B. Tech.
(SEM. VII) EXAMINATION, 2008-09
DIGITAL IMAGE PROCESSING

Time: 3 Hours] [Total Marks: 100

Note: All questions are compulsory.

1 Attempt any four questions of the following: 5x4=20
(a) Choose 32 intensity levels from a scale calibrated as 0, 1, 2, ..., 255 such that Weber ratio between any two levels is maximum.
(b) Consider the two image subsets S1 and S2:
For $V = \{1\}$, determine whether S1 and S2 are
4-connected 8-connected m-connected

<table>
<thead>
<tr>
<th>S1</th>
<th>S2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1 1 0 0</td>
<td>1 1 1 0 0</td>
</tr>
<tr>
<td>0 0 0 0 0</td>
<td>1 1 1 0 0</td>
</tr>
<tr>
<td>0 0 0 1 1</td>
<td>0 1 0 0 1</td>
</tr>
<tr>
<td>1 0 0 1 0</td>
<td>0 1 0 0 1</td>
</tr>
<tr>
<td>0 1 1 0 0</td>
<td>0 0 0 0 0</td>
</tr>
</tbody>
</table>

(c) 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:
(i) How many minutes would it take to transmit
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       For \( V = \{1\} \), determine whether S1 and S2 are 4-connected 8-connected \( m \)-connected

\[
\begin{array}{c|c}
S1 & S2 \\
\hline
1 & 1 & 1 & 1 & 0 & 0 & 1 & 1 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 \\
0 & 0 & 0 & 1 & 1 & 0 & 1 & 0 & 0 & 1 \\
1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 1 \\
0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
\end{array}
\]

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

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

(d) Gray level histogram of an image is given below:

<table>
<thead>
<tr>
<th>Gray level</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>400</td>
<td>700</td>
<td>1350</td>
<td>2500</td>
<td>3000</td>
<td>1500</td>
<td>550</td>
<td>0</td>
</tr>
</tbody>
</table>

Compute the gray level histogram of the output image obtained by enhancing the input by the histogram equalization technique.

(e) 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 \( 3 \times 3 \) neighbourhood in the spatial domain. Then what will be the new value \( f'(2, 2) \) using the:

(i) The mean filter (ii) Weighted average filter (iii) Median filter (iv) Min filter and (v) Max filter

\[
\begin{bmatrix}
0 & 1 & 0 & 6 & 7 \\
2 & 0 & 1 & 6 & 5 \\
1 & 1 & 7 & 5 & 6 \\
1 & 0 & 6 & 6 & 5 \\
2 & 5 & 6 & 7 & 6
\end{bmatrix}
\]

(f) 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 \( f(x+1, y) - f(x, y) \).
(i) Obtain a filter transfer function, $H(u, v)$, for performing the equivalent process in the frequency domain.

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

(b) Given a matrix of size $3 \times 3$ as $A = \begin{pmatrix} 1 & 2 & 1 \\ 2 & 3 & 4 \\ 3 & 4 & 2 \end{pmatrix}$.

Compute $|A|$, $A^{-1}$, trace of $A$, Euclidean 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) Describe the RGB, CMY and HIS color models. Write an algorithm/code for converting a monochrome image to RGB and Normalized RGB images.

(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 $f \cdot h$. Also plot the corresponding graphs.

(c) Describe a morphological algorithm for thinning. State the difference between medial axis and the skeleton obtained through thinning.
Attempt any **two** of the following:

(a) Define image segmentation. In terms of this definition, state the property satisfied by the pixels in each region obtained by graylevel thresholding technique. Elaborate the terms 'local', 'global' and 'dynamic' threshold.

(b) Write short notes on:
   (i) Edge-based segmentation
   (ii) Adaptive Thresholding.

(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.

Attempt any **two** of the following:

(a) In a pattern recognition problem, feature vectors have two elements. Three class centers are given by (20, 20)\(T\), (20, 100)\(T\) and (100, 20)\(T\) respectively. Plot class centers in the feature space. Find discriminating functions and draw corresponding boundaries between the classes considering Euclidean distance.

(b) Generate a 32 * 24 image of the character 'B' such that the strokes are 7 pixels thick. Design a morphological algorithm to decompose the character into horizontal and vertical straight segments and arcs.

(c) How Principal Component analysis is used for description of shape of any segmented region? Obtain the gray-level co-occurrence matrix of a 5\(\times\)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.