EN2550 Assignment 01

Index No. : 190018V

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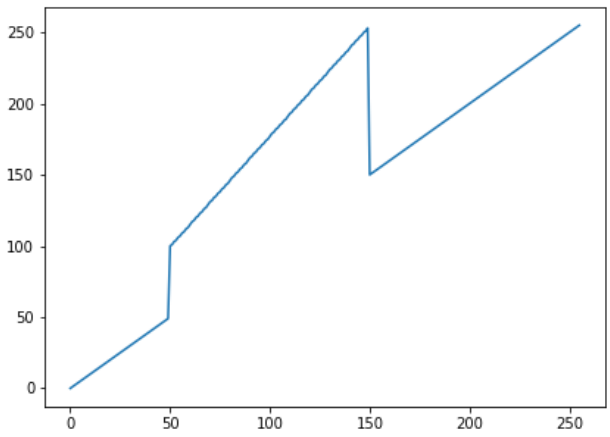
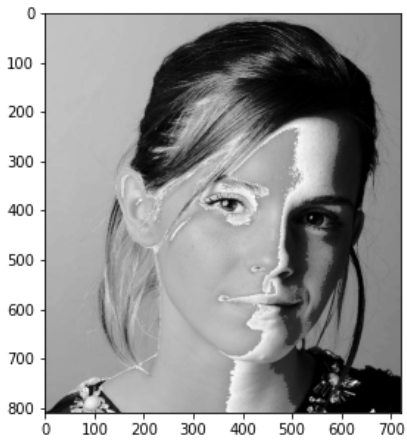
Github : https://github.com/KCSAbeywickrama/EN2550-Excercises/tree/master/Assignment_01

In [ ]:
```
# imports
import numpy as np
import cv2 as cv
import matplotlib.pyplot as plt
```

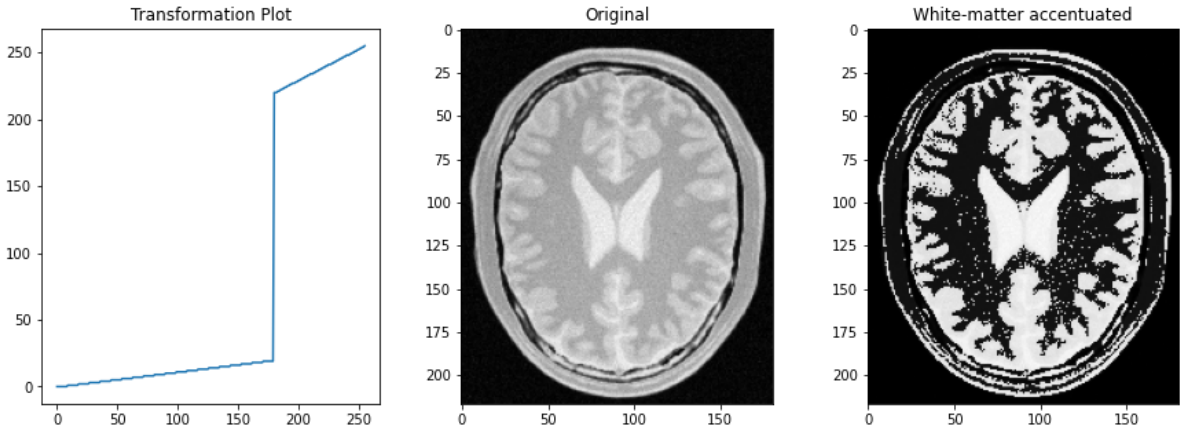
In [ ]:
```
# 1

f=cv.imread('emma_gray.jpg',cv.IMREAD_GRAYSCALE)
assert f is not None

t=np.zeros(255-0+1).astype(np.uint8)
r1=np.linspace(0,50,(50+1-0)).astype(np.uint8)
r2=np.linspace(100,255,(150+1-50)).astype(np.uint8)
r3=np.linspace(150,255,(255+1-150)).astype(np.uint8)
t[0:50+1]=r1
t[50:150+1]=r2
t[150:255+1]=r3

g=cv.LUT(f,t)

fig,ax=plt.subplots(1,2,figsize=(15,5))

ax[0].plot(t)
ax[1].imshow(g,cmap='gray', vmin=0, vmax=255)

plt.show()
```





