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project3

source code

```
import numpy as np
import matplotlib.pyplot as plt
import cv2
import math

def get_norm_magnitude(ft):
   mg = np.abs(ft)
   scale = 1/(np.log(np.max(mg)+1))
   mg = scale*np.log(mg+1)*255
   mg = np.clip(np.uint8(mg), 0, 255)
   return mg


def get_masked(H, radius):
   rows, cols = H.shape
   crow, ccol = rows//2, cols//2

   mask = np.zeros((rows, cols), np.float64)
   for x in range(rows):
       for y in range(cols):
           dist = np.linalg.norm(np.array([x, y]) - np.array([crow, ccol]))
           if dist < radius:
               mask[x, y] = H[x, y]
           else:
               mask[x, y] = 1

   return mask


# read degaded image
g = plt.imread('Bird 2 degraded.tif')
g = np.float64(g)/255.0
print(g.shape)

# dtft
G = np.fft.fft2(g)
G = np.fft.fftshift(G)

# magnitude of dtft
G_m = get_norm_magnitude(G)
cv2.imwrite('G_magnitude.png', G_m)
```

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```
# degradation model H
H = np.zeros((G.shape), np.float64)
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*(math.pow(
           (u-H.shape[0]/2)**2+(v-H.shape[1]/2)**2, 5/6)))

H_m = get_norm_magnitude(H)
cv2.imwrite('H_magnitude.png', H_m)

# inverse filter
for r in [50, 85, 120]:
   F_hat = G/get_masked(H,r)
   F_hat = np.nan_to_num(F_hat)
   cv2.imwrite('F_hat_magnitude_%d.png'%r, get_norm_magnitude(F_hat))
   F_hat = np.fft.ifftshift(F_hat)
   f_hat = np.fft.ifft2(F_hat)
