Lab 3

Contents

```
clear all;
close all;
clc;
```

Spatial Frequencies 1

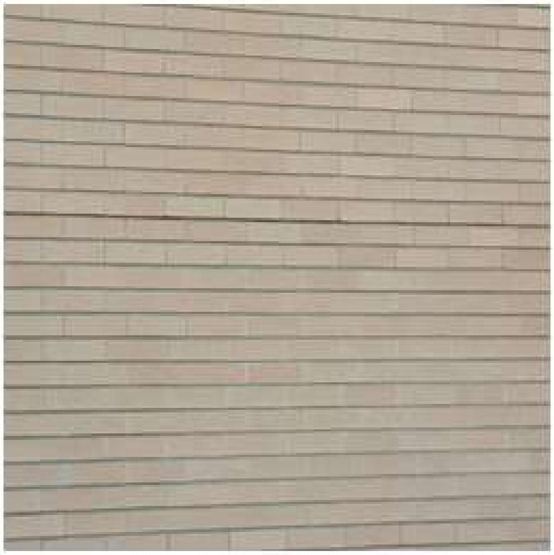
Loading in and Resizing the images

```
bricks = imread('bricks.jpg');
sky = imread('sky.jpg');

bricks_256 = imresize(bricks, [256 256]);
sky_256 = imresize(sky, [256 256]);
```

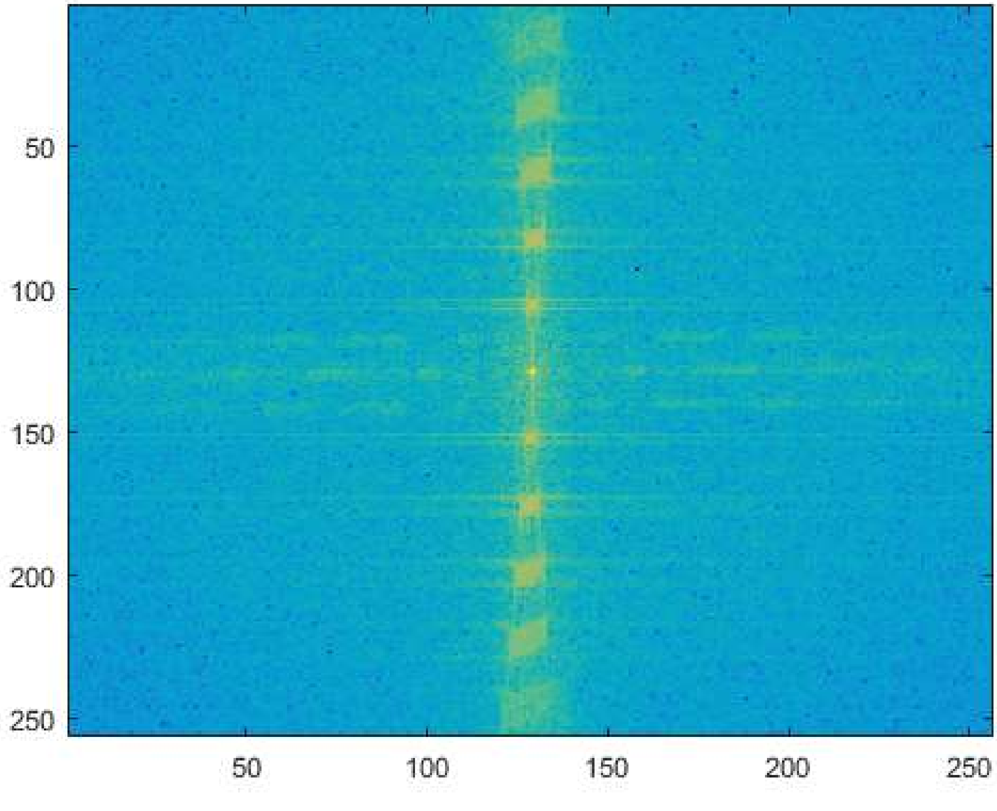
Displaying the Fourier Transform of the bricks and the sky

```
figure;
imshow(bricks_256)
bricks_gray = rgb2gray(bricks_256);
title('Sky Image')

figure;
imagesc(log(abs(fftshift(fft2(bricks_gray)))))
title('FFT of bricks')

figure;
imshow(sky_256)
sky_gray = rgb2gray(sky_256);
title('Sky image')

figure;
imagesc(log(abs(fftshift(fft2(sky_gray)))))
title('FFT of sky')
```