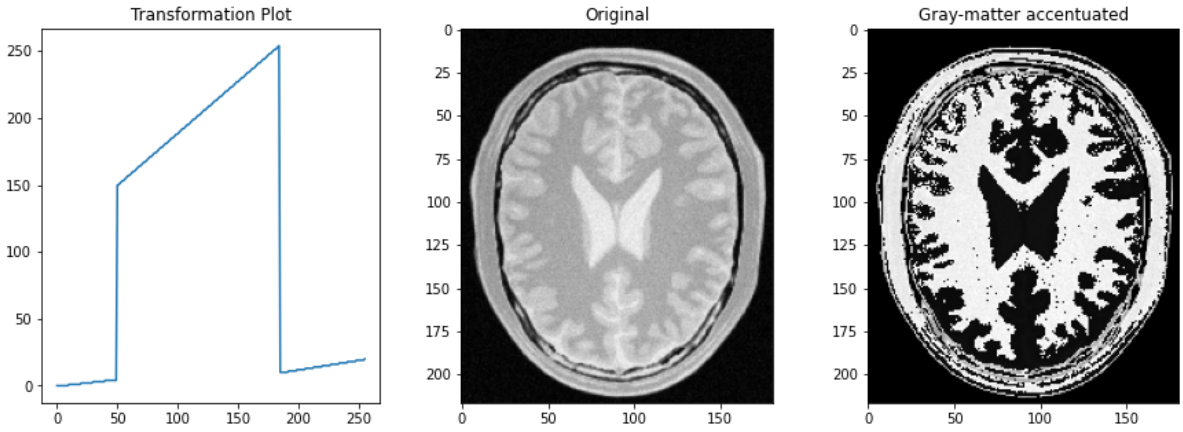
In [ ]:
```
# 2 (a) white matter

f=cv.imread('brain_proton_density_slice.png',cv.IMREAD_GRAYSCALE)
assert f is not None

a=180
t=np.zeros(256).astype(np.uint8)

r1=np.linspace(0,20,(a+1)).astype(np.uint8)
```

```
r2=np.linspace(220,255,(255+1-a)).astype(np.uint8)
t[0:a+1]=r1
t[a:255+1]=r2

g=cv.LUT(f,t)

fig,ax=plt.subplots(1,3,figsize=(15,5))

ax[0].plot(t)
ax[0].set_title("Transformation Plot")
ax[1].imshow(f,cmap='gray', vmin=0, vmax=255)
ax[1].set_title("Original")
ax[2].imshow(g,cmap='gray', vmin=0, vmax=255)
ax[2].set_title("White-matter accentuated")
plt.show()
```

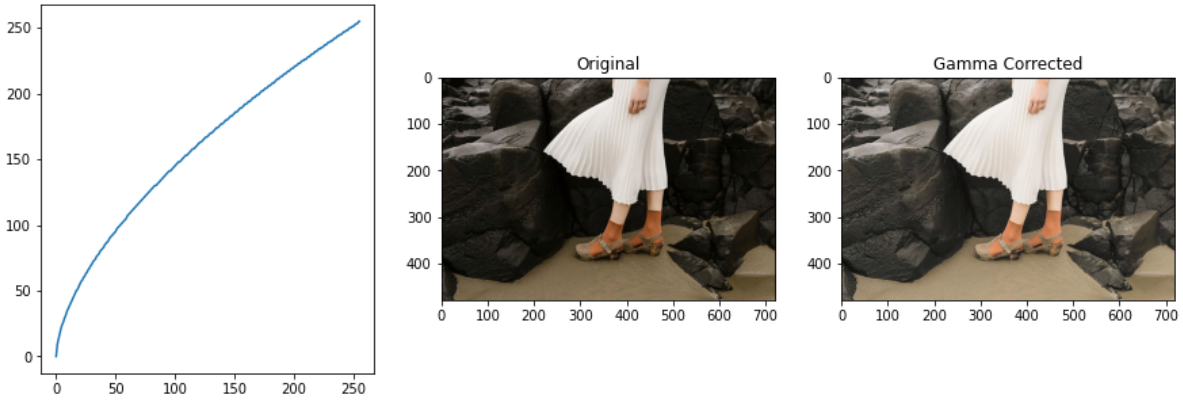


In [ ]:

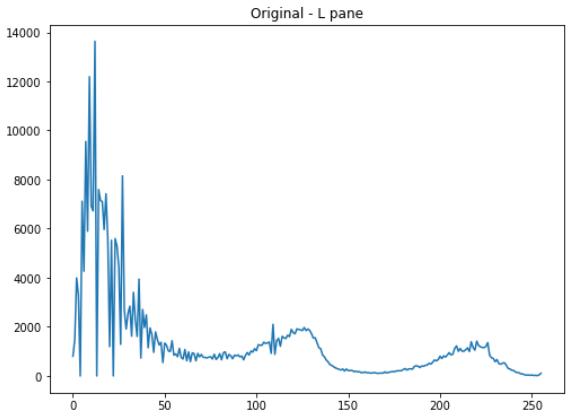
```
# 2 (b) gray matter

f=cv.imread('brain_proton_density_slice.png',cv.IMREAD_GRAYSCALE)
assert f is not None

a1,a2=50,185
t=np.zeros(256).astype(np.uint8)
r1=np.linspace(0,5,(a1+1-0)).astype(np.uint8)
r2=np.linspace(150,255,(a2+1-a1)).astype(np.uint8)
r3=np.linspace(10,20,(255+1-a2)).astype(np.uint8)
t[0:a1+1]=r1
t[a1:a2+1]=r2
t[a2:255+1]=r3

g=cv.LUT(f,t)

fig,ax=plt.subplots(1,3,figsize=(15,5))
ax[0].plot(t)
ax[0].set_title("Transformation Plot")
ax[1].imshow(f,cmap='gray', vmin=0, vmax=255)
ax[1].set_title("Original")
ax[2].imshow(g,cmap='gray', vmin=0, vmax=255)
ax[2].set_title("Gray-matter accentuated")
plt.show()
```

