



Sri Lanka Institute of Information Technology

B.Sc. Honours Degree in Information Technology

Final Examination
Year 4, Semester 1 (2022)

IT 4130 – Image Understanding and Processing

Duration: 3 Hours

June 2022

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 10 pages, including the cover page and worksheet.
- ◆ Electronic devices capable of storing and retrieving text, including calculators are allowed.

Question 1

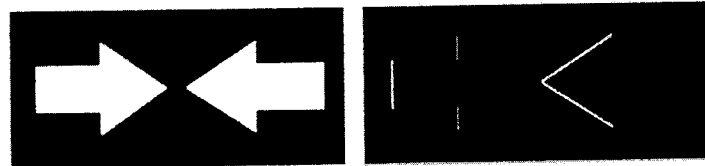
(24 marks)

- a) Suppose that you are required to find the field boundaries of the original image in Figure (A). Distinguish the basic transformation(s) could be made to the original image to further improve edge detection. (6 marks)



Figure (A)

- b) To select a particular edge detector in a machine vision application, you should know the comparative performance of edge detectors in the type of application that we are faced with. Assess THREE important factors in edge detection that can be effectively evaluated. (6 marks)
- c) Assume that you are testing various edge detection operators. Do you get edges where you expect them? The following figure demonstrates an application of edge detection. Evaluate possible reasons that result in losing few edges in Output Image (B). (6 marks)



Input Image (A)

Output Image (B)

- d) Image subtraction is used often in industrial applications for detecting missing components in product assembly. The approach is to store a “golden” image that corresponds to a correct assembly. This image is then subtracted from incoming images of the same product. Ideally, the differences would be zero if the new products are assembled correctly. Images of products with missing components, would be nonzero in the area where they differ from the golden image. Analyze the conditions you think must be met in practice to detect missing components in product assembly accurately? (6 marks)

Question 2

(18 marks)

- a) Image **B** represents the values denoted in Figure **A**. It is difficult for human eye to distinguish colors which are very closer with each other. Compare different type of transformation(s) that can be used to see the differences in the image.

(4 marks)

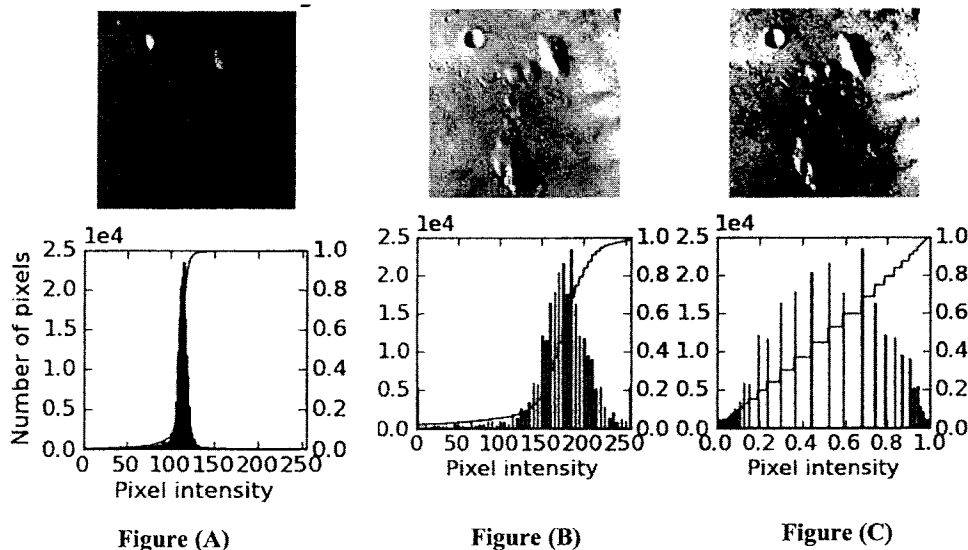
151	151	151	152	152
150	151	151	151	152
150	150	150	151	151
149	149	149	150	151
148	147	148	150	151
148	148	148	150	150



Figure (A)

Image (B)

- b) "The voltage-to-intensity response in non-linear, so it is necessary to correct it into linear response." Assess whether the statement is correct or not in terms of power law transformation. Justify your answer.
- (4 marks)
- c) The histogram and an imperfect image are given below in Figure (A). Determine the quality of the figure image (A) and suggest the most suitable techniques which could be used to enhance the visual appearance of the Figure Image (B) and Figure Image (C). The histograms of the output images are given respectively.
- (4 marks)



- d) Perform histogram equalization given the following histogram. Calculate *only* the *discrete cumulative density* function. (r =Gray level, n =number of occurrences). (6 marks)

r	0	1/7	2/7	3/7	4/7	5/7	6/7	7/7
n	400	700	800	900	500	400	196	200

Question 3

(20 Marks)