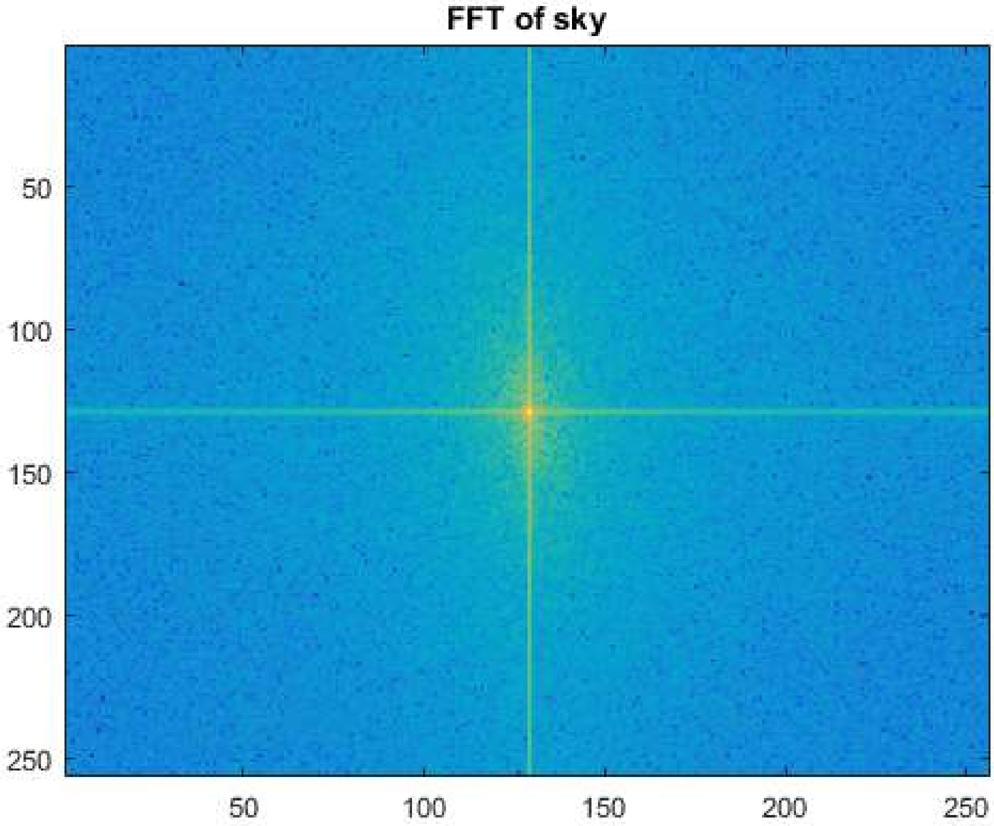
Sky Image



FFT of bricks



Sky image

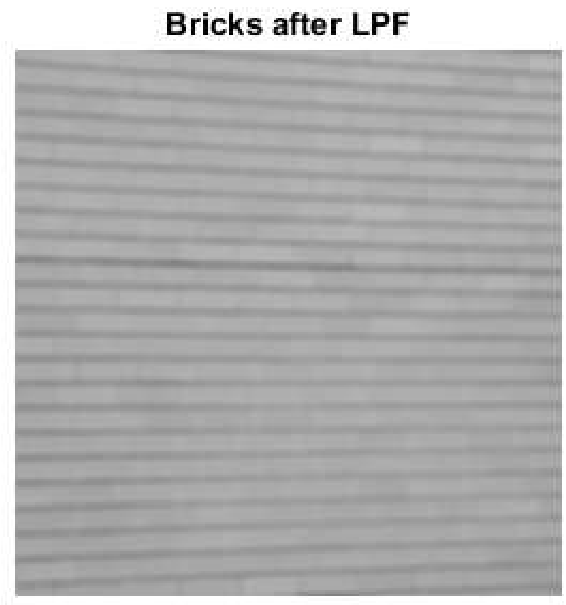


FFT of sky

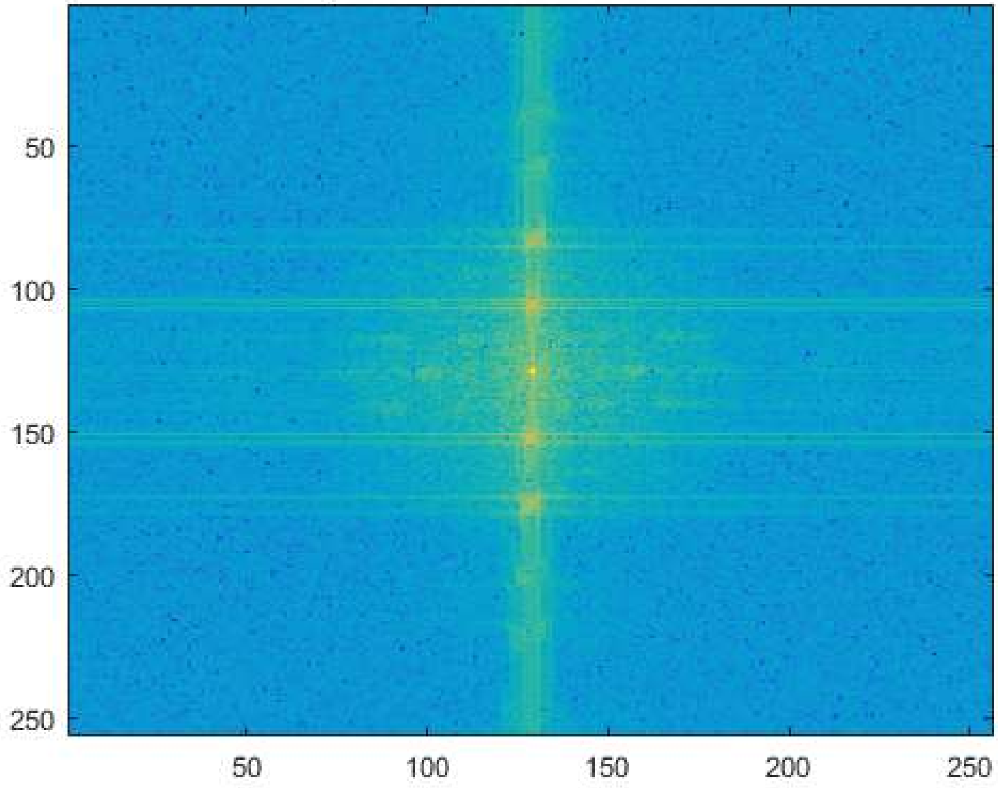
Applying a low pass filter to the bricks yields the following

```
lpf = fspecial('gaussian',5,1.7);
hpf = [0  0  0  0  0;
        0  0  0  0  0;
```

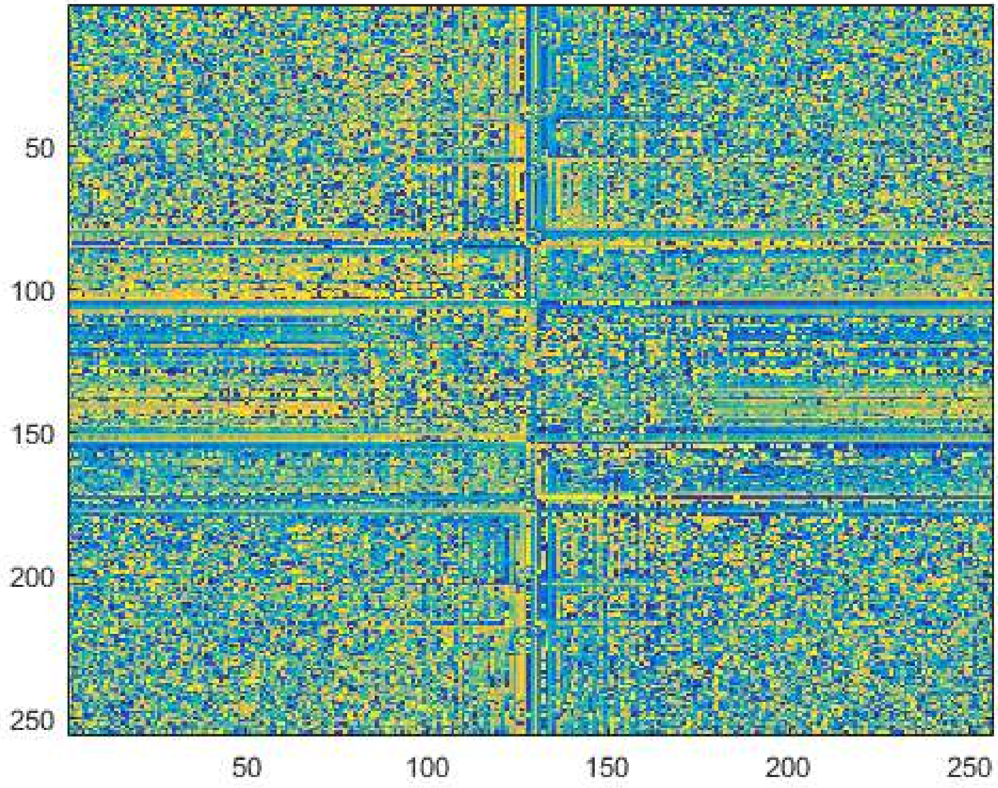
```
       0 0 1 0 0;
       0 0 0 0 0;
       0 0 0 0 0] - lpf;
bricks_lpf = imfilter(bricks_gray, lpf, 'replicate');
bricks_hpf = imfilter(bricks_gray, hpf, 'replicate');

figure;
imshow(uint8(bricks_lpf))
title('Bricks after LPF');
figure;
imagesc(log(abs(fftshift(fft2(bricks_lpf)))))
title('Magnitude of the bricks after LPF');
figure;
imagesc(angle(fftshift(fft2(bricks_lpf))))
title('Phase of the bricks after LPF');

figure;
imshow(uint8(bricks_hpf))
title('Bricks after HPF');
figure;
imagesc(log(abs(fftshift(fft2(bricks_hpf)))))
title('Magnitude of the bricks after HPF');
figure;
imagesc(angle(fftshift(fft2(bricks_hpf))))
title('Phase of the bricks after HPF');
```



