190622R_excercise_3

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1 Name : Tharindu O.K.D

2 Index No. : 190622R

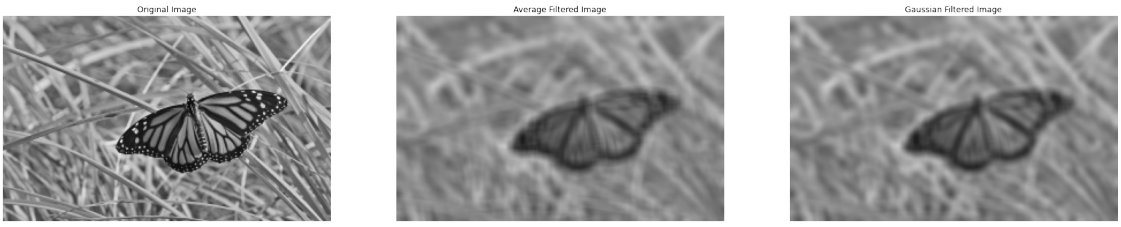
2.1 Question 01

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

img = cv.imread(r"butterfly.jpg", cv.IMREAD_REDUCED_GRAYSCALE_4)
assert img is not None

box_kernel = np.ones((9, 9), np.float) / 81
avg_img = cv.filter2D(img, -1, box_kernel)
gaussian_img = cv.GaussianBlur(img, (9, 9), 4)

fig, ax = plt.subplots(1, 3, figsize=(30, 10))
ax[0].imshow(img, cmap="gray", vmin=0, vmax=255)
ax[0].set_title("Original Image")
ax[1].imshow(avg_img, cmap="gray", vmin=0, vmax=255)
ax[1].set_title("Average Filtered Image")
ax[2].imshow(gaussian_img, cmap="gray", vmin=0, vmax=255)
ax[2].set_title("Gaussian Filtered Image")
for i in range(3):
    ax[i].axis("off")
plt.show()
```



2.2 Question 02

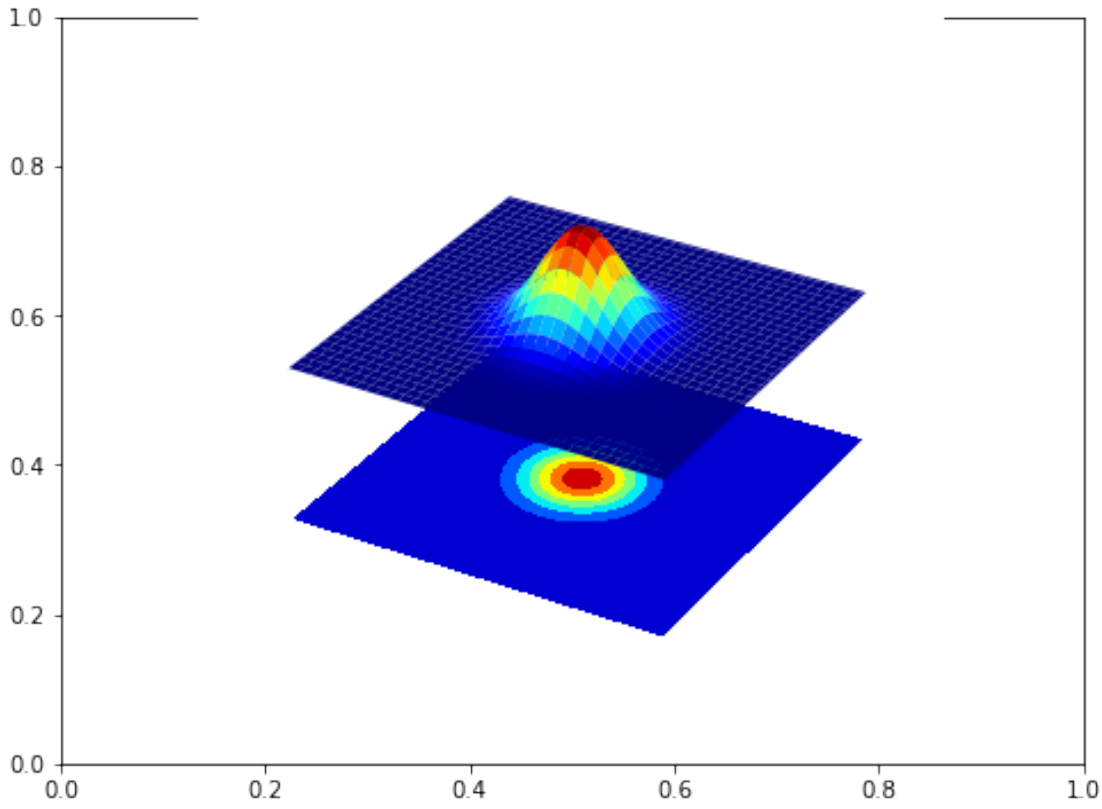
[ ]:
```
from mpl_toolkits.mplot3d import Axes3D
from matplotlib import cm

