Lab02

February 3, 2022

1 CO543 - Image Processing Lab 02

1.1 E/17/297

[ ]:
```
import cv2
import numpy as np
import matplotlib.pyplot as plt
from google.colab.patches import cv2_imshow
import matplotlib.image as mpimg
```

[ ]:
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call
drive.mount("/content/drive", force_remount=True).
```

[ ]:
```
folder = '/content/drive/MyDrive/CO543/Lab 2/'
img = cv2.imread(folder + 'images/img22.jpg')
print(img.shape[:2])
cv2_imshow(img)
```

```
(250, 500)
```

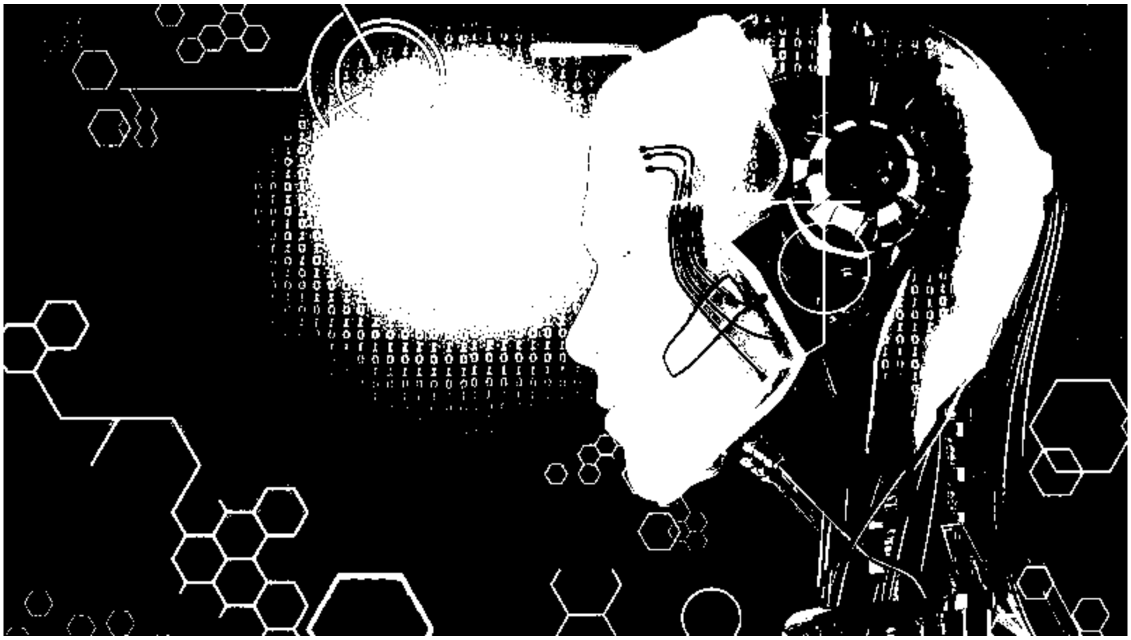
[ ]:
```
def plotImg(img):
    imgplot = plt.imshow(img)
    plt.show()

#plotImg(img)
```

1.2 1. Image thresholding

1.2.1 Lab Task 01 : Write a function to perform image thresholding using point processing taking the image file and the threshold value from the user.

[ ]:
```
#compare the pixel value with the threshold value
#if pixel value is less than threshold then replace it with 0
#else replace with 255

def thresholding(img,val):
    #get the image dimensions
    height , width = img.shape[:2]

    for row in  range(height):
        for column in range(width):
            #compare with the threshold value
            if(img[row][column] < val):
                img[row][column] = 0
            else:
                img[row][column] = 255

    return img
```

[ ]:
```
img = cv2.imread(folder +'test_image.jpg' ,0)

cv2_imshow(thresholding(img,120))
```



1.3 2. Image arithmetic operations

[ ]:
```
img1 = cv2.imread(folder+ 'images/img11.jpg',0)
img2 = cv2.imread(folder+ 'images/img22.jpg',0)

print("Original Images")
cv2_imshow(img1)
cv2_imshow(img2)
print()
#addition and substraction
print("Addition")
cv2_imshow(cv2.add(img1,img2))
print("Substraction")
cv2_imshow(cv2.subtract(img1,img2))
```

```
Original Images
```

Addition

Substraction

1.4 3. Spatial Processing

1.4.1 1.Write simple programs to demonstrate the following. Show the original and resultant images in the same figure to compare them easily.

a. Log transformation

s = clog(1+r)

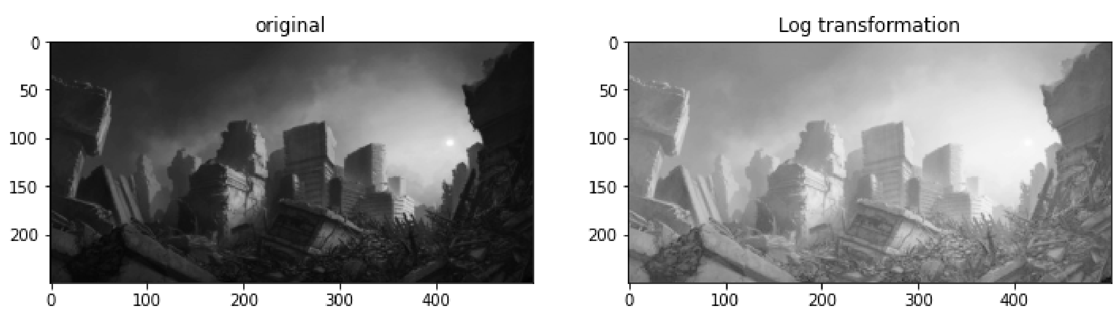
s = output intensity , c = scaling constant

log transformation maps a narrow range of low-intensity input values to a wide range of output values

[ ]:
```
#Log transformation
def logTransformation(img):
    #log transformation
    c = 255 / np.log(1 + np.max(img)) #calculating C
    log_img = c * np.log(1+img)

