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MMTE-003

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

Term-End Examination

December, 2010

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) Propose a set of intensity slicing transformations capable of producing all individual planes of an 8 - bit monochrome image. 4

   (b) What effect would setting to zero the lower - order bit planes have on the histogram of an image ? 2

   (c) Explain with an example that the discrete histogram equalization does not in general yield a flat histogram. 4

2. (a) Explain the decimation in time FFT implementation. Write all the mathematical steps involved in detail. 5

(b) Obtain the Fourier transform of the following 2 - D functions. 2+3=5

(i) $\nabla^2 f(t, z)$

(ii) $A2\pi\sigma^2 e^{-2\pi^2\sigma^2\left(t^2+z^2\right)}$

3. (a) Obtain the mean and variance of the following probability density functions 3+3=6

(i) $p(Z)= \begin{cases} \frac{2}{b}(Z-a)e^{-(Z-a)^2/b}; Z \geq a;\ Z < a \\ O \end{cases}$.

(ii) $p(Z)= \begin{cases} \frac{1}{b-a}\ ; a \leq Z\ b. \\ O\ ; \text{otherwise.} \end{cases}$

(b) Define the following filters 1+1+2=4

(i) Contraharmonic mean filter
(ii) Geometric mean filter
(iii) Alpha trimmed mean filter.

4. (a) Find the Radon transforms of the following functions by applying the projection theorem. 6

(i) $e^{-\frac{\pi}{x^2 + y^2}}\ \forall\ x,y$

(ii) $\cos 2\pi(\alpha x+\beta y),\ \sqrt{x^2 + y^2} \leq a.$

Assume the given functions are zero outside the region of support defined.

(b) Explain the Marr - Hildreth edge detector. What is the mask used to approximate this operation ? 4

5. (a) Consider an image given in matrix form as follows : 5

$$h\ (m,\ n) = \delta(m,n) + \frac{1}{4}\,\delta(m-1,n) + \frac{1}{4}\,\delta$$

$$(m+1,\ n)\ + \frac{1}{4}\,\delta(m,n-1) + \frac{1}{4}\,\delta(m,n+1).$$

Assume image to be 0, outside the window. Find the effect of applying the mark (which is h(m,n) itself).

(b) Explain how motion can be used for segmentation. Briefly explain one spatial and one Frequency domain technique to perform segmentation using motion. 5

6. (a) Given a source with following symbols and corresponding probabilities. 6

	$P(a_i)$.
a_1	0.6
a_2	0.3
a_3	0.08
a_4	0.02

Obtain the average length for the following coding schemes :

(i) Huffman

(ii) Arithmetic

(iii) Zeroth order exponential Golomb code.

(b) Draw the block diagram of a typical motion compensated video encoder. Briefly explain the functioning of such an encoder. 4

7. (a) Explain the use of principal components for image description/representation. Clearly bring out the underlying mathematics. 5

(b) The following pattern classes have Gaussian probability density functions 5

$$W_1 : \{(-1, 0)^T, (0, -1)^T, (1,0)^T, (0,1)^T\}.$$

$$W_2 : \{(-2, 0)^T, (0, -2)^T, (2,0)^T, (0,2)^T\}.$$

Assume that $P(W_1) = P(W_2) = 1/2$ and obtain the equation of the Bayes decision boundary between these two classes. Sketch the boundary.