Sri Lanka Institute of Information Technology

B.Sc. Honours Degree in Information Technology

Repeat Examination
Year 4, Semester 1 (2022)

IT 4130 – Image Understanding and Processing

| Duration: 3 Hours |
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December 2022

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 08 pages, including the cover page and worksheet.
- ♦ Electronic calculators are allowed.

Question 1 (24 marks)

a) Suppose you are required to find the boundaries of the original in image (A). In the output image (B), edges are detected, and a few edges are lost. Distinguish the possible reasons for losing a few edges in the output image (B).   (6 marks)
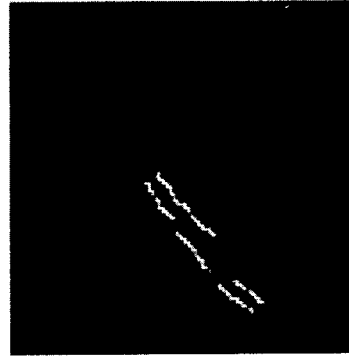
Original Image (A)   **Output Image (B)**

b) Suppose you are required to create a system that can detect and count moving vehicles. Assess THREE essential factors in image sequence processing that can be evaluated.
(6 marks)

c) The following figure demonstrates an application of finding edges. Edge provides several derivative estimators, each of which implements one of these definitions. For some of these estimators, you can specify whether the operation should be sensitive to horizontal edges, vertical edges, or both. Assess the technique(s) used to obtain the output image (**B**) and Output image (**C**) from an input image (**A**).   (6 marks)
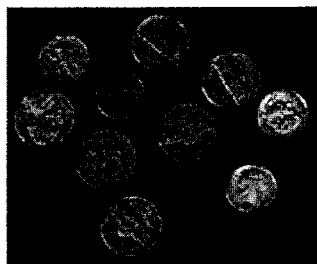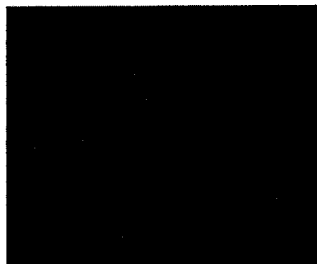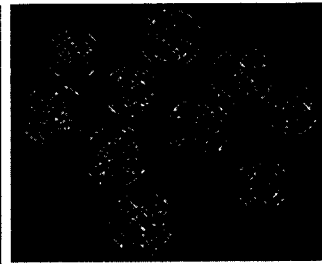

Input Image (A)   Output Image (B)   Output Image (C)

d) Digital images are prone to various types of noise. This is because pixel values do not reflect the accurate intensities of the actual scene in the image acquisition process. However, there are several ways that noise can be removed. One of the approaches is noise reduction using averaging. Analyze conditions you think must be met in practice to remove noise by averaging without blurring?   (6 marks)

Question 2 (18 marks)

a) Figure (B) represents the values denoted in the input image (A). Compare different types of transformation(s) that can be used to recover the input image (A). (4 marks)
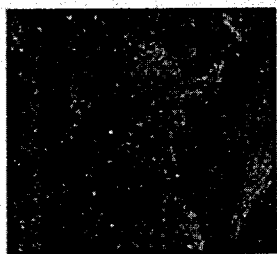
158	159	159	158	155	153	153	154	255	158
155	156	156	155	152	151	151	152	0	160
255	154	155	154	152	0	151	255	153	255
154	156	156	156	154	153	0	155	156	164
153	255	0	156	155	154	0	157	159	166
0	153	154	255	255	0	155	255	163	166
152	255	155	156	255	155	157	159	166	165
154	255	158	159	0	255	160	162	0	164
156	158	0	158	160	255	166	0	167	164
161	161	160	160	161	163	165	165	164	162

Input Image (A)   **Figure (B)**

b) "*Power law transform overcomes the limitation of log transform.*" Assess whether the statement is correct or not in terms of power law transformation. Justify your answer.