    #type casting to int
    log_img = np.array(log_img, dtype = np.uint8)

    return log_img
```

[ ]:
```
img = cv2.imread(folder + '/images/img11.jpg',0)
logImg = logTransformation(img)

#show images
fig, axis = plt.subplots(nrows=1, ncols=2, figsize=(12, 6))
axis[0].imshow(img, cmap ="gray")
axis[0].set_title("original")

axis[1].imshow(logImg, cmap ="gray")
axis[1].set_title("Log transformation")
```

[ ]:
```
Text(0.5, 1.0, 'Log transformation')
```



1.4.2 b. Power transformation

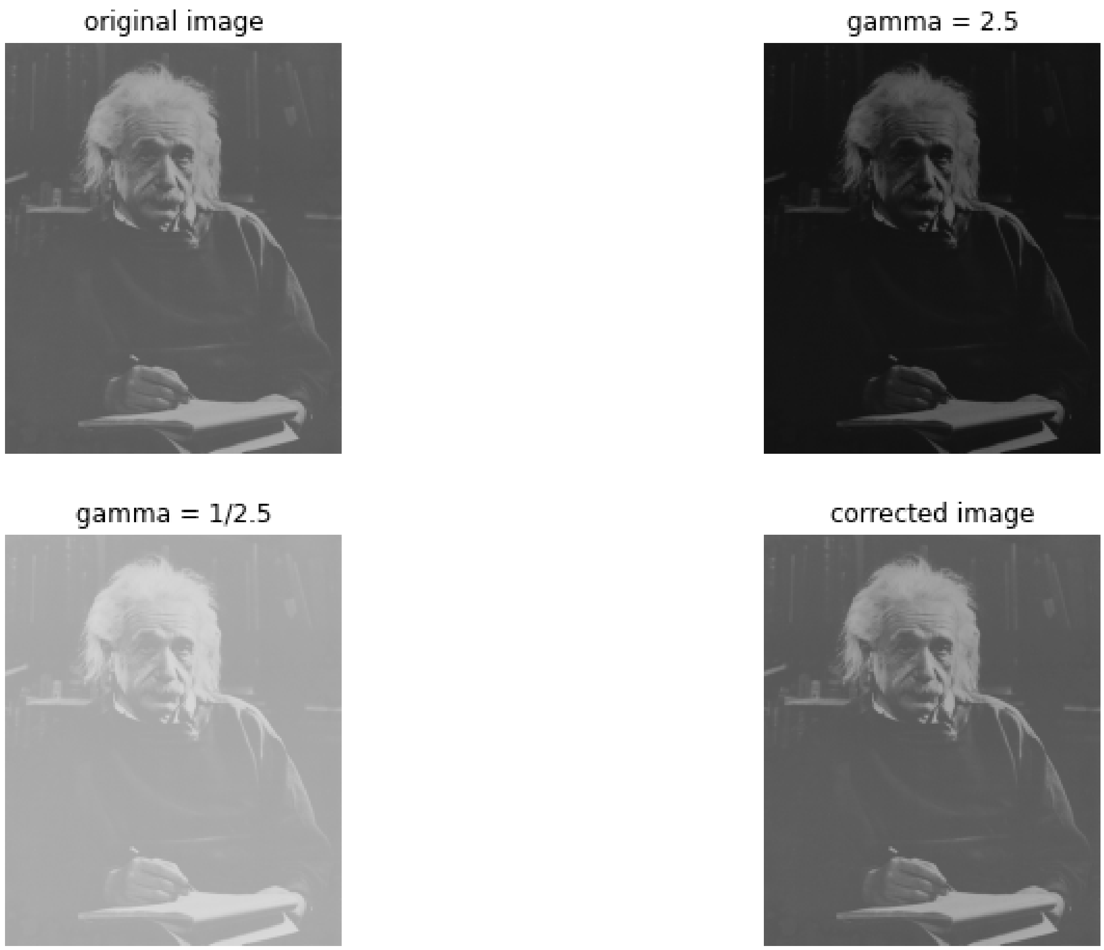
s = cr^

gamma >1 (curve corresponding to 'nth power' label on the graph) -The intensity of pixels decreases.

gamma<1 (curve corresponding to 'nth root' label on the graph) - the intensity increases

[ ]:
```
img = cv2.imread(folder + 'Fig0354(a)(einstein_orig).tif')
#cv2_imshow(img)

gamma = 2.5
gamma_c = 1/gamma

#creating lookup tables
lookupTable = np.empty((1,256),np.uint8)
lookupTable1 = np.empty((1,256),np.uint8)

#filling lookup table
for i in range(256):
  lookupTable[0,i] = np.clip(pow(i/255.0, gamma) * 255.0,0,255)
  lookupTable1[0,i] = np.clip(pow(i/255.0, gamma_c) * 255.0,0,255)

#Simulate CRT monitor
res = cv2.LUT(img, lookupTable)
#cv2_imshow(res)

