Session 4

Image Histogram

OBJECTIVES:

The objective of this lab is to understand & implement

1. Histogram
2. Histogram Equalization
3. Histogram Matching

HISTOGRAM EQUALIZATION:

Histogram of a digital image with gray levels in range $[0, L-1]$ is a discrete function $h(k) = n_k$ where $k = k^{th}$ gray level and $n_k =$ no. of pixels of an image having gray level r_k. In histogram there are 3 possibilities as follows,

1. For a dark image the components of histogram on the low (dark) side.
2. For a bright image the component are on high (bright) side &
3. For an image with low contrast they are in the middle of gray side.

Histogram equalization is done to spread their component uniformly over the gray scale as far as possible. This is obtained by function

$$S_k = \sum_{i=0}^{k} \frac{h_i}{n}; k = 0, 1, 2, , \ldots, i-1$$

Thus processed image is obtained by mapping each pixel with level r_k into a corresponding pixel with level s_k in outpup image. This transformation is called Histogram equalization.

ALGORITHM:

1. Read the input image & its size.
2. Obtain the gray level values of each pixel & divide them by total number of gray level values.
3. Implement the function S_k
4. Plot the equalized histogram and original histogram.
5. Display the original and the new image

CONCLUSION:

Digital histogram enhances image but it does not generate a flat histogram.

Question 1. What information one can get by observing histogram?

HISTOGRAM SPECIFICATION:

Histogram equalization automatically determines a transformation function that seeks to produce an output image that has a uniform histogram. But it is useful sometimes to be able specify the shape of the histogram that we wish the processed image to have. The method used to generate a processed image that has a specified histogram is called histogram specification.

$$S_k = T(r_k) = \sum Pr(r_j); k = 0, 1, 2, 3, \ldots, L-1$$

$$V_k = G(z_k) = \sum Pz(z_j); k = 0, 1, 2, 3, \ldots, L-1$$

$$Z_k = G^{-1}(T(r_k)); k = 0, 1, 2, 3, \ldots, L-1$$

Map each pixel with level r_k into a corresponding pixel with level s_k . Obtain the transformation function G from a given histogram $P_z(z)$. For any Z_q this transformation function yields a corresponding value V_q. We would find the corresponding value Z_q from G^{-1}.

ALGORITHM:

1. Obtain the histogram of the given image.
2. Map each level r_k to s_k
3. Obtain the transformation function G from the given $P_z(z)$
4. Calculate z_k for each value of s_k
5. For each pixel in the original image, if the value of that pixel is r_k , map this value to its corresponding level s_k ,then map level s_k into the final value z_k
6. Display the modified image and its histogram.

Task 1. Write a program to equalize the histogram.

Task 2. Write a program to implement Histogram Matching Algorithm in Matlab.