

MyMainScript

```
tic;
```

Your code here

```
%reading in images
barbara = imread('../data/barbara.png');
TEM = imread('../data/TEM.png');
canyon = imread('../data/canyon.png');
retina = imread('../data/retina.png');
church = imread('../data/church.png');
```

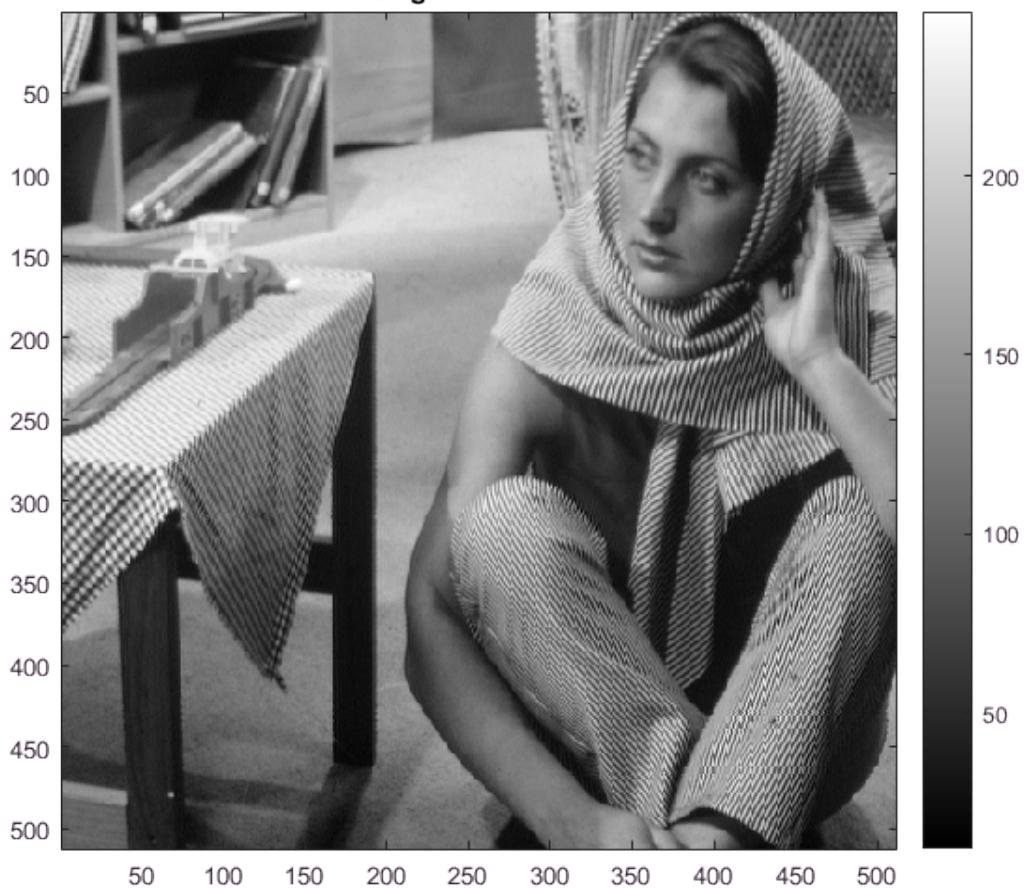
Q2(a) Image Enhancement by Linear Contrast Stretching

$$I_{\text{new}} = \frac{255}{I_{\max} - I_{\min}} \times (I - I_{\min})$$

where I_{new} is the pixel intensity after linear contrast stretching, I_{\min} and I_{\max} are the minimum and maximum values of pixel intensity in the input image. For coloured images, this is applied to each channel independently.

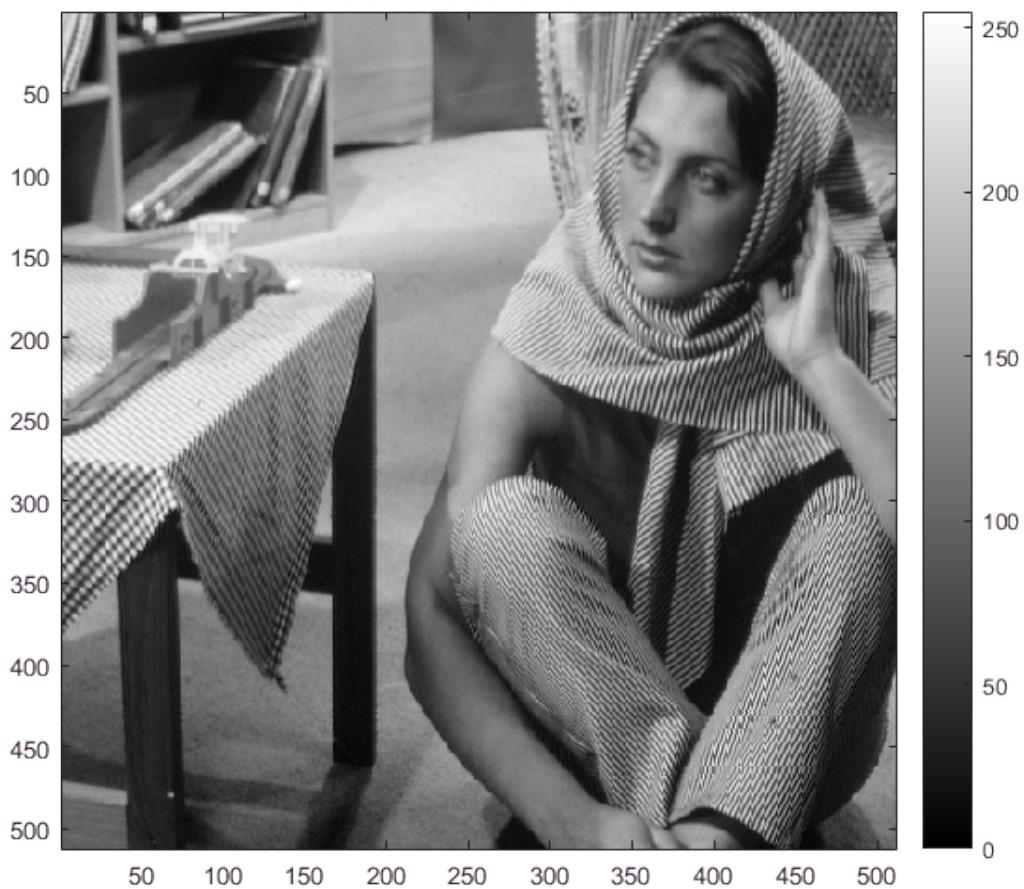
```
%basic linear contrast stretching
tic;
barbara_linstretch = myLinearContrastStretching(barbara, 'g');
my_imshow(barbara, 'Original Barbara');
```