#corrected image
corr = cv2.LUT(img,lookupTable1)

#feed to crt
fin = cv2.LUT(corr,lookupTable)

#show images
fig, axis = plt.subplots(2,2,figsize=(12, 8))

axis[0,0].imshow(img, cmap="gray")
axis[0,0].set_title("original image")
axis[0,0].axis('off')

axis[0,1].imshow(res, cmap="gray")
axis[0,1].set_title("gamma = 2.5")
axis[0,1].axis('off')

axis[1,0].imshow(corr, cmap="gray")
axis[1,0].set_title("gamma = 1/2.5")
axis[1,0].axis('off')

axis[1,1].imshow(fin, cmap="gray")
axis[1,1].set_title("corrected image")
axis[1,1].axis('off')
```

[ ]:
```
(-0.5, 489.5, 599.5, -0.5)
```



1.4.3 c. Contrast Stretching

Contrast = (I_max - I_min)/(I_max + I_min)

[ ]:
```
#contrast streching function
def constrastStretch(pixel, r1, s1, r2, s2):
  if( pixel >= 0 and pixel <= r1):
    return (s1 / r1) * pixel
  elif(r1 < pixel and pixel <= r2):
    return ((s2-s1)/(r2-r1)) * (pixel - r1) + s1
  else:
    return ((255 - s2)/(255 - r2)) * (pixel - r2) + s2
```

[ ]:
```
#parameters
r1 = 120
s1 = 50
r2 = 180
s2 = 20
```

```python
pixelVal_vec = np.vectorize(constrastStretch)
img = cv2.imread(folder + 'bright.tif')
constrastStretched = pixelVal_vec(img, r1, s1, r2, s2)

print("original")
cv2_imshow(img)
print("constrast Stretched")
cv2_imshow(constrastStretched)
```

original

constrast Stretched

1.4.4 d. Gray level slicing

[ ]:
```
# x1-x2 is the range
def grayLevelSlicing(pixel,x1,x2,max,min):
  if(x1 <= pixel and pixel <=x2):
    return max
  else:
    return min
```

[ ]:
```
# parameters
x1 = 80
x2 = 160
```

```
max = 255
min = 0

pixelVal_vec = np.vectorize(grayLevelSlicing)
img = cv2.imread(folder + 'trees.jpeg')
sliced = pixelVal_vec(img,x1,x2,max,min)

print("Original image")
cv2_imshow(img)
print("Gray level sliced")
cv2_imshow(sliced)
```

Output hidden; open in https://colab.research.google.com to view.

1.4.5 e. Bit plane slicing

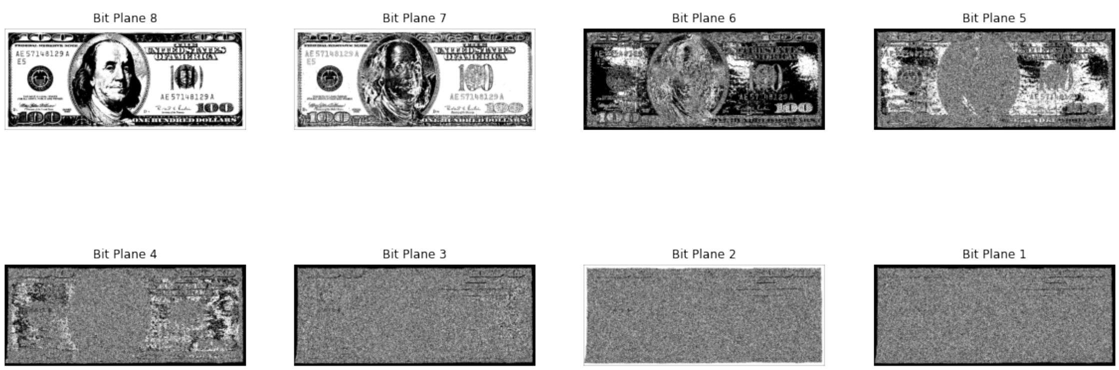
[65]:
```
def BitPlaneSlicing(img, bit):
  li = []
  height,width = img.shape

  for row in range(height):
    for col in range(width):
      li.append(np.binary_repr(img[row][col], width=8))

  sliced = (np.array([int(i[8-bit]) for i in li], dtype = np.uint8) *␣
 ↪(2**(bit-1))).reshape(height,width)

  return sliced
```

[66]:
```
img = cv2.imread(folder + '/images/DIP Gonzalez/DIP3E_Original_Images_CH03/
 ↪Fig0314(a)(100-dollars).tif',0)

img1 = BitPlaneSlicing(img,8)
img2 = BitPlaneSlicing(img,7)
img3 = BitPlaneSlicing(img,6)
img4 = BitPlaneSlicing(img,5)
img5 = BitPlaneSlicing(img,4)
img6 = BitPlaneSlicing(img,3)
img7 = BitPlaneSlicing(img,2)
img8 = BitPlaneSlicing(img,1)

images = [img1,img2,img3,img4,img5,img6,img7,img8]
```

[67]:
```
print("original image")
cv2_imshow(img)

fig, axis = plt.subplots(2,4,figsize=(20, 8))
```

```python
i = 0
n = 8
for rows in range(2):
  for cols in range(4):
    axis[rows,cols].imshow(images[i], cmap="gray")
    axis[rows,cols].set_title("Bit Plane " + str(n))
    axis[rows,cols].axis('off')
    i += 1
    n -= 1
```

original image



1.5 2. Consider the graph for a typical transformation function used for Contrast Stretching in the given figure and determine the behavior of the function with respect to given changes.

1.5.1 a. When r1 =s1 and r2=s2

[68]:
```
#parameters
r1 = 50
s1 = 50
r2 = 140
s2 = 140

