Date of Examination: 29 March 2023

AHSANULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Department: Computer Science and Engineering

Program: Bachelor of Science in Computer Science and Engineering

Semester Final Examination: Spring 2022

Year: 4th **Semester: 2nd**

Course Number: CSE 4227

Course Name: Digital Image Processing

Time: 3 (Three) hours **Full Marks: 70**

Instruction: *There are seven (7) questions. **Question#1 is mandatory to answer.** Answer any **other four (4)** questions out of six (6) from question#2 to question#7. Marks allotted are indicated in the right margin.*

Question 1. [Marks: 18]

a) i. Explain with an example how a spatial filter affect an image. [2] [9]

ii. Suppose we have a 3x3 image as [(2, 5, 8), (5, 1, 3), (4, 7, 2)]. Now if we apply an average filter on this image of size 3x3 and zero padding is considered, what would be the filtered output image? [4]

iii. Explain why the output of applying a median filter preserves more edge sharpness in compared to that of applying an average filter. [3]

b) Consider the simple 3x3, 8 bit image as [(3,4,7),(3,4,7),(3,4,7)]. Suppose you want to compress the image using a loss less Lempel-Ziv-Welch (LZW) fixed length coding algorithm. [9]

i. Generate your new codebook using 9 bits and illustrate your step by step LZW encoding process for the above image. [5]

ii. What kind of redundancy of image data it reduces in your encoding process? Explain. [2]

iii. Any compression achieved by employing LZW in your above encoding process? Proof it. [2]

Answer any *FOUR (4)* questions from the following:

Question 2. [Marks: 13]

a) The locations of two points (r1, s1) and (r2, s2) control the shape of transformation function in Piecewise Linear Transformation. Now illustrate the relation between (r1,s1) and (r2,s2) for [5]

i. Linear Identity function. [1]

ii. Thresholding function. [2]

iii. Contrast Stretching function. [2]

b) Consider a 4x4 image with 5-bit gray values [(11,10,12,7),(6,8,7,7),(5,6,11,11), (9,9,7,7)]: [8]

i. Calculate the histogram of image. [1]

ii. Compute and sketch the normalized histogram of the image. [2]

iii. Compute and sketch the equalize histogram of the image. [4]

iv. Sketch the transformation curve. [1]

Question 3. [Marks: 13]

a) i. Mention two techniques those made the digital representation of analog world possible. [3] [5]

ii. "The more intensity level used, the finer level of detail discernible in an image"- explain why? [2]

b) Consider the image below with V = {0, 1, 2, 4} and answer the followings: [8]

	0	1	2	3	
p 0	1	4	3	4	r
1	2	3	4	7	
2	0	5	1	6	
3	3	4	7	1	q

p (0, 0)
r (3, 0)
q (3, 3)

i. What are the properties of Distance Function for Distance Metrics if there are 3 pixels p, q and r? [2]

ii. Calculate the distances: $D_4(p,q)$, $D_4(p,r)$, $D_8(p,q)$ and $D_e(p,q)$. [2]

iii. Define the terms $N_4(p)$, $N_D(p)$ and $N_8(p)$ of above image. [1.5]

iv. Does 4-path exist between p and q? Explain your answer. [1]

v. Does m-path exist between p and q? Explain your answer. [1.5]

Question 4. [Marks: 13]

a) Describe two different morphological basic operations along with mathematical equations. Explain the effects of them and give examples of their applications. [5]

b) Consider the following image F and structuring element B: [8]

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

F

1
1
1

B

Compute the followings:

i. Reflection of B

ii. F dilated by B

iii. F^c eroded by B

iv. (F dilated by B) – F

v. Opening of F by B (and also write the process with mathematical equation)

vi. Closing of F by B (and also write the process with mathematical equation)

Question 5. [Marks: 13]

a) i. Why image compression is needed? [1] [5]

ii. How many and what types of data redundancies are there in an image? [2]

iii. A 512 X 512 8-bit image with 5.3 bits/pixel entropy is to be Huffman Coding. What is the maximum compression that can be expected? [2]

b) Consider the simple 3x3, 8 bit image [(18,16,16),(11,11,14),(11,14,16)]. Suppose you want to compress the image using Huffman code algorithm. [8]

i. Illustrate your Huffman encoding process for the above image. [3]

ii. Compute the entropy of the above image. [2]

iii. What kind of redundancy of image data it reduces in your encoding process? Is it a loss less compression technique? [1]

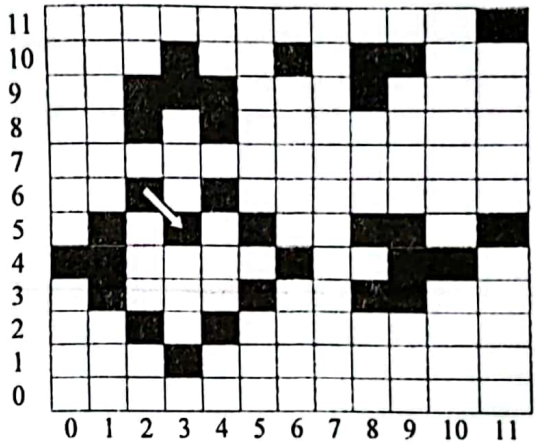
iv. Any compression achieved by employing Huffman coding in your above encoding process? Proof it. [2]

Question 6. [Marks: 13]

a) How many steps are in Canny Edge detection algorithm and what are the steps? Explain any one step of them. What are the false positive and the false negative edge pixels? How canny reduces these errors? [5]

b) i. Suppose we have a 3x3 image with values as [(3, 7, 6), (2, 5, 8), (3, 4, 7)]. Using Sobel operator on the image illustrate the gradient magnitude image. Also, find the edge direction of central pixel. [4] [8]

ii. Consider the following image where each black square denotes a point and the numbers are the coordinates.



Find the Chain Code of the above image that is invariant in starting point and rotation. An arrow marks the reference pixel and the direction. Use 8-neighbor relationship. [4]

Question 7. [Marks: 13]

a) Describe the RGB color model with schematic of RGB color cube. [5]

b) i. Why RGB color model is called ***'Additive'*** where as CMYK is called ***'Subtractive'***? [4] [8]

ii. What is the basic differences between RGB image and Indexed color image? Which representation is preferred in case of storage and transmission? [4]