CS663 Assignment 1 Question 2

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September 1, 2020

. This document describes the findings regarding question 2 of assignment 1. For each section in the question, we have added the relevant comments, graphs and images.

1 Question 2a

In the function myForegroundMask, a foreground mask has been constructed taking the threshold frequency as 12 which was obtained after analysis of the masks at various intensities.

The masked image was constructed after multiplying the input image by the foreground mask and normalizing the values.

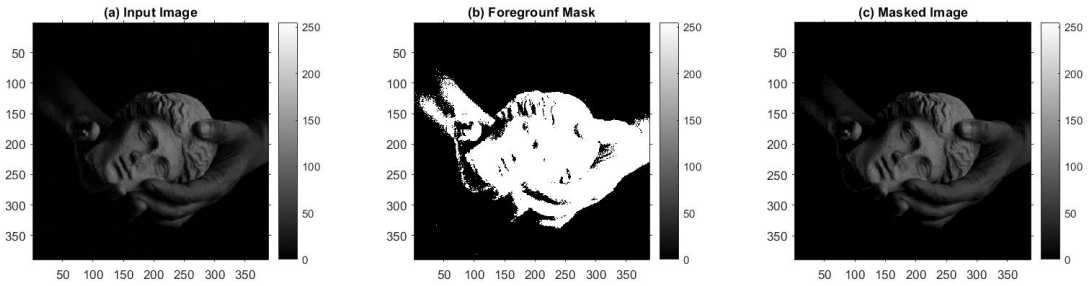


Figure 1: Implementation of Foreground Mask on statue.png image

2 Question 2b

Formula used for Linear Contrast Stretching is as follows:

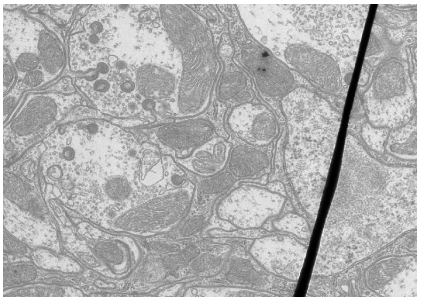
$$output = \frac{255}{(M-m)} input + \frac{(255-m)}{(M-m)} \tag{1}$$

where M = maximum intensity in input image, m = minimum intensity in input image, 255 is the maximum intensity we want to extend to.

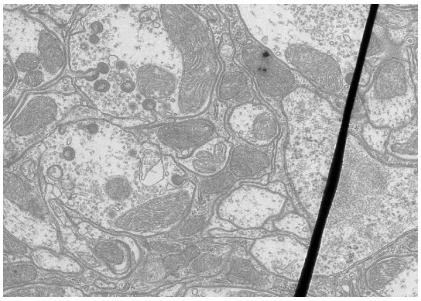
(a) Original image

(b) Processed image

Figure 2: Linear Contrast Stretching on barbara.png



(a) Original image



(b) Processed image

Figure 3: Linear Contrast Stretching on TEM.png

(a) Original image

(b) Processed image

Figure 4: Linear Contrast Stretching on canyon.png

(a) Original image

(b) Processed image

Figure 5: Linear Contrast Stretching on church.png

(a) Original image

(b) Processed image

Figure 6: Linear Contrast Stretching on chestXray.png

(a) Masked image

(b) Processed image

Figure 7: Linear Contrast Stretching on masked image of statue.png

Observations:

We can see significant contrast enhancement in statue.png, as there is much larger change in the intensities when it is mapped to 0-255 as earlier the maximum value was very less than 255.
We see a little bit of enhancement in chestXray and barabara images, as there is a slight change of intensities. Original minimum and maximum in barbara image is 12 and 246. Original minimum and maximum in chestXray is 6 and 226. So more the difference in the values of minimum and maximum with 0 and 255 respectively, more is the enhancement.
We hardly see any enhancement in church, canyon and TEM as their minimum and maximum intensities are exactly or nearly same to 0 and 255 in all channels. We can conclude that Linear Contrast Stretching is not effective in these cases.

3 Question 2c

In this section, we will apply histogram equalization method over various images. The input image and the output image are shown below. In all of these images there are red, green and Blue components. e have equalized the histogram of all of these 3 components in order to achieve the final image.

