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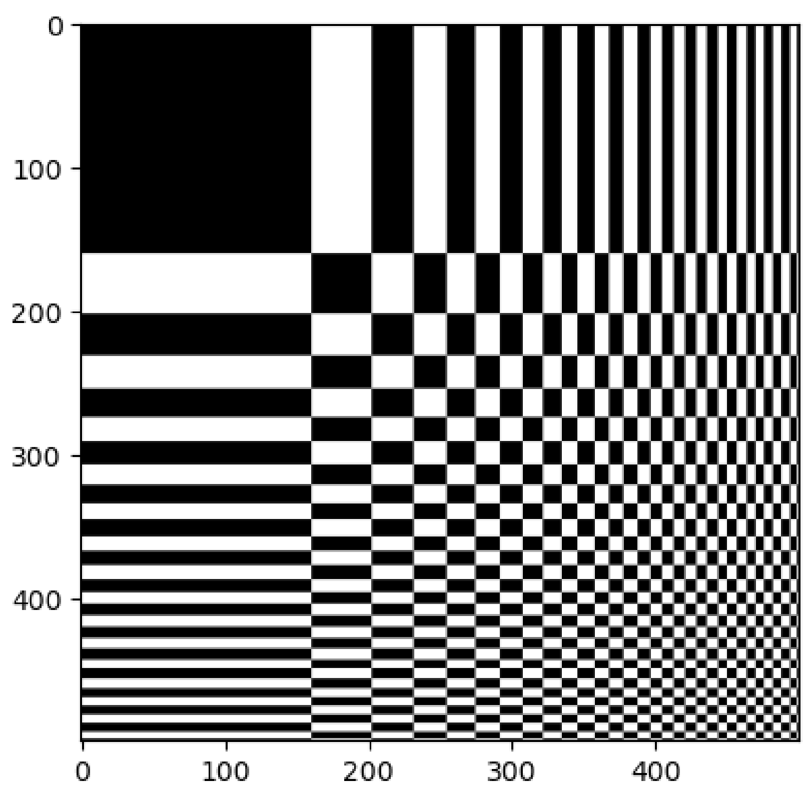
SUBJECT : DIGITAL IMAGE PROCESSING

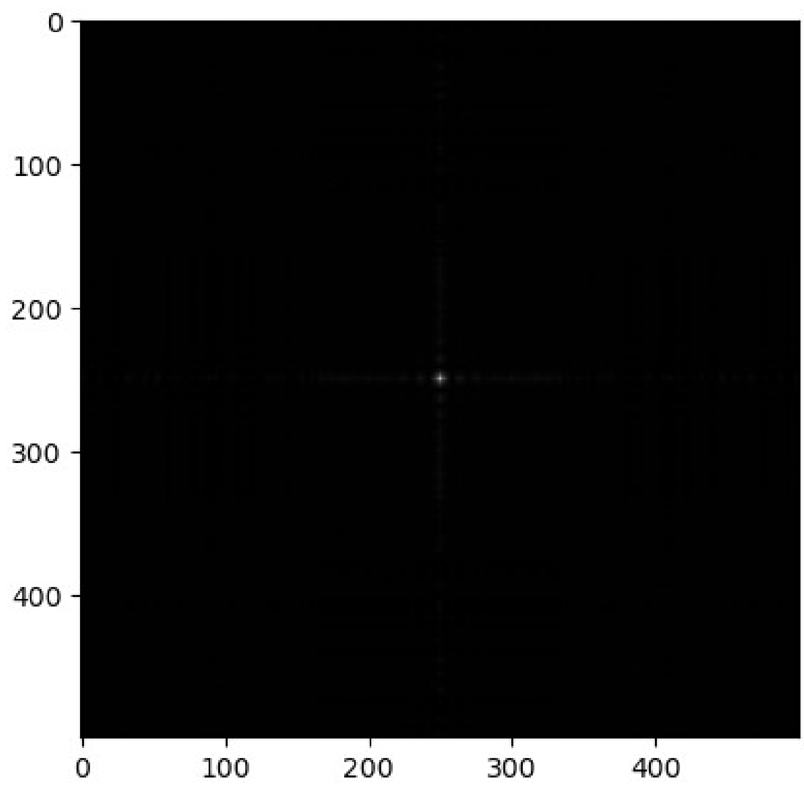
DEPARTMENT : ECE

Question 1

```
import numpy as np
from PIL import Image
import matplotlib.pyplot as plt
image1 = Image.open('dynamicCheckerBoard.png')
image = np.asarray(image1)
plt.imshow(image, cmap = 'gray');
```



