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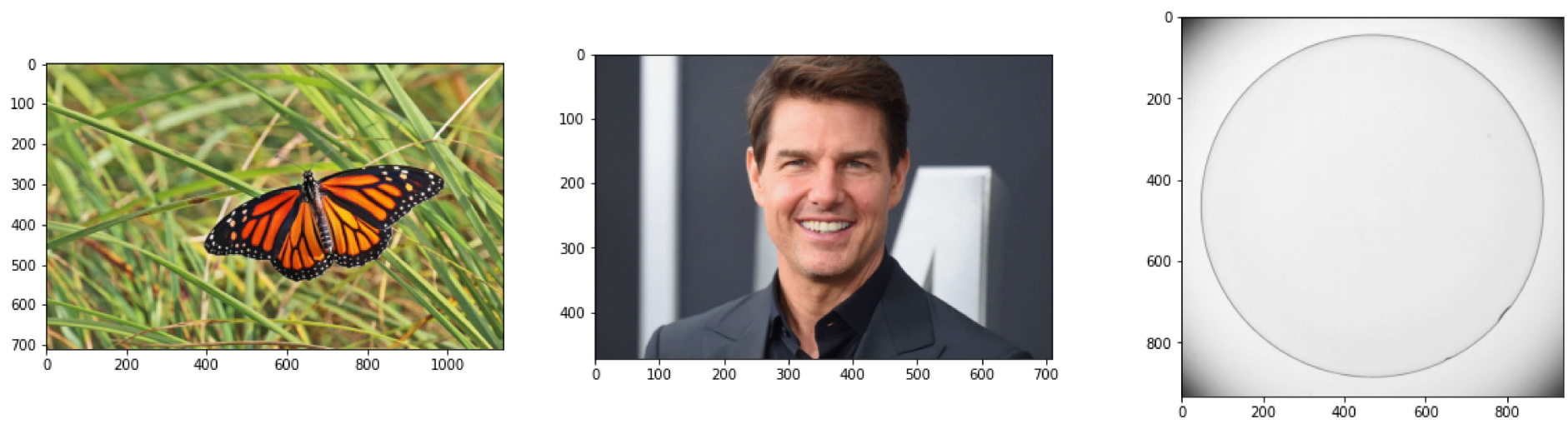
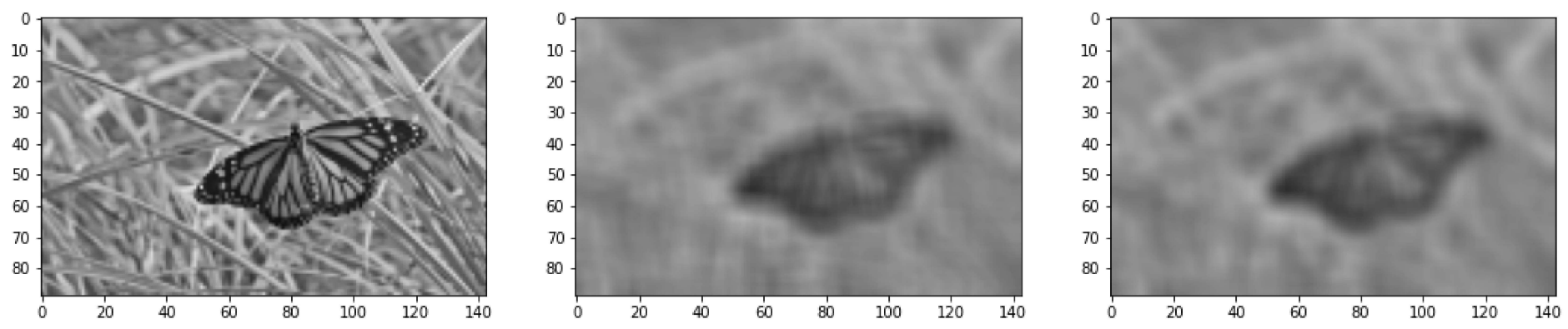
In [ ]:
```
%matplotlib inline
import cv2 as cv
import numpy as np
import matplotlib.pyplot as plt
img1 = cv.imread('butterfly.jpg')
img2 = cv.imread('tom.jpg')
img3 = cv.imread('contact_lens.tif')


img1_1 = cv.cvtColor(img1,cv.COLOR_BGR2RGB)
img2_1 = cv.cvtColor(img2,cv.COLOR_BGR2RGB)
f,ax = plt.subplots(1,3,figsize = [20,5])
ax[0].imshow(img1_1)
ax[1].imshow(img2_1)
ax[2].imshow(img3,cmap = 'gray',vmin =0,vmax =255)
# ax[0].set_title("")
plt.show()
```