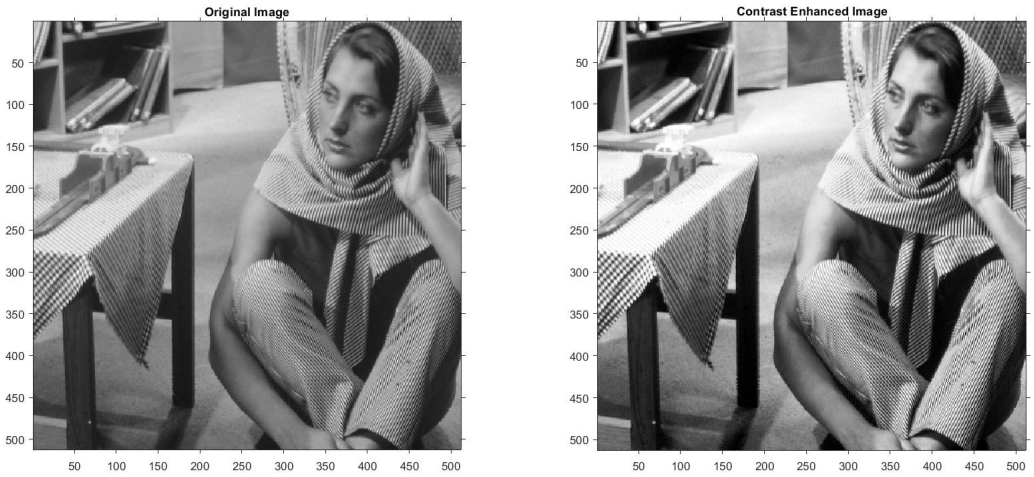


Figure 8: Histogram equalized image for barbara.png

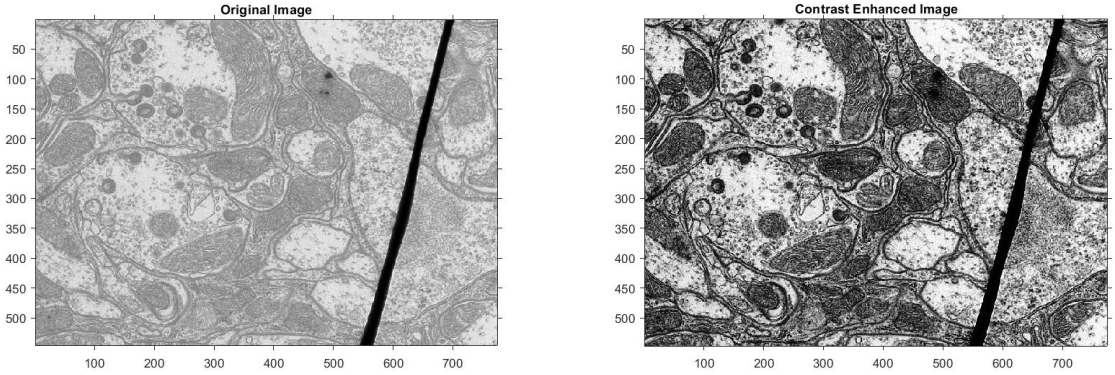


Figure 9: Histogram equalized image for TEM.png

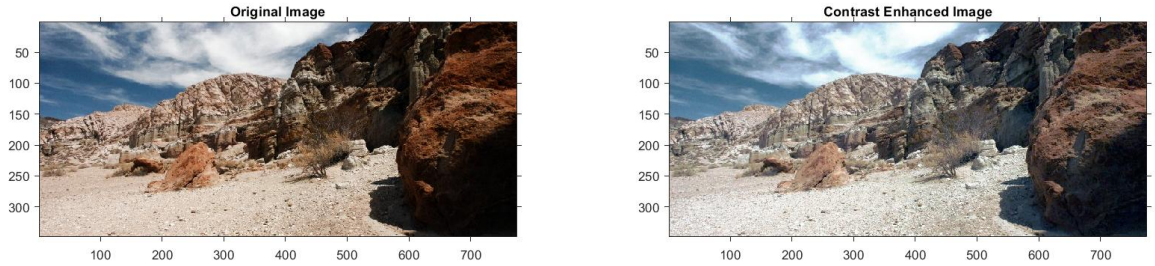


Figure 10: Histogram equalized image for canyon.png

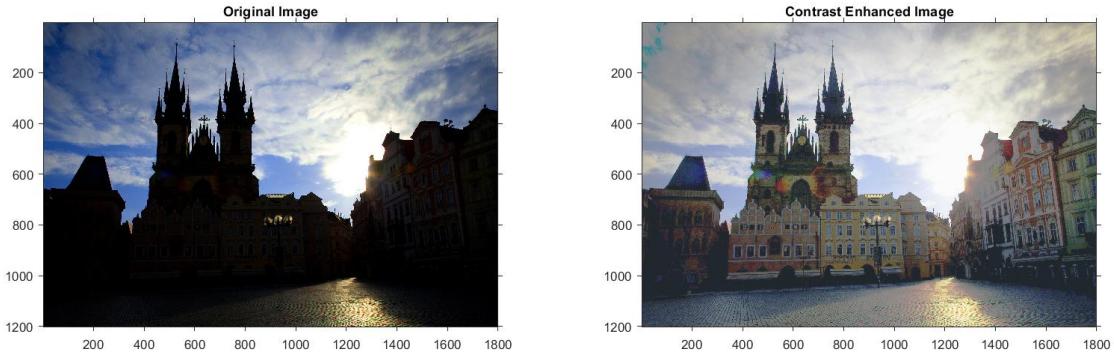


Figure 11: Histogram equalized image for church.png

Figure 12: Histogram equalized image for chestXray.png

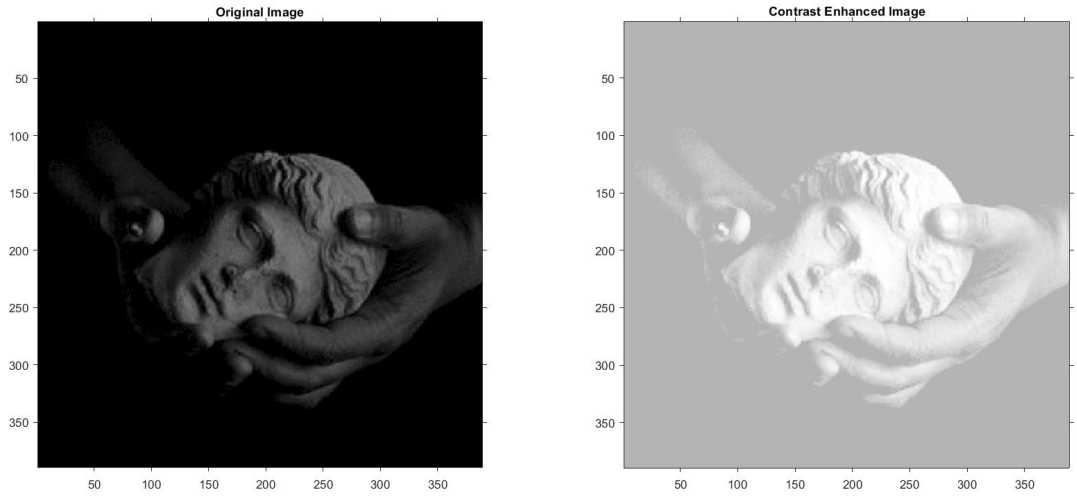


Figure 13: Histogram equalized image for foreground region of statue.png

In order to observe the performance of histogram equalization, we will consider the image 'church.png'. In figure 11, it is seen that the histogram equalization has resulted in a much better image quality and much finer details are now visible. Comparing this to the contrast stretching algorithm as seen in figure 5, the image quality enhancement is negligible.

Thus in cases where the spread of intensities is all over 0 to 255, the equalization method will out-perform the contrast stretching method.

4 Question 2d

We implement a function myHM.m which will take as input two RGB images in_image and ref_image. The final output of the function will be a RGB image whose each layer's(R,G,B) histogram is matched with the histogram of the corresponding layers of ref_image.

