Assignment No 4



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**CSE-408 Digital Image Processing**

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Section: C

“On my honor, as a student of the University of Engineering and Technology, I have neither given nor received unauthorized assistance on this academic work”

Submitted to:

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(20 June 2025)

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**Activity 1**

**Code:**

% Clear environment

clc; clear; close all;

% Load grayscale image

img = imread('cameraman.tif');

img = im2double(img);

[M, N] = size(img);

% Fourier Transform

F = fft2(img);

F\_shifted = fftshift(F);

% Set cutoff frequency

D0 = 50;

% Create meshgrid

u = 0:(M-1);

v = 0:(N-1);

u = u - floor(M/2);

v = v - floor(N/2);

[U, V] = meshgrid(v, u);

D = sqrt(U.^2 + V.^2);

% Ideal Highpass Filter

H\_ideal = double(D > D0);

% Butterworth Highpass Filter (order = 2)

n = 2;

H\_butter = 1 ./ (1 + (D0 ./ D).^(2 \* n));

% Gaussian Highpass Filter

H\_gauss = 1 - exp(-(D.^2) ./ (2 \* D0^2));

% Apply filters in frequency domain

G\_ideal = F\_shifted .\* H\_ideal;

G\_butter = F\_shifted .\* H\_butter;

G\_gauss = F\_shifted .\* H\_gauss;

% Inverse FFT

img\_ideal = real(ifft2(ifftshift(G\_ideal)));

img\_butter = real(ifft2(ifftshift(G\_butter)));

img\_gauss = real(ifft2(ifftshift(G\_gauss)));

% Display results

figure;

subplot(1,2,1), imshow(img, []), title('Original Image');

subplot(1,2,2), imshow(log(1+abs(F\_shifted)), []), title('Original Spectrum');

figure;

subplot(1,2,1), imshow(img\_ideal, []), title('IHPF Output');

subplot(1,2,2), imshow(log(1+abs(G\_ideal)), []), title('IHPF Spectrum');

figure;

subplot(1,2,1), imshow(img\_butter, []), title('BHPF Output');

subplot(1,2,2), imshow(log(1+abs(G\_butter)), []), title('BHPF Spectrum');

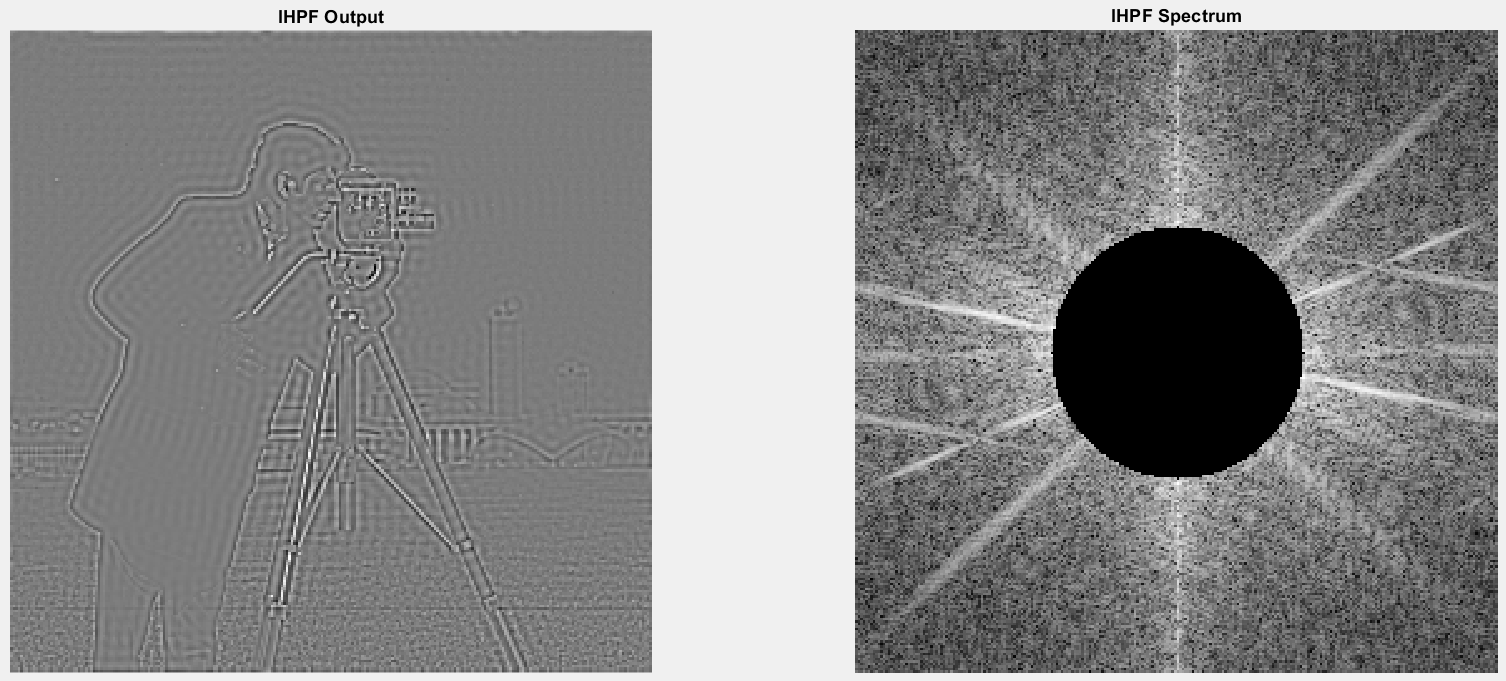
figure;

