DSP Assignment - 2 A Dilna BE A

Roll no - 21

Q1] i] $r_1 = 3$ $r_2 = 5$

$S = L-1 \quad r_1 \leq r \leq r_2$

$\;\;= r \quad$ otherwise.

Here $L-1 = 7$, $3 \leq r \leq 5$.

So the pixels are

6	2	7	2
1	7	0	7
7	7	2	1
2	7	7	6

ii] Bit Plane Slicing.

Convert the original image into 3-bit binary image.

110	010	011	010
001	101	000	111
100	011	010	001
010	101	111	110

We create three plane.

MSB Plane

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

LSB Plane.

0	0	1	0
1	1	0	1
0	1	0	1
0	1	1	0.

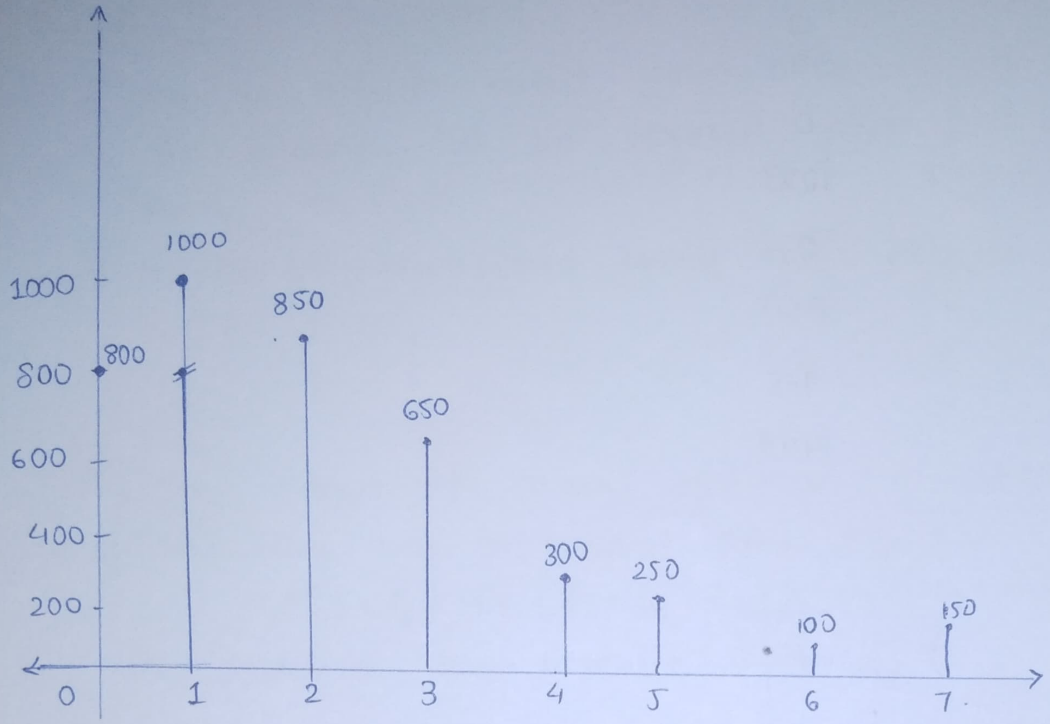
Middle Plane

1	1	1	1
0	0	0	1
0	1	1	0
1	0	1	1.

