| D.O.P.: | L.D.O.S.: |
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| Grade: | Faculty: |

# Experiment No. 3:

**Aim:** Implementing image enhancement using Histogram techniques

a. Finding histogram of an image.

b. Histogram equalization.

**Prerequisite:**

1. Knowledge of Matlab programming syntax.
2. Knowledge of histogram processing operations.
3. Availability of Soft copy of your Photograph for experiment.

**Objective:**

a. Plotting histogram of an image.

b. Applying Histogram equalization on an image.

**Outcome:**

1. Observation of equal spread of intensity on an image for better visual appearance.

**Theory:**

Histogram of an image is a plot of the no. of occurrences of gray levels in the image against the gray level values. It provides summary of intensities in an image but unable to convey any information about spatial relationship between pixels.

Histogram is an effective tool for evaluating image quality assessment, for manipulating the contrast & brightness of an image. The quality of an image can be controlled indirectly by controlling its histogram, by normalizing it to a target histogram profile.

An image histogram is a type of histogram that acts as a graphical representation of the intensity distribution in a digital image. It plots the number of pixels for each intensity value. By looking at the histogram for a specific image a viewer will be able to judge the entire intensity distribution at a glance.

Image histograms are present on many modern digital cameras. Photographers can use them as an aid to show the distribution of intensity possessed by every pixel, and whether

image detail has been lost to blown-out highlights or blacked-out shadows. This is less useful when using a raw image format, as the dynamic range of the displayed image may only be an approximation to that in the raw file.

The horizontal axis of the graph represents the intensity variations, while the vertical axis represents the number of pixels attended that intensity in an image. The left side of the horizontal axis represents the black [or dark] areas, the middle represents medium grey and the right hand side represents light [or pure white] areas. The vertical axis represents the size of the area that is captured in each one of these zones. Thus, the histogram for a very dark image will have the majority of its data points on the left side and centre of the graph. Conversely, the histogram for a very bright image with few dark areas and/or shadows will have most of its data points on the right side and centre of the graph.

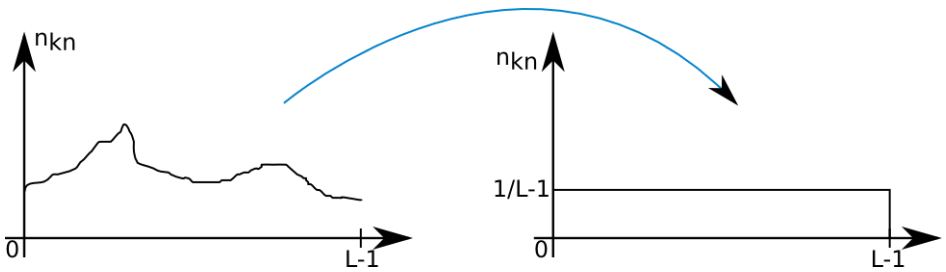
## Histogram Equalization

Histogram Eq u alization is a computer image processing technique used to improve contrast in images . This allows for areas of lower local contrast to gain a higher contrast. ... A color histogram of an image represents the number of pixels in each type of color component.

Histogram equalization is a method to process images in order to adjust the contrast of an image by modifying the intensity distribution of the histogram. The objective of this technique is to give a linear trend to the cumulative probability function associated to the image.

The processing of histogram equalization relies on the use of the cumulative probability function (cdf). The cdf is a cumulative sum of all the probabilities lying in its domain.

The idea of this processing is to give to the resulting image a linear cumulative distribution function. Indeed, a linear cdf is associated to the uniform histogram that we want the resulting image to have.




**Procedure:**

**Histogram Plotting:**

1. Read gray image.
2. Write command to plot Histogram of an image.
3. Analyze the histogram plotted in step two and conclude the nature of image (Dark, Bright, Low Contrast)
4. Note the values of pixel attempting different levels of intensities.

