BCSE 0101: Digital Image Processing

Assignment – I

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MM: 100 **Submission Due Date: March 14, 2022**

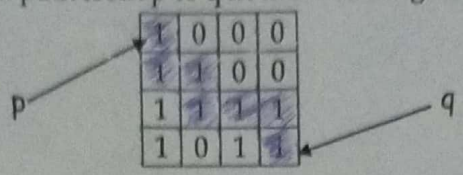
Note:

Take a printout of this assignment and write your answers in the space provided. Scan and upload the filled answer sheet and submit the hardcopy to the faculty.

I. Complete the following statements. **[1 x 10 = 10]**

1. The discretization of image data in spatial coordinates is known as Sampling.
2. The number of bits required to store a 1024 x 512 image with 512 gray shades is 589824 Bytes.
3. The smallest discernible change in the gray level of an image is called its Gray level resolution.
4. When the number of pixels in an image is reduced keeping the number of gray levels in the image constant, we observe checker board effect.
5. When the no. of gray-levels in the image is low, the foreground details of the image merge with the background details of the image, causing ridge like structures. This degradation phenomenon is known as False Contouring.

6. Mark the m-adjacent path from p to q in the following image.



7. Two image subsets S_1 & S_2 are adjacent if

their union forms a connected set. (Pixels in S_1 is adjacent to pixels in S_2. Adjacent can be either 4-, 8- or m-adjacent

8. The distance between pixels p & q in the above image:

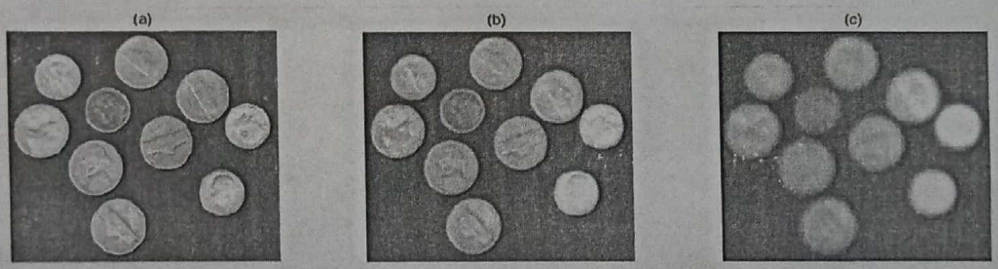
   a. Euclidean distance: $D_e(P,q) = [(x-s)^2 + (y-t)^2]^{1/2} \Rightarrow 3\sqrt{2}$

   b. City block distance: $D_4(P,q) = |x-s| + |y-t| \Rightarrow 6$

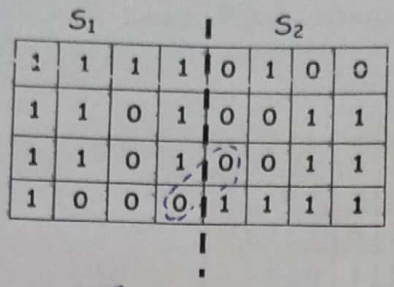
   c. Chess board distance: $D_8(P,q) = \max(|x-s|, |y-t|) \Rightarrow 3$

9. Dark characteristics in an image are better enhanced using Power Law transformation(s).

10. Consider the following images. (a) is the original image. On (b) and (c) average filters of different sizes have been applied. On (c) filter of size 3 x 3 has been applied while on Low Pass (b) filter of size 9 x 9 has been applied.



II. Consider two image subsets S1 & S2 as shown in the following figure. For V= {0} determine whether the regions are: i) 4- Adjacent ii) 8-Adjacent iii) m-Adjacent . Give reasons for your answer. [2 x 3 = 6]



i) 4- Adjacent - Yes / No

Pixels are not in left, right, up & down position to each other.

ii) 8-Adjacent - Yes / No

Pixels are diagonally adjacent.

iii) m-Adjacent- Yes / No

Pixels are diagonally adjacent & common 4-ajacent are not belong to V.

