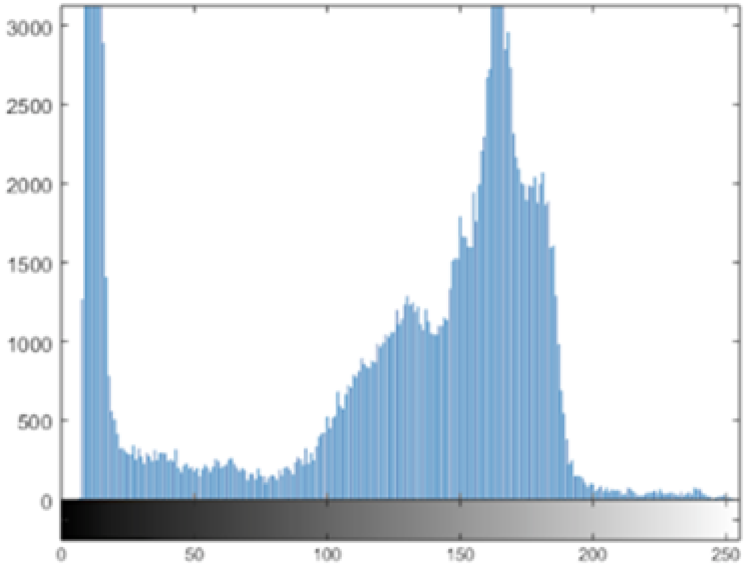
Module 1b: Analyzing your image - The Histogram

Histogram



Open CV Histogram Guide

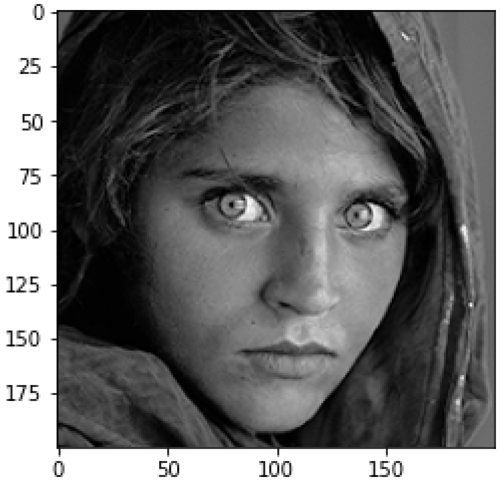
We need tools to analyze the information contained in images. One of the main tools used in any image processing for this task is the **Histogram**. A **Histogram** is a plot of the brightness (intensity) distribution of an image which in our case has a range of 0 to 255 (8-bit). The X-axis corresponds to the brightness value and the Y-axis corresponds to the number of pixels at the given brightness in the image.

In [ ]:

```
#Import Libraries
import cv2
import numpy as np
import matplotlib.pyplot as plt

#Saving an image. 0 for grayscale. 1 for color. -1 for color with a alpha channe
img = cv2.imread('Graphics/face.png', 1)


#OpenCV by defualt uses BGR instead of RGB.  BGR is an old digital camera standa
img = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

#Use matplotlib while using a python notebook
plt.imshow(img, cmap='gray')
```

Out[ ]:

```
<matplotlib.image.AxesImage at 0x7fb826484a30>
```



So now we use cv2.calcHist() function to find the histogram. Let's familiarize ourselves with the function and its parameters :

```
cv2.calcHist(image, channels, mask, histSize, ranges)
```

- **image** : it is the source image of type uint8 or float32. it should be given in square brackets, ie, "[img]".
- **channels** : it is also given in square brackets. It is the index of channel for which we calculate histogram. For example, if input is grayscale image, its value is [0]. For color image, you can pass [0], [1] or [2] to calculate histogram of blue, green or red channel respectively.
- **mask** : mask image. To find histogram of full image, it is given as "None". But if you want to find histogram of particular region of image, you have to create a mask image for that and give it as mask. (I will show an example later.)
- **histSize** : this represents our BIN count. Need to be given in square brackets. For full scale, we pass [256].
- **ranges** : this is our RANGE. Normally, it is [0,255].

