3. Frequency Domain Low-pass, Band-pass and High-pass Filtering

```
% Reading input image : input_image
input_image = imread('C:\Users\Abinaya Ravichandran\Desktop\Fall 2020\ECE613\Homework2\Q3\bridg
% imshow(input_image)
%Apply 2D-DFT to the original image
FT_img = fft2(double(input_image));
%Shift the DC component to the center
img_shift = fftshift(FT_img);

%%%%%%%%%%%%%%%%%%%% Ideal Low Pass Filter %%%%%%%%%%%%%%%%%%%%%%%%

[M, N] = size(img_shift);

% Assign Cut-off Frequency pi/8
D0 = M/8; % assuming 1/8 OF 100% of the image

[V, U] = meshgrid(-N/2:N/2-1, -N/2:N/2-1);

% Calculating Euclidean Distance
D = sqrt(U.^2+V.^2);
H_1 = (D <= D0);

G_1 = H_1.*img_shift;

%%%%%%%%%%%%%%%%%%%% Ideal High Pass Filter %%%%%%%%%%%%%%%%%%%%%%%%

[M, N] = size(img_shift);
% Assign Cut-off Frequency pi/8
D0 = M/2; % assuming 1/2 of 100% of the image

[V, U] = meshgrid(-N/2:N/2-1, -N/2:N/2-1);
D = sqrt(U.^2+V.^2);
H_2 = ( D > D0 );

G_2 = H_2.*img_shift;

%%%%%%%%%%%%%%%%%%%% Ideal Band Pass Filter %%%%%%%%%%%%%%%%%%%%%%%%

[M, N] = size(img_shift);
% Assign Cut-off Frequency between pi/8 and pi/2
D0 = M/8; % assuming 1/8 of 100% of the image
D1 = M/2; % assuming 1/2 of 100% of the image

[V, U] = meshgrid(-N/2:N/2-1, -N/2:N/2-1);
D = sqrt(U.^2+V.^2);
H_3 = (D0 < D) & (D < D1);

G_3 = H_3.*img_shift;

%%%%%%%%%%%%%%%%%%%%%%%% Spatial Domain %%%%%%%%%%%%%%%%%%%%%%%%%%%%

% Shifting back & inverse
output_image_ideal_lowpass = ifftshift(real(ifft(G_1)));
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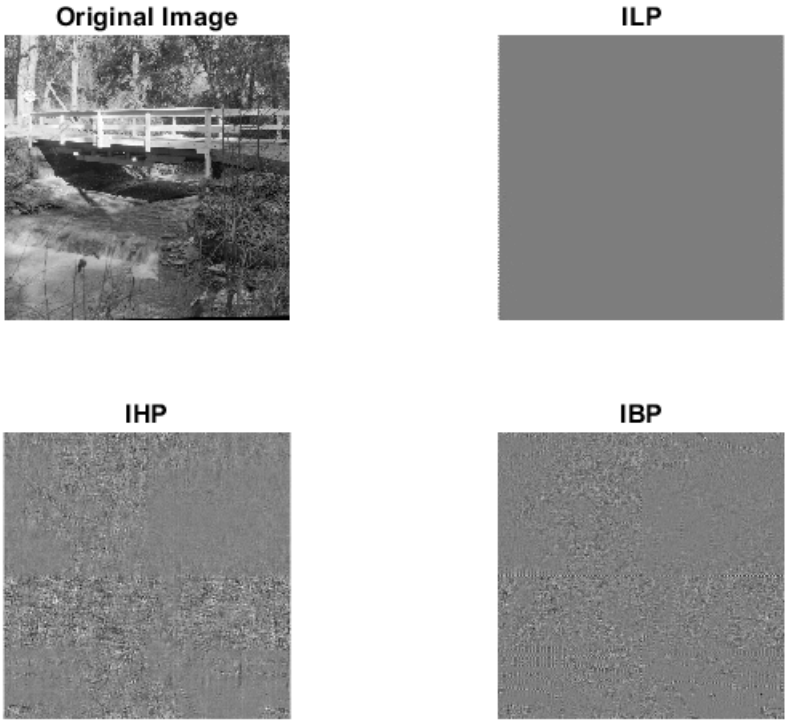
```
output_image_ideal_highpass = ifftshift(real(ifft2(G_2)));
output_image_ideal_bandpass = ifftshift(real(ifft2(G_3)));