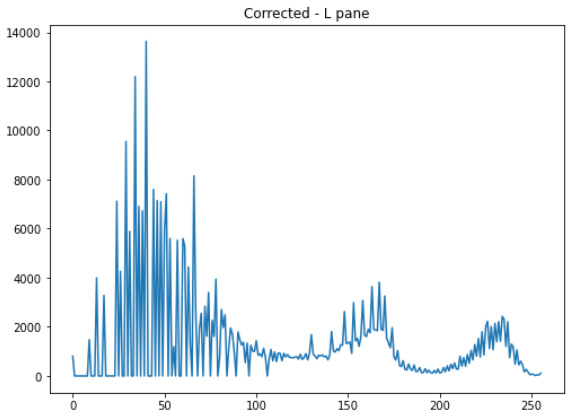


In [ ]:
```
# 3 (a)

f=cv.imread('highlights_and_shadows.jpg')
assert f is not None

lab_org=cv.cvtColor(f,cv.COLOR_BGR2Lab)
gamma=0.6
t=np.array([(p/255)**gamma*255 for p in range(0,256)]).astype(np.uint8)

lab_t=np.copy(lab_org)
lab_t[:,:,0]=t[lab_t[:,:,0]]
rgb_org=cv.cvtColor(lab_org,cv.COLOR_Lab2RGB)
rgb_t=cv.cvtColor(lab_t,cv.COLOR_Lab2RGB)
fig,ax=plt.subplots(1,3,figsize=(15,5))
ax[0].plot(t)
ax[1].imshow(rgb_org)
ax[1].set_title("Original")
ax[2].imshow(rgb_t)
ax[2].set_title("Gamma Corrected")
plt.show()
```

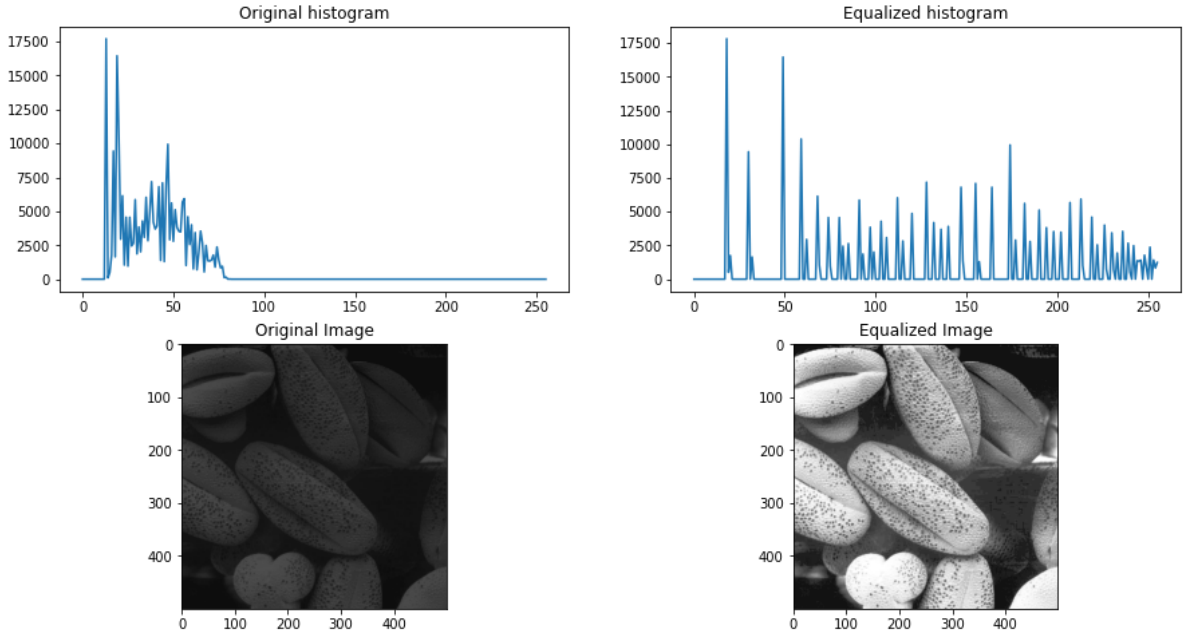


In [ ]:
```
# 3 (b)

hist_org=cv.calcHist([lab_org],[0],None,[256],[0,256])
hist_t=cv.calcHist([lab_t],[0],None,[256],[0,256])
fig,ax=plt.subplots(1,2,figsize=(18,6))
ax[0].plot(hist_org)
ax[0].set_title("Original - L pane")
ax[1].plot(hist_t)
ax[1].set_title("Corrected - L pane")

plt.show()
```