(4 marks)

c) The histograms and images are given below. First, determine the quality of the image (A) and (B) and suggest the most suitable techniques if the quality of the images is poor. When determining the techniques, you can decide which could be used to enhance the visual appearance of the images. (4 marks)
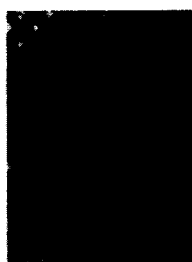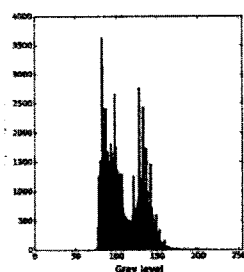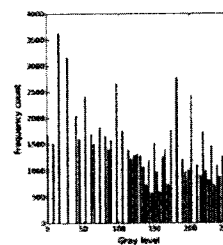

Image (A   **Histogram of Image (A)**   **Image (B)**   **Histogram of Image (B)**

d) A 3-bit grayscale image of size 8x4 is given below. Perform histogram equalization to the given image. Round the resulting intensities to the nearest integer. Discuss the effect of histogram equalization by comparing the two histograms. (6 marks)

0	1	1	2	2	3	4	4
0	1	1	2	2	3	4	4
0	1	1	2	2	3	4	4
0	1	1	2	2	3	4	4

Question 3 (20 Marks)

a) The below figure represents output images generated using Sobel filter output (**A**) with noisy edges present and output (**B**) without nosy edges within the interior of the house. Considering the *Sobel filter*, decide which intermediate step (s) is/are used to obtain the outputs (**A**) and (**B**). (3 marks)

Sobel Filter Output (A)   **Sobel Filter Output (B)**

b) Consider the following 3-bit 2D image and the intensity profile along the horizontal scan line of the image given in figure (**A**). Plot the *first derivative response* along the horizontal scan line. (4 marks)
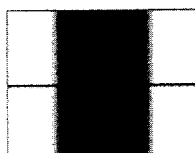

Figure (A)

c) The following figure (**A**) below demonstrates an effect where a sequence of steps is required to make the image look better and obtain like figure (**B**). Interpret the operations required. (5 marks)
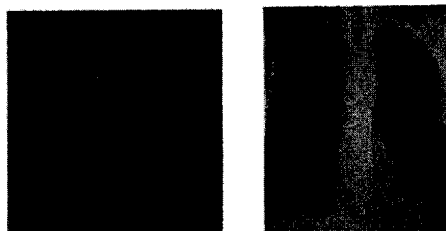

Figure (A)   **Figure (B)**

d) Consider a 3x3 input image and a 3x3 filter. Convolve the input image with the given filter using zero padding. Show the result in a form of a metric. (4 marks)

Input image $\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$ Filter $\begin{bmatrix} -2 & -1 & -2 \\ -1 & 0 & -1 \\ -2 & -1 & -2 \end{bmatrix}$

e) Discuss the different effects between a 3x3 smoothing and a 3x3 median filter to an input image (**A**). Show your calculations. (4 marks)


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## Question 4   (27 Marks)

a) *"Morphological operation can be used for filtering"*. Do you agree with this statement? Justify your answer with an example of your own.   (5 marks)

b) Suppose that you were asked to develop an algorithm to reconstruct text of an image ONLY using Morphological operations. The below diagram indicates a corrupted image. Justify the steps to obtain the reconstructed image.   (4 marks)
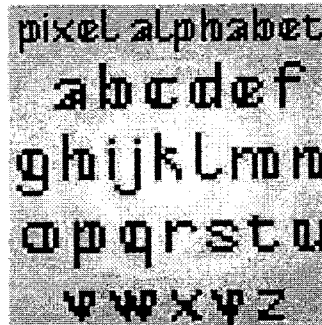
c) The following figure demonstrates different operations applied to the input image (A). Briefly explain the technique(s) used to obtain the output image (B), (C) and (D) from an input image (A).   (5 marks)

Image (A)

Image (B)   Image (C)   Image (D)
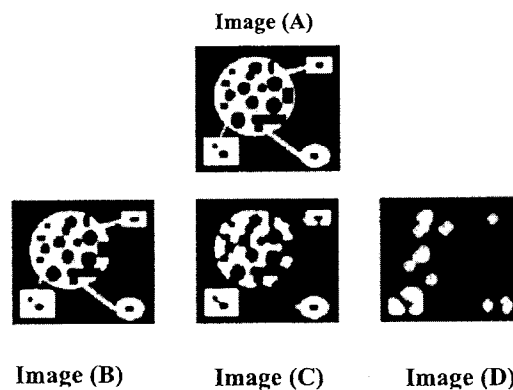
d) Briefly explain the techniques used in the figure below to generate the output image (B) with respect to background and foreground pixels.   (4 marks)

