Module 2a: Pixel Neighbors

So far we have looked at pixels in isolation. More advanced image processing techniques need to take into account the neighboring pixel values. Remember the 3D pixel array in Module 1, we have been manipulating pixel values in the 3rd dimension where the RGB color values of each individual pixel are located. We need to search in the 1st and 2nd dimensions to move beyond the ono-to-one pixel processing.

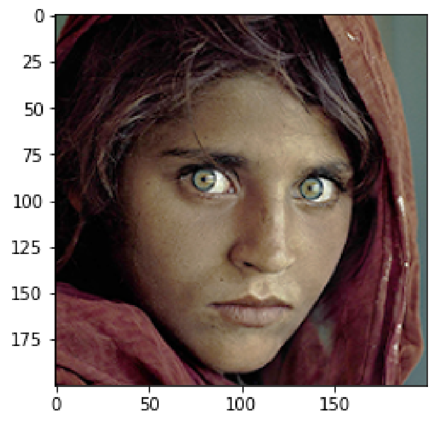
3D Array [[[ ]]]

	0	1	2
0	55,100,200	74,124,100	89,210,10
1	124,74,191	174,43,34	201,142,60
2	191,50,10	215,111,84	245,139,81

[1st Dimension][2nd Dimension][3rd Dimension]

In [ ]:
```python
#Install Open CV and give tutorial on getting Jupyter notebook up and running.
# %pip install opencv-contrib-python
# %pip install matplotlib

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

#Saving the image in a variable
img = cv2.imread('Graphics/face.png')

#OpenCV by defualt uses BGR instead of RGB.  Old digital camera standard.
img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)

#Use matplotlib while using a python notebook. Draw the image.
plt.imshow(img)
```

Out[ ]:
```
<matplotlib.image.AxesImage at 0x7fe2e133d940>
```



Detecting features

As we move close to the computer vision section of this course, algorithms that detect features within an image become powerful tools. What is a image feature? Lines (horizontal, vertical, diagonal), circles, edges, color combinations, and any other pattern you can think off. All images are a collections of these low level features. Let's build a filter to detect vertical edges in our image.

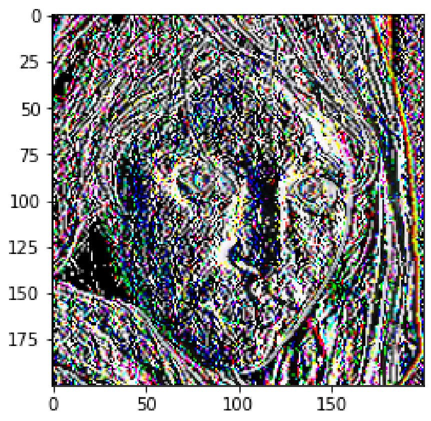
Here is the sudo code of our vertical edge detector:
For each row in the image
Visit each pixel in the row

Subtract the current pixel's RGB values with the pixel to the left
Set the current pixel to this value.

This sudo code describes a very simple edge detection algorithm. If pixel values differ greatly from their neighbors they are most likely a part of an edge. If many pixels in a sequence have this large difference they will form an edge.

In [ ]:
```
#Save the height and width.
h = img.shape[0]
w = img.shape[1]
d = img.shape[2]

#Let's create a blank array for our edge detector image.
imgEdge = np.zeros((200,200,3), dtype=np.uint8)

#For each row in our grid.
for y in range(0,h):
    #Search each pixel in the row.  **Notice we are starting at the 2nd pixel, array position 1, so we alway
    for x in range(1,w):
        # For each pixel RGB value
         for z in range(0,d):
            curPixel = img[y,x,z]
            leftPixel = img[y,x-1,z]
            imgEdge[y,x,z] = np.abs(np.subtract(curPixel, leftPixel))



#Draw the image.  Use matplotlib while using a python notebook.
plt.imshow(imgEdge)
```

Out[ ]:
```
<matplotlib.image.AxesImage at 0x7fe2e150a520>
```



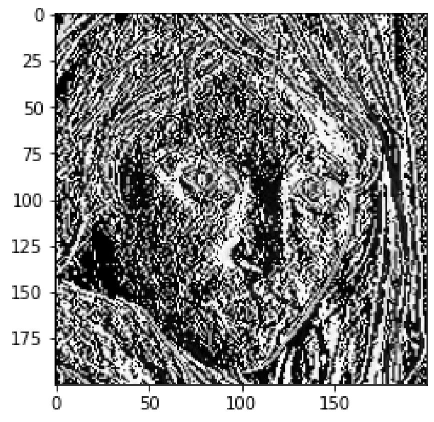
Results

- You can make out the edges of the face but we are dealing with a lot of color noise. Image noise is random variation of brightness or color information in images.
- Let's convert the image to greyscale to help out our edge detecting algorithm.

In [ ]:
```
#Let's convert the image to grayscale so we can remove the color noise.

#Save the height and width.
h = img.shape[0]
w = img.shape[1]
d = img.shape[2]

#Convert all the pixels to greyscale values
imgGrey = cv2.cvtColor(img, cv2.COLOR_RGB2GRAY)

#Let's create a blank array for our edge detector image.
imgEdge = np.zeros((200,200,3), dtype=np.uint8)

#For each row in our grid.
```

```
for y in range(0,h):
    #Search each pixel in the row.  **Notice we are starting at the 2nd pixel, array position 1, so we alway
    for x in range(1,w):
        curPixel = imgGrey[y,x]
        leftPixel = imgGrey[y,x-1]
        imgEdge[y,x] = np.abs(np.subtract(curPixel, leftPixel))



# #Draw the image.  Use matplotlib while using a python notebook.
plt.imshow(imgEdge)
```