In [ ]:

```
print(img.shape)

# 2D array only containing on value for the brightness.
```

```
(200, 200)
```

Plot the 1-D histogram using Open CV

In [ ]:

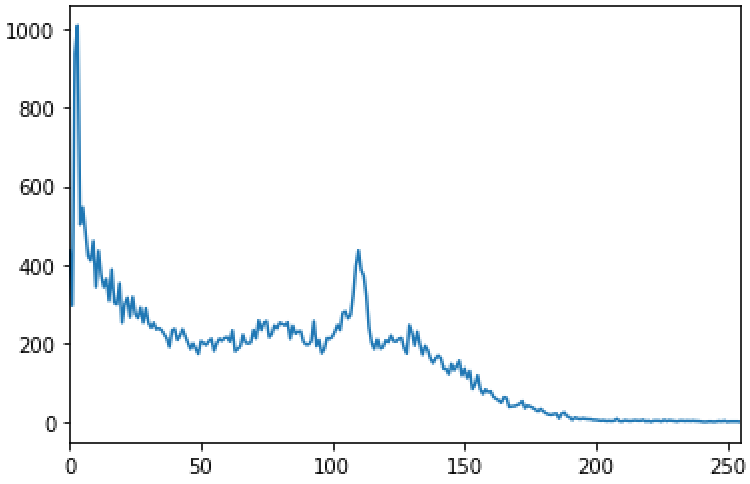
```
hist = cv2.calcHist([img],[0],None,[256],[0,255])
print(hist.shape)
```

```
(256, 1)
```

In [ ]:

```
# Plot the histogram
plt.plot(hist)
# Limit the range to 0, 255
plt.xlim([0,255])
```

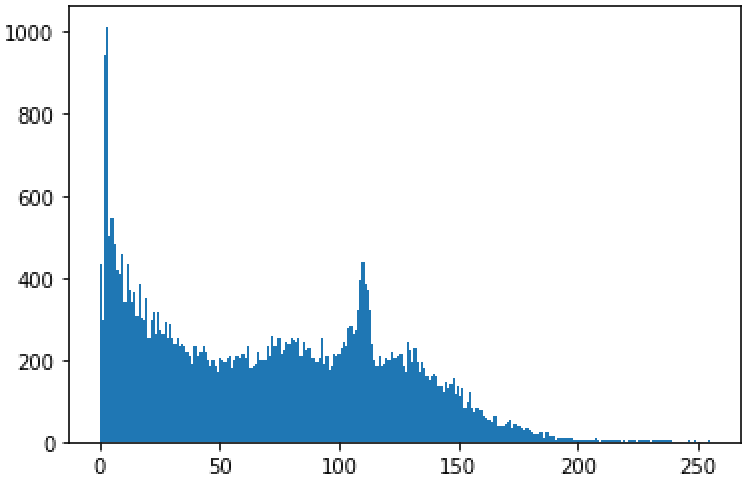
```python
# Show the plot
plt.show()
```



Plot the histogram using MatPlotLib

In [ ]:

```python
plt.hist(img.ravel(),256,[0,255]); plt.show()
```



In [ ]:

```python
# ravel() flattens a multi-dimensional array into a 1-D array.  same as reshape(

# Create a 2-D array
arrayFlat = np.array([[1,2,3,4],[5,6,7,8],[9,10,11,12]])

# This is the arrays shape
print("This is the shape of the original array:",arrayFlat.shape)

# The original array
print("The original array:")
print(arrayFlat)

# Apply ravel
arrayFlat = np.ravel(arrayFlat)

# 1-D array
print("Converted to 1-D array:")
print(arrayFlat)
```

```
This is the shape of the original array: (3, 4)
The original array:
[[ 1  2  3  4]
 [ 5  6  7  8]
 [ 9 10 11 12]]
Converted to 1-D array:
[ 1  2  3  4  5  6  7  8  9 10 11 12]
```