pixelVal_vec = np.vectorize(constrastStretch)
img = cv2.imread(folder + '/images/DIP Gonzalez/DIP3E_Original_Images_CH03/
↪Fig0314(a)(100-dollars).tif',0)
constrastStretched = pixelVal_vec(img, r1, s1, r2, s2)

fig, axis = plt.subplots(nrows=1, ncols=2, figsize=(12, 6))
axis[0].imshow(img, cmap ="gray")
axis[0].set_title("Original")
axis[0].axis('off')

axis[1].imshow(constrastStretched, cmap ="gray")
axis[1].set_title("Contrast Stretched")
axis[1].axis('off')
```

[68]:
```
(-0.5, 1191.5, 499.5, -0.5)
```

1.5.2 We can see that there are no differences in two images.Reason for that is the slope of the graph is 1

1.5.3 b. When r1=r2, s1=0 and s2=L-1

[69]:
```
#parameters
r1 = 50
s1 = 0
r2 = 50
s2 = 255
```

```
pixelVal_vec = np.vectorize(constrastStretch)
img = cv2.imread(folder + '/images/DIP Gonzalez/DIP3E_Original_Images_CH03/
↪Fig0314(a)(100-dollars).tif',0)
constrastStretched = pixelVal_vec(img, r1, s1, r2, s2)

fig, axis = plt.subplots(nrows=1, ncols=2, figsize=(12, 6))
axis[0].imshow(img, cmap ="gray")
axis[0].set_title("Original")
axis[0].axis('off')

axis[1].imshow(constrastStretched, cmap ="gray")
axis[1].set_title("Contrast Stretched")
axis[1].axis('off')
```

[69]: (-0.5, 1191.5, 499.5, -0.5)

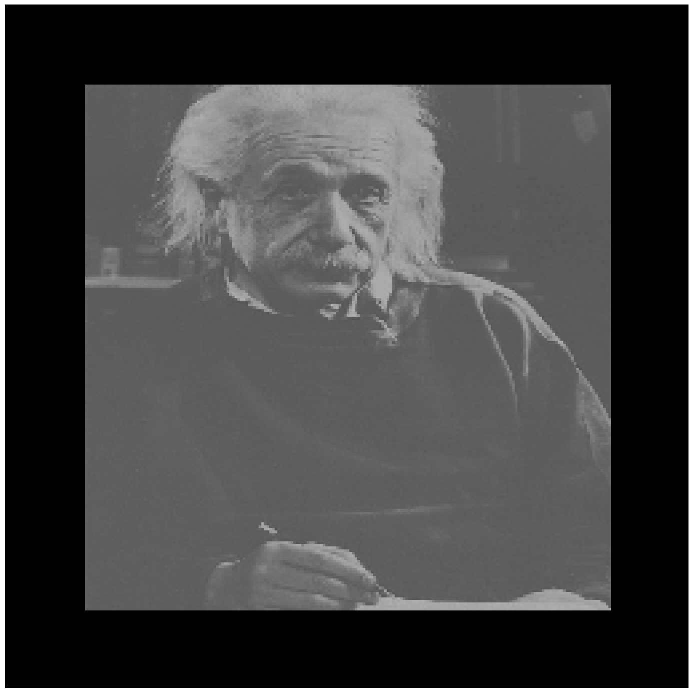
1.5.4 We can see that in here the grayscale image has been converted to a binary image.The threshold value is r1

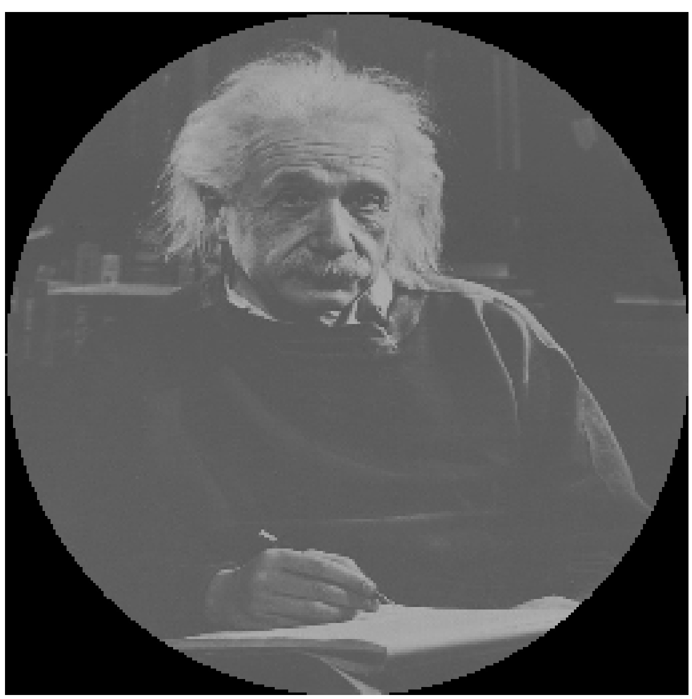
1.6 4. Masking

1.6.1 Lab Task 04 :

[76]:
```
#Creating a rectangle mask
rectangle = np.zeros((256, 256), dtype="uint8")
cv2.rectangle(rectangle, (30, 30), (226, 226), 255, -1)

