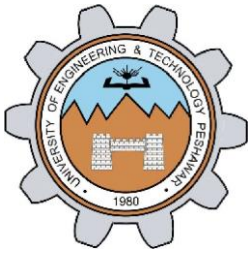
Assignment No 3



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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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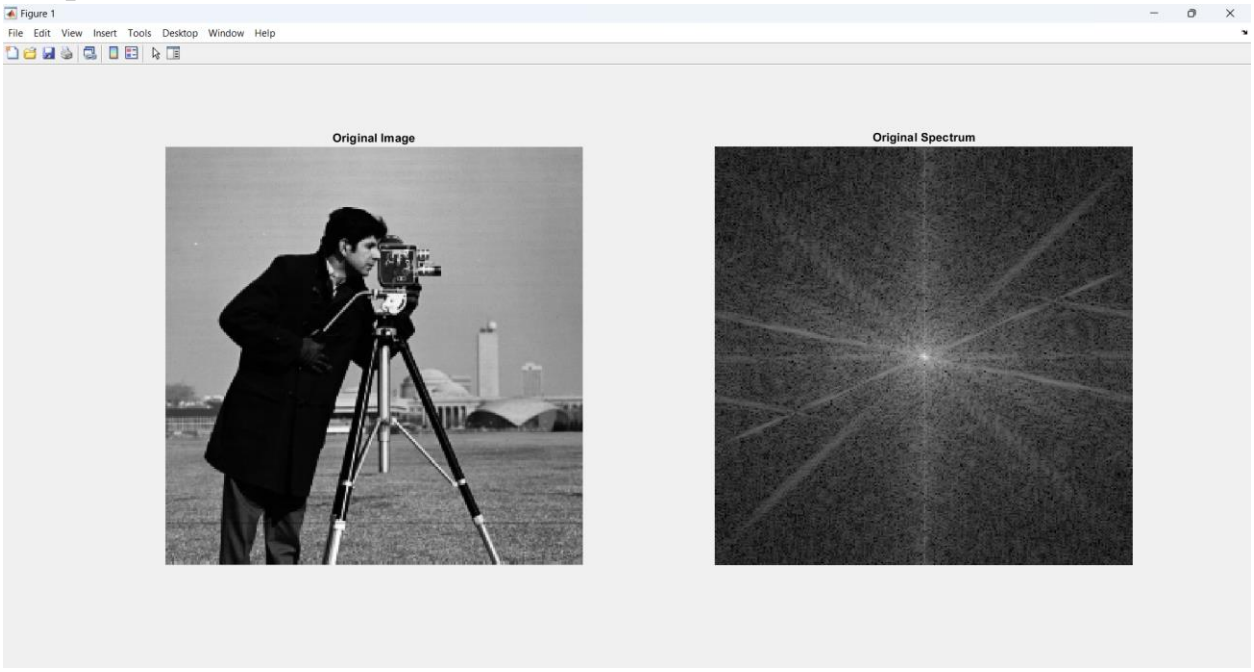
Activity 1

