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AHSANULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Department: Computer Science and Engineering
Program: B.Sc. in Computer Science and Engineering
Semester Final Examination: Fall 2020
Year: 4th Semester: 2nd
Course Number: CSE4227
Course Name: Digital Image Processing

Time: 2 (Two) Hours **Full Marks: 50**

Use separate answer script for each part

Instructions:	i)	Answer script should be hand written and should be written in A4 white paper. You must submit the hard copy of this answer script to the Department when the university reopens.
	ii)	You must write the following information at the top page of each answer script: **Part A/Part B** **Department:** **Program:** **Course no:** **Course Title:** **Examination:** **Semester (Session):** **Student ID:** **Signature and Date:**
	iii)	Write down Student ID, Course number and put your signature on top of every single page of the answer script.
	iv)	Write down page number at the bottom of every page of the answer script.
	v)	Upload the scan copy of your answer script in PDF format through provided **google form** at the respective course site (i.e., **google classroom)** using institutional email within the allocated time. Uploading clear and readable scan copy (uncorrupted) is your responsibility and must cover the full page of your answer script. However, for clear and readable scan copy of the answer script student should use only one side of a page for answering the questions.
	vi)	You must avoid **plagiarism,** maintain **academic integrity and ethics**. You are not allowed to take any help from another individual and if taken so can result in stern disciplinary actions from the university authority.
	vii)	Marks allotted are indicated in the **right margin.**
	viii)	Assume any reasonable data if needed.
	ix)	Symbols and characters have their usual meaning.
	x)	Before uploading rename the PDF file as **CourseNo_StudentID_PartNo.pdf** For example, CSE4227_170103001_PartA.pdf CSE4227_170103001_PartB.pdf

PART A

The answer script (**one single pdf file**) of this part (**Part A)** must be uploaded at designated location in the provided **google form link** available in the google classroom.

There are 3 (Three) Questions. Answer any 2 (Two).

Question 1. [Marks: 12.5]

a) Image compression algorithms are developed by taking advantage of the redundancy that is inherent in image data. How many primary types of redundancies are there in an image and what are those? Discuss one redundancy type that can be overcome using variable length code words. [2+4] **[6]**

b) Given a 5x5 pixel image and respective pixel values (8-bit code for each pixel) below, **[6.5]**

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

i. What is Entropy? Give the equation to calculate Entropy. [1+0.5]

ii. Compute the entropy of the image. [1]

iii. Calculate the respective Huffman Codes for each symbol (each pixel value). [2]

iv. What is the compression ratio achieved by employing Huffman Coding instead of 8-bit fixed length coding? [1]

v. Calculate the relative data redundancy of the given 8-bit image. [1]

Question 2. [Marks: 12.5]

a) i. What is the limitations in parameter space representation in Hough transform? [1]

ii. Using Hough transform, show that the points (1,2), (2,2) and (3,4) are collinear. Also find the equation of the line. [5] **[6]**

b) i. Explain the basic three steps of Edge Detection. [3]

ii. What is false positive and false negative edge pixels? How it overcomes in Canny edge detection algorithm? [3.5] **[6.5]**

Question 3. [Marks: 12.5]

a) **[6]**

i. Define Erosion and Dilation with set theory. [3]

ii. The figure shows an 8 × 8 image (A) and a disk structuring element(B)

Image A

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

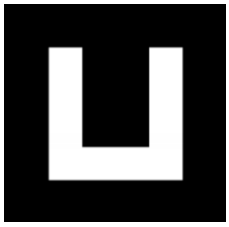
Structuring Element B

	1	
1	1	1
	1	

a. Sketch the result of Erosion of A by B. [1]
b. Sketch the result of Dilation of A by B. [1]
c. Sketch the result of Closing of A by B. [1]

b) **[6.5]**

i. Consider the binary image A shown below on the left. Show the result of applying the following (as mentioned the operations on the right) with a 3x3 structuring element S.



$$B = (A \oplus S) \cap A^c$$

$$B = (A \oplus S) \cup A^c$$

Just draw the resulting images B. Indicate it clearly on your drawing the white and black parts. No need to show your calculations. [3]

ii. What is the objective of sharpening spatial filters? The following figure shows a 3-bit image of size 5-by-5 in the square. Calculate the gradient magnitude and angle using **Sobel mask** at the highlighted center pixel. [3.5]

5x5 Image

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

PART B

The answer script (**one single pdf file**) of this part (**Part B)** must be uploaded at designated location in the provided **google form link** available in the google classroom.

There are 3 (Three) Questions. Answer any 2 (Two).