Input Image (A)   Output Image (B)
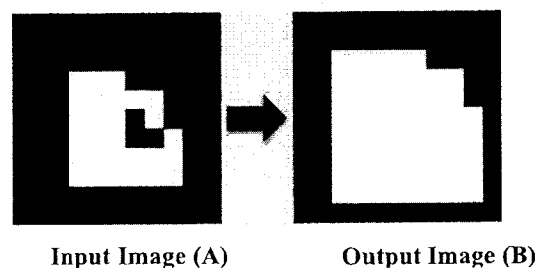
e) Apply the Threshold operator to the following figure (A) using threshold value 22. After that, find the results of *the hit or miss* operation performed on the intermediate output image, using the structuring elements shown in Figure (B). Note that the origin is in the center of the structuring element. **Finally, show your answers (intermediate output and the hit or miss output) in the worksheet.**
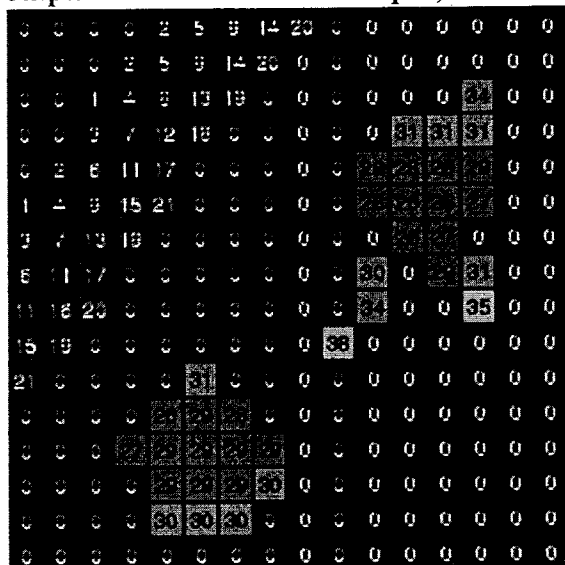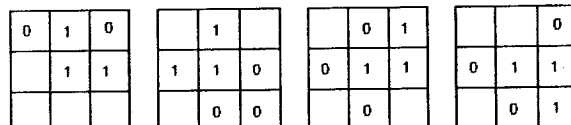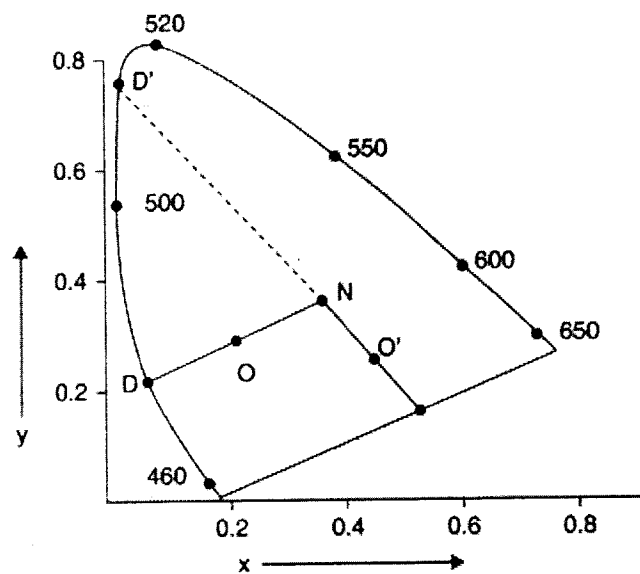
(9 marks)

Fig. (A)

Fig. (B)

Question 5 (11 Marks)

a) "*The purpose of a color model is to facilitate the specification of colors in some standard, generally accepted way*". Do you agree with this statement? Justify your answer. (3 marks)

b) Briefly explain ONE example of the *additive nature of the color of light* and ONE *subtractive nature of color pigments*. (2 marks)

c) The following chromaticity diagram shows all visible colors to human vision. Briefly explain what a line can generate by joining the point of equal energy to any point on the boundary. (2 marks)

d) Briefly explain where zero saturation is located by referring to the above figure. (2 marks)

e) Briefly explain the importance of points 520, 460, and 650 by referring to the diagram above. (2 marks)

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