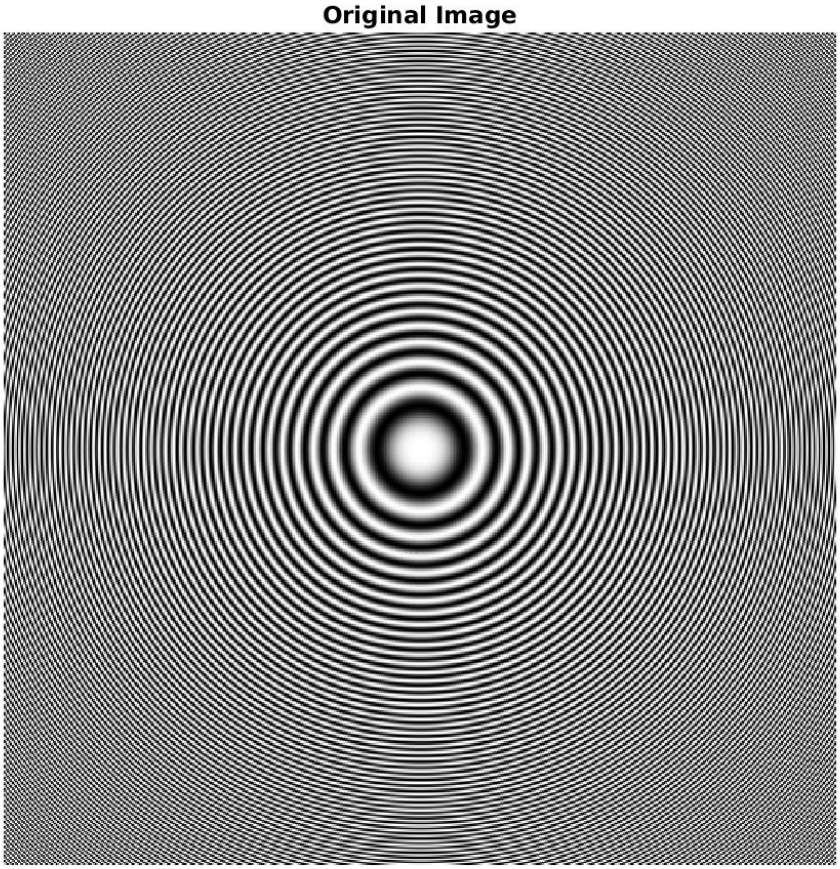
CS663: Digital Image Processing

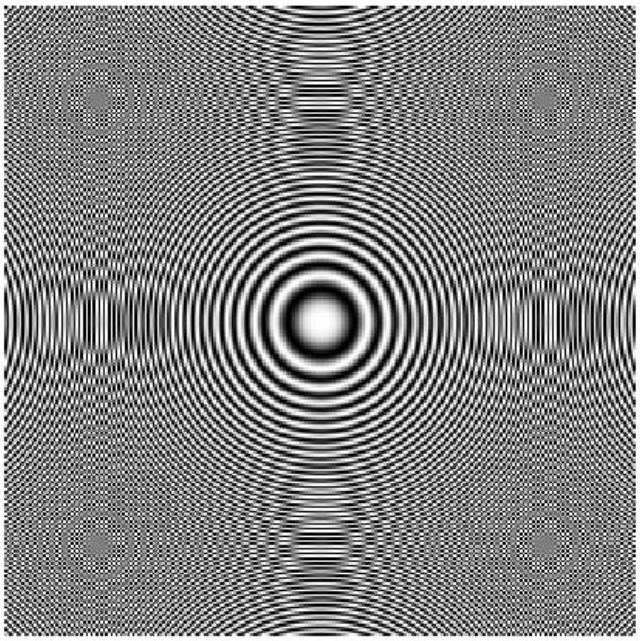
Assignment 1 - Report

Adarsh Kumar - 160110071
Kumar Ashutosh - 16D070043
Nisha Brahmankar - 16D070019

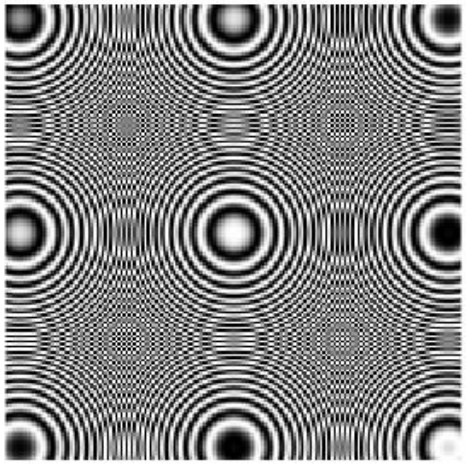
Question 1:



Shrinked Image by factor of 2



Shrinked Image by factor of 3



Original Image

Bilinear Interpolated Image

Original Image

NearestNeighbor Interpolated Image

Question 2:

a)

