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MMTE-003

**M. Sc. (MATHEMATICS WITH
APPLICATIONS IN COMPUTER
SCIENCE) [(M. Sc.) MACS]**

Term-End Examination

June, 2022

**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) Briefly discuss the terms “Convolution” and “Correlation”. Also discuss their respective roles in image processing. 2
- (b) Consider a digital image of size 1024×1024 , and a convolution mask of size 64×64 . Compute the number of multiplications needed in spatial domain and frequency domain to perform the convolution operation. 3

P. T. O.

- (c) For the reference image : 5

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

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

Compute the MSE, SNR and PSNR for an 8-bit image.

2. (a) What is histogram equalization ? How is it applied in image processing ? Verify the statement, “The second pass of histogram equalization will produce exactly the same results as the first pass has produced.” 5
- (b) What is ‘Huffman coding’ ? How many total bits are required to code for the string *abcdef*, whose data given below, by using Huffman coding ? 5

Symbol	Frequency
<i>a</i>	21
<i>b</i>	16
<i>c</i>	15
<i>d</i>	18
<i>e</i>	32
<i>f</i>	8

3. (a) Find out the maximum entropy of a sequence consisting of 14 binary digits, having nine 1's and five 0's. 2
- (b) How does Bayesian classifier perform classification ? Apply the Bayesian classifier on the following dataset and predict the class of (2, 2) : 6

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

- (c) Show that Fourier transform matrix for a 4×4 image is a unitary matrix. 2
4. (a) What are Median fillers ? Briefly discuss their utility in image processing. Compute the median value of the pixel circled below, using 3×3 mask : 5

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

(b) Briefly discuss any *two* of the following, and illustrate through an example for each : 5

- (i) Sampling
- (ii) Quantization
- (iii) Clustering

5. (a) What is digital image watermarking ? Give block diagrams for embedding and extraction of a digital image watermark. 5

(b) Briefly discuss Sobel operator and Prewitt operator. Apply Sobel operator and prewitt operator on the image given below : 5

$$\begin{bmatrix} a_1 & a_2 & a_3 \\ a_4 & a_5 & a_6 \\ a_7 & a_8 & a_9 \end{bmatrix}$$

6. (a) Determine the Fourier spectrum of a one-dimensional constant function $f(x)$, defined as : 2

$$f(x) = c \quad \text{for } 0 \leq x \leq N - 1$$

(b) Briefly discuss the following transforms : 8

- (i) DCT
- (ii) DFT
- (iii) FFT
- (iv) HAAR

7. (a) Compute Euclidean, Manhattan average and Chebyshev distances for the objects O_1 and O_2 with two attributes x_1 and x_2 , whose details are as follows : 3

Variable

Object	x_1	x_2
O_1	5	6
O_2	2	3

- (b) Write Canny edge-detection algorithm. What are the three stages of Canny edge-detector ? Briefly explain each phase. 7