

Histogram Equalization

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Abstract

My goal in this lab is to perform histogram equalization on a greyscale image. To accomplish this I calculated the normalized histogram of the given grayscale image. The normalized histogram is used to calculate the transformation function which will be used to perform histogram equalization on the image. Lastly, the standard deviation and mean of the equalized and original image are computed for analysis.

Technical Discussion

The function `equalize` is able to take a greyscale image as an input and return a histogram equalized version of the image. The function calls a total of 3 other functions which are `compute_histogram`, `plot_histogram`, and `histogram_transform`. Furthermore, the histogram that is returned by the function `histogram_transform` is used to assign values to the output image which will result in the histogram equalized version of our original greyscale image.

The function `compute_histogram` takes in a greyscale image and calculates the normalized histogram of the image (PMF). The calculation is performed by the following equation: $h = h/(r*c)$ where h represents the frequency of the pixel intensity values (0-255) and each value is divided by the number of pixels in the image.

The function `histogram_transform` takes in a histogram and calculates the transformation function required to perform histogram equalization on the greyscale image. The following formula is used to calculate the transformation function: $T(i) = (L-1)\sum h(i)$ where L represents the maximum number of pixel intensity values and $h(i)$ represents the values of the normalized histogram.

The function `plot_histogram` takes a histogram and plots a bar graph where the x-axis represents the pixel intensity values and the y-axis represents the probability mass function (PMF).

Results

The first image that was used to test our `equalize` function is Figure 1a. The result is very noticeable when we compare Figure 1a to Figure 1b because there aren't as many lower intensity values in Figure 1b as there were in Figure 1a. Similarly, when the image in Figure 2a was tested the resulting image has better contrast which can be seen in Figure 2b. I believe that both Figure 2b and Figure 1b are better than the original image because in the original image there isn't as much contrast.



