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MMTE-003

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

M.Sc. (MACS)

00942

Term-End Examination

December, 2014

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 calculators is **not** allowed.*

1. (a) What are the important components of image processing system ? Describe any two components briefly. *2*

(b) It is given that

Symbol	a	b	c	d	e	f
Frequency	21	16	15	18	32	8

How many bits are required to code the above data using Huffman coding ? *4*

(c) Suppose that a digital image is subjected to histogram equalization. Show that a second pass of histogram equalization will produce exactly the same result as the first pass. *4*

2. (a) Show that the Laplacian of a continuous function f(t, z) of continuous variables t and z satisfies the following Fourier transform pair :

$$\nabla^2 f(t, z) \Leftrightarrow -4\pi^2 (\mu^2 + \eta^2) F(\mu, \eta)$$

where $F(\mu, \eta)$ is the Fourier transform of $f(t, z)$. 5

(b) Show that subtracting the Laplacian of an image from that image is proportional to the Unsharp masking. 5

3. (a) 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, then find the blurring function H (u, v). You may assume that the shutter opening and closing times are negligible. 6

(b) A binary image contains four straight lines which are oriented horizontally and vertically, at 45° and at – 45° respectively. Give a set of 3×3 masks that can be used to detect 1-pixel-long breaks in these lines. Assume that the grey level of the lines is 1 and that the grey level of the background is 0. 4

4. (a) Determine whether the following statements are *true* or *false*. Explain the reason for each answer. *6*

(i) The non-zero entries of the absolute ADI continue to grow in dimension as long as the object is moving.

(ii) The non-zero entries in the positive ADI always occupy the same area, regardless of the motion undergone by the object.

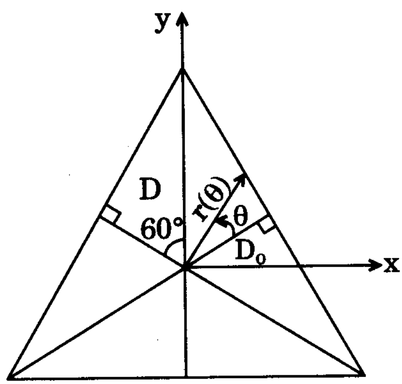
(iii) The non-zero entries of the negative ADI continue to grow in dimension as long as the object is moving.

(b) The speed of a bullet in flight is to be estimated by using high-speed imaging technique. The method of choice involves the use of a TV camera and flash that exposes the scene for K seconds. The bullet is 2·5 cm long, 1 cm wide, and its range of speed is 750 ± 250 m/s. The camera optics produces an image in which the bullet occupies 10% of the horizontal resolution of 256×256 digital image. Determine the maximum value of K that will guarantee that the blur from the motion does not exceed 1-pixel. *4*

5. (a) Show that redefining the starting point of a chain code, so that the resulting sequence of numbers forms an integer of minimum magnitude, makes the code independent of the initial starting point on the boundary. 3

(b) Find the normalized starting point of the code 11076765543322. 2

(c) Find the expression for the signature for the boundary of an equilateral triangle as shown in the following figure : 5



6. (a) The Bayes decision functions $d_j(x) = p(x \mid w_j)\, p(w_j)$, $j = 1, 2, \ldots w$; were derived using a 0 – 1 loss function. 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 probability of being correct and for a pattern vector x belonging to class w_i, $p(c \mid x) = p(w_i \mid x)$. 5

(b) Specify the structure and weights of a neural network capable of performing exactly the same function as a minimum distance classifier in n-dimensional space. 5

7. (a) Perform the linear convolution between two matrices X (m, n) and h (m, n) given as

$$X(m, n) = \begin{bmatrix} 11 & 12 & 13 \\ 14 & 15 & 16 \\ 17 & 18 & 19 \end{bmatrix} \text{ and}$$

$$h(m, n) = [3\ 4\ 5]$$

Also obtain the linear correlation between X and h and comment on the result obtained. 4

(b) Consider the four vectors $\mathbf{x}_1 = (0, 0, 0)^t$, $\mathbf{x}_2 = (1, 0, 0)^t$, $\mathbf{x}_3 = (1, 1, 0)^t$, $\mathbf{x}_4 = (1, 0, 1)^t$.

Find the projected points, if the dimensions are reduced from three to two using Principal Component analysis. 6