For this the histogram matching can be implemented for each of the three layer separately. In the below figure 14, we have compared the results of histogram equalization method and histogram matching method.

Figure 14: Comparison of histogram matching and histogram equalization

The right-most image is our input image, we can observe that most of the intensity is due to the Red component, also the overall intensity is very low. We match the histogram of this input with the corresponding reference image to obtain the output image shown in centre. This has resulted in converting the input image to almost the reference image.

The last image is a histogram equalized image of the input image. In this image all the R,G,B layers are equalized, leading to increased intensity of the green and blue components also. Thus in this kind of scenarios involving image standardization, histogram matching is a much better option than histogram equalization.

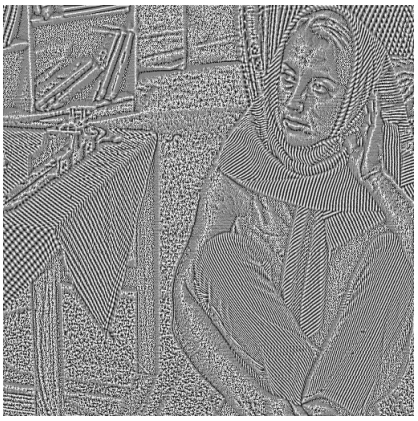
5 Question 2e

In the function myCLAHE, we perform Contrast-Limited Adaptive Histogram Equalization (CLAHE) on the images and manually tune the windowsize and threshold limit parameter.

We observe that larger window size results in very low contrast improvement. For very large window sizes, the output is almost similar to the input image. For very small window size, there is very large noise amplification and full distortion of image. On halving the threshold limit, there is less contrast improvement but unnecessary noise is removed from images which may occur.

(a) Original image

(b) Tuned windowsize of 50 with tuned threshold 10

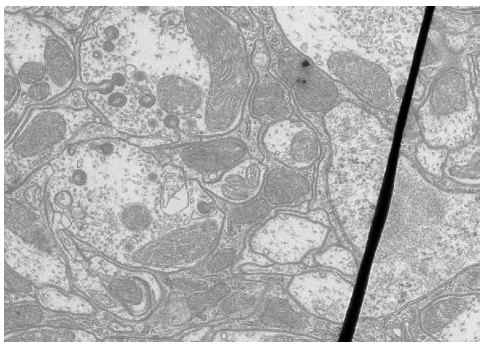


(c) Small windowsize of 5 with tuned threshold 10

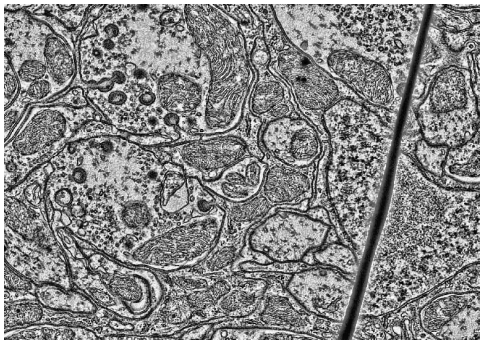
(d) Large windowsize of 100 with tuned threshold 10