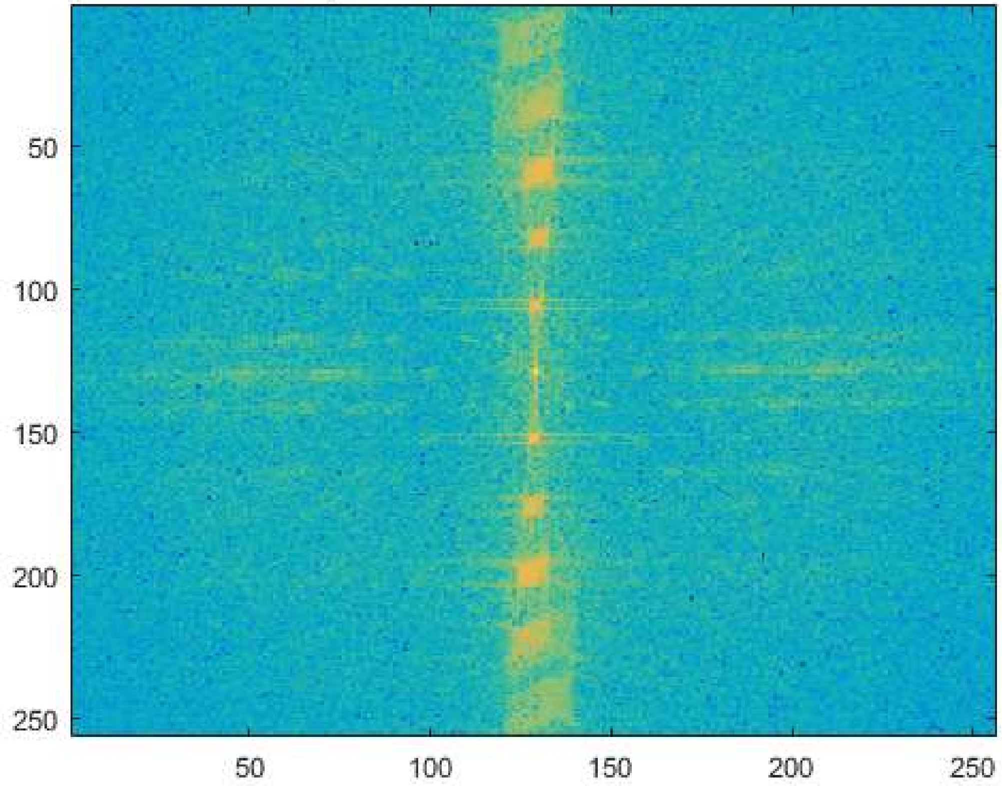
Magnitude of the bricks after LPF



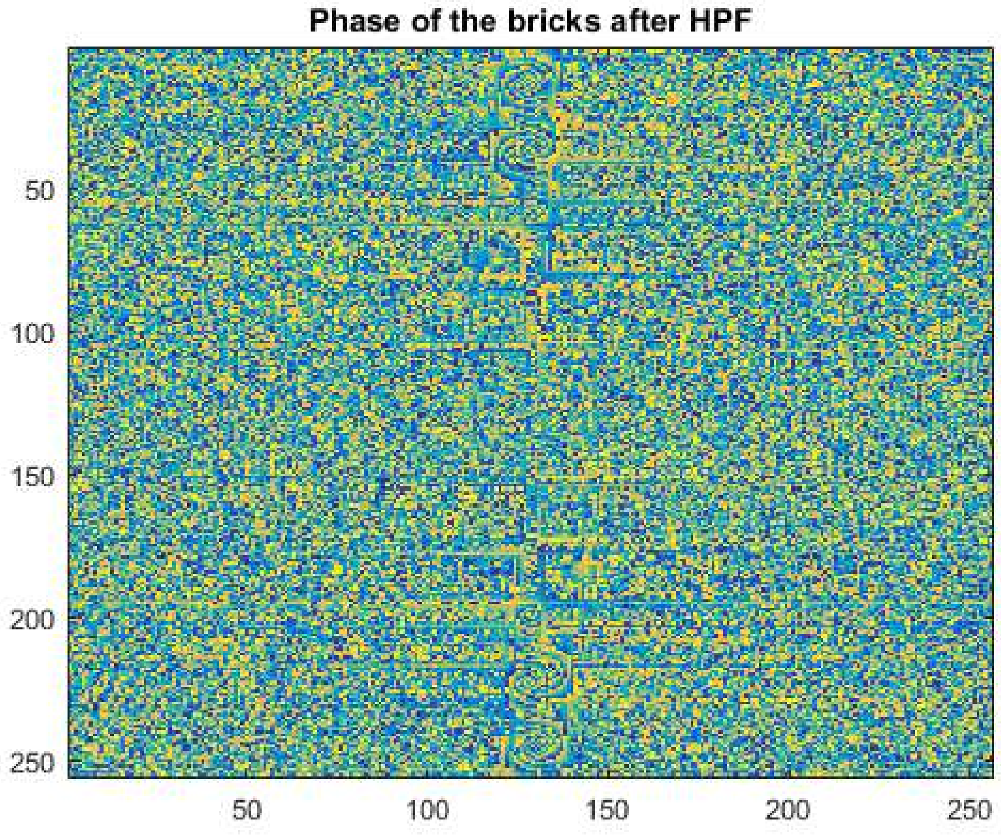
Phase of the bricks after LPF



Bricks after HPF



Magnitude of the bricks after HPF



The energy for the high pass and low pass are given by:

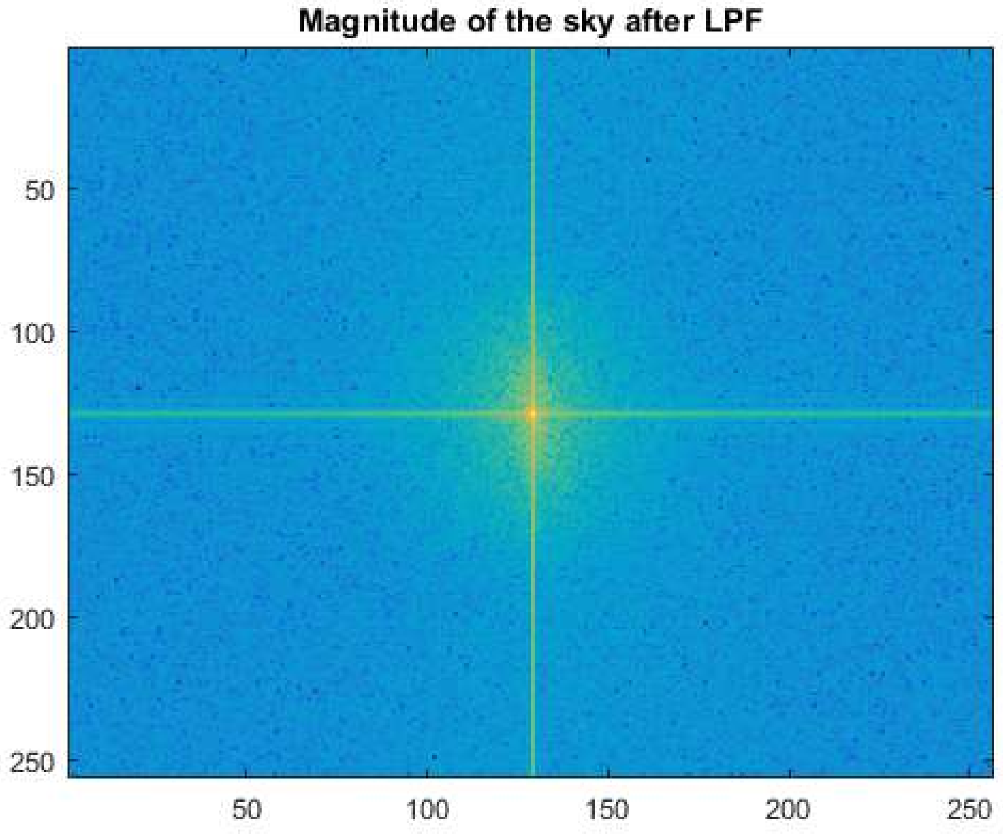
```
energy_lpf = norm(fft2(bricks_lpf),2);
energy_hpf = norm(fft2(bricks_hpf),2);
fprintf('Bricks Energy HPF = %d, LPF Energy = %d\n', energy_hpf, energy_lpf);
```

```
Bricks Energy HPF = 2.691808e+05, LPF Energy = 1.083897e+07
```

