Question 2

Table of Contents

Objectives:

- Linear Contrast Stretching
- Histogram Equalization (HE)
- Adaptive Histogram Equalization (AHE)
- Contrast-Limited Adaptive Histogram Equalization (CLAHE)

Colormap and Helper Functions

```
myNumOfColors= 256;
myColorScale = [ [0:1/(myNumOfColors-1):1]' , [0:1/(myNumOfColors-1):1]' , [0:1/(m
displayGrayScale = @(image, title) displayImageWithColorBar(image, title, myColorS
displayColoredImage = @(image, title) displayImageWithColorBar(image, title, myCol
```

Lambda functions for AHE with low, medium and High window size

```
myAHEforLowWindowSize = @(image) myAHE(image, 2);
myAHEforMediumWindowSize = @(image) myAHE(image, 20);
myAHEforLargeWindowSize = @(image) myAHE(image, 100);
```

Lambda functions for CLAHE with

```
myCLAHEWithMediumWindowSize = @(image) myCLAHE(image, 20, 0.05);
myCLAHEWithMediumWindowSizeAndHalfThreshold = @(image) myCLAHE(image, 20, 0.01);
```

Input files

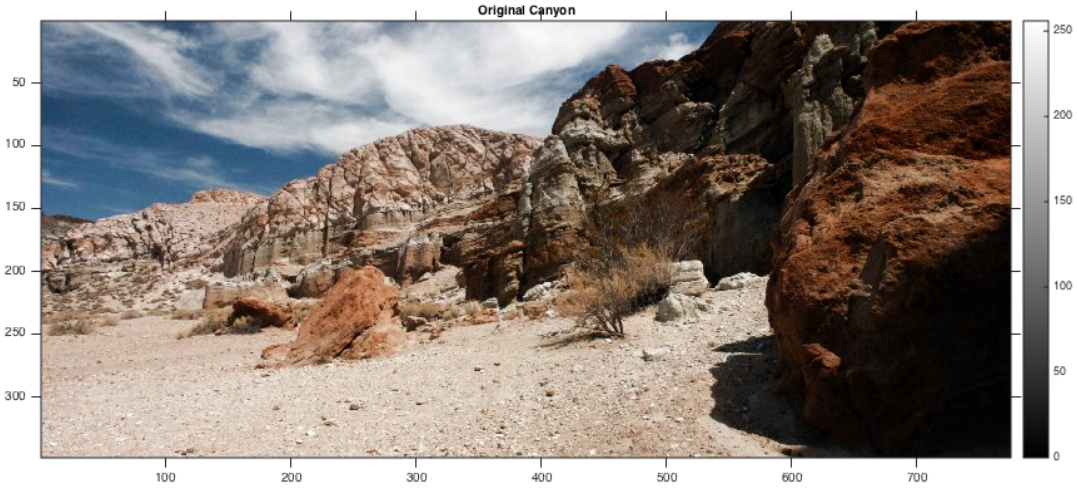
```
barbara_filename = '../data/barbara.png';
canyon_filename = '../data/canyon.png';
tem_filename = '../data/TEM.png';

barbara = imread(barbara_filename);
canyon = imread(canyon_filename);
tem = imread(tem_filename);
```

Original Barbara

```
displayGrayScale(barbara, 'Original Barbara');
```

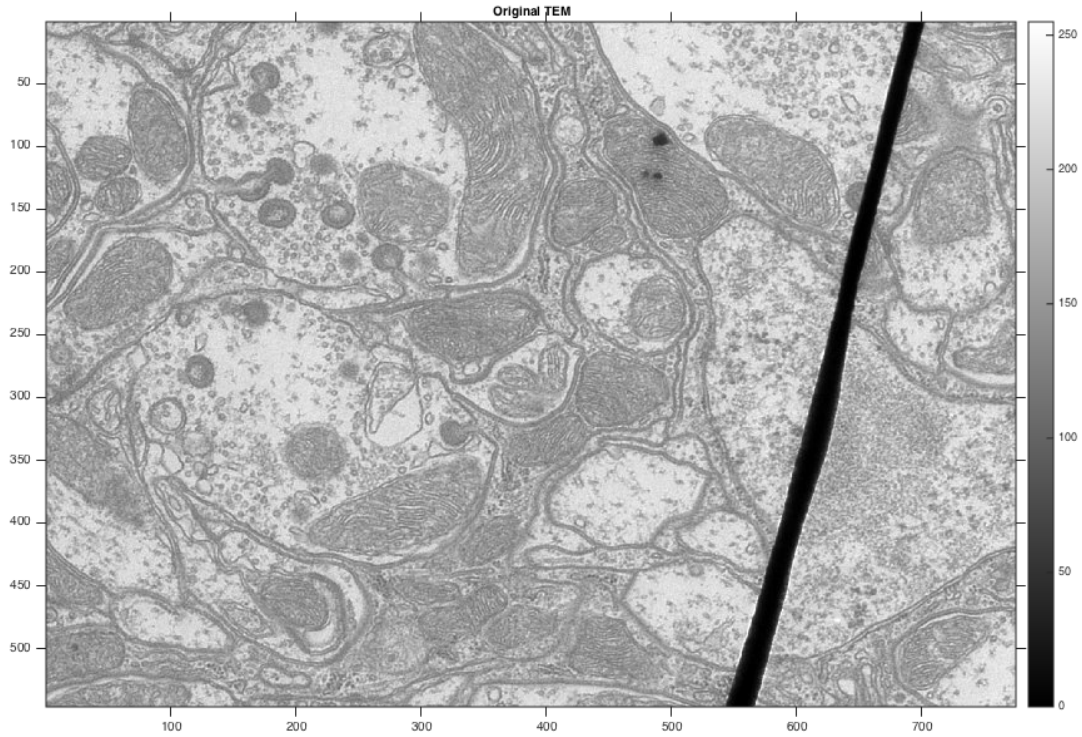
Original Canyon

```
displayColoredImage(canyon, 'Original Canyon');
```



Original TEM

```
displayGrayScale(tem, 'Original TEM');
```



Linear Contrast Stretching

Psuedocode:

```
min := min(image)
max := max(image)

if (min is not equal to max):
    for every point p in image:
        I(p) := 255 * ((I(p) - min) / (max - min))
```