Original Barbara

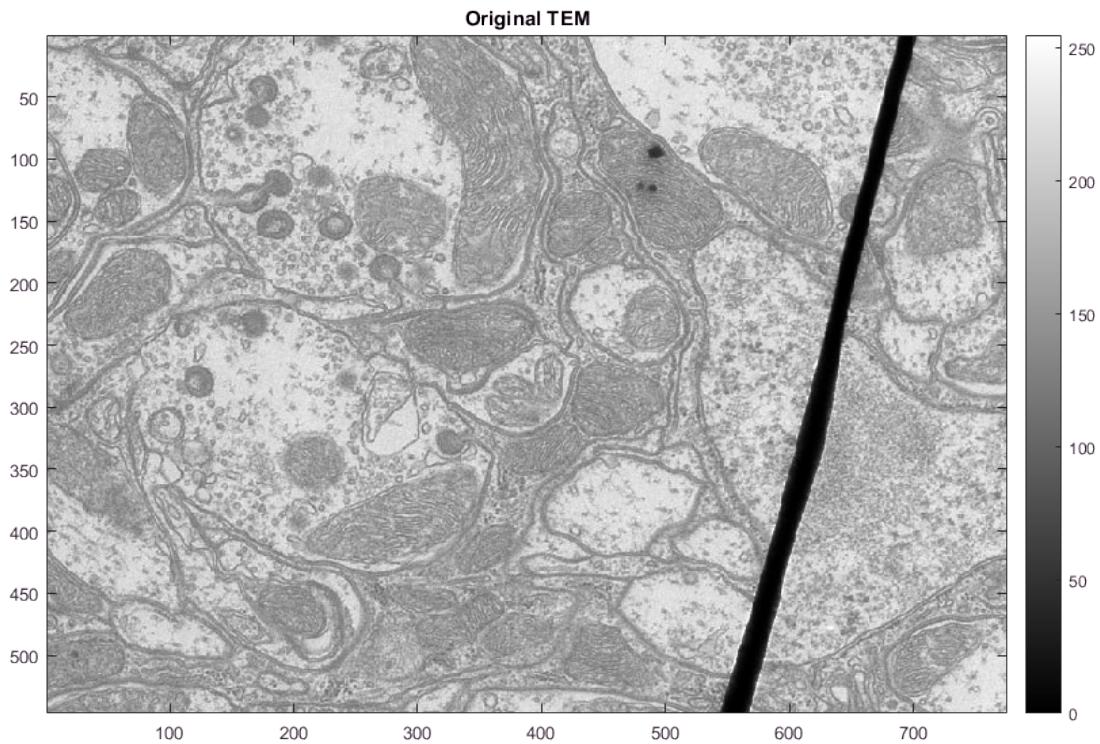


```
my_imshow(barbara_linstretch, 'Linear Contrast Stretched Barbara');
```

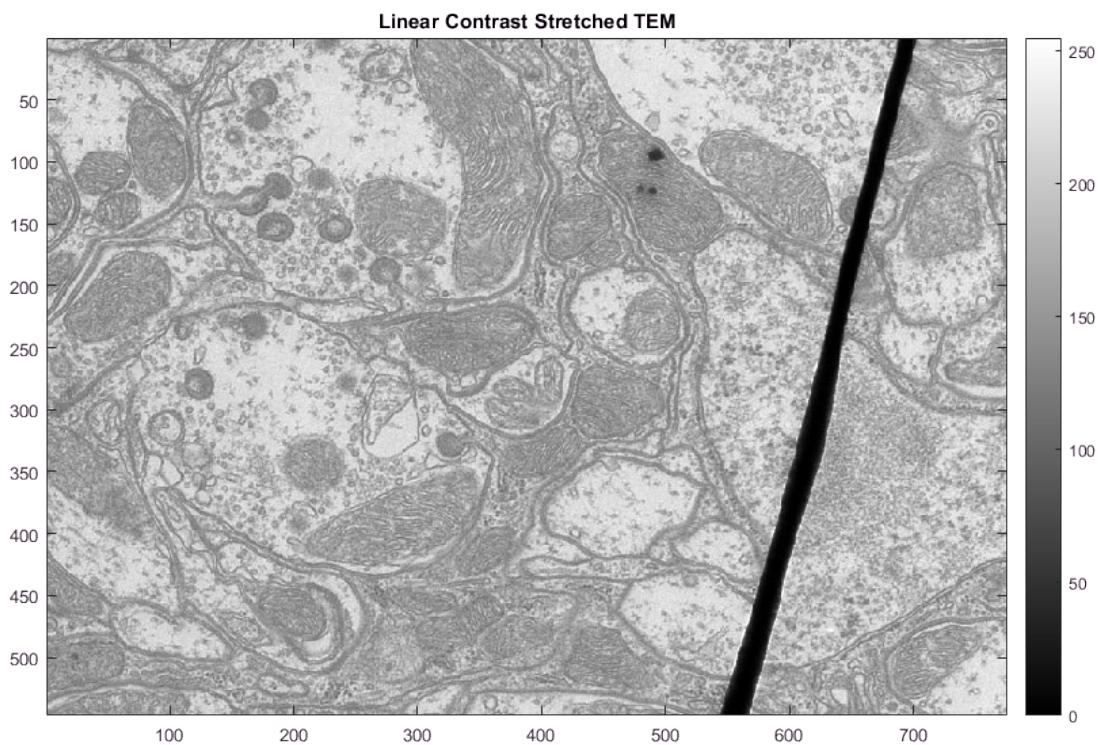
Linear Contrast Stretched Barbara



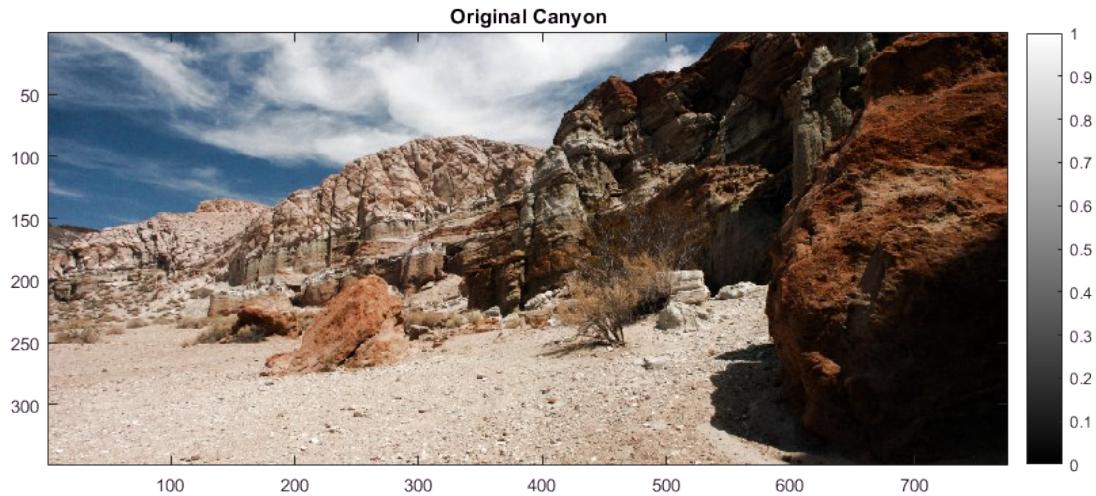
```
TEM_linstretch = myLinearContrastStretching(TEM, 'g');
my_imshow(TEM, 'Original TEM');
```



```
my_imshow(TEM_linstretch, 'Linear Contrast Stretched TEM');
```



```
canyon_linstretch = myLinearContrastStretching(canyon, 'rgb');
my_imshow(canyon, 'Original Canyon');
```



```
my_imshow(canyon_linstretch, 'Linear Contrast Stretched Canyon');
```



```
church_linstretch = myLinearContrastStretching(church, 'rgb');
my_imshow(church, 'Original Church');
```

