



Sri Lanka Institute of Information Technology

B.Sc. Honours Degree in Information Technology

Final Examination  
Year 4, Semester 1 (2023)

IT 4130 – Image Understanding and Processing

Duration: 3 Hours

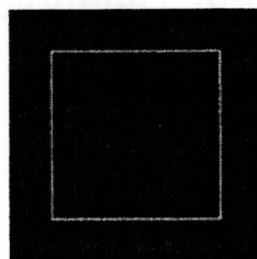
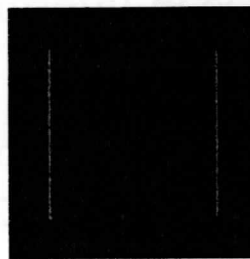
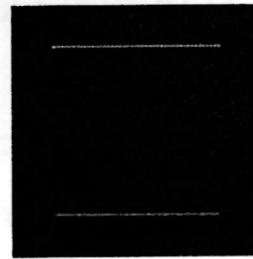
November 2023

Instructions to Candidates:

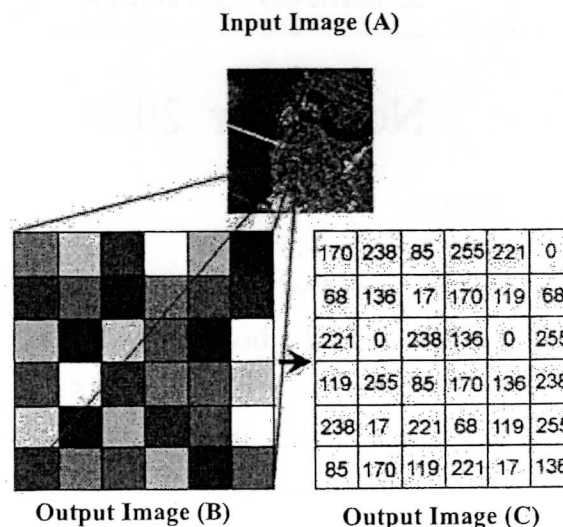
- ◆ This paper has 5 questions.
- ◆ Answer all questions in the booklet given.
- ◆ The total mark for the paper is 100 marks.
- ◆ This paper contains 8 pages, including the cover page and worksheet.
- ◆ Scientific Calculators allowed.

**Question 1****(25 marks)**

- a) Why is edge detection considered a crucial step in image processing and computer vision, and how does it contribute to enhancing the accuracy and efficiency of various applications in these fields? Justify your answer. (6 marks)
- b) In the context of automated quality control in industrial applications, identify and discuss three key factors that machine vision technology can effectively assess during the inspection process. Provide examples to illustrate your points. (6 marks)
- c) In the context of edge detection in image processing, explain the techniques used to generate output images like (B) and (C) from an input image (A). (6 marks)

**Input Image (A)****Output Image (B)****Output Image (C)**

- d) The following figure demonstrates the basic properties of a digital image. Briefly explain the technique(s) used to obtain the output image (B) and Output image (C) from an input image (A). (2 marks)



- e) The following figure (A) shown below enlists a sequence of steps required to make the image look better as shown in figure (B). Interpret the operations required and justify the operations. (3 marks)

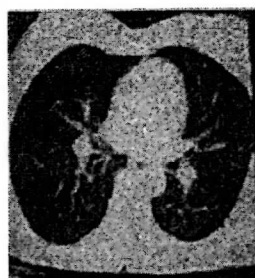


Figure (A)

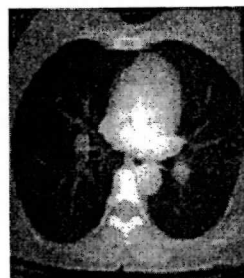


Figure (B)

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

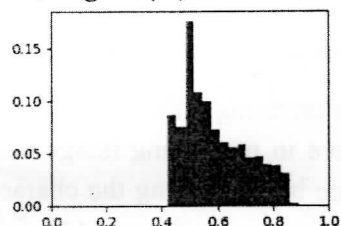


Figure (C)

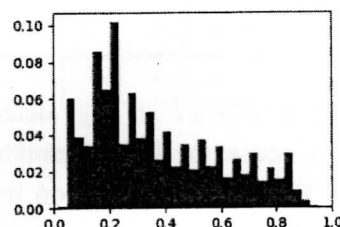


Figure (D)

## Question 2

(20 marks)

- a) Why is noise filtering an essential step in image processing, and how do different noise filtering techniques contribute to the improvement of image quality, ensuring better interpretation and analysis of visual data? (6 marks)
- b) Consider a 2D image and its intensity profile along a horizontal scan line. Plot the second derivative response along the scan line and explain the significance of zero crossings in detecting edges. How do zero crossings help in identifying and localizing edges within the image? (5 marks)

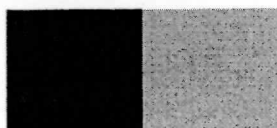


Figure (A)

- c) Compare common techniques used to mitigate the impact of salt and pepper noise, and discuss the trade-offs associated with these methods in preserving image details and noise reduction. (2 marks)

- d) "Power law transformation can be more useful than the log transformation." Justify your assessment by explaining the strengths and limitations of both power law and log transformations, highlighting when and why you might prefer one over the other for image enhancement. (4 marks)
- e) Perform histogram equalization on a given grayscale image and explain the process involved. Justify the importance of histogram equalization in enhancing image contrast and improving visual quality. (3 marks)

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

### Question 3

(20 Marks)

