**The LNMIIT, Jaipur**

**Tutor: Ankit Jha – Generative Adversarial Networks**

**Assignment-1**

**Question 1:** Given an 8-bit grayscale image with the following pixel intensity values:

$$\begin{bmatrix} 52 & 55 & 61 & 59 & 79 & 61 & 76 & 85 \\ 62 & 59 & 55 & 104 & 94 & 85 & 59 & 71 \\ 63 & 65 & 66 & 113 & 144 & 104 & 63 & 72 \\ 64 & 70 & 70 & 126 & 154 & 109 & 71 & 69 \\ 67 & 73 & 68 & 106 & 122 & 88 & 68 & 68 \\ 68 & 79 & 60 & 70 & 77 & 66 & 58 & 75 \\ 69 & 85 & 64 & 58 & 55 & 61 & 65 & 83 \\ 70 & 87 & 69 & 68 & 65 & 73 & 78 & 90 \end{bmatrix}$$

Calculate the histogram of this image.

**Question 2:** Using the histogram calculated from the previous question, compute the cumulative distribution function (CDF) for each intensity level.

**Question 3:** Perform histogram equalization on the following 3-bit grayscale image:

$$\begin{bmatrix} 0 & 1 & 1 & 2 \\ 3 & 3 & 2 & 1 \\ 2 & 1 & 1 & 0 \\ 1 & 2 & 3 & 2 \end{bmatrix}$$

Map each original intensity level to the new intensity level using the CDF, and provide the resulting equalized image.

**Question 4:** After applying histogram equalization to an image, the resulting intensity levels are:

$$\begin{bmatrix} 0 & 128 & 128 & 255 \\ 255 & 255 & 128 & 128 \\ 128 & 0 & 0 & 128 \\ 128 & 255 & 255 & 128 \end{bmatrix}$$

Verify that the histogram of the equalized image is approximately uniform by calculating the histogram of the equalized image.

**Question 5:** Consider a low-contrast 4-bit grayscale image given by:

$$\begin{bmatrix} 5 & 5 & 6 & 6 \\ 5 & 5 & 6 & 6 \\ 7 & 7 & 8 & 8 \\ 7 & 7 & 8 & 8 \end{bmatrix}$$

Apply histogram equalization to this image and explain how the contrast has been enhanced. Provide the final equalized image.

**Question 6:** Given the following gradient operators:

$$G_{x1} = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}, \quad G_{x2} = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

and

$$G_{y1} = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}, \quad G_{y2} = \begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix}$$

Identify which of these operators correspond to the Sobel filter and which correspond to the Prewitt filter. Explain the difference in the way these operators are constructed.

**Question 7:** Given the following $3 \times 3$ image patch:

$$\begin{bmatrix} 50 & 50 & 50 \\ 100 & 100 & 100 \\ 150 & 150 & 150 \end{bmatrix}$$

Apply both the Sobel and Prewitt filters to this image patch. Calculate and compare the gradient magnitudes at the center pixel for both filters. Which filter produces a stronger response, and why?

**Question 8:** Consider a $3 \times 3$ image patch with the following intensity values:

$$\begin{bmatrix} 50 & 51 & 52 \\ 50 & 50 & 50 \\ 49 & 48 & 47 \end{bmatrix}$$

This image contains a small amount of noise. Apply both the Sobel and Prewitt filters to this patch. Discuss how each filter responds to the noise. Which filter is more robust to noise and why?