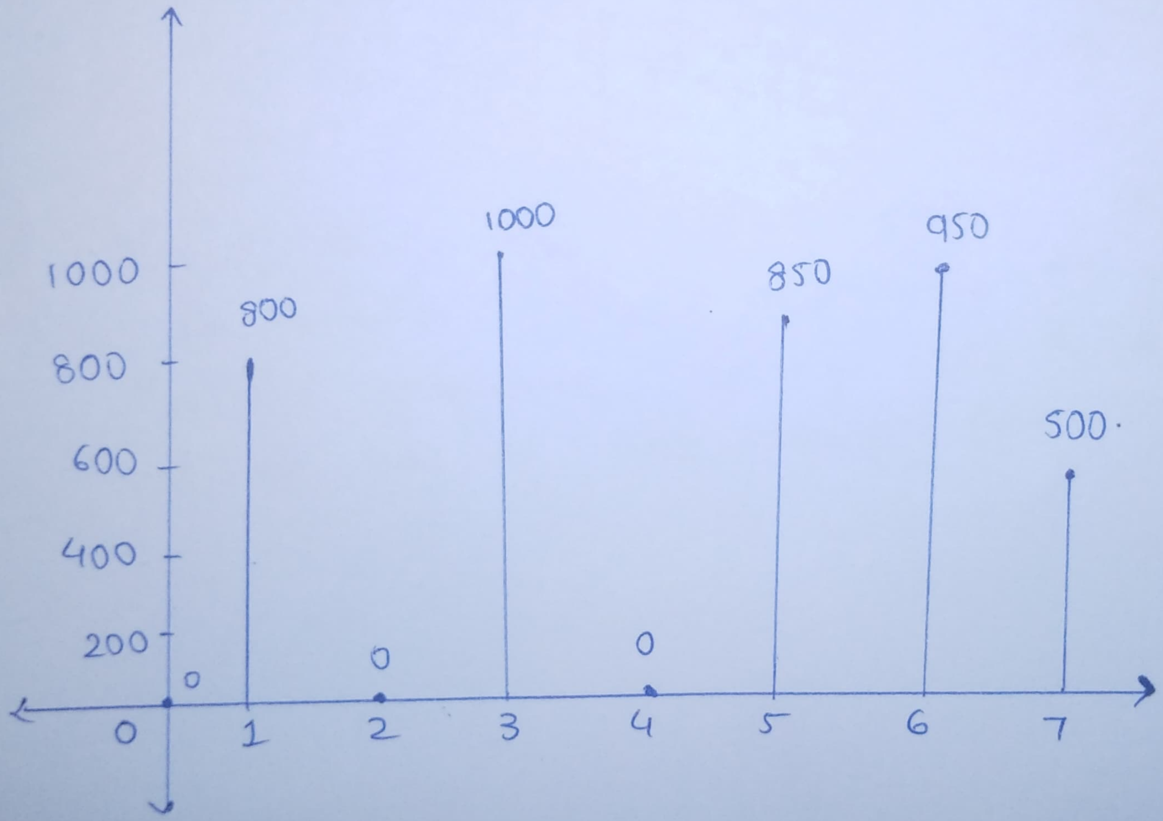
Q2]

Gray Level	0	1	2	3	4	5	6	7	N
No pixel	800	1000	850	650	300	250	100	150	4100

The Histogram ...


1000
850
800
650
300
250
100
150
1000
800
600
400
200
0
1
2
3
4
5
6
7

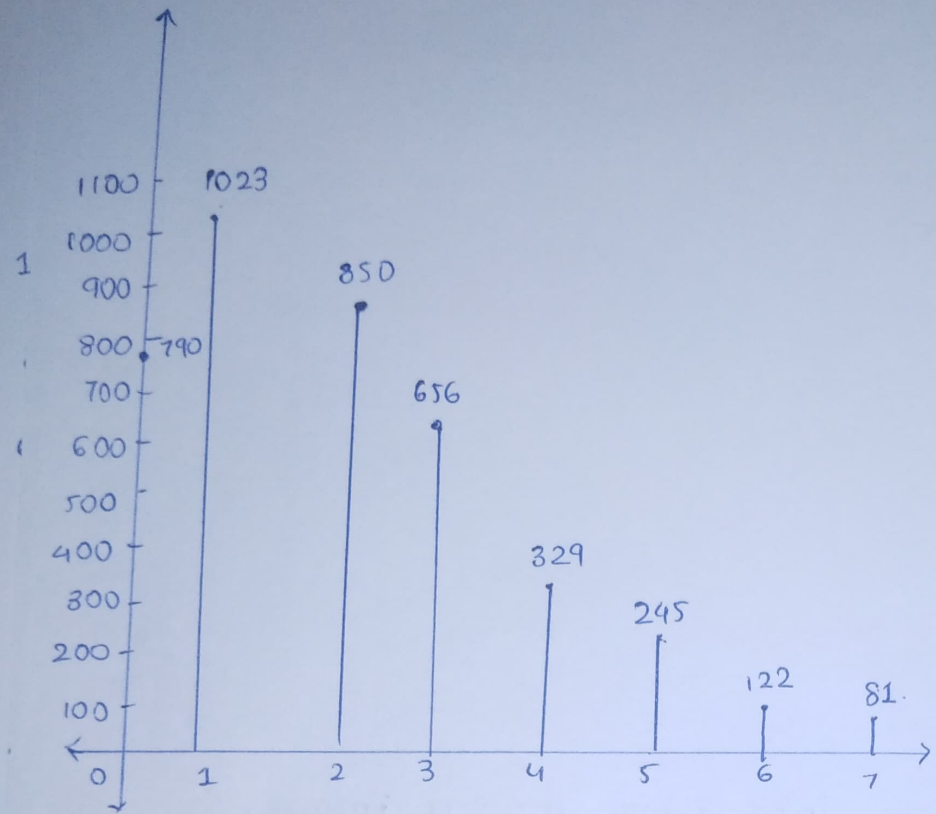
Graylevel	Freq	P(nK)	CDF	CDF*7	Roundup	New Frequency.
0	800	0.195	0.195	1.365	1.	800.
1	1000	0.243	0.438	3.06	3	1000.
2	850	0.207	0.645	4.515	5	850.
3	650	0.158	0.803	5.621	6	950
4	300	0.073	0.876	6.23	6	950
5	250	0.060	0.936	6.65	7	500
6	100	0.024	0.96	6.86	7	500
7	150	0.036	1.	7.	7	500.