Figure 1a. Dark Image



Figure 1b. Histogram Equalized Version of Dark Image

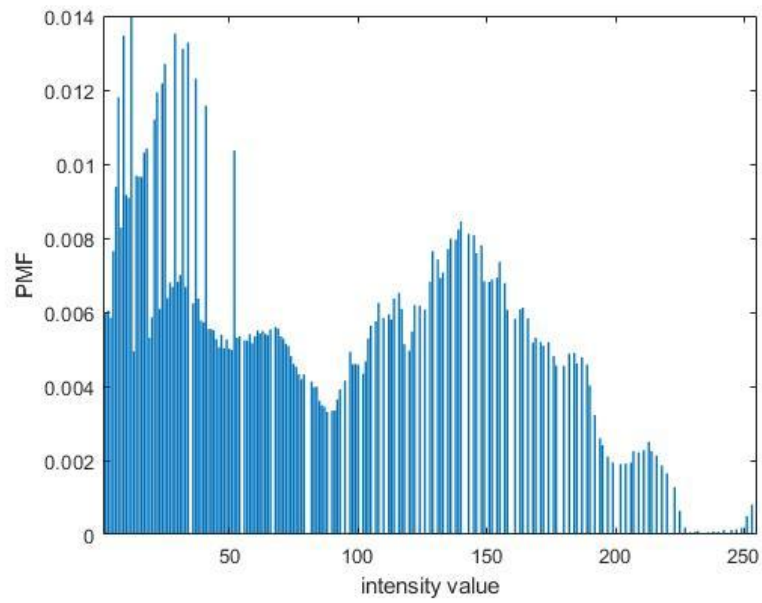


Figure 1c. Histogram of Dark Image

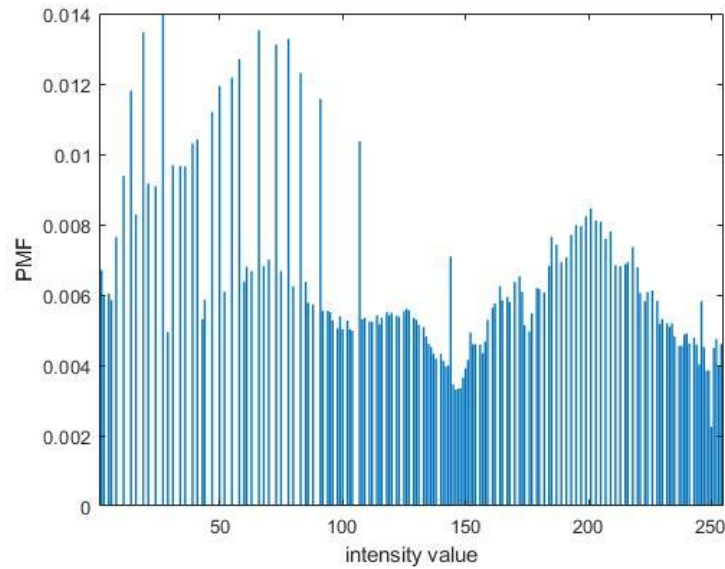


Figure 1d. Histogram of Equalized Dark Image

Dark Image: Standard Deviation = 60.353473 Mean = 82.816909

Equalized Image: Standard Deviation = 73.397536 Mean = 128.400086



Figure 2a. Light Image



Figure 2b. Histogram Equalized Version of Light Image

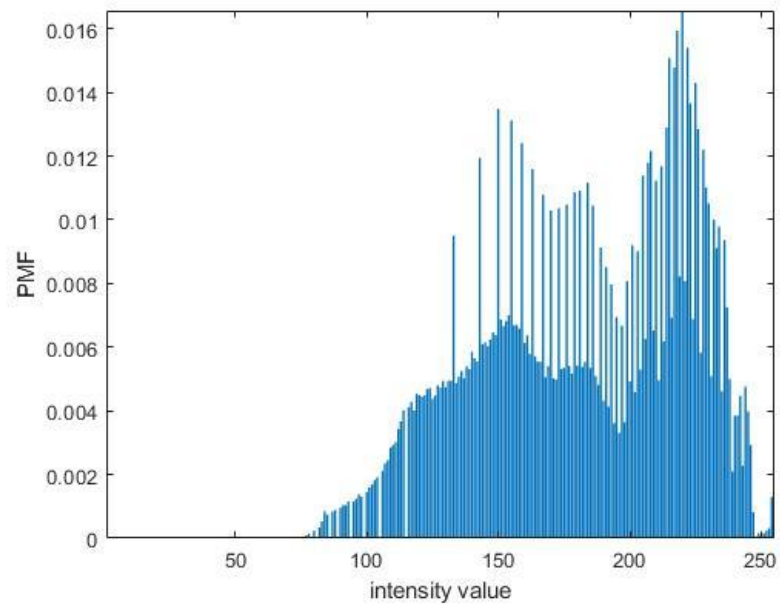


Figure 2c. Histogram of Light Image

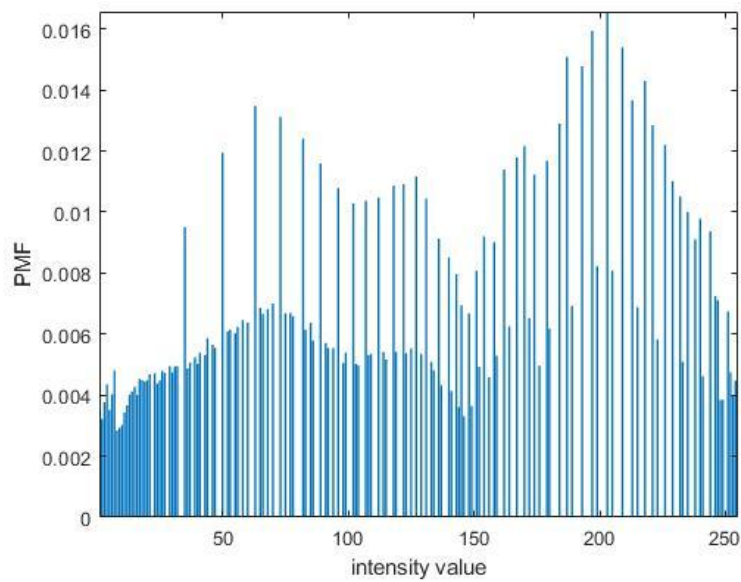


Figure 2d. Histogram of Equalized Light Image

Light Image: Standard Deviation = 39.150753 Mean = 182.023691

Equalized Image: Standard Deviation = 73.816858 Mean = 128.575921