Out[ ]:
```
<matplotlib.image.AxesImage at 0x7fe2e21e4c10>
```



Results

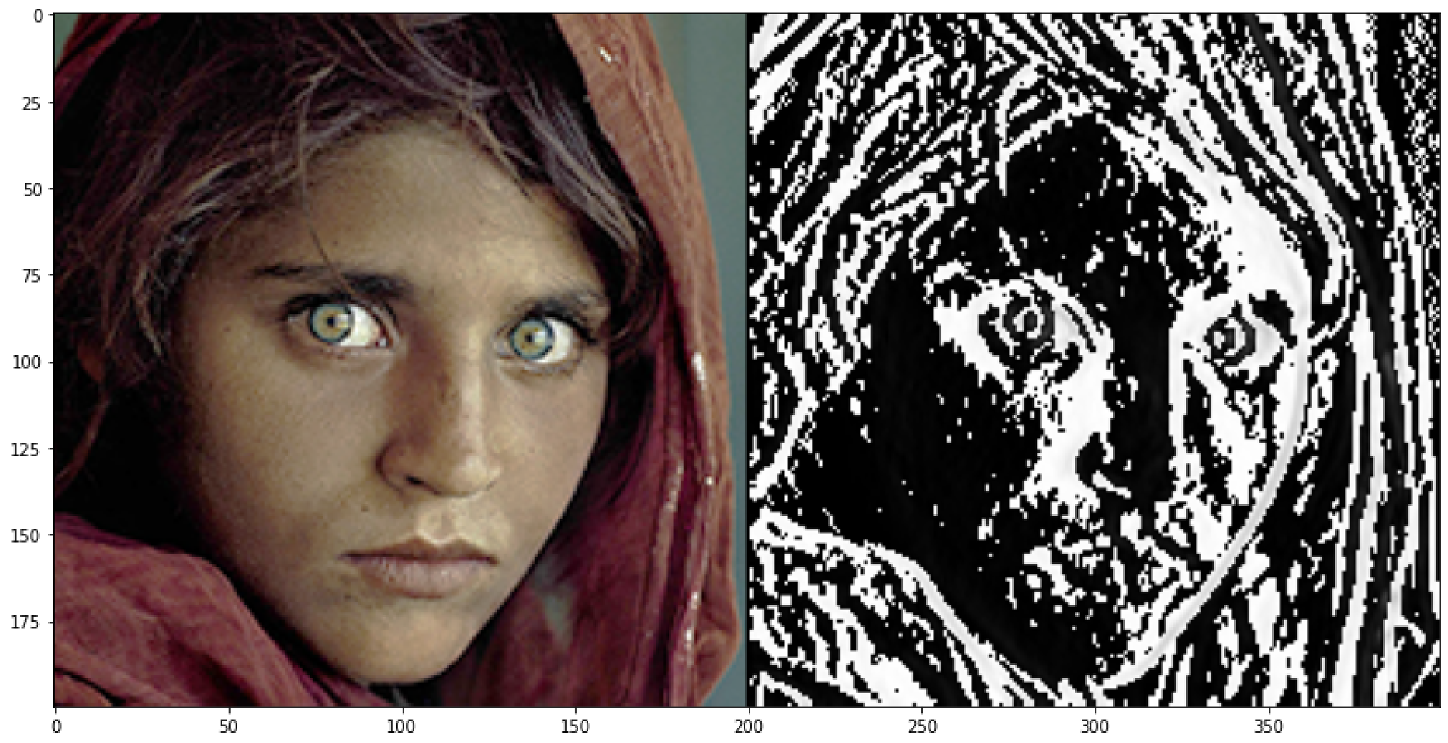
- The conversion to black and white removed the color noise and made the edges more evident but we still have a noisy image.

Next Steps

- A simple approach to removing noise is blurring or smoothing the image. How this work? The blur filter reduces the difference between neighboring pixels. Small pixel differences will be eliminated leaving only the larger ones.

In [ ]:
```
#Blur
kernel = np.array(([.111,.111,.111],[.111,.111,.111],[.111,.111,.111]), dtype=np.float32)

imgGrey = cv2.filter2D(imgGrey,-1,kernel)

#Let's create a blank array for our edge detector image.
imgEdge = np.zeros((200,200,3), dtype=np.uint8)

#For each row in our grid.
for y in range(0,h):
    #Search each pixel in the row.  **Notice we are starting at the 2nd pixel, array position 1, so we alway
    for x in range(1,w):
        curPixel = imgGrey[y,x]
        leftPixel = imgGrey[y,x-1]
        imgEdge[y,x] = np.abs(np.subtract(curPixel, leftPixel))


# Combine the two images
imgTwo = np.concatenate((img, imgEdge), axis=1)

# #Draw the image.  Use matplotlib while using a python notebook.
fig = plt.figure(figsize = (15,30))
plt.imshow(imgTwo)
```

Out[ ]:
```
<matplotlib.image.AxesImage at 0x7fe2ddab0b20>
```



The Canny Edge Dectoctor

Open CV Canny Edge

The Canny operator first smoothes or blurs the image and then contour segments the image by following the intensity differences of neighboring pixels.

Sobel Filtering - Edge Detection

Sobel Operator

In [ ]:
```
edges = cv2.Canny(img,100,200)

fig = plt.figure(figsize=(15,30))
plt.subplot(121),plt.imshow(img,cmap = 'gray')
plt.title('Original Image'), plt.xticks([]), plt.yticks([])
plt.subplot(122),plt.imshow(edges,cmap = 'gray')
plt.title('Edge Image'), plt.xticks([]), plt.yticks([])
plt.show()
```

Original Image

Edge Image