1000
800
600
400
200
0
1
2
3
4
5
6
7
0
800
0
1000
0
850
950
500·

Q3]

Gray Level	0	1	2	3	4	5	6	7.	N.
No of pixel	790	1023	850	656	329	245	122	81	4096

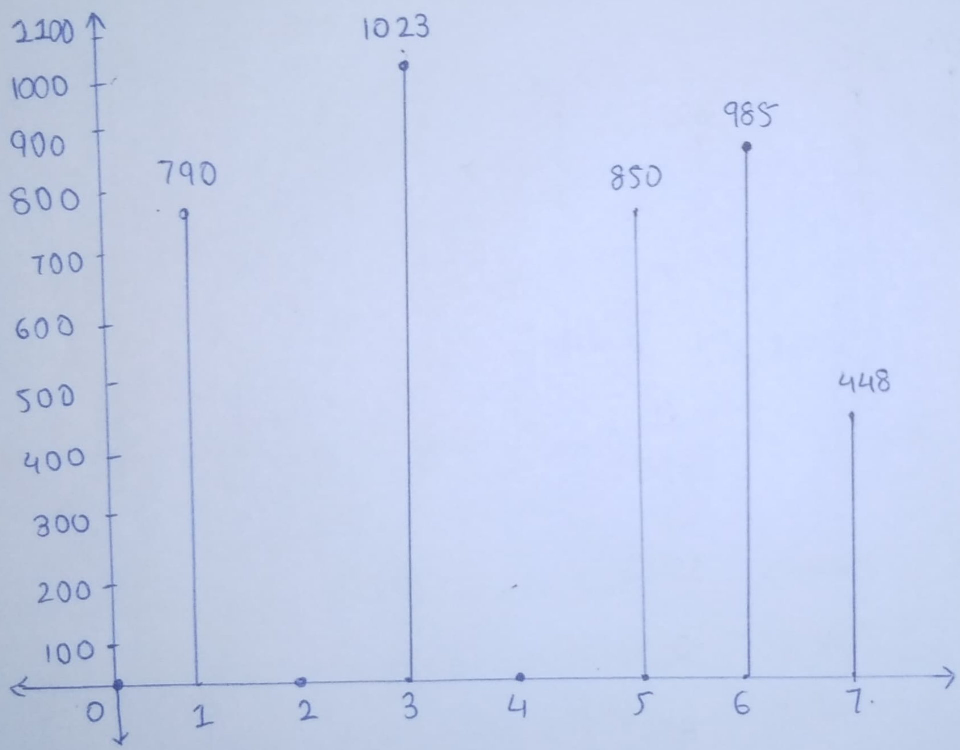
The Histogram -.