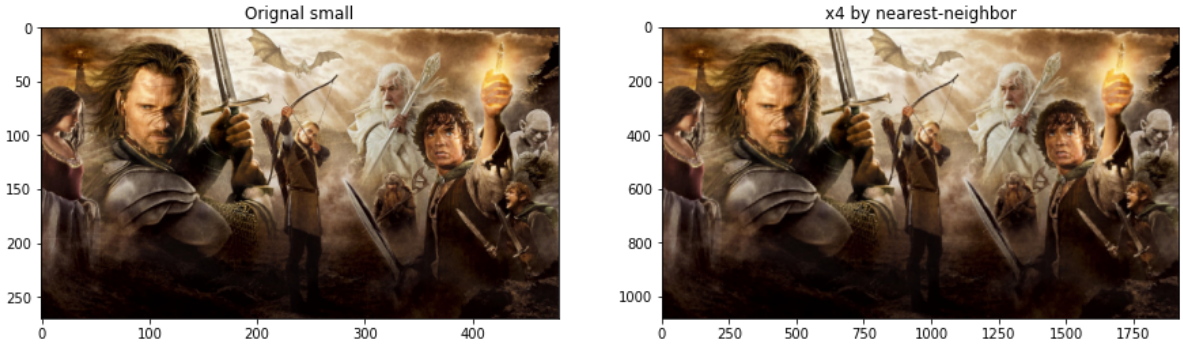
In [ ]:
```
# 4

f=cv.imread('shells.png',cv.IMREAD_GRAYSCALE)
assert f is not None


hist_org=cv.calcHist([f],[0],None,[256],[0,256])
cumsum=hist_org.cumsum()
t=np.round(cumsum*255/f.size).astype(np.uint8)
g=t[f]
hist_eq=cv.calcHist([g],[0],None,[256],[0,256])

fig,ax=plt.subplots(2,2,figsize=(15,8))
ax[0][0].plot(hist_org)
ax[0][0].set_title("Original histogram")
ax[0][1].plot(hist_eq)
ax[0][1].set_title("Equalized histogram")
ax[1][0].imshow(f,cmap='gray', vmin=0, vmax=255)
ax[1][0].set_title("Original Image")
ax[1][1].imshow(g,cmap='gray', vmin=0, vmax=255)
ax[1][1].set_title("Equalized Image")
plt.show()
```



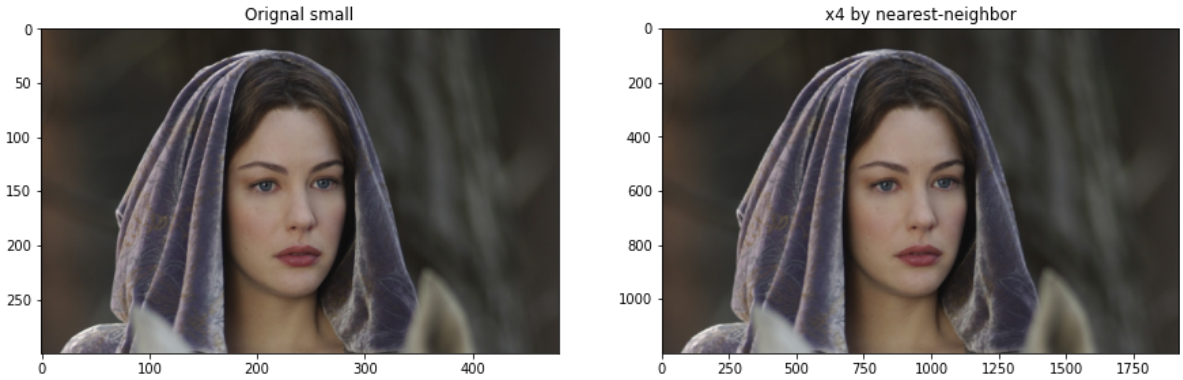
In [ ]:
```
# 5 (a)

def zoomNearestNeighbor(im,scale):

    rows=int(scale*im.shape[0])
    cols=int(scale*im.shape[1])
```

```
    chnls=im.shape[2]

    zoomed=np.zeros((rows,cols,chnls),dtype=im.dtype)

    for i in range(rows):
        for j in range(cols):
            im_i=round(i/scale)
            im_j=round(j/scale)
            if(im_i>=im.shape[0]): im_i=im.shape[0]-1
            if(im_j>=im.shape[1]): im_j=im.shape[1]-1
            zoomed[i,j]=im[im_i,im_j]

    return zoomed

for i in range(1,4):
    im=cv.imread('a1q5images\im0{}small.png'.format(i))
    zoomed=zoomNearestNeighbor(im,4)
    fig, ax = plt.subplots(nrows=1, ncols=2, figsize=(15, 10))
    ax[0].imshow(cv.cvtColor(im,cv.COLOR_BGR2RGB))
    ax[0].set_title("Orignal small")
    ax[1].imshow(cv.cvtColor(zoomed,cv.COLOR_BGR2RGB))
    ax[1].set_title("x4 by nearest-neighbor")

    imlarge=cv.imread('a1q5images\im0{}.png'.format(i))
    nssd = cv.matchTemplate(imlarge,zoomed,cv.TM_SQDIFF_NORMED)
    print("im0{}.png: noramalized sum of squared difference = {}".format(i,nssd[0,0

    plt.show()
```