%%%%%%%%%%%%%%%%%%%%%%%%% OUTPUTS %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% Figure 1

if true
    figure,
    subplot(2,2,1); imshow(input_image);title('Original Image');
    subplot(2,2,2); imshow(output_image_ideal_lowpass, [ ]);title('ILP');
    subplot(2,2,3); imshow(output_image_ideal_highpass+128, [ ]);title('IHP');
    subplot(2,2,4); imshow(output_image_ideal_bandpass+128, [ ]);title('IBP');
end
```

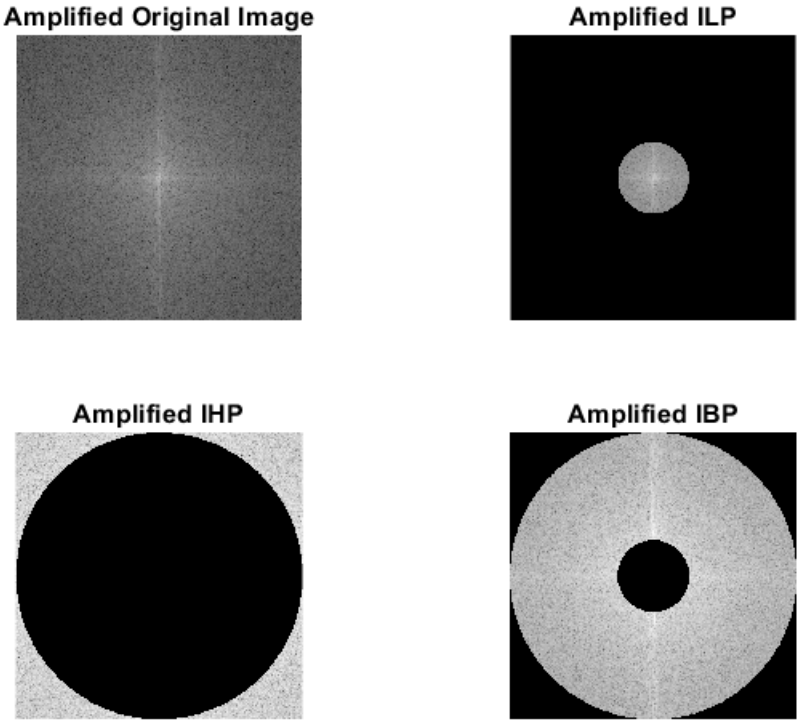



```
% Intensity transformation of logn(1+x)
log_original = real(log(1+abs(img_shift)));
log_lp = real(log(1+abs(G_1)));
log_hp = real(log(1+abs(G_2)));
log_bp = real(log(1+abs(G_3)));

% Figure 2

if true
    figure,
    subplot(2,2,1); imshow(log_original, [ ]);title('Amplified Original Image');
    subplot(2,2,2); imshow(log_lp, [ ]);title('Amplified ILP');
```

```
    subplot(2,2,3); imshow(log_hp, [ ]);title('Amplified IHP');
    subplot(2,2,4); imshow(log_bp, [ ]);title('Amplified IBP');
end
```



Observations:

The Ideal Low pass amplifier removed all the frequencies that is above the given threshold point of 1/8 of the pixel values from the center of the image, High pass amplifier removed all the frequencies less than the threshold point 1/2 of image, band pass is the difference between the low pass and high pass filter, between 1/8 and 1/2 of the pixel value. The amplified images shows the portion of the image which is amplified.