fig, ax = plt.subplots(figsize=(8,6))
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.axis("off")
plt.show()
```



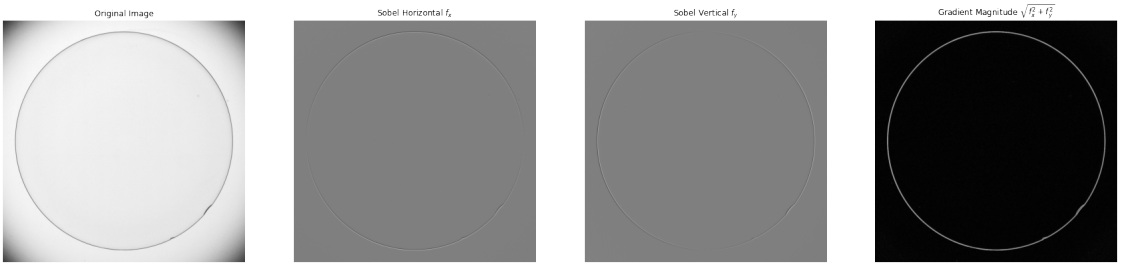
2.3 Question 03

[ ]:
```
img = cv.imread(r"contact_lens.tif", cv.IMREAD_GRAYSCALE).astype(np.float32)
assert img is not None

sobel_v_kernel = np.array([[-1, -2, -1], [0, 0, 0], [1, 2, 1]], dtype=np.
 ↪float32)
f_x = cv.filter2D(img, -1, sobel_v_kernel)

sobel_h_kernel = np.array([[-1, 0, 1], [-2, 0, 2], [-1, 0, 1]], dtype=np.
 ↪float32)
f_y = cv.filter2D(img, -1, sobel_h_kernel)
grad_mag_img = np.sqrt(f_x**2 + f_y**2)

fig, ax = plt.subplots(1, 4, figsize=(30, 18))
ax[0].imshow(img, cmap="gray", vmin=0, vmax=255)
ax[0].set_title("Original Image")
ax[1].imshow(f_x, cmap="gray", vmin=-1020, vmax=1020)
ax[1].set_title(r"Sobel Horizontal $f_x$")
ax[2].imshow(f_y, cmap="gray", vmin=-1020, vmax=1020)
ax[2].set_title(r"Sobel Vertical $f_y$")
ax[3].imshow(grad_mag_img, cmap="gray")
ax[3].set_title(r"Gradient Magnitude $\sqrt{f_x^2+f_y^2}$")
for i in range(4):
    ax[i].axis("off")
plt.show()
```



2.4 Question 04

[ ]:
```
img = cv.imread(r"tom.jpg", cv.IMREAD_GRAYSCALE).astype(np.float32)
assert img is not None

sigma = 5
gaussian_kernel = cv.getGaussianKernel(5, sigma=sigma)
f_lp = cv.sepFilter2D(img, -1, gaussian_kernel, gaussian_kernel)
f_hp = img - f_lp
```

```
f_sharpened = cv.addWeighted(img, 1, f_hp, 2, 0)

fig, ax = plt.subplots(1, 4, figsize=(30, 15))
ax[0].imshow(img, cmap="gray", vmin=0, vmax=255)
ax[0].set_title("Original Image")
ax[1].imshow(f_lp, cmap="gray")
ax[1].set_title(r"Smoothed Image $f_{LP}$")
ax[2].imshow(f_hp, cmap="gray")
ax[2].set_title(r"$f_{HP}$")
ax[3].imshow(f_sharpened, cmap="gray")
ax[3].set_title(r"Sharpened Image")
for i in range(4):
    ax[i].axis("off")
plt.show()
```