Date: 29 October 2020

AHSANULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Department of Computer Science and Engineering
Program: B.Sc. in Computer Science and Engineering
Semester Final Examination, Fall-2019

Part-A

Year: 4th **Course No: CSE4227**

Semester: 2nd **Course Name: Digital Image Processing**

Time: 2 (Two) hours **Full marks: 40**

Use separate Answer Script for each section

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)	Write down Student ID, Course number, and put your signature on top of every single page of the answer script
	iii)	Write down page number at the bottom of every page of the answer script.
	iv)	Upload the scan copy of your answer script in PDF format at the respective site of the course at **google classroom** using institutional email within the allocated time. Uploading clear and readable scan copy is your responsibility and must be covered the full page of your answer script.
	v)	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

Part-A (SECTION-1)

The answer script of this section will be uploaded to the concerned course teacher's Google Classroom.

Instructions:	i)	Before uploading rename the PDF file as **CourseNo_StudentID_PartNo_SectionNo** eg. CSE4227_180107001_partA_section1.pdf CSE4227_180107001_partA_section2.pdf
	ii)	There are **3 (Three) Questions in each section. Answer any 2 (Two) from each section.**
	iii)	Marks allotted are indicated in the **right margin**
	iv)	Assume any reasonable data if needed
	v)	Symbols and characters have their usual meaning

Question 1. [Marks: 10]

a) Suppose we have a grayscale image with most of the values of pixels being same. What can we use to compress the size of the image? **[1+5]**

In Fig 1.1, *** is representing the last three digits of your ID (e.g. for ID 160104001, *** will be 001).

***	40	60	80	100
***	40	60	80	100
***	40	60	80	100
***	40	60	80	100
***	40	60	80	100

Fig 1.1 A 7-bit input image

Show your step by step **LZW** encoding process (To generate your codebook, use **9** bits). Any compression achieved by employing **LZW** in your above encoding process?

b) Assume that, we applied a lossy compression technique to Fig 1.1. After the compression, we decompressed the image in which all the pixel intensity values are increased by two (2) [For example – 40 becomes 42, 60 becomes 62]. Find the Root Mean Square Error and Signal-to-Noise Ratio of the decompressed image. **[4]**

Question 2. [Marks: 10]

a) Image Thinning process subtract the pixels from a shape to thin the line to one pixel width. Thin the image of Fig 2.1 using the given structuring element of Fig 2.2. Show the set of SEs those will be used in your thin process. Illustrate the thinning process and show your results after each passes of your structuring elements until the convergence was achieved and also show your final thinned image after eliminating multiple paths. **[6]**

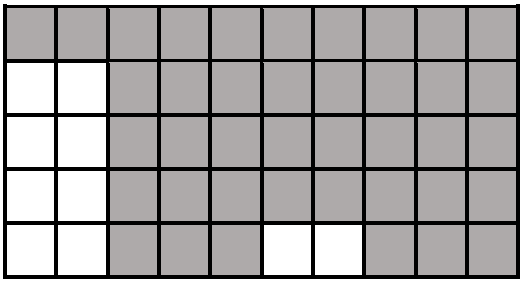


Fig 2.1 A gray-level image (I)

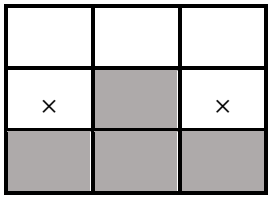


Fig 2.2 Structuring Element (SE)

b) Considering the image of Fig. 2.3 and structuring element of Fig. 2.4, find the output of the following operations: **[4]**

i. $(A \ominus s) \oplus s$

ii. $(A \oplus s) \ominus s$

iii. Prove the duality relationship between Dilation and Erosion.

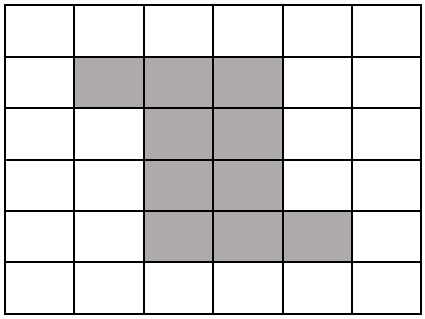


Fig 2.3 6 × 6 Gray-level Image (A)

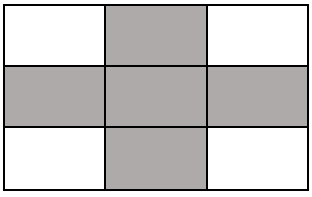


Fig 2.4 Structuring Element (s)

Question 3. [Marks: 10]

a) i. In the following image of Fig 3.1, you can find an **edge** labeled in the red region. Which form of discontinuity creates this kind of **edge**? [1] **[6]**