1100
1000
900
800
700
600
500
400
300
200
100
790
1023
850
656
329
245
122
81
0
1
2
3
4
5
6
7

Graylevel.	Freq	P(nk)	CDF	CDF * 7	Roundup	New frequency.
0	790	0.19	0.19	1.33	1	790
1	1023	0.25	0.44	3.08	3	1023
2	850	0.21	0.65	4.55	5	850
3	656	0.16	0.81	5.53	6	985
4	329	0.08	0.89	6.23	6	985.
5	245	0.06	0.95	6.86	7	448
6	122	0.03	0.98	6.86	7	448
7	81	0.02	1	7.	7	448

Equalized gray level.	No of pixels.
0	0
1	790
2	0
3	1023
4	0
5	850
6	985
7.	448.



Q4]. a. Point Detection

1] This is used to detect isolated spots in an image
2] The graylevel of an isolated point will be very different from its neighbour.
3] It can be accomplished using the following 3x3 mask -

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

4] The output of mask operation is usually thresholded
5]. We say that an isolated point has been detected if,

$|8 f_5 - (f_1 + f_2 + f_3 + f_4 + f_6 + f_7 + f_8 + f_9)| > T$. for some pre-specified non-negative threshold T.

b. Detection of lines -

1] This is used to detect lines in an image
2] It can be done using following four masks.

$$D_0 = \begin{bmatrix} -1 & -1 & -1 \\ 2 & 2 & 2 \\ -1 & -1 & -1 \end{bmatrix}$$ Detects horizontal lines

$$D_{45^\circ} = \begin{bmatrix} -1 & -1 & 2 \\ -1 & 2 & -1 \\ 2 & -1 & -1 \end{bmatrix}$$ Detect 45° lines

$$D_{90^\circ} = \begin{bmatrix} -1 & 2 & -1 \\ -1 & 2 & -1 \\ -1 & 2 & -1 \end{bmatrix}$$ Detect vertical lines

$$D_{135^\circ} = \begin{bmatrix} 2 & -1 & -1 \\ -1 & 2 & -1 \\ -1 & -1 & 2 \end{bmatrix}$$ Detect 135° lines

3] let R_0, R_{45}, R_{90°, R_{135} respectively be the response to masks D_0, D_{45}, D_{90} & D_{135} respectively. At given pixel (m,n) if R_{135} is maximum among $\{R_0, R_{45}, R_{135}, R_{90}\}$ we say that a 135 line is most likely passing through that pixel

c) Edge Detection-

1] Isolated points & thin lines do not occur frequently in most practical applications

2] For image segmentations, we are mostly interested in detecting the boundary between two regions with relatively distinct gray-level properties.

3) An edge in an image may be defined as discontinuity or abrupt change in gray level.

4) A useful mathematical tool for developing edge detectors is the first & second derative operators.

5) The Sobel edge detector masks are

$$\frac{1}{8}\begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \quad \begin{bmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{bmatrix} \quad \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

6] All masks considered so far have entries that add up to zero. This is typical of any derivative mask

Q5] A] 1st Order Derivative Filter. (Sobel Filter).

1] most edge detection methods work on the assumption that the edge occurs where there is a discontinuity in intensity function or a very steep gradient in image

2] The gradient is a vector, whose components measure how rapid pixel value are changing with distance in x & y direction. Thus, the components of gradient found by using the following eq (1) & (2) -

$$\frac{\partial f(x,y)}{\partial x} = \Delta x = \frac{f(x+dx,y) - f(x,y)}{dx} \quad -(1)$$

$$\frac{\partial f(x,y)}{\partial y} = \Delta y = \frac{f(x,y+dy) - f(x,y)}{dy} \quad -(2)$$

where dx & dy measures distance along the x & y directions respectively. In distance images, one can consider dx & dy in terms of numbers of pixel between two points. $dx = dy = 1$ is the point at which pixel coordinates are (i,j) thus, the value of $(\Delta x$ & $\Delta y)$ can calculated by eq. (3) & (4)

$$\Delta x = f(i+1,j) - f(i,j) \quad -(3)$$

$$\Delta y = f(i,j+1) - f(i,j) \quad -(4)$$

$$\phi = \tan^{-1}\left[\frac{\Delta y}{\Delta}\right] \quad -(5).$$

$$\Delta x = \begin{bmatrix} -1 & 1 \\ 0 & 0 \end{bmatrix} \qquad \Delta y = \begin{bmatrix} -1 & 0 \\ 1 & 0 \end{bmatrix}$$

The Sobel edge operator masks are given as:

$$\Delta x = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \qquad \Delta y = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix}$$

B]. 2nd Order Derivative Operators. (Laplacian Filter).