- a) You were requested to build an edge detection algorithm using either a Sobel filter or a Laplacian filter. Choose the filter that is most effective in preserving image data while mitigating noise. Provide a justification for your choice by comparing the characteristics and outcomes of the two filters. (4 marks)
- b) Why are low-pass filters, particularly weighted filters, considered more effective than simple box filters in reducing small artifacts without excessive blurring in image processing? Justify your choice by explaining the differences in filtering techniques and their impact on noise reduction and image quality. (5 marks)
- c) In image enhancement, a sequence of operations is performed to transform Image (A) into the improved Image (B). Explain the intended operations and justify the significance of the order in which they are executed. (5 marks)



Image (A)



Image (B)

- d) Intensity metrics of a small part of an 8-bit gray scale image (**X**) is given below. The input image is filtered by a 3x3 **Prewitt filter in X direction**, and the output values are recorded in output image (**Y**). What are the values of the pixels **A**, **B**, and **C** in the output image (**Y**)? Show your calculations as well. You may need to pick the correct filter based on the given figure (**Z**). (6 marks)

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

Input Image (X)

	A			
		B	C	

Output Image (Y)

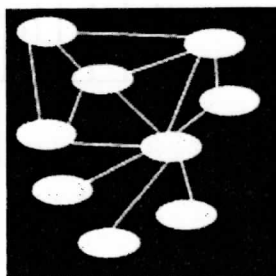
-1	0	1
-1	0	1
-1	0	1

-1	-1	-1
0	0	0
1	1	1

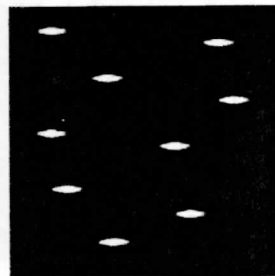
Filters (Z)

**Question 4****(25 Marks)**

- a) "In boundary extraction in image processing, the structuring element is often chosen to be smaller than the image". Do you agree with this practice, and can you justify the significance of using a smaller structuring element for boundary extraction? Provide an example to illustrate the concept. (6 marks)
- b) The following figure shows the result (**B**) of applying morphological operation(s) to the input image (**A**). Critique the technique(s) used to obtain the output (**B**). (2 marks)

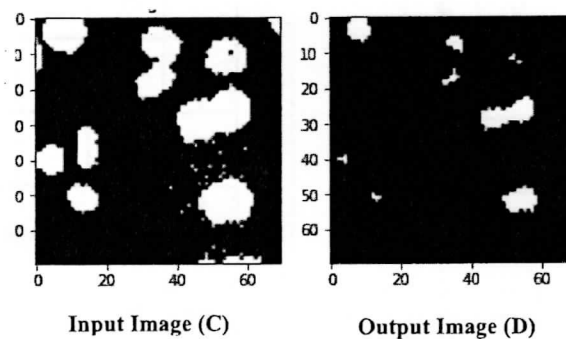


Input Image (A)



Output Image (B)

- c) Explain the role of set operations, in morphological image processing. Provide examples to illustrate how these operations are applied in morphological operations and justify their significance in enhancing image analysis and manipulation. (3 marks)
- d) Briefly explain the terminologies used in below figure to generate the output image (D) from input image (C) with respect to background and foreground pixels. (4 marks)



- e) “Hit-or-Miss transformation is a fundamental tool in mathematical morphology”. Do you agree that this operation is valuable for extracting specific patterns or features within an image, and that it plays a crucial role in solving problems related to pattern recognition or shape analysis? Justify your answer and provide examples to illustrate its significance in image processing. (4 marks)
- f) Apply *hit or miss* operation on the figure (E), using the structuring elements shown in Figure (F). Note that the origin is in the center of the structuring element. **Show your answers in the given worksheet.** (6 marks)

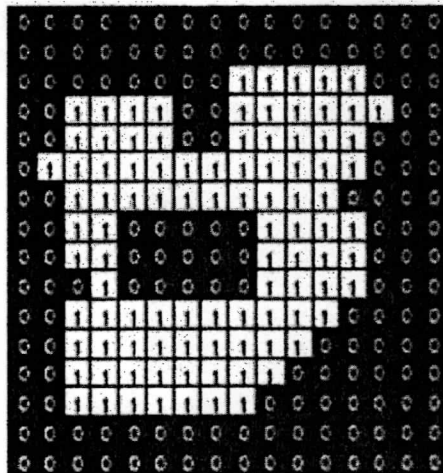


Figure. (E)

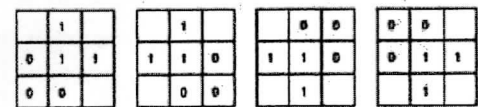
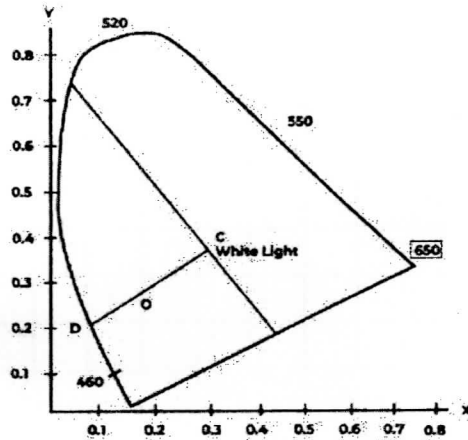


Figure. (F)

**Question 5****(10 Marks)**

- a) *"It is not possible to represent all perceivable colors using a single-color model"*. Do you agree with this statement? Justify your answer. (4 marks)
- b) Provide one example of the additive nature of color in the context of light, and one example of the subtractive nature of color with respect to pigments. (2 marks)
- c) The following chromaticity diagram shows all visible colors to human vision. How does the concept of 'white point' apply in chromaticity diagrams? (1 marks)



- d) How are saturated colors represented within a chromaticity diagram, and why is it important to visualize them in the context of color science and color spaces? (1 marks)
- e) According to the figure above briefly explain the importance of points 520, 460 and 650. (2 marks)

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