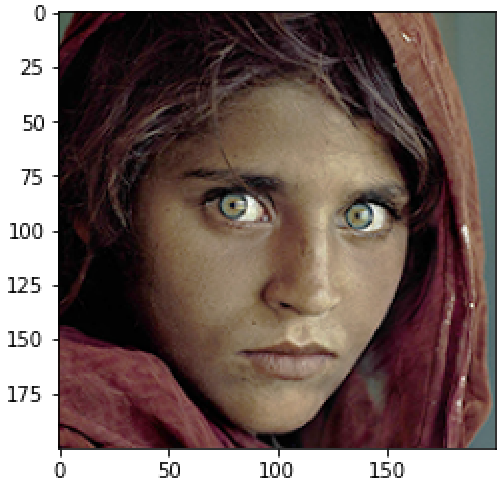
Let's plot the Histogram of a color image.

In [ ]:

```
#Saving an image. 0 for grayscale. 1 for color. -1 for color with a alpha channe
img = cv2.imread('Graphics/face.png', 1)

#OpenCV by defualt uses BGR instead of RGB.  BGR is an old digital camera standa
img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)

plt.imshow(img)
```

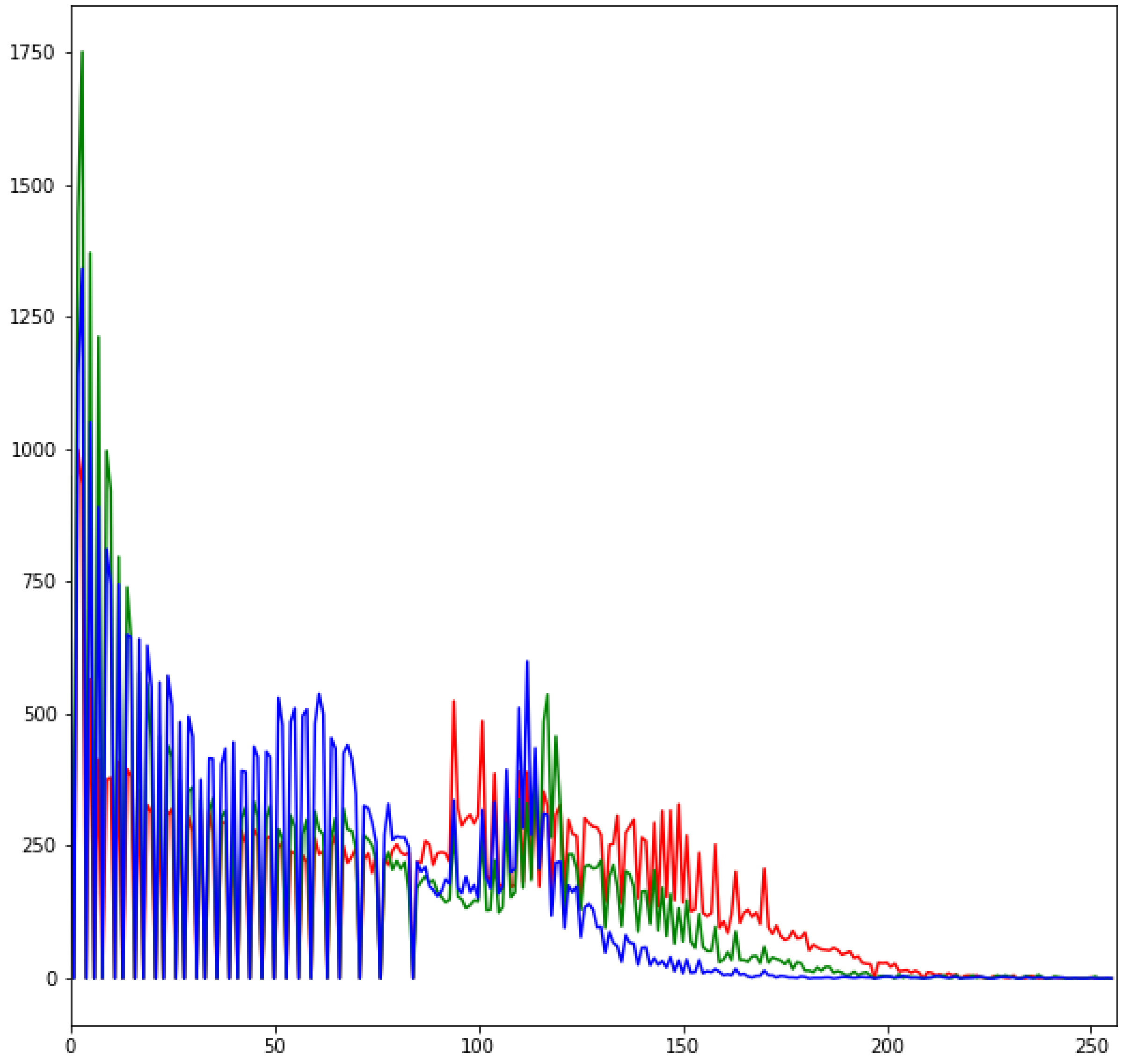
Out[ ]:

```
<matplotlib.image.AxesImage at 0x7fb8267ce820>
```