Warning: Image is too big to fit on screen; displaying at 33%



```
my_imshow(church_linstretch, 'Linear Contrast Stretched Church');
```

Warning: Image is too big to fit on screen; displaying at 33%



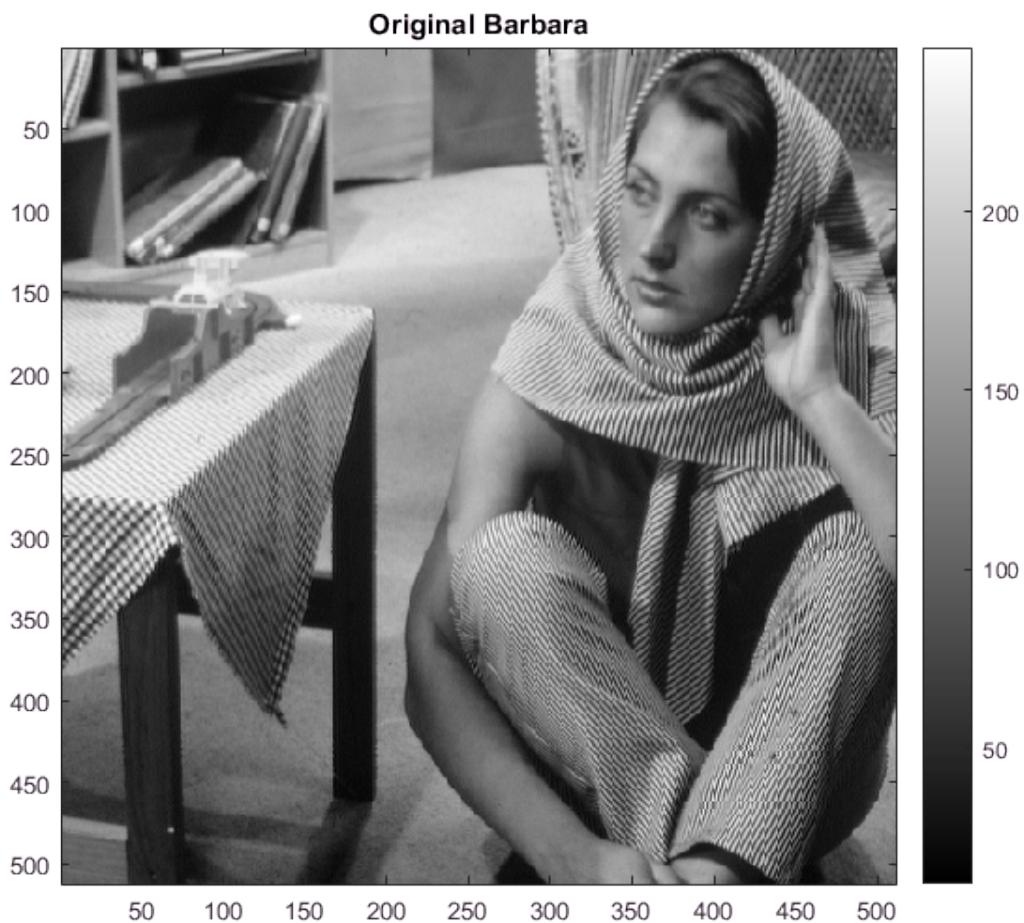
```
toc;
```

```
Elapsed time is 48.005830 seconds.
```

Linear contrast stretching is ineffective in improving contrast in the church.png image. Linear contrast stretching aims to stretch the range of the image to span the entire possible range i.e 0-255. However, the input image contains pixel intensities of both 0(white) and 255(black) in all 3 channels. Thus the transformation is an identity transform, with the output identical to the input image.

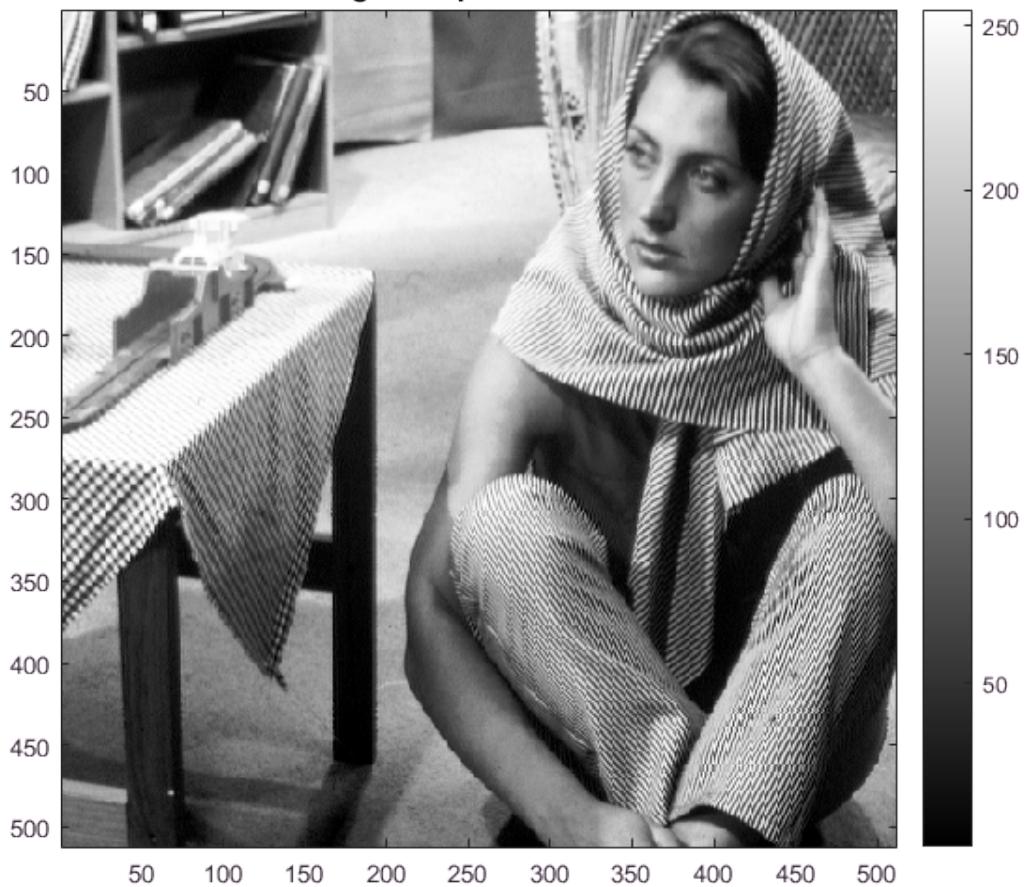
Q2(b) Image Enhancement using Independent channel Histogram Equalisation

```
%Histogram Equalisation  
tic;  
barbara_he = myHE(barbara, 'g');  
my_imshow(barbara, "Original Barbara");
```