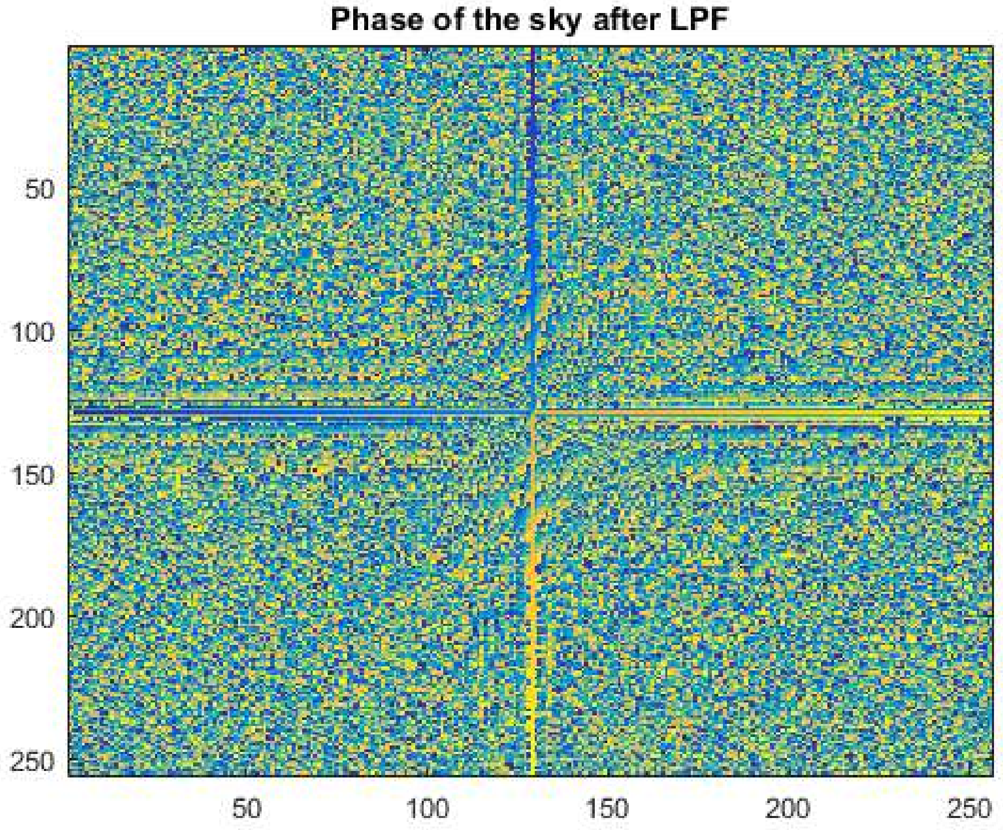
Doing the same to the sky image yields the following:

```
sky_lpf = imfilter(sky_gray, lpf, 'replicate');
sky_hpf = imfilter(sky_gray, hpf, 'replicate');

figure;
imshow(uint8(sky_lpf))
title('Sky after LPF');
figure;
imagesc(log(abs(fftshift(fft2(sky_lpf)))))
title('Magnitude of the sky after LPF');
figure;
imagesc(angle(fftshift(fft2(sky_lpf))))
title('Phase of the sky after LPF');

figure;
imshow(uint8(sky_hpf))
```

```
title('Sky after HPF');
figure;
imagesc(log(abs(fftshift(fft2(sky_hpf)))))
title('Magnitude of the sky after HPF');
figure;
imagesc(angle(fftshift(fft2(sky_hpf))))
title('Phase of the sky after HPF');
```