- a) You were asked to construct an edge detector using a *Sobel filter* based on a *first order derivative* function. Briefly explain the first order derivative responses at a *step edge* and *uniform area* using an example. (3 marks)
- 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 *second derivative response* along the horizontal scan line shown above. Explain why 'zero crossing' is useful in detecting edges. (4 marks)

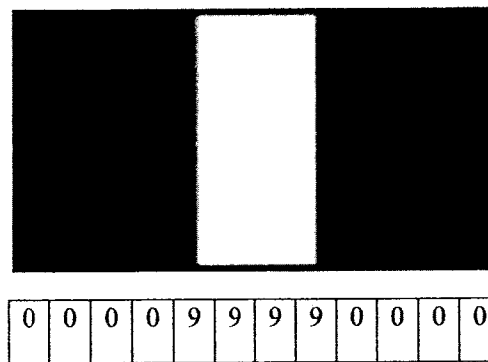


Figure (A)

- c) The following figure (A) shows a gaussian filter, one of the simplest noise removable filters. Briefly explain why a linear filter works well than a gaussian filter to reduce gaussian noise but not salt and pepper noise. (5 marks)

$$\frac{1}{273}$$

1	4	7	4	1
4	16	26	16	4
7	26	41	26	7
4	16	26	16	4
1	4	7	4	1

Figure (A)

- d) The following figure (A) shown below enlist a sequence of steps required to make the image look better. Interpret the operations required and justify whether the order of operations is important or not?

(4 marks)



Figure (A)

- e) 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 averaging filter and the output values are recorded in image (Y).

(4 marks)

- 1) What is the value of the pixel A in the input image (X)? Show your calculations as well.
- 2) What are the values of the pixels P, Q, and R in the output image (Y)? Show your calculations as well.

3	3	4	3	3	3	0
3	0	0	0	0	0	3
3	4	0	0	4	4	3
4	5	7	7	0	0	3
3	3	6	0	0	7	0
3	0	A	3	3	5	3
3	4	3	3	0	0	4

Input Image (X)

3x3 Averaging
Filter

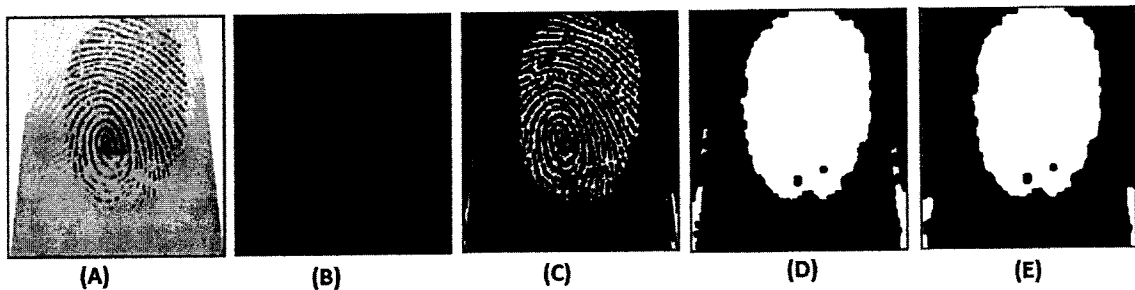
	R	Q				
		P				
		4				

Output Image (Y)

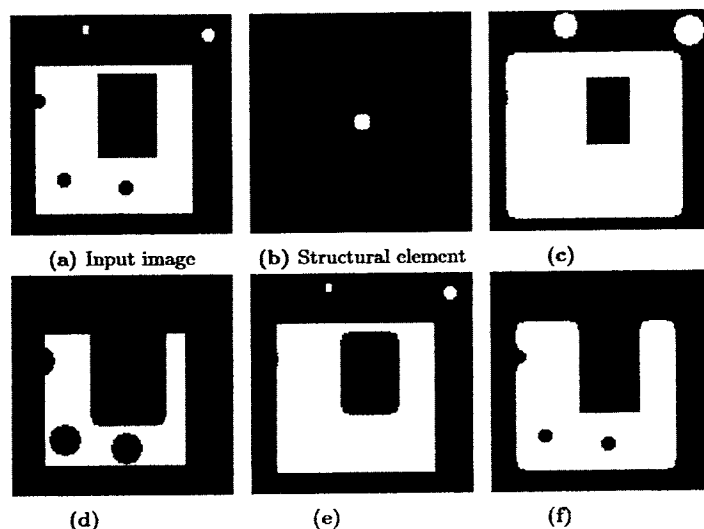
Question 4

(26 Marks)

