Sri Lanka Institute of Information Technology

B.Sc. Honours Degree in Information Technology

Final Examination
Year 4, Semester 1 (2024)

IT 4130 – Image Understanding and Processing

Duration: 3 Hours

# May 2024

Instructions to Candidates:

- ◆ This paper has 5 questions.
- ◆ Answer all questions in the booklet given.
- ◆ The total marks for the paper is 100 marks.
- ◆ This paper contains 09 pages, including the cover page.
- ◆ Electronic devices capable of storing and retrieving text, including calculators are allowed.

Question 1 (25 marks)

a) Consider edge detection, as demonstrated in the figure below. Discuss potential causes for false edge detections in the output image (**B**). Discuss several strategies that can be employed to mitigate false edge detections in the input image (**A**). (7 marks)
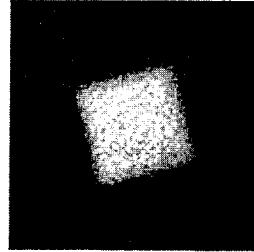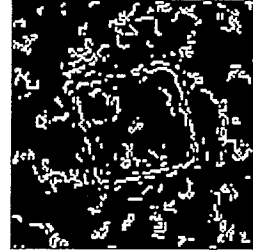
Input Image (A)   Output Image (B)

b) Tracking moving objects is a critical task in various fields such as surveillance, autonomous vehicles, and sports analytics. Discuss **TWO** fundamental challenges in tracking moving objects. Justify the answer with an example. (7 marks)

c) Edge detection algorithms utilize different derivative estimators to identify significant changes in pixel intensity, which often correspond to object boundaries or transitions between regions Briefly explain the technique(s) used to obtain the output image (**Y**) and Output image (**Z**) from an input image (**X**). (4 marks)
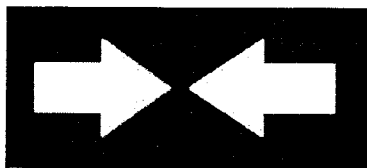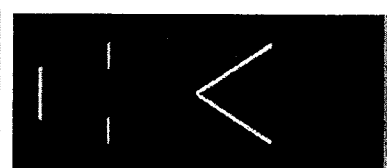
Input Image (X)   Output Image (Y)   Output Image (Z)

d) The following figure demonstrates the image quantization process. Briefly explain the reasons to result as in output image (**Q**) and Output image (**R**) from an input image (**P**). (3 marks)

Input Image (P)   Output Image (Q)   Output Image (R)

e) The following figure (S) shown below exhibits a type of noise. Interpret the operations required to remove the noise effectively. (2 marks)
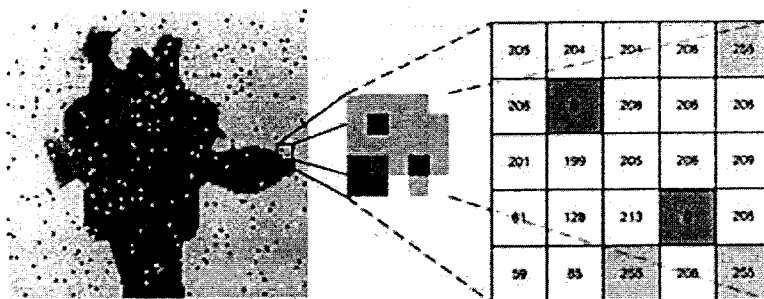

Figure (S)

f) The histograms of input image Figure (T) and a processed image Figure (U) are given below. Suggest suitable technique(s) which could be used to satisfy the visual appearance given in figure (U). (2 marks)
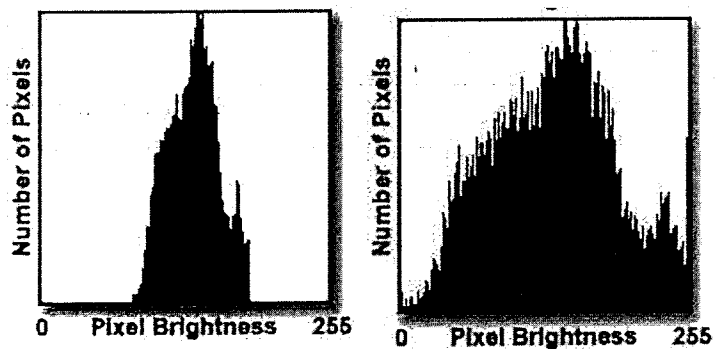

Figure (T)   Figure (U)

Question 2   (20 marks)

a) The following Figure (A) shows three different gamma correction settings. Describe and compare each gamma correction setting in terms of their impact on image brightness and contrast. (3 marks)
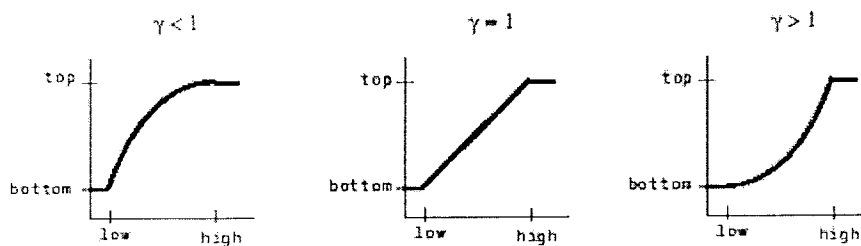