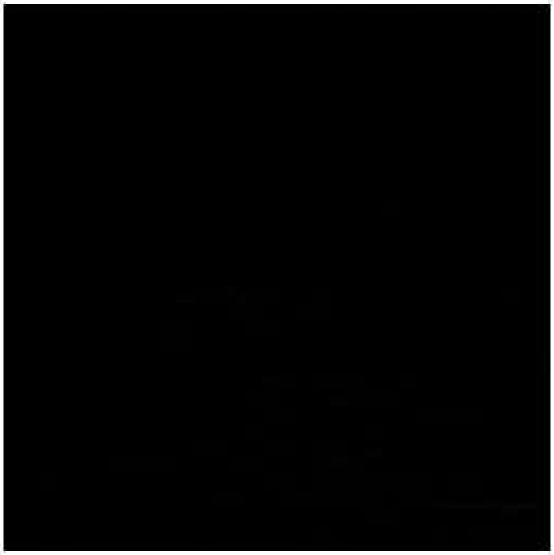


Magnitude of the sky after LPF

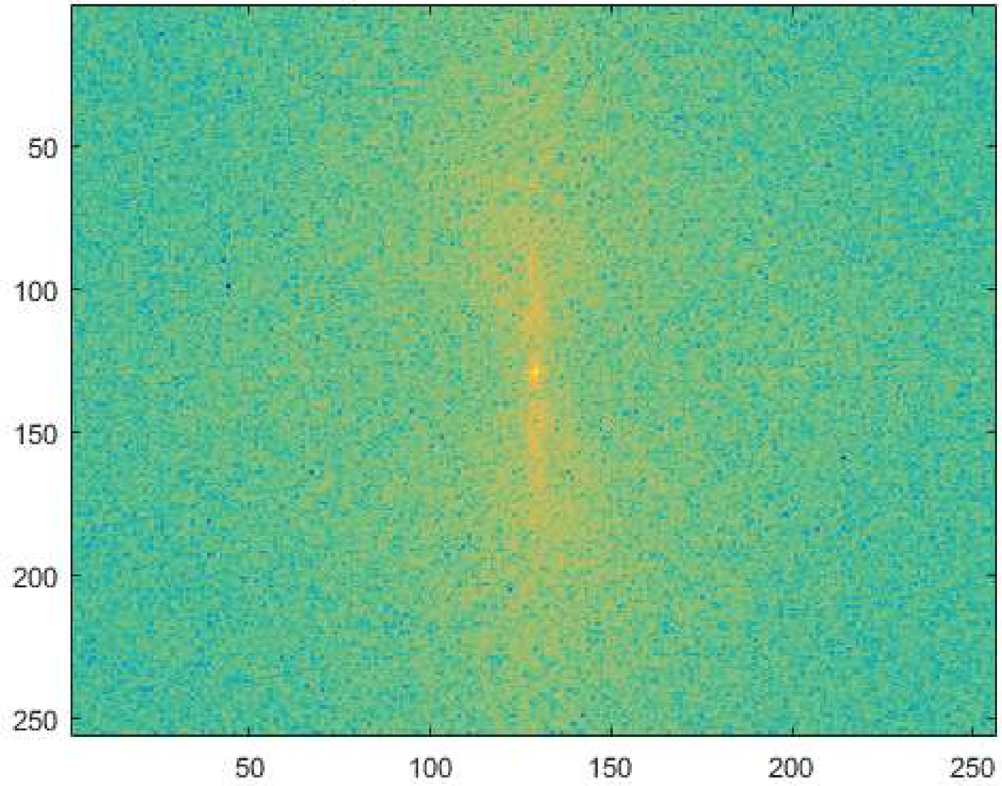


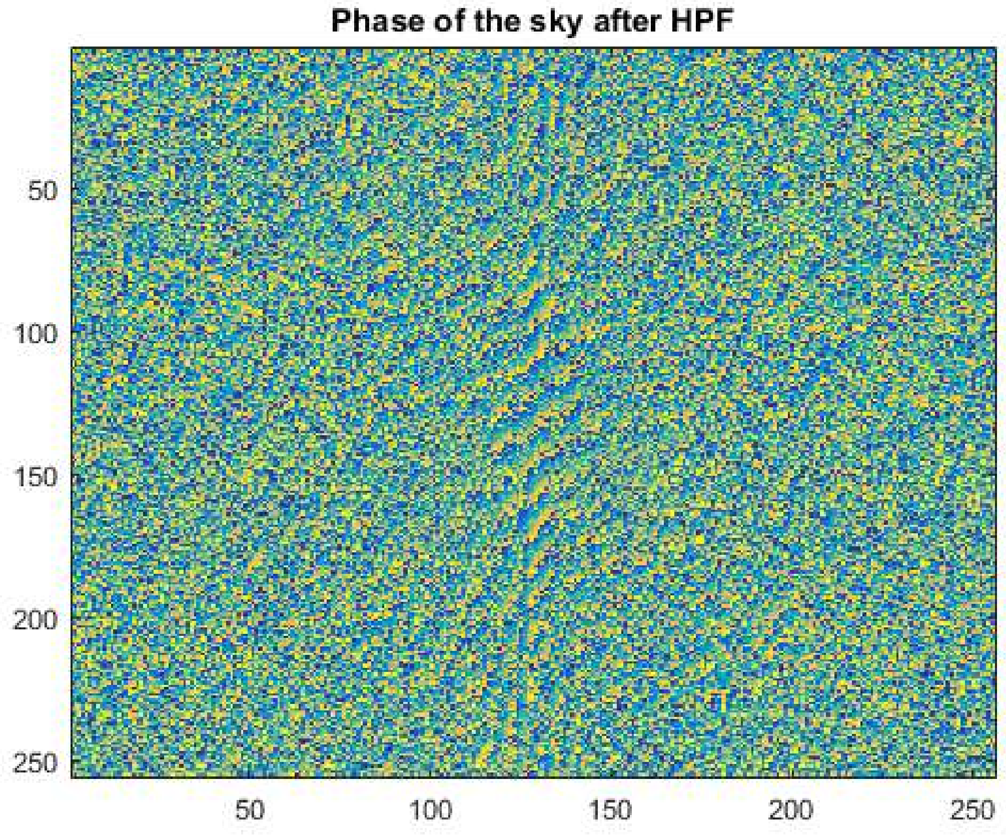
Phase of the sky after LPF

Sky after HPF



Magnitude of the sky after HPF





The energy for the high pass and low pass are given by:

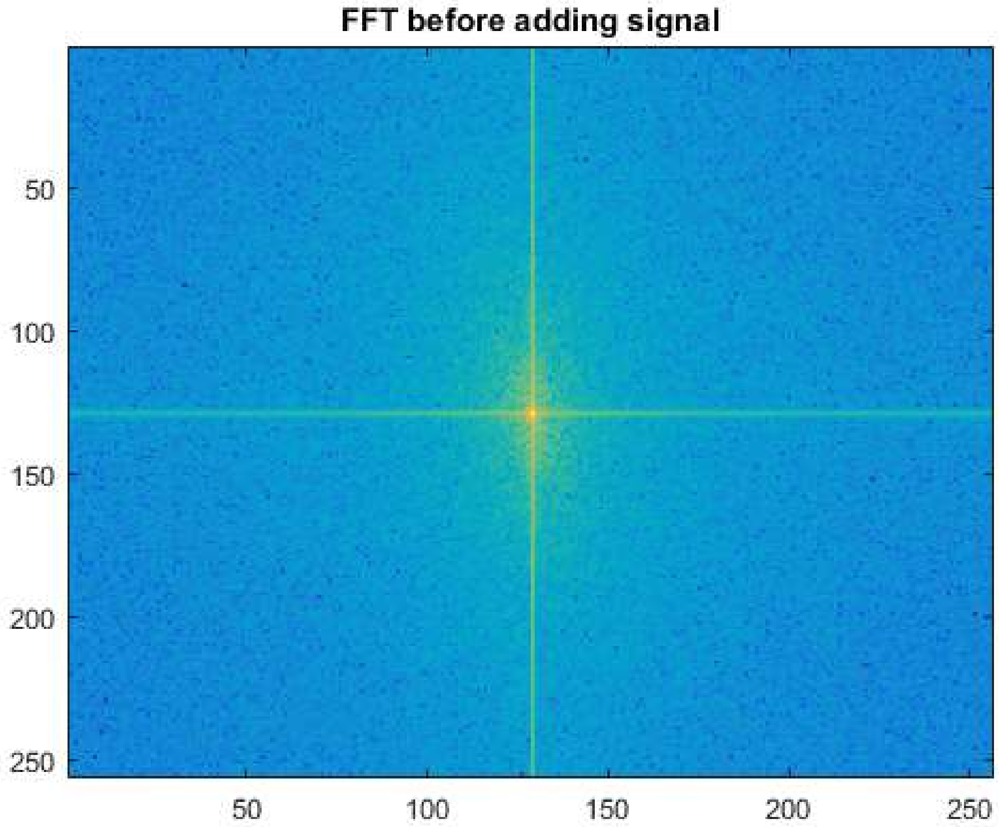
```
energy_lpf = norm(fft2(sky_lpf),2);
energy_hpf = norm(fft2(sky_hpf),2);
fprintf('Sky Energy HPF = %d, LPF Energy = %d\n', energy_hpf, energy_lpf);
```

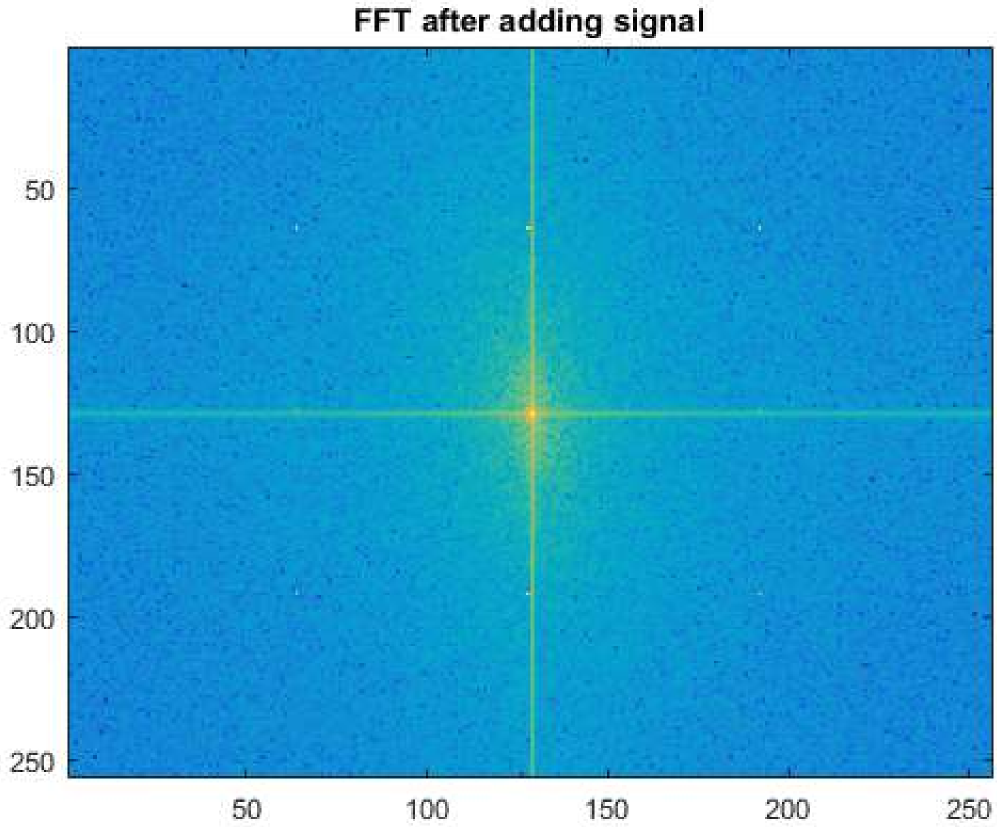
```
Sky Energy HPF = 1.646941e+04, LPF Energy = 8.817600e+06
```