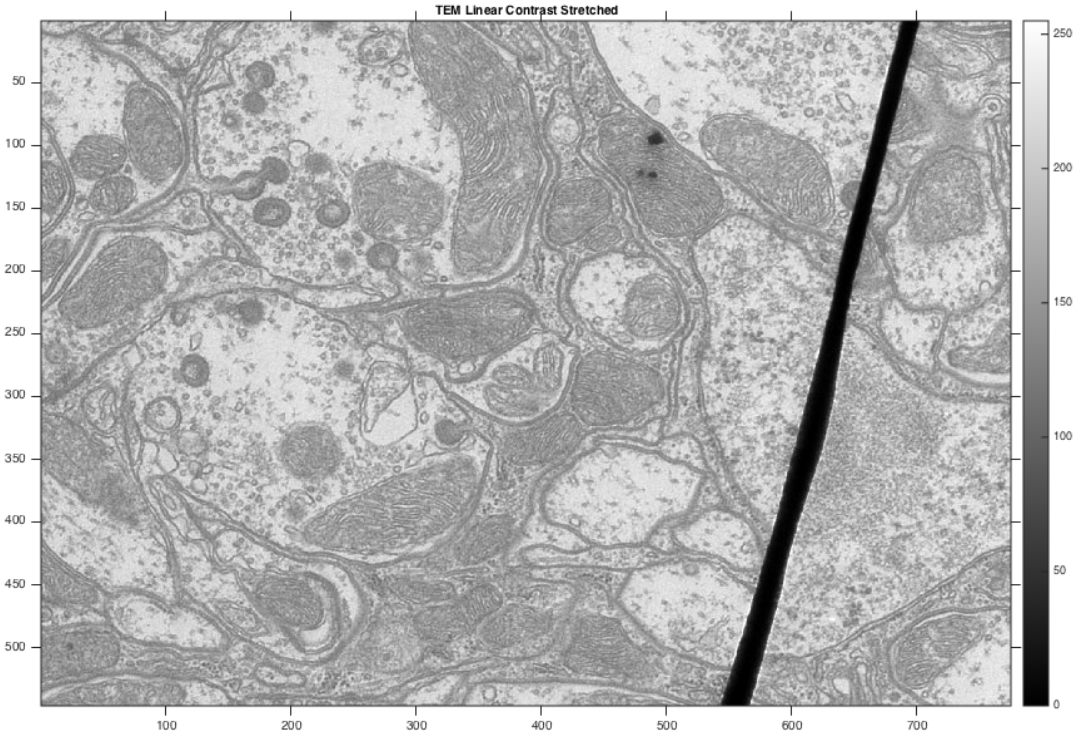
Barbara Linear Contrast Stretched

```
tic;
barbara_linear = myLinearContrastStretching(barbara);
toc;
displayGrayScale(barbara_linear, 'Barbara Linear Contrast Stretched');

Elapsed time is 0.023086 seconds.
```

TEM Linear Contrast Stretched

```
tic;
tem_linear = myLinearContrastStretching(tem);
toc;
displayGrayScale(tem_linear, 'TEM Linear Contrast Stretched');
```

Elapsed time is 0.043869 seconds.



Canyon Linear Contrast Stretched

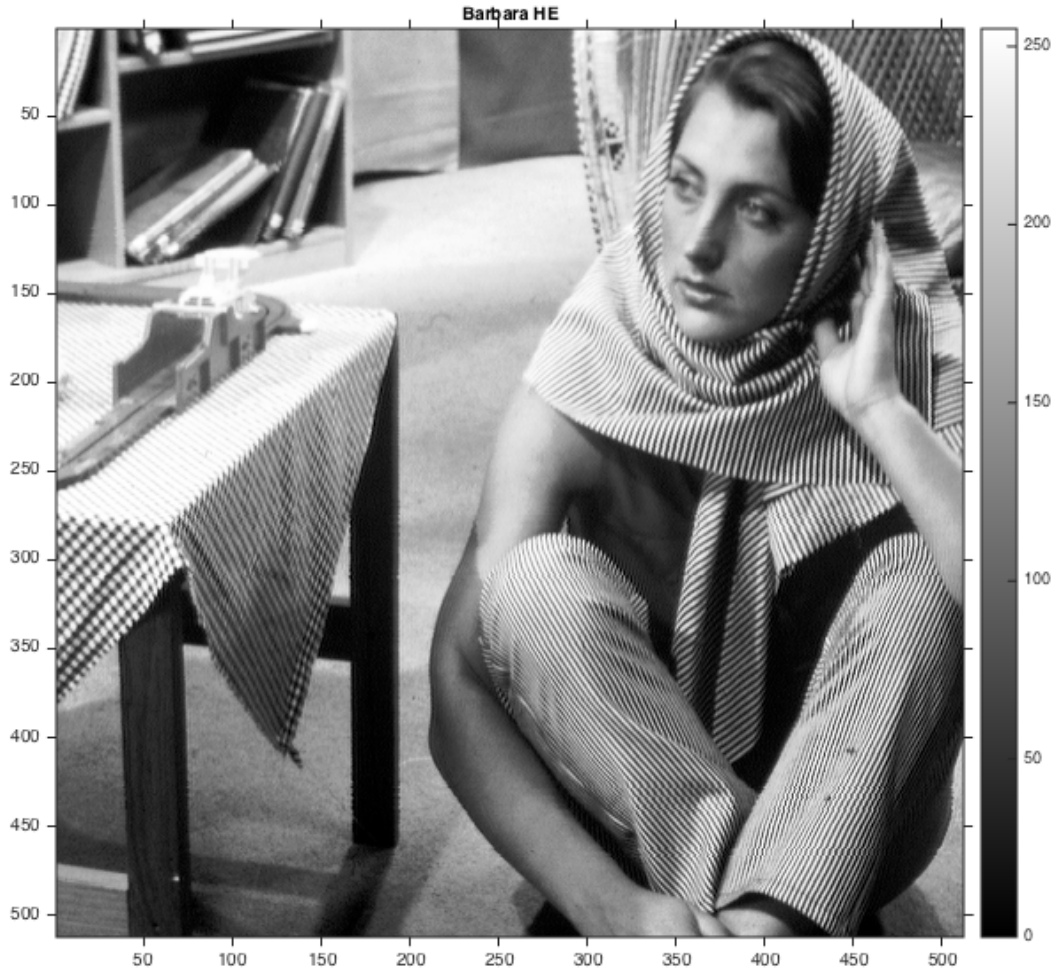
```
tic;
canyon_linear = processColoredImage(canyon, @myLinearContrastStretching);
toc;
displayColoredImage(canyon_linear, 'Canyon Linear Contrast Stretched');
```

```
Elapsed time is 0.073332 seconds.
```

Histogram Equilization (HE)

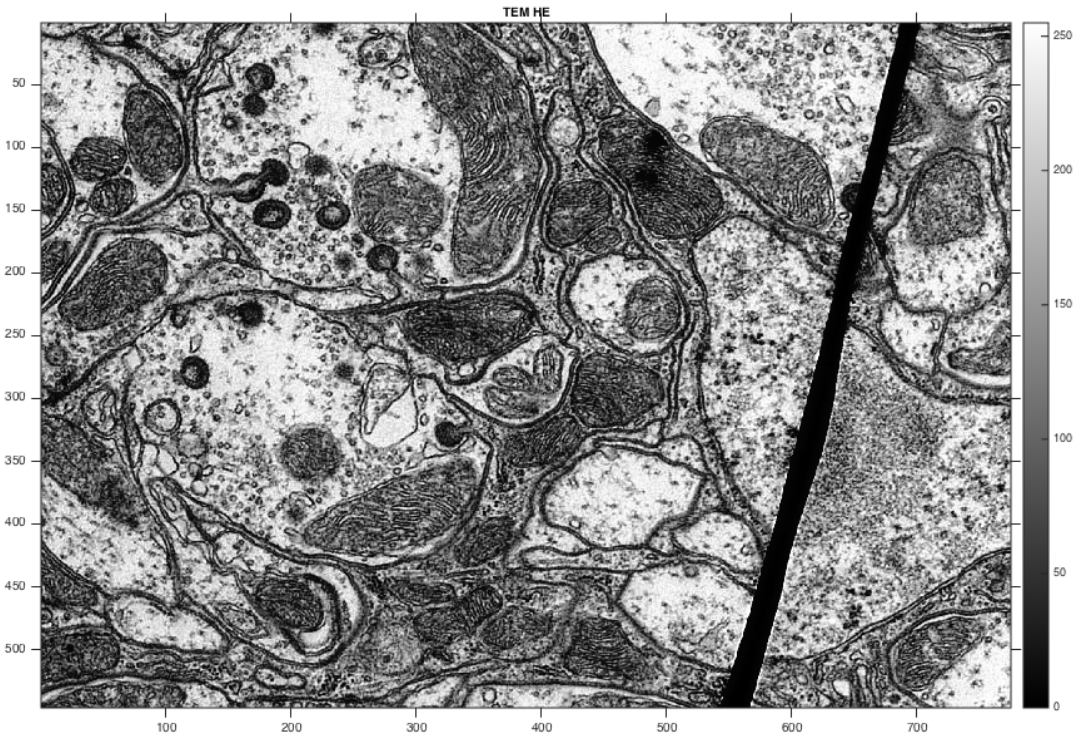
Barbara HE

```
tic;
barbara_he = myHE(barbara);
toc;
displayGrayScale(barbara_he, 'Barbara HE');

Elapsed time is 0.342726 seconds.
```