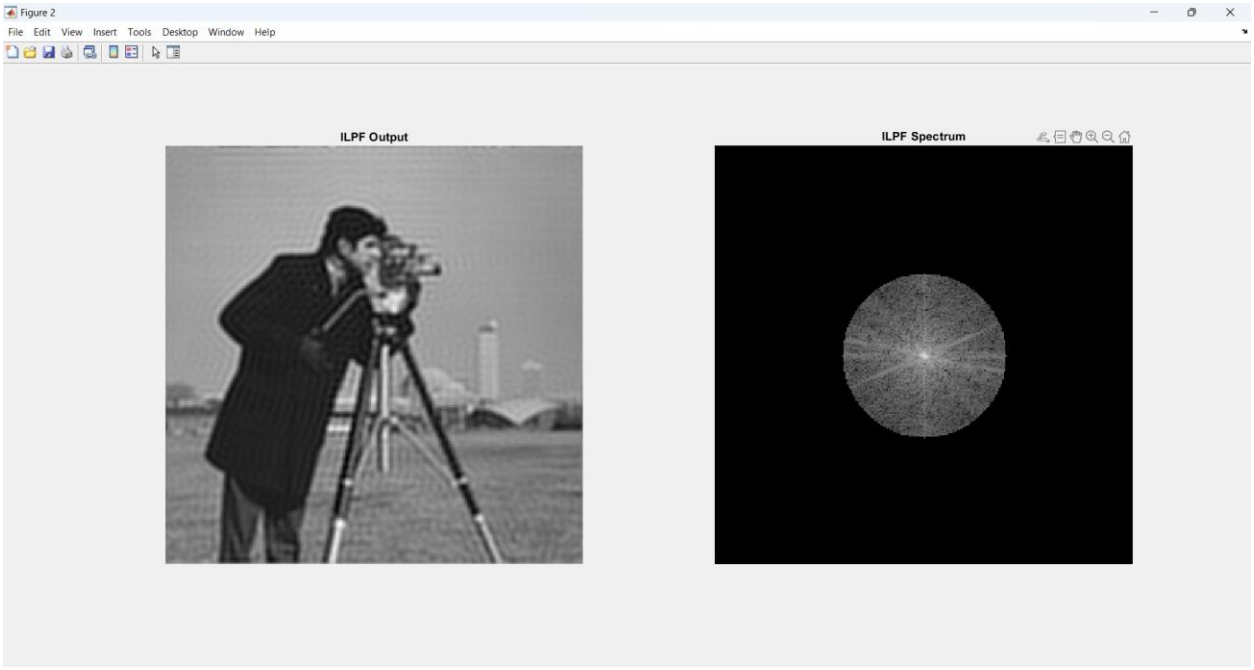
Code:

```
% 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 Lowpass Filter
H_ideal = double(D <= D0);

% Butterworth Lowpass Filter (order = 2)
n = 2;
H_butter = 1 ./ (1 + (D ./ D0).^(2 * n));

% Gaussian Lowpass Filter
H_gauss = 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('ILPF Output');
subplot(1,2,2), imshow(log(1+abs(G_ideal)), []), title('ILPF Spectrum');
```

```
figure;
subplot(1,2,1), imshow(img_butter, []), title('BLPF (n=2) Output');
subplot(1,2,2), imshow(log(1+abs(G_butter)), []), title('BLPF Spectrum');

figure;
subplot(1,2,1), imshow(img_gauss, []), title('GLPF Output');
subplot(1,2,2), imshow(log(1+abs(G_gauss)), []), title('GLPF Spectrum');
```

Output:





