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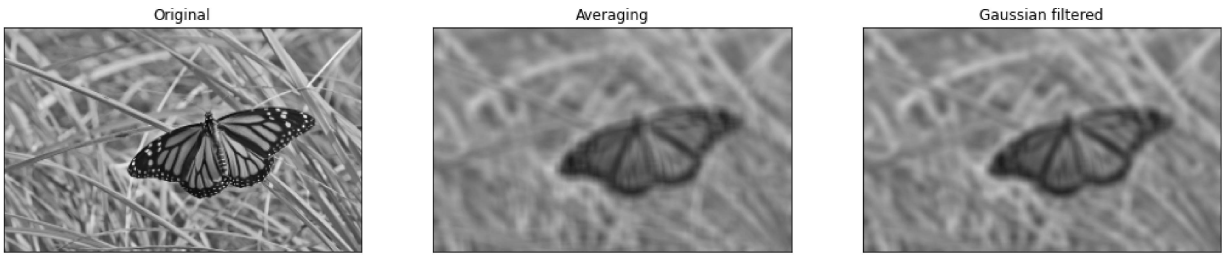
Index Number = 190128H

Question 1

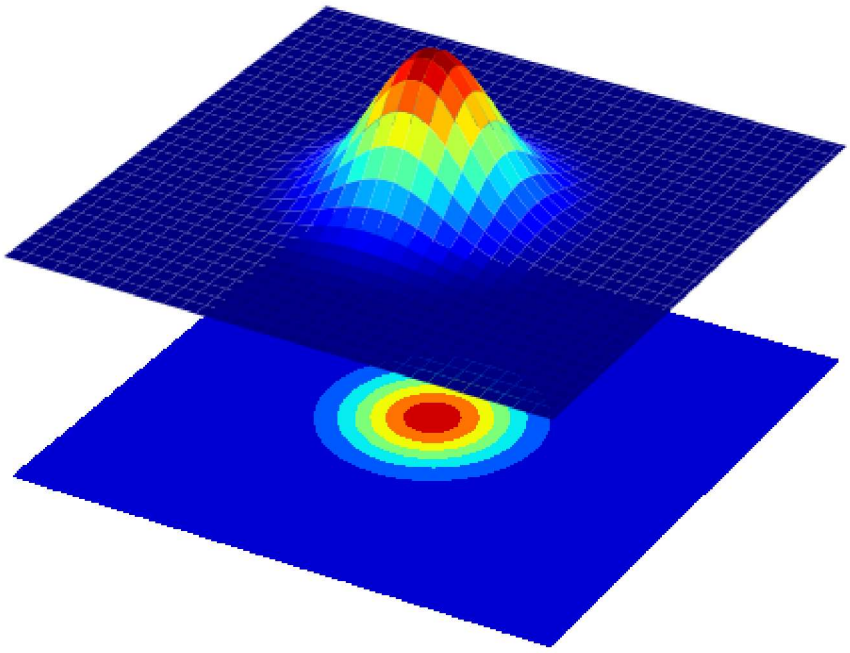
In [ ]:
```
%matplotlib inline
import numpy as np
import cv2 as cv
import matplotlib.pyplot as plt

im=cv.imread(r'butterfly.jpg',cv.IMREAD_REDUCED_GRAYSCALE_4)
assert im is not None

k_size=9
sigma=4
kernel = 1./81*np . ones ((k_size ,k_size ) , np . float32 )
imgc=cv.filter2D(im,-1,kernel)
im_g= cv.GaussianBlur(im,(k_size,k_size),sigma)

fig,axes = plt.subplots(1,3,sharex="all",sharey="all",figsize=(18,18))
axes[0].imshow(im, cmap="gray",vmin=0, vmax=255)
axes[0] . set_title( "Original")

axes [1] . imshow( imgc , cmap= "gray",vmin=0, vmax=255)
axes [1] . set_title( "Averaging" )

axes [2] . imshow( im_g , cmap= "gray",vmin=0, vmax=255)
axes [2] . set_title( "Gaussian filtered" )


for i in range(3):
    axes [i] . set_xticks ([]) , axes [i] . set_yticks ([])
plt . show()
```



Question 2

In [ ]:
```
from mpl_toolkits.mplot3d import Axes3D
from matplotlib import cm


fig = plt.figure(figsize=(10,10))
ax= fig.add_subplot(111,projection = '3d')
sigma = 1

x=np.arange(-5,5+0.1,0.1)
```

```
y=np.arange(-5,5+0.1,0.1)
x,y = np.meshgrid(x,y)
z=np.exp(-(x**2+y**2)/(2*sigma**2))


surf = ax.plot_surface(x,y,z, cmap=cm.jet, linewidth=0, antialiased = True)

cset = ax.contourf(x,y,z, zdir ='z', offset=np.min(z) -1.5,cmap=cm.jet)
ax.set_zlim(np.min(z) - 2,np.max(z))

plt.axis('off')
plt.show()
```