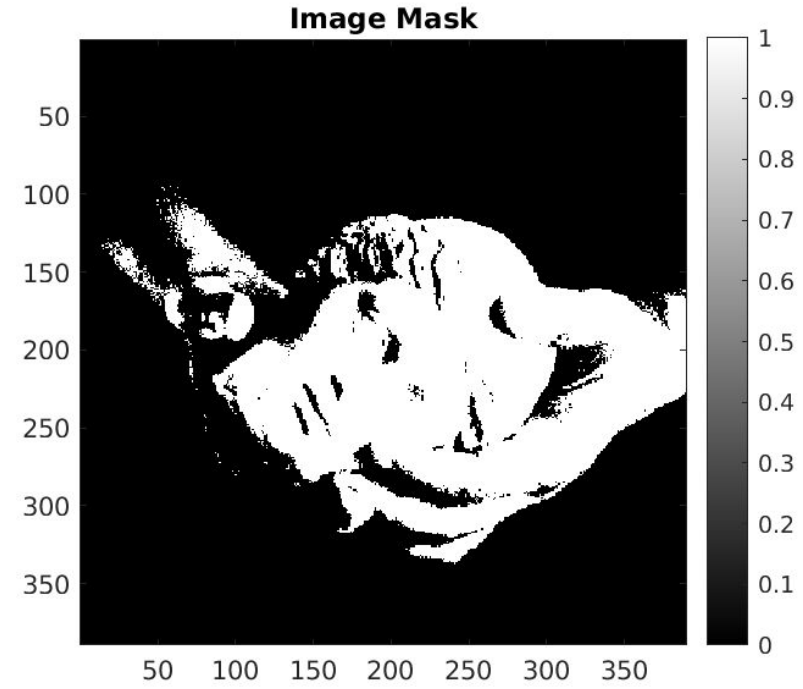
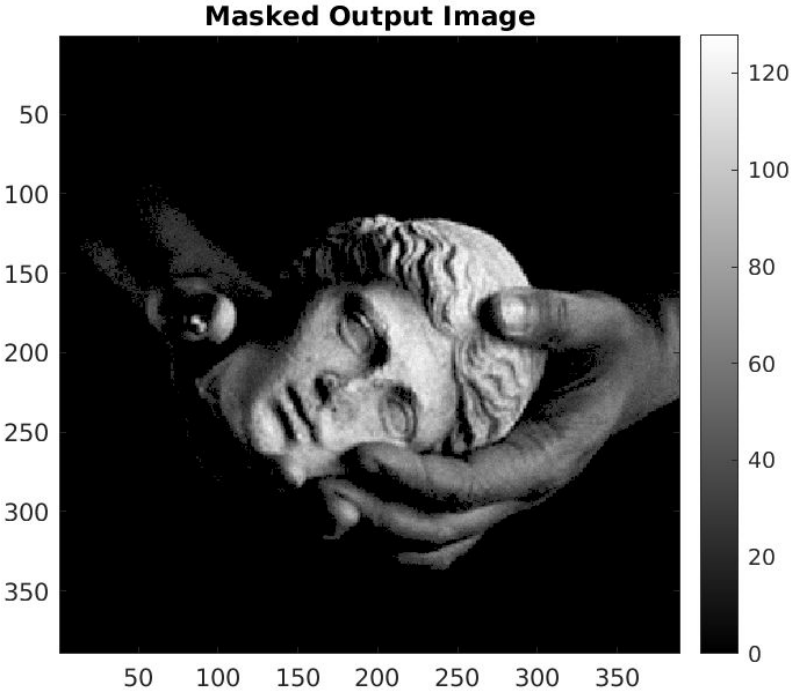


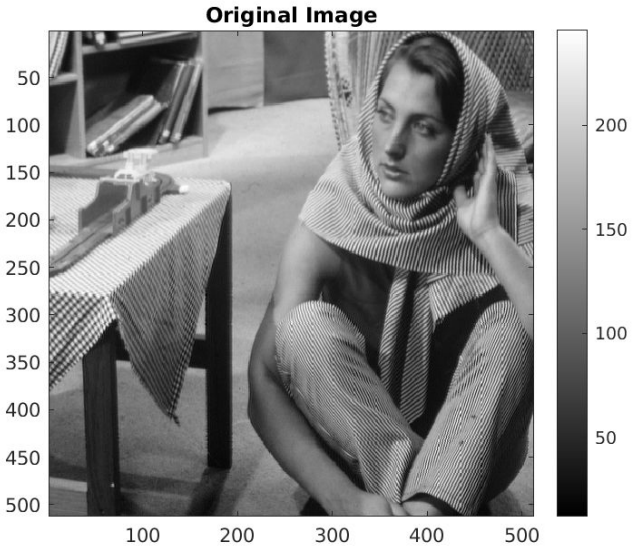
Image Mask
50
100
150
200
250
300
350
50 100 150 200 250 300 350
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

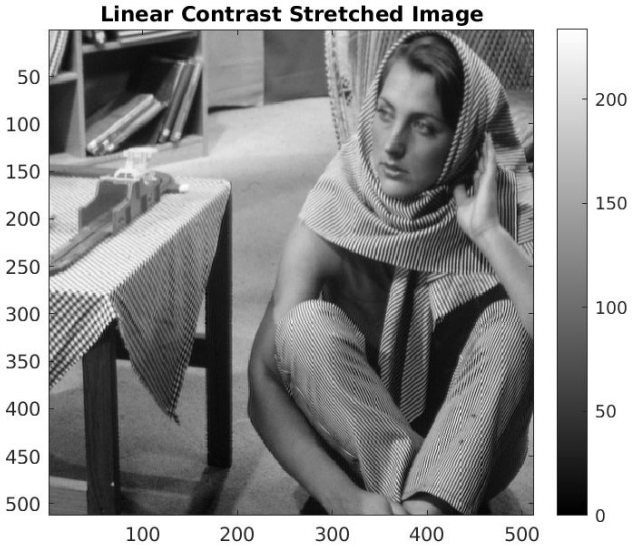

Masked Output Image
50
100
150
200
250
300
350
50 100 150 200 250 300 350
120
100
80
60
40
20
0

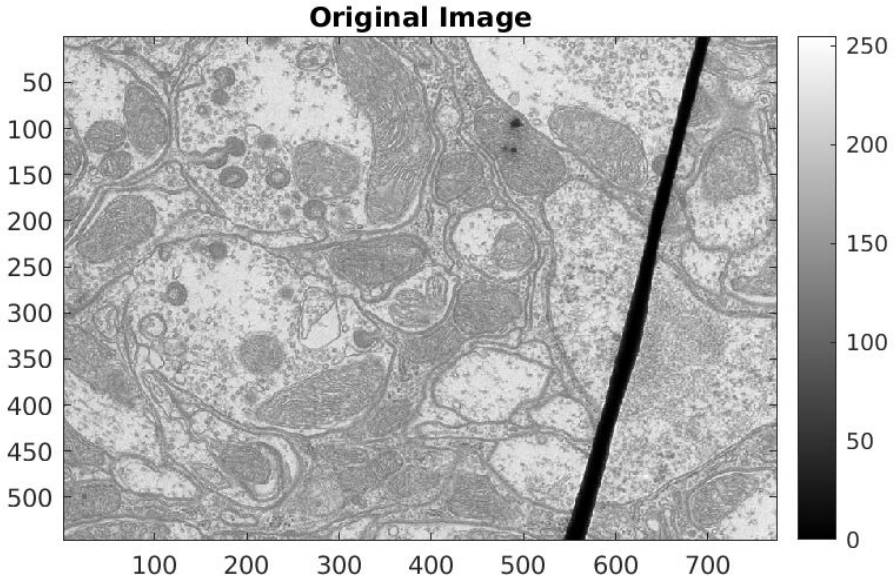
b) The formula used for interpolation of pixel r is:

