Assignment-2

Canny edge detector algorithm

Summer 2022 CS 59000 VT- Topic Computer Sci-XB9 Cross list

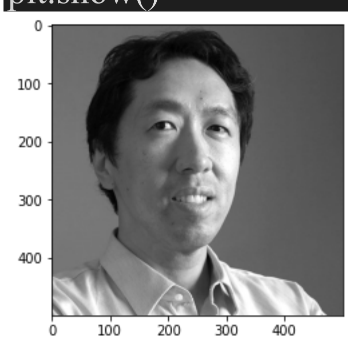
By- Rudraksh Sugandhi

Code:

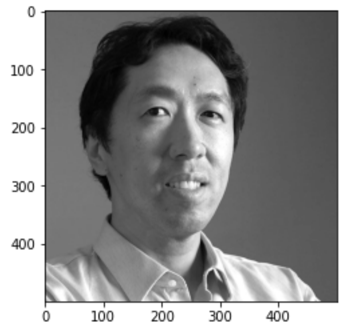
1. **Include code with comments in the report.**

```
from scipy import misc
from scipy import ndimage
import numpy as np
import matplotlib.pyplot as plt
import imageio
import warnings
warnings.filterwarnings('ignore')
```

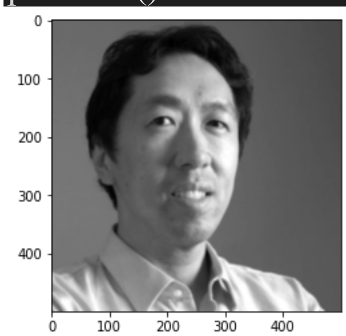
```
# Load image into variable and display it
lion = imageio.imread("Andrew.jpeg")
plt.imshow(lion, cmap = plt.get_cmap('gray'))
plt.show()
```



```python
# Convert color image to grayscale to help
lion_gray = np.dot(lion[...,:3], [0.299, 0.587, 0.114])
plt.imshow(lion_gray, cmap = plt.get_cmap('gray'))
plt.show()
```



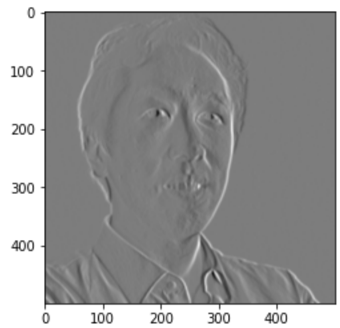

```python
# Blur the grayscale image
lion_gray_blurred = ndimage.gaussian_filter(lion_gray, sigma=1.4)
plt.imshow(lion_gray_blurred, cmap = plt.get_cmap('gray'))
plt.show()
```



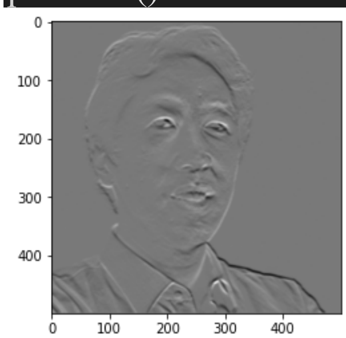

```python
# Apply Sobel Filter using the convolution operation
def SobelFilter(img, direction):
    if(direction == 'x'):
        Gx = np.array([[-1,0,+1], [-2,0,+2],  [-1,0,+1]])
        Res = ndimage.convolve(img, Gx)

    if(direction == 'y'):
        Gy = np.array([[-1,-2,-1], [0,0,0], [+1,+2,+1]])
        Res = ndimage.convolve(img, Gy)

    return Res
# Normalize the pixel array, so that values are <= 1
```

```
def Normalize(img):
    img = img/np.max(img)
    return img
```

```
# Apply Sobel Filter in X direction
gx = SobelFilter(lion_gray_blurred, 'x')
gx = Normalize(gx)
plt.imshow(gx, cmap = plt.get_cmap('gray'))
plt.show()
```

