Seventh Semester B.E. Degree Examination, June/July 2014
Image Processing

Time: 3 hrs.  Max. Marks: 100

Note: Answer any FIVE full questions, selecting atleast TWO questions from each part.

**PART – A**

1. a. What is a digital image? With block diagram, explain the fundamental steps in digital image processing. (10 Marks)

   b. Write a short note on:
      i) Image formation in the eye.
      ii) Brightness adaptation in an eye. (10 Marks)

2. a. Explain an image acquisition using a sensor arrays. (06 Marks)

   b. Briefly explain the following terms:
      i) Neighbours
      ii) Path
      iii) Connectivity of pixels. (06 Marks)

   c. Consider an image segment:

   ![Image Segment]

   i) Let \( V = \{0, 1, 2\} \) compute the length of the shortest 4, 8m path between \( p \) and \( q \). (08 Marks)

   ii) Repeat for \( V = \{2, 3, 4\} \).

3. a. Show that the DFT of the two dimensional circular convolution of two arrays are the product of their DFT's. (10 Marks)

   b. For the given orthogonal matrix ‘A’ and image ‘u’, obtain transformed image, original image and basis image.

   \[
   A = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}, \quad u = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}
   \] (10 Marks)

4. a. Give an expression for 2D-forward and inverse discrete cosine transform and list its properties. (08 Marks)

   b. Generate Hadamard transform matrix \( H_n \) for \( n = 3 \) from the core matrix

   \[
   H_i = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}
   \] (08 Marks)

   c. List the properties of Slant transform. (04 Marks)
PART – B

5 a. Explain the following: i) Gray-level slicing; ii) Bit plane slicing. (06 Marks)
b. For the given $4 \times 4$ image having grey scale between $[0, 9]$, get histogram equalized image and draw the histogram of image before and after equalization.

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

(08 Marks)
c. Briefly explain how arithmetic and logic operations are used for image enhancement. (06 Marks)

6 a. Explain and compare ideal low pass filter and Butterworth filter for image smoothing. (10 Marks)
b. What is homomorphic filtering? With block diagram, explain the homomorphic filtering approach for image enhancement and list the advantages. (10 Marks)

7 a. Draw and explain image degradation and restoration model. (06 Marks)
b. Discuss various mean filters used in image restoration system. (06 Marks)
c. Explain in brief the inverse filtering approach. List its limitations in image restoration. (08 Marks)

8 a. Briefly discuss the following:
   i) RGB colour model.
   ii) HIS color model. (08 Marks)
b. What is pseudocolor? Explain its processing technique. (06 Marks)
c. $(R, G, B) = (0.683, 0.1608, 0.1922)$ convert this into HIS model. (06 Marks)

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PART - A

1. a. With the help of a block diagram, explain the fundamental steps in digital image processing. (07 Marks)
   b. With a block diagram, explain the components of a general purpose image processing system. (07 Marks)
   c. Explain any two applications of digital image processing. (06 Marks)

2. a. Explain image acquisition using sensor strips and sensor arrays. (08 Marks)
   b. What do you mean by image sampling and quantization? (06 Marks)
   c. With examples explain the following distance measures:
      i) Euclidean
      ii) City-block
      iii) Chess-board
      (06 Marks)

3. a. Explain separability of unitary transforms and basis images. (06 Marks)
   b. List few properties of unitary transforms. (06 Marks)
   c. Given the orthogonal matrix ‘A’ and image ‘u’ find the transformed image and the basis
      images
      \[
      A = \frac{1}{\sqrt{2}} \begin{pmatrix}
      1 & 1 \\
      1 & -1
      \end{pmatrix},
      u = \begin{pmatrix}
      1 \\
      2 \\
      3 \\
      4
      \end{pmatrix}
      \]  (08 Marks)

4. a. Write the expression used to compute Haar transform for N. Using these construct Haar transform for N = 2. (10 Marks)
   b. Explain how an N x N Slant transform matrix is obtained by recursion. (10 Marks)