#Creating a circle mask
circle = np.zeros((256, 256), dtype="uint8")
cv2.circle(circle, (128, 128), 128, 255, -1)

img = cv2.imread(folder + 'Fig0354(a)(einstein_orig).tif',0)
img_resized = cv2.resize(img,(256,256))

#using bitwise and operation to combine image and mask
mask1 = cv2.bitwise_and(img_resized,rectangle)
mask2 = cv2.bitwise_and(img_resized,circle)
```

```
cv2_imshow(mask1)
print()
cv2_imshow(mask2)
```





1.7 5. Brightness

1.7.1 Lab Task 05 : Write your own Python OpenCV function addbrightness() and use it to increase brightness of a given image.

[97]:
```
def addbrightness(img,val):
  height,width = img.shape[:2]

  img1 = np.zeros(( height,width))

  for row in range(height):
    for col in range(width):
      if(img[row][col] + val > 255):
        img1[row][col] = 255
      else:
        img1[row][col] = img[row][col] + val

  return img1
```

[99]:
```
img = cv2.imread(folder + 'test_image.jpg',0)

img_1 = addbrightness(img,50)
img_2 = addbrightness(img,100)

fig, axis = plt.subplots(nrows=1, ncols=3, figsize=(20, 10))

axis[0].imshow(img, cmap ="gray")
axis[0].set_title("Original")
axis[0].axis('off')

axis[1].imshow(img_1, cmap ="gray")
axis[1].set_title("brightness +50")
axis[1].axis('off')

axis[2].imshow(img_2, cmap ="gray")
axis[2].set_title("brightness +100")
axis[2].axis('off')
```

[99]: (-0.5, 799.5, 449.5, -0.5)

1.8 6. Histogram Processing

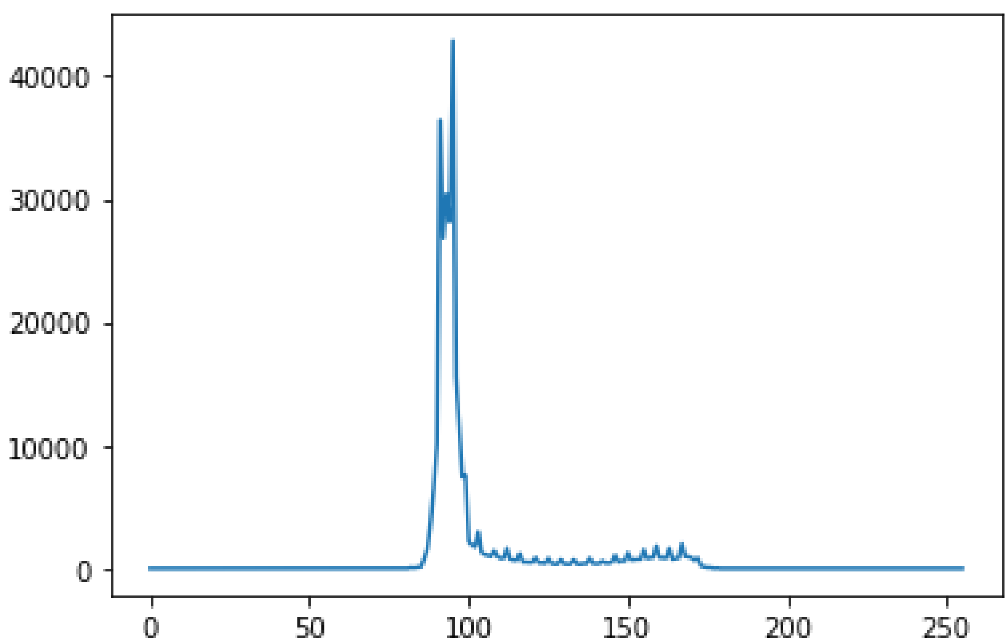
1.8.1 Lab Task 06 :

1.8.2 1. Histogram Calculation in OpenCV

1.8.3 Use inbuilt OpenCV cv2.calcHist() function to display the histogram of a given image.

[102]:
```
img = cv2.imread(folder + 'Fig0354(a)(einstein_orig).tif',0)

hist = cv2.calcHist([img], [0], None, [256], [0, 256])

x = np.arange(256)

