Printed Pages : 7 TCS-702

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 0101 Roll No.

B. Tech.

(SEM. VII) EXAMINATION, 2007-08

DIGITAL IMAGE PROCESSING

Time : 3 Hours] *[Total Marks : 100*

Note : *(1) All questions are* ***compulsory.***

(2) All questions carry ***equal*** *marks.*

1 Attempt any **four** questions of the following : 5×4=20

(a) Consider the two image subsets S_1 and S_2 :

For $V = \{1\}$, determine whether S_1 and S_2 are

4-connected

8-connected

m-connected

	S_1				S_2				
1	1	1	0	0	1	1	1	0	0
0	0	0	0	0	1	1	1	0	0
0	0	0	1	1	0	1	0	0	1
1	0	0	1	0	0	1	0	0	1
0	1	1	0	0	0	0	0	0	0

(b) A common measure for the transmission of digital data is baud rate, Generally, transmission is accomplished in packets consisting of a start bit, a byte (8 bits) of information, and a stop bit. Using these facts answer the following :

(1) How many minutes would it take to transmit 1024×1024 image with 256 gray levels using a 56 K baud modem ?

(2) What would the time be if the same image is transmitted over at 750 K baud phone connection ?

(c) The 4×4 input image is defined by the following matrix with gray scale [0.9] :

2	3	3	2
4	2	4	3
3	2	3	5
2	4	2	4

Draw the image histogram and show the new output image along with its histogram after histogram equalization.

(d) The following matrix defines a 5×5 image $f(x, y)$. The center pixel $f(2, 2)$ is underlined. Suppose smoothing is done to the image using 3×3 neighborhood in the spatial domain. Then what will be the new value $f(2, 2)$ using the :

(1) the mean filter

(2) weighted average filter

(3) median filter

(4) min filter and

(5) max filter

0	1	0	6	7
2	0	1	6	5
1	1	7	5	6
1	0	6	6	5
2	5	6	7	6

(e) Give the Roberts cross gradient and Sobel operators. How these masks can be used to implement spatial domain filtering ?

2 Attempt any **two** of the following : **10×2=20**

(a) The basic approach used to approximate a discrete derivative (as in spatial domain) involves taking difference of the form

$f(x+1,\ y) - f(x, y)$.

(1) Obtain a filter transfer function, $H(u,\ v)$ for performing the equivalent process in the frequency domain.

(2) Show that $H(u,\ v)$ is a highpass filter.

(b) Given a matrix of size 3×3 as

$$A = \begin{pmatrix} 1 & 2 & 1 \\ 2 & 3 & 4 \\ 3 & 4 & 2 \end{pmatrix}$$

Compute $|A|$, A^{-1}, Trace of A, Eucledian norm of A, Eigen values and Eigen vectors of A.

(c) What is meant by singularity and ill-condition in relation to image restoration ? Derive expression of restored image using least-square approach. Comment on the singularity of this filter.

3 Attempt any **two** of the following : **10×2=20**

(a) Let an RGB image is given as an input :

(1) Convert the image into monochrome (linear and nonlinear), normalized RGB and HSI image.

(2) Suppose RGB color triplet for a particular color is given by (0.3, 0.5, 0.2). Compute corresponding YIQ and HSV triplets.

(b) Suppose two discrete one dimensional functions are represented by the sequences

$f = [5 \ 7 \ 11 \ 8 \ 2 \ 6 \ 8 \ 9 \ 7 \ 4 \ 3]$

$h = [1 \ 2 \ 1]$

Compute $f \oplus h$, $f \ominus h$, $f \circ h$ and $f \bullet h$.

Also plot the corresponding graphs.

(c) Suppose that A, B and C are three points. Prove that

(1) $\big((A \cdot B) \circ C) \bullet B\big) \circ C = (A \bullet B) \circ C$

(2) $\big((A \circ B) \bullet C) \circ B\big) \bullet C = (A \circ B) \bullet C$.

4 Attempt any **two** of the following : 10×2=20

(a) Suppose an image contains two types of regions, R_1 and R_2. The priori probability that a pixel belongs to R_1 is 0.4 and to R_2 is **0.6**. Probability density function of intensity in R_1 and R_2 are denoted by $p_1(z)$ and $p_2(z)$ respectively, where

$$p_1(z) = 0.2 - 0.04\,|5 - z| \quad \text{for} \quad 0 \le z \le 10$$

$$p_2(z) = 0.2 - 0.04\,|10 - z| \quad \text{for} \quad 5 \le z \le 15$$

Determine the optimum threshold for image segmentation by the gray level thresholding technique.

(b) Write short notes on :

(1) Region Merging and Region Splitting

(2) Watershed Segmentation Algorithm.

(c) How many degrees of freedom are there in a plane projective transformation ? Name the properties that are preserved under such transformations. What simplification needs to be imposed on plane projective transformation to arrive at plane affine transformation ? Give the physical interpretation of parameters of plane affine transformation.

5 Attempt any **two** of the following : **10×2=20**

(a) Suppose in a two-class pattern recognition problem, classes are distributed as Gausssian where mean vectors and covariance matrices are as follows :

For class-I : $\mu 1 = \begin{pmatrix} 2 \\ 3 \end{pmatrix}$, $\sum 1 = \begin{pmatrix} 1 & 0 \\ 0 & 3 \end{pmatrix}$

and

For Class-II : $\mu 2 = \begin{pmatrix} 5 \\ 7 \end{pmatrix}$, $\sum 1 = \begin{pmatrix} 2 & 0 \\ 0 & 1 \end{pmatrix}$

Determine the class boundary considering Bayesian classification scheme. Assume a priori probabilities of class-I and class-II are 0.4 and 0.6 respectively.

(b) How Principal Component Analysis is used for Description of shape of any segmented region? Obtain the gray-level co-occurrence matrix of a 5×5 image composed of a checkerboard of alternating 1's and 0's. The position operator P is defined as "one pixel to the right". Assume that the top level pixel has value 0.

(c) Explain any two regional descriptors in short. Given a 4*4 image whose gray levels ordered lexicographically are as follows :

2 3 0 1 1 3 1 2 0 2 0 3 1 1 2 3

Calculate the spatial moments up to the second order.
