```
# Anirudh Sathish
# CS20B1125
# Assignment 7

# import libraries
import numpy as np
import matplotlib.pyplot as plt
import cv2

dog = cv2.imread("dog.jpg",0)
lena = cv2.imread("lena.png",0)

# apply dft on dog
dog_f = np.fft.fft2(dog)

# apply dft on lena
lena_f = np.fft.fft2(lena)
```

Task1 with inbuilt function

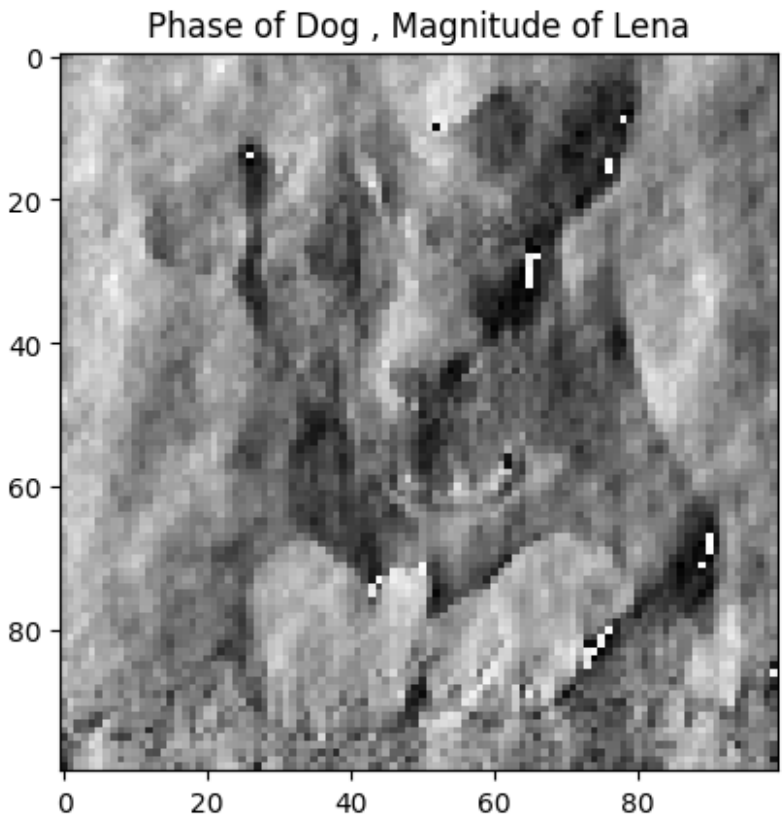
```
# swap phases and magnitudes

# Task1
# phase of dog and magnitude of lena
new_img1_mag , new_img1_phase = np.abs(lena_f),np.angle(dog_f)

# apply idft
# Reconstruct outputs
new_img1  =  np.fft.ifft2
(new_img1_mag*np.exp(1j*new_img1_phase)).real.astype('uint8')

# display
plt.imshow(new_img1,cmap='gray')
plt.title('Phase of Dog , Magnitude of Lena')

Text(0.5, 1.0, 'Phase of Dog , Magnitude of Lena')
```



Inference

We can majorly see the dog in the outline. This agrees with our intution that the phase dominates the magnitude in case of images

Task 2 with inbuilt function

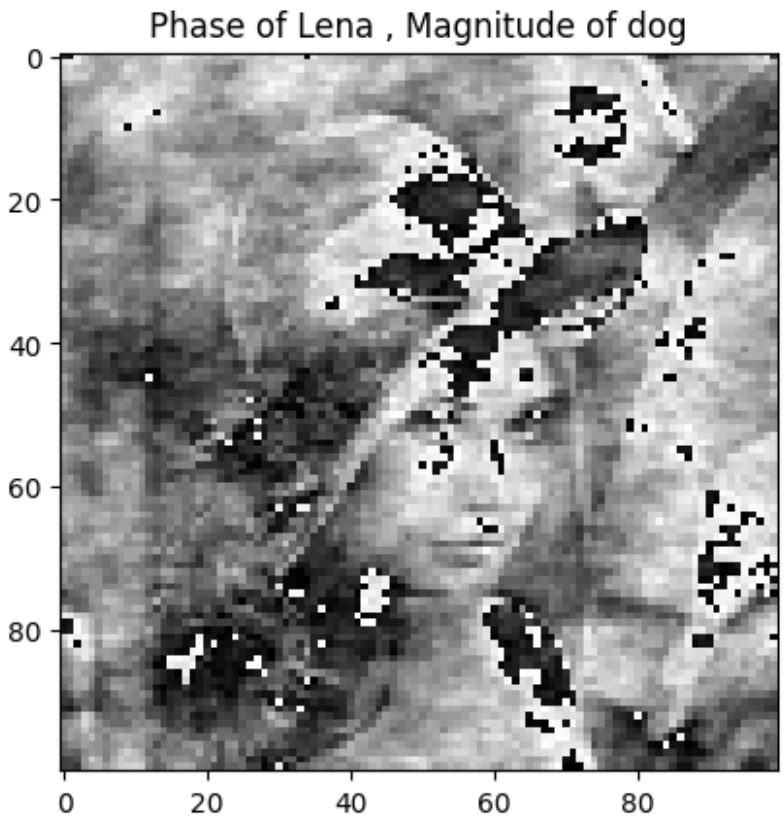
```
# Phase of lena and magnitude of dog
new_img2_mag , new_img2_phase = np.abs(dog_f),np.angle(lena_f)

# apply idft

# reconstruct image
new_img2 =
np.fft.ifft2(new_img2_mag*np.exp(1j*new_img2_phase)).real.astype('uint
8')

# display the image
plt.imshow(new_img2,cmap='gray')
plt.title('Phase of Lena , Magnitude of dog')
```

```
Text(0.5, 1.0, 'Phase of Lena , Magnitude of dog')
```



