No. of Printed Pages : 6

MMTE-003

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

Term-End Examination

00718

June, 2015

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.*

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1. (a) Consider the following 2-bit image of size 5×5.

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

Compute histogram components and second order moments of the image before and after histogram equalization. *6*

(b) Two images f(x, y) and g(x, y), have histograms h_f and h_g respectively. Give the conditions under which you can determine the histograms of the following : 4

(i) f(x, y) + g(x, y)

(ii) f(x, y) – g(x, y)

2. (a) Show that if a filter transfer function H(u, v) is real and symmetric, then corresponding spatial domain filter h(x, y) is also real and symmetric. 4

(b) Can you use the Fourier transform to compute the magnitude of the gradient for use in image differentiation ? Justify your answer. 2

(c) A continuous Gaussian low pass filter in the continuous frequency domain has the transfer function

$$H(u, v) = A \exp[-(u^2 + v^2)/2\,\sigma^2].$$

Show that the corresponding filter in the spatial domain is

$$h(x, y) = A \cdot 2\pi\,\sigma^2 \exp[-2\pi^2\,\sigma^2(x^2 + y^2)].$$ 4

3. (a) The arithmetic decoding process is the reverse of the encoding procedure. Decode the message 0·23355 given the coding model. *7*

Symbol	Probability
a	0·2
e	0·3
i	0·1
o	0·2
u	0·1
!	0·1

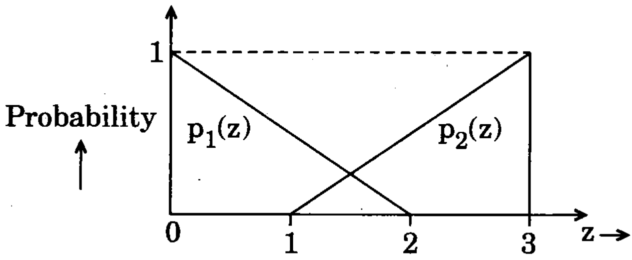
(b) Define measure of similarity between two strings a and b. Find its value, when

(i) all the symbols used in a and b are exactly the same,

(ii) all the symbols used in a and b are different. *3*

4. (a) Use the LZW coding algorithm to encode the 7-bit ASCII string “aaaaaaaaaa”. *5*

(b) Suppose that an image has the gray-level probability density functions shown below :



Here, $p_1(z)$ corresponds to objects and $p_2(z)$ corresponds to background. Assume that $P_1 = P_2$ and find the optimal threshold between object and background pixels. *5*

5. (a) Define the following : *3*

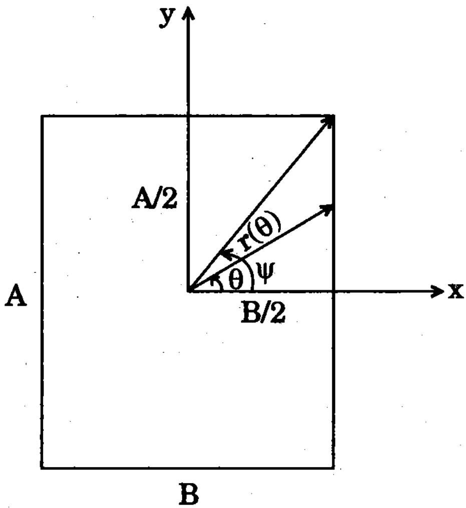
(i) Image acquisition

(ii) Image compression

(iii) Morphological processing

(b) Find the normalized starting point of the code 41076765541322. *2*

(c) Find the expression for the signature of a rectangular boundary for the following figure : *5*



6. (a) Give two boundary shapes that have the same mean and same third statistical moment descriptors, but different second moments. *2*

(b) Consider a checkerboard image composed of alternating black and white squares, each of size m × m. Give a position operator that would yield a diagonal co-occurrence matrix. *3*

(c) Obtain the gray-level co-occurrence matrix of a 5×5 image composed of a checkerboard of alternating $1's$ and $0's$, if the position operator P is defined as

(i) "one pixel to the right" and

(ii) "two pixels to the right".

Assume that top left pixel has value 0. *5*

7. (a) The following pattern classes have Gaussian probability density functions :

$w_1 = \{(0, 0)^t, (2, 0)^t, (2, 2)^t, (0, 2)^t\}$ and

$w_2 = \{(4, 4)^t, (6, 4)^t, (6, 6)^t, (4, 6)^t\}$.

Assume that $P(w_1) = P(w_2) = \frac{1}{2}$ and obtain the equation of the Bayes' decision boundary between these two classes. Also, sketch the boundary. *6*

(b) Describe the following : *4*

(i) Fourier Descriptors

(ii) Homomorphic Filtering