Image Processing (CS40019)

Number of Students: 14
Mid-Semester Examination **Total Time: 2 Hours**
Maximum Marks: 60

Instructions: *Answer Q.1, any two questions from Part A and any two questions from Part B. All questions of the same part must be answered together. Clearly state any reasonable assumption that you make.*

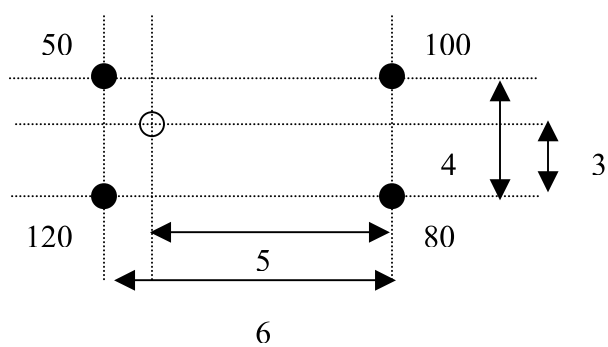
Q1. **[5X4=20]**

(a) Name one application of the image averaging operation. Explain how image averaging helps to remove noise in such images.
(b) Which type of spatial filter is best suited for the removal of salt-and-pepper noise in images and why?
(c) Explain the image acquisition technique used in capturing CAT scan images.
(d) Suggest one way of generating color histograms in the RGB color space from images. What is the number of histogram components in such a histogram?
(e) Which are the "safe RGB colors"? Why is it important to use only the safe colors in certain applications?

Part A

Q2. **[5+2+3=10]**

(a) We want to generate a zoomed image from an original image. In the following figure, the four bold pixels belong to the original image and the non-bold pixel belongs to the zoomed image. Gray levels of the original pixels are 50, 100, 120 and 80. Pixel-to-pixel distances are shown using an arbitrary unit. Determine the gray level of the new pixel using Bi-linear Interpolation.



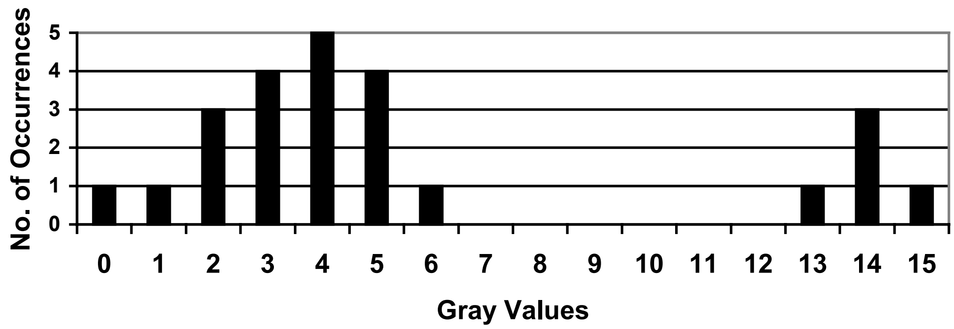
(b) For the binary image with pixel values shown below, mark the pixels that are m-adjacent to the underlined pixel.

0	**0**	**1**	**1**
0	**1**	$\underline{\mathbf{1}}$	**0**
1	**1**	**1**	**1**

(c) Draw all possible digital paths between the top-right corner pixel to the bottom-left corner pixel of the same binary image considering m-adjacency.

Q3. **[10]**

Consider a gray-scale image with the following histogram. Plot the histogram generated after performing histogram-equalization transformation on the image.



Q4. **[5+5=10]**

Consider an area in an image having the following gray levels:

9	**10**	**10**
8	**4**	**10**
10	**8**	**9**

(a) If we apply a 3×3 median filter for smoothing the above image, what would be the output gray levels? From the output, comment on the effectiveness of the median filter.

(b) For the same image shown above, show the output of a Laplacian filter. You need to consider horizontal, vertical and diagonal differences.

Part B

Q5. **[1+3+3+3=10]**

(a) Define the Fourier Transform of a continuous function x(t), $-\infty < t < \infty$

(b) Obtain Discrete Fourier Transform (DFT) for a finite sequence x(n), n=0, 1, 2,…,N-1 from the above expression (Refer Q. 5a).

(c) Explain why there exist different types of Discrete Cosine Transform (DCT) of a finite sequence.

(d) Express type-II DCT of an image (of size M×N) in the form of matrix multiplication.

Q6. **[4+4+2=10]**

(a) Give examples of a set of orthogonal basis vectors and a set of non-orthogonal basis vectors in 2-D. Justify your answer.

(b) Compute Haar Transform efficiently for the following input sequence (of length 16).

1, 2, -3, -4, 5, 6, -7, -8, 9, -10, -11, 12, -13, -14, 15, 16

(c) Explain why Haar Transform provides multi-resolution representation of signals and images.

Q7. **[5+2+3=10]**

(a) Describe an algorithm for image sharpening using DFT and IDFT. Identify the parameters affecting the sharpening operation in your algorithm.

(b) Extend your algorithm (Refer Q. 7a) to color images.