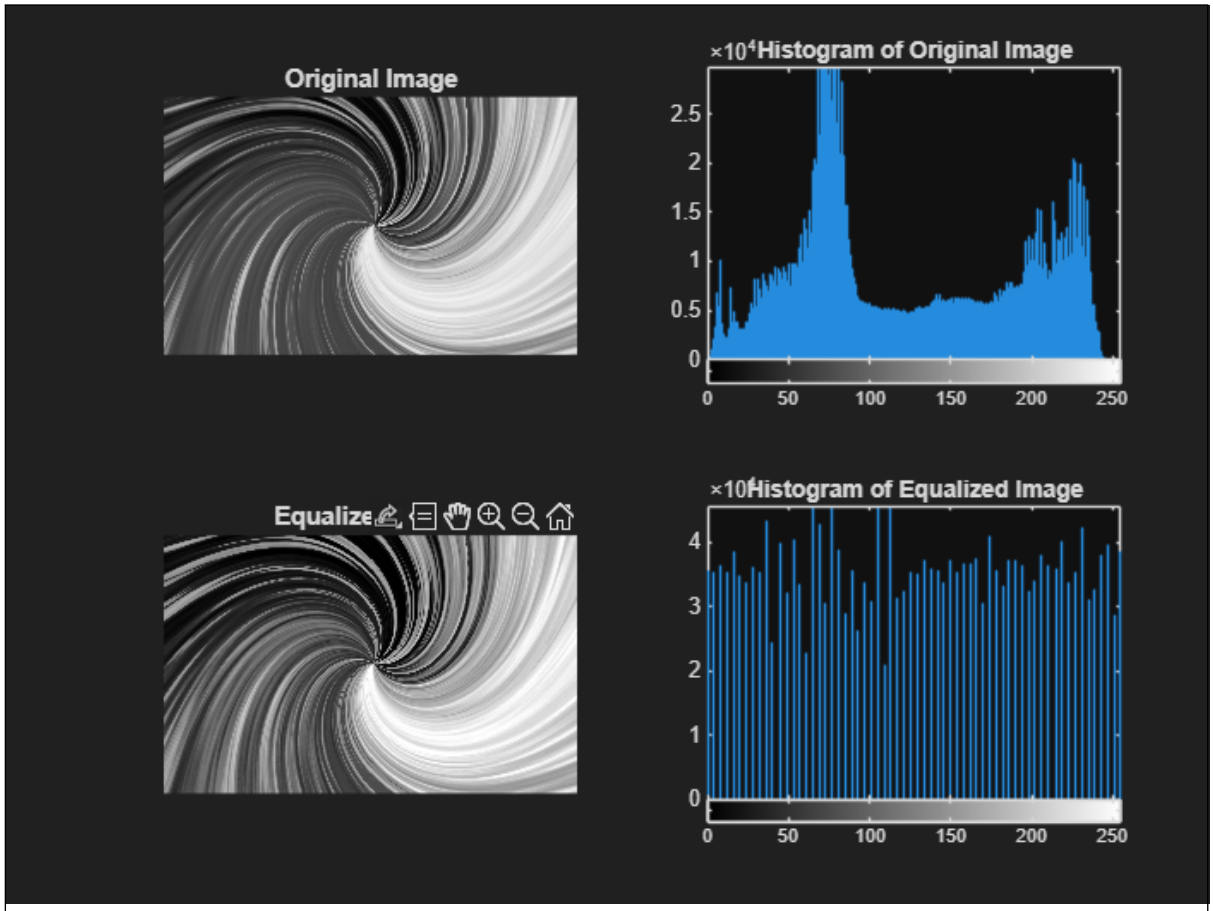
**Histogram Equalization**

1. Select an image for Histogram Equalization.
2. Write the command to plot Histogram Equalization.
3. Plot Histogram of equalized image.
4. Display input image, histogram of input image, histogram of equalized image and histogram equalized image.
5. Examine the effect of equalization on the test images by comparing the histograms.

