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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Sixth Semester B.Tech (Hons) Degree Examination July 2021 (2018 Admission)

Course Code: EC370
Course Name: DIGITAL IMAGE PROCESSING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks Marks

1 a) Define colour model with respect to image processing. Discuss two hardware oriented colour models and their practical significance. Justify the statement " Thecolour models RGB and CMY are not suitable for describing the human colour interpretation". (7)

b) Define Toeplitz matrix. Illustrate how the response of an LTI system can be expressed as the product of a Toeplitz matrix and a column matrix. (5)

c) Let H_2 be the Hadamard matrix of order 2. Then find the Hadamard matrix H_8 of order 8 in terms of H_2. (3)

2 a) State 2-D sampling theorem. Consider a two dimensional function $f(x,y) = 3\sin(4\pi x + 6\pi y)$. The function is sampled with a sampling intervals of $\Delta x = 0.2, \Delta y = 0.16,$ in the x and y directions respectively. Determine the following (8)

(i) Spectrum of $f(x,y)$

(ii) Sampled function $f(m,n)$

(iii) Spectrum of the sampled function

(iv) Transfer function of the lowpass filter to perfectly reconstruct $f(m,n)$ from $f(x,y)$.

b) Let $A(x,y) = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$. Find the 2D-DFT of $A(x,y)$. Without direct computation find the 2D-DFT of $B(x,y) = \begin{bmatrix} 1 & -2 \\ -3 & 4 \end{bmatrix}$ (7)

3 a) Explain the working principle of digital cameras. (4)

b) Define the terms (i) m-adjacency, (ii) digital path (iii) saturation (3)

c) The orthonormal matrices associated with the singular value decomposition of a 2x3 matrix A are $= \begin{bmatrix} 1/\sqrt{2} & 1/\sqrt{2} & 0 \\ -1/\sqrt{2} & 1/\sqrt{2} & 0 \end{bmatrix}, V = \begin{bmatrix} 0 & 1 & 0 \\ -1/\sqrt{2} & 0 & -1/\sqrt{2} \\ 1/\sqrt{2} & 0 & -1/\sqrt{2} \end{bmatrix}$. The Eigen values of AA^T are 4, 2 and 0. Determine the matrix A. (5)

d) How image compression can be achieved using Singular Value Decomposition? (3)

PART B

Answer any two full questions, each carries 15 marks

4 a) Show mathematically that image averaging will diminish the effect of additive noise. Assume noise is uncorrelated and has zero average value. (4)

b) Write the transfer function of (i) 2-D ideal lowpass filter (ii) 2-D Butterworth filter. Justify the reason for the ringing effect in the ideal lowpass filtered images. (4)

c) Explain inverse filtering. Mention two drawbacks of inverse filtering. (7)

5 a) Obtain the transfer function of Wiener filter. Deduce the condition under which Wiener filter reduces to an inverse filter. (8)

b) Explain how the size of a box filter affects the quality of filtered image. Given 3x3 region of an image $\begin{bmatrix} 0.1 & 0.27 & 0.7 \\ 0.13 & 0.34 & 0.8 \\ 0.14 & 0.37 & 0.9 \end{bmatrix}$. Apply Laplacian sharpening using window of size 3x3 (having negative value in the center) on this region for highlighting horizontal, vertical and diagonal edges. Determine the resultant value of middle pixel in the sharpened region. (7)

6 a) Consider an image of size 64x64 whose intensity values are distributed in the range 0 to 7. The number of pixels having values from 0 to 7 are listed in the same order as {128, 344, 560, 75, 323, 1123, 987, 556}. Perform histogram equalisation and obtain the new intensity value distribution. (8)

b) Explain constrained least squares filtering (7)

PART C

Answer any two full questions, each carries 20 marks

7 a) Explain the segmentation technique based on basic global thresholding. (6)

b) Compare sobel and prewitt operators for edge detection (4)

c) Explain steps in Huffman coding. A source has the symbol probability (10)

distribution given by {0.125, 0.0625, 0.0625, 0.25, 0.25, 0.125, 0.125}. The symbols in the same order are $\{a_1, a_2, a_3, a_4, a_4, a_5, a_6, a_7\}$. Perform Huffman encoding for this source and also find the coding efficiency.

8 a) Explain the role of Hough transform in linking the edges of images. (7)

b) What is a ramp edge in an image? How the second derivative operator characterizes the ramp edges? (3)

c) Explain arithmetic coding with an example. (10)

9 a) Discuss region growing method of image segmentation (10)

b) Explain in detail JPEG image compression standard. (10)

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