Date of Examination: 12/04/2022

AHSANULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Department: Computer Science and Engineering

Program: Bachelor of Science in Computer Science and Engineering

Semester Final Examination: Spring 2021

Year: 4th Semester: 2nd

Course Number: CSE4227

Course Name: Digital Image Processing

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

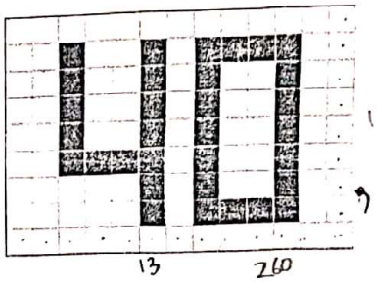
Instruction: *There are seven questions carrying a total of 14 marks each. Answer any five questions. Marks allotted are indicated in the right margin.*

Question 1. [Marks: 14]

a) What is histogram of an image? Describe the histogram equalization algorithm. Consider {(9, 9, 7, 7), (5, 6, 11, 11), (6, 8, 7, 7), (11, 10, 12, 7)} is a 4X4 image with 4-bit gray values. Compute and sketch the equalize histogram of it. [8]

b) Consider Recursive_40.bmp is a 180 × 260 binary image. [6]

i. Calculate the histogram of Recursive_40.bmp.
ii. Calculate the bit size of Recursive_40.bmp.
iii. Describe how the histogram differ for the dark, bright, low contrast or high contrast image of the same scene.



Recursive_40.bmp

Question 2. [Marks: 14]

a) What is Edge? How many steps are there in Canny Edge Detection Algorithm and what are the steps? Explain the step Non Maximum Suppression. What are the false positive and the false negative edge pixels? How does canny reduce these errors? [8]

b) What is region based Segmentation? Explain two techniques of image segmentation: **Region Growing** and **Region Splitting & Merging,** with examples. [6]

Question 3. [Marks: 14]

a) [8]

i. Define the average filter. How does it affect an image?
ii. What can be removed by using smoothing filter?
iii. Suppose we have a 3x3 image with values as [2, 5, 8, 5, 1, 3, 4, 7, 2]. Now if we apply average filter on this image of size 3x3 and zero padding is used, what would be the value of the filtered image?
iv. Suppose we have an image that has salt-and-pepper noise. Which filtering technique will be the best choice to denoising this image? Explain how it works.

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b) What is an image gradient operator? Suppose we have a 5x5 image with values as [(3, 7, 6, 2, 0), (2, 5, 8, 5, 1), (3, 4, 7, 2, 4), (1, 4, 3, 4, 2), (3, 7, 4, 5, 2)]. Now if we apply a Sobel operator on the point (3,3) of the image what will be the gradient magnitude of point (3,3) and the gradient direction? Find the edge direction on the same point. [6]

Question 4. [Marks: 14]

a) Define the Power Law intensity transformation function that enhance an image. What is gamma Correction? For a given image using power law transformation function, what will be the effect on output image: [8]

i. if $\gamma > 1$?
ii. if $\gamma < 1$? and
iii. if $\gamma = 1$?

Suppose, you have made a software which performs intensity transformation of a given image using power law transformation. In default setting, it uses $\gamma = 2.5$.

iv. Now if a user changes $\gamma = 5.0$, what will be the effect on the output image?
v. Repeat iv for $\gamma = 0.04$.

b) Define the Bit Plane Slicing method. What are the three main goals of bit plane slicing? [6]
Consider I = {(150, 60), (60, 210)} as a 2 X 2 image with 8-bit gray values.

i. Give 8 bit planes of I.
ii. Determine the reconstructed image using bit planes 8 and 7.

Question 5. [Marks: 14]

a) [8]

i. Why do we need image compression?
ii. How many types of data redundancies are there in an image?
iii. Define a loss less compression technique.
iv. Write down the properties of Arithmetic coding.
v. Consider the Table-1 below that represents the five-symbol sources with the probabilities and initial subintervals. What is the Arithmetic code for the sequence $a_1a_4a_3a_4a_2a_5$?

Source Symbol	Probability	Initial Subinterval
a_1	0.2	[0.0, 0.2)
a_2	0.2	[0.2, 0.4)
a_3	0.3	[0.4, 0.7)
a_4	0.2	[0.7, 0.9)
a_5	0.1	[0.9, 1.0)

Table-1

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b) Given a 5x5 pixel image and respective pixel values (8-bit code for each pixel) below, [6]

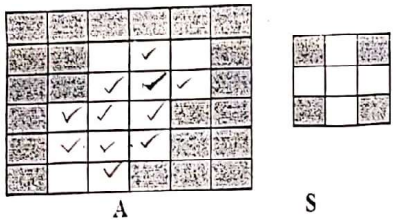
180	160	160	140	120
110	110	120	140	120
110	140	120	120	140
120	160	160	170	170
170	120	110	140	110

An 8-bit Image

i. Compute the entropy of the image.
ii. Calculate the respective Huffman Codes for each pixel value.
iii. What is the compression ratio achieved by employing Huffman Coding instead of 8-bit fixed length coding?
iv. Calculate the relative data redundancy of the given 8-bit image.
v. Compute the effectiveness of the Huffman coding.

Question 6. [Marks: 14]

a) i. Describe two different morphological basic operations along with mathematical equations. Explain the effects of them and give examples of their applications. [8]
ii. Explain if it is possible to achieve edge detection using morphological basic operations. Write down the algorithm of your operation of edge detection.

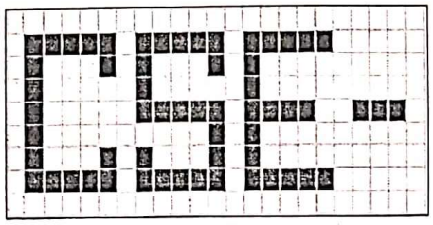


A S

Given an image **A** and a structuring element **S** above. Considering white pixels are foreground and dark pixels are background, compute the followings:

iii. Sketch the result of Erosion of A by S
iv. Sketch the result of Opening of A by S

b) i. What is Hit and Miss transformation in image morphology? [6]
ii. Design four Hit-or-miss transformation structure elements (SEs) for locating four connected endpoints of an image and show them. Perform your all SEs to the image below and use OR/ADD operation to combine the four results. How many corners will be detected in your final output image? Draw your final output image.



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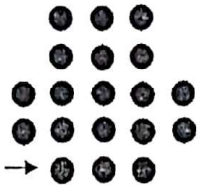
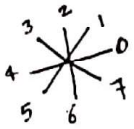
Question 7. [Marks: 14]

a) What is image representation? What information we can use to represent an image? What is Chain Code? Describe the Problems in Chain Code Representation. Find the Chain Code of the following image. An arrow marks the reference pixel and the direction. [Use 8-neighbor relationship]. [8]





b) Consider the image segment shown on the table where V be the set of gray level values used to define the connectivity in the image. Compute D_4, D_8 and D_m distances between pixel P and Q for, [6]

i. V= {2, 3}
ii. V= {2, 6}

2(P)	3	2	6	1
6	2	3	6	2
5	3	2	3	5
2	4	3	5	2
4	5	2	3	6(Q)

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