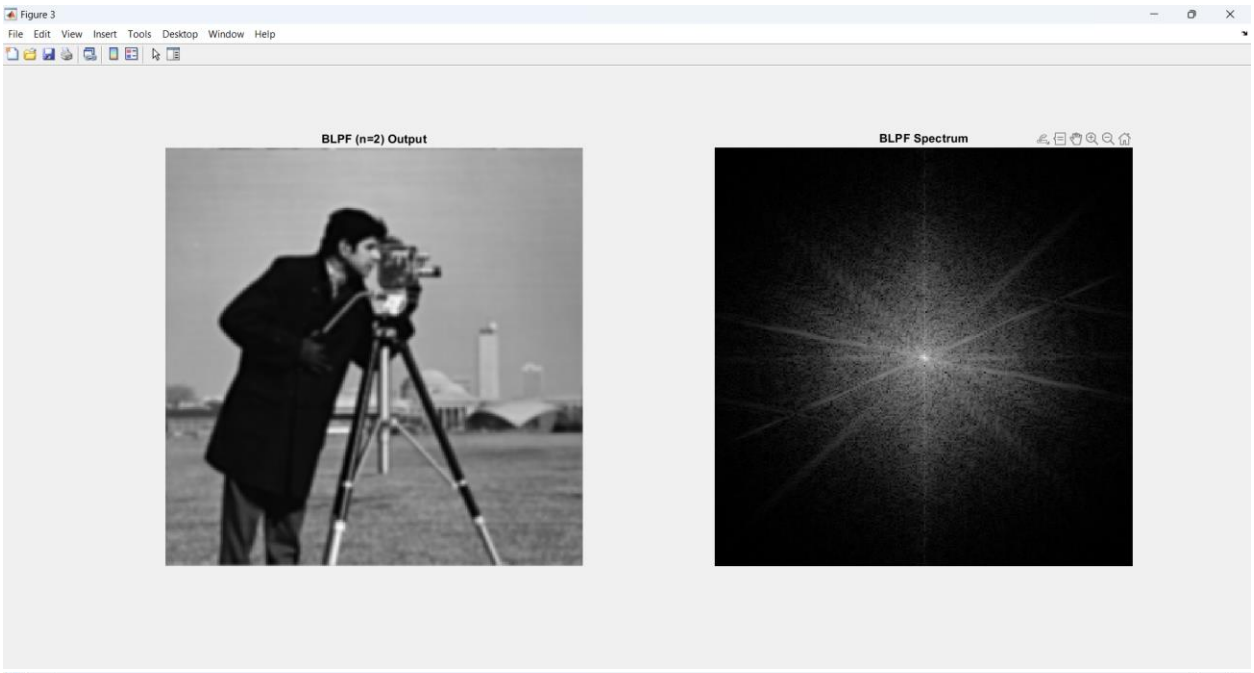


Figure 3
File Edit View Insert Tools Desktop Window Help
BLPF (n=2) Output
BLPF Spectrum

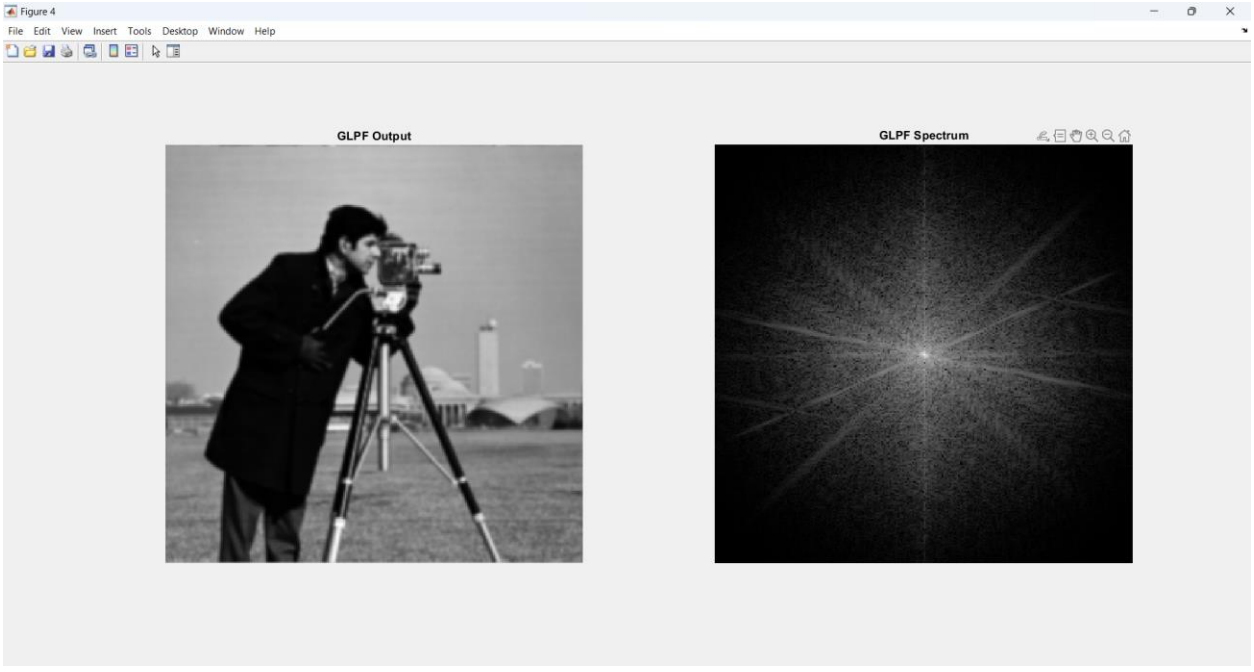


Figure 4
File Edit View Insert Tools Desktop Window Help
GLPF Output
GLPF Spectrum

Analysis

Three frequency domain lowpass filters were applied to a grayscale image:

- **Ideal Lowpass Filter (ILPF):** Strong smoothing but introduces ringing artifacts due to abrupt frequency cutoff. Poor at preserving edges.
- **Butterworth Lowpass Filter (BLPF):** Offers a good balance between noise reduction and edge preservation with fewer artifacts than ILPF.
- **Gaussian Lowpass Filter (GLPF):** Smoothest filtering with excellent noise reduction and minimal artifacts. Best at preserving image details.

Conclusion

The **Gaussian Lowpass Filter** performs best overall, effectively reducing noise while preserving edges and avoiding artifacts. The **Butterworth Filter** is a good compromise, while the **Ideal Filter** is least effective due to noticeable visual distortions.