plt.plot(x,hist.ravel())
```

[102]:
```
[<matplotlib.lines.Line2D at 0x7f8a708cf4d0>]
```

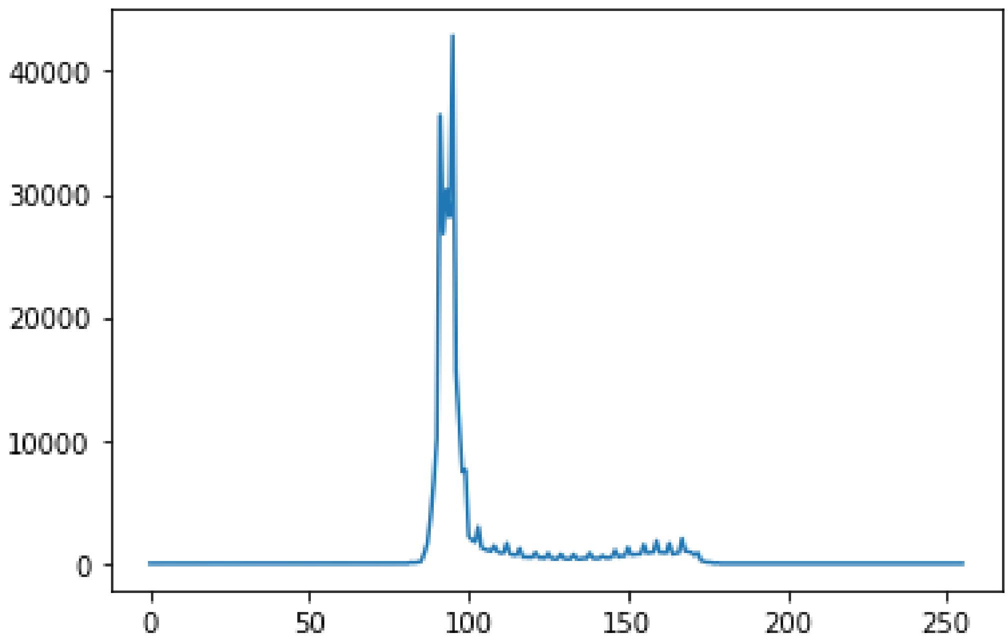


1.8.4 2. Histogram Calculation in Numpy

1.8.5 Use inbuilt numpy np.histogram() function to display the histogram of a given image.

[103]:
```
img = cv2.imread(folder + 'Fig0354(a)(einstein_orig).tif',0)

hist,bin = np.histogram(img.ravel(),256,[0,255])

x = np.arange(256)

plt.plot(x,hist.ravel())
```

[103]:
```
[<matplotlib.lines.Line2D at 0x7f8a707b2fd0>]
```



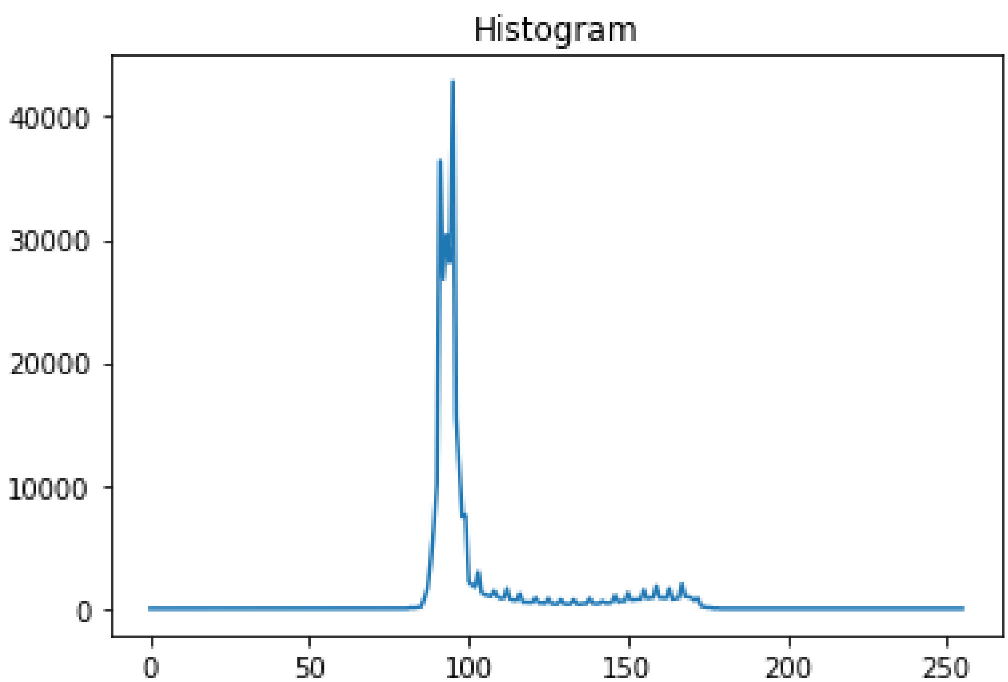
1.8.6 3. Then write your own histogram functions for the following scenarios

1.8.7 a. Show a histogram plot for a grayscale image.

[104]:
```
def grayscale_hist(img):
  #to store number of occurences of intensity values (0-255)
  histogram = np.zeros(256)

  height,width = img.shape[:2]

  for row in range(height):
    for col in range(width):
      histogram[img[row][col]] += 1
```

```
  # plot the histogram
  x = np.arange(256)
  fig, axis = plt.subplots()

  axis.plot(x,histogram)
  plt.title('Histogram')
  plt.show()
```

[105]:
```
img = cv2.imread(folder + 'Fig0354(a)(einstein_orig).tif',0)

