Project #3

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- Source codes

```
# library
import numpy as np
import cv2
from matplotlib import pyplot as plt
import math
%matplotlib inline
```

```
# load picture from google drive
from google.colab import drive
drive.mount('/content/drive')
```

```
# loaded the image in grayscale
image = cv2.imread('/content/drive/MyDrive/Bird 2 degraded.tif',0)
```

```
# convert from uint8 into float32
image_float32 = np.float32(image)

# Computed the 2-d discrete Fourier Transform
dft = np.fft.fft2(image_float32)

# Shift the zero-frequency component to the center of the spectrum.
dft_shift = np.fft.fftshift(dft)

# compute magnitude spectrum
one = np.ones(dft_shift.shape[:2])
magnitude_spectrum = np.log(one + np.abs(dft_shift)) / np.log(np.max(np.abs(dft_shift))+1)
```

```
# plot magnitude spectrum of degraded image
plt.imshow(magnitude_spectrum, cmap = "gray")
plt.colorbar()
plt.title("Magnitude Spectrum of degraded image")
```

```
# degradation model H
H = np.zeros(magnitude_spectrum.shape[:2],np.float32)
k = 0.001 # mild turbulence
for u in range(H.shape[0]):
    for v in range(H.shape[1]):
        H[u][v] = math.exp(-k*((u-H.shape[0]/2)**2+(v-H.shape[1]/2)**2)**(5/6))
H_mag = np.log(H+1) / np.log(np.max(H)+1)
```

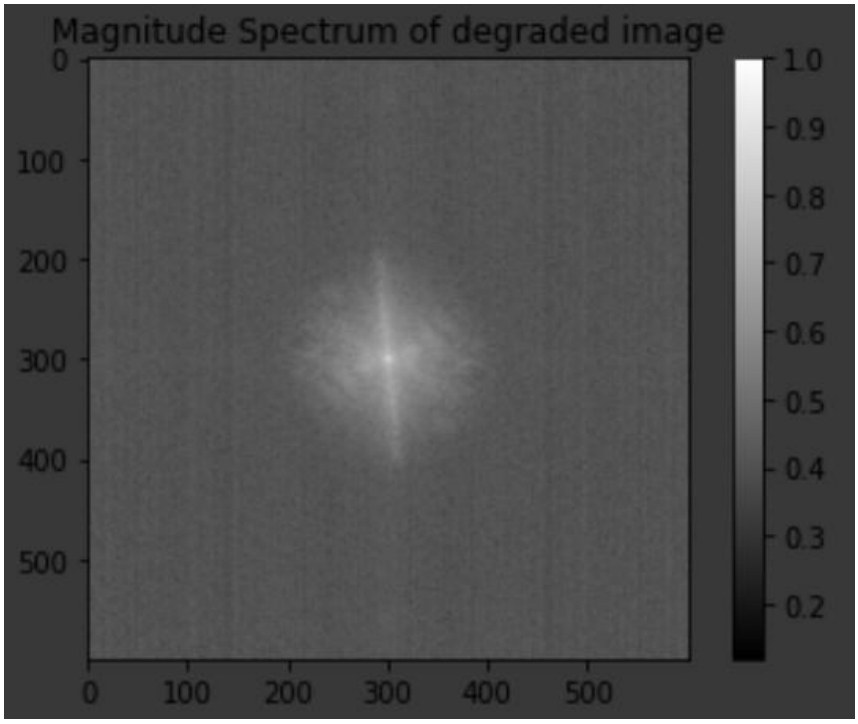
```
# plot magnitude of H
plt.imshow(H_mag, cmap = "gray")
plt.colorbar()
plt.title("Magnitude Spectrum of H")
```

```
# calculate distance
def distance(x,y,cx,cy):
    return ((x-cx)**2+(y-cy)**2)**0.5
```

```
# get mask with different radius
def gen_mask(mask,radius):

    result = np.zeros(mask.shape,dtype=np.float32)
    cx, cy = mask.shape[0]//2, mask.shape[1]//2

    for i in range(mask.shape[0]):
        for j in range(mask.shape[1]):
            d = distance(i,j,cx,cy)
            if d < radius:
                result[i,j] = mask[i,j]
            else:
                result[i,j] = 1
    return result
```