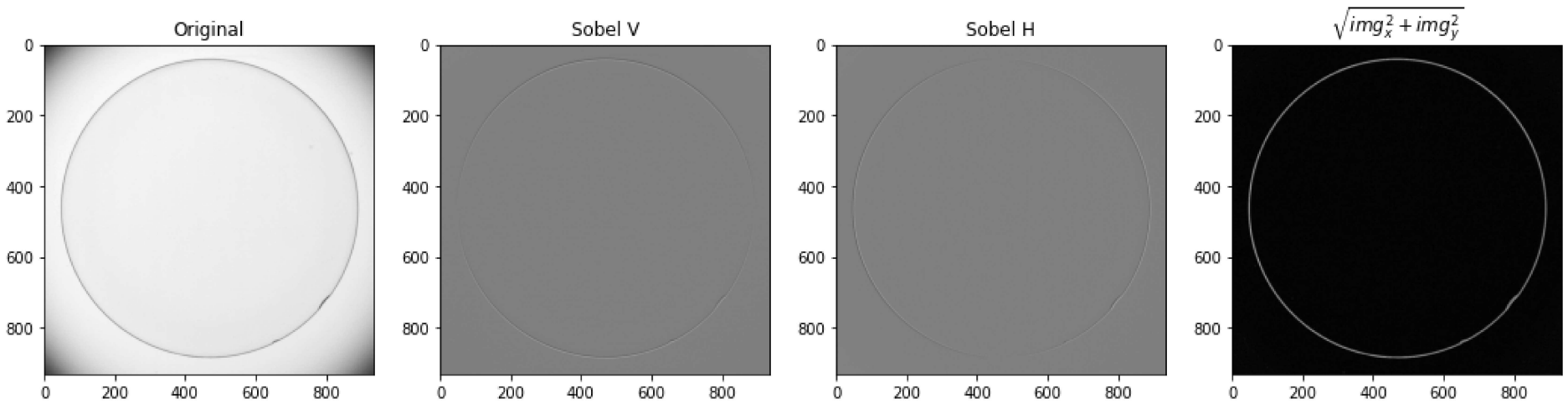


In [ ]:
```
im = cv.imread('butterfly.jpg',cv.IMREAD_REDUCED_GRAYSCALE_8).astype('float32')
assert im is not None

k_size = 9
sigma = 4

box_kernal = 1./81*np.ones((9,9))
im_avg = cv.filter2D(im,-1,box_kernal)
im_gau = cv.GaussianBlur(im,(9,9),4)


fig,ax = plt.subplots(1,3,figsize=(18,6))
ax[0].imshow(im,cmap='gray',vmin=0,vmax=255)
ax[1].imshow(im_avg,cmap='gray',vmin=0,vmax=255)
ax[2].imshow(im_gau,cmap='gray',vmin=0,vmax=255)

plt.show()
```



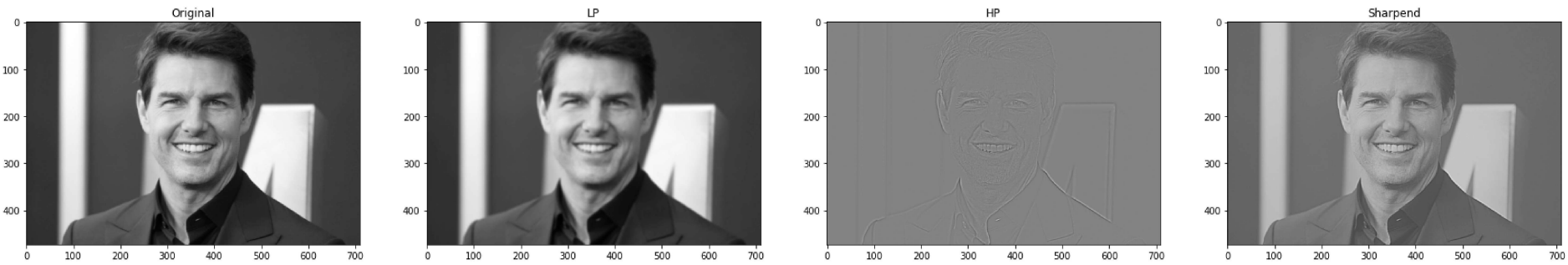
In [ ]:
```
im = cv.imread('contact_lens.tif',cv.IMREAD_GRAYSCALE).astype('float32')
assert im is not None

k_size = 9
sigma = 4

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

im_x = cv.filter2D(im,-1,sobel_v)
im_y = cv.filter2D(im,-1,sobel_h)

grad_mag = np.sqrt(im_x**2 +im_y**2)


fig,ax = plt.subplots(1,4,figsize=(18,6))
ax[1].imshow(im_x,cmap='gray',vmin=-1020,vmax=1020)
ax[0].imshow(im,cmap='gray',vmin=0,vmax=255)
```

```
ax[2].imshow(im_y,cmap='gray',vmin=-1020,vmax=1020)
ax[3].imshow(grad_mag,cmap='gray')

ax[0].set_title("Original")
ax[1].set_title("Sobel V")
ax[2].set_title("Sobel H")
ax[3].set_title("$\sqrt{img_x^2 + img_y^2}$")

plt.show()
```