Figure (A)

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b) Consider the following 3-bit 2D image and the intensity profile along the horizontal scan line of the image given in Figure (**B**). Plot the second derivative response along the horizontal scan line shown above. Explain why ·zero crossing· is useful in detecting edges.
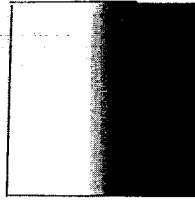
(5 marks)

Figure (B)

c) The following Image (**X**) demonstrates an application of image enhancement. Briefly explain the technique(s) used to describe the process below.
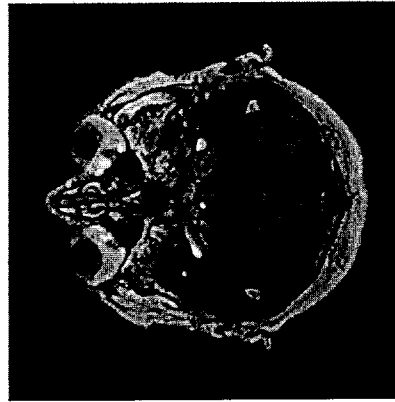
(2 marks)

Image (X)

d) "*Median filtering is more effective than Gaussian smoothing in reducing salt-and-pepper noise from images.*" Assess whether the statement is correct or not. Justify your answer."

(4 marks)

e) Perform histogram equalization given the following 3-bit image.

(6 marks)

Intensity	0	1	2	3	4	5	6	7
No. of pixels	70	100	40	60	10	70	10	40

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Question 3   (20 Marks)

a) Evaluate the output image (**B**) generated by the Sobel filter below. Analyze the effectiveness of the Sobel filter in enhancing edge features while maintaining image clarity and suppressing noise artifacts.   (4 marks)
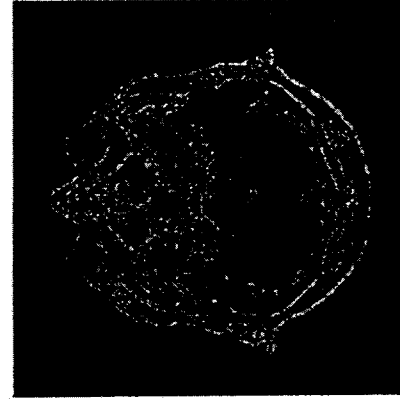
Input Image (A)   Output Image (B)

b) The weighted average filter is tone of the simplest noise removable filters. Briefly explain why a weighted average filter works better than a box filter to remove small artifacts with less blurring.   (5 marks)

c) The following Image (**X**) shown below enlists a sequence of steps required to improve the quality and get Image (**Y**). Interpret the operations required and justify whether the order of operations is important or not?   (5 marks)

Input Image (X)   Output Image (Y)

d) Intensity metrics of a small part of an 8-bit gray scale image (**P**) is given below. The input image is filtered by a 3x3 **Kernal Image (Q)**. What are the values of the shaded area in the input image (**P**)? Show your calculations as well. (6 marks)

0	0	0	0	5	5
0	0	0	0	5	5
0	0	0	0	5	5
5	5	5	5	5	5
5	5	5	5	5	5
5	5	5	5	5	5

Input Image (P)

| 1	1	1
0	3	0
-1	-1	-1

Kernal Image (Q)

Question 4   (25 Marks)

a) *"Structuring elements in morphological operations can only be square or rectangular in shape."*. Do you agree with this statement? Justify your answer with an example of your own. (6 marks)

b) The following figure shows the result (**Q**) of applying morphological operation(s) to the input image (**P**). Critique the technique(s) used to obtain the output (**Q**). (2 marks)
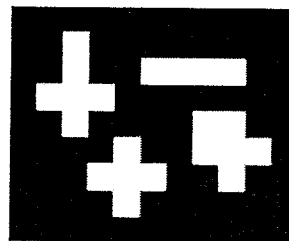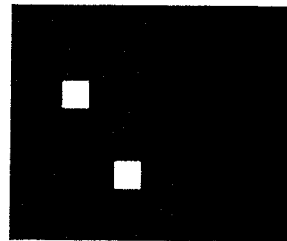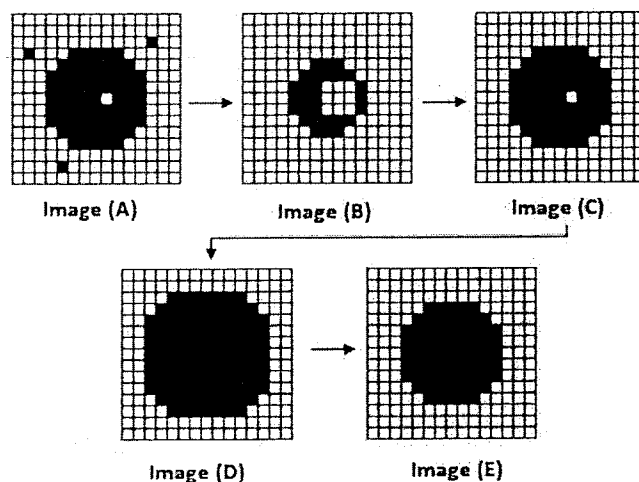
Input Image (P)   Output Image (Q)