TEM He

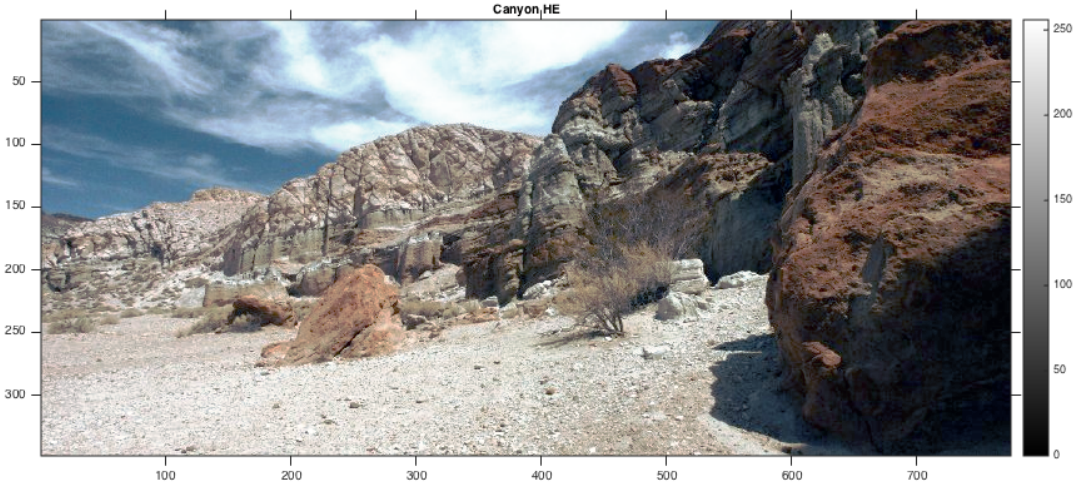
```
tic;
tem_he = myHE(tem);
toc;
displayGrayScale(tem_he, 'TEM HE');

Elapsed time is 0.022737 seconds.
```



Canyon HE

```
tic;
canyon_he = processColoredImage(canyon, @myHE);
toc;
displayColoredImage(canyon_he, 'Canyon HE');
```

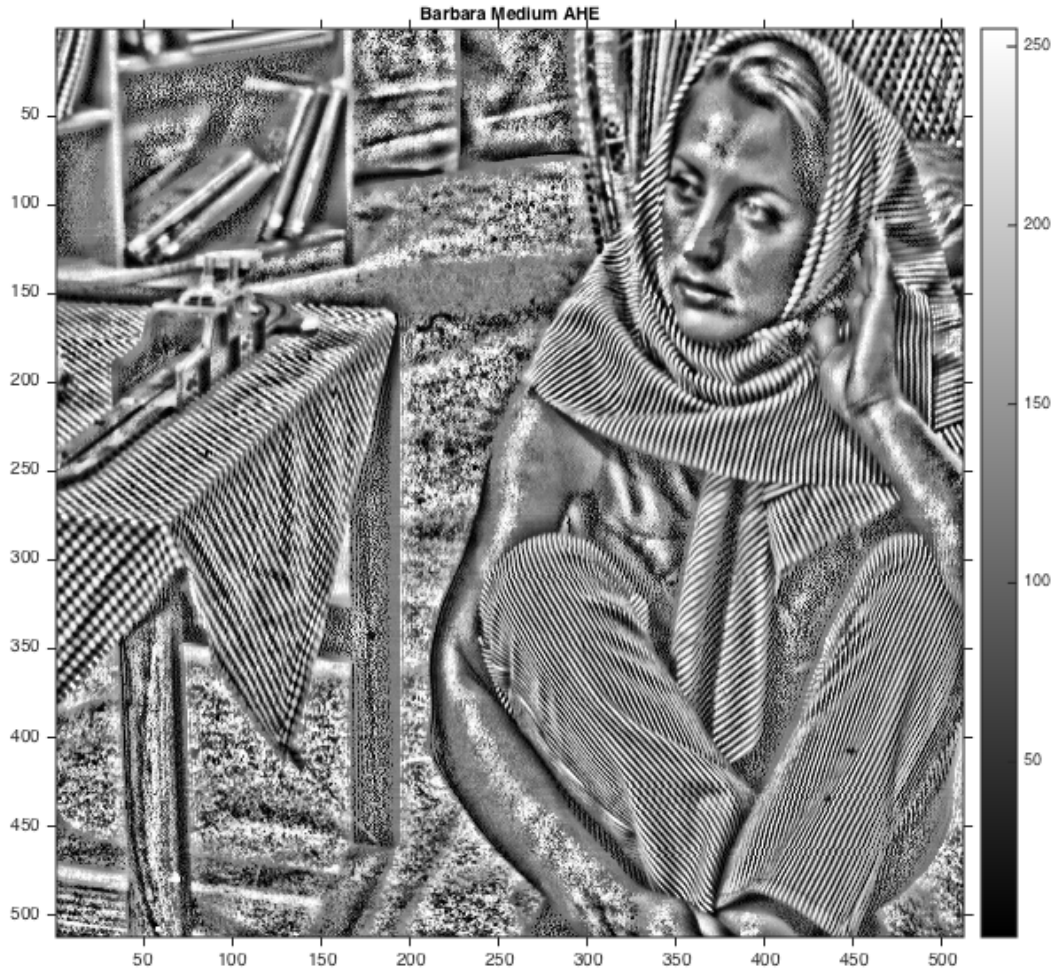
```
Elapsed time is 0.036766 seconds.
```



Adaptive Histogram Equalization (AHE)