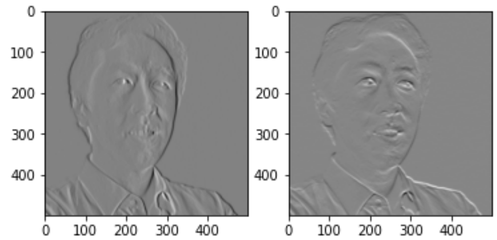



```
# Apply Sobel Filter in Y direction
gy = SobelFilter(lion_gray_blurred, 'y')
gy = Normalize(gy)
plt.imshow(gy, cmap = plt.get_cmap('gray'))
plt.show()
```



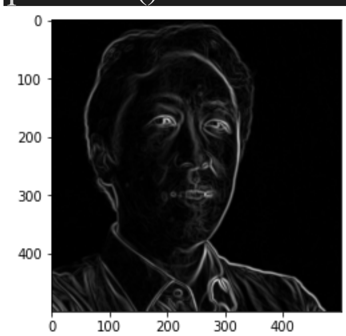

```
# Apply the Sobel Filter using the inbuilt function of scipy, this was done to verify
the values obtained from above

dx = ndimage.sobel(lion_gray_blurred, axis=1) # horizontal derivative
dy = ndimage.sobel(lion_gray_blurred, axis=0) # vertical derivative
# Plot the derivative filter values obtained using the inbuilt function
plt.subplot(121)
plt.imshow(dx, cmap = plt.get_cmap('gray'))
```

```
plt.subplot(122)
plt.imshow(dy, cmap = plt.get_cmap('gray'))
plt.show()
```

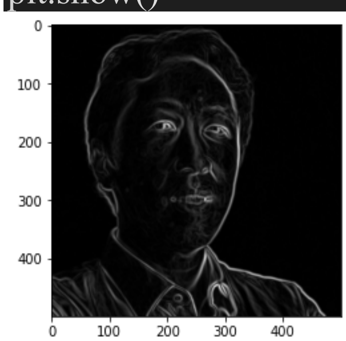


Gradient

```
# Calculate the magnitude of the gradients obtained
Mag = np.hypot(gx,gy)
Mag = Normalize(Mag)
plt.imshow(Mag, cmap = plt.get_cmap('gray'))
plt.show()
```




```
# Calculate the magnitude of the gradients obtained using the inbuilt function,
again done to verify the correctness of the above value
mag = np.hypot(dx,dy)
mag = Normalize(mag)
plt.imshow(mag, cmap = plt.get_cmap('gray'))
plt.show()
```



```
# Calculate direction of the gradients
Gradient = np.degrees(np.arctan2(gy,gx))
```

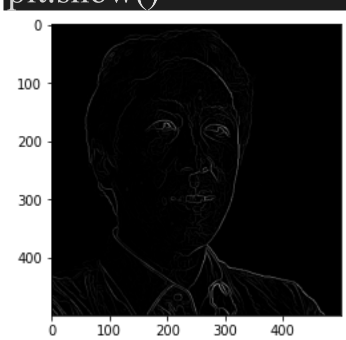
```
# Calculate the direction of the gradients obtained using the inbuilt sobel function
gradient = np.degrees(np.arctan2(dy,dx))
```

