

Histogram Equalization

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1 Introduction

Histogram equalization is a process where the intensity values of an image are adjusted to create a higher overall contrast.

Digital Image Processing (DIP) is a significant aspect of data science. It is used to enhance and modify images so that their attributes are more easily understandable.

Image histograms are largely used to obtain information about image attributes.

Image contrast can be determined by looking at the range of pixel intensity values that the histogram bars are spread over. If the range is low, image contrast is also low. Meanwhile, a higher range of pixel intensity values means a higher contrast.

An example of a low contrast image is shown below.

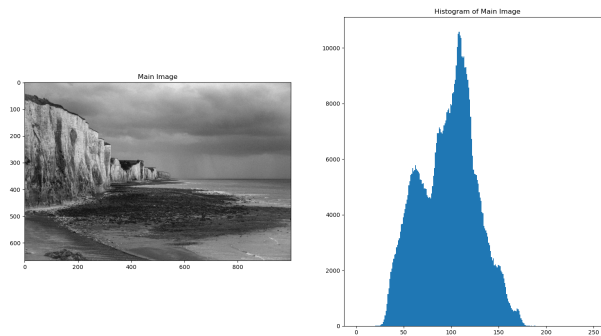


Figure 1: A low contrast image and histogram

2 How To Perform Histogram Equalization

Histogram equalization is done by using the following formula:

$$s_k = T(r_k) = \sum_{j=0}^k p_m(r_j) = \frac{(L-1)}{MN} \sum_{j=0}^k n_j$$

where

$$k = 0, 1, 2, \dots, L-1$$

Figure 2: Histogram Equalization Equation

- L: The maximum intensity level of the image. For a 8-bit image, L is 256.
- M: The width of the image.
- N: The height of the image.
- n: The frequency corresponding to each intensity level.
- rj: The range of values from 0 to L-1.
- pin: The total frequency that corresponds to a specific value of rj.
- rk: The new frequencies.
- sk: The new equalized histogram.

OpenCV has a function to do this, `cv2.equalizeHist()`. Its input is just grayscale image and output is our histogram equalized image.

Let's see an example below how histogram equalization looks like:

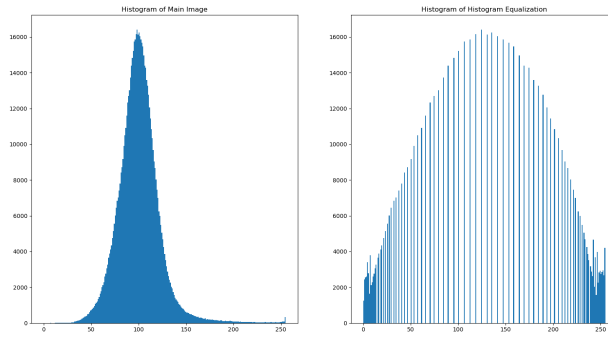


Figure 3: Histogram Equalization

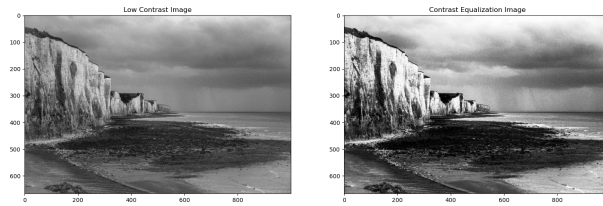


Figure 4: Compare between two images

Let's apply histogram equalization operations on images and see the effect how histogram equalization works on images.

Let's see another example and their corresponding histogram.

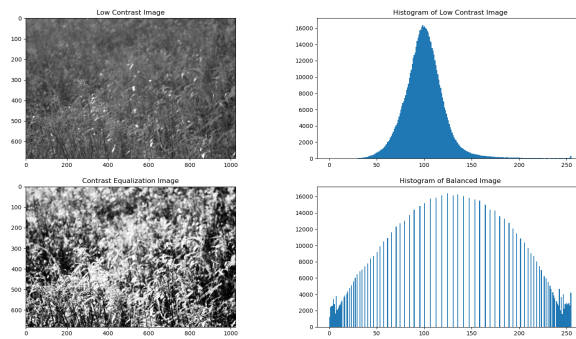


Figure 5: Compare between two images