BCSE 0101: Digital Image Processing

Assignment – I

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Section: A

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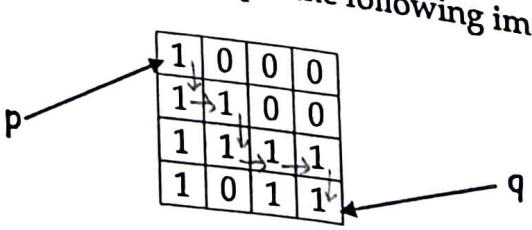
Note:

Submission Due Date: Sept 2, 2022

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

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 1024 x 512 x 9 = 4718592 bits (512 gray shades = 29)
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 checkerboard 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.

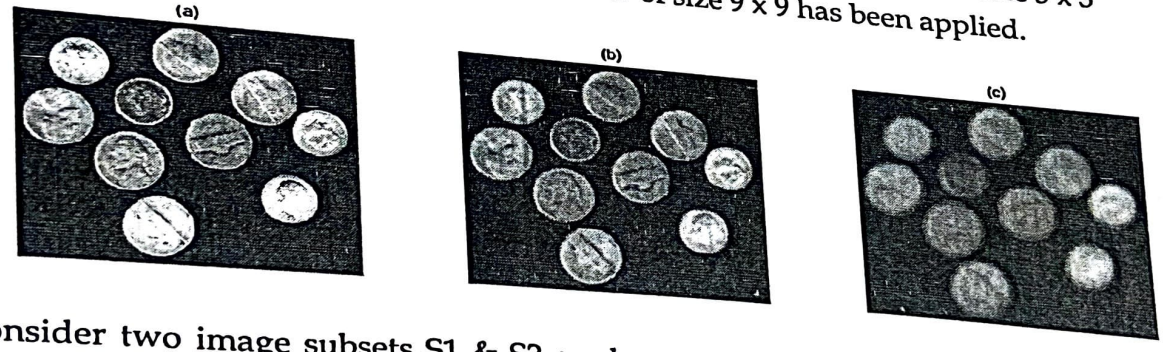


7. The distance between pixels p & q in the above image:
   a. Euclidean distance: $\sqrt{(4-1)^2+(4-1)^2} = \sqrt{18} = 3\sqrt{2}$
   b. City block distance: $|4-1|+|4-1| = 6$
   c. Chess board distance: $\max(|4-1|, |4-1|) = 3$

8. Two image subsets S1 & S2 are adjacent if Some pixel in S1 is adjacent to Some pixel in S2.

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 has been applied. On C filter of size 3 x 3 has been applied while on 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]

S_1				S_2			
1	1	1	1	0	1	0	0
1	1	0	1	0	0	1	1
1	1	0	1	(0)	0	1	1
1	0	0	(0)	1	1	1	1

i) 4- Adjacent – Yes / No

Let a and b be two pixels as shown in figure such that q is not in the set $N_4(p)$ so they are not 4-adjacent

ii) 8-Adjacent - Yes / No

As a and b are adjacent in the given figure so q is in set $N_4(p)$

iii) m-Adjacent - Yes / No

As a and b are adjacent and q is in set $N_4(p)$ and the set $N_4(p) \cap N_4(q) = \phi$

III. Given the following 3 x 3 image, find its bit planes.
Note: There are only 8 Intensity values in the image. [3 x 3 = 9]

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		

IV. 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

MN = 64

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	0.15625	0.28125	1.96875	2	10
2	10	0.15625	0.4375	3.0625	3	12
3	2	0.03125	0.46875	3.28125	3	
4	12	0.1875	0.65625	4.59375	5	12
5	16	0.25	0.90625	6.34375	6	16
6	4	0.0625	0.96875	6.78125	7	6
7	2	0.03125	1.0	7.0	7	

V. 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:

$$\frac{r - r_{min}}{r_{max} - r_{min}} = \frac{s - s_{min}}{s_{max} - s_{min}}$$

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

Gray level	
0	0
1	0
2	12
3	28
4	20
5	4
6	0
7	0

Space for Calculation

$$r = \frac{s - s_{min}}{s_{max} - s_{min}} \times (r_{max} - r_{min}) + r_{min}$$