- a) "The number of pixels added or removed from the objects in an image depends on the size and shape of the structuring element used to process the image". Do you agree with this statement? Justify your answer. (6 marks)
- b) The following figure shows the results (B, C, D and E) of applying different operation(s) to the original image (A). Critique the technique(s) used to obtain the output set. (2 marks)



- c) The following figure demonstrates mathematical morphology operations applied to the input image (a) using a structuring element (b). Briefly explain the technique(s) used to obtain the output image (c), (d), (e) and (f) from an input image (a). (4 marks)



- d) Briefly explain the terminologies used in *Hit or miss* transformation to a binary image with respect to background and foreground pixels. (4 marks)
- e) "There is a slight overlap between Morphology and Image Segmentation". Do you agree with this statement? Justify your answer. (4 marks)
- f) If 0 and 1 are used to represent the background and foreground pixels respectively, find the results of *hit or miss* operation performed on the image given in Figure (A), using the structuring elements shown in Figure (B). Note that the origin is highlighted. **Show your answers in the given worksheet.** (6 marks)

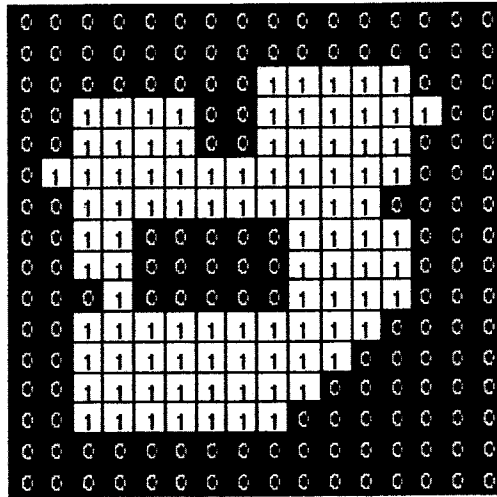


Fig. (A)

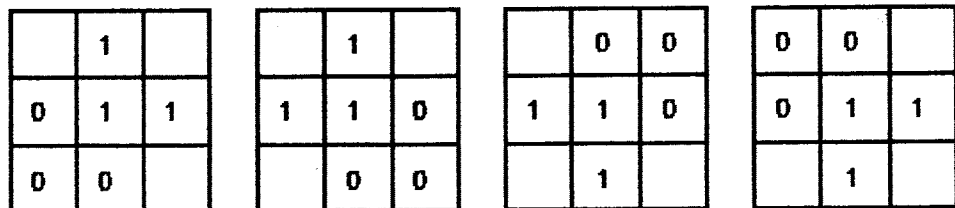
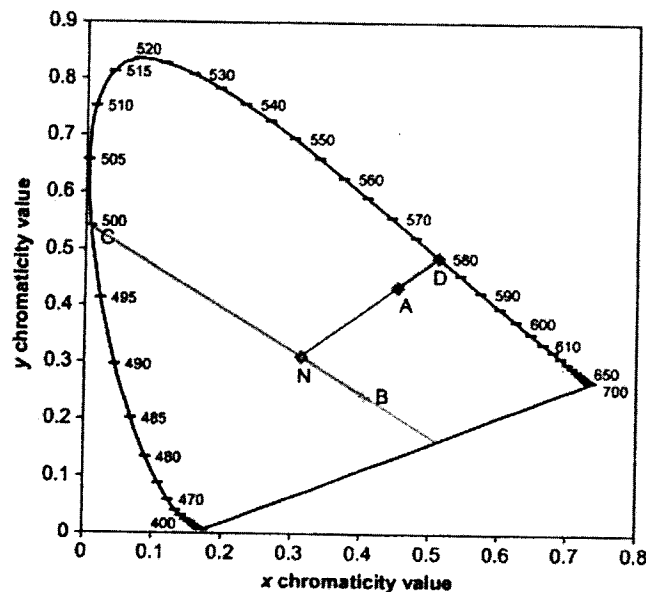


Fig. (B)

Question 5

(12 Marks)

- a) "In an image, a great deal of extra information may be contained in the color, and this extra information can then be used to simplify image analysis". Do you agree with this statement? Justify your answer. (4 marks)
- b) Briefly explain color model(s) which are most suitable for printing devices and filtering. (2 marks)
- c) The following chromaticity diagram shows all visible colors to human vision. Briefly explain ONE practical advantage of the chromaticity diagram. (2 marks)



- d) Briefly explain where various saturated pure spectral colors are located by referring the above figure. (2 marks)
- e) State the figure above and briefly explains the point(s) where the primary colors is produced. (2 marks)

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