Course code: **Ex/ET/PE/B/T/424/G/2024**

B.ETCE 4TH YEAR 2ND SEMESTER EXAMINATION

Digital Image Processing

Session 2023-24

Full Marks: 100. Total Time 3 Hours.

Part I Answer any 10 questions **(CO1) 10x2=20**

1. What is the range of chromatic light in the EM energy spectru?.
2. State the Gamma correction relation.
3. Give another term for histogram equalization.
4. Name the different types of spatial operation on pixels.
5. What is the bilinear interpolation?
6. State the difference between array operation and matrix operation.
7. Give the expression for a 2-D circular convolution.
8. What are adaptive filters in digital image processing?
9. Give the expression for the mean square error.
10. Name the steps involved to generate the .JPEG files.
11. State the characteristics of the TIFF format?
12. What is the characteristic of an isotropic edge detector?
13. Name the three fundamental steps performed in edge detection.
14. State the characteristics of the Roberts cross-gradient operators.
15. What is the LoG operator?

Part II Answer any 3 questions **(CO2) 10x3=30**

1. a) Laplacian mask with a -8 in the centre yields sharper image than the one with a -4 in the centre. Explain the result in detail. 5

   b) Clarify how this type of filtering behaves as a function of mask size. 5

2. Develop an algorithm for a nxn filter, showing the nature of the computations involved and the scanning sequence used for the mask around the image by moving the centre of the mask throughout an image and, at each location, computing the sum of products of the mask coefficients with the corresponding pixels at that location. 10

[Turn over

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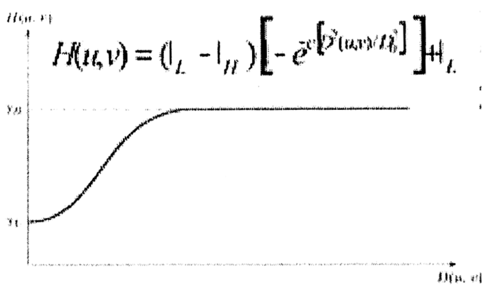
3. Find the best transformation function for histogram equalization if we model the histogram of input images as Gaussian probability density functions of the form shown.

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$

10

4. Construct a homomorphic filter using a Buttersworth highpass, that has the same general shape as the filter shown. State the steps in detail. 10

Homomorphic Filtering



Part III Answer any 3 questions **(CO3) 10x3=30**

1. Develop an expression for the blurring function *H(u,v)* for the following case: During acquisition an image undergoes uniform linear motion in the vertical direction for a time T_1. The direction of motion then switches to the horizontal direction for a time interval T_2. Assuming the time taken for the image to change directions is negligible, and that the shutter opening and closing times are negligible too. 10

2. Examine the differences between an Inverse Filter and Wiener Filter in the frequency domain. Under what circumstances does Wiener filtering score higher than Inverse filtering. 6+4

3. Illustrate variable-length coding procedures to be used for compression of a histogram equalized image with 2^n intensity levels. Also show how such an image containing spatial or temporal redundancies can be exploited for data compression. 5+5

4. Consider the simple 4x8, 8-bit image as given:

21 21 21 95 169 243 243 243

21	21	21	95	169	243	243	243
21	21	21	95	169	243	243	243
21	21	21	95	169	243	243	243

a) Compute the entropy of the image.
b) Compress the image using Huffman coding.
c) Compute the compression achieved and the effectiveness of the Huffman coding.
3+3+4

5. Implement the LZW coding algorithm to encode the 7-bit ASCII string "aaaaaaaaaaa". 10

Part IV Answer any 2 questions **(CO4) 10x2=20**

6. Establish the importance of gradient operator for image segmentation. Demonstrate that the Sobel and Prewitt masks give isotropic results only for horizontal and vertical edges oriented at $\pm 45^0$, respectively. 5+5

7. a) Write the Canny edge detector algorithm.
b) Formulate Step I and the gradient magnitude image computation in Step II of the Canny algorithm using 1-D instead of 2-D convolutions.
c) Demonstrate the computational advantages of using the 1-D convolution approach.
2+4+4

8. a) Show that if the histogram of an image is uniform over all possible intensity levels, the basic global thresholding algorithm converges to the average intensity of the image (L-1)/2.
b) Illustrate the case where if the histogram is bimodal with identical modes that are symmetric about their means, then the basic global algorithm will converge to the point halfway between the modes.
Let the threshold value during iteration is bounded in the open interval (0, L-1).
5+5