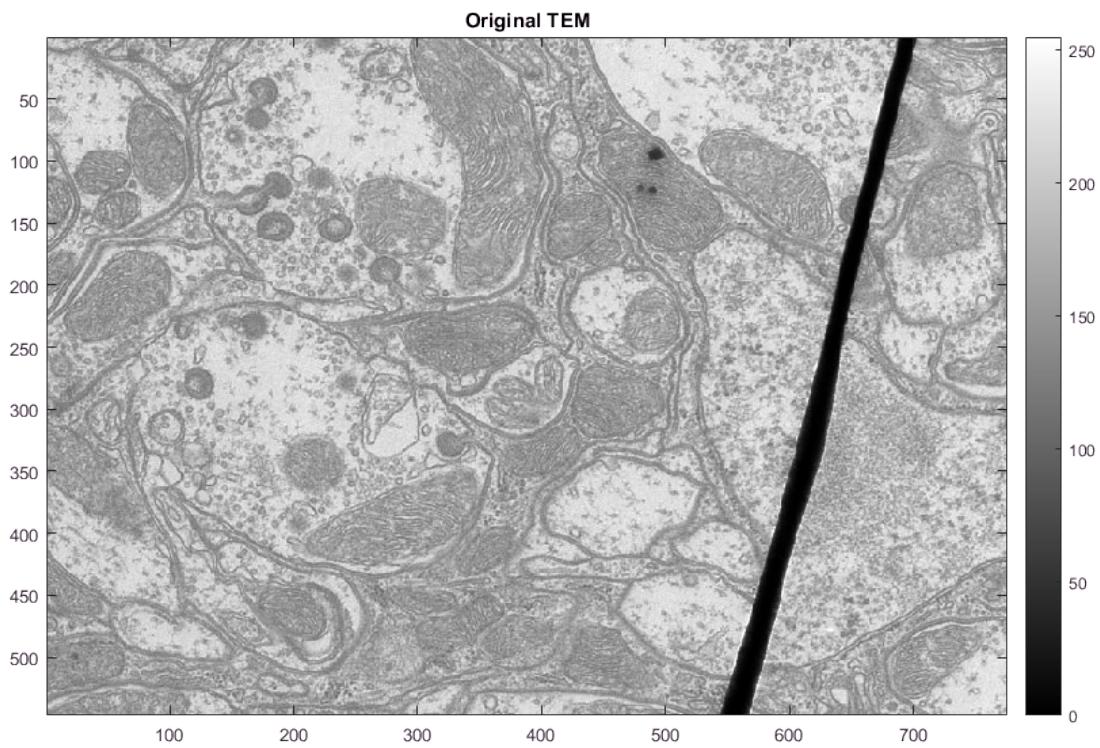


```
my_imshow(barbara_he, 'Histogram Equalised Barbara');
```

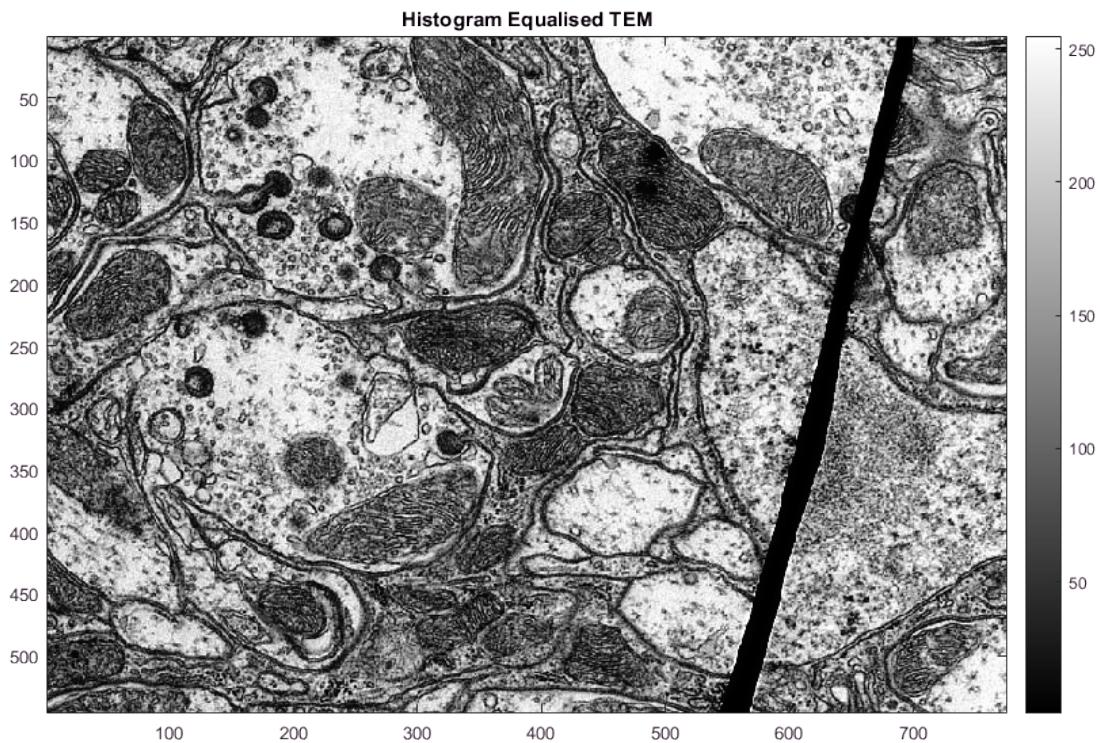
Histogram Equalised Barbara



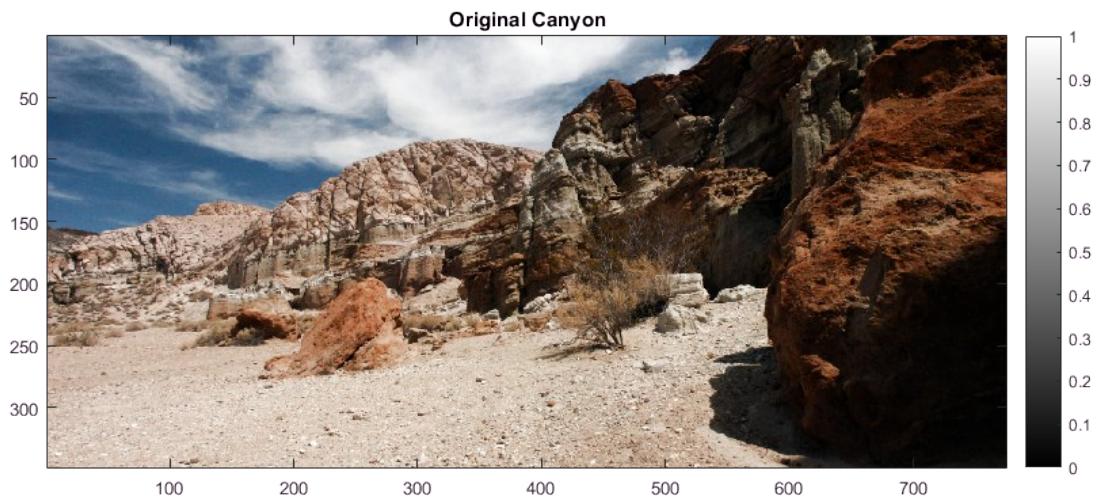
```
TEM_he = myHE(TEM,'g');
my_imshow(TEM, 'Original TEM');
```