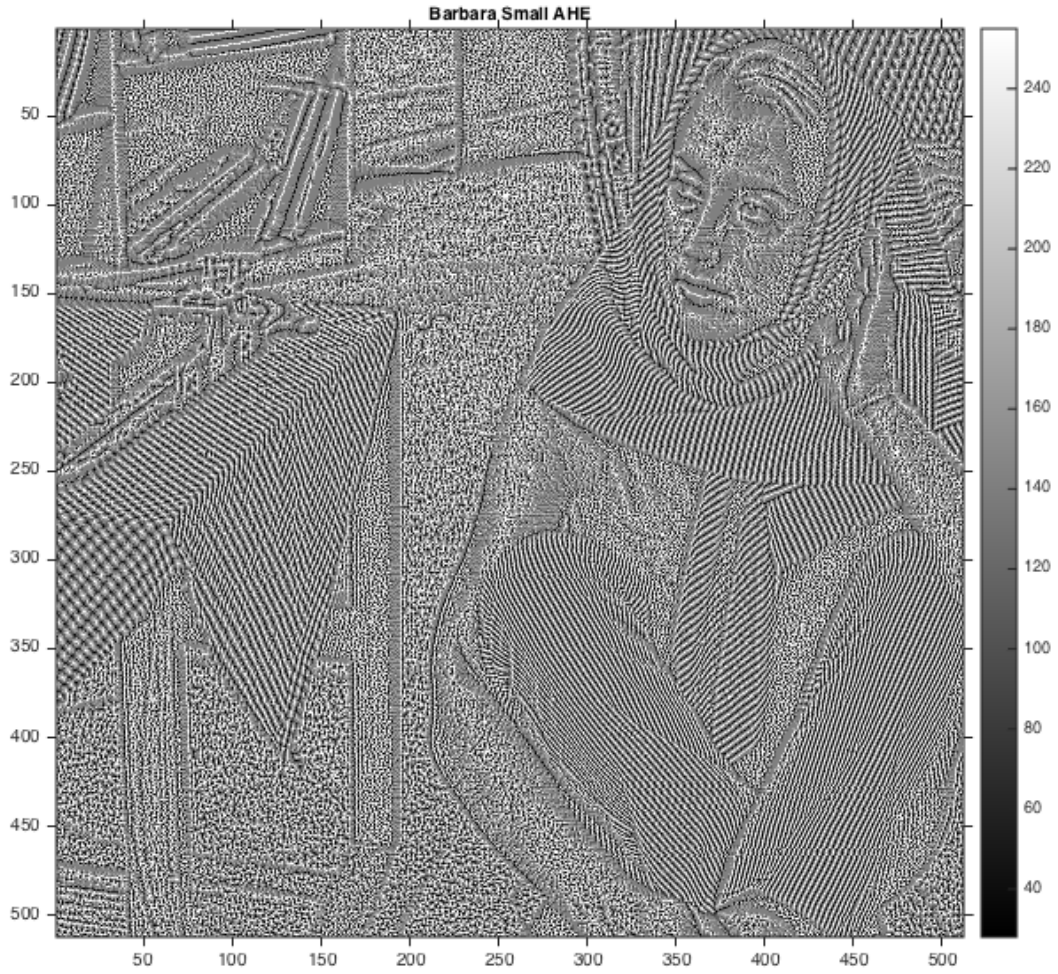
Barbara AHE With Medium Window Size

```
tic;
barbara_medium_ahe = myAHEforMediumWindowSize(barbara);
elapsedTime = toc;
if elapsedTime > 300
    save('../images/barbara_medium_ahe.mat', 'barbara_medium_ahe');
end
displayGrayScale(barbara_medium_ahe, 'Barbara Medium AHE');
```



Barbara AHE With Small Window Size

```
tic;
barbara_small_ahe = myAHEforLowWindowSize(barbara);
elapsedTime = toc;
if elapsedTime > 300
    save('../images/barbara_small_ahe.mat', 'barbara_small_ahe');
end
displayGrayScale(barbara_small_ahe, 'Barbara Small AHE');
```

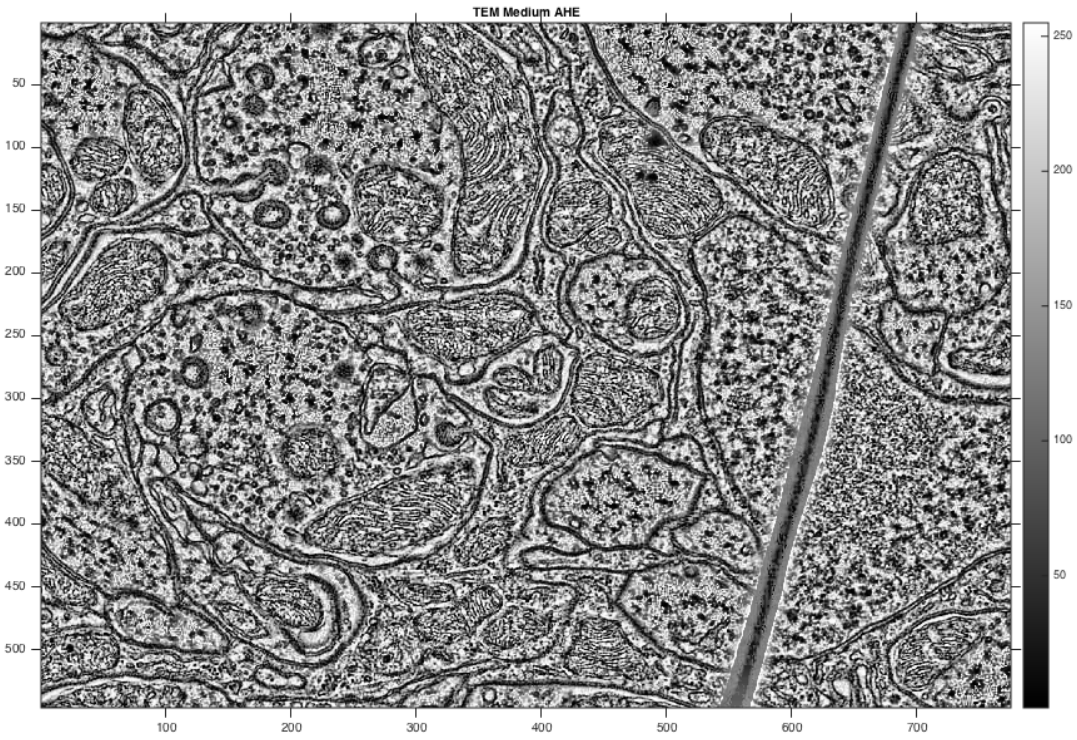


Barbara AHE With Large Window Size

```
tic;
barbara_large_ahe = myAHEforLargeWindowSize(barbara);
elapsedTime = toc;
if elapsedTime > 300
    save('../images/barbara_large_ahe.mat', 'barbara_large_ahe');
end
displayGrayScale(barbara_large_ahe, 'Barbara Large AHE');
```