Inference

We can majorly see Lena in the outline. This agrees with our intution that the phase dominates the magnitude in case of images

Lets perform the same task with our own functions

```
def FFT_paddded(signal):
    N = len(signal)

    # algo works for N , being power of 2
    if N == 1:
        return signal

    # obtain odd and even values
    even_signal = FFT_paddded(signal[::2])
    odd_signal =  FFT_paddded(signal[1::2])

    # Combining odd and even
    res = np.zeros(N, dtype =np.complex_)
    for u in range(N//2):
        res[u] = even_signal[u] + np.exp(-2j*np.pi*u/N)*odd_signal[u]
        res[u+N//2] = even_signal[u] - np.exp(-
2j*np.pi*u/N)*odd_signal[u]
    return res
```

```
def FFT(signal):
    N_init = len(signal)

    # finding the nearest power of 2 to pad to
    N = 2**int(np.ceil(np.log2(N_init)))
    signal_padded = np.zeros(N, dtype = signal.dtype)

    # setting the first N inital values as the signal values , rest
will be 0
    signal_padded[:N_init] = signal

    # perform FFT on this
    res_signal = FFT_paddded(signal_padded)

    # again now to obtain final , remove the padded
    signal_f = res_signal[:N_init]
    return signal_f


def pad_to_power_of_two(image):
    """Pad the image with zeros to the nearest power of 2 in both
dimensions"""
    h, w = image.shape[:2]
    padded_h = 2 ** int(np.ceil(np.log2(h)))
    padded_w = 2 ** int(np.ceil(np.log2(w)))
    padded_image = np.zeros((padded_h, padded_w) + image.shape[2:],
dtype=image.dtype)
    padded_image[:h, :w] = image
    return padded_image

def FFT2D(imgN):
    # obtain the r and c of img
    height , width = imgN.shape
    img = pad_to_power_of_two(imgN)
    r , c = img.shape

    fft_res = np.zeros((r,c),dtype = complex)

    # loop through r's then columns

    for i in range(r):
        fft_res[i,:] = FFT(img[i,:])
    for j in range(c) :
        fft_res[:,j] = FFT(fft_res[:,j])

    return fft_res , imgN.shape
```

```
# defining the function to perform inverse discrete fourier transform
for images using fft_1D function
def idft_2D(image):
    rows, cols = image.shape
    idft = np.zeros((rows, cols), dtype=complex)
    for i in range(rows):
        idft[i,:] = FFT(image[i,:])
    for i in range(cols):
        idft[:,i] = FFT(idft[:,i])
    idft /= (rows * cols)
    idft = np.fliplr(idft)
    idft = np.flipud(idft)
    return idft

# apply fft without using inbuilt

# apply dft on dog
dog_fi , org_dimDog = FFT2D(dog)

# apply dft on lena
lena_fi , org_dimLena= FFT2D(lena)
```