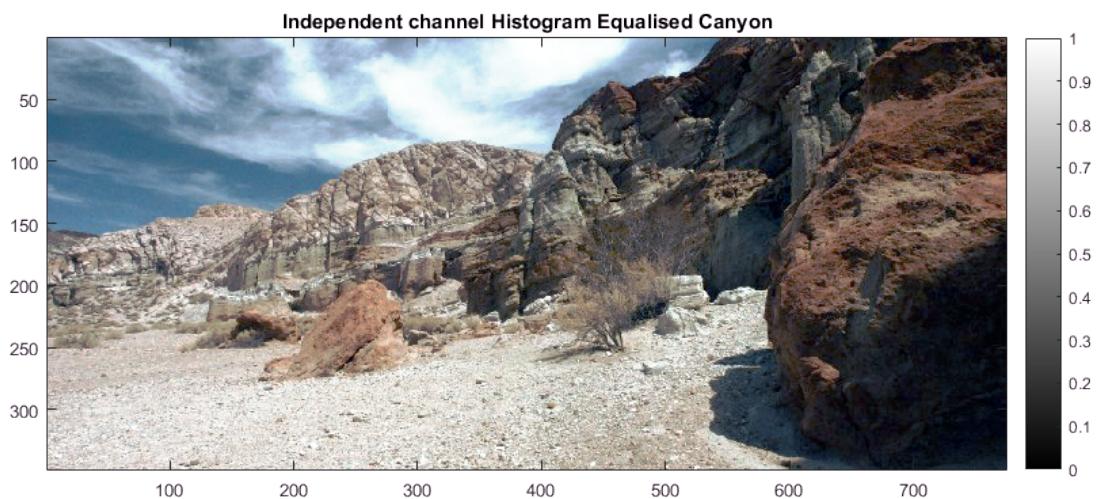
```
my_imshow(TEM_he, 'Histogram Equalised TEM');
```



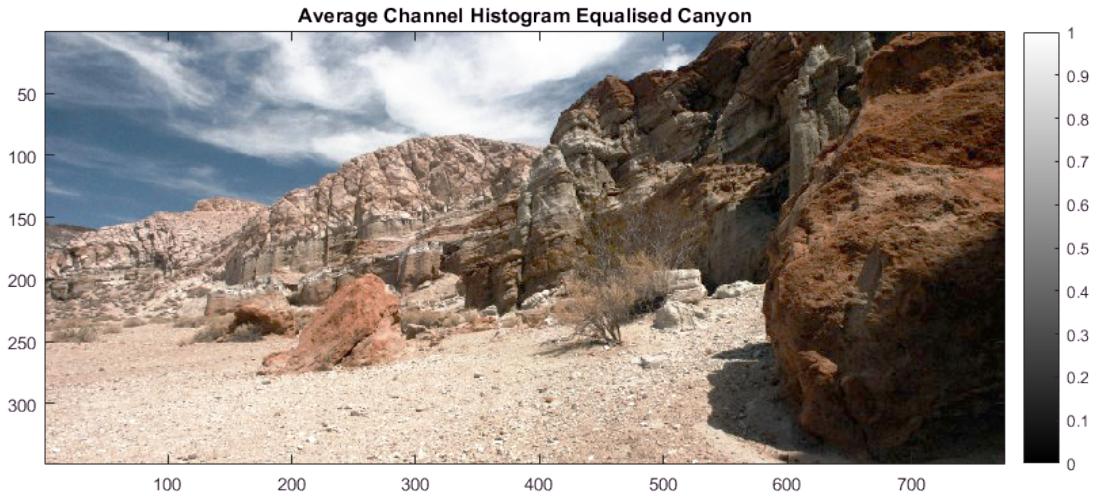
```
canyon_ind_he = myHE(canyon,'ind');
canyon_avg_he = myHE(canyon,'avg');
my_imshow(canyon, 'Original Canyon');
```



```
my_imshow(canyon_ind_he, 'Independent channel Histogram Equalised Canyon');
```



```
my_imshow(canyon_avg_he, 'Average Channel Histogram Equalised Canyon');
```



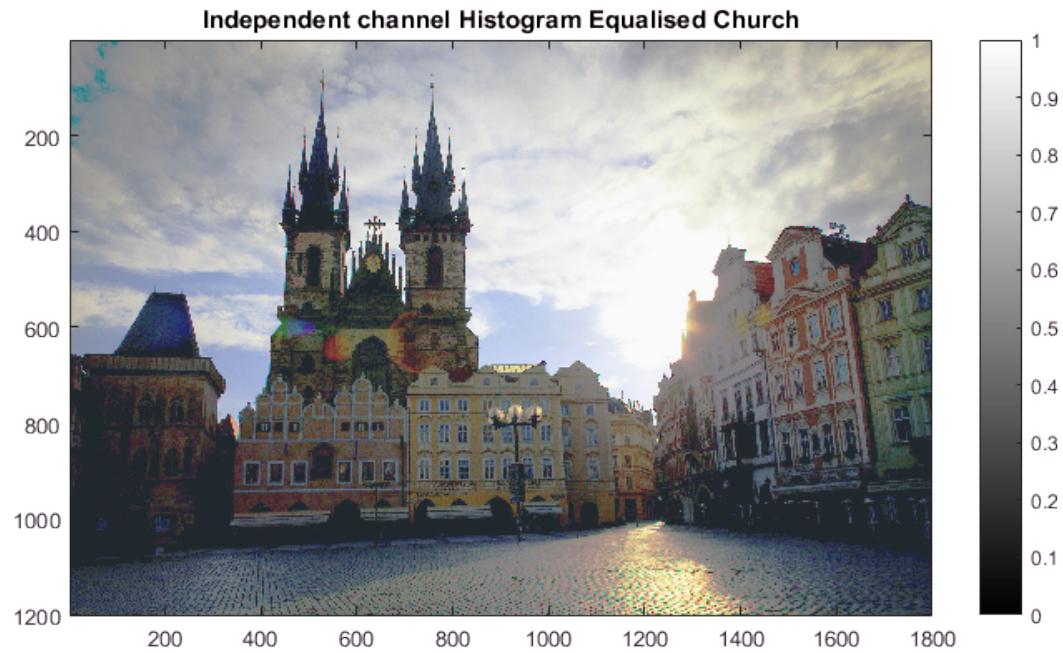
```
church_ind_he = myHE(church, 'ind');
chruch_avg_he = myHE(church, 'avg');
my_imshow(church, 'Original Church');
```