III. Given the following 3 x 3 image, find its bit planes.
Note: There are only 8 Intensity values in the image. [3 x 8 = 24]

1	2	3
4	5	0
7	6	2

1	0	1	0	1	1	0	0	0
0	1	0	0	0	0	1	1	0
1	0	0	1	1	1	1	1	0
Bit Plane 0			Bit Plane 1			Bit Plane 2		

Space for Calculations

IV. Consider the following image. What will be the **new value of the pixel (2, 2)** if smoothing is done using a 3x3: **[1 x 5 = 5]**

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

a) Mean filter 3.9 ≈ 4

b) Weighted average filter 8.1 ≈ 8

(Assign weights as 3, 2 and 1)

c) Median filter 6

d) Min filter 1

e) Max filter 7

V. Compute the convolution of the Laplacian kernels L_4 and L_8 with the image given below. Use border values to extend the image. **[2 x 10 = 20]**

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

0	0	0	0	0
-10	-10	-10	-10	-10
10	10	10	10	10
0	0	0	0	0
0	0	0	0	0

L_4

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

L_8

VI. Perform histogram equalization on the following 8x8 image. The gray level distribution of the image is given below. [15]

Gray levels (r_k)	0	1	2	3	4	5	6	7
Number of pixels (p_k)	8	10	10	2	12	16	4	2

i/p Gray Level (r_k)	No. of pixels (n_k)	$p(r_k) = n_k / MN$	Σ	(L-1) Σ (S_k)	o/p Gray Level	No. of pixels in o/p image
0	8	0.125	0.125	0.875	1	8
1	10	0.156	0.281	1.967	2	10
2	10	0.156	0.437	3.059	3	12
3	2	0.031	0.468	3.276	3	
4	12	0.187	0.655	4.585	5	12
5	16	0.25	0.905	6.335	6	16
6	4	0.0625	0.967	6.769	7	6
7	2	0.031	0.998	6.986	7	

• Total no. of pixels = 64.

VII. For a 8 x 8 image as shown below, generate the linear contrast stretched image with minimum gray level 0 and maximum gray level 7. [10]

Note: $$\frac{r - rmin}{rmax - rmin} = \frac{s - smin}{smax - smin}$$

3	3	3	3	3	3	3	3
3	4	4	4	4	4	4	3
3	4	2	2	2	2	4	3
3	4	2	5	5	2	4	3
3	4	2	5	5	2	4	3
3	4	2	2	2	2	4	3
3	4	4	4	4	4	4	3
3	3	3	3	3	3	3	3

Space for Calculation

rk	sk
0	12
1	0
2	28
3	0
4	0
5	20
6	0
7	4

0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	28	28	28	28	0	0
0	0	28	20	20	28	0	0
0	0	28	20	20	28	0	0
0	0	28	28	28	28	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Output Image

VIII. Assume a 6-bit gray scale image I and consider the spatial filter H given by

$$H = \begin{bmatrix} -1 & -2 & 0 \\ -2 & 0 & 3 \\ 0 & 3 & 1 \end{bmatrix}$$

a) Determine the maximum and minimum possible values that a pixel, to which this spatial filter is applied, can have. Do not apply any type of normalization. [5]

- Positive values : 3, 3, 1 | Negative values : -1, -2, -2
- Max. possible value = $(3+3+1)63 + (-1-2-2)\times 0 \Rightarrow 441$ //.
- Min. possible value = $(3+3+1)\times 0 + (-1-2-2)\times 63 \Rightarrow -315$ //.

$V_{max} = 441$ & $V_{min} = -315$.

b) Propose a gray-level transformation function to ensure that any output of this filter will be a standard 6-bit gray scale image. [5]

- $I_{out} = 63\left(\frac{I_{in} - V_{min}}{V_{max} - V_{min}}\right) \Rightarrow \boxed{63\left(\frac{I_{in} + 315}{756}\right)}$ //.

where,
$I_{in} \rightarrow$ I/P image.
$I_{out} \rightarrow$ O/P image.