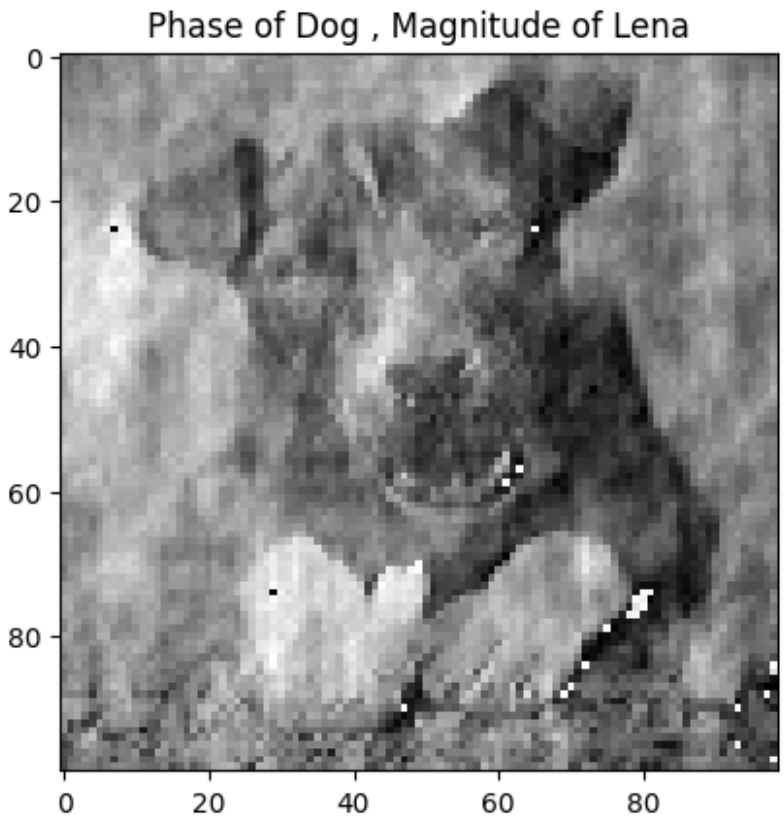
Task 1 without using inbuilt

```
# Task1
# phase of dog and magnitude of lena
new_img3_mag , new_img3_phase = np.abs(lena_fi),np.angle(dog_fi)

# apply idft
# Reconstruct outputs
new_img3  =
idft_2D(new_img3_mag*np.exp(1j*new_img3_phase)).real.astype('uint8')
# display
new_img3 = new_img3[:org_dimDog[0]-1,:org_dimDog[1]-1]

plt.imshow(new_img3,cmap='gray')
plt.title('Phase of Dog , Magnitude of Lena')
```

```
Text(0.5, 1.0, 'Phase of Dog , Magnitude of Lena')
```

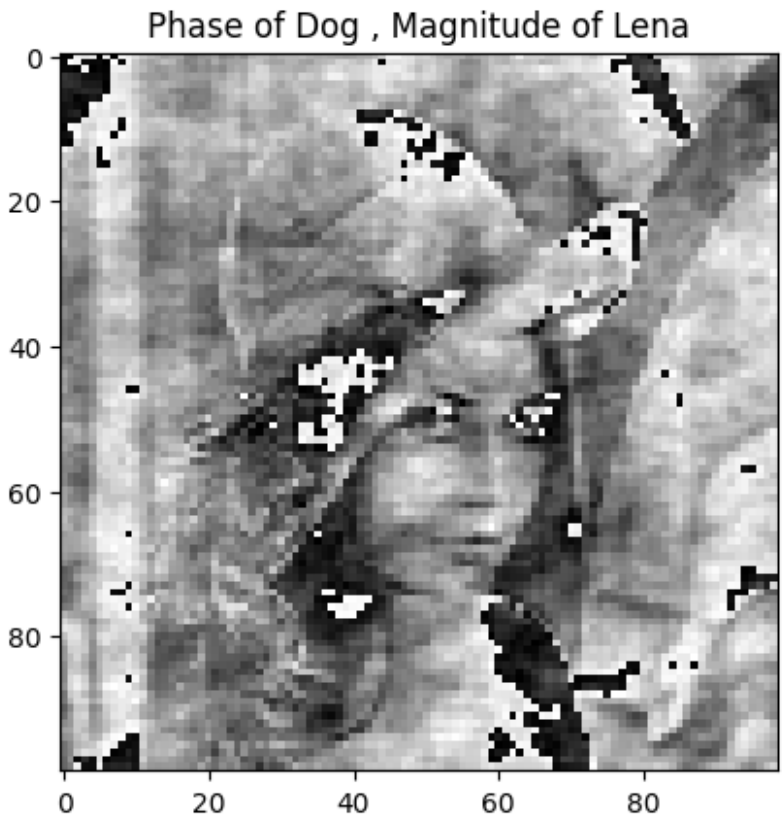



```
# Task2
# phase of lena and magnitude of dog
new_img4_mag , new_img4_phase = np.abs(dog_fi),np.angle(lena_fi)

# apply idft
# Reconstruct outputs
new_img4  =  idft_2D
(new_img4_mag*np.exp(1j*new_img4_phase)).real.astype('uint8')
# display
new_img4 = new_img4[:org_dimLena[0]-1,:org_dimLena[1]-1]

plt.imshow(new_img4,cmap='gray')
plt.title('Phase of Dog , Magnitude of Lena')

Text(0.5, 1.0, 'Phase of Dog , Magnitude of Lena')
```



Inferences

The same inferences for the task for inbuilt holds here also