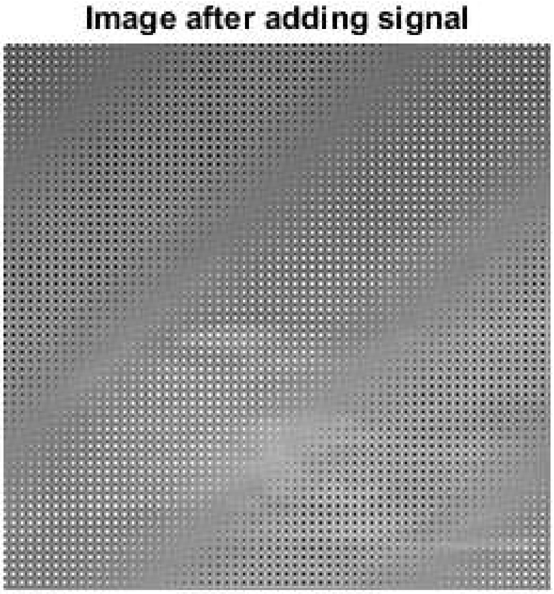
Adding in some singals to the FFT yields the following:

```
sky_fft = fftshift(fft2(sky_gray));

figure;
imagesc(log(abs(sky_fft)));
title('FFT before adding signal');

amt_to_add = 10e5;

sky_fft(128+64,128+64) = amt_to_add;
sky_fft(128-64,128-64) = amt_to_add;
sky_fft(128-64,128+64) = amt_to_add;
sky_fft(128+64,128-64) = amt_to_add;

sky_fft(128,128+64) = amt_to_add;
sky_fft(128,128-64) = amt_to_add;
sky_fft(128+64,128) = amt_to_add;
sky_fft(128-64,128) = amt_to_add;

figure;
imagesc(log(abs(sky_fft)));
title('FFT after adding signal');

sky_fft_modified = ifftshift(sky_fft);
sky_gray_modfied = uint8(ifft2(sky_fft_modified));

figure;
imshow(sky_gray_modfied);
title('Image after adding signal');
```

```
Warning: Displaying real part of complex input.
```







Removing the signal

```
sky_fft(128+64,128+64) = 0;
sky_fft(128-64,128-64) = 0;
sky_fft(128-64,128+64) = 0;
sky_fft(128+64,128-64) = 0;

sky_fft(128,128+64) = 0;
sky_fft(128,128-64) = 0;
sky_fft(128+64,128) = 0;
sky_fft(128-64,128) = 0;

figure;
imagesc(log(abs(sky_fft)));
title('FFT after removing signal');

sky_fft_modified = ifftshift(sky_fft);
sky_gray_modfied = uint8(ifft2(sky_fft_modified));

figure;
imshow(sky_gray_modfied);
title('Image after Removing signal');
```