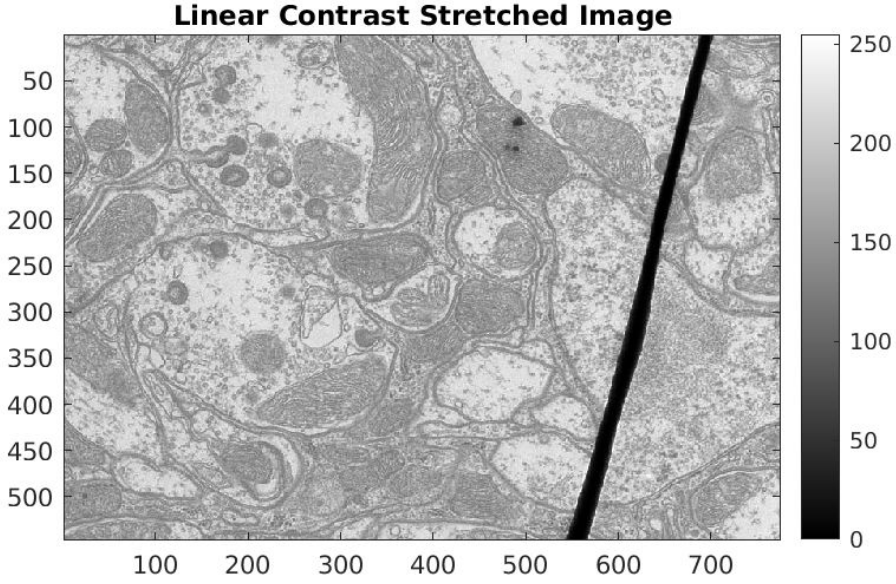
r’ = (r - I_min) * (255/(I_max - I_min))

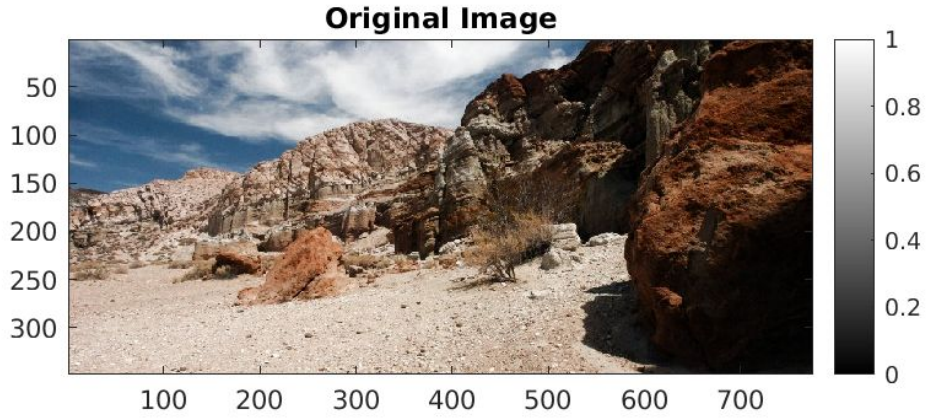
Here I_max and I_min are the maximum and minimum intensity values in the image respectively.

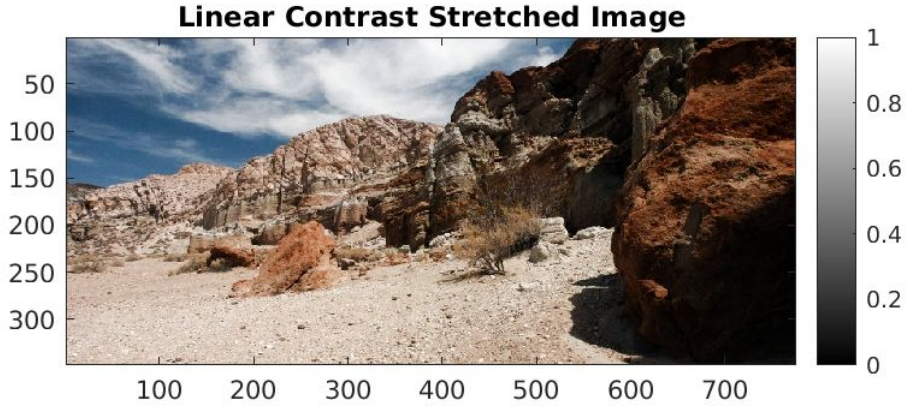


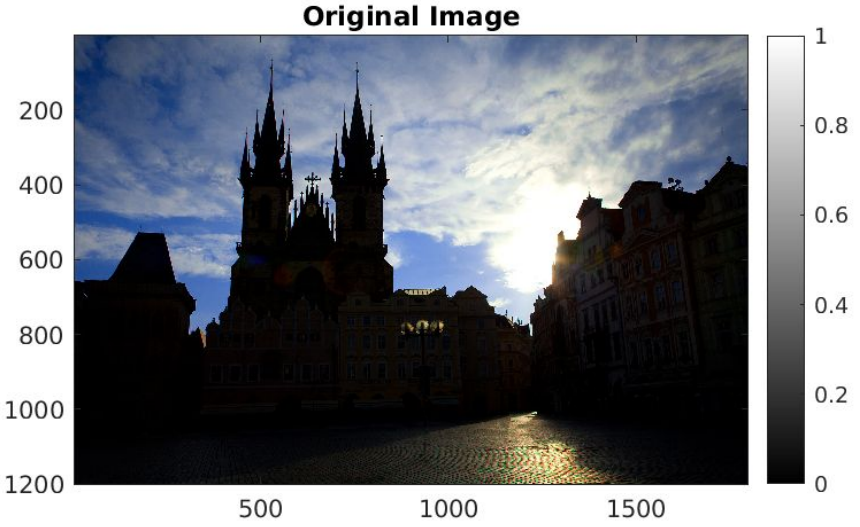


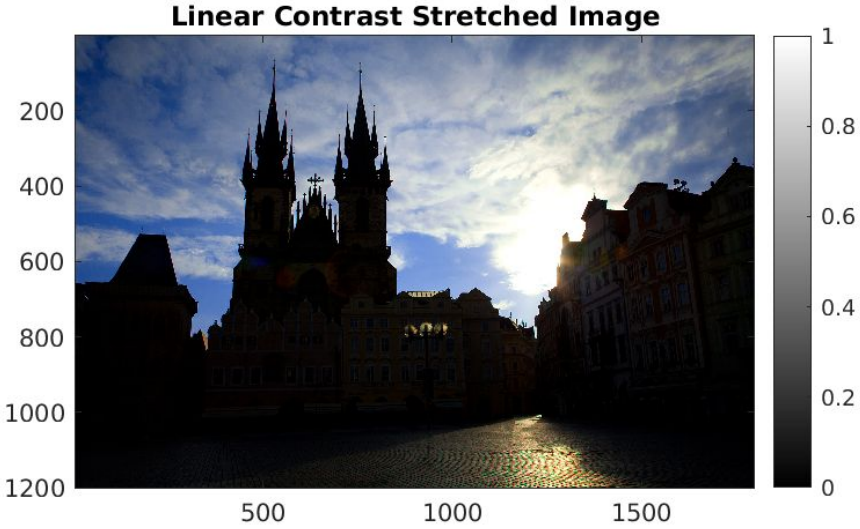

Original Image
50
100
150
200
250
300
350
400
450
500
100
200
300
400
500
600
700
250
200
150
100
50
0