c) The following figure shows the results (**B, C, D, E**) of applying different morphological operators (s) to the original images (**A**). Critique the technique(s) used to obtain the output set. (3 marks)

Image (A)   Image (B)   Image (C)

Image (D)   Image (E)

d) The input image (**X**) and structuring element (**Y**) are shown below. Apply region filing algorithm and obtain the output image. (4 marks)

Input Image (X)

Structuring
Element (Y)
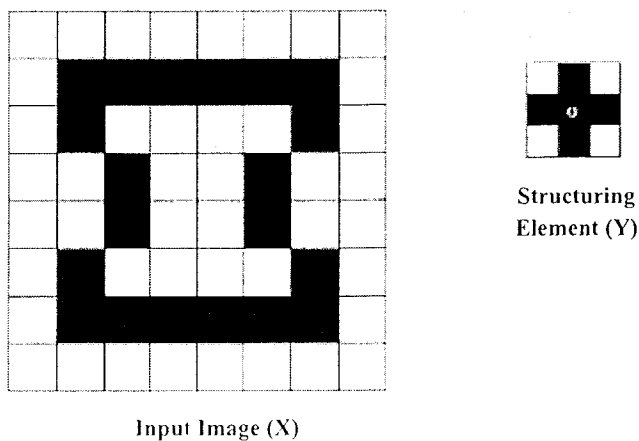
e) "*Mathematical morphology plays a crucial role in tasks such as image segmentation and feature extraction in image processing*". Do you agree with this statement? Justify your answer. (4 marks)

f) Consider the binary image (**A**) below, which represents a segmented object. Each connected region of shaded pixels in the image forms a connected component. Illustrate and label the connected components present in the image using the structuring element shown in Figure (**B**). Note that the origin is in the center of the structuring element.
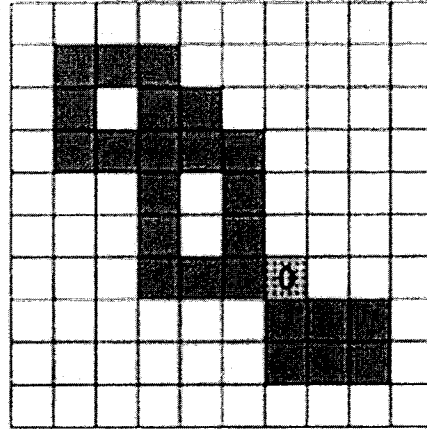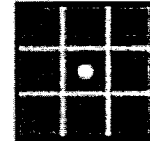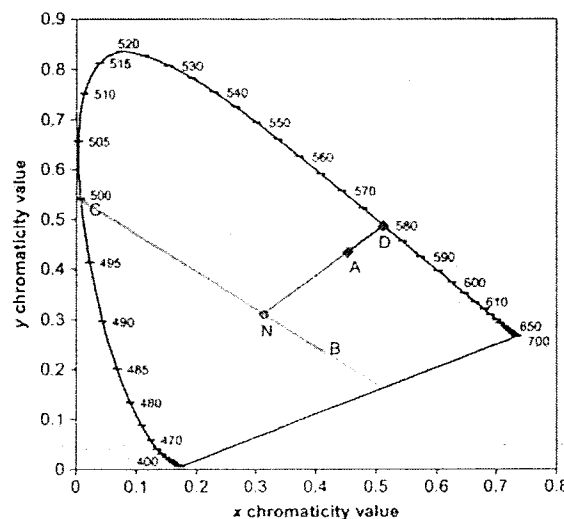
(6 marks)

Image (A)

Fig. (B)

Question 5 (10 Marks)

a) *"Understanding the differences between additive and subtractive color models is crucial for effective color management in both digital and print media"*. Do you agree with this statement? Justify your answer. (4 marks)

b) Briefly explain the concept of color segmentation and its significance in object detection and recognition tasks. (2 marks)

c) The following chromaticity diagram shows all visible colors to human vision. Briefly explain where the white point of the display is represented on the diagram, and why is it important in color reproduction. (1 marks)

d) Explain how points on a chromaticity diagram are used to represent the color gamut of a display or printing device. (1 marks)

e) According to the figure above briefly explains the importance of line connecting from N to D. (2 marks)

.... **End of the Paper**...................