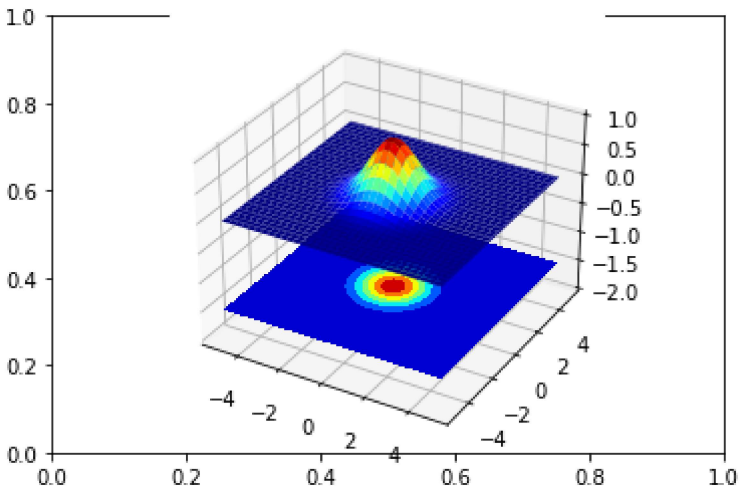
In [ ]:

```
#Q4
im = cv.imread('tom.jpg',cv.IMREAD_GRAYSCALE).astype('float32')
assert im is not None
f = np.ones((5,5))

sigma = 5
gaussian_1D = cv.getGaussianKernel(5,sigma)
# plt.plot(gaussian_1D)
im_lp = cv.sepFilter2D(im,-1,gaussian_1D,gaussian_1D)
im_hp = im - im_lp
im_sharpen = cv.addWeighted(im,1.0,im_hp,2.0,0)


fig,ax = plt.subplots(1,4,figsize=(30,5))

ax[0].imshow(im,cmap='gray')
ax[1].imshow(im_lp,cmap='gray')
ax[2].imshow(im_hp,cmap='gray')
ax[3].imshow(im_sharpen,cmap='gray')

ax[0].set_title("Original")
ax[1].set_title("LP")
ax[2].set_title("HP")
ax[3].set_title("Sharpend")
plt.show()
```



In [ ]:

```
#Q2
from mpl_toolkits.mplot3d import Axes3D
from matplotlib import cm

fig,ax = plt.subplots()
ax = fig.add_subplot(111,projection='3d')

step = 0.1
sigma = 1
X = np.arange(-5,5+step,step)
Y = np.arange(-5,5+step,step)

XX,YY = np.meshgrid(X,Y)

g = np.exp(-(XX**2 + YY**2)/(2*sigma**2))

surf = ax.plot_surface(XX,YY,g,cmap=cm.jet)
cset = ax.contourf(XX,YY,g,zdir='z',offset=np.min(g)-1.5,cmap=cm.jet)
ax.set_zlim(np.min(g)-2,np.max(g))

plt.show()
```



In [ ]:

```
#Q2

im = cv.imread('tom.jpg',cv.IMREAD_GRAYSCALE).astype('float32')

step = 0.1
sigma = 0.5
X = np.arange(-5,5+step,step)
Y = np.arange(-5,5+step,step)

XX,YY = np.meshgrid(X,Y)

g = np.exp(-(XX**2 + YY**2)/(2*sigma**2))
g /= np.sum(g)


blurred = cv.filter2D(im,-1,g)


fig,ax = plt.subplots(1,2,figsize=(20,5))

ax[0].imshow(im,cmap='gray')
ax[1].imshow(blurred,cmap='gray')

plt.show()
```