PART - B

5. a. Explain: i) Contrast stretching, ii) Gray level slicing, iii) Bit-plane slicing. (06 Marks)
   b. What is a histogram? How does histogram of the following image look like:
      i) Dark image
      ii) Bright image
      iii) Low control image
      iv) High contrast image (08 Marks)
   c. Explain high boost filtering. (06 Marks)

6. a. Explain homomorphic filtering approach for image enhancement. (10 Marks)
   b. Explain five important noise probability density functions. (10 Marks)

7. a. Explain the following order statistic filters:
      i) Median filter
      ii) Max and min filters (08 Marks)
   b. Explain minimum mean square error filter. (12 Marks)

8. a. What is HSI color model? Give the expressions for converting RGB to HSI and also for HSI to RGB. (10 Marks)
   b. Write a note on full color image processing. (10 Marks)

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Image Processing

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PART – A

1. a. With a neat block diagram, explain the steps in image processing. (10 Marks)
   b. Explain the following terms as applicable to image processing with necessary graphs:
      i) Brightness adaptation
      ii) Weber ratio
      iii) Mach bands
      (10 Marks)

2. a. Discuss the role of sampling and quantization with an example. (08 Marks)
   b. Explain the image acquisition using micro densitometer. (06 Marks)
   c. Explain spatial resolution and gray level resolution of an image. (06 Marks)

3. a. Describe the following terms applied to image processing:
      i) Neighbors of a pixel
      ii) Adjacency of pixels
      iii) Digital path
      iv) City-block distance measure (04 Marks)
   b. Let \( V = \{0, 1\} \), compute \( D_0, D_4, D_8 \) distance between the pixels \( p \) and \( q \) for the Fig.Q3(b).
      \[
      \begin{align*}
      (q) & \quad 1 & 1 & 2 & 3 \\
      & 0 & 2 & 2 & 1 \\
      & 1 & 1 & 0 & 2 \\
      & 2 & 1 & 2 & 1 \quad \text{(p)}
      \end{align*}
      \]
      Fig.Q3(b) (08 Marks)
   c. For the \( 2 \times 2 \) transform ‘A’ and the image ‘U’, calculate the transformed image ‘V’ and basis images.
      \[
      A = \frac{1}{\sqrt{2}} \begin{bmatrix}
      1 & 1 \\
      1 & -1
      \end{bmatrix}; \quad U = \begin{bmatrix}
      1 & 2 \\
      3 & 4
      \end{bmatrix}
      \]
      (08 Marks)

4. a. Explain any four properties of two dimensional Fourier transform. (08 Marks)
   b. Define 2-D forward and inverse discrete cosine transform and mention its properties. (08 Marks)
   c. Generate the Hadamard transform \( H_n \) matrix for \( n = 3 \). Given the core matrix
      \[
      H_1 = \frac{1}{\sqrt{2}} \begin{bmatrix}
      1 & 1 \\
      1 & -1
      \end{bmatrix}
      \]
      Also, indicate its sequency. (04 Marks)
PART – B

5 a. With necessary graphs, explain the following spatial image enhancement operations:
   i) Image negative
   ii) Log transformation
   iii) Power law transformation
   iv) Contrast stretching
   (12 Marks)

   b. Perform histogram equalization of the $5 \times 5$ image whose data is shown in Table Q5(b).

<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>Number of pixels</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>14</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

   Table Q5(b)
   (08 Marks)

6 a. Explain with a block diagram, the basic steps for image filtering in frequency domain.
   (10 Marks)

   b. Illustrate Homomorphic filtering approach for image enhancement. Derive the suitable result.
   (10 Marks)

7 a. Explain the basic model of image restoration process. Also, with necessary equations, explain the most common PDFs in an image processing.
   (10 Marks)

   b. With necessary mathematical equations, explain inverse filtering and Wiener filtering for image restoration.
   (10 Marks)

8 a. Discuss briefly any two color models used in color image processing.
   (10 Marks)

   b. Explain intensity slicing and Graylevel to color transformation as applied to pseudocolor image processing.
   (10 Marks)