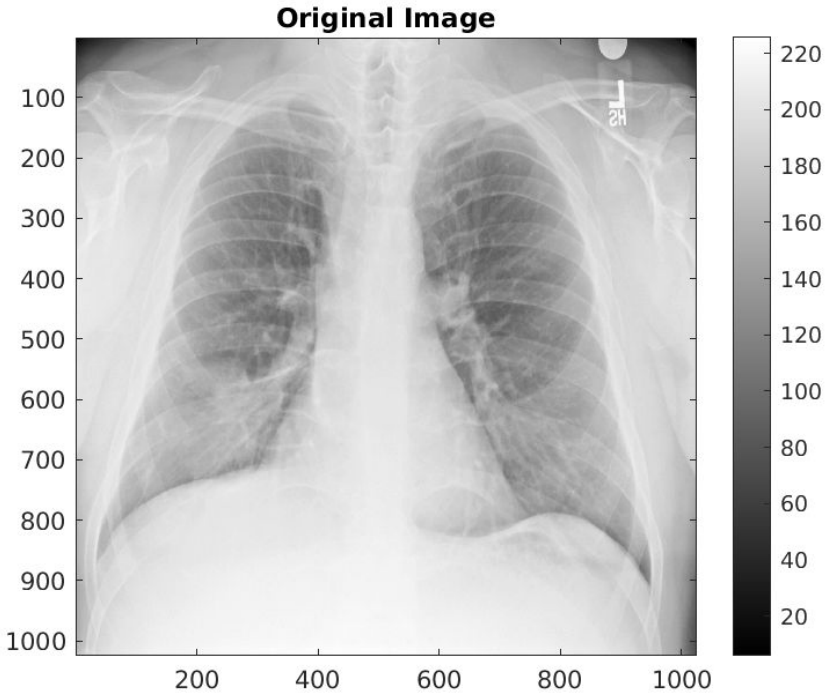

Linear Contrast Stretched Image
50
100
150
200
250
300
350
400
450
500
100
200
300
400
500
600
700
250
200
150
100
50
0

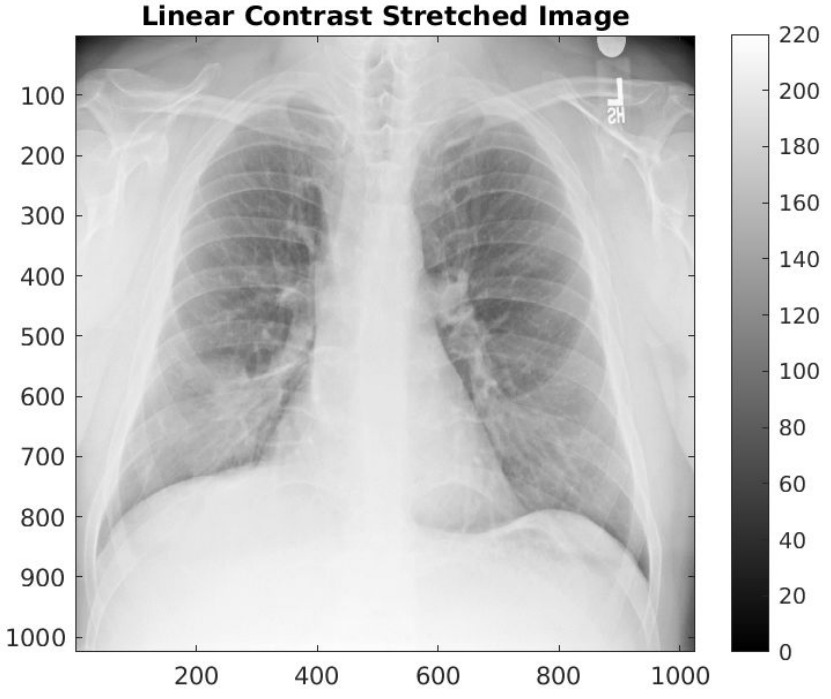

Original Image
50
100
150
200
250
300
100
200
300
400
500
600
700
1
0.8
0.6
0.4
0.2
0

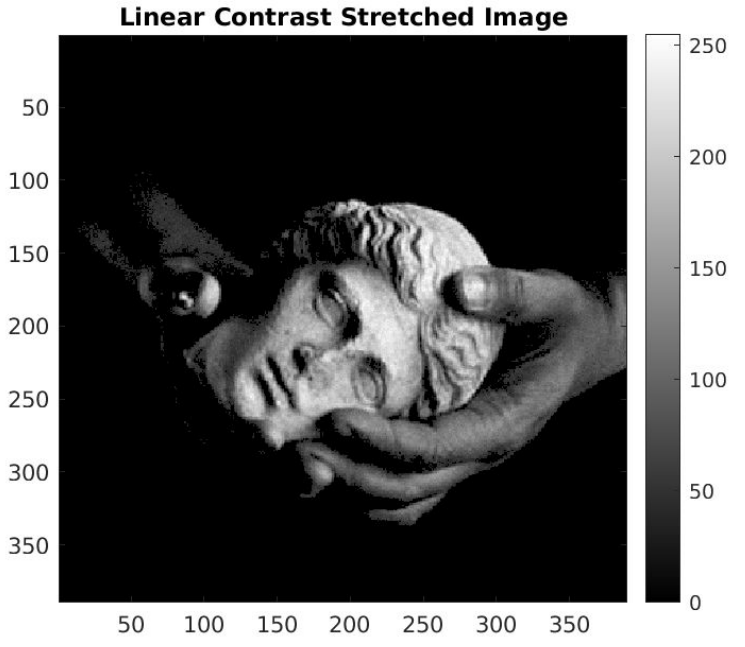

Linear Contrast Stretched Image
50
100
150
200
250
300
100
200
300
400
500
600
700
1
0.8
0.6
0.4
0.2
0


