MMTE-003

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

Term-End Examination
June, 2024

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) State Shannon-Nyquist theorem. Briefly discuss its relevance in context of digitization of images. How Shannon-Nyquist theorem relates to the determination of the ideal size of the pixel.

    4

    (b) What is Discrete Fourier Transform (DFT) ? Write 2-D DFT of an image $f(x,y)$ of size M × N. Compute the 2-D DFT of a 2 × 2 image $f(x,y) = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$.

    6

2. (a) Compare Haar Transform with Discrete Cosine Transform (DCT). Why DCT is considered for image compression ? Compute the 2×2 discrete Haar Transformation matrix for $N = 2$.   6

   (b) Briefly discuss the RGB model, with suitable diagram. How do we determine the composite colour in RGB colour model at any point ? Discuss.   4

3. (a) What does the histogram of an image represent ? Determine the histogram and the normalized histogram of the image

   $$\begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 1 & 2 & 3 \\ 0 & 2 & 4 & 6 \end{bmatrix}.$$ 5

   (b) Define Histogram specification. Compare it with Histogram equalization. Write the stepwise procedure for histogram specification.   5

4. (a) What are Non-linear filters ? Discuss the stepwise working of median filter. Also, give advantages and disadvantages of median filter. Apply median filter. Apply

median filter on the image $f(x,y)$ given

below :   5

$$f(x,y) = \begin{bmatrix} 0 & 1 & 0 & 6 & 5 \\ 2 & 3 & 1 & 2 & 3 \\ 1 & 2 & 7 & 5 & 4 \\ 1 & 0 & 6 & 5 & 2 \\ 2 & 3 & 5 & 7 & 6 \end{bmatrix}$$

(b) Which domain is better for image enhancement, frequency domain on spatial domain ? Justify. Give classification of various frequency domain filter with suitable diagram. Also, write the steps of frequency domain filtering with the help of block diagram.   5

5. (a) Write short notes on following :   6

(i)   Ringing effect

(ii) Butterworth low pass filter

(iii) Gaussian low pass filter

(b) Explain the image degradation/restoration model, with a suitable block diagram.   4

6. (a) Differentiate between supervised and unsupervised learning. Write K-means algorithm. Also, give advantages and disadvantage of K-means algorithm.   6

(b) Explain Linear Discrimination Function. Also, give properties of Linear Discriminate Analysis (LDA). 4

7. Explain the following : 2×5=10

(i) Hierarchical clustering

(ii) Bayesian classifier and its properties

(iii) Region Detection in image segmentation

(iv) Rayleigh Noise

(v) High pass filters and its applications