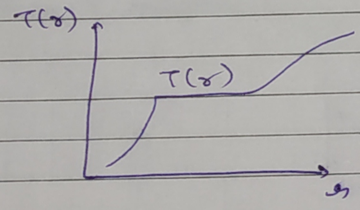
Histogram Equalization :

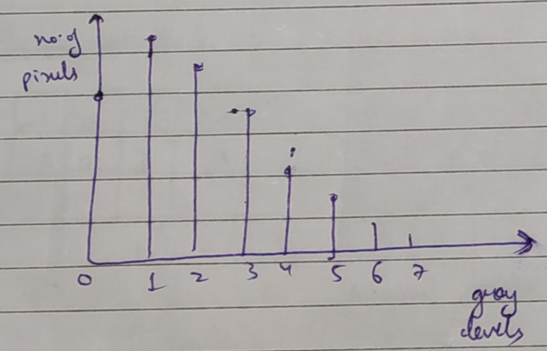
CDF	gray levels	No.	PDF	
0.19	0	790	0.19	8 → 8 or greater
0.44	1	1023	0.25	
0.65	2	850	0.21	
0.81	3	656	0.16	
0.89	4	329	0.08	
0.95	5	245	0.06	
0.98	6	122	0.03	
1.00	7	81	0.02	

H.E. → Original

Monotonically increasing func.



Details are seen



Multiply CDF by n-1

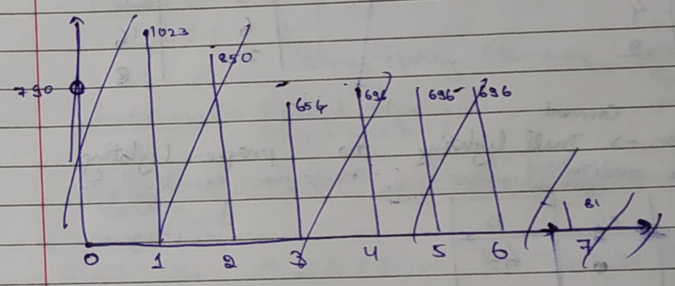
where n is no. of levels

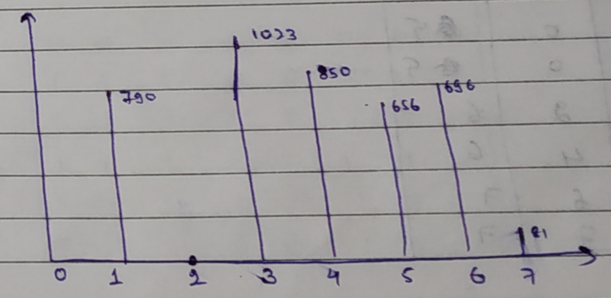
i.e. n = 8

n-1 = 8-1 = 7

gray level	CDF * (n-1)	
0	1.33	1
1	3.08	3
2	4.55	4
3	5.67	5
4	6.23	6
5	6.65	6
6	6.86	6
7	7	7

} add no. of pixels





Ques Predict shape of figure

Calculate angle and edge length

↓ using edge detection

using euclidean distance

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Histogram Specification :-

Given Histogram :-

Intensity	#
0	8
1	10
2	10
3	2
4	12
5	16
6	4
7	2

Map given → Histogram to the desired histogram

Desired Histogram

Desired Intensity	#
0	0
1	0
2	0
3	0
4	20
5	20
6	16
7	8

Application → Convert Dull lighting to proper lighting

Histogram equalization of given histogram → Histogram equalization of desired histogram

C_0	C_1	C_2	D
0	1	0	4
1	2	0	4
2	3	0	5
3	3	0	5
4	5	2	6
5	6	4	6
6	7	6	7
7	7	7	7

* From C_1, find the element in C_2, which is greater than or equal to, then replace it with the corresponding value of C_0

New pixels

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

No. of pixels

0	1	2	3	4	5	6	7
0	0	0	0	18	12	28	6

#(4) = #(0) + #(1)
#(5) = #(2) + #(3)
#(6) = #(4) + #(5)
#(7) = #(6) + #(7)

Morphological Operations :-

Dilation

$$A = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 0 & 0 & 1 \\ 1 & 0 & 0 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix}$$

1 → Foreground
0 → Background / holes

$$B = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$$

Structuring Elements : Partial Match
Some match → 1
No match → 0

Erosion :- Exact Match
Perfect match → 1

Opening OPENING : EROSION & THEN DILATION

CLOSING : DILATION & THEN EROSION

Ques

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

* Convert ing to Blue ing → intensity level slicing
* Then dilation (Superimpose structuring elements, if some match, then 1 else if no match, then 0

