BITS Pilani, K K Birla Goa Campus
Digital Image Processing (EEE F435) [IC: Ashish Chittora]
End-Semester Examination, Semester-II (2022-23)

Date: 08/05/2023 **Duration: 180 Minutes**
Maximum marks: 80 **Time: 2 PM-5 PM**

Note: Write the answers clearly with suitable explanation/process. Directly written final answers will not be evaluated.

Q.1. Write a MATLAB program to create a black grid over a grayscale image 'apple.jpg' of size 128 x 128. The gridlines are 4 pixel wide and divides the image into 16 blocks (4 x 4 format) as shown in Fig-Q1. [Hint function (but not necessary): y = linspace(x1,x2,n) generates n points. The spacing between the points is (x2-x1)/(n-1)] [10]

Q.2. Suppose that f : $R^2 \longrightarrow R^2$ is an affine transformation such that

f(1,1) = (3,-4), f(0,2) = (-1,-1) and f(-1, 1) = (1,0)

(a) Find the matrix **A** that represents f in homogeneous coordinates. [5]
(b) Compute f(6,-8). [5]

Q.3. (a) Imagine a 64 x 64 image with 2 bits/pixel representation. The normalized gray levels are 0, 1/3, 2/3, 1. Suppose the image distribution is given by Table-Q3a.

(i) Apply histogram equalization and draw the equalized histogram. [5]

(ii) Apply Huffman encoding on the original image to determine variable length codes for each gray level. Calculate the entropy and compression ratio achieved. [5]

(b) Use Run-Length Encoding to encode the MSB plane of following 4-bit image Fig-Q3b: [5]

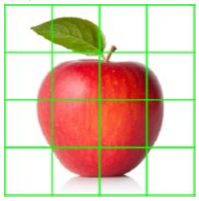


Fig-Q1

Gray level	No. of pixels
0	1813
1/3	1506
2/3	574
1	203

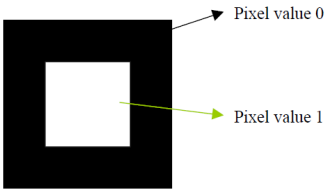
Table-Q3a

1	7	10	10
6	13	15	15
6	13	15	15
1	7	10	10

Fig-Q3b

Q.4. Given a 10x10 size binary image, whose central 4 x 4 pixels are all 1 and others are 0. Sketch the gradient of this image using the Sobel operator Hy. Show all the pixel values. [5]

$$H_y = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$



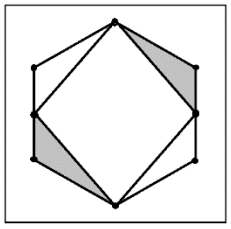
Q.5. (a) For the following sample vectors: $x_1 = (4,11)^T$, $x_2 = (8,4)^T$, $x_3 = (13,5)^T$ and $x_4 = (7,14)^T$.

(i) Calculate the mean vector (m_X) and Covariance matrix (C_X). [5]

(ii) Calculate vectors **y**, where **y** is derived from **x** using Hotelling-transform. [5]

(iii) Covariance matrix of **y** vectors (C_Y). [5]

(b) Calculate the Euler number for the following images: [5]

(i)  (ii) 

Q. 6. (b) For the triangle shape boundary as shown in Fig.Q6 and given three boundary points:

(i) Find the Fourier descriptors (FD) with starting point as O. [5]

(ii) State and verify the FD's translation property for the translation with $\Delta_{xy} = 1+2j$. [5]

Q.7. (a) Perform the morphological 'Closing' operation on a binary image (Fig. Q7a) using the given structuring element. [Assume sufficient zero padding at the image border] [5]

(b) Perform Region (or hole) filling operation on a binary image in Fig. Q7b using given structuring element B (dot = 1). Write the first four intermediate images (X_1, X_2, X_3 X_4) of the operation. [Take start point (in image X_0) of your choice. X_n is last step] [5]

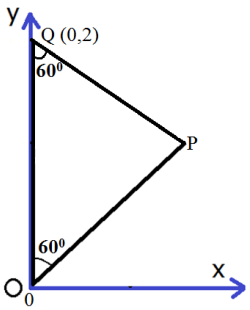
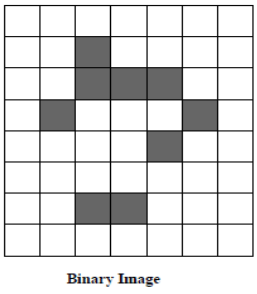


Figure-Q6



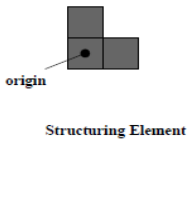


Figure-Q7a (perform Closing)

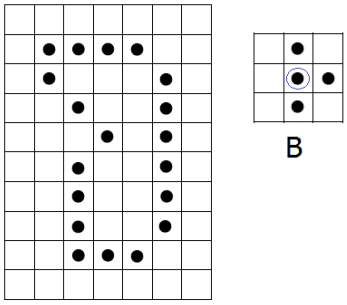


Figure-Q7b (Region filling)