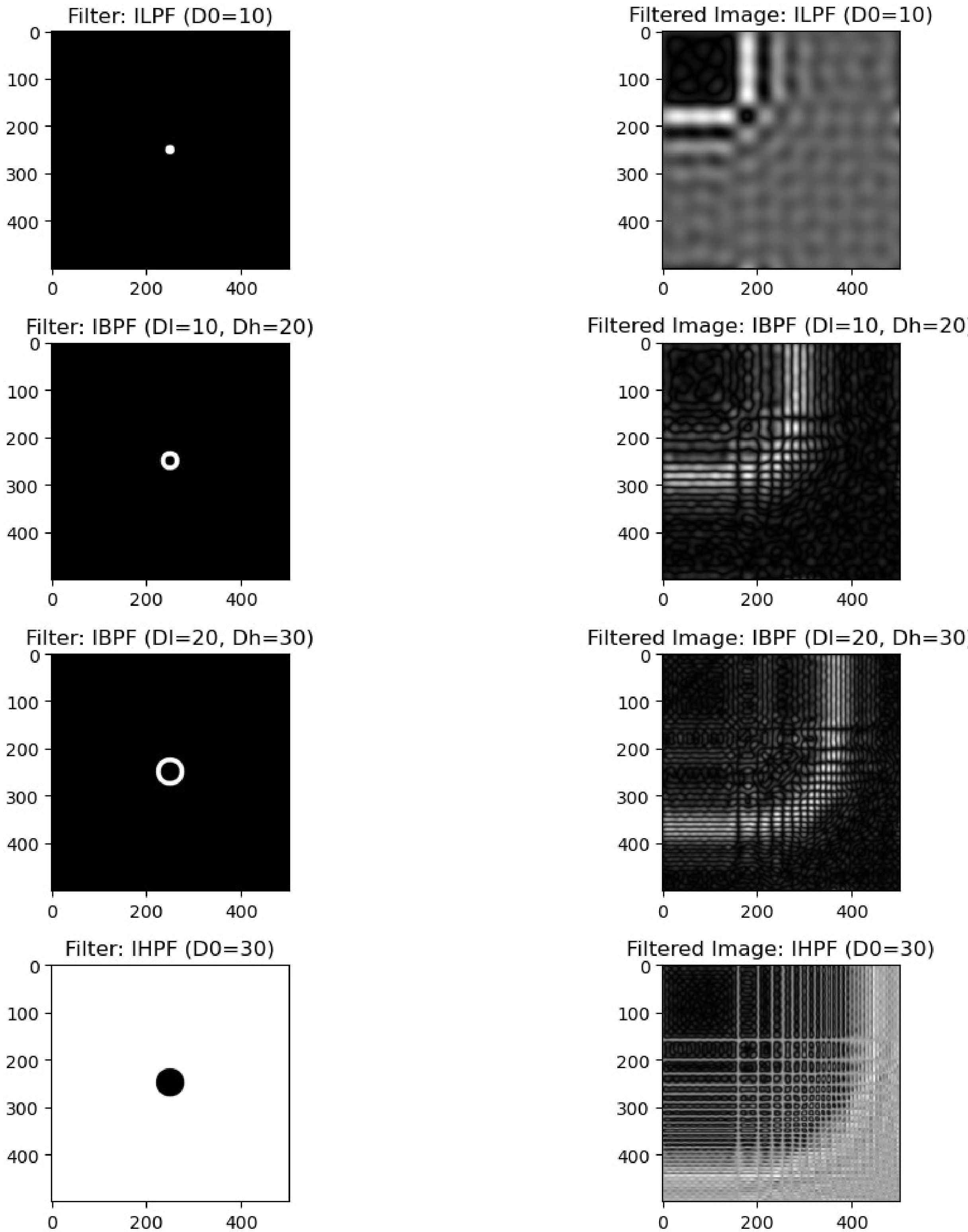
```
def dft(image):
    dft_img_shift=np.fft.fftshift(image)
    dft_img=np.fft.fft2(dft_img_shift)
    dft_img=np.abs(dft_img)
    return dft_img

def idft(img):
    idft_img=np.fft.ifft2(img)
    idft_shift_img=np.fft.fftshift(idft_img)
    idft_shift_img=np.abs(idft_shift_img)
    return idft_shift_img

img3=dft(image)
img4=idft(img3)
#plt.imshow(img4,cmap='gray')
plt.imshow(img4, cmap = 'gray');
```




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

# Distance D(u, v) from center
def compute_distance(rows, cols):
    u, v = np.meshgrid(np.arange(cols), np.arange(rows))
    distance_uv = np.sqrt((u - cols / 2) ** 2 + (v - rows / 2) ** 2)
```

