2110431 Introduction to Digital Imaging

2147329 Digital Image Processing and Vision Systems

Homework #2

Deadline: October 13, 2021 @23:59

Submissions: (1) PDF version of this file

(2) Python files (homework2_1_<ID>.py, homework2_2_<ID>.py)

Before submitting the python file (free style) for displaying results for homework 1 and 2, respectively, please make sure it can be successfully compiled and correctly in its format name (1 points).

**** Submitted python code is collected for plagiarism check. Any work which is not passing plagiarism check, total homework score will be ZERO.**

1. (2 points) Apply Gaussian low pass filter in frequency domain on “Kitty3.png” image which has $M\ x\ N$ pixels. Find the minimum cutoff frequency (C) that still maintain the total image power P_T more than 99%. Where the total image power, P_T is calculated by summing the components of spectrum power at each point (u, v), for $u = 1,2, \ldots . M-1$ and $v = 1,2, \ldots, N-1$

$$P_T = \sum_{u=0}^{M-1} \sum_{v=0}^{N-1} P(u, v)$$

$P(u, v)$ is the spectrum power provided in the lecture slides

α percent of the image power can be calculated from 100 x P_{T_f} / P_{T_org}, where P_{T_org} is the total image power of the original image and P_{T_f} of the filtered image

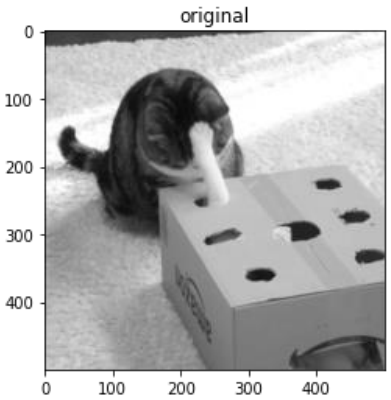
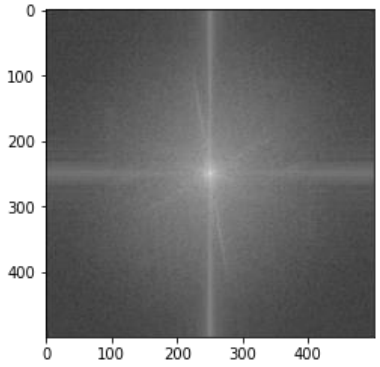
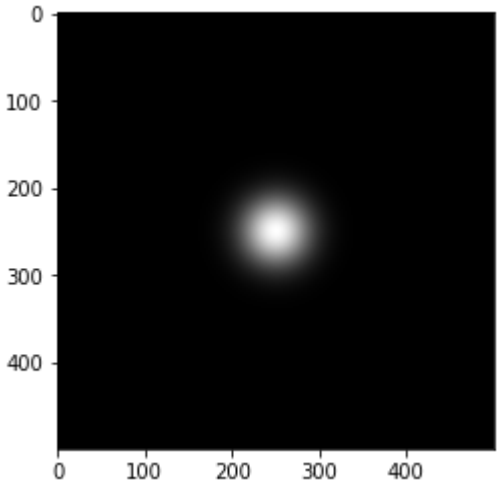
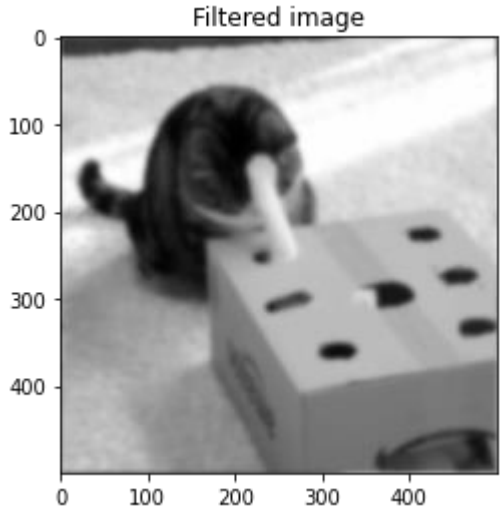
Put your results in the blank box below

Cutoff frequency (C) =

27 (if we are considering the frequency as integer)

α =

99.01590767196541

Original Image (“kitty55.png”)	Fourier Spectrum of the original image
	
Fourier Spectrum of the filtered image	**Filtered images (P_T > 99%)**
	

Put your code here:

(you can paste all the code or put only the highlighted code for this problem)

```
image1 = cv2.imread("kitty55.png",0)
F = np.fft.fft2(image1)
FShift = np.fft.fftshift(F)
magnitude_spectrum = np.log(1+np.abs(FShift))

c = 27
ny, nx = image1.shape
x = np.linspace(-nx/2, nx/2-1, nx)
```

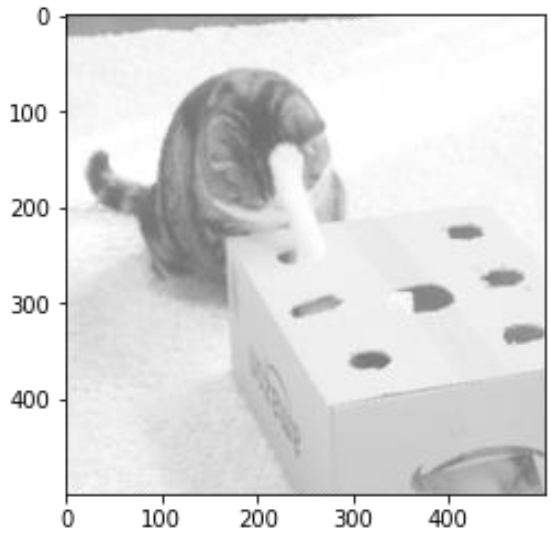
```
y = np.linspace(-ny/2, ny/2-1, ny)
new_x = np.array([list(x)]*ny)
new_y = np.array([list(y)]*nx).T

gaussian_filter = np.exp(-(new_x**2+new_y**2)/(2*(c**2)))

img_ft_filter = FShift*gaussian_filter
fshift_power = (np.abs(FShift)**2).sum()
filter_power = (np.abs(img_ft_filter)**2).sum()

alpha = 100*(filter_power/fshift_power)

f_ishift = np.fft.ifftshift(img_ft_filter)
img_back = np.fft.ifft2(f_ishift)
img_back = np.abs(img_back)
```

2) (2 points) There is some periodic noise in “noisy_kitty55.png” image. Remove the periodic noise and calculate PSNR.

Show how to restore the image from periodic noise and display the result,

ทำการคำนวณ magnitude spectrum จาก Fourier Transform เพื่อหา frequency domain จะเห็นว่าภาพที่มี noise จะมีคล้ายๆวงแหวนของ magnitude ที่เกิดจาก noise จึงทำการ restore ด้วย band reject เป็นวงกลม ซึ่งเมื่อทำการทดลอง จะได้ band มี radius เป็น 135 และ 170 ตามลำดับ

Result



What is the PSNR before adding noise (compared with “kitty55.png”)?

```
28.777556580091797
```

PSNR of the restored image

```
11.79510709517572
```