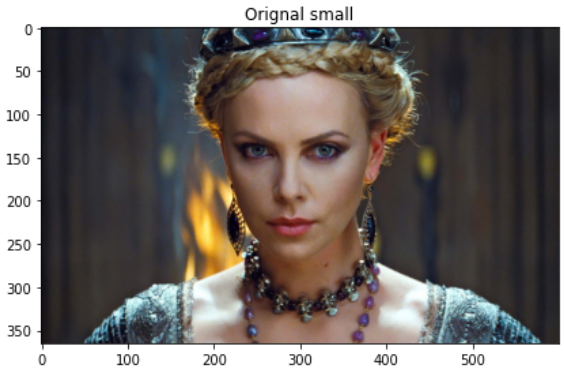
```
im01.png: noramalized sum of squared difference = 0.022723643109202385
```




```
im02.png: noramalized sum of squared difference = 0.010222389362752438
```



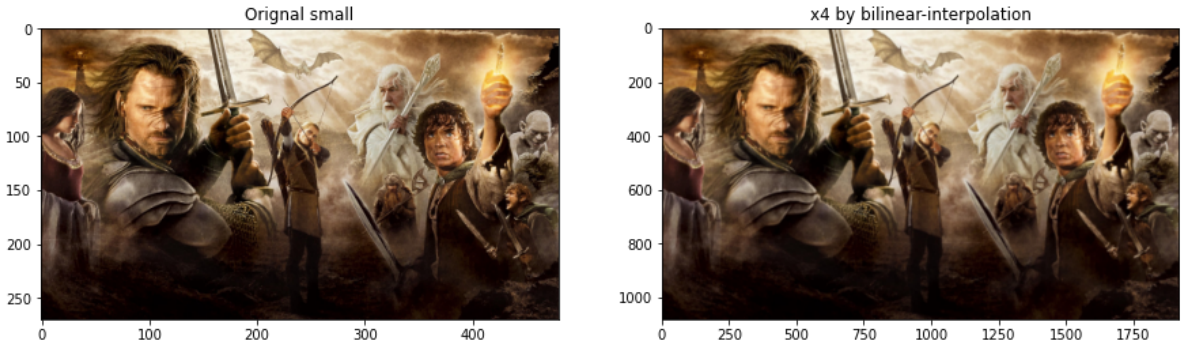

```
im03.png: noramalized sum of squared difference = 0.014736237935721874
```