```
    return distance_uv

# Ideal Low Pass Filter (ILPF)
def ideal_low_pass_filter(rows, cols, cutoff_freq):
    distance_uv = compute_distance(rows, cols)
    H_lowpass = np.where(distance_uv <= cutoff_freq, 1, 0)
    return H_lowpass

# Ideal High Pass Filter (IHPF)
def ideal_high_pass_filter(rows, cols, cutoff_freq):
    H_lowpass = ideal_low_pass_filter(rows, cols, cutoff_freq)
    H_highpass = 1 - H_lowpass
    return H_highpass

# Ideal Band Pass Filter (IBPF)
def ideal_band_pass_filter(rows, cols, low_cutoff, high_cutoff):
    H_lowpass_highcutoff = ideal_low_pass_filter(rows, cols,
high_cutoff)
    H_highpass_lowcutoff = ideal_high_pass_filter(rows, cols,
low_cutoff)
    H_bandpass = H_lowpass_highcutoff * H_highpass_lowcutoff
    return H_bandpass

# Filter in the frequency domain
def apply_filter(image, filter_function, *filter_params):

    rows, cols = image.shape


    dft_image = np.fft.fft2(image)
    dft_image_shifted = np.fft.fftshift(dft_image)


    filter_mask = filter_function(rows, cols, *filter_params)


    filtered_dft = dft_image_shifted * filter_mask


    filtered_image_shifted = np.fft.ifftshift(filtered_dft)
    filtered_image = np.fft.ifft2(filtered_image_shifted)


    filtered_image = np.abs(filtered_image)

    return filter_mask, filtered_image


filter_dict = {
    "ILPF (D0=10)": (ideal_low_pass_filter, 10),
```

```
    "IBPF (Dl=10, Dh=20)": (ideal_band_pass_filter, 10, 20),
    "IBPF (Dl=20, Dh=30)": (ideal_band_pass_filter, 20, 30),
    "IHPF (D0=30)": (ideal_high_pass_filter, 30),
}


plt.figure(figsize=(12, 10))

for i, (filter_name, (filter_function, *params)) in
enumerate(filter_dict.items()):
    filter_mask, filtered_image = apply_filter(image, filter_function,
*params)


    plt.subplot(4, 2, 2 * i + 1)
    plt.imshow(filter_mask, cmap='gray')
    plt.title(f"Filter: {filter_name}")


    plt.subplot(4, 2, 2 * i + 2)
    plt.imshow(filtered_image, cmap='gray')
    plt.title(f"Filtered Image: {filter_name}")