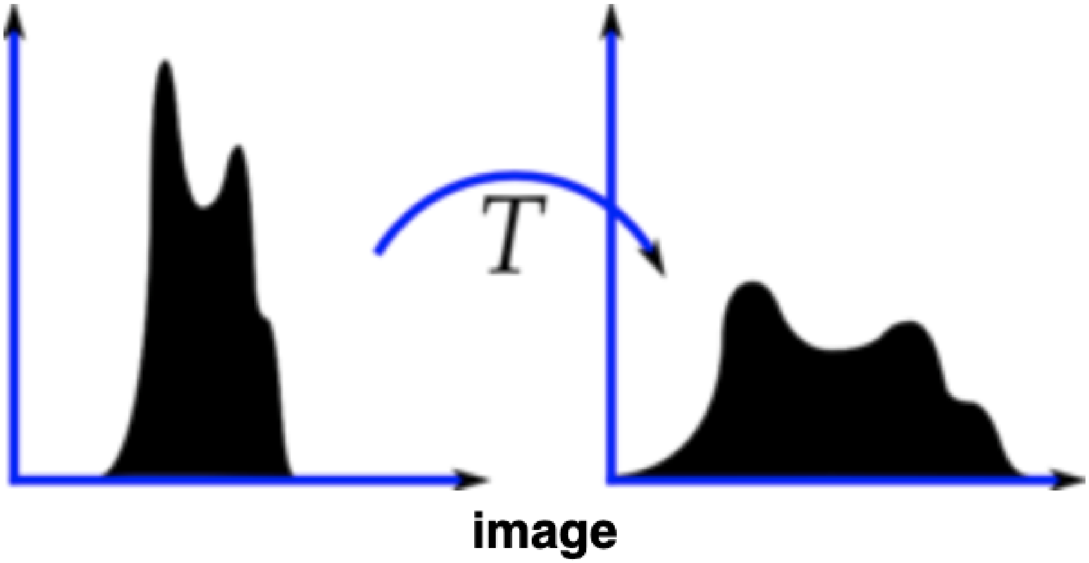
In [ ]:

```
#Saving an image. 0 for grayscale. 1 for color. -1 for color with a alpha channe
img = cv2.imread('Graphics/face.png', 1)

#OpenCV by defualt uses BGR instead of RGB.  BGR is an old digital camera standa
img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)

# Let's make the plot larger.
fig = plt.figure(figsize=(10,10))

# First plot for the red channel.
hist = cv2.calcHist([img],[0],None,[256],[0,255])
plt.plot(hist, color='red')
plt.xlim([0,256])

# Second plot for the green channel.
hist = cv2.calcHist([img],[1],None,[256],[0,255])
plt.plot(hist, color='green')
plt.xlim([0,256])

# Third plot the the blue channel.
hist = cv2.calcHist([img],[2],None,[256],[0,255])
plt.plot(hist, color='blue')
plt.xlim([0,256])

plt.show()
```



Equalization

Consider an image whose pixel values are confined to some specific range of values only. For eg, brighter image will have all pixels confined to high values. But a good image will have pixels from all regions of the image. So you need to stretch this histogram to either ends. This normally improves the contrast of the image.



