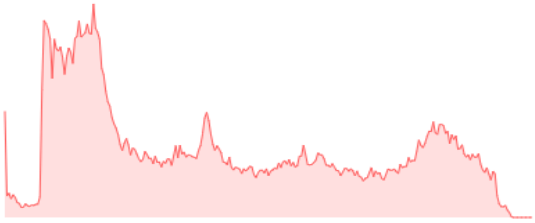
Histograms Introduction

In digital image processing, the histogram is used for graphical representation of a digital image. A graph is a plot by the number of pixels for each tonal value. Nowadays, image histogram is present in digital cameras. Photographers use them to see the distribution of tones captured.

In a graph, the horizontal axis of the graph is used to represent tonal variations whereas the vertical axis is used to represent the number of pixels in that particular pixel. Black and dark areas are represented in the left side of the horizontal axis, medium grey color is represented in the middle, and the vertical axis represents the size of the area.



Histogram of the above scenery

Applications of Histograms

1. In digital image processing, histograms are used for simple calculations in software.
2. It is used to analyze an image. Properties of an image can be predicted by the detailed study of the histogram.
3. The brightness of the image can be adjusted by having the details of its histogram.
4. The contrast of the image can be adjusted according to the need by having details of the x-axis of a histogram.
5. It is used for image equalization. Gray level intensities are expanded along the x-axis to produce a high contrast image.
6. Histograms are used in thresholding as it improves the appearance of the image.
7. If we have input and output histogram of an image, we can determine which type of transformation is applied in the algorithm.

Histogram Processing Techniques

Histogram Sliding

In Histogram sliding, the complete histogram is shifted towards rightwards or leftwards. When a histogram is shifted towards the right or left, clear changes are seen in the brightness of the image. The brightness of the image is defined by the intensity of light which is emitted by a particular light source.

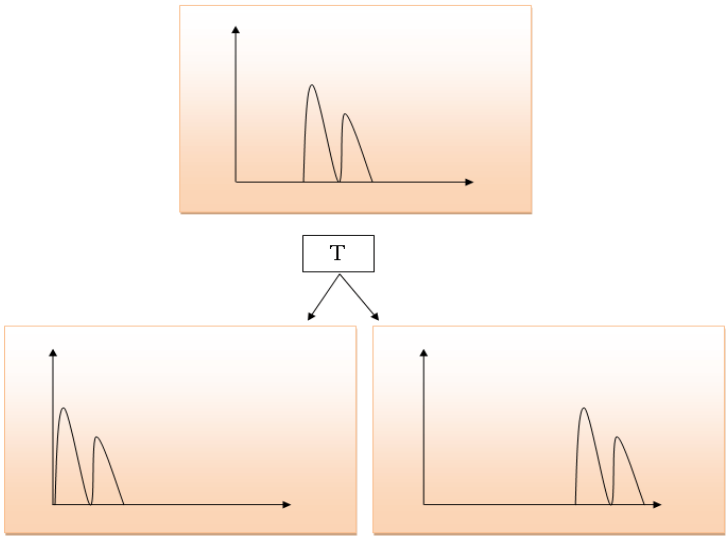


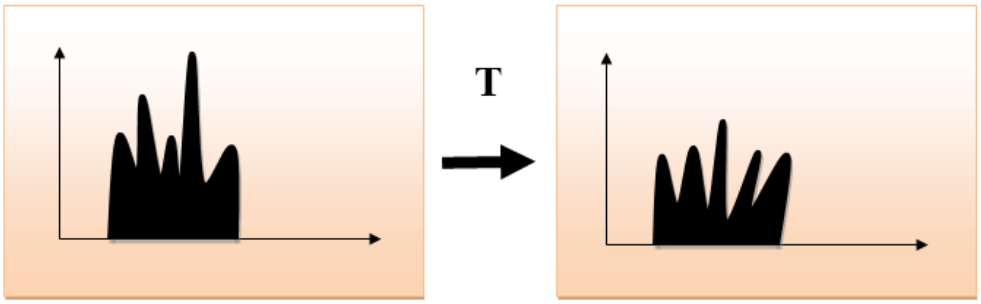
Fig. Histogram Sliding

Histogram Stretching

In histogram stretching, contrast of an image is increased. The contrast of an image is defined between the maximum and minimum value of pixel intensity.

If we want to increase the contrast of an image, histogram of that image will be fully stretched and covered the dynamic range of the histogram.

From histogram of an image, we can check that the image has low or high contrast.

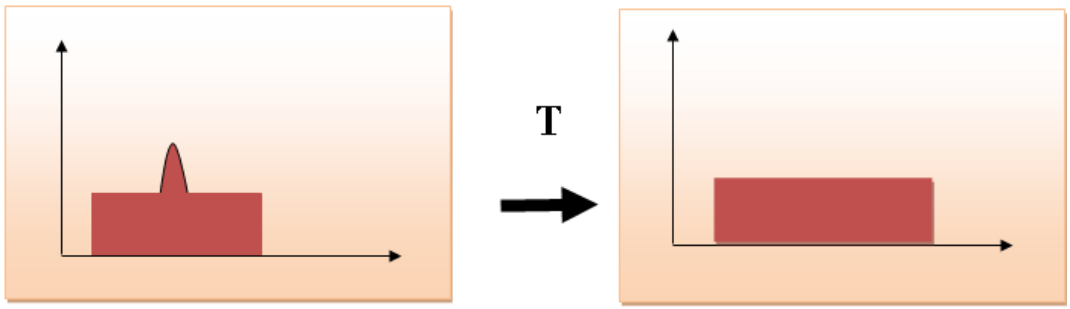


Histogram Equalization

Histogram equalization is used for equalizing all the pixel values of an image. Transformation is done in such a way that uniform flattened histogram is produced.

Histogram equalization increases the dynamic range of pixel values and makes an equal count of pixels at each level which produces a flat histogram with high contrast image.

While stretching histogram, the shape of histogram remains the same whereas in Histogram equalization, the shape of histogram changes and it generates only one image.



Brightness and Contrast

Brightness

Brightness is a visual perception in which a source appears to be reflecting light. Brightness is a subjective property of an object which is being observed. Brightness is an absolute term and different from lightness.

A color screens use three colors i.e., RGB scheme (red, green and blue) the brightness of the screen depends upon the sum of the amplitude of red green and blue pixels, and it is divided by 3.

$$\mu = \frac{(R+G+B)}{3}$$

The perception of brightness depends upon the optical illusions to appear brighter or darker.

When the brightness is decreased, the color appears dull, and when brightness increases, the color is clearer.

In mobile devices, when brightness setting is high, device battery drains fast as compare to the low setting.

Contrast

Contrast is a color which makes an object distinguishable. We can say that contrast is determined by the color and brightness of the object.

Contrast is the difference between the maximum and minimum pixel intensity of an image.

Original image

Contrast image

Formula:

1. Contrast = maximum pixel intensity - minimum pixel intensity

For example:

Let's take the original image which has a matrix of

100	100	100	100	100
100	100	100	100	100
100	100	100	100	100
100	100	100	100	100
100	100	100	100	100

As, we can see that the maximum value and minimum value of the pixel is 100

According to formula

1. Contrast = 100 - 100 = 0

The answer is 0, which means the image has zero contrast.