1]. The Laplacian is a 2-D measure of 2nd derivative of an image. The Laplacian of an image highlights regions of rapid intensity change & is therefore often used for edge detection zero crossing edge detectors.

2]. The Laplacian is often applied to an image that has first been smoothed with something approximating a Gaussian Smoothing fiber in order to reduce its sensitivity to noise.

3] The operator normally takes a single gray level image as input & produces another binary image as output.

4] The derivative operator Laplacian for an image is defined as shown.

$$\Delta^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} \quad - (6).$$

For x-direction, $\frac{\partial^2 f}{\partial x^2} = f(x+1,y) + f(x-1,y) - 2f(x,y) \quad - (7).$

For y-direction, $\frac{\partial^2 f}{\partial y^2} = f(x,y+1) + f(x,y-1) - 2f(x,y) - (8).$

By (7), (8), (6). & (9),

$$\Delta^2 f(x,y) = f(x+1,y) + f(x-1,y) + f(x,y-1) - 4f(x,y) \quad - (9).$$

The value of Mask is

0	1	0
0	-4	1
0	1	0.

Q6] 1] The term spatial domain means working in given space, the image. It implies working with values ~~on~~ in other work, working directly with the raw data.

2]. It can be carried out in 2 different ways.

A] Point Processing

1] We work with single pixels i.e. T is 1×1 operator. It means that new value f(x,y) deper. Some of common examples of point processing are.

a. Digital negative.
b. Contrast Stretching
c. Thresholding
d. Gray level slicing
e. Bit plane Slicing
f. Dynamic range compression

B] Neighbourhood Processing.

i]. Unlike the point processing techniques where we consider one pixel at the time & modify it depending on our requirement, hear we not only consider a pixel but also its immediate neighbour.

ii] we change the value of the pixel $f(x,y)$ based on values of its 8 neighbours. Instead of 3x3 neighbourhood, we could also use a 5x5 or 7x7 neighbourhood.

	y-1	y	y+1
x-1	f(x-1, y-1)	f(x-1, y)	f(x-1, y+1)
x	f(x, y-1)	f(x, y)	f(x, y+1)
x+1	f(x+1, y-1)	f(x+1, y)	f(x+1, y+1)

A 3x3 neighbourhood.

w1	w2	w3
w4	w5	w6
w7	w8	w9

3x3 mask

If f is original image & g is modified image,

$$g(x,y) = f(x-1, y-1) * w1 + f(x-1, y) * w_2 + f(x-1, y+1) * w_3 + f(x, y-1) * w4$$

$$+ f(x,y) * w5 + \dots + f(x+1, y+1) * w9$$

97].

10	10	15	10	10			-1	-1	-1
10	10	15	10	10		*	2	2	2
200	200	200	200	200			-1	-1	-1.
5	5	20	10	10					
5	5	20	10	10.					

Image pixel. Horizontal filter.

⇓

-565	-565	-565
1135	1130	1125
-570	-565	-560.

Since line detection masks are high pass masks, we make negative values zero.

0	0	0
1135	1130	1125
0	0	0.

10	10	15	10	10			-1	2	-1
10	10	15	10	10		*	-1	2	-1
200	200	200	200	200			-1	2	-1
5	5	20	10	10					
5	5	20	10	10					

Image pixel Vertical filter.

⇓

-10	20	-10
-20	35	-15
-30	50	-20.

Since line detection, masks are high pass masks, we make negative values zero.

0	20	0
0	35	0
0	50	0

Q8]. 1]. Smoothing filter is used for blurring & noise reduction in the image.

2] Blurring is pre-processing steps for removal of small details & Noise Reduction is accomplished by blurring.

Types -

A] Mean filter.

1. Linear Spatial filter is simply the average of pixels contained in neighbourhood of filter mask. The idea is replacing the value of every pixel in an image by average of grey level in neighbourhood define by filter mask.

Types -

i] Averaging filter.

ii] weighted averaging filter.

B] order statistics Filter -

i] It is based on ordering the pixels contained in image area encompassed by the filter.

2) It replaces the value of center pixel with the value determined by ranking results. Edges are better preserved in this filtering.

Types -

i] minimum filter

ii] maximum filter

iii]. Median filter.