NON-MAX SUPPRESSION

```
#Non Maximum Suppression
# This is done to get thin edges
def NonMaxSupWithInterpol(Gmag, Grad, Gx, Gy):
    NMS = np.zeros(Gmag.shape)

    for i in range(1, int(Gmag.shape[0]) - 1):
        for j in range(1, int(Gmag.shape[1]) - 1):
            if((Grad[i,j] >= 0 and Grad[i,j] <= 45) or (Grad[i,j] < -135 and Grad[i,j] >=
-180)):
                yBot = np.array([Gmag[i,j+1], Gmag[i+1,j+1]])
                yTop = np.array([Gmag[i,j-1], Gmag[i-1,j-1]])
                x_est = np.absolute(Gy[i,j]/Gmag[i,j])
                if (Gmag[i,j] >= ((yBot[1]-yBot[0])*x_est+yBot[0]) and Gmag[i,j] >=
((yTop[1]-yTop[0])*x_est+yTop[0])):
                    NMS[i,j] = Gmag[i,j]
                else:
                    NMS[i,j] = 0
            if((Grad[i,j] > 45 and Grad[i,j] <= 90) or (Grad[i,j] < -90 and Grad[i,j] >= -
135)):
                yBot = np.array([Gmag[i+1,j] ,Gmag[i+1,j+1]])
                yTop = np.array([Gmag[i-1,j] ,Gmag[i-1,j-1]])
                x_est = np.absolute(Gx[i,j]/Gmag[i,j])
                if (Gmag[i,j] >= ((yBot[1]-yBot[0])*x_est+yBot[0]) and Gmag[i,j] >=
((yTop[1]-yTop[0])*x_est+yTop[0])):
                    NMS[i,j] = Gmag[i,j]
                else:
                    NMS[i,j] = 0
            if((Grad[i,j] > 90 and Grad[i,j] <= 135) or (Grad[i,j] < -45 and Grad[i,j] >=
-90)):
                yBot = np.array([Gmag[i+1,j] ,Gmag[i+1,j-1]])
                yTop = np.array([Gmag[i-1,j] ,Gmag[i-1,j+1]])
```

```
                x_est = np.absolute(Gx[i,j]/Gmag[i,j])
                if (Gmag[i,j] >= ((yBot[1]-yBot[0])*x_est+yBot[0]) and Gmag[i,j] >=
((yTop[1]-yTop[0])*x_est+yTop[0])):
                    NMS[i,j] = Gmag[i,j]
                else:
                    NMS[i,j] = 0
            if((Grad[i,j] > 135 and Grad[i,j] <= 180) or (Grad[i,j] < 0 and Grad[i,j] >= -
45)):
                yBot = np.array([Gmag[i,j-1] ,Gmag[i+1,j-1]])
                yTop = np.array([Gmag[i,j+1] ,Gmag[i-1,j+1]])
                x_est = np.absolute(Gy[i,j]/Gmag[i,j])
                if (Gmag[i,j] >= ((yBot[1]-yBot[0])*x_est+yBot[0]) and Gmag[i,j] >=
((yTop[1]-yTop[0])*x_est+yTop[0])):
                    NMS[i,j] = Gmag[i,j]
                else:
                    NMS[i,j] = 0

    return NMS
```

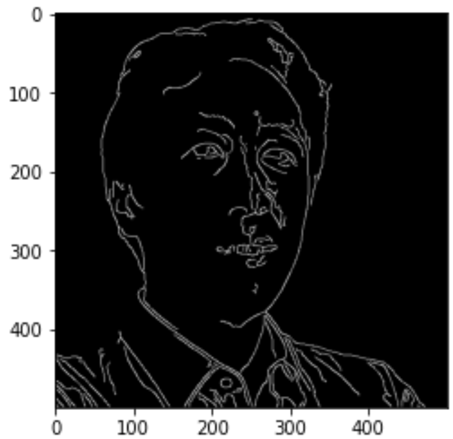
```
# Get the Non-Max Suppressed output
NMS = NonMaxSupWithInterpol(Mag, Gradient, gx, gy)
NMS = Normalize(NMS)
plt.imshow(NMS, cmap = plt.get_cmap('gray'))
plt.show()
```



Hysteresis thresholding

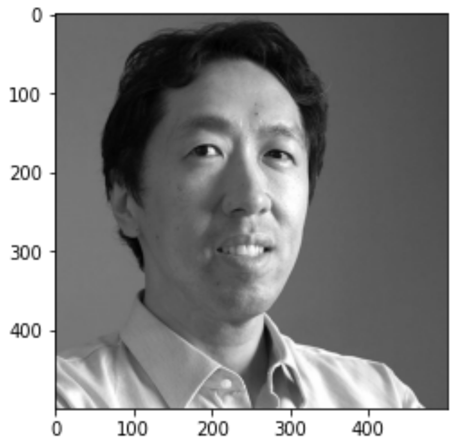
```python
# Threshold Hysterisis
def DoThreshHyst(img):
    highThresholdRatio = 0.2
    lowThresholdRatio = 0.15
    GSup = np.copy(img)
    h = int(GSup.shape[0])
    w = int(GSup.shape[1])
    highThreshold = np.max(GSup) * highThresholdRatio
    lowThreshold = highThreshold * lowThresholdRatio
    x = 0.1
    oldx=0


    while(oldx != x):
        oldx = x
        for i in range(1,h-1):
            for j in range(1,w-1):
                if(GSup[i,j] > highThreshold):
                    GSup[i,j] = 1
                elif(GSup[i,j] < lowThreshold):
                    GSup[i,j] = 0
                else:
                    if((GSup[i-1,j-1] > highThreshold) or
                        (GSup[i-1,j] > highThreshold) or
                        (GSup[i-1,j+1] > highThreshold) or
                        (GSup[i,j-1] > highThreshold) or
                        (GSup[i,j+1] > highThreshold) or
                        (GSup[i+1,j-1] > highThreshold) or
                        (GSup[i+1,j] > highThreshold) or
                        (GSup[i+1,j+1] > highThreshold)):
                        GSup[i,j] = 1
        x = np.sum(GSup == 1)

    GSup = (GSup == 1) * GSup

    return GSup
```