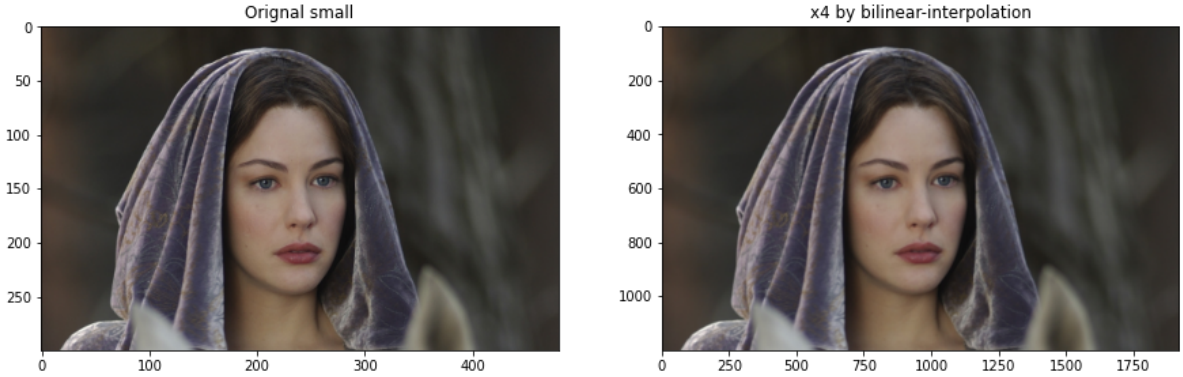
In [ ]:

```
# 5 (b)

def zoomBilinearInterpolation(im,scale):

    rows=int(scale*im.shape[0])
    cols=int(scale*im.shape[1])
    chnls=im.shape[2]

    zoomed=np.zeros((rows,cols,chnls),dtype=im.dtype)

    for m in range(rows):
        for n in range(cols):
                i,j=m/scale,n/scale
                i0,j0=int(i),int(j)
                i1,j1=i0+1,j0+1
                di0,dj0=i-i0,j-j0
                di1,dj1=1-di0,1-dj0

                if(i1>=im.shape[0]): i1=im.shape[0]-1
                if(j1>=im.shape[1]): j1=im.shape[1]-1

                k0=im[i0,j0]*di1+im[i1,j0]*di0
                k1=im[i0,j1]*di1+im[i1,j1]*di0
                k=k0*dj1+k1*dj0

                zoomed[m,n]=k

    return zoomed

for i in range(1,4):
    im=cv.imread('a1q5images\im0{}small.png'.format(i))
    zoomed=zoomBilinearInterpolation(im,4)
    fig, ax = plt.subplots(nrows=1, ncols=2, figsize=(15, 10))
    ax[0].imshow(cv.cvtColor(im,cv.COLOR_BGR2RGB))
    ax[0].set_title("Orignal small")
    ax[1].imshow(cv.cvtColor(zoomed,cv.COLOR_BGR2RGB))
    ax[1].set_title("x4 by bilinear-interpolation")

    imlarge=cv.imread('a1q5images\im0{}.png'.format(i))
    nssd = cv.matchTemplate(imlarge,zoomed,cv.TM_SQDIFF_NORMED)
    print("im0{}.png: noramalized sum of squared difference = {}".format(i,nssd[0,(

    plt.show()
```

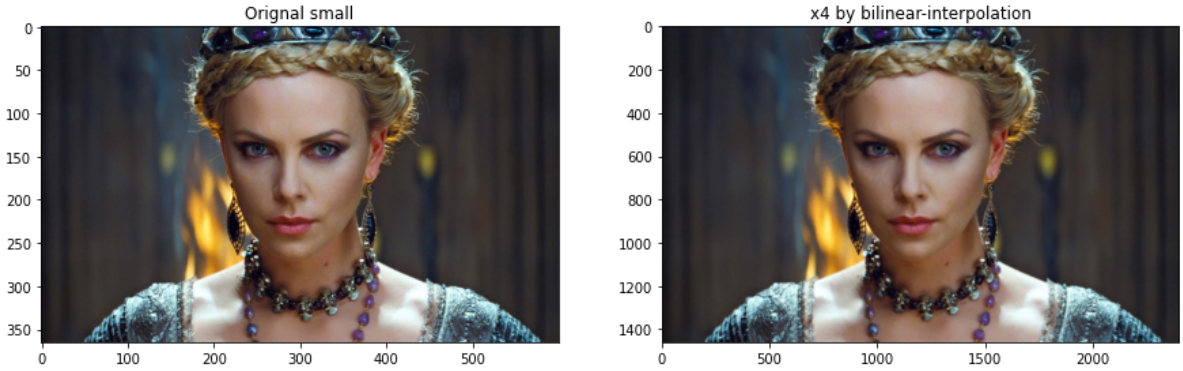
```
im01.png: noramalized sum of squared difference = 0.017942212522029877
```



im02.png: noramalized sum of squared difference = 0.007791651412844658



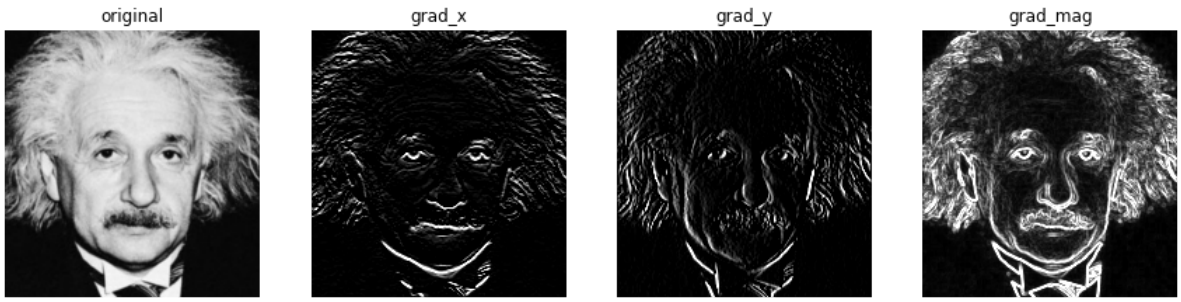
im03.png: noramalized sum of squared difference = 0.011208901181817055