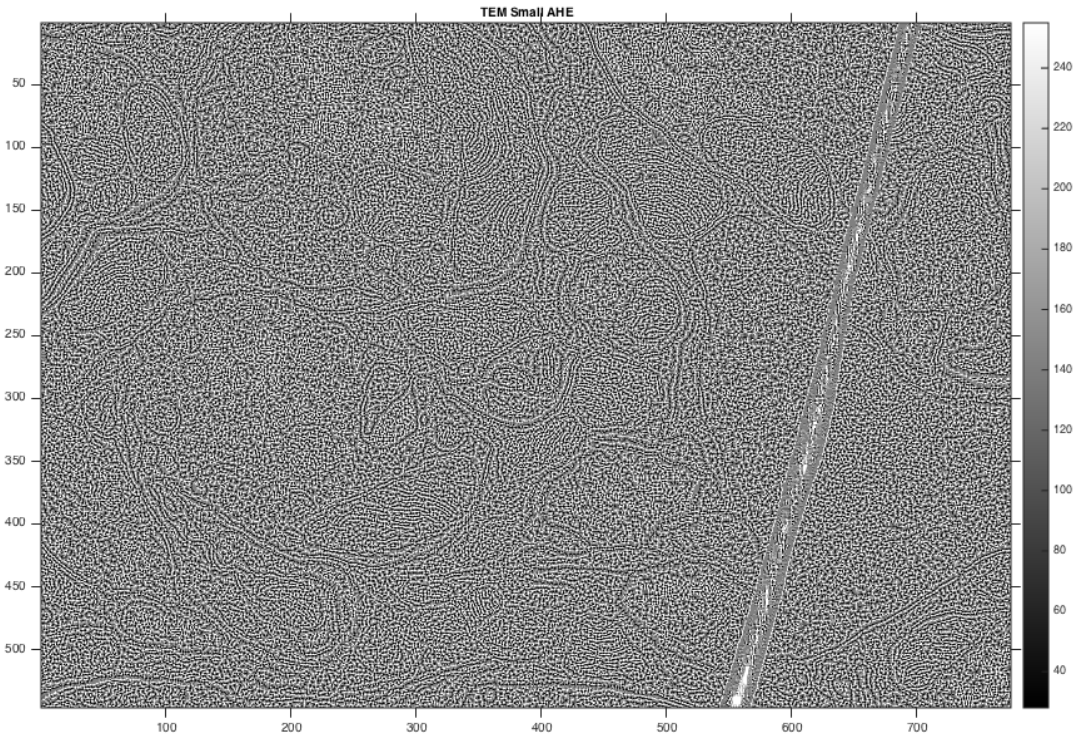
TEM AHE With Medium Window Size

```
tic;
tem_medium_ahe = myAHEforMediumWindowSize(tem);
elapsedTime = toc;
if elapsedTime > 300
    save('../images/tem_medium_ahe.mat', 'tem_medium_ahe');
end
displayGrayScale(tem_medium_ahe, 'TEM Medium AHE');
```



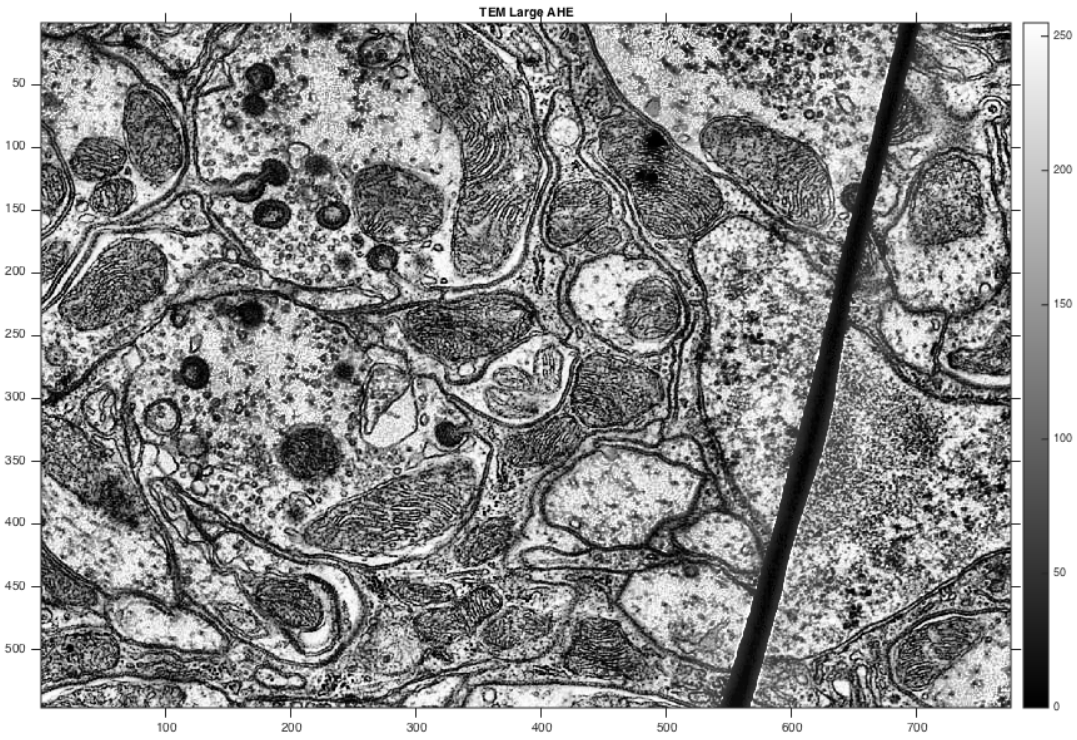
TEM AHE With Small Window Size

```
tic;
tem_small_ahe = myAHEforLowWindowSize(tem);
elapsedTime = toc;
if elapsedTime > 300
    save('../images/tem_small_ahe.mat', 'tem_small_ahe');
end
displayGrayScale(tem_small_ahe, 'TEM Small AHE');
```



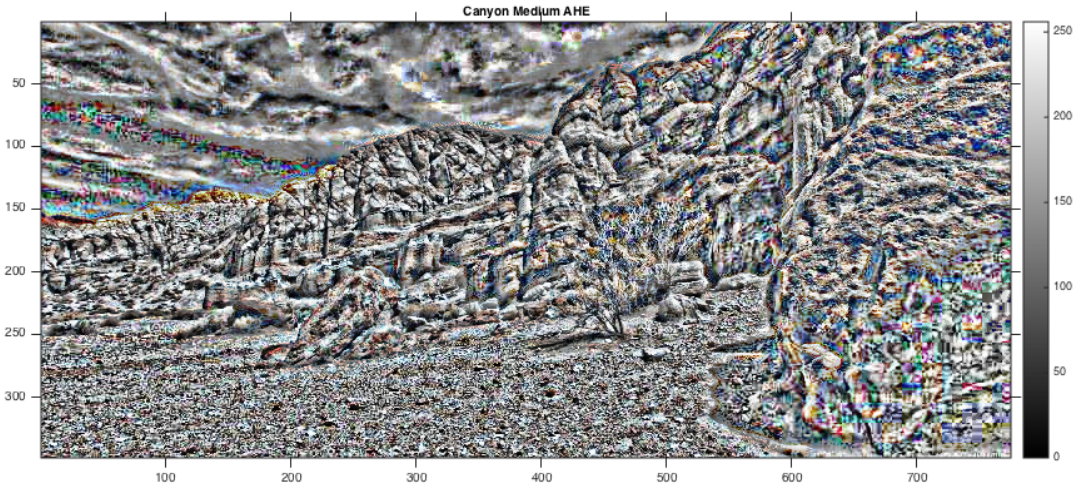
TEM AHE With Large Window Size

```
tic;
tem_large_ahe = myAHEforLargeWindowSize(tem);
elapsedTime = toc;
if elapsedTime > 300
    save('../images/tem_large_ahe.mat', 'tem_large_ahe');
end
displayGrayScale(tem_large_ahe, 'TEM Large AHE');
```