   f_hat = np.clip(np.uint8(np.abs(f_hat)*255), 0, 255)
   cv2.imwrite('restoration_%d.png'%r, f_hat)
```

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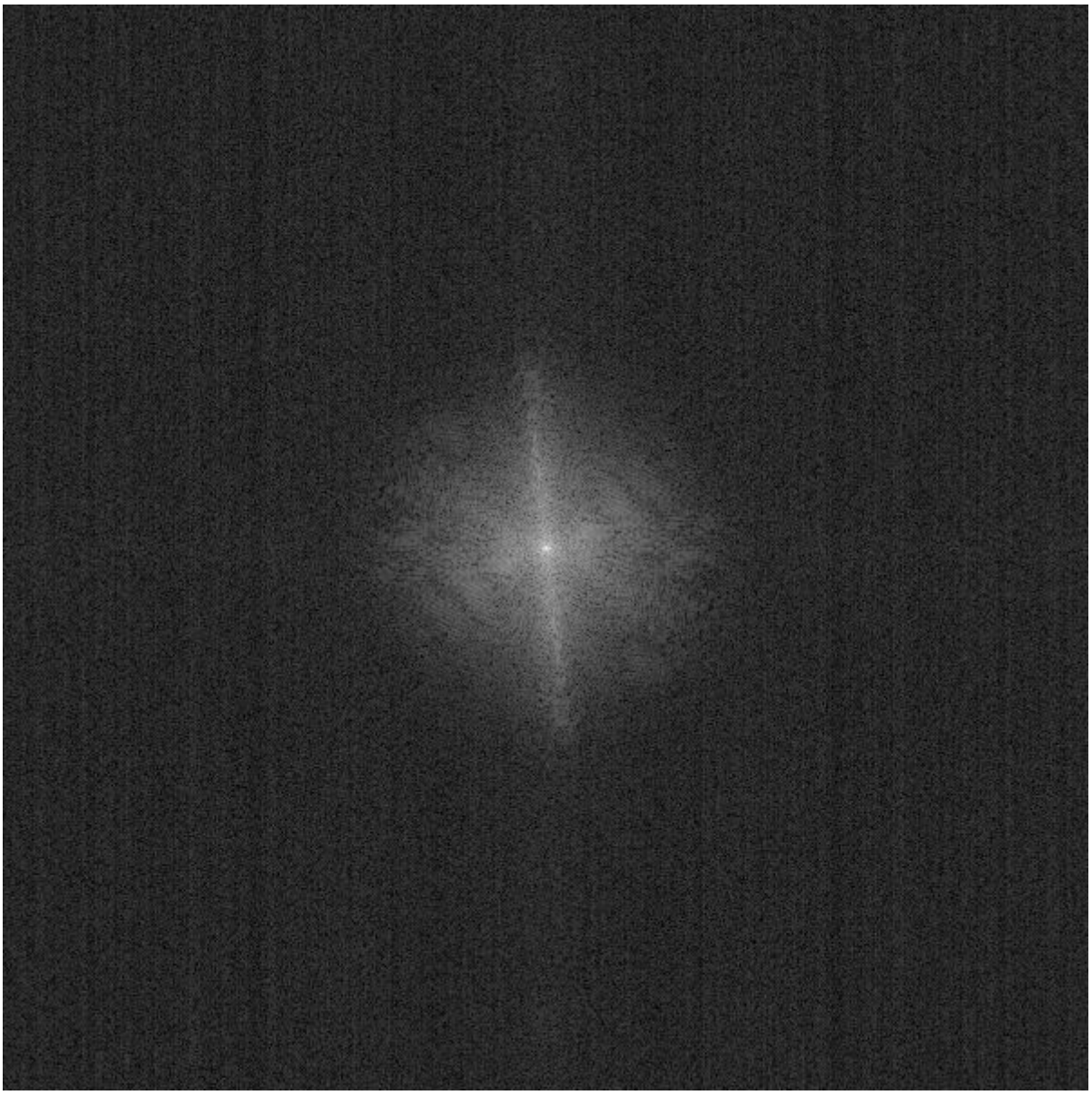
degraded image FFT



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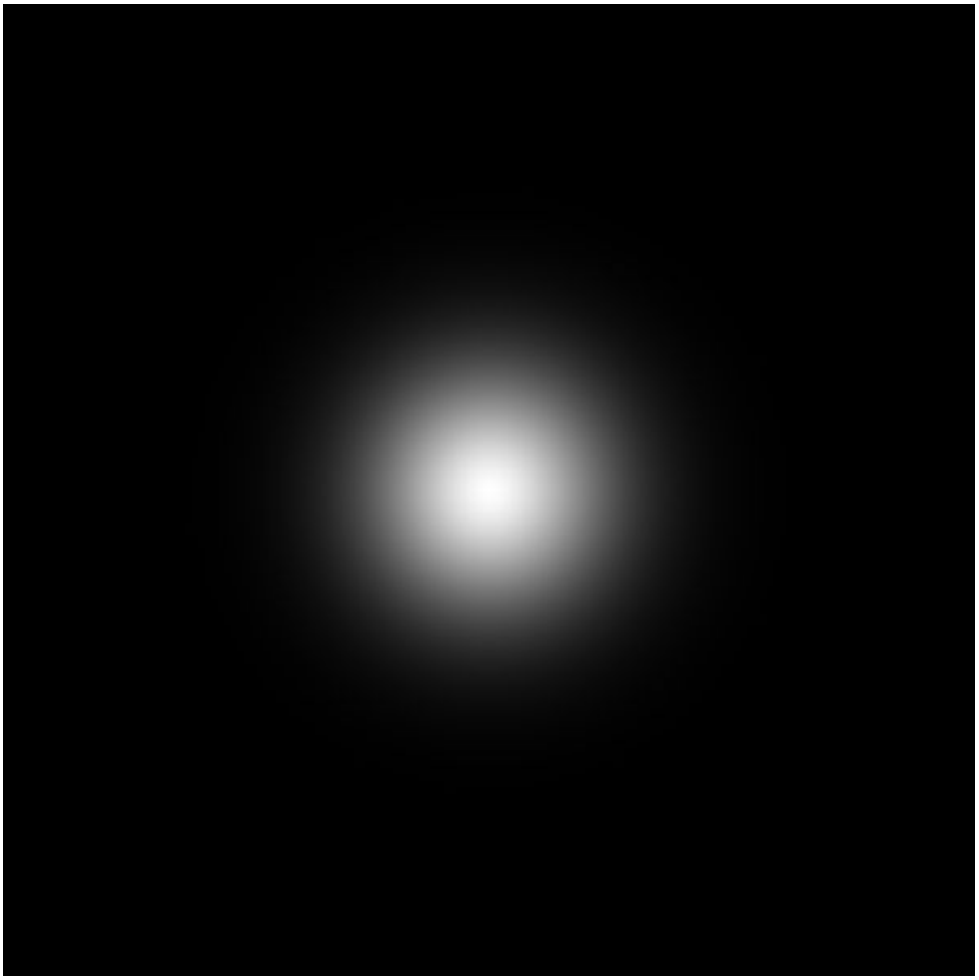
degradation model H

mild atmospheric turbulence, estimate k = 0.001

$$H(u,v) = e^{-k[(u-M/2)^2+(v-N/2)^2]^{5/6}}$$



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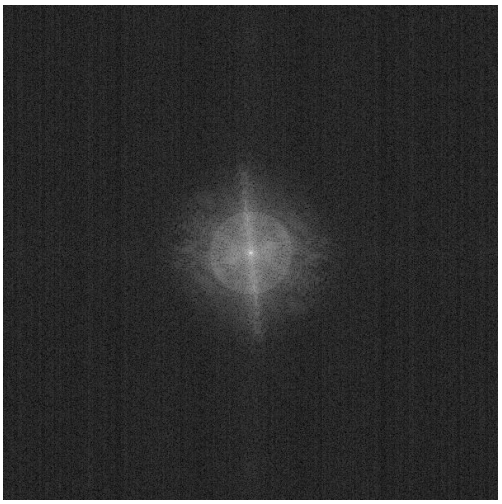
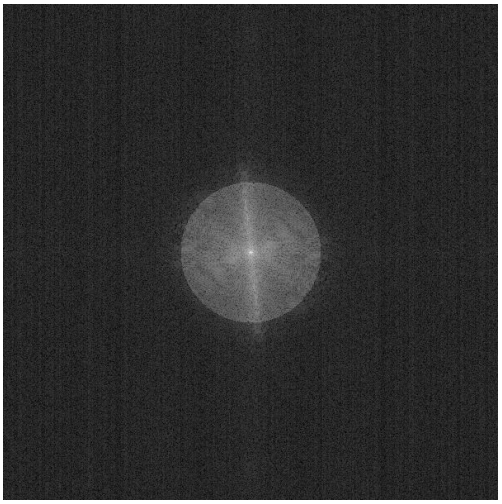
restoration

F_hat magnitude radius 50



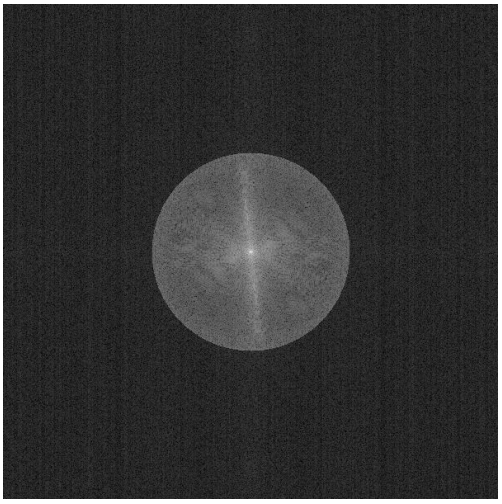
restoration radius 50

F_hat magnitude radius 80



restoration radius 80

F_hat magnitude radius 120



restoration radius 120