M.Sc. (MATHEMATICS WITH APPLICATIONS IN COMPUTER SCIENCE)

M.Sc. (MACS)

Term-End Examination

June, 2021

MMTE-003 : PATTERN RECOGNITION AND IMAGE PROCESSING

Time : 2 hours *Maximum Marks : 50*

Note : *Attempt any* ***five*** *questions. All questions carry equal marks. Use of calculator is* ***not*** *allowed.*

1. (a) Define the following intensity transformation functions, with suitable examples : *4*

(i) Log Transformations

(ii) Power-Law (Gamma) Transformations

(b) What is Histogram Equalization ? Why is it performed ? Perform histogram equalization of the following image : *6*

$$\begin{bmatrix} 1 & 3 & 5 \\ 4 & 4 & 3 \\ 5 & 2 & 2 \end{bmatrix}$$

2. (a) Find the DFT to the following image : *6*

$$\begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

Hence, find its inverse DFT.

(b) Compare high pass filters with low pass filters, with suitable examples. *4*

3. (a) Compute the degree of compression that can be achieved using (i) Huffman coding, and (ii) Run length coding, assuming two-bits to represent the pixel value and two-bits to represent the run length. *6*

$$I = \begin{bmatrix} 3 & 3 & 3 & 2 \\ 2 & 3 & 3 & 3 \\ 3 & 2 & 2 & 2 \\ 2 & 1 & 1 & 0 \end{bmatrix}$$

(b) Find the entropy of the image *4*

$$\begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 1 & 2 & 2 \\ 0 & 1 & 2 & 3 \\ 1 & 2 & 2 & 3 \end{bmatrix}.$$

4. (a) Two images $g_1(x, y)$ and $g_2(x, y)$ have histograms hg_1 and hg_2, respectively. Give the condition under which the histograms of the following can be determined :

(i) $g_1(x, y) + g_2(x, y)$

(ii) $g_1(x, y) - g_2(x, y)$

(iii) $g_1(x, y) \times g_2(x, y)$

(iv) $g_1(x, y) \div g_2(x, y)$

Hence, obtain the histogram in each case in terms of hg_1 and hg_2. *4*

(b) Construct a 4-directional and 8-directional chain code for the shape of the alphabet 'C'. Hence, obtain its difference code and shape number. *6*

5. (a) Compute MSE and SNR for the images given below : *6*

$$f(x, y) = \begin{bmatrix} 3 & 2 & 1 \\ 1 & 2 & 1 \\ 3 & 2 & 2 \end{bmatrix} \text{ and } \hat{f}(x, y) = \begin{bmatrix} 3 & 1 & 1 \\ 1 & 1 & 2 \\ 1 & 1 & 1 \end{bmatrix}$$

(b) What do you understand by the term Data Compression ? How is relative data redundancy (R) related to the compression ratio (C) ? *4*

6. (a) What is Discrete Cosine Transform (DCT) ? Apply DCT to the following image F : *5*

$$F = \begin{bmatrix} 1 & 2 \\ 2 & 1 \end{bmatrix}$$

(b) Find the minimum D_4 and D_8 distances between the marked pixels 1 and 5 for the image

$$\begin{bmatrix} \textcircled{1} & 2 & 4 & 8 \\ 2 & 6 & 4 & 2 \\ 1 & 3 & 4 & \textcircled{5} \\ 2 & 2 & 1 & 5 \end{bmatrix}.$$ *2*

(c) A 4×4 image is given by $\begin{bmatrix} 2 & 3 & 4 & 5 \\ 1 & 2 & 4 & 6 \\ 2 & 3 & 2 & 4 \\ 1 & 5 & 7 & 6 \end{bmatrix}$.

If this image is filtered by a min filter with a mask  , find the resultant image, assuming zero padding. *3*

7. (a) Write short notes on the following : *6*

(i) Feature Selection Criteria

(ii) Principal Component Analysis

(iii) Wiener Filtering

(b) Find the value of x for which the mask

$$\begin{bmatrix} -1 & -1 & -1 & -1 & -1 \\ -1 & -1 & -1 & -1 & -1 \\ -1 & -1 & x & -1 & -1 \\ 1 & -1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \end{bmatrix}$$

acts as a high pass filter. *4*