Canyon AHE with medium Window Size

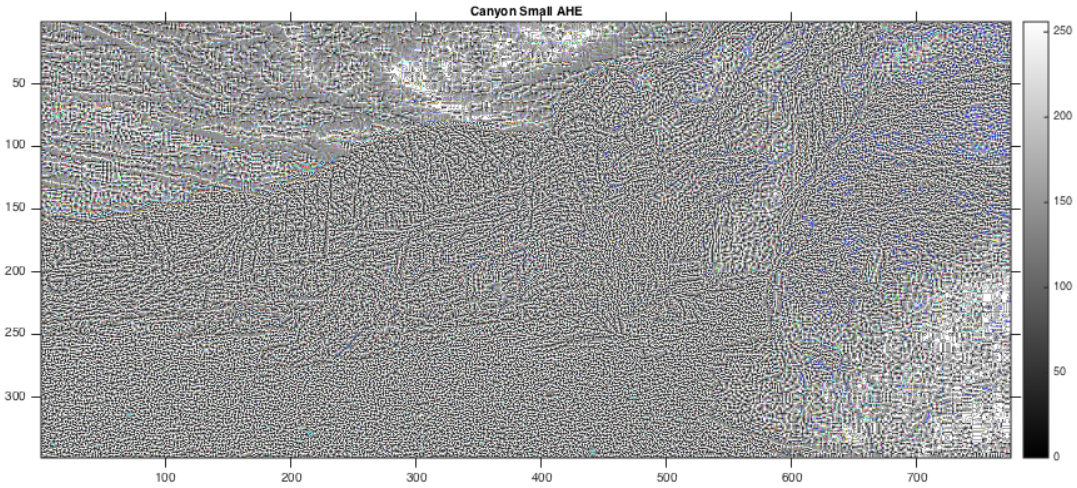
```
tic;
canyon_medium_ahe = processColoredImage(canyon, @(image) myAHEforMediumWindowSize(
elapsedTime = toc;
if elapsedTime > 300
    save('../images/canyon_medium_ahe.mat', 'canyon_medium_ahe');
end
displayColoredImage(canyon_medium_ahe, 'Canyon Medium AHE');
```



Canyon AHE with medium Window Size

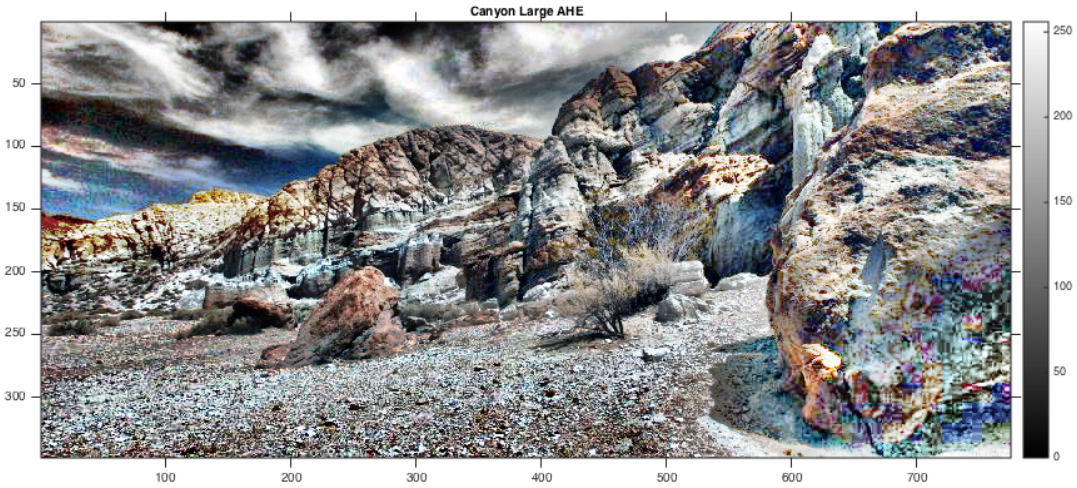
```
tic;
```

```
canyon_small_ahe = processColoredImage(canyon, @(image) myAHEforLowWindowSize(imag
elapsedTime = toc;
if elapsedTime > 300
    save('../images/canyon_small_ahe.mat', 'canyon_small_ahe');
end
displayColoredImage(canyon_small_ahe, 'Canyon Small AHE');
```



Canyon AHE with Large Window Size

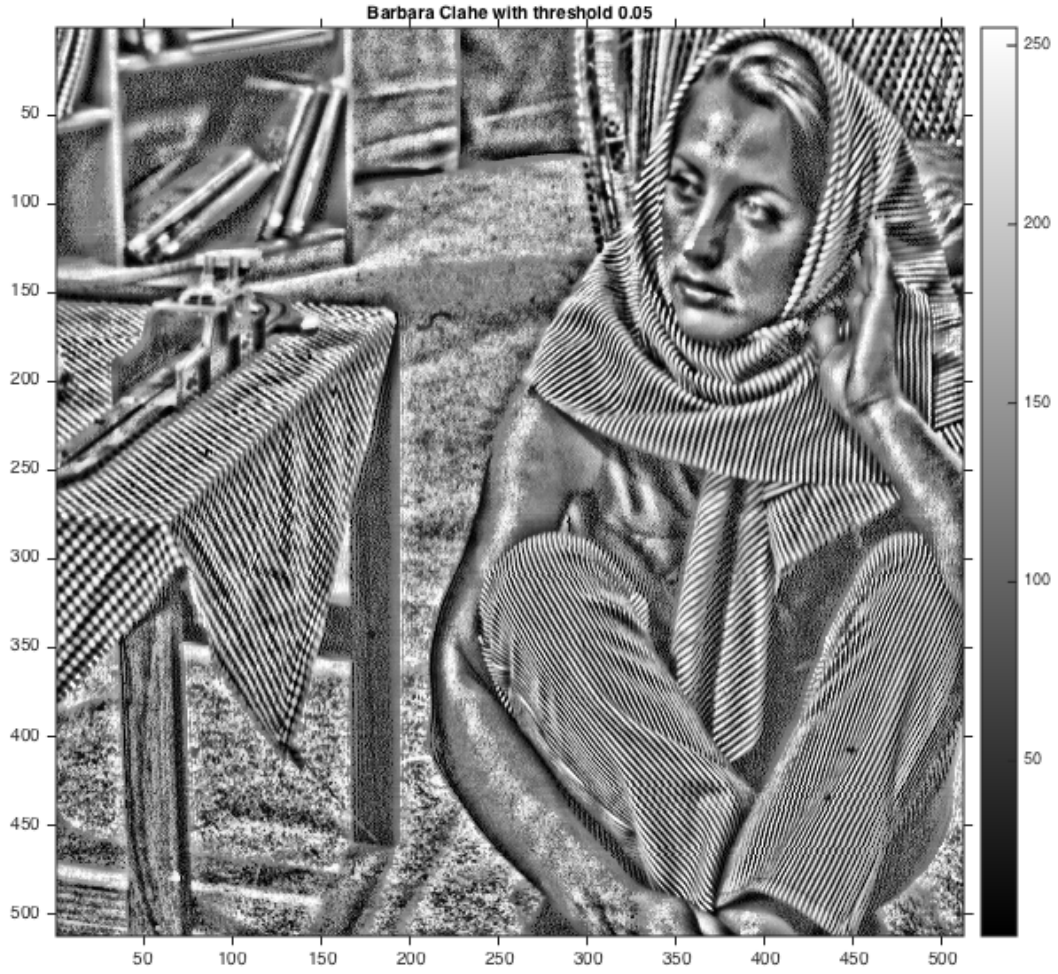
```
tic;
canyon_large_ahe = processColoredImage(canyon, @(image) myAHEforLargeWindowSize(im
elapsedTime = toc;
if elapsedTime > 300
    save('../images/canyon_large_ahe.mat', 'canyon_large_ahe');
end
displayColoredImage(canyon_large_ahe, 'Canyon Large AHE');
```