**Code:**

```
img = imread(&#39;pic.jpg&#39;); % Change filename as needed
% Convert to grayscale if needed
if size(img, 3) == 3
img = rgb2gray(img);
end
% Compute histogram of original image
figure;
subplot(2,2,1);
imshow(img);
title(&#39;Original Image&#39;);
subplot(2,2,2);
imhist(img);
title(&#39;Histogram of Original Image&#39;);
% Perform histogram equalization
eq_img = histeq(img);
% Compute histogram of equalized image
subplot(2,2,3);
imshow(eq_img);
title(&#39;Equalized Image&#39;);
subplot(2,2,4);
imhist(eq_img);
title(&#39;Histogram of Equalized
```

**Output:**




**Observations:**

The original image often has pixel intensities concentrated in a narrow range (low contrast).

After histogram equalization, pixel values are redistributed more evenly across the entire range [0–255].

As a result, the image appears **clearer and sharper with improved contrast**, especially in darker or brighter regions.

**Conclusion**:

Histogram equalization enhances the **overall contrast** of an image by spreading out intensity levels uniformly. This makes hidden details more visible and improves image quality. It is widely used in **medical imaging, satellite imaging, and photography** where clarity and contrast are important.

**Questions:**

1. What is the logic of histogram equalization?
2. Enlist three merits of plotting Histogram?
3. Enlist three practical applications plotting Histogram?

**Additional Task:**

1. Select a color image and plot its histogram? Write difference between plot of histogram of gray image and histogram of color image?

| Feature | Contrast Stretching | Power Law Transformation | Histogram Equalization |
|---|---|---|---|
| **Purpose** | Improve contrast by stretching intensity range | Enhance brightness/darkness non-linearly | Improve global contrast by equalizing histogram |
| **Basic Idea** | Linearly maps pixel values to wider range | Applies non-linear transformation | Redistributes intensity values uniformly |
| **Formula** | Piecewise linear: s=(r−r1)(r2−r1)·(s2−s1)+s1s = \frac{(r - r_1)}{(r_2 - r_1)} \cdot (s_2 - s_1) + s_1s=(r2−r1)(r−r1)·(s2−s1)+s1 | s=c·rγs = c \cdot r^\gammas=c·rγ | sk=(L−1)·∑j=0kpr(rj)s_k = (L-1) \cdot \sum_{j=0}^{k} p_r(r_j)sk=(L−1)·∑j=0kpr(rj) |
| **Adjustable Parameters** | r1,r2,s1,s2r_1, r_2, s_1, s_2r1,r2,s1,s2 (input/output thresholds) | ccc, γ\gammaγ (gamma controls shape) | No manual parameters |
| **Effect on Image** | Enhances specific ranges of intensity | Enhances dark/light areas based on gamma | Spreads intensities evenly across histogram |
| **Output Histogram** | Stretched version of original | Depends on γ\gammaγ | Uniform (or near-uniform) |
| **Computational Complexity** | Low | Low | Medium (involves CDF calculation) |
| **Control Over Transformation** | High (user-defined thresholds) | Medium (controlled via γ\gammaγ) | Low (automatic process) |
| **Best Used When** | Image has limited contrast | Brightness correction needed | Image has poor global contrast |
| **Example Use Case** | Medical imaging | Gamma correction in display systems | Satellite or low-contrast images |

2. Also can we apply histogram equalization on color image, display the result? Write your observations.

```
img = imread(&#39;pic.jpg&#39;); % Change filename as needed
% Convert to grayscale if needed
% Compute histogram of original image
figure;
subplot(2,2,1);
```

```
imshow(img);
title(&#39;Original Image&#39;);
subplot(2,2,2);
imhist(img);
title(&#39;Histogram of Original Image&#39;);
% Perform histogram equalization
eq_img = histeq(img);
% Compute histogram of equalized image
subplot(2,2,3);
imshow(eq_img);
title(&#39;Equalized Image&#39;);
subplot(2,2,4);
            imhist(eq_img)
```