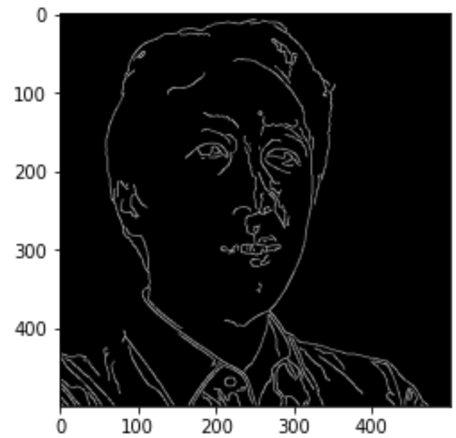
```python
# The output of canny edge detection
Final_Image = DoThreshHyst(NMS)
plt.imshow(Final_Image, cmap = plt.get_cmap('gray'))
plt.show()
```



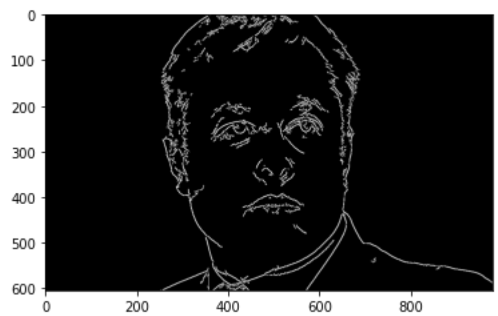
2. Choose at least three images for showing your result.

a. INPUT IMAGE CANNY IMAGE

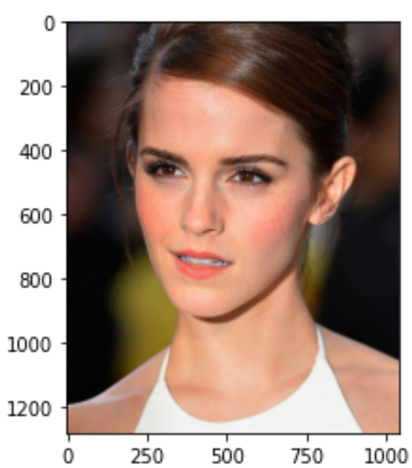


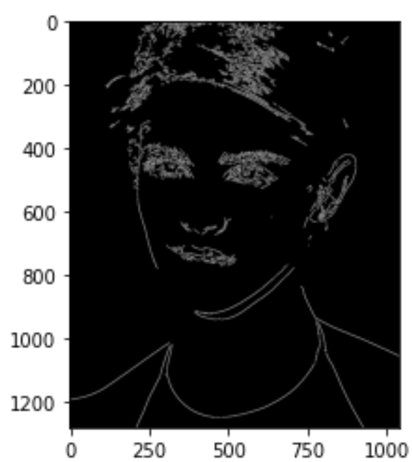


b.



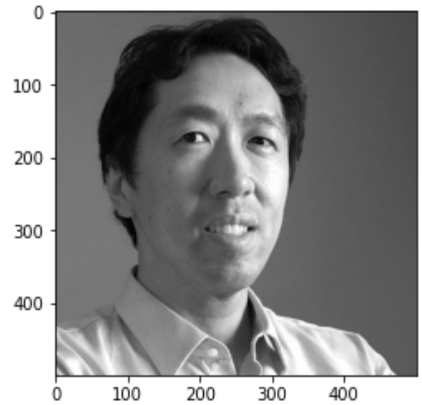
c.