Fig 3.1

Fig 3.2

5	10	7	9
12	11	8	2
21	32	25	14
30	31	20	21

Fig 3.3

ii. To blur an image, can you use a linear filter? Justify your answer with an example. [1]

iii. Suppose we have a noisy image as in Fig 3.2. The type of noise in the image is called salt-and-pepper noise. What is the best way to denoise this image? Describe your process with explanation. [1]

iv. If we convolve an image with a 3x3 matrix as [0, 0, 0, 0, 0, 1, 0, 0, 0], what would be the relation between the original and modified image? [1]

v. How can you smooth an image? If you subtract your smoothed image from the original image, what will happen if we add the subtracted result back to the original image? [1]

vi. Sharpen the 4x4 image of Fig 3.3 using the second derivative operator and draw your output image (consider zero-padding for the border pixels). [1]

b) The histogram of an image is shown in Table 3.1. Show the histogram table for a desired image where the number of pixel distribution will be in reverse order of the original image. For example – there will be 43 pixels in gray level 2, 11 pixels in gray level 18, and vice-versa. **[4]**

Table 3.1

Gray Levels (r)	2	18	33	58	67	96	114	152	184	206	220	245
No. of pixels	10	24	52	14	21	71	49	27	31	47	11	43

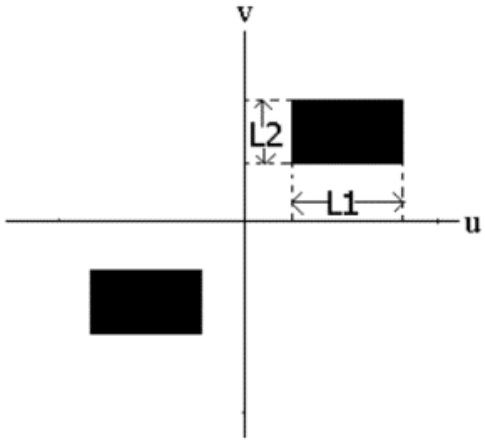
Sketch the normalized histograms of the original and desired images. What will be the output after applying histogram equalization process on the original image (Table 3.1)?

Part-A (SECTION-2)

The answer script of this section will be uploaded to the concerned course teacher Google Classroom.

Question 4. [Marks: 10]

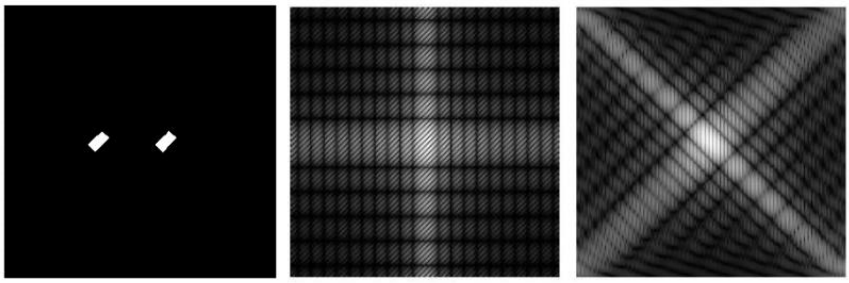
a) The following figure shows the frequency domain representation of a notch filter. Here, the dark area has a value of 0 while the white area has value 1. The centers of the two dark rectangles (which are symmetric with respect to the origin) are (u0, v0) and (−u0, −v0), respectively. The sides of the rectangle are of lengths L1 and L2, respectively. Is this a bandpass or bandreject filter? Explain. Write down the H(u, v) of this notch filter. **[4]**



b) i. Give the Fourier transform of the 2D image, $f(x, y) = 3\cos(0.3x)\cos(0.2y)$. **[6]**

ii. Consider the image shown in Figure (a) below. Two plots of magnitude of Two-Dimensional. Discrete Fourier Transform (2D DFT) are shown in Figure (b) and (c) below. Which one is the magnitude of the 2D DFT of the image of Figure (a)? Justify your answer.

iii. Suppose you are given a sample image of text with broken characters. You need to join the broken texts with no visible ringing effect. Which frequency domain filter will you use? Justify your answer. Also, define the filter function H(u, v) in the frequency domain.