plt.tight_layout()
plt.show()
```


Filter: ILPF (D0=10)
Filtered Image: ILPF (D0=10)
Filter: IBPF (Dl=10, Dh=20)
Filtered Image: IBPF (Dl=10, Dh=20)
Filter: IBPF (Dl=20, Dh=30)
Filtered Image: IBPF (Dl=20, Dh=30)
Filter: IHPF (D0=30)
Filtered Image: IHPF (D0=30)
0
100
200
300
400
0
200
400

comment:

We first calculated the distance of each pixel in the frequency domain from the center of the image. This helped us determine which pixels should be kept or removed based on the filter type.

Ideal Low pass filter keeps frequencies below a certain value (cut-off frequency) and removes the higher ones.

Ideal High pass filter removes frequencies below the cut-off frequency and keeps the higher ones.

Ideal Band pass filter Keeps frequencies between a lower and higher cut-off value.

ILFP (D0=10): The image became blurred because the filter removed all the high-frequency details.

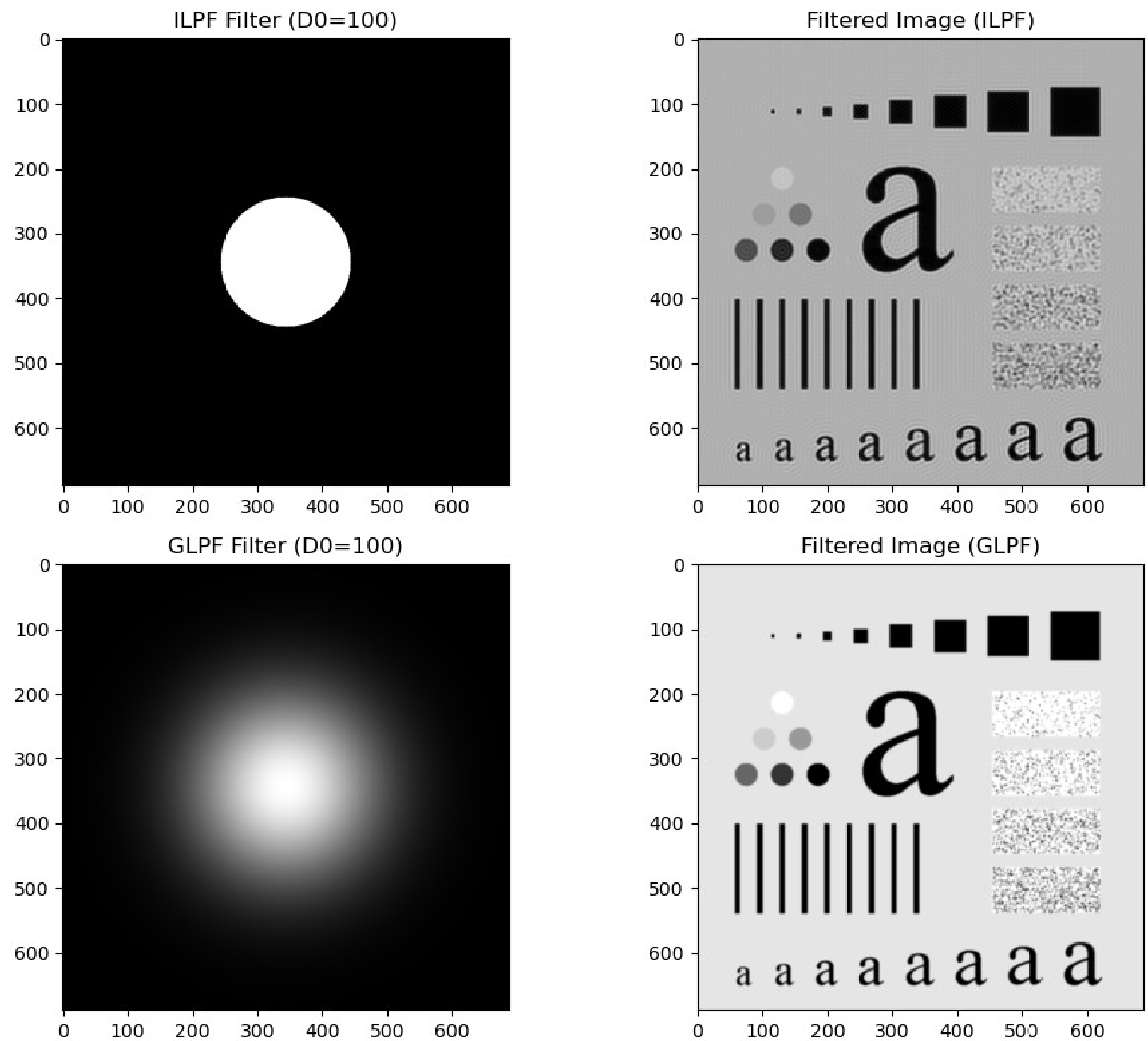
IBPF (10-20, 20-30): These filters allowed specific ranges of frequencies, so some details were kept while others were blurred. The images showed a mix of sharp and smooth areas.

IHPF (D0=30): The image showed only the edges and sharp transitions, with the smooth parts removed.

QUESTION 2

```
def gaussian_low_pass_filter(P, Q, D0):
    D_uv = compute_distance(P, Q)
    H_GLPF = np.exp(-(D_uv ** 2) / (2 * D0 ** 2))
    return H_GLPF

image_characters = Image.open('characters.tif')
image_characters1 = np.asarray(image_characters)



D0 = 100


H_ILPF, filtered_ILPF = apply_filter(image_characters1,
ideal_low_pass_filter, D0)


H_GLPF, filtered_GLPF = apply_filter(image_characters1,
gaussian_low_pass_filter, D0)


plt.figure(figsize=(10, 8))


plt.subplot(2, 2, 1)
plt.imshow(H_ILPF, cmap='gray')
plt.title('ILPF Filter (D0=100)')

plt.subplot(2, 2, 2)
```

```python
plt.imshow(filtered_ILPF, cmap='gray')
plt.title('Filtered Image (ILPF)')


plt.subplot(2, 2, 3)
plt.imshow(H_GLPF, cmap='gray')
plt.title('GLPF Filter (D0=100)')

plt.subplot(2, 2, 4)
plt.imshow(filtered_GLPF, cmap='gray')
plt.title('Filtered Image (GLPF)')

plt.tight_layout()
plt.show()
```



comment:

Gaussian low pass filter gives a somoother, more natural result compared to the ideal low pass filter because it doesn't block frequencies abruptly.