(e) Tuned windowsize of 50 with half tuned threshold=5

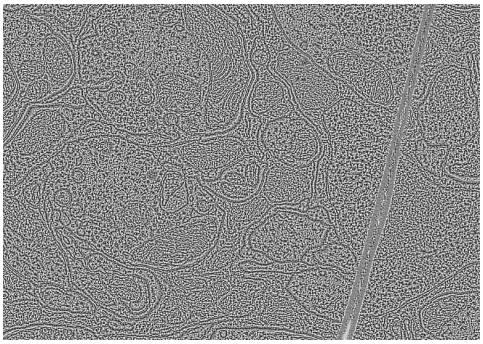
Figure 15: CLAHE on barbara.png



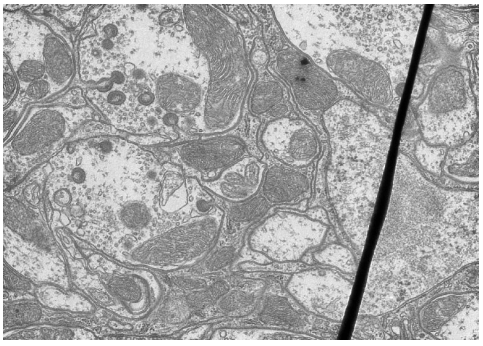
(a) Original image



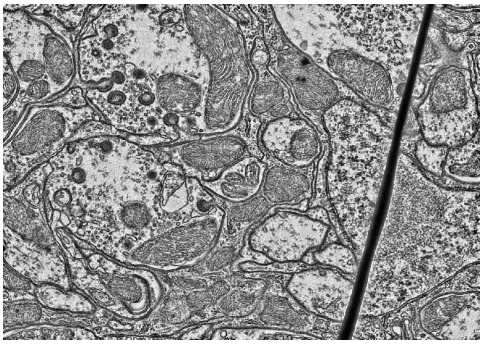
(b) Tuned windowsize of 30 with tuned threshold 20



(c) Small windowsize of 5 with tuned threshold 20



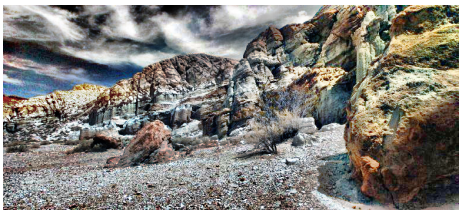
(d) Large windowsize of 100 with tuned threshold 20



(e) Tuned windowsize of 30 with half tuned threshold=10

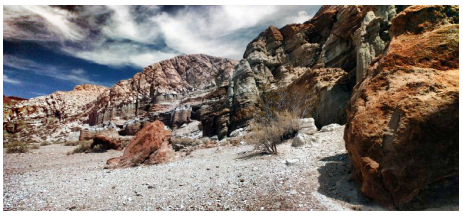
Figure 16: CLAHE on TEM.png

(a) Original image

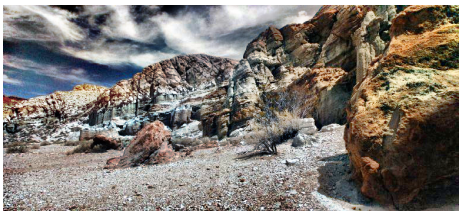


(b) Tuned windowsize of 100 with tuned threshold 200

(c) Small windowsize of 30 with tuned threshold 200



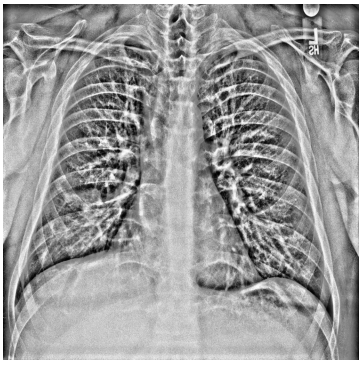
(d) Large windowsize of 200 with tuned threshold 200



(e) Tuned windowsize of 100 with half tuned threshold=100

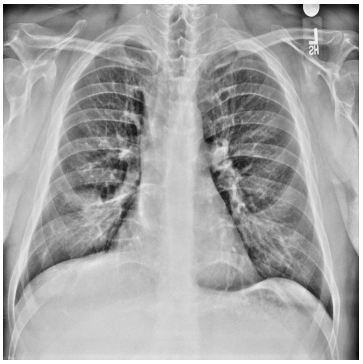
Figure 17: CLAHE on canyon.png

(a) Original image

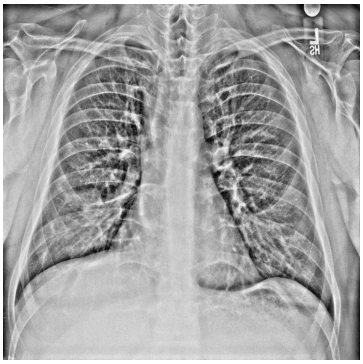


(b) Tuned windowsize of 50 with tuned threshold 100

(c) Small windowsize of 5 with tuned threshold 100



(d) Large windowsize of 100 with tuned threshold 100



(e) Tuned windowsize of 50 with half tuned threshold=50

Figure 18: CLAHE on chestXray.png