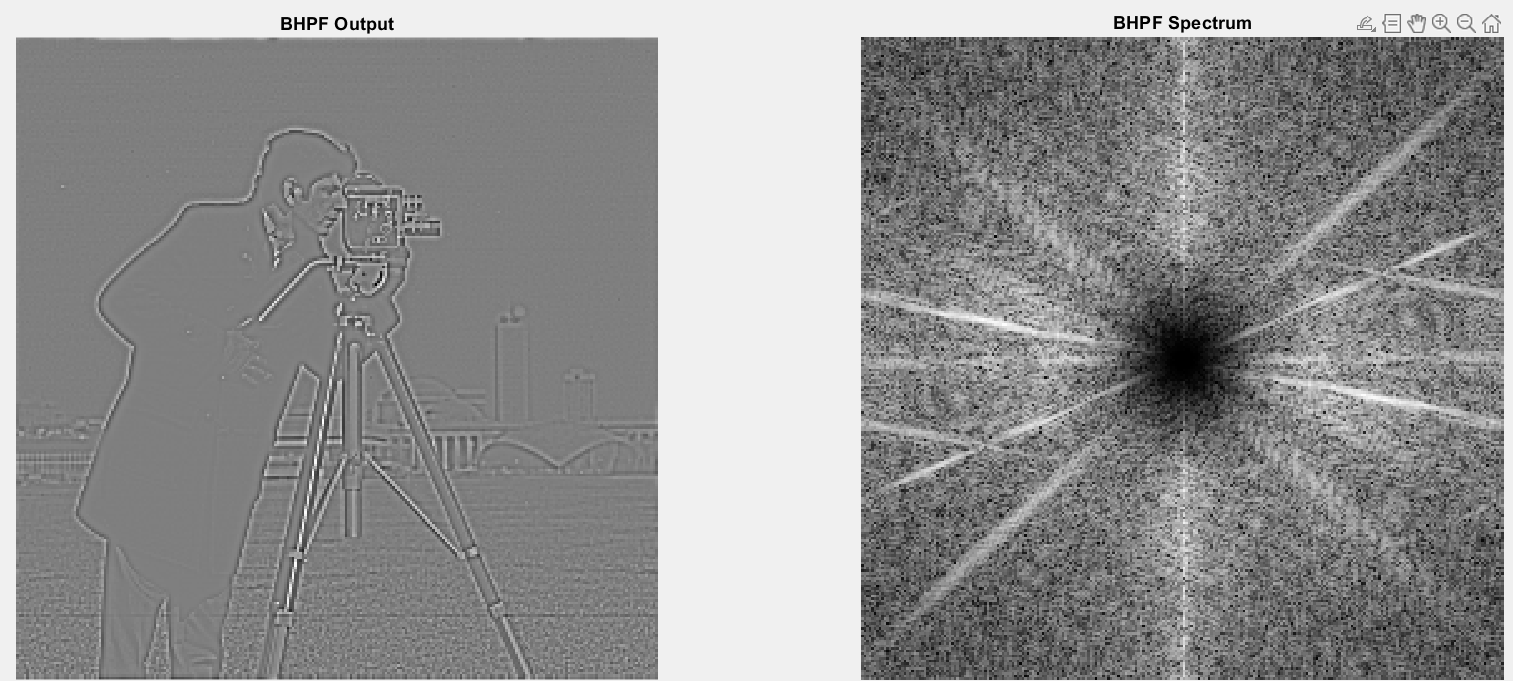
subplot(1,2,1), imshow(img\_gauss, []), title('GHPF Output');