Warning: Image is too big to fit on screen; displaying at 33%



```
my_imshow(church_ind_he, 'Independent channel Histogram Equalised Church');
```

Warning: Image is too big to fit on screen; displaying at 33%



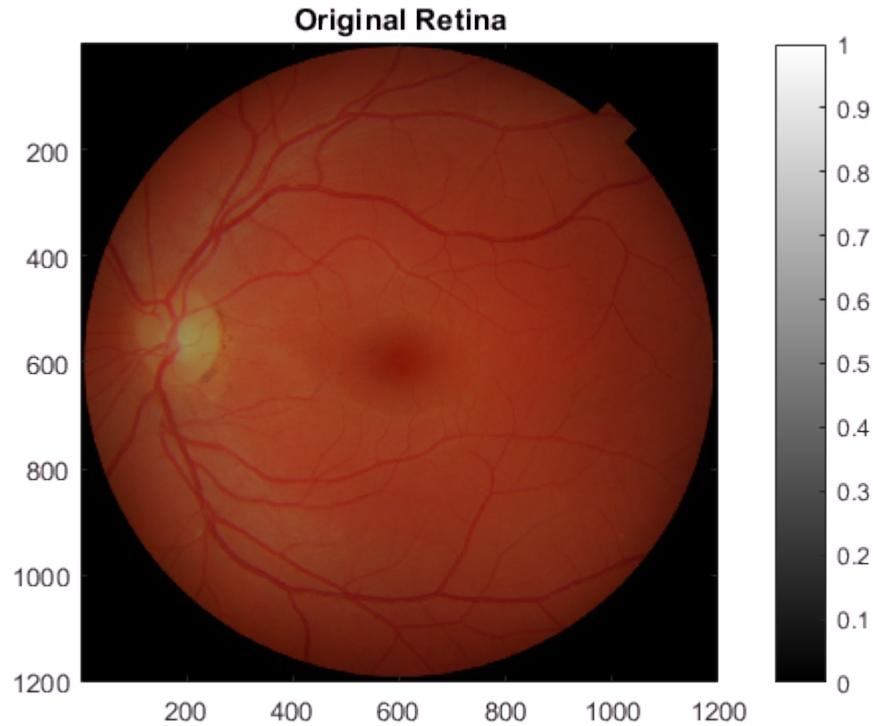
```
my_imshow(chruch_avg_he, 'Average Channel Histogram Equalised Church');
```

Warning: Image is too big to fit on screen; displaying at 33%



```
my_imshow(retina, 'Original Retina');
```

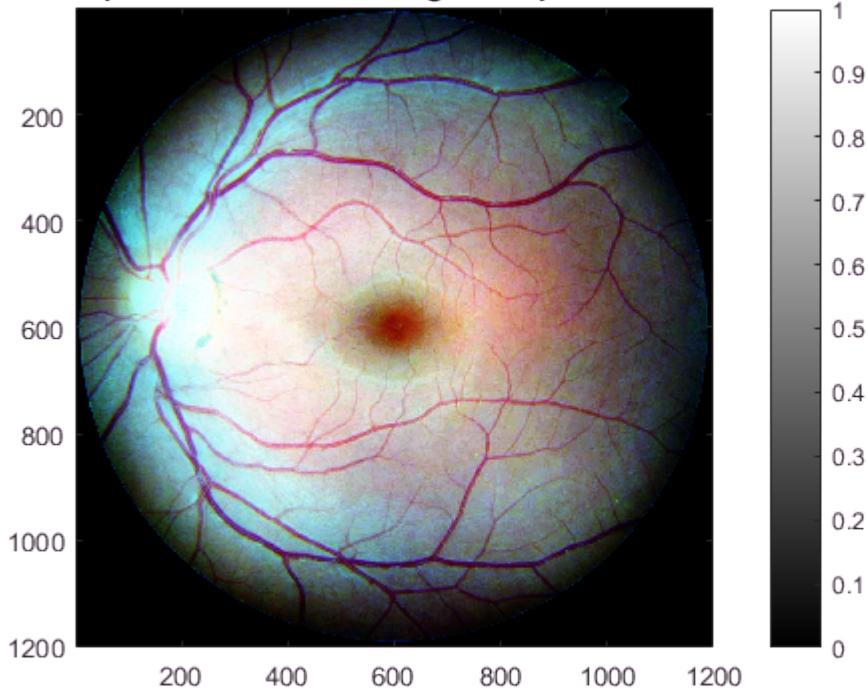
Warning: Image is too big to fit on screen; displaying at 33%



```
retina_mask = imread('..../data/retinaMask.png');
retina_ind_he = myHE(retina,'ind',retina_mask);
my_imshow(retina_ind_he, 'Independent channel Histogram Equalised Retina');
```

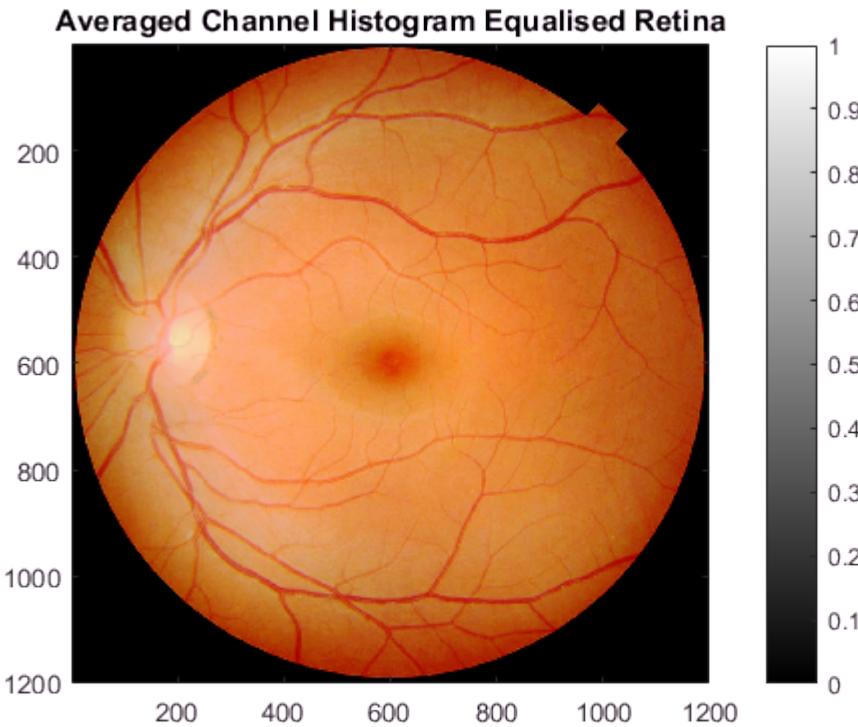
Warning: Image is too big to fit on screen; displaying at 33%

Independent channel Histogram Equalised Retina



```
retina_avg_he = myHE(retina,'avg',retina_mask);
my_imshow(retina_avg_he, 'Averaged Channel Histogram Equalised Retina');
```

Warning: Image is too big to fit on screen; displaying at 33%



```
toc;
```

Elapsed time is 147.376917 seconds.

