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MMTE-003

M.Sc. (MATHEMATICS WITH APPLICATIONS IN COMPUTER SCIENCE)
M.Sc. (MACS)
Term-End Examination

00735

December, 2019

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) Give examples in which histogram specification is applied rather than equalization. Perform the histogram equalization on the following image : 5

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

(b) Define the terms 'Entropy' and 'Coding redundancy of Huffman code'. Calculate both for the data given below : 5

Symbol	1	2	3	4	5	6
Huffman Code	0	10	110	1110	11110	111111
Probability	0·4	0·2	0·2	0·1	0·05	0·05

[Given $\log_2 0{\cdot}05 = -4{\cdot}32$]

2. (a) A binary image X and the structuring element B are given as

$$X = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 0 & 0 & 1 & 1 \\ 1 & 0 & 0 & 0 & 1 & 1 \\ 1 & 1 & 0 & 0 & 0 & 1 \\ 1 & 1 & 0 & 0 & 0 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix}, \quad B = \begin{bmatrix} 1 & 0 & 1 \\ 0 & \textcircled{0} & 0 \\ 1 & 0 & 1 \end{bmatrix}.$$

(i) Find X^c, $X \oplus B$, $X^c \ominus B$, $X \ominus B$ and $X^c \oplus B$.

(ii) Find the relationship between $X \ominus B$ and $X^c \oplus B$. 5

(b) What is the relevance of determining the Laplacian of an image ? Show that subtracting the Laplacian of an image from the image itself is proportional to unsharp masking. 5

3. (a) Compute Mean Square Error (MSE) and Signal to Noise Ratio (SNR) for the reference image $f(x, y)$ and processed image $\hat{f}(x, y)$ where

$$f(x, y) = \begin{bmatrix} 3 & 2 & 4 \\ 4 & 2 & 4 \\ 3 & 2 & 2 \end{bmatrix} \text{ and } \hat{f}(x, y) = \begin{bmatrix} 3 & 1 & 1 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{bmatrix}$$ 5

(b) What is Discrete Fourier Transform (DFT) ? Find DFT to the sequence (x) given below :

$$X = \{1\ 2\ 3\ 4\}$$

Also, find Inverse Discrete Fourier Transform. 5

4. (a) What is Digital Image Watermarking ? Write the steps involved in the process of watermark embedding and extraction through suitable block diagram. 5

(b) What is the difference between the terms Bandpass and Bandreject filters, in context of their utility in Digital Image processing ? Determine the equation for the Bandpass filters corresponding to the Bandreject filters given below : 5

(i) Ideal :

$$H(u, v) = \begin{cases} 0 & \text{if } D_0 - \frac{W}{2} \le D \le D_0 + \frac{W}{2} \\ 1 & \text{otherwise} \end{cases}$$

(ii) Gaussian :

$$H(u, v) = 1 - e\left[\frac{D^2 - D_0^2}{DW}\right]^2$$

5. (a) What is linear convolution ? How is it different from linear correlation ? Perform the linear convolution between two matrices X(m, n) and h(m, n) given below :

$$X(m, n) = \begin{bmatrix} 3 & 1 \\ 2 & 4 \end{bmatrix} \text{ and } h(m, n) = \begin{bmatrix} 1 & 5 \\ 2 & 3 \end{bmatrix}$$

Also obtain the linear correlation between the matrices X(m, n) and h(m, n). Finally, comment on the result obtained. *5*

(b) What is Bayesian classification ? How is it different from clustering ? Apply the Bayesian classifier to predict the class of (2, 2) from the dataset given below : *5*

a_1	2	0	2	0	3
a_2	0	2	4	2	2
Class (i)	c_1	c_1	c_2	c_2	c_2

Assume that both the classes follow multivariate normal density function.

6. (a) Use the Naive Bayes classifier and classify the unknown pixel X in the image shown below :

$$\begin{bmatrix} \# & \# & \# & * \\ \# & X & \# & * \\ \# & \# & * & * \\ \# & \# & * & * \end{bmatrix}$$

where # and * are two different classes of pixels present in the image. Consider the 8 – neighbourhood of X and determine the class of X. *5*

(b) Find the resultant image if the image

$$\begin{bmatrix} 2 & 3 & 4 & 5 \\ 1 & 2 & 4 & 6 \\ 2 & 3 & 2 & 4 \\ 1 & 5 & 7 & 6 \end{bmatrix}$$

is filtered by a Min filter with a mask  . *5*

7. (a) List three properties of a median filter. *3*

(b) Using 0, 1 and -1 as coefficient values, give the form for eight operators that measure gradient of edges oriented in eight directions : E, NE, N, NW, W, SW, S and SE. Specify the gradient direction of each mask. *4*

(c) Define principal component analysis with example. *3*