In [ ]:

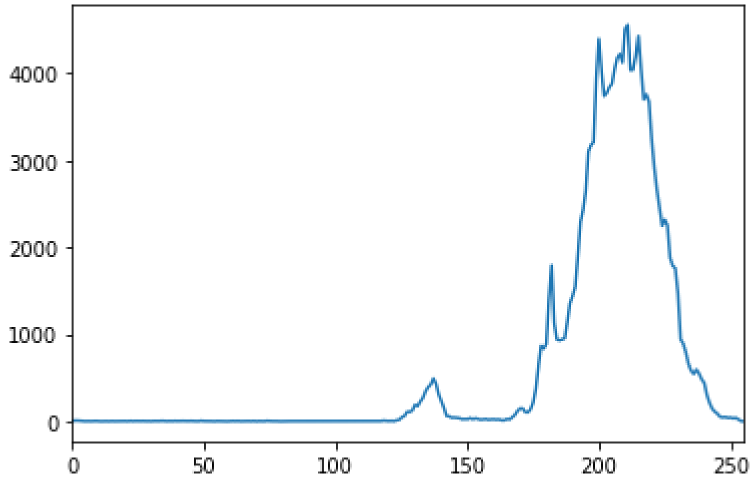
```
#Saving an image. 0 for grayscale. 1 for color. -1 for color with a alpha channe
imgContrast = cv2.imread('Graphics/lowcontrast.png', 0)

#OpenCV by defualt uses BGR instead of RGB.  BGR is an old digital camera standa
imgContrast = cv2.cvtColor(imgContrast, cv2.COLOR_BGR2RGB)

# Set the size of the plot.
fig = plt.figure(figsize = (10,10))

# Show the image as grayscale.
plt.imshow(imgContrast, cmap='gray')
```

Out[ ]:

```
<matplotlib.image.AxesImage at 0x7fb821850070>
```

In [ ]:

```
hist = cv2.calcHist([imgContrast],[0],None,[256],[0,255])
# Plot the hitogram
plt.plot(hist)
# Limit the range to 0, 255
plt.xlim([0,255])
# Show the plot
plt.show()
```



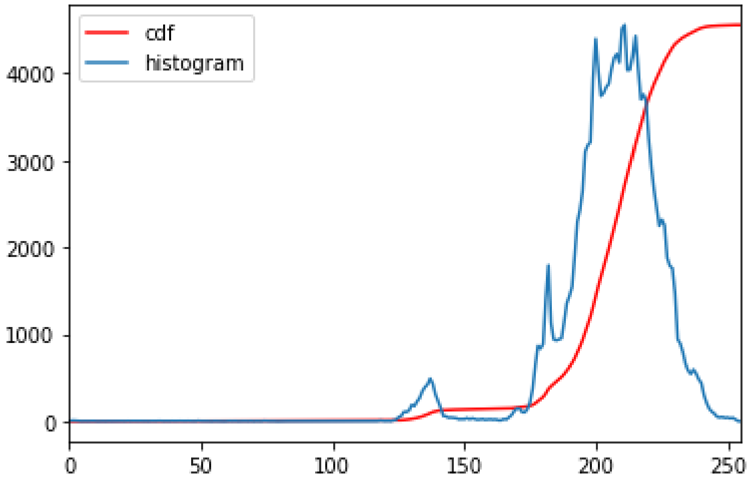
Histogram Equalization Formula

Lookup table (LUT)

An LUT is simply a table of cross-references linking index numbers to output values. The most common use is to determine the colors and intensity values with which a particular image will be displayed, and in this context the LUT is often called simply a colormap.