Applying Histogram equaisation independently for each channel results in a significant change in colour (as made abundantly clear for the retina image).

A variation of the independent channel histogram equalisation is the average channel histogram equalisation, where the average transform across channels is applied to all channels. While the colour scheme is retained in this enhancement, for certain applications (such as a pre-processing step before segmenting the eye blood vessels), independent channel histogram equaisation maybe preferred.

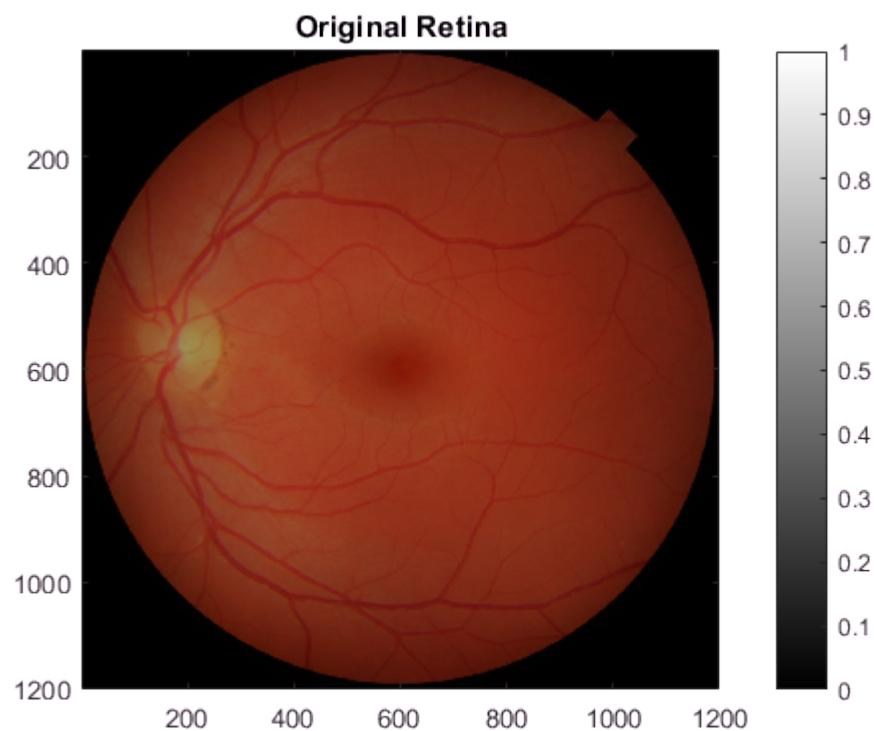
Comparing the performance of Histogram Equalisation and contrast stretching for image(5), it is clear that historgam equalisation is much better in improving contrast than linear contrast stretching. Linear contrast stretching's effects is greatly diminished if the range of pixel values is large, regardless of the number of such locations of extremely small or latge values. Histogram equalisation, on the other hand, has sufficient non-linearity to not be weakened by such factors.

Q2(c) Histogram Matching

```
% Histogram Matching
tic;
retina_mask = imread('../data/retinaMask.png');
retina_ref = imread('../data/retinaRef.png');
retina_ref_mask = imread('../data/retinaRefMask.png');
```

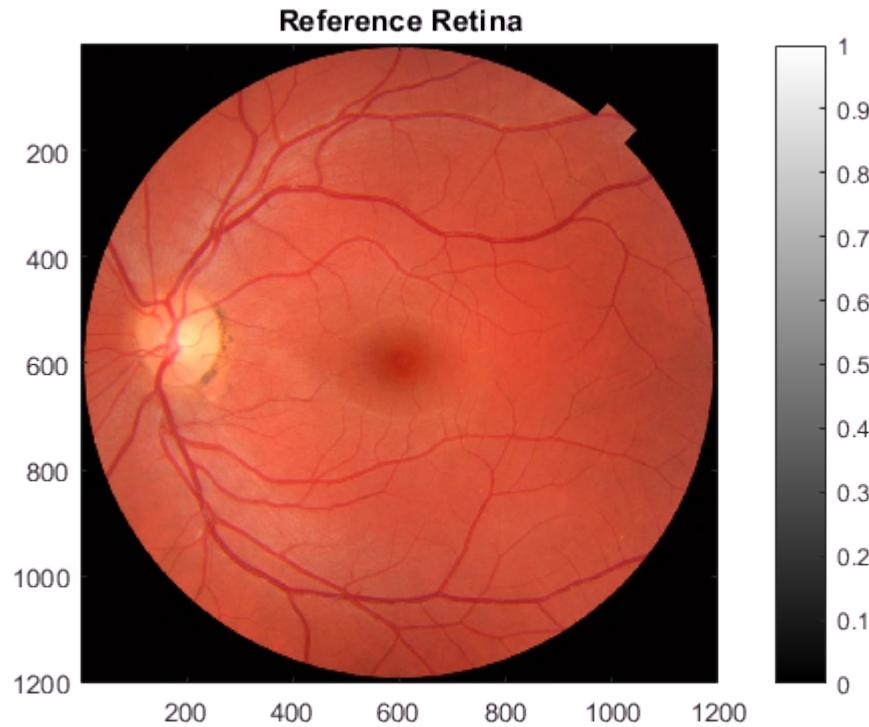
```
my_imshow(retina, 'Original Retina');
```

Warning: Image is too big to fit on screen; displaying at 33%



```
my_imshow(retina_ref, 'Reference Retina');
```