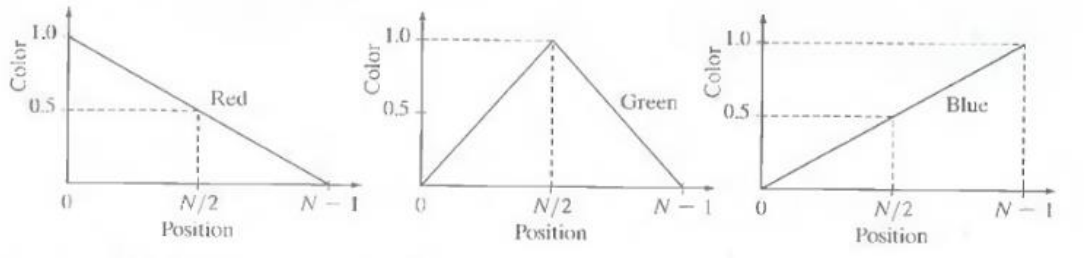


(a) (b) (c)

Question 5. [Marks: 10]

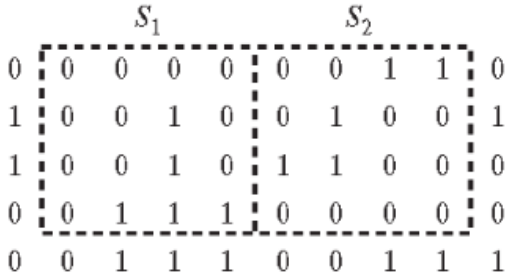
a) i. How many different shades of gray are there in a color RGB system in which each RGB image is an 8-bit image? **[6]**

ii. In a simple RGB image, the R, G, and B component images have the horizontal intensity profiles shown in the following diagram. What color would a person see in the middle column of this image?



iii. Suppose that we replace every color in the RGB cube by its CMY color. This new cube is displayed on an RGB monitor. Label with a color name the eight vertices of the new cube that you would see on the screen. Show your calculation.

b) Consider the two image subsets, S_1 and S_2, shown in the following figure. For V = {1}, determine whether these two subsets are (a) 4-adjacent, (b) 8-adjacent, or (c) m-adjacent. **[4]**

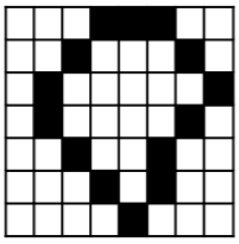


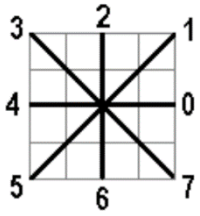
Question 6. [Marks: 10]

a) For the following boundary (in counterclockwise direction) compute the chain code that is: **[4]**

i. invariant to starting point

ii. invariant to starting point and rotation

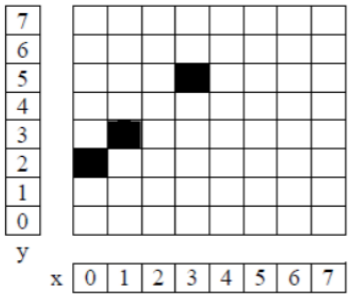




b) Consider the binary image "Aust.jpg". Now, **[2 + 4]**

i. Calculate the votes for the accumulator cells $(\frac{\pi}{4}, 2\sqrt{2})$, $(\frac{\pi}{4}, 4\sqrt{2})$, (0, 3), and $(\frac{\pi}{2}, 3)$.

ii. Identify the cell receiving the most votes (among all the accumulator cells) and deduce the equation of the line in polar coordinates, which connects the 3 points of "Aust.jpg"



Aust.jpg

θ \ ρ	0	1	$\sqrt{2}$	2	$2\sqrt{2}$	3	$4\sqrt{2}$	5
0								
π/4								
π/2								
3π/4								

Accumulator

Date: 29 October 2020

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Part-B (Open book exam)

Year: 4th **Course No: CSE4227**

Semester: 2nd **Course Name: Digital Image Processing**

Submission deadline: Next day 6.30 pm **Full marks: 20**

Use separate answer script for each section

Instructions:	i)	Before uploading rename the PDF file as **CourseNo_StudentID_PartNo_SectionNo** eg. CSE4227_180107001_partB_section1.pdf CSE4227_180107001_partB_section2.pdf
	ii)	**Answer all the Questions**
	iii)	Marks allotted are indicated in the **right margin**
	iv)	Assume any reasonable data if needed
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Part-B (SECTION-1)

The answer script of this section will be uploaded to the concerned course teacher's Google Classroom.

Question 1. [Marks: 10]

a) Congratulations to the students of CSE 37th batch for getting an intern project from ICT ministry. The project is an automatic process of transparent water bottle filling and capping on. The process will check that the bottles are filled and capped with pure water, also will count the bottles before packing for the production. All the bottles are placed into the conveyor line for these checking purposes. As the complete process is an automated process, one of the important tasks is to check the completeness of the bottle. As an Artificial Intelligence Engineer, your responsibility is to build a system that can identify four types of bottles — Full Bottle, Empty Bottle, Incomplete Bottle, and consists of stains Bottle (the water is dark / colored). Now propose a system that can detect all these four types of bottles considering the topics that covers in this DIP course. You should state with proper explanation about all the **[6]**

assumptions and other necessary factors you make for the solution. Mention all the names of the DIP techniques you are using into your proposal with justifications.