In [ ]:

```
# Get the cumulative sum of the images histogram. [2,4,6,1,3,5] -> [2,6,12,13,16
cdf = hist.cumsum()

# normalize the cumulative sum.  Cumulative sum multiplied by the value with the
cdf_normalized = cdf * float(hist.max()) / cdf.max()

# Plot the normalized cdf in red.
plt.plot(cdf_normalized, color = 'r')

#Plot the histogram
plt.plot(hist)

# Limit the range to 0, 255
plt.xlim([0,255])

#Add a legend.
plt.legend(('cdf','histogram'), loc = 'upper left')

#Show the plot.
plt.show()
```



In [ ]:

```
# Mask out 0 to find your minimum value.  This is what np.ma.masked_equal accomp
cdf_m = np.ma.masked_equal(cdf,0)

# Histogram equalization equation.  Taken from wikipedia.
cdf_m = (cdf_m - cdf_m.min())*255/(cdf_m.max()-cdf_m.min())

# Set values to uint8 and fill the look up table.
cdf = np.ma.filled(cdf_m,0).astype('uint8')
```

In [ ]:

```
# We've created a look up table to map the original pixel values to equalized va
imgContrast = cdf[imgContrast]

# Example of using a look up table (LUT).
arr = np.array([[1,2,3],[0,0,1]])
lut = np.array([0,2,5,7,8,12])
print(lut[arr])
```