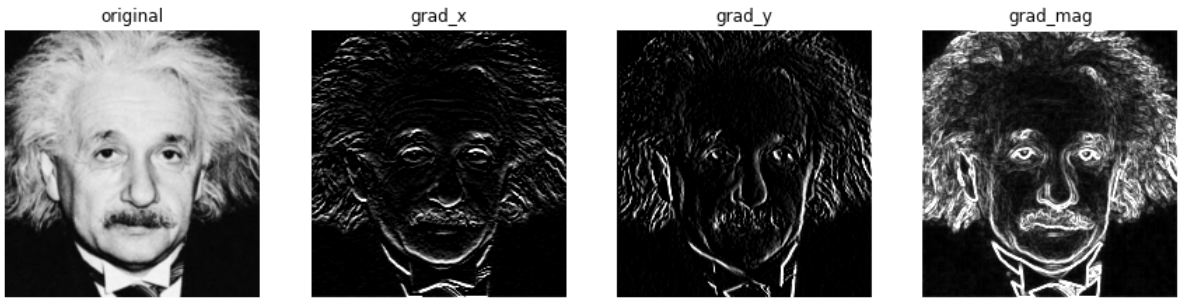
In [ ]:

```python
# 6 (a)

f=cv.imread('einstein.png',cv.IMREAD_GRAYSCALE).astype(np.float32)
assert f is not None

sobel_v=np.array([[-1,-2,-1],[0,0,0],[1,2,1]],
dtype=np.float32)

f_x=cv.filter2D(f,-1,sobel_v)

sobel_h=np.array([[-1,0,1],[-2,0,2],[-1,0,1]],
dtype=np.float32)

f_y=cv.filter2D(f,-1,sobel_h)

grad_mag=np.sqrt(f_x**2+f_y**2)

fig,ax=plt.subplots(1,4,figsize=(15,8))

ax[0].imshow(f,cmap='gray', vmin=0, vmax=255)
ax[0].set_title('original')
ax[1].imshow(f_x,cmap='gray', vmin=0, vmax=255)
ax[1].set_title('grad_x')
ax[2].imshow(f_y,cmap='gray', vmin=0, vmax=255)
ax[2].set_title('grad_y')
ax[3].imshow(grad_mag,cmap='gray', vmin=0, vmax=255)
```

```
ax[3].set_title('grad_mag')

for axi in ax.ravel(): axi.axis('off')
```

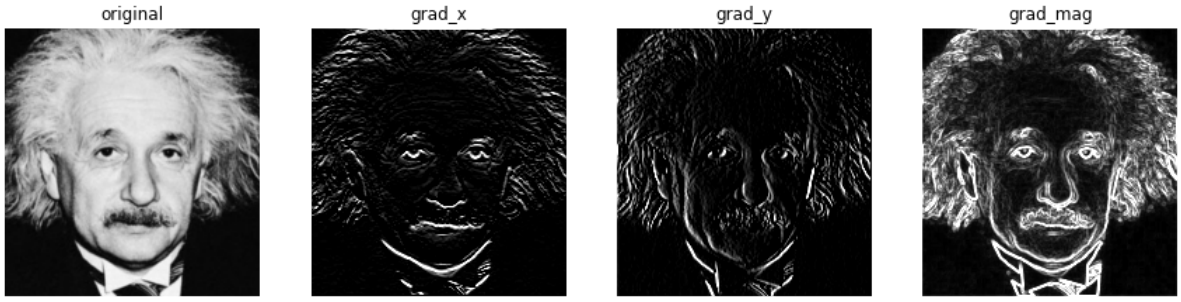


In [ ]:
```
# 6 (b)

def convolve(img,kernal):
    kw=kernal.shape[0]
    kh=kernal.shape[1]
    kernal180=kernal[::-1,::-1]
    padded=np.pad(img,((kw//2,kw//2),(kh//2,kh//2)))
    res=np.zeros(img.shape).astype(np.float32)
    for m in range(img.shape[0]):
        for n in range(img.shape[1]):
            res[m,n]=np.sum(padded[m:m+kw,n:n+kh]*kernal180)

    return res

f_x=convolve(f,sobel_v)
f_y=convolve(f,sobel_h)

grad_mag=np.sqrt(f_x**2+f_y**2)

fig,ax=plt.subplots(1,4,figsize=(15,8))

ax[0].imshow(f,cmap='gray', vmin=0, vmax=255)
ax[0].set_title('original')
ax[1].imshow(f_x,cmap='gray', vmin=0, vmax=255)
ax[1].set_title('grad_x')
ax[2].imshow(f_y,cmap='gray', vmin=0, vmax=255)
ax[2].set_title('grad_y')
ax[3].imshow(grad_mag,cmap='gray', vmin=0, vmax=255)
ax[3].set_title('grad_mag')

for axi in ax.ravel(): axi.axis('off')
```