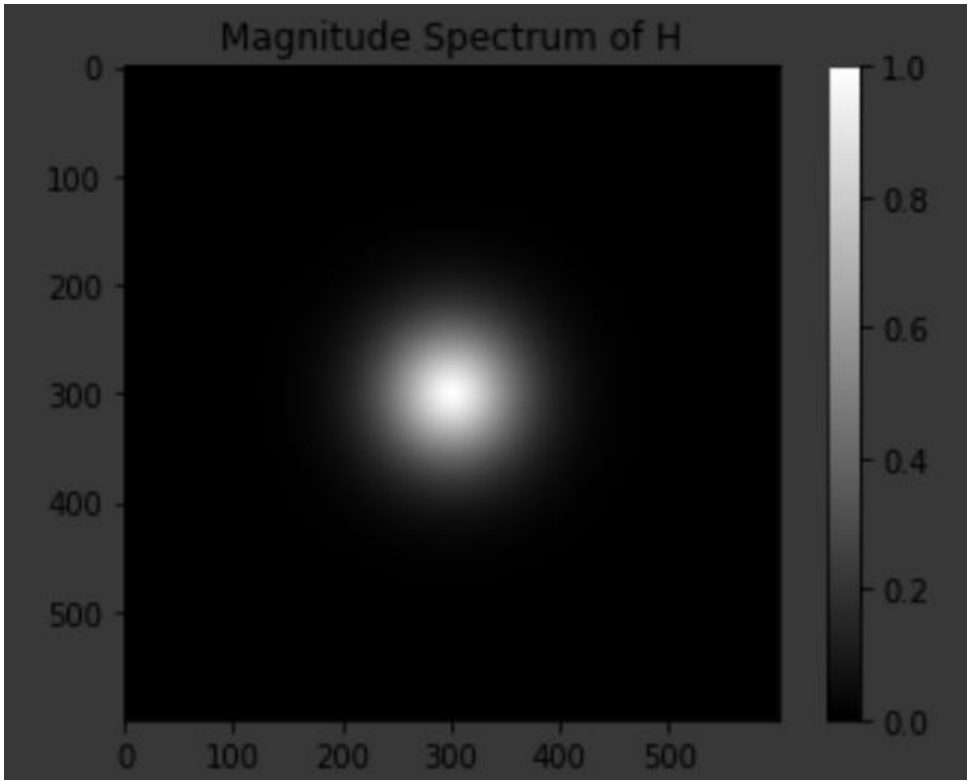
```
# plot restored image with three radius
for d in [50,85,120]:
    output=dft_shift/gen_mask(H,d)
    one = np.ones(output.shape[:2])
    output_mag = np.log(one + np.abs(output)) / np.log(np.max(np.abs(output))+1)

    fig = plt.figure()
    plt.figure(figsize=(15,9))
    plt.subplot(1, 2, 1)
    plt.imshow(output_mag, cmap = "gray")
    plt.title("Inverse filter for radius %d" %d)

    f_inv = np.fft.ifftshift(output)
    f = np.fft.ifft2(f_inv)

    f = np.clip(np.abs(f),0,255)
    plt.subplot(1, 2, 2)
    plt.imshow(f, cmap = "gray")
    plt.title("Restored image for radius %d" %d)
```

- Figure of the Fourier magnitude spectrum of the degraded image Bird 2 degraded



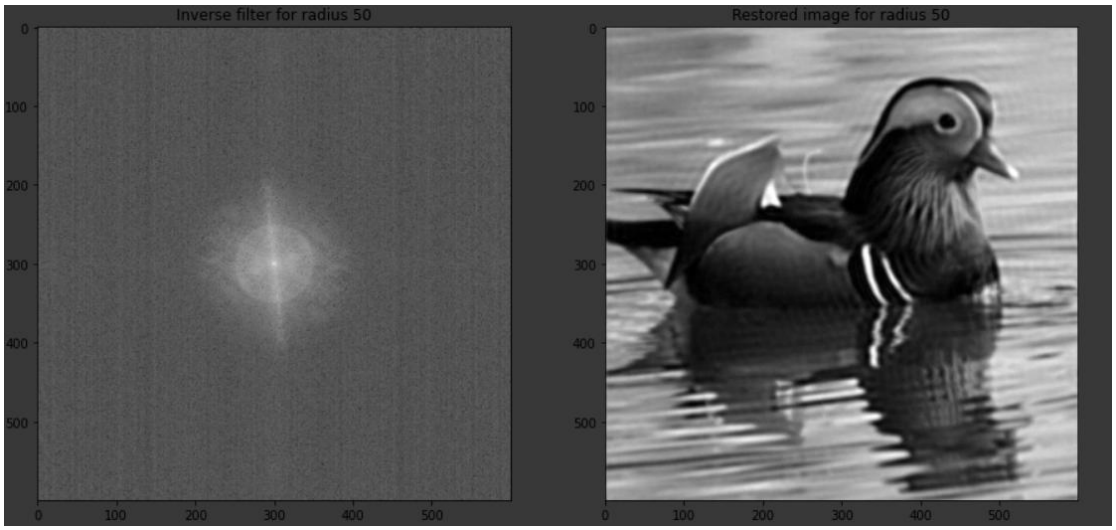
- Figure of the Fourier magnitude (frequency response) of degradation

model H(u,v)