Contrast-Limited Adaptive Histogram Equalization (CLAHE)

Barbara CLAHE with 0.05 Threshold

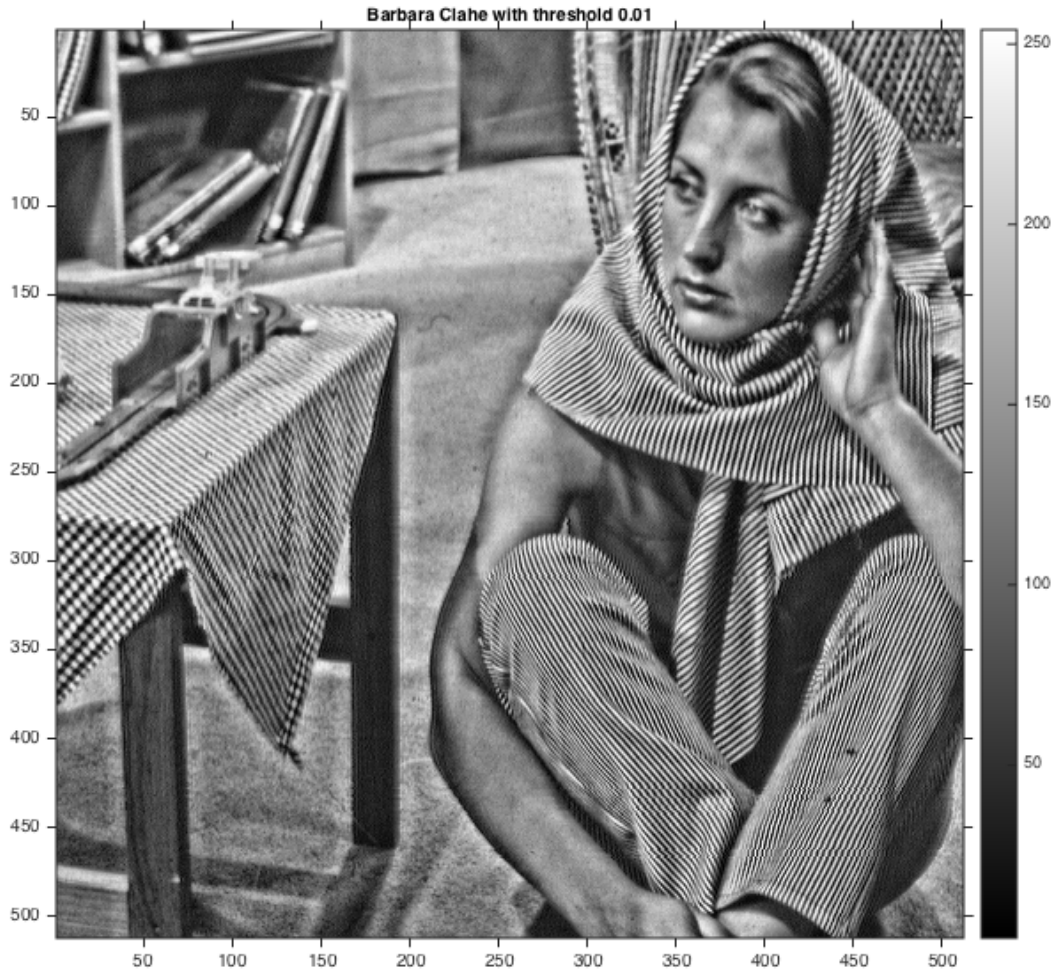
```
tic;
barbara_clahe_high = myCLAHEWithMediumWindowSize(barbara);
elapsedTime = toc;
if elapsedTime > 300
    save('../images/barbara_clahe_high.mat', 'barbara_clahe_high');
end
displayGrayScale(barbara_clahe_high, 'Barbara Clahe with threshold 0.05');
```



Barbara CLAHE with 0.01 Threshold

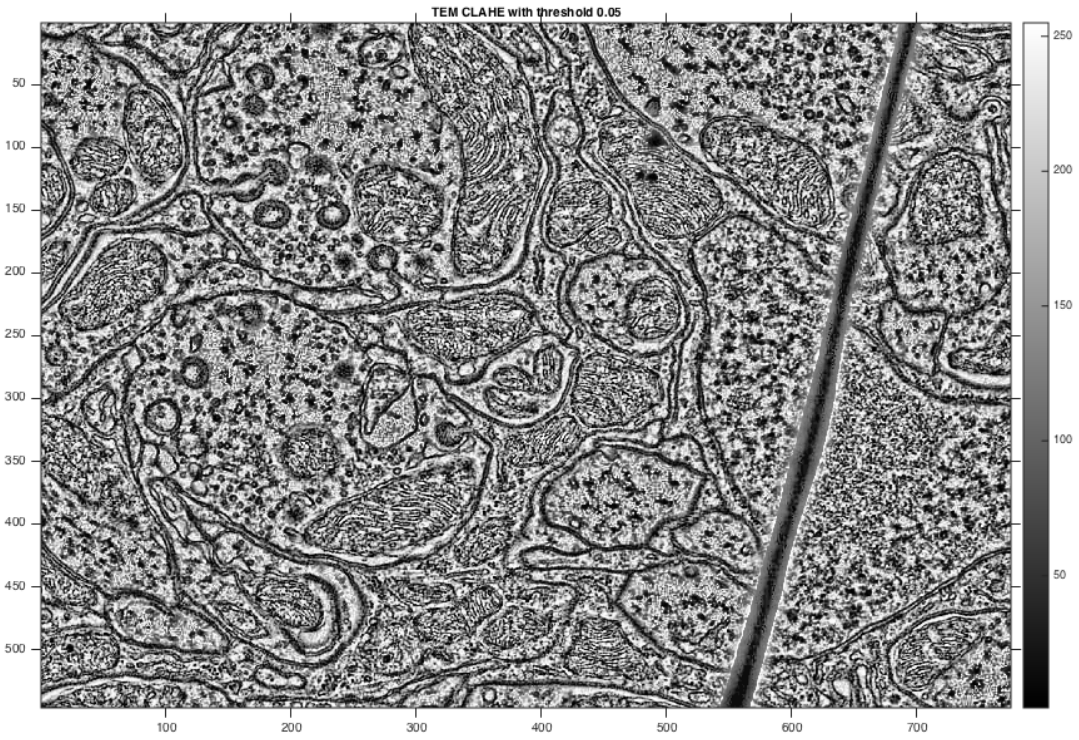
```
tic;
barbara_clahe_low = myCLAHEWithMediumWindowSizeAndHalfThreshold(barbara);
elapsedTime = toc;
if elapsedTime > 300
    save('../images/barbara_clahe_low.mat', 'barbara_clahe_low');
```

```
end
displayGrayScale(barbara_clahe_low, 'Barbara Clahe with threshold 0.01');
```