grayscale_hist(img)
```

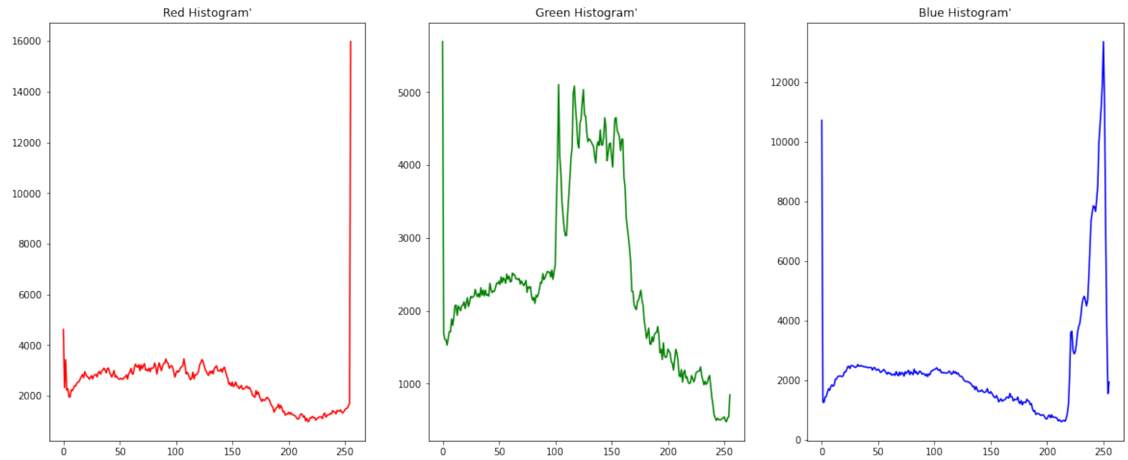


1.8.8 b. Show three histograms for a given RGB image.

[122]:
```
def RGB_hist(img):
  #to store number of occurences of intensity values (0-255)
  red_histogram = np.zeros(256)
  green_histogram = np.zeros(256)
  blue_histogram = np.zeros(256)

  height,width = img.shape[:2]

  for row in range(height):
```

```
    for col in range(width):
      blue_histogram[img[row][col][0]] += 1
      green_histogram[img[row][col][1]] += 1
      red_histogram[img[row][col][2]] += 1

  # plot the histogram
  x = np.arange(256)
  fig, axis = plt.subplots(1,3,figsize=(20, 8))

  axis[0].plot(x,red_histogram,color='r')
  axis[0].set_title("Red Histogram'")

  axis[1].plot(x,green_histogram,color='g')
  axis[1].set_title("Green Histogram'")

  axis[2].plot(x,blue_histogram,color='b')
  axis[2].set_title("Blue Histogram'")
```

[125]:
```
img = cv2.imread(folder + 'cities.jpg')
cv2_imshow(img)
RGB_hist(img)
```

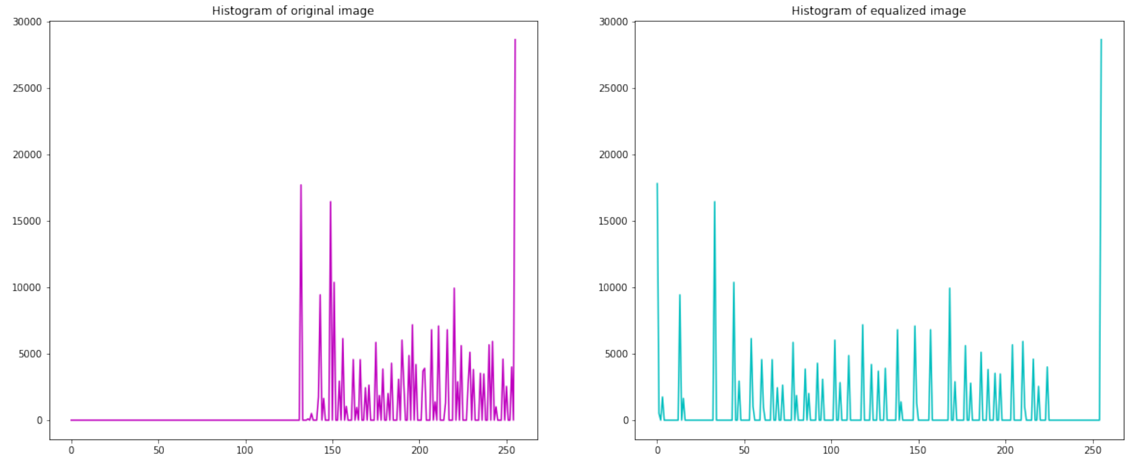


1.8.9 4. Consider the four images given in the resources folder. Plot the histogram for each image. Perform Histogram Equalization on each image and plot the histograms of the resultant images. Comment on the results you have obtained.

[138]:
```
def hist_equalization(img):
    img_hist_eq = cv2.equalizeHist(img)

    #histogram values for original image
    hist_org = cv2.calcHist([img], [0], None, [256], [0,256])

    #histogram values for equalized image
    hist_eq = cv2.calcHist([img_hist_eq], [0], None, [256], [0,256])


    #cv2_imshow(img_hist_eq )

    # plot the histogram
    x = np.arange(256)
    fig, axis = plt.subplots(1,2,figsize=(20, 8))

    axis[0].plot(x,hist_org,color='m')
    axis[0].set_title("Histogram of original image")