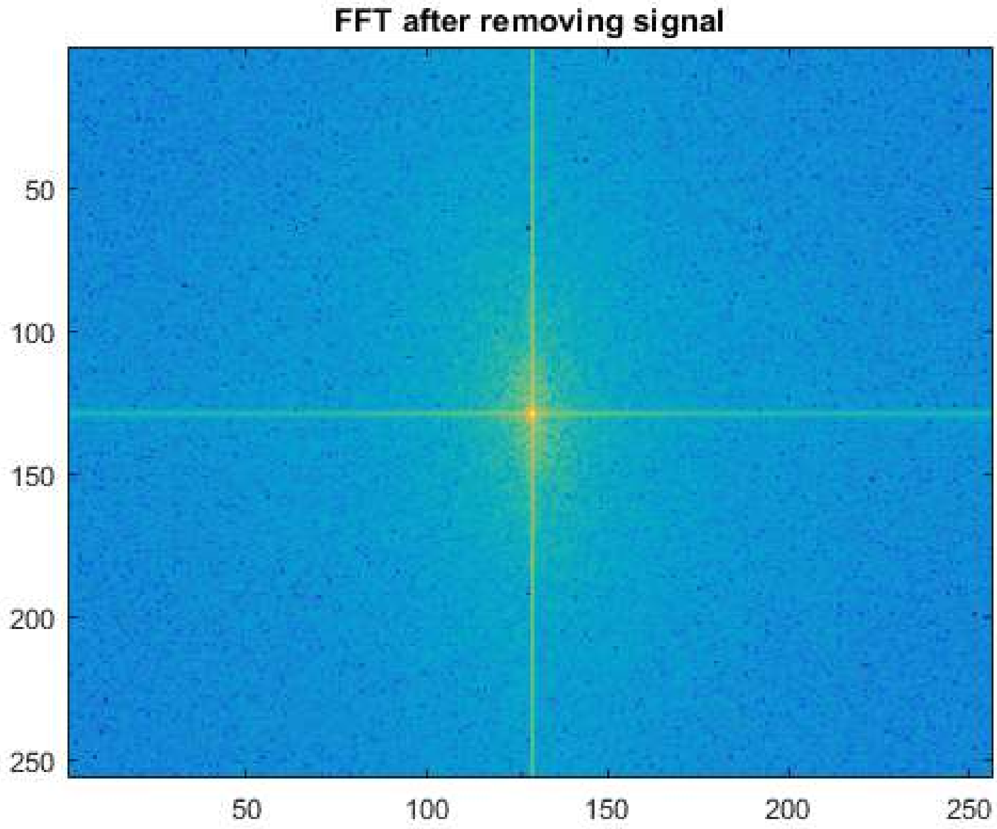


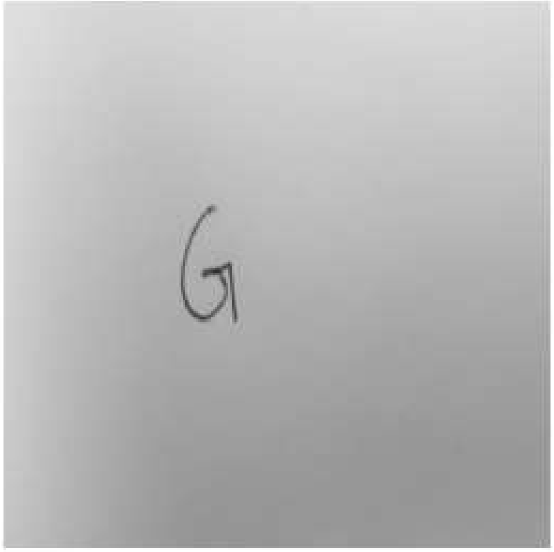
Image after Removing signal

Spatial Frequencies 2

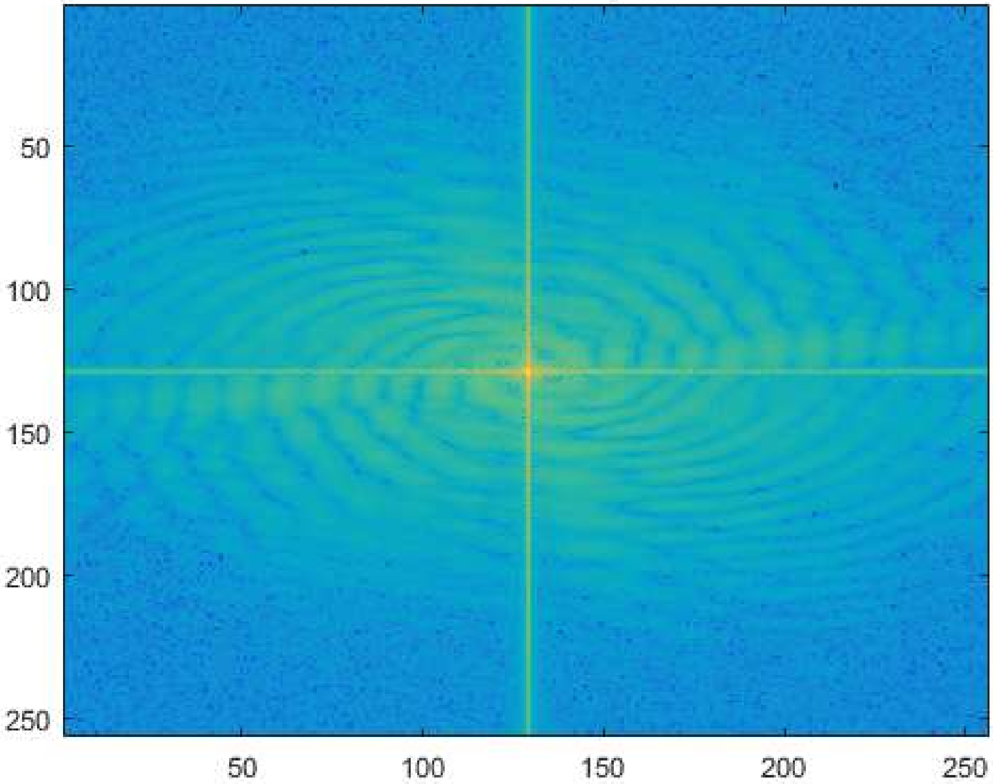
Load in the images

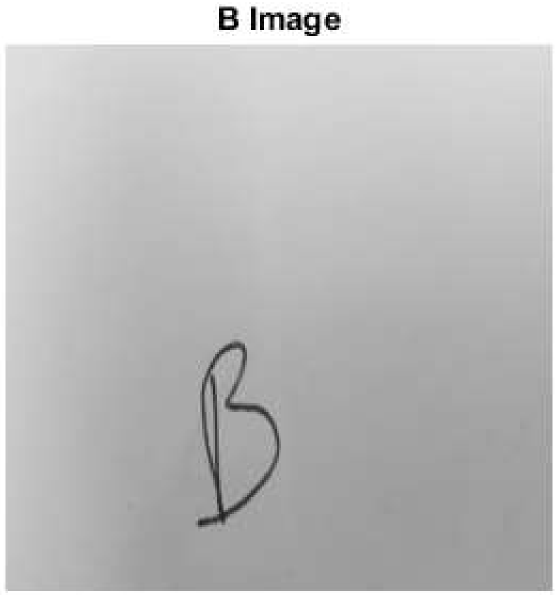
```
g_img = imread('G.jpg');
b_img = imread('B.jpg');

g_256 = imresize(g_img, [256 256]);
b_256 = imresize(b_img, [256 256]);

g_gray = rgb2gray(g_256);
g_gray = imrotate(g_gray, 90);
b_gray = rgb2gray(b_256);

g_fft = fft2(g_gray);
b_fft = fft2(b_gray);

figure;
imshow(g_gray);
title('G Image');

figure;
imagesc(log(abs(fftshift(g_fft))));
title('FFT of G Image');

figure;
imshow(b_gray);
title('B Image');

figure;
imagesc(log(abs(fftshift(b_fft))));
title('FFT of B Image');
```