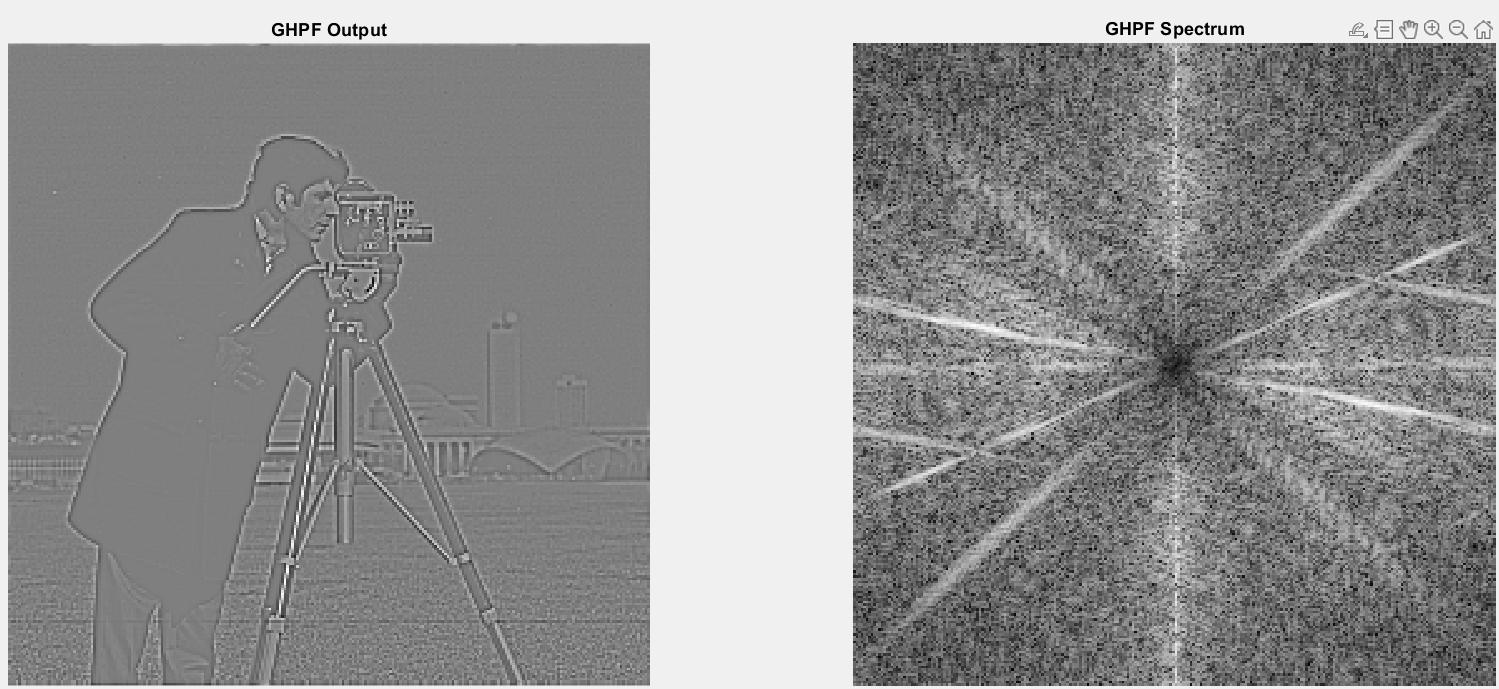
subplot(1,2,2), imshow(log(1+abs(G\_gauss)), []), title('GHPF Spectrum');

**Output:**









## ****Analysis****

Three frequency domain highpass filters were applied to enhance edges in a grayscale image:

* **Ideal Highpass Filter (IHPF):** Provides strong edge enhancement but introduces ringing artifacts and amplifies noise due to its abrupt cutoff.
* **Butterworth Highpass Filter (BHPF):** Offers smoother sharpening than IHPF, with moderate noise amplification and minimal artifacts.
* **Gaussian Highpass Filter (GHPF):** Produces clean edge enhancement with the least noise and no visible artifacts, due to its smooth frequency response.

## ****Conclusion****

The **Gaussian Highpass Filter** gives the best sharpening results with minimal noise and no artifacts. It is the most suitable for clean and smooth image enhancement. The **Butterworth filter** is a good compromise, while the **Ideal filter**, despite strong sharpening, introduces unwanted visual distortions.