    axis[1].plot(x,hist_eq,color='c')
    axis[1].set_title("Histogram of equalized image")
```

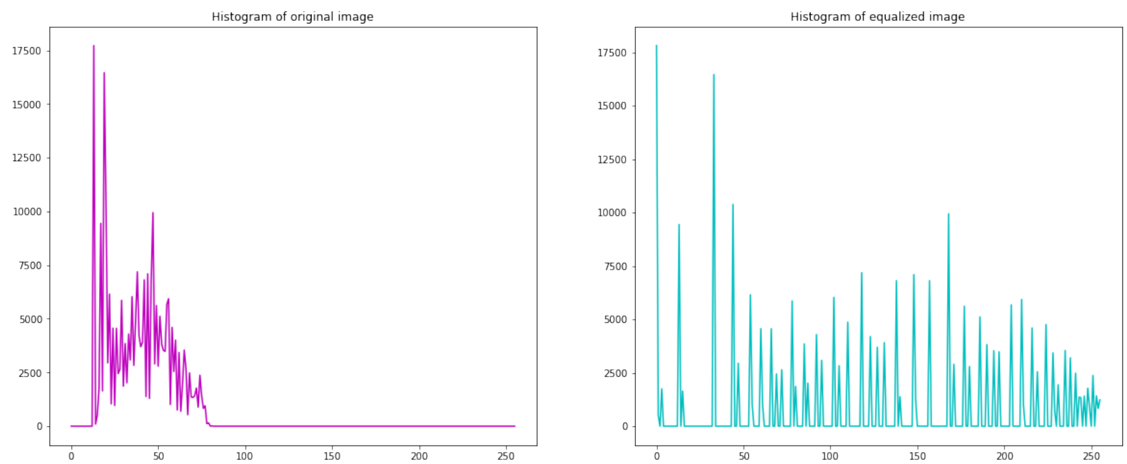
[139]:
```
img = cv2.imread(folder + 'bright.tif',0)

print("bright.tif")
hist_equalization(img)
```

bright.tif



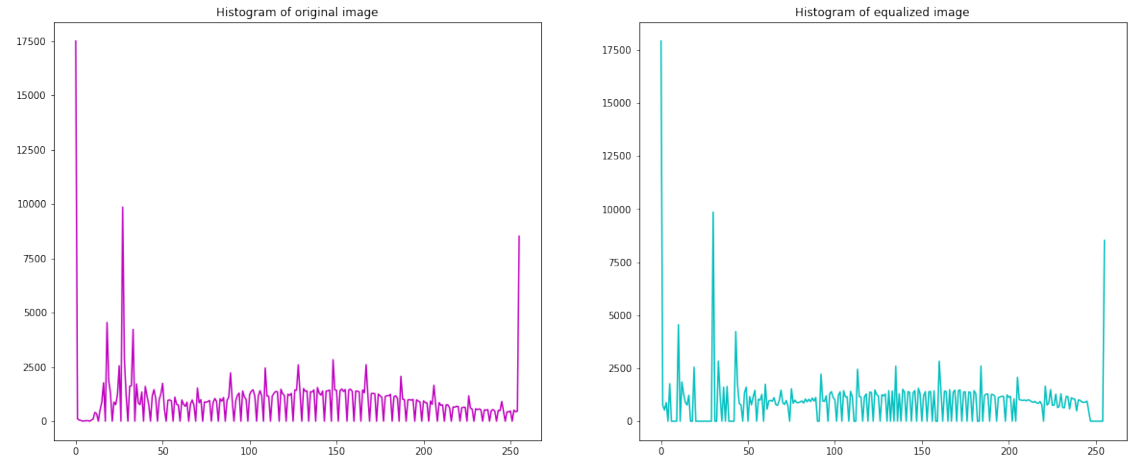
[140]:
```
img = cv2.imread(folder + 'dark.tif',0)

print("dark.tif")
hist_equalization(img)
```

dark.tif



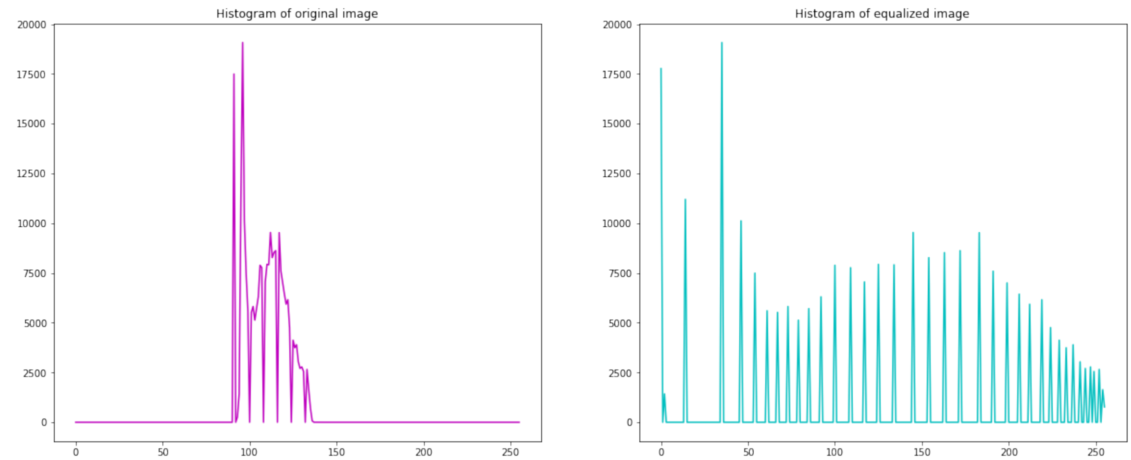
[141]:
```
img = cv2.imread(folder + 'high_contrast.tif',0)

print("high_contrast.tif")
hist_equalization(img)
```

high_contrast.tif




```
[142]: img = cv2.imread(folder + 'low_contrast.tif',0)

print("low_contrast.tif")
hist_equalization(img)
```

```
low_contrast.tif
```



1.8.10 We can clearly see that after performing Histogram Equalization histogram values are well spread out in the entire range and images have become clearer.

```
[ ]: %%capture
!wget -nc https://raw.githubusercontent.com/brpy/colab-pdf/master/colab_pdf.py
from colab_pdf import colab_pdf
colab_pdf('Lab02.ipynb',folder)
```

[ ]:

```

```