$r_{min} = 0$
$r_{max} = 7$
$s_{min} = 2$
$s_{max} = 5$

$$r = \frac{s - 2}{5 - 2} \times (7 - 0) + 0$$

$$r = \frac{(s-2)}{3} \times 7$$

for At $s = 2$
$\Rightarrow r = 0$

At $s = 3$
$\Rightarrow r = 2.33 \approx 2$

At $s = 4$
$r = 4.66 \approx 5$

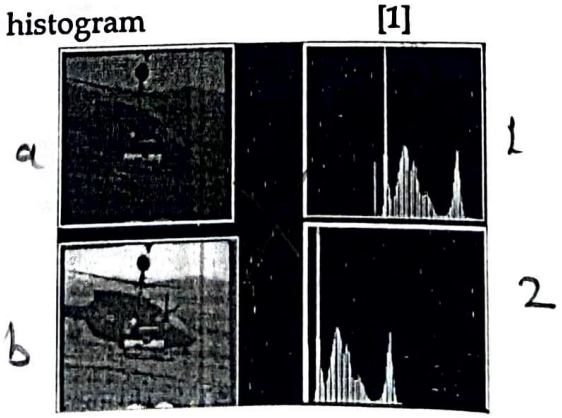
At $s = 5$
$r = 7$

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

2	2	2	2	2	2	2	2
2	5	5	5	5	5	5	2
2	5	0	0	0	0	5	2
2	5	0	7	7	0	5	2
2	5	0	7	7	0	5	2
2	5	0	0	0	0	5	2
2	5	5	5	5	5	5	2
2	2	2	2	2	2	2	2

Output Image

VI. Match the image to its histogram [1]



b → 1

a → 2

MN = 64

VII. Perform Histogram Specification between the following histograms [15]

Original Image Histogram Equalization

I/p Gray Level (r_k)	no. of pixels (n_k)	$p(r_k) = n_k/MN$	Σ	$(L-1)\Sigma$	O/p Gray Level (s)
0	2	0.03125	0.03125	0.21875	0
1	3	0.046875	0.078125	0.546875	1
2	5	0.078125	0.15625	1.09375	1
3	6	0.09375	0.25	1.75	2
4	9	0.140625	0.390625	2.734375	3
5	12	0.1875	0.578125	4.046875	4
6	14	0.21875	0.796875	5.578125	6
7	13	0.203125	1.0	7.0	7

Specified Image Histogram Equalization

I/p Gray Level (r_k)	no. of pixels (n_k)	$p(r_k) = n_k/MN$	Σ	$(L-1)\Sigma$	O/p Gray Level (s)
0	13	0.203125	0.203125	1.421875	1
1	12	0.1875	0.390625	2.734375	3
2	14	0.21875	0.609375	4.265625	4

3	14	0.21875	0.828125	5.796875	6
4	11	0.171875	1.0	7.0	7
5	0	0	1.0	7.0	7
6	0	0	1.0	7.0	7
7	0	0	1.0	7.0	7