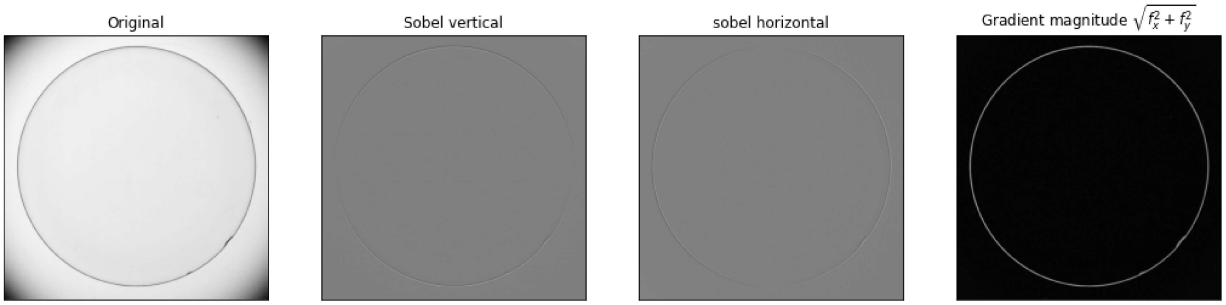


Question 3

In [ ]:

```
im=cv.imread(r'contact_lens.tif',cv.IMREAD_GRAYSCALE).astype(np.float32)
assert im is not None

ver_kernel = np . array ([[-1,-2,-1 ],[0,0,0],[1,2,1]] , dtype=np.float32)
f_x=cv.filter2D(im,-1,ver_kernel)

hor_kernel = np . array ([[-1,0,1 ],[-2,0,2],[-1,0,1]] , dtype=np.float32)
f_y=cv.filter2D(im,-1,hor_kernel)
```

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

fig,axes = plt.subplots(1,4,sharex="all",sharey="all",figsize=(18,18))
axes[0].imshow(im, cmap="gray")
axes[0] . set_title( "Original")

axes[1] . imshow( f_x , cmap= "gray",vmin=-1020,vmax=1020)
axes[1] . set_title( "Sobel vertical" )

axes[2] . imshow( f_y , cmap= "gray",vmin=-1020,vmax=1020)
axes[2] . set_title( "sobel horizontal" )

axes[3] . imshow( grad_mag , cmap= "gray")
axes[3] . set_title( "Gradient magnitude $ \sqrt{f_x^2 + f_y^2}$" )

for i in range(4):
    axes [i] . set_xticks ([]) , axes [i] . set_yticks ([])
plt . show()
```



Question 4

In [ ]:

```
%matplotlib inline
import numpy as np
import cv2 as cv
import matplotlib.pyplot as plt

img=cv.imread(r'tom.jpg',cv.IMREAD_GRAYSCALE).astype(np.float32)
assert im is not None

sigma=2
gaussian_1d=cv.getGaussianKernel(5,sigma)
#blurred = cv.sepFilter2D(img, -1, gaussian_1d, gaussian_1d, anchor=(-1,-1), delta=0,
blurred = cv.sepFilter2D(img, -1, gaussian_1d, gaussian_1d)
#diff = img.astype('float32')-blurred.astype('float32')
diff=img-blurred

#sharpened = cv.addWeighted(img.astype('float32'),1.0,diff,1.5,0)
sharpened = cv.addWeighted(img,1.0,diff,2.0,0)

fig,axes = plt.subplots(2,2,sharex="all",sharey="all",figsize=(18,18))
axes[0,0].imshow(img, cmap="gray")
axes [0,0] . set_title( "Original")
axes [0,0] . set_xticks ([]) , axes [0,0] . set_yticks ([])
axes [0,1] . imshow( blurred , cmap= "gray")
axes [0,1] . set_title( "Blurred" )
axes [0,1] . set_xticks([]) , axes [0,1] . set_yticks([])
axes [1,0] . imshow( diff , cmap= "gray")
axes [1,0] . set_title( "Difference" )
axes [1,0] . set_xticks([]) , axes [1,0] . set_yticks([])
```

```
axes [1,1] . imshow( sharpened , cmap= "gray")
axes [1,1] . set_title( "Sharpened" )
axes [1,1] . set_xticks([]) , axes [1,1] . set_yticks([])


plt . show()
```