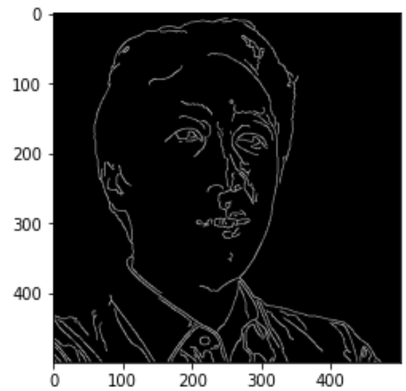




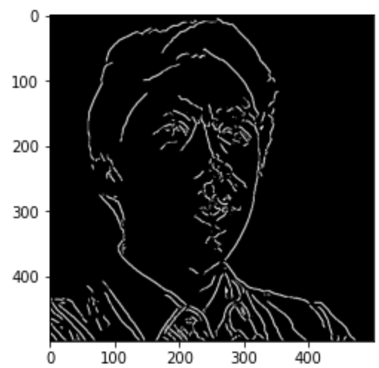
3. Apply different sigma and different thresholding (high-low) and discuss the results.

Sigma = 1.4





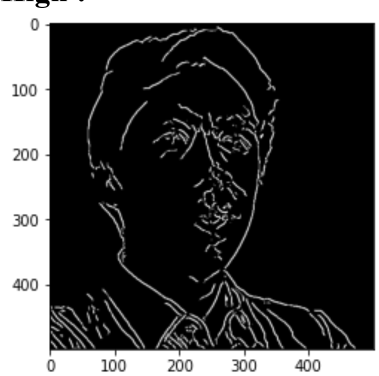
Sigma = 3



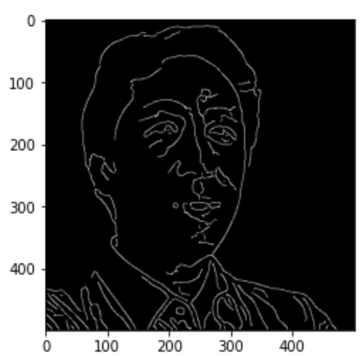
Applying more Sigma can detect more edges in image with brighter pixel.

Different Thresholding

High :

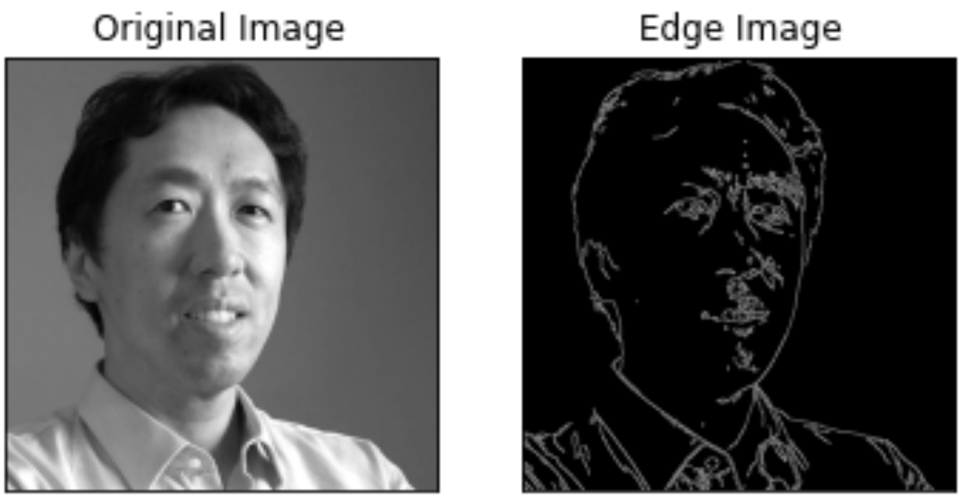


Low:



4. <u>If you are using libraries that have canny edge detector compare your implementation of canny with the method and discuss the change.</u>

```
import numpy as np
import cv2 as cv
from matplotlib import pyplot as plt
img = cv.imread('Andrew.jpeg',0)
edges = cv.Canny(img,100,200)
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()
```



Reason: The edge detection using OpenCV is able to find the minute details based on change in intensity of image. The output edges are more accurate and more precise.