Question 4. [Marks: 12.5]

a) Consider the following matrix, which is part of an image. **[6]**

q	w	
	p	
	u	

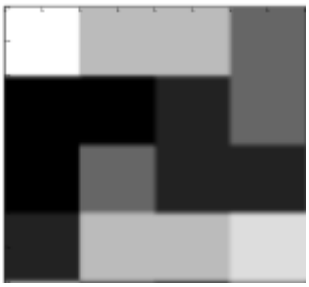
The values of pixels p, q, u and w belong to set V, which is the set of intensity values used to define adjacency.

i. Are pixels p and q 4-adjacent? Are they 8-adjacent? Are they m-adjacent? Provide one answer to each question.

ii. What is the Euclidean distance, the chessboard distance and the city-block distance between pixels q and u?

iii. Is there a 4-path from pixel u to pixel q? If so, what is it?

b) Consider the following 4 × 4 image (at the left) with respective pixel values (at the right). Zoom it to a 6 × 6 image using nearest neighbor interpolation. **[6.5]**



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

Question 5. [Marks: 12.5]

a) An image f(x, y) with dimensions M = 512 and N = 512 has the following 2-D DFT. Find the image f(x, y) and comment on the spatial frequency of the image. **[5.5]**

$$F(u,v) = \begin{cases} 1, & u = 0,\ v = 8 \\ 1, & u = 0,\ v = N - 8 \\ 0, & \text{otherwise} \end{cases} .$$

b) Figure presents the result of applying a filter to an image below. Now answer the following questions. **[3]**

i. What type of filter do you think was used? Justify your answer.

ii. Propose at least one way to improve the result.

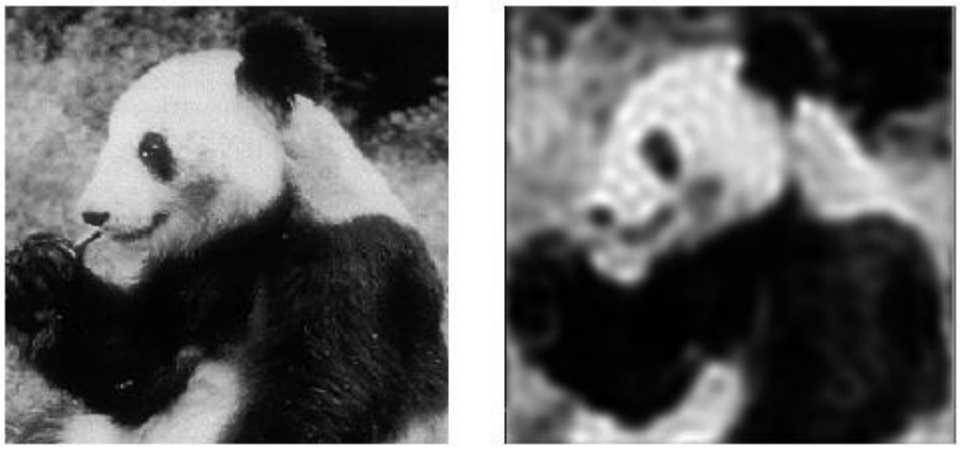


Figure: Image before filtering (left) and after filtering(right)

c) Consider the following 2 x 2 spatial-domain image where the pixel with value 2 has coordinates equal to (0, 0). **[4]**

2	0
0	1

i. Compute the 2-D DFT magnitude and give the result in a 2 x 2 array.

ii. Compute the 2-D DFT phase and give the result in a 2 x 2 array.

Question 6. [Marks: 12.5]

a) **[6]**

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 and write the transformation functions for each of the following operations. Also, describe the produced effect on the image contrast and brightness.

i. Calculation of the image negative.

ii. Addition of 50 to all pixel gray levels.

iii. Application of a threshold function with a threshold value of 128.

b) **[3]**

Consider the spatial filter H given by

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

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.

c) **[3.5]**

Consider the original and processed image given in Figure below. Explain, which is the most likely processing from the list below to give this result?

i. Edge detection by a Laplacian operator.

ii. Median filtering followed by an edge detection.

iii. Edge detection followed by a median filtering.

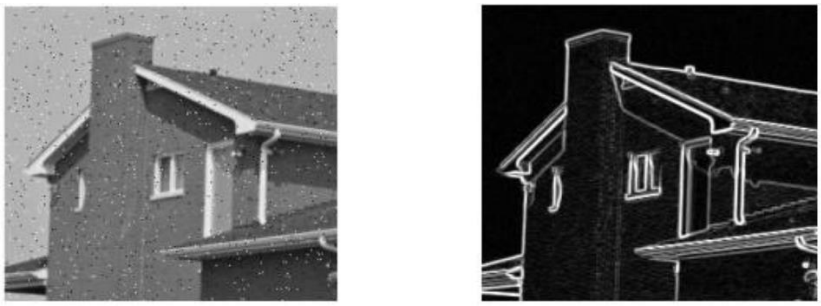


Figure: Original image (left) and processed image (right)