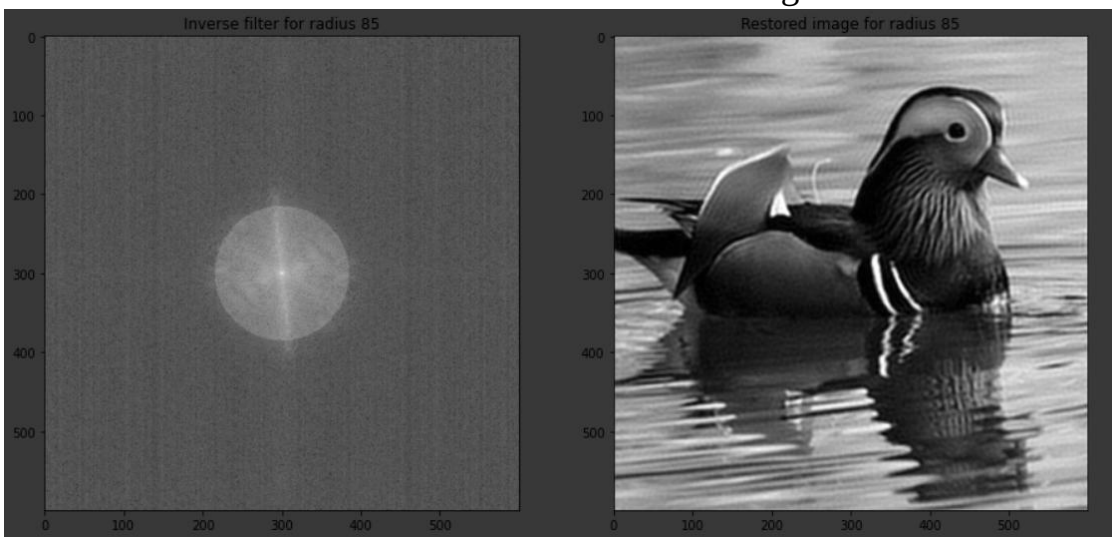


- Figures of the output images using different radii (50, 85, 120) of inverse filtering

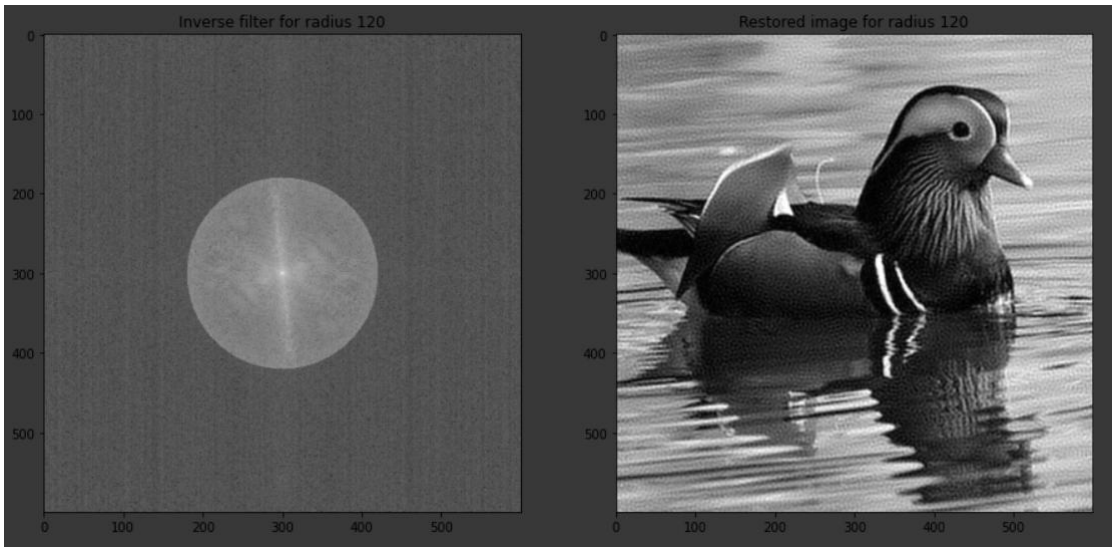
Inverse filter for radius 50 Restored image for radius 50



Inverse filter for radius 85 Restored image for radius 85



Inverse filter for radius 120 Restored image for radius 120



- Model parameter k
  k=0.001