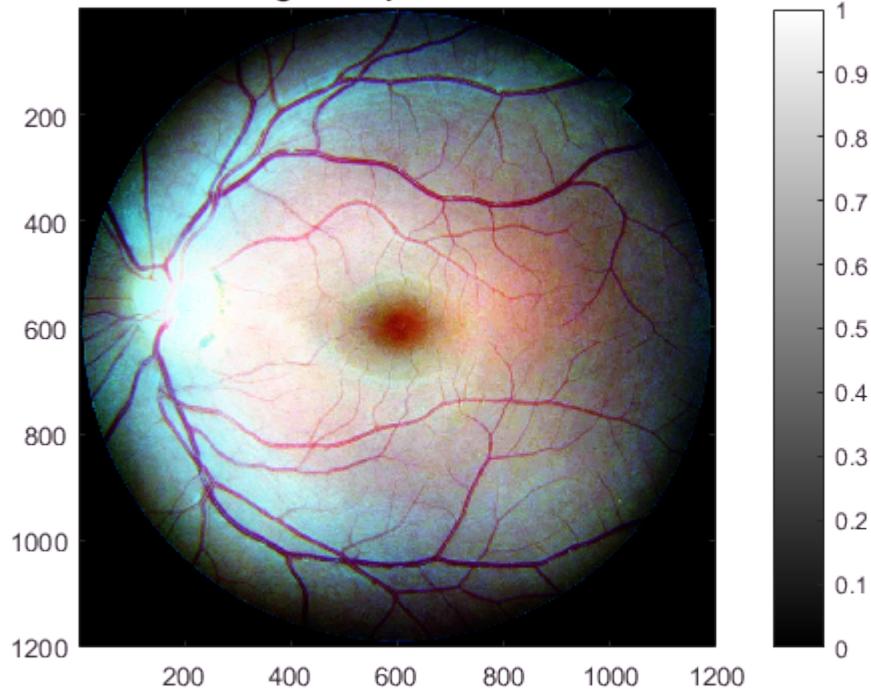
Warning: Image is too big to fit on screen; displaying at 33%



```
[HM_int,HM_op] = myHM(retina,retina_mask, retina_ref,retina_ref_mask);  
my_imshow(HM_int, 'Histogram Equalised Retina');
```

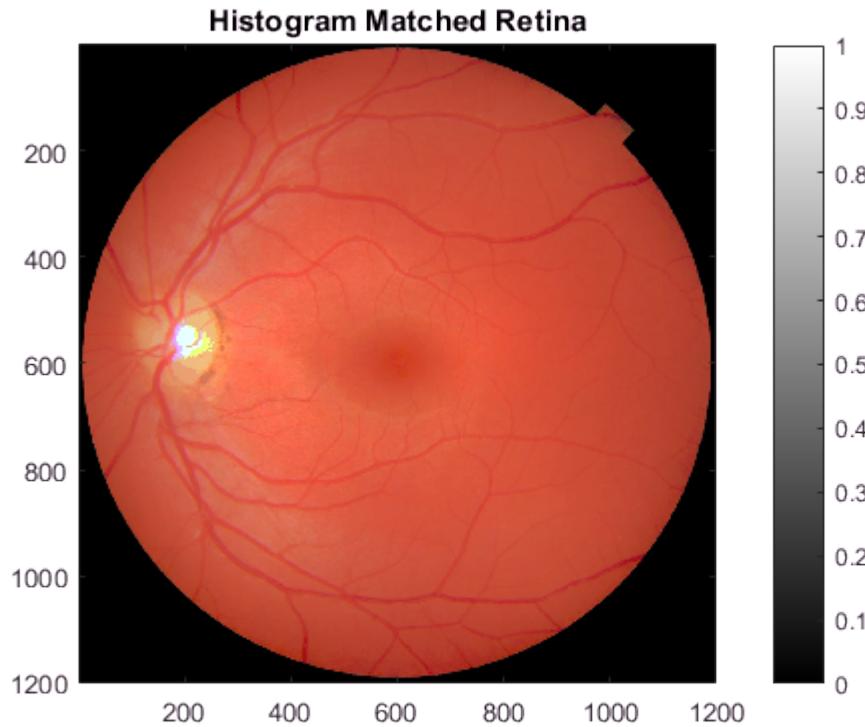
Warning: Image is too big to fit on screen; displaying at 33%

Histogram Equalised Retina



```
my_imshow(HM_op, 'Histogram Matched Retina');
```

Warning: Image is too big to fit on screen; displaying at 33%



```
toc;
```

Elapsed time is 84.922776 seconds.

Q2(d) Adaptive Histogram Equalisation`

```
% % Adaptive Histogram Equalisation`  
tic;  
my_imshow(barbara, "Original Barbara");  
barbara_ahe_51 = myAHE(barbara,51);  
my_imshow(barbara_ahe_51, 'Adaptive Histogram Equalised Barbara - window size = 51');  
barbara_ahe_3 = myAHE(barbara,3);  
my_imshow(barbara_ahe_3, 'Adaptive Histogram Equalised Barbara - window size = 3');  
barbara_ahe_201 = myAHE(barbara,201);  
my_imshow(barbara_ahe_201, 'Adaptive Histogram Equalised Barbara - window size = 201');  
  
my_imshow(TEM, 'Original TEM');  
TEM_ahe_51 = myAHE(TEM,51);  
my_imshow(TEM_ahe_51, 'Adaptive Histogram Equalised TEM - window size = 51');  
TEM_ahe_3 = myAHE(TEM,3);  
my_imshow(TEM_ahe_3, 'Adaptive Histogram Equalised TEM - window size = 3');  
TEM_ahe_201 = myAHE(TEM,201);  
my_imshow(TEM_ahe_201, 'Adaptive Histogram Equalised TEM - window size = 201');  
  
% canyon_avg_ahe = myAHE(canyon,'avg');  
my_imshow(canyon, 'Original Canyon');
```

```

canyon_ahe_51 = myAHE(canyon,51);
my_imshow((canyon_ahe_51)/255, 'Independent channel Adaptive Histogram Equalised Canyon- window');
canyon_ahe_3 = myAHE(canyon,3);
my_imshow((canyon_ahe_3)/255, 'Independent channel Adaptive Histogram Equalised Canyon- window');
canyon_ahe_201 = myAHE(canyon,201);
my_imshow((canyon_ahe_201)/255, 'Independent channel Adaptive Histogram Equalised Canyon- window');
toc;

```

Q2(e) Contrast-limited Adaptive Histogram Equalisation`

```

% Contrast-limited Adaptive Histogram Equalisation`tic;
my_imshow(barbara, "Original Barbara");
barbara_thresh = 0.05;
barbara_clahe_51 = myCLAHE(barbara,51,barbara_thresh);
my_imshow(barbara_clahe_51, 'CL-Adaptive Histogram Equalised Barbara');
barbara_clahe_half = myCLAHE(barbara,51,barbara_thresh/2);
my_imshow(barbara_clahe_half, 'CL-Adaptive Histogram Equalised Barbara');

my_imshow(TEM, 'Original TEM');
TEM_thresh = 0.05;
TEM_clahe_51 = myCLAHE(TEM,51,TEM_thresh);
my_imshow(TEM_clahe_51, 'CL-Adaptive Histogram Equalised TEM');
TEM_clahe_half = myCLAHE(TEM,51,TEM_thresh/2);
my_imshow(TEM_clahe_half, 'CL-Adaptive Histogram Equalised TEM');

my_imshow(canyon, 'Original Canyon');
canyon_thresh = 0.05;
canyon_clahe_51 = myCLAHE(canyon,51,canyon_thresh);
my_imshow((canyon_clahe_51)/255, 'Independent channel CL-Adaptive Histogram Equalised Canyon');
canyon_clahe_half = myCLAHE(canyon,51,canyon_thresh/2);
my_imshow((canyon_clahe_half)/255, 'Independent channel CL-Adaptive Histogram Equalised Canyon');
toc;

```

```
toc;
```