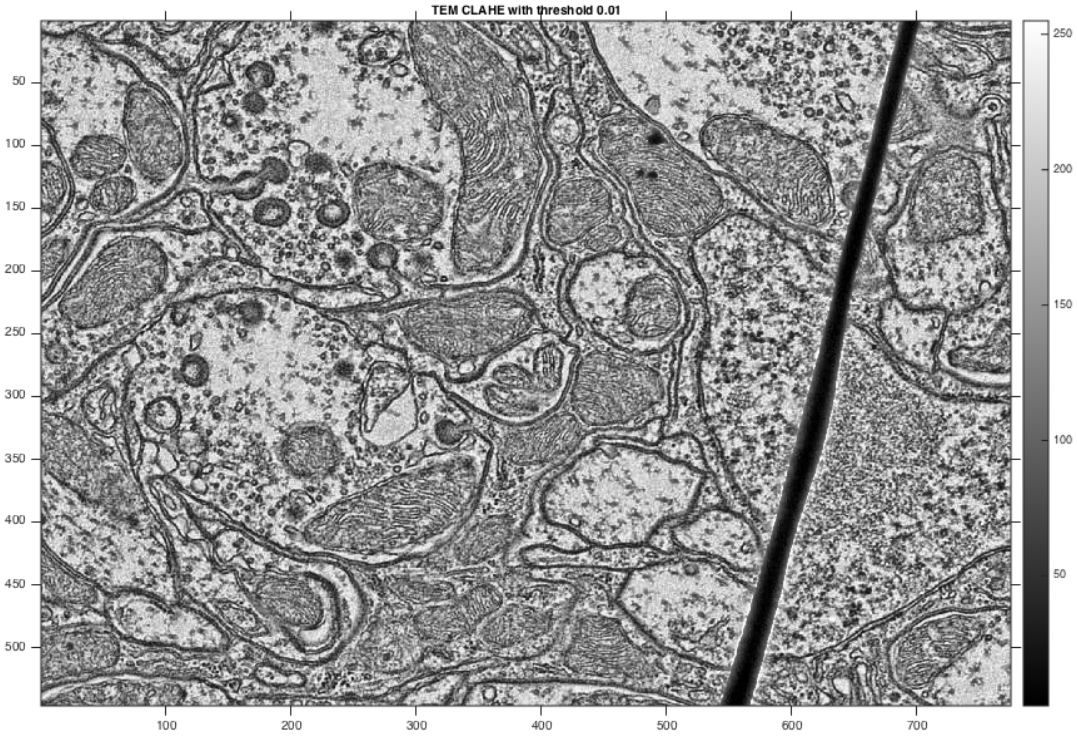
TEM CLAHE with 0.05 Threshold

```
tic;
tem_clahe_high = myCLAHEWithMediumWindowSize(tem);
elapsedTime = toc;
if elapsedTime > 300
    save('../images/tem_clahe_high.mat', 'tem_clahe_high');
end
displayGrayScale(tem_clahe_high, 'TEM CLAHE with threshold 0.05');
```



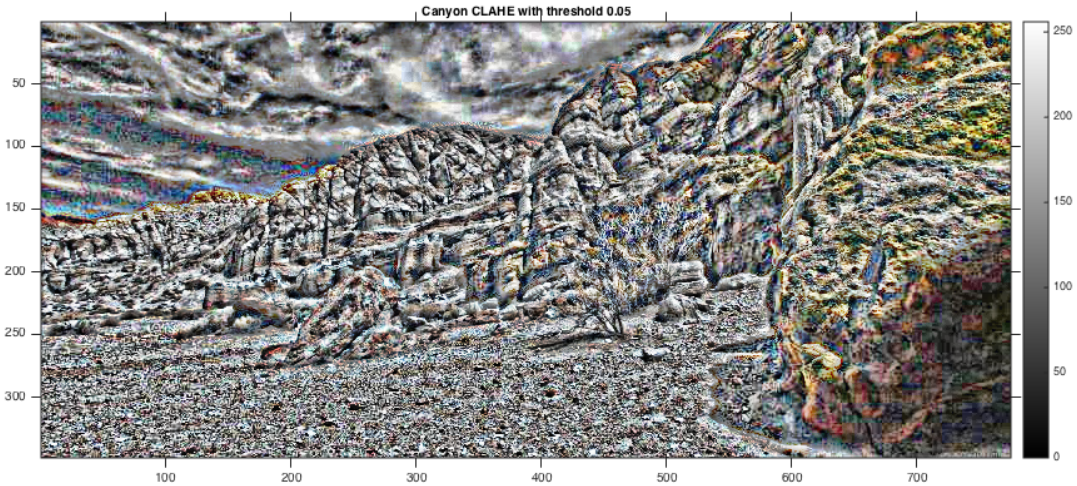
TEM CLAHE with 0.01 Threshold

```
tic;
tem_clahe_low = myCLAHEWithMediumWindowSizeAndHalfThreshold(tem);
elapsedTime = toc;
if elapsedTime > 300
    save('../images/tem_clahe_low.mat', 'tem_clahe_low');
end
displayGrayScale(tem_clahe_low, 'TEM CLAHE with threshold 0.01');
```



Canyon CLAHE with 0.05 Threshold

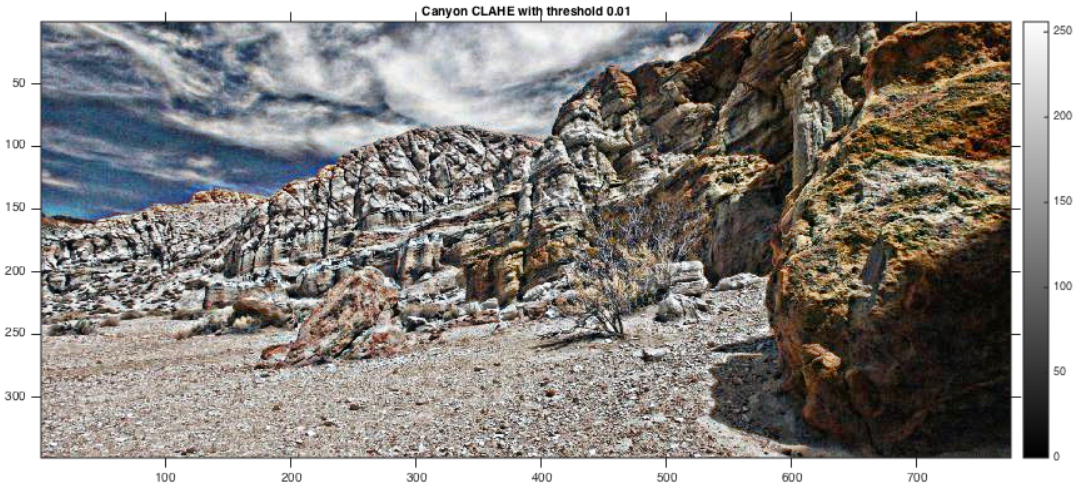
```
tic;
canyon_clahe_high = processColoredImage(canyon, @(img) myCLAHEWithMediumWindowSize
elapsedTime = toc;
if elapsedTime > 300
    save('../images/canyon_clahe_high.mat', 'tem_clahe_high');
end
displayGrayScale(canyon_clahe_high, 'Canyon CLAHE with threshold 0.05');
```



Canyon CLAHE with 0.01 Threshold

```
tic;
```

```
canyon_clahe_low = processColoredImage(canyon, @(img) myCLAHEWithMediumWindowSizeA
elapsedTime = toc;
if elapsedTime > 300
    save('../images/canyon_clahe_low.mat', 'tem_clahe_low');
end
displayGrayScale(canyon_clahe_low, 'Canyon CLAHE with threshold 0.01');
```



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