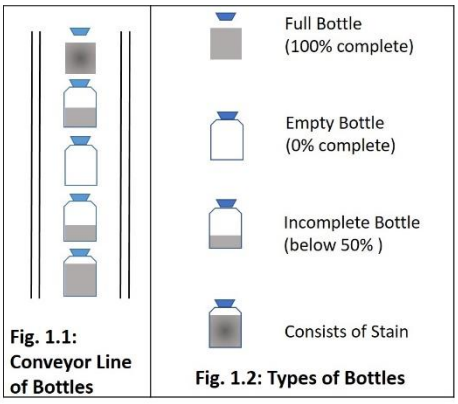


Fig. 1.1: Conveyor Line of Bottles

Fig. 1.2: Types of Bottles

b) Satellite image plays an important role in various kinds of security purposes for a nation. One of the prominent examples can be Road Line Detection. Consider the following Fig. 1.3 of three different satellite images containing road line. Now propose a method which will identify a section of road line from any one of the satellite images from Fig. 1.3. You may use morphological operation, segmentation, edge detection, and/or other image processing techniques for this purpose. A sample identified image is depicted in Fig. 1.4(a) and then 1.4(b). Furthermore, discuss if your method is appropriate to identify road line from all of the images of Fig. 1.3. **[4]**

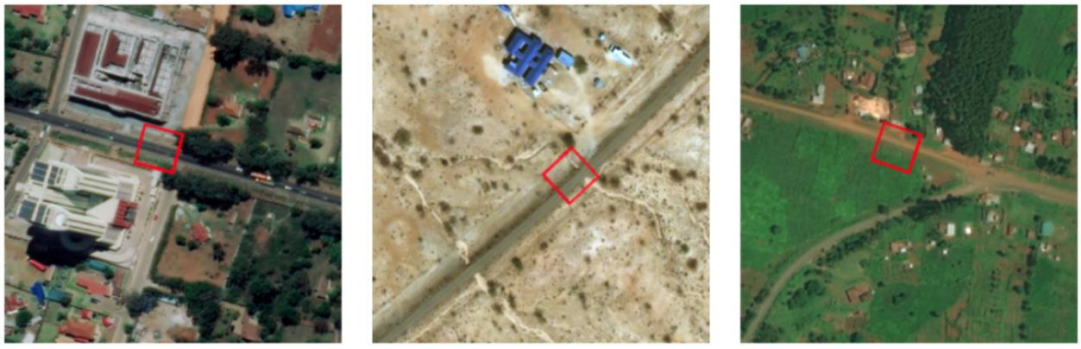


Fig 1.3: Road Satellite Image

(a) (b)

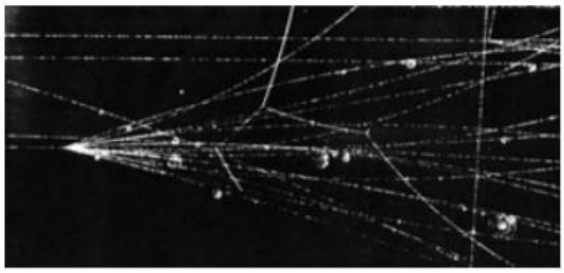
Fig 1.4 Segmented Road Satellite Image

Part-B (SECTION-2)

The answer script of this section will be uploaded to the concerned course teacher Google Classroom.

Question 2. [Marks: 10]

a) Suppose you are given the following image consisting of tracks of variable lengths obtained from a scientific experiment. Using Hough Transforms as a basis, propose a segmentation approach for detecting all tracks that contain at least 100 pixels and are angled at any of the following six directions off the horizontal: ±30°, ±60°, and ±45°. For a track to be valid, it must be at least 100 pixels long and not have more than three gaps, any of which cannot exceed 10 pixels. You may assume that the images have been processed so that they are binary and all tracks are 1 pixel wide. **[5]**



b) Consider the images shown. The image on the right was obtained by (a) multiplying the image on the left by $(-1)^{(x+y)}$; (b) computing the DFT; (c) taking the complex conjugate of the transformation; (d) computing the inverse DFT; and (e) multiplying the real part of the result by $(-1)^{(x+y)}$. Explain (mathematically) why the image on the right appears as it does. What will be the difference if we plot – (i) the amplitude and (ii) phase of the two images? **[5]**