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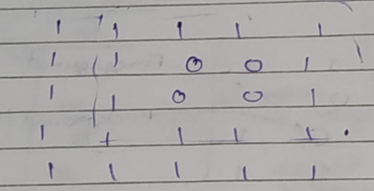
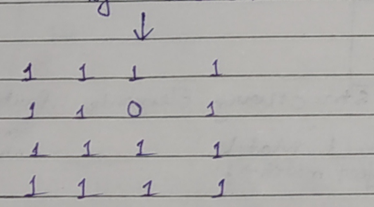
Dilation

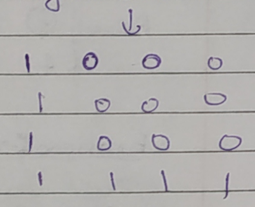
After padding



After dilation

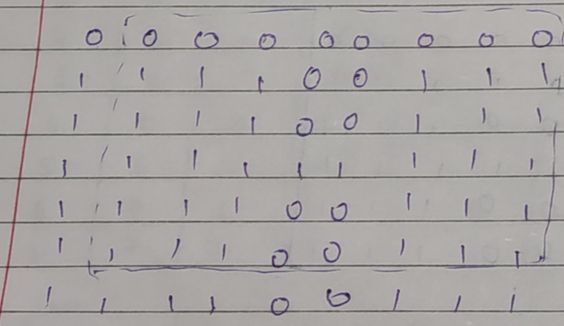


After erosion



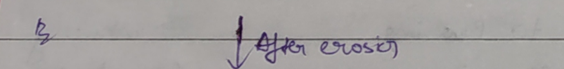
* In dilation, holes decrease & connectivity increases
* In erosion, holes increase & foreground decrease

Ques



After dilation →

After erosion ↓



OPENING

According to structuring element application, increase the size of structuring element

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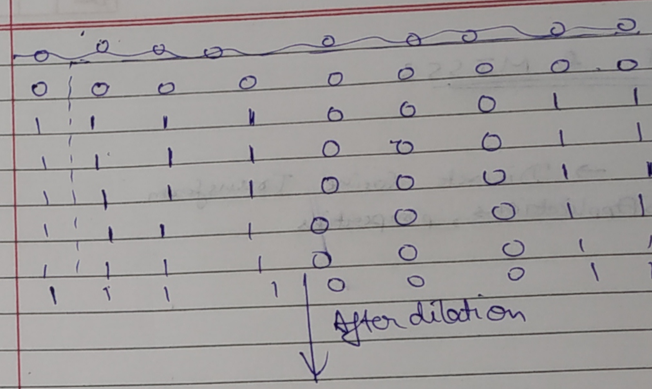
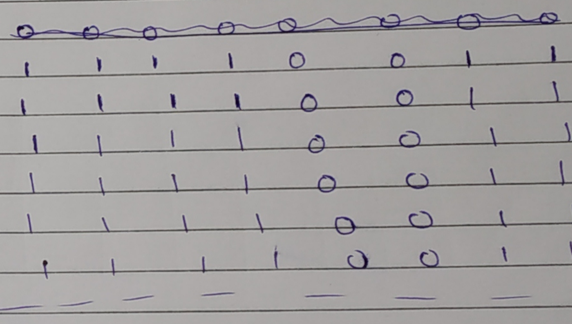
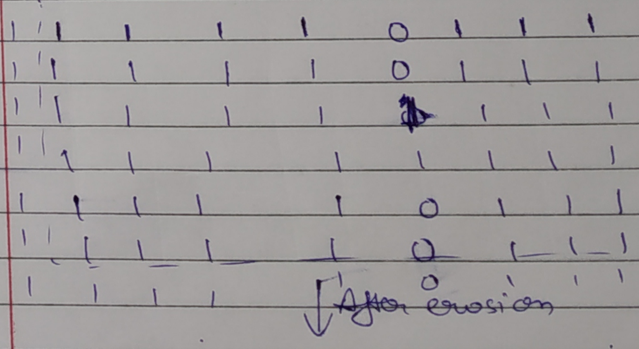


After dilation ↓



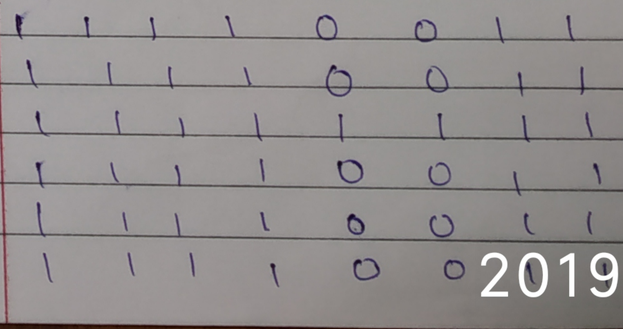
It will break the connectivity b/w pixels

Application: Object Detection



After erosion ↓

CLOSING



It will improve the connectivity

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HIT & MISS:

DCT → Discrete Cosine Transform
↳ Applications, properties