r_k	z_q	No. of pixels
0	0	2
1	0	3
2	0	5
3	0	1
4	1	9
5	2	12
6	3	14
7	4	13

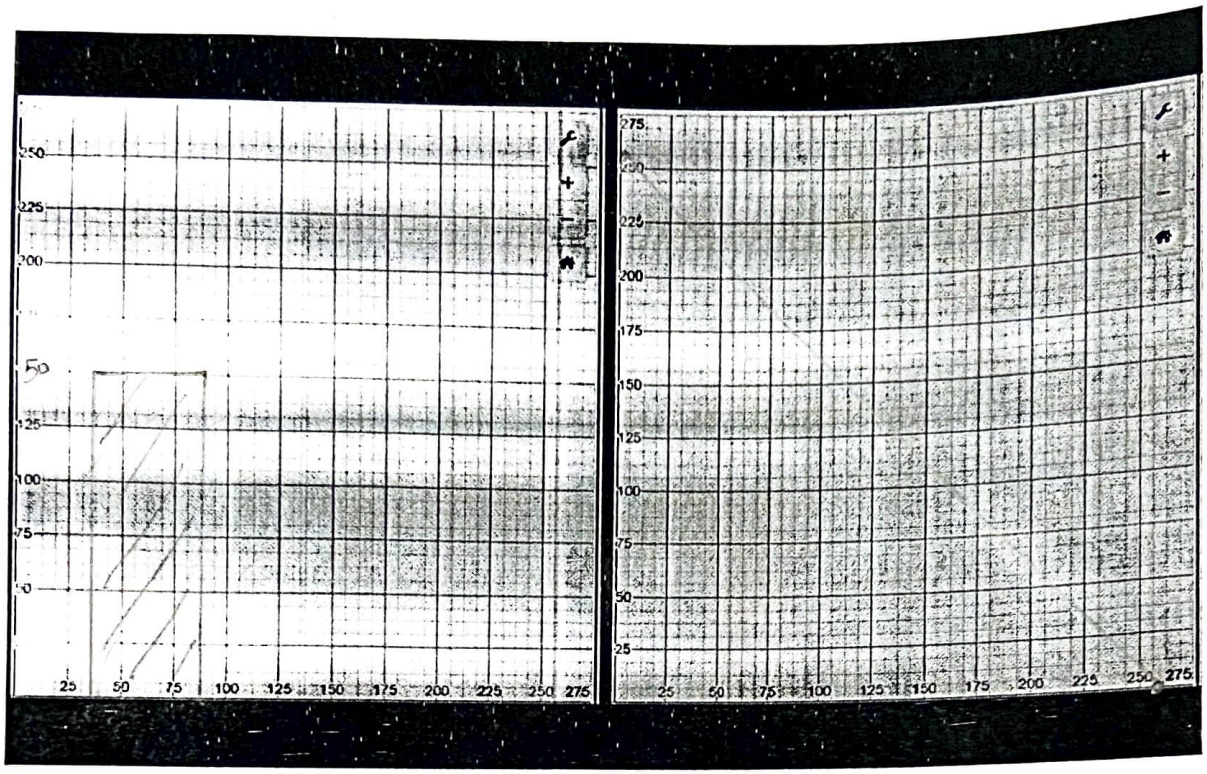
16

VIII. An 8-bit digital image has a histogram where the gray levels are equally distributed in the range from 160 to 220 (uniform distribution). Sketch the new histograms for each operation as well as the transformation functions for each, and describe the produced effect on the image contrast and brightness.

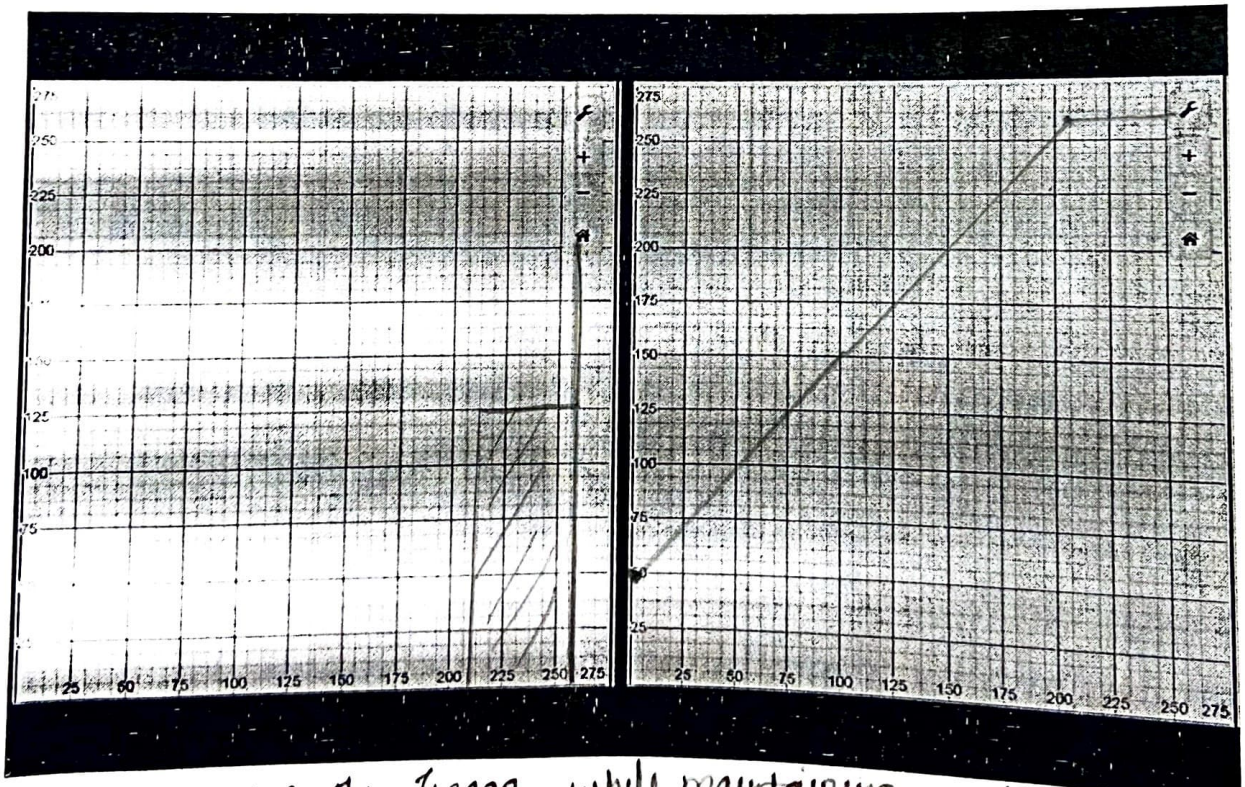
a) Calculation of the image negative [4 + 4 + 2]
b) Addition of 50 to all pixel gray levels [4 + 4 + 2]
c) Application of a thresholding function where the threshold is selected as gray level 128. [4 + 4 + 2]

a) All pixels which were 160 become (255-160) => 95 and All pixels which were 220 become (255 - 220) = 35.
The Image will be The Inverse.
The Image will still have low contrast but now it will be darker.
Transformation function S = (L - 1 - r)