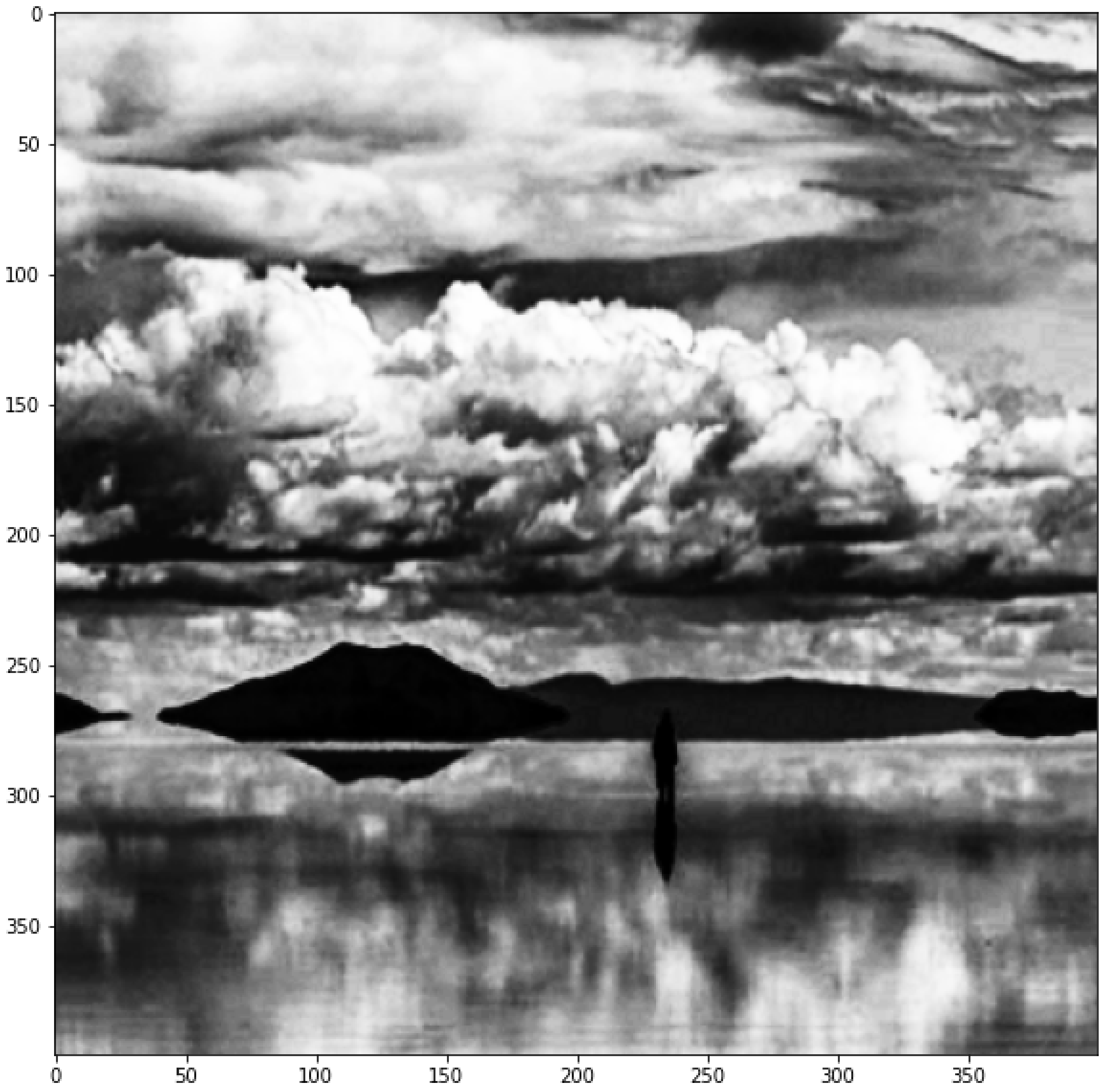
```
[[2 5 7]
 [0 0 2]]
```

In [ ]:

```
fig = plt.figure(figsize = (10,10))
plt.imshow(imgContrast)
```

Out[ ]:

```
<matplotlib.image.AxesImage at 0x7fb824afa9d0>
```

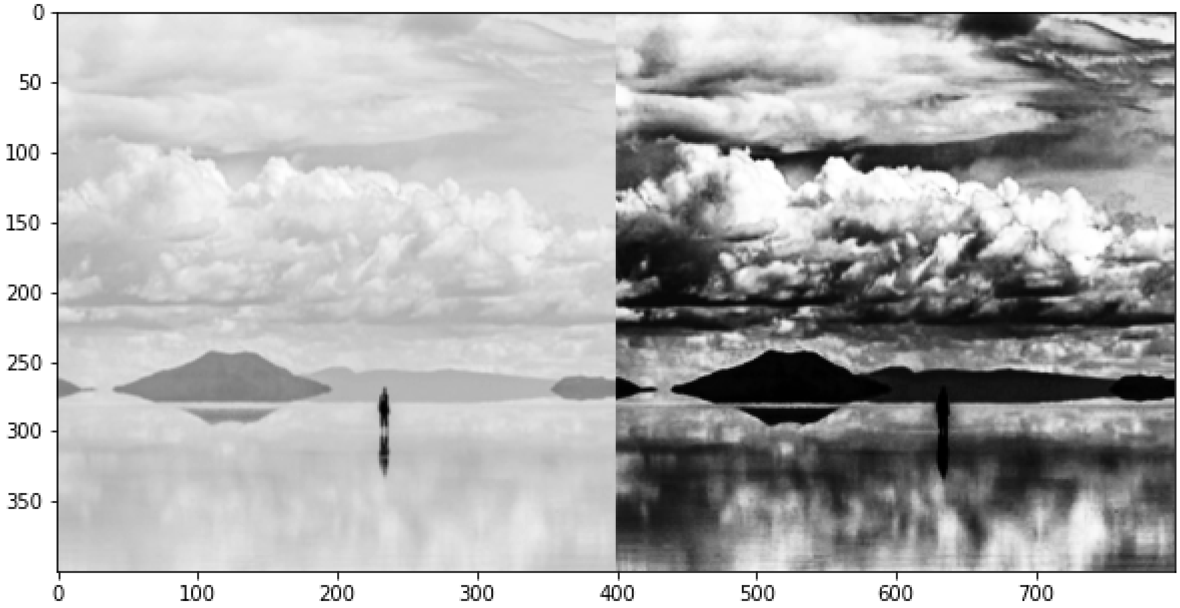


In [ ]:

```python
#Read in and save image.
imgContrast = cv2.imread('Graphics/lowcontrast.png', 0)

#Equalize histogram in OpenCv.
equ = cv2.equalizeHist(imgContrast)

#Combine the original and equalized image along the horizontal axis so they can
imgTwo = np.concatenate((imgContrast, equ), axis=1)

#Set figure size.
fig = plt.figure(figsize = (10,10))

#Display the images
plt.imshow(imgTwo, cmap='gray')
```

Out[ ]:

```
<matplotlib.image.AxesImage at 0x7fb826765fa0>
```


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