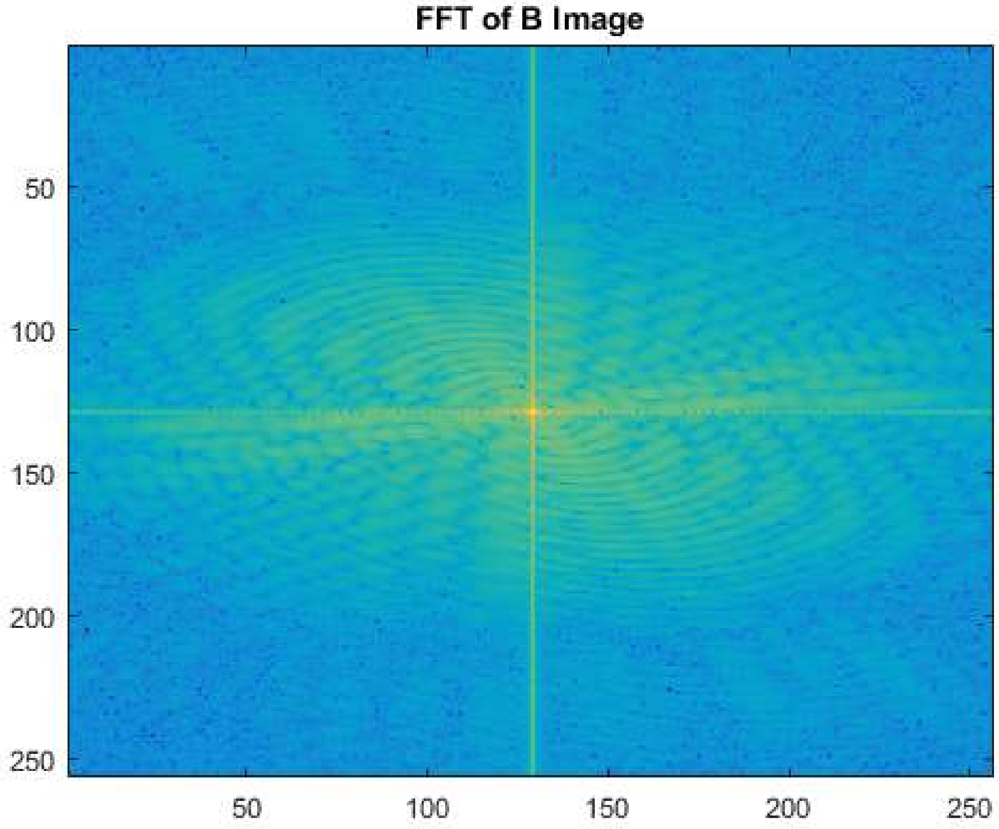
G Image



FFT of G Image



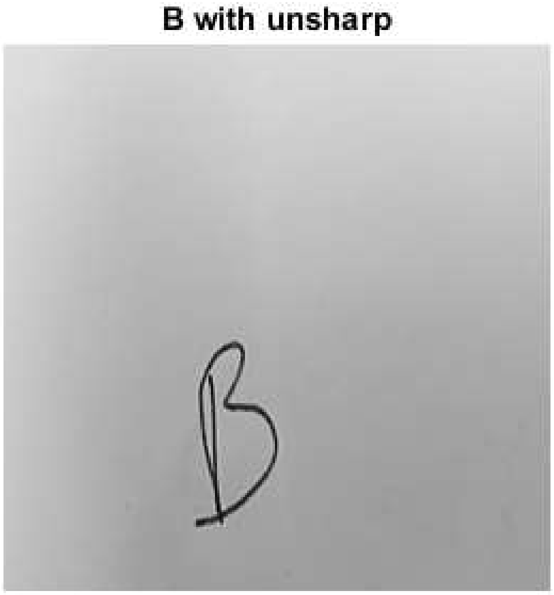

B Image


FFT of B Image

Sharpening the image with unsharp

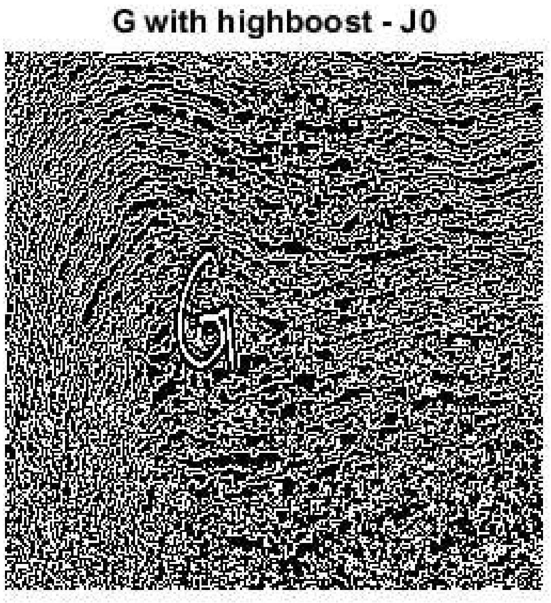
```
g_unsharp = imsharpen(g_gray);
b_unsharp = imsharpen(b_gray);
```

```
figure;
imshow(g_unsharp);
title('G with unsharp');

figure;
imshow(b_unsharp);
title('B with unsharp');
```

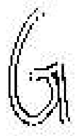


Sharpening the images with high boost

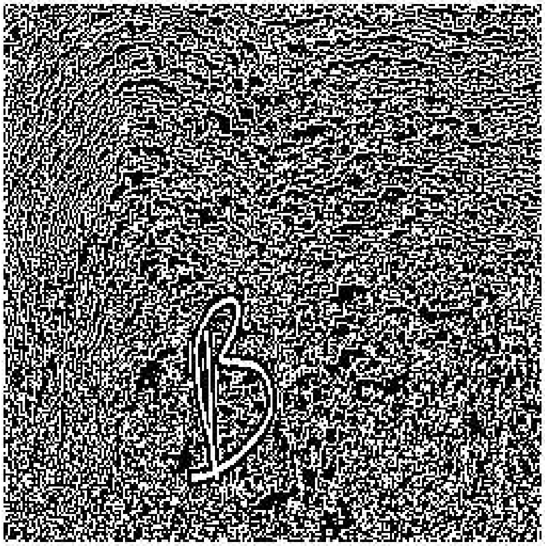
```
[J0, J1] = Highboost(g_gray, 1.5);

figure;
imshow(J0);
title('G with highboost - J0');

figure;
imshow(J1);
title('G with highboost - J1');

[J0, J1] = Highboost(b_gray, 1.5);

figure;
imshow(J0);
title('B with highboost - J0');

figure;
imshow(J1);
title('B with highboost - J1');
```

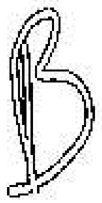


G with highboost - J1



B with highboost - J0

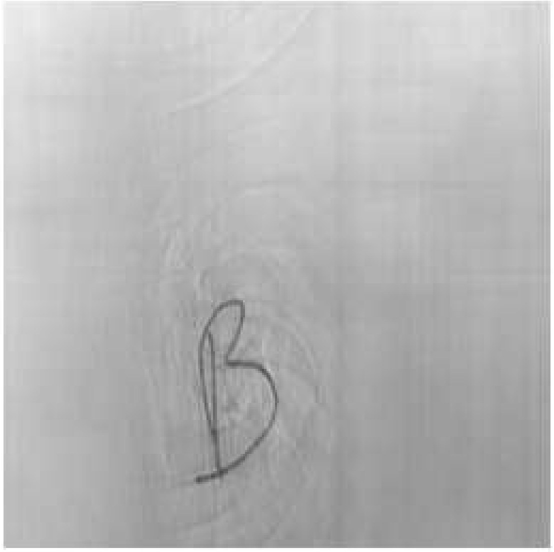



B with highboost - J1

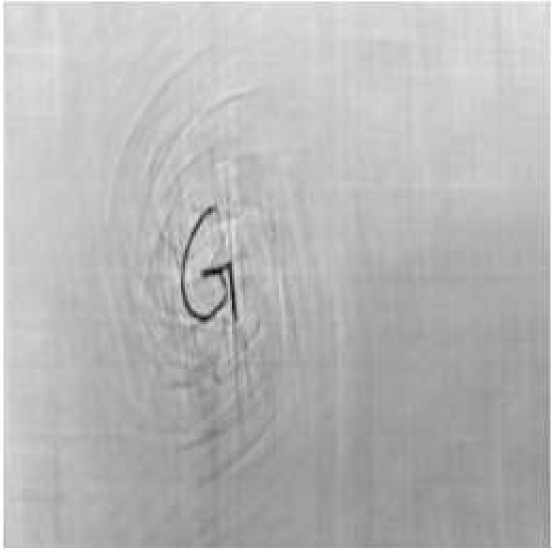
Swapping the phase of the two images.

```
g_mag = abs(g_fft);
b_mag = abs(b_fft);
g_phase = angle(g_fft);
b_phase = angle(b_fft);

swapped1 = g_mag .* exp(1i*b_phase);
swapped2 = b_mag .* exp(1i*g_phase);

s1_img = uint8(ifft2(swapped1));
s2_img = uint8(ifft2(swapped2));

figure;
imshow(s1_img);
title('G Magnitude with B phase');

figure;
imshow(s2_img);
title('B Magnitude with G phase');
```

G Magnitude with B phase

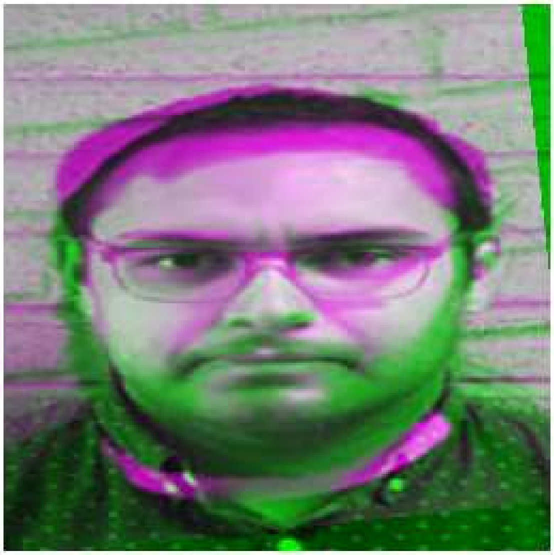


B Magnitude with G phase

