Unique Paper Code : 32347509
Name of the Course : B.Sc. (H) Computer Science (LOCF)
Name of the Paper : Digital Image Processing (DSE II)
Semester : V
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Duration: 3 Hours Maximum Marks: 75

Attempt any **four** questions.
All questions carry equal marks.

Q1. Consider the following sub-image **I**:

5(**p**)	4	3	2	5	5	4
5	3	4	4	3	2	4
3	4	5	4	4	3	3
2	2	5	5	4	3	2
5	4	3	5	5	2	3
5	5	3	3	4	4	4(**q**)

(I)

Let **T** = {3, 4, 5} be the set of gray level values used to define adjacency of pixels. Determine whether the pixels **p** and **q** are a) 4-adjacent, b) 8-adjacent and c) *m*-adjacent w.r.t **T**. If yes, show and compute the length of the shortest 4-path, 8-path and *m*-path between them w.r.t the set **T**.

Q2. Give one advantage and one disadvantage of a filter based on first-order derivatives over a filter based on the second-order derivatives. Calculate the first-order partial and second-order partial derivatives for the given 1-D signal. How many zero crossings are there?

7	7	7	7	6	6	6	6	6	5	5	2	1	1	1	1	5	5	5	5

Q3. Consider the following 5-bit sub-image (**I**) of size 6x6:

0	10	5	2	4	2
1	2	3	2	3	4
5	2	3	2	3	2
3	4	3	4	3	4
2	3	5	2	2	3
1	2	0	7	2	5

(**I**)

Plot the histogram of the given sub-image (**I**). Interpret the histogram of the above gray scale image. Improve the contrast of the image **I** using histogram equalization. Briefly explain one filter each in spatial and frequency domain to sharpen the resultant image.

Q4. Consider a 3-bit sub-image **I** of size10 x 10 with 3 different grey levels (black, grey, white).

7	7	7	7	7	7	7	7	7	7
7	7	7	7	7	7	7	7	7	7
7	7	7	7	7	7	7	7	7	7
7	7	7	7	7	7	7	7	7	7
4	4	4	4	0	4	4	4	4	4
4	4	4	4	4	0	4	4	4	4
7	7	7	7	7	7	7	7	7	7
7	7	7	7	7	7	7	7	7	7
7	7	7	7	7	7	7	7	7	7
7	7	7	7	7	7	7	7	7	7

(**I**)

- Compute the variable length Huffman code for the given sub-image (**I**).
- Calculate the following w.r.t the image **I**:
  - Average length of the fixed length code and Huffman code.
  - Entropy of the image.
  - Compression ratio and relative coding redundancy.

Q5. Consider the given equations (1), (2) and (3), where $g(x, y)$ is the corrupted image, $g_r(x, y)$ is the remaining image obtained after removing d/2 lowest and d/2 highest gray level values of g(x, y) and $\hat{f}(x, y)$ is the corresponding restored image. S_{xy} represents the set of coordinates in a rectangular sub-image window (neighborhood) of size m x n centered at point (x, y) and Q is the order of the filter.

$$\hat{f}(x,y) = \frac{mn}{\sum_{(s,t)\in S_{xy}} \frac{1}{g(s,t)}} \qquad (1)$$

$$\hat{f}(x,y) = \frac{\sum_{(s,t)\in S_{xy}} g(s,t)^{Q+1}}{\sum_{(s,t)\in S_{xy}} g(s,t)^{Q}} \qquad (2)$$

$$\hat{f}(x,y) = \frac{1}{mn-d} \sum_{(s,t)\in S_{xy}} g_r(s,t) \qquad (3)$$

- ❖ Answer the following questions:
  - Write the name of the filters represented by the equations (1), (2) and (3).
  - Which type(s) of noise can be removed by the filters for the given equations (1), (2) and (3).
  - What is the effect of the filter given in equation (2) for positive, negative and zero values of Q?
- ❖ Answer the following questions for the given equation (3):
  - How can this filter be converted into two other order statistics filters?
  - Apply the filter given in equation (3) on the given image (**A)** of size 5x5 at pixel **x** for d = 4 and filter size 3x3.

3	3	4	4	3
6	2	2	1	3
4	4	5(**x**)	3	2
5	4	4	3	6
1	2	3	4	4

(**A)**

Q6. Fill the hole in the given 10 x 6 binary sub-image **A** using structuring element **B** (origin is at the center). Show all the intermediate steps.

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

(A)

0	1	0
1	**1**	1
0	1	0

(B)