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MMTE-003

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

Term-End Examination

June, 2020

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) What is the value of encircled pixel after applying 5 × 5 median filter on the following image ? 5

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

P. T. O.

(b) Given an image of size 3 × 3 as : 5

$$f(m,n) = \begin{bmatrix} 128 & 212 & 255 \\ 54 & 62 & 124 \\ 140 & 152 & 156 \end{bmatrix}$$

find the output image g (m, n) using logarithmic transformation $g(m, n) = \log_{10}(1 + f(m, n))$.

2. (a) Show that a two-dimensional Gaussian operator is separable, while the Laplacian of a Gaussian operator is not separable. 5

(b) What is Radon Transform ? Show that the Radon transform of the unit impulse $\delta(x, y)$ is a straight vertical line in $\rho\theta$ plane passing through the origin. 5

3. (a) Determine the mean and variance for the salt and pepper noise, having the following pdf : 5

$$f(z) = \begin{cases} p_a; & z = -255 \\ p_b; & z = 255 \\ 1 - (p_a + p_b); & z = 0 \end{cases}$$

(b) What is Disctate Cosine Transform (DCT) ? Why do we apply DCT for any image ? Apply DCT to the following image (f) : 5

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

4. (a) An alphabet contains four symbols a, b, c and d having their probabilities of occurrences 0.2, 0.2, 0.4 and 0.2 respectively. Encode the string *cbcad* using arithmetic technique. 5

(b) Find the entropy of the image given by : 5

$$f(m, n) = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 1 & 2 & 2 \\ 0 & 1 & 2 & 3 \\ 1 & 2 & 2 & 3 \end{bmatrix}$$

5. (a) Determine the Blurring function H (u, v) for the situation given below : 5

"Consider the problem of image blurring caused by uniform acceleration in the x-direction. If an image is at rest at time

$t = 0$ and accelerates with a uniform acceleration $X_0(t) = \frac{at^2}{2}$ for time t."

You may assume that the shutter opening and closing times are negligible.

(b) The Bayes decision function : 5

$$d_j(x) = p(x \mid w_j)p(w_j)\ j = 1, 2, ..., w;$$

were derived using 0 – 1 loss function.

$d_j(x) = p(x \mid w_j)p(w_j)$

Prove that these decision functions minimize the probability of error. Find $p(c)$ and show that $p(c)$ is maximum, when $p(x \mid w_i)\, p(w_i)$ is maximum. Assume that the probability of error $p(e)$ is $1 - p(c)$ where $p(c)$ is the probability of being correct and for a pattern vector x belonging to class w_i, $p(c / x) = p(\omega_i / x)$.

6. Differentiate between the following with suitable examples : 10

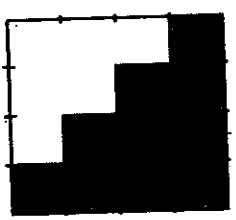
   (a) Clustering and classification techniques in image processing.

   (b) Image restoration and image enhancement.

   (c) Basic global thresholding method and optimum global thresholding method.

   (d) Band pass filters and band reject filters

7. (a) Apply the split-and-merge technique to segment the following image : 4



   (b) Compute the covariance matrix of the data given by $x_1 = [2 \quad 1]'$, $x_2 = [3 \quad 2]'$, $x_3 = [2 \quad 3]'$ and $x_4 = [1 \quad 4]'$. 6

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