(a)

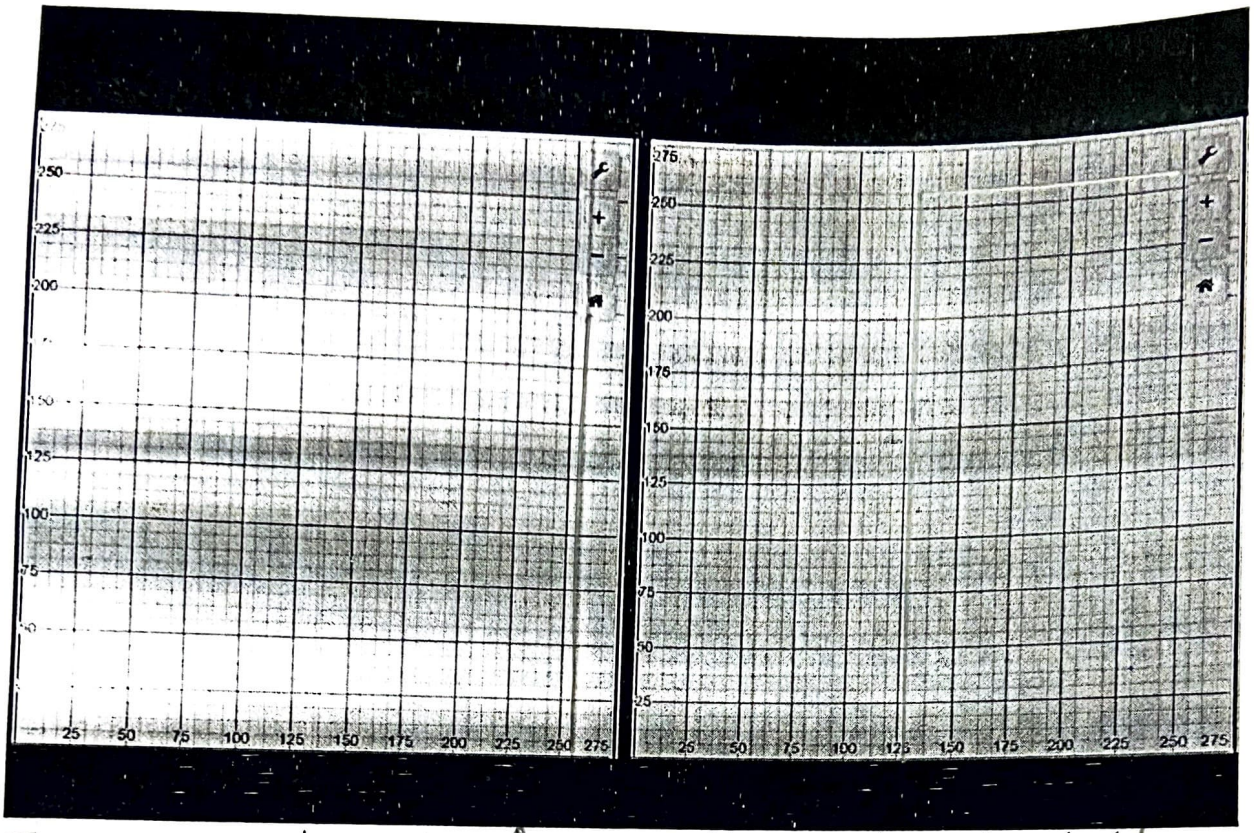


(b)



(b) This will lighter the Image while maintaining a poor contrast. Addition of 50 to all pixels gray levels and now grayscale values b/w 206 and 220 to grayscale 255. This will make more pixels have value 255 resolving the contrast. (0,50) to (205, 255)

(c)



(c) This will make the entire image white as the threshold is set below every grey scale value in this image.
This histogram will have values only at 255.

IX. Suppose you want to send two episodes of one hour each of Big Bang Theory to your friend. In HD video the frame size is 1920 x 1080. The frames are sent at a rate of 30 fps. The display is 8-bit RGB. How many bits will you have to send? [4]

Total given time : 2 hours = 7200 sec
Frame rate : 30 fps
So, Total frame : $30 \times 7200 = 216000$ frames
Now frame size = 1920×1080
display = 8-bit RGB = 24 bit pixel
Total pixels in 1 frame = 2073600 pixels
Total bits in 1 frame = 49766400 bits
So, Total bits in 216000 frames : 216000×49766400
$= 1.074954 24 \times 10^{13}$ bits