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# Experiment – 02: To perform histogram equalization

Date: _____

1. **Aim:** To perform histogram equalization on an image.

2. **Requirements:** Python

3. **Pre-Experiment Exercise**

**3.1 Brief Theory**

A histogram is a way of counting the number of occurrences of different values of some variable. An image histogram is a type of histogram that acts as a graphical representation of the tonal distribution in a digital image. It plots the number of pixels for each tonal value. By looking at the histogram for a specific image a viewer will be able to judge the entire tonal distribution at a glance. The horizontal axis of the graph represents the tonal variations, while the vertical axis represents the number of pixels in that particular tone. The left side of the horizontal axis represents the black and dark areas, the middle represents medium grey and the right hand side represents light and pure white areas. The vertical axis represents the size of the area that is captured in each one of these zones.

In histogram equalization the idea is to spread out the histogram so that it makes full use of the dynamic range of the image. Histogram of a digital image with gray levels in range [0, L-1] is a discrete function

$$h(r_k) = n_k$$

Where, $r_k$ is the 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

$$S_k = \sum_{i=0}^{k} \frac{n_k}{n}$$

Where, $k$ = 0,1,2,3,...L-1 and $n$ = total no. of pixels

Thus processed image is obtained by mapping each pixel with level $r_k$ into a corresponding pixel with level $S_k$ in o/p image. This transformation is called Histogram equalization.

It is observed that, in the dark image the components of the histogram are concentrated on the low (dark) side of the gray scale. Similarly, the components of the histogram of the bright image are biased toward the high side of the gray scale. An image with low contrast has a histogram that will be narrow and will be centered toward the middle of the gray scale. For a monochrome image this implies a dull, washed-out gray look.

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Finally, we can observe that the components of the histogram in the high-contrast image cover a broad range of the gray scale.

Histogram equalization does not operate on the histogram itself but uses the results of one histogram to transform the original image into an image that will have equalized histogram. Histogram equalization does not introduce new intensities in the image. Existing values will be mapped to new values keeping actual number of intensities in the resulting image equal or less than the original number of intensities.

## 4. Laboratory Exercise

### 4.1 Algorithm :

1. Read the input gray scale image and its size.
2. Obtain the histogram discrete function $h(r_k)$ of an image and display it.
3. Obtain the normalized histogram function
4. Obtain the transformation function $S_k$ and display it
5. Obtain histogram equalized image and display it.
6. Plot the histogram of an output image.

## 5. Post Experiment

### 5.1 Conclusion

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### 5.2 Questions

i. Image can be obtained if histogram is given,(True or False, justify)
ii. Explain the difference between Histogram specification and Histogram Equalization.
iii. Can two different images have the same histogram? Justify
iv. Perform histograms equalization for the following digital image. Draw input and output image histogram, transformation function.

| | | | |
|---|---|---|---|
| 10 | 2 | 13 | 7 |
| 11 | 14 | 6 | 9 |
| 4 | 7 | 3 | 2 |
| 0 | 5 | 10 | 7 |