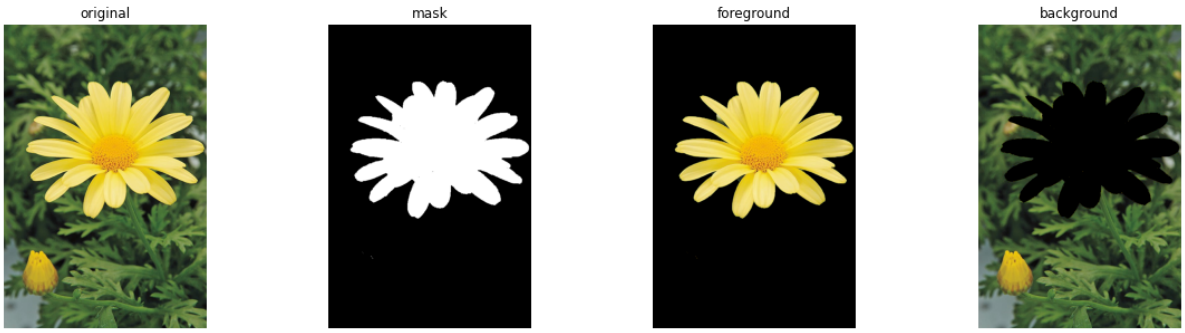
In [ ]:
```
# 6 (c)

sobel_h1=np.array([[1],[2],[1]])
sobel_h2=np.array([[1,0,-1]])

sobel_v1=np.array([[1],[0],[-1]])
sobel_v2=np.array([[1,2,1]])
```

```
f_y=convolve(f,sobel_h1)
f_y=convolve(f_y,sobel_h2)

f_x=convolve(f,sobel_v1)
f_x=convolve(f_x,sobel_v2)


grad_mag=np.sqrt(f_x**2+f_y**2)

fig,ax=plt.subplots(1,4,figsize=(15,8))
ax[0].imshow(f,cmap='gray', vmin=0, vmax=255)
ax[0].set_title('original')
ax[1].imshow(f_x,cmap='gray', vmin=0, vmax=255)
ax[1].set_title('grad_x')
ax[2].imshow(f_y,cmap='gray', vmin=0, vmax=255)
ax[2].set_title('grad_y')
ax[3].imshow(grad_mag,cmap='gray', vmin=0, vmax=255)
ax[3].set_title('grad_mag')

for axi in ax.ravel(): axi.axis('off')
```



In [ ]:

```
# 7 (a)

img=cv.imread('daisy.jpg')
assert img is not None

mask = np.zeros(img.shape[:2],np.uint8)
bgdModel = np.zeros((1,65),np.float64)
fgdModel = np.zeros((1,65),np.float64)
rect = (56,150,560,500)
cv.grabCut(img,mask,rect,bgdModel,fgdModel,2,cv.GC_INIT_WITH_RECT)
mask = np.where((mask==2)|(mask==0),0,1).astype('uint8')

imgFg = img*mask[:,:,np.newaxis]
imgBg=img-imgFg

fig,ax=plt.subplots(1,4,figsize=(20,5))

ax[0].imshow(cv.cvtColor(img,cv.COLOR_BGR2RGB))
ax[0].set_title('original')
ax[1].imshow(mask,cmap='gray', vmin=0, vmax=1)
ax[1].set_title('mask')
ax[2].imshow(cv.cvtColor(imgFg,cv.COLOR_BGR2RGB))
ax[2].set_title('foreground')
ax[3].imshow(cv.cvtColor(imgBg,cv.COLOR_BGR2RGB))
ax[3].set_title('background')

for axi in ax.ravel(): axi.axis('off')
```



In [ ]:
```
# 7 (b)

imgBgBlur=cv.GaussianBlur(imgBg,(9,9),12)
imgEnhnsd=np.bitwise_or(imgFg,imgBgBlur)
fig,ax=plt.subplots(1,2,figsize=(8,5))

ax[0].imshow(cv.cvtColor(img,cv.COLOR_BGR2RGB))
ax[0].set_title('original')
ax[1].imshow(cv.cvtColor(imgEnhnsd,cv.COLOR_BGR2RGB))
ax[1].set_title('enhanced')

for axi in ax.ravel(): axi.axis('off')
```

7 (c)

When we blur the background image, foreground area of background image is existed as black. So, in the blurred image pixels near edge become more darker due to mixing with that black area when blurring. So, edge of the flower quite dark in the enhanced image.