Original Image
200
400
600
800
1000
1200
500
1000
1500
1
0.8
0.6
0.4
0.2
0

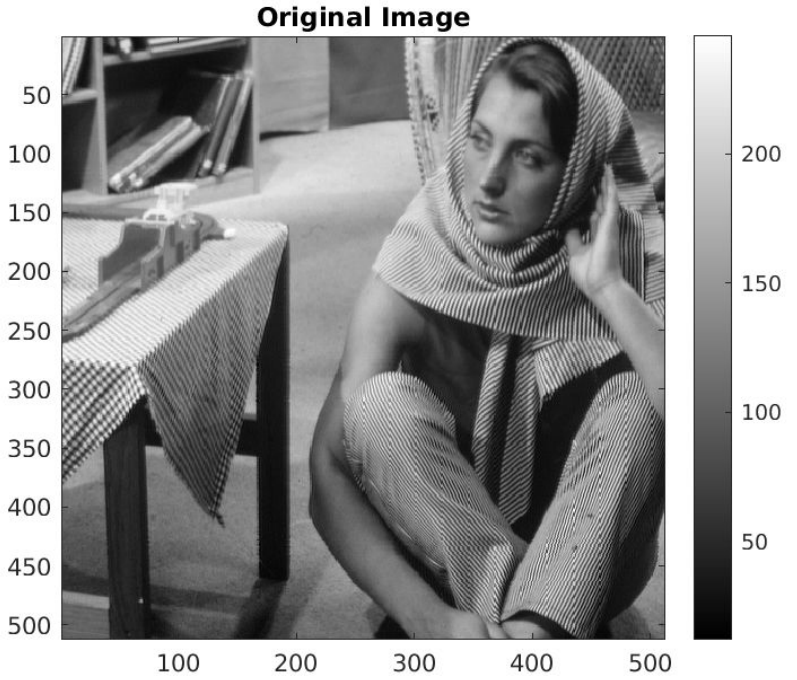

Linear Contrast Stretched Image
200
400
600
800
1000
1200
500
1000
1500
1
0.8
0.6
0.4
0.2
0


Original Image
100
200
300
400
500
600
700
800
900
1000
200
400
600
800
1000
220
200
180
160
140
120
100
80
60
40
20

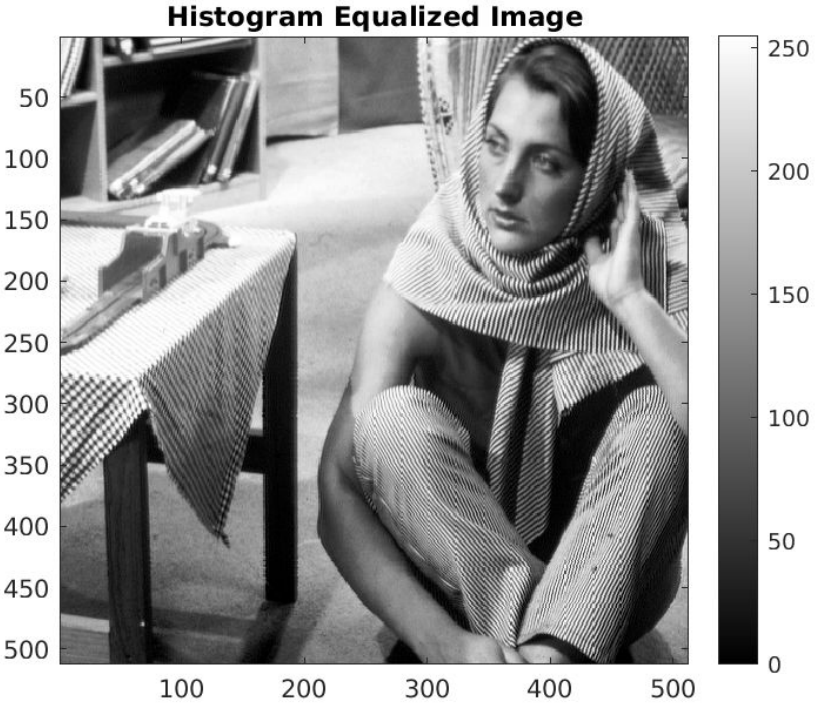

Linear Contrast Stretched Image
100
200
300
400
500
600
700
800
900
1000
200
400
600
800
1000
220
200
180
160
140
120
100
80
60
40
20
0

