**GENERAL SIR JOHN KOTELAWALA DEFENCE UNIVERSITY**
Faculty of Engineering
Department of Electrical, Electronic and Telecommunication Engineering

BSc Engineering Degree
Semester 5 Examination – May/June 2018
(Intake 33 - BM)

**BM3122 – FUNDAMANTALS OF MACHINE VISION AND IMAGE PROCESSING**

Time allowed: 3 hours 25 May, 2018

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**ADDITIONAL MATERIAL PROVIDED**

None

**INSTRUCTIONS TO CANDIDATES**

This paper contains 4 questions on 6 pages.

Answer ALL FOUR questions.

This is a closed book examination.

This examination accounts for 80% of the module assessment. A total maximum mark obtainable is 100. The marks assigned for each question and parts thereof are indicated in square brackets.

If you have any doubt as to the interpretation of the wordings of a question, make your own decision, but clearly state it on the script.

Assume reasonable values for any data not given in or provided with the question paper, clearly make such assumptions made in the script.

All examinations are conducted under the rules and regulations of the KDU.



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**Question 1**

The images in which we are interested are generated by the combination of an "illumination" source and the reflection or absorption of energy from that source by the elements of the "scene" being imaged.

a. Explain the role of sampling and Quantization in digital image processing [05 Marks]

b. Explain following terms,
   i. Adjacency
   ii. Connectivity
   iii. Regions and boundaries [06 Marks]

c. Consider the two image subsets, S1 and S2, shown in the following Figure Q1.1. For V={1},

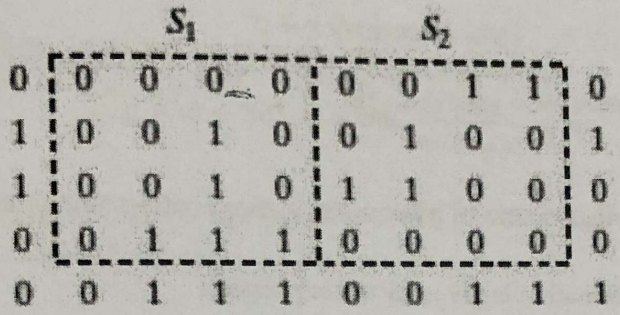


Figure Q1.1

Explain whether these two subsets are 4-adjacent, 8-adjacent, or m-adjacent. [04 Marks]

d. A conventional color image using the RGB coordinate requires 8 bits per color component or 24 bits per pixel. One way to reduce the bit requirement is by converting the RGB to YCbCr representation, and representing Cb and Cr components using fewer bits than the Y component, because the human eye is less sensitive to the chrominance. Suppose we use 6 bits for Y, and 3 bits each for the Cb and Cr components respectively, and use uniform quantizer in the range of 0-256 for each component. The RGB to YCbCr conversion matrix and the inverse conversion matrix are given in Figure Q1.2.

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1.164 & 0.000 & 1.596 \\ 1.164 & -0.392 & -0.813 \\ 1.164 & 2.017 & 0.000 \end{bmatrix} \begin{bmatrix} Y-16 \\ C_b-128 \\ C_r-128 \end{bmatrix} \qquad \begin{bmatrix} Y \\ C_b \\ C_r \end{bmatrix} = \begin{bmatrix} 0.257 & 0.504 & 0.098 \\ -0.148 & -0.291 & 0.439 \\ 0.439 & -0.368 & -0.071 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} + \begin{bmatrix} 16 \\ 128 \\ 128 \end{bmatrix}$$

Figure Q1.2

i. Assume a pixel has the following RGB values: R=205, G=113, B=81. What are the corresponding Y, Cb, and Cr values? [05 Marks]

ii. What are the reconstructed R,G,B values? [05 Marks]

**Question 2**

Given a 3x3 image

$$f = \begin{array}{|c|c|c|}\hline 0 & 2 & 4 \\ \hline 2 & 4 & 6 \\ \hline 4 & 6 & 8 \\ \hline \end{array}$$

a. Contrast stretching is denoted by

$$i = m \times r + c$$

Where

$$m = \frac{255}{r_{max} - r_{min}} \text{ and } c = 255 - m \times r_{max}$$

Find the resulting image matrix of given image, after contrast stretching

[08 Marks]

b. The negative transformation is given by the expression

$$i = L - 1 - r$$

Where L = largest value of the image, $f$

Find the negative transformed image matrix of image $f$

[07 Marks]

c. The general form of log transformation is

$$s = c \times log(1 + r)$$

If c = 50, find the log transformed image matrix of aforementioned image.

[10 Marks]

**Question 3**

a. Explain what histogram.

[05Marks]

b. What is meant by histogram equalization?

[06 Marks]

c. Discuss the image smoothing filter with its model in the spatial domain.

[06 Marks]



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d. Suppose that the gray scale is of range [0, 9] instead of [0, 255].

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 5 | 7 | 7 | 5 | 8 | 7 | 8 |
| 7 | 2 | 6 | 2 | 6 | 5 | 6 | 8 |
| 6 | 9 | 7 | 7 | 0 | 7 | 2 | 7 |
| 6 | 6 | 1 | 7 | 6 | 7 | 7 | 5 |
| 9 | 6 | 0 | 7 | 8 | 2 | 6 | 7 |
| 2 | 8 | 8 | 2 | 7 | 6 | 7 | 8 |
| 7 | 3 | 2 | 6 | 1 | 7 | 5 | 8 |
| 9 | 9 | 5 | 6 | 7 | 7 | 7 | 7 |

Figure Q3.1

$$T(x) = \text{round}\left[\left(\frac{cdf(x) - cdf_{min}}{N \times N - cdf_{min}}\right) * (L-1)\right], \quad \begin{cases} x: \text{pixel value} \\ N: \text{image size} \\ L: \text{max gray scale value} \end{cases} \quad \ldots\ldots\ldots(3.1)$$

Perform histogram equalization of the image Figure Q3.1 according to the expression (3.1).

[08 Marks]

**Question 4**

a. Explain two types of gray level transformation used for image enhancement [04 Marks]

b. Explain the properties of 2D Discrete Fourier Transform [04 Marks]

c. Explain the application of wiener filter in image restoration. [04 Marks]

d. Consider the image given in Figure Q4.1

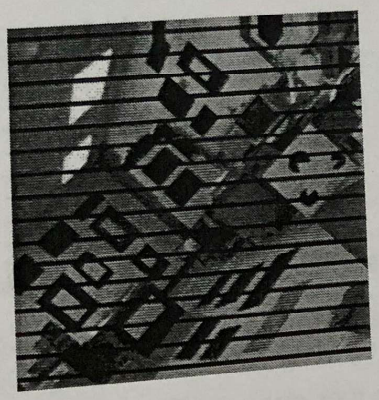

Figure Q4.1

Explain how image in FigureQ4.1 can be processed using the Fourier Transform to remove the superimposed horizontal lines. [06 Marks]



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e. Explain how the Hough Transform detects straight lines in an image [07 Marks]

End of question paper

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