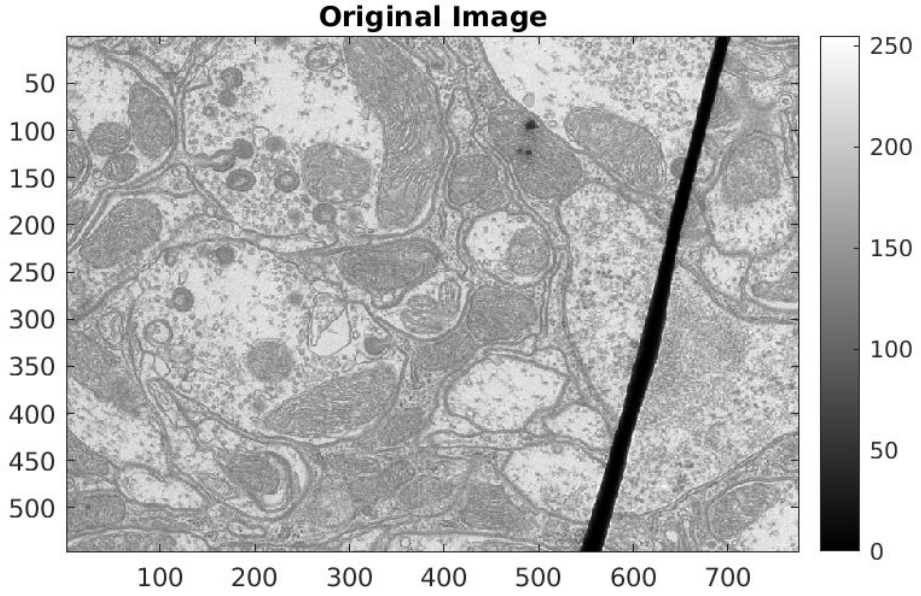


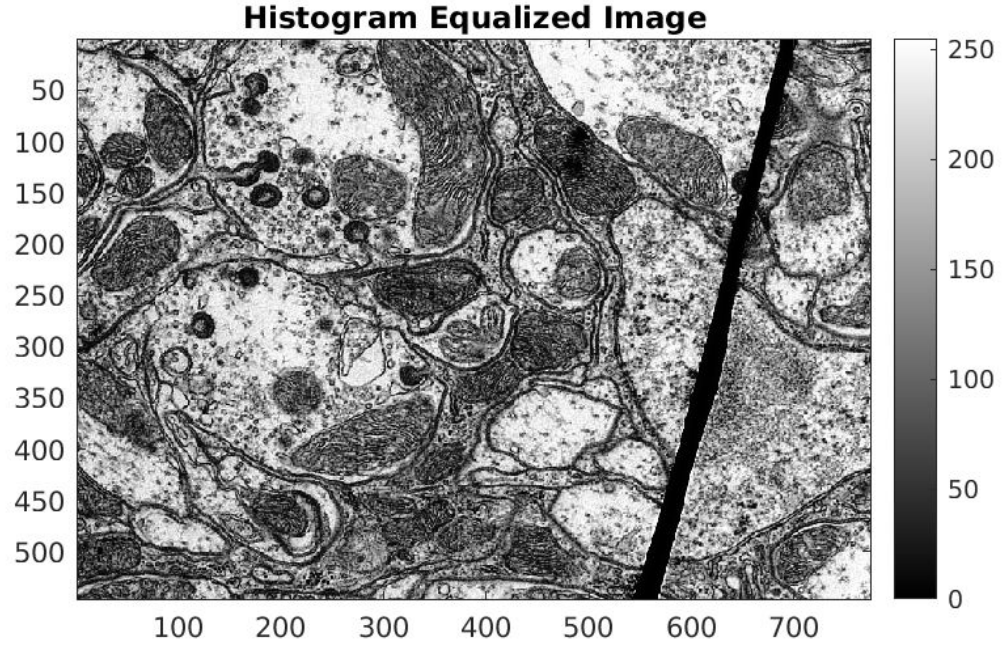
Contrast Stretching is not effective in (5) because the pixel values in the image already has a maximum of around 255 and a minimum of 0. In the case when the maximum and minimum are close to 255 and 0, we get no change in linear interpolation.

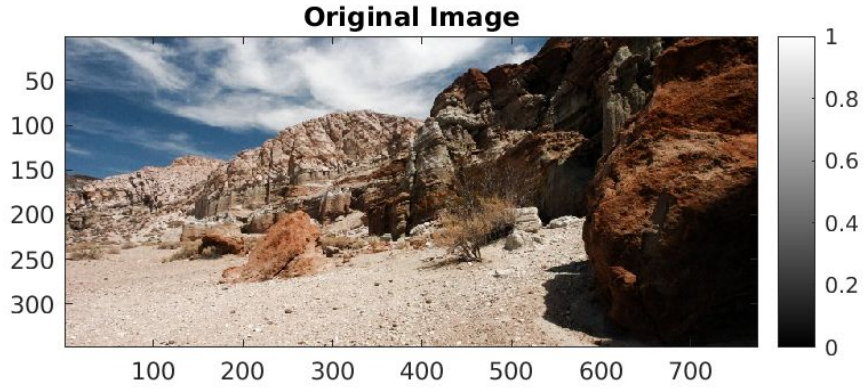

Original Image
50
100
150
200
250
300
350
400
450
500
100
200
300
400
500
200
150
100
50

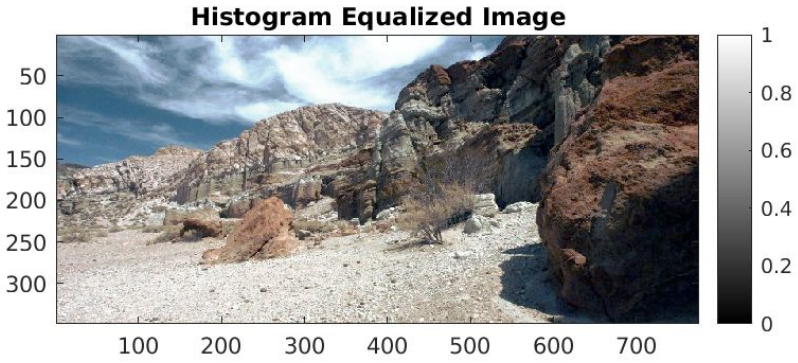
c)

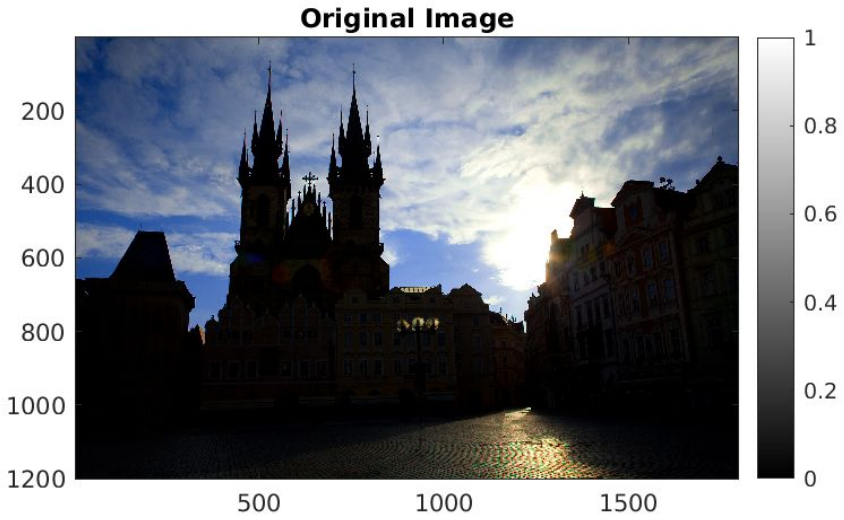

Histogram Equalized Image
50
100
150
200
250
300
350
400
450
500
100
200
300
400
500
250
200
150
100
50
0

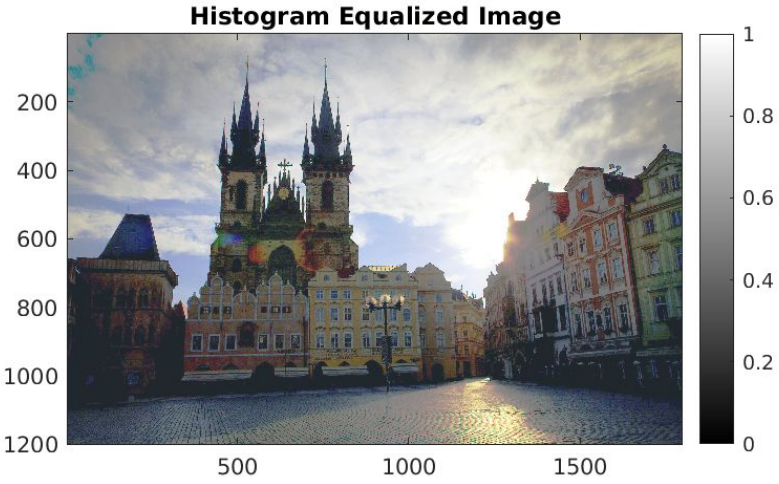

Original Image
50
100
150
200
250
300
350
400
450
500
100
200
300
400
500
600
700
250
200
150
100
50
0

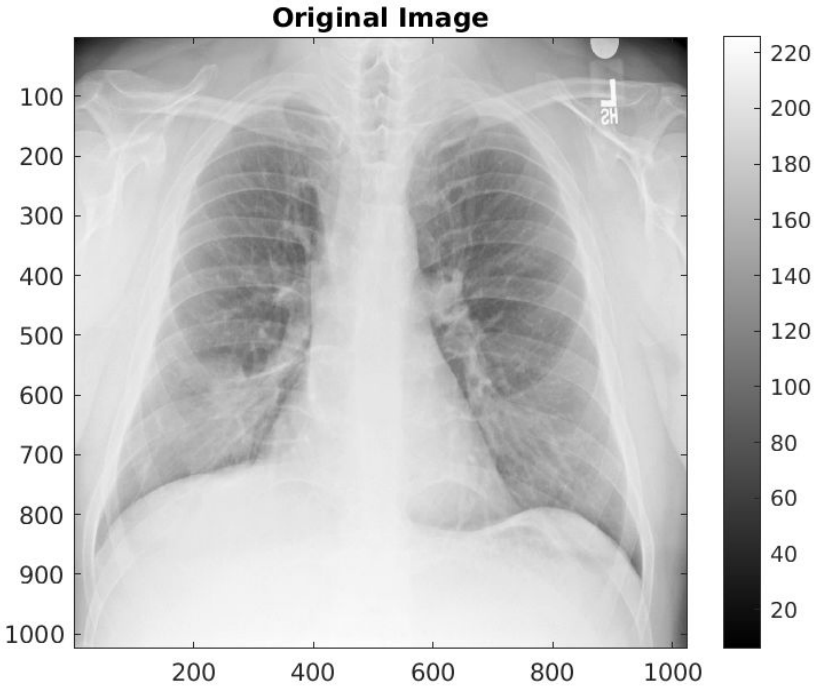

Histogram Equalized Image
50
100
150
200
250
300
350
400
450
500
100
200
300
400
500
600
700
250
200
150
100
50
0

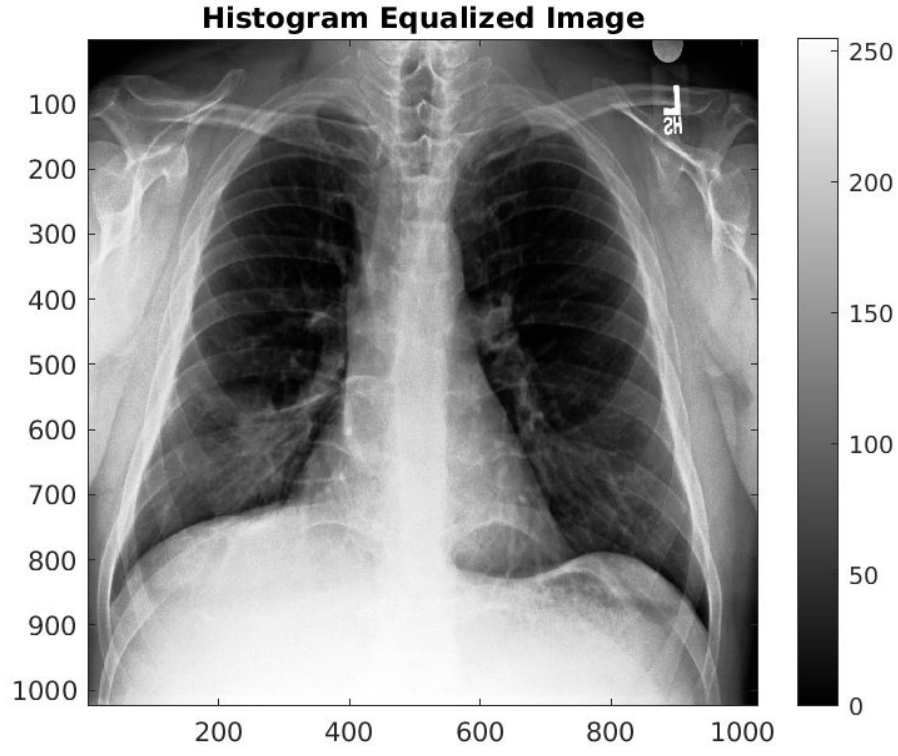

Original Image
50
100
150
200
250
300
100
200
300
400
500
600
700
1
0.8
0.6
0.4
0.2
0

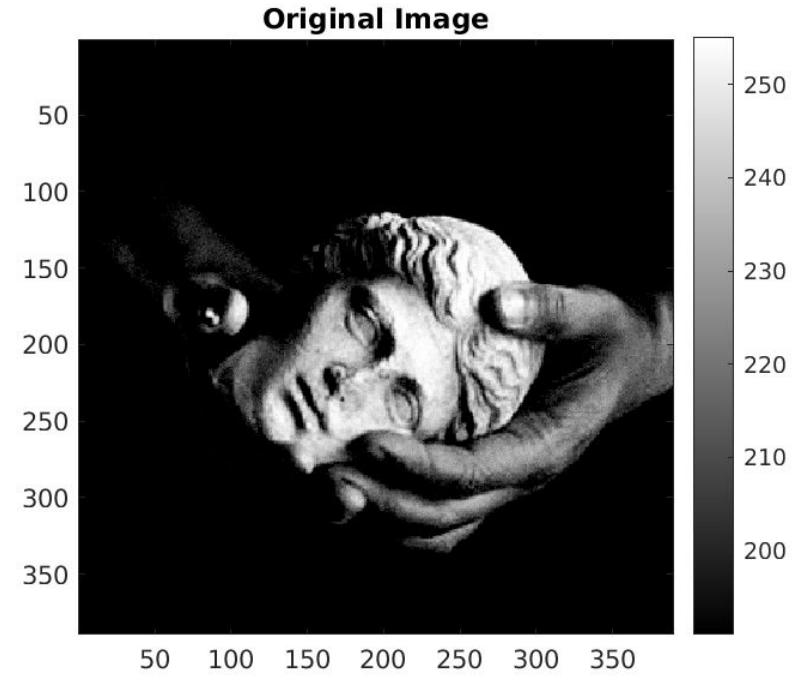

Histogram Equalized Image
50
100
150
200
250
300
100
200
300
400
500
600
700
1
0.8
0.6
0.4
0.2
0


Original Image
200
400
600
800
1000
1200
500
1000
1500
1
0.8
0.6
0.4
0.2
0


Histogram Equalized Image
200
400
600
800
1000
1200
500
1000
1500
1
0.8
0.6
0.4
0.2
0

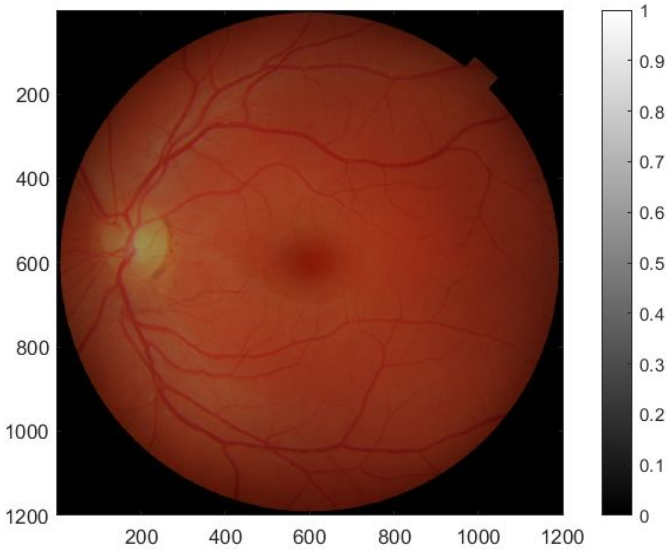

Original Image
100
200
300
400
500
600
700
800
900
1000
200
400
600
800
1000
220
200
180
160
140
120
100
80
60
40
20


Histogram Equalized Image
100
200
300
400
500
600
700
800
900
1000
200
400
600
800
1000
250
200
150
100
50
0

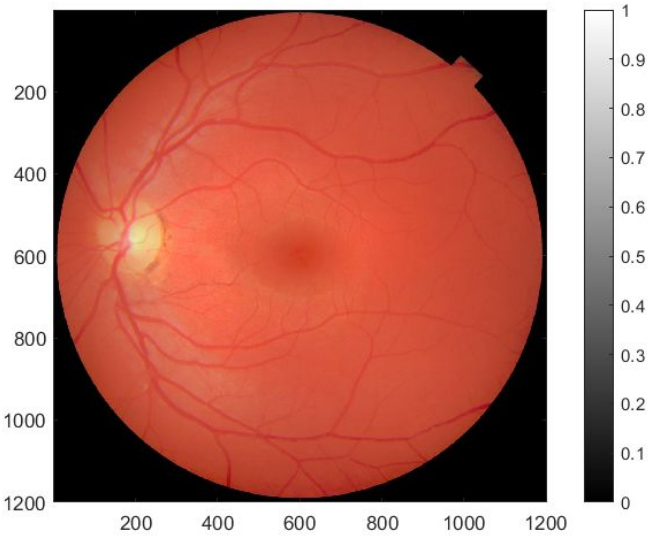


As we saw in the last part, there is no effect of Contrast Stretching on (5). However, we see a better result in HE. Hence HE is preferred in this case.

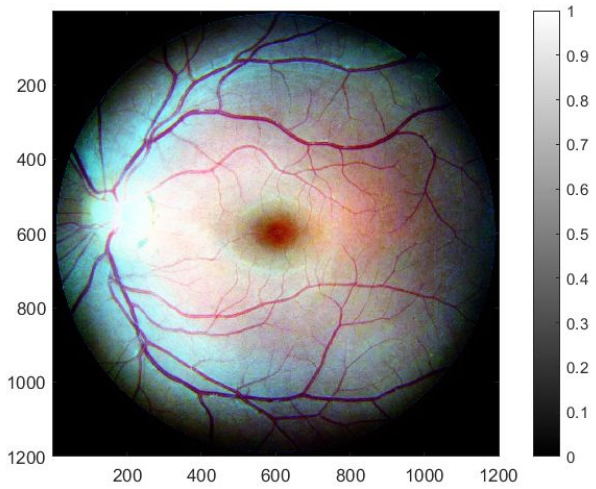
d)



Original Image



HM image



HE image

It is evident from the three images that Histogram Matching more resembles the reference image. This is helpful when we want the image to have a particular appearance. HE image has a very low orange tint and looks unrealistic. Hence this is not recommended.

e)

Part e results and best parameters are written in the mainScript.m. They are not added in this document due to a large number of photos.

Please refer to the code (mainscript)

Question 3:

a)

The CDF of a histogram equalized image is a ramp, that is, its histogram is uniform in the region. As mentioned in the question, after the transformation h1 and h2 should be equalized individually in the intervals [0, a] and [a,1]. Let the transformed histogram be g and g1 and g2 respectively in the intervals [0,a] and [a,1].

Therefore, keeping mass preservation:

$$g = \frac{\alpha}{a} \quad ; I \in [0, a]$$

$$g = \frac{1-\alpha}{1-a} \quad ; I \in [a, 1]$$

Where,

$$\alpha = \int_0^a h(I)dI$$

The mean intensity of this new transformed histogram would be its expectation:

$$E[g] = \int_0^1 g(I)IdI$$

$$E[g] = (\int_0^a \frac{\alpha}{a} \, IdI) + (\int_a^1 \frac{1-\alpha}{1-a} \, IdI)$$

$$E[g] = \frac{(1-\alpha)(1+a)}{2} + \frac{\alpha a}{2}$$

$$E[g] = \frac{1-\alpha+a}{2}$$

Therefore the mean of g is (1-α+a)/2.

b)

Since ‘a’ is the median intensity therefore, α = ½.

Therefore mean intensity of the resulting histogram is (1+a)/2.

c)

Histogram equalization can cause the gray-scale stretching which changes the average luminescence of the picture which is undesirable in some cases. This method of dividing the picture into two parts based on their gray levels and contrast stretching them individually thus restricts big changes of luminescence level of the picture. Therefore, for those pictures which need to be contrast stretched with minimal change in luminescence levels we should apply this new method.

d)

In the below three images, we can clearly see that the Modified HE image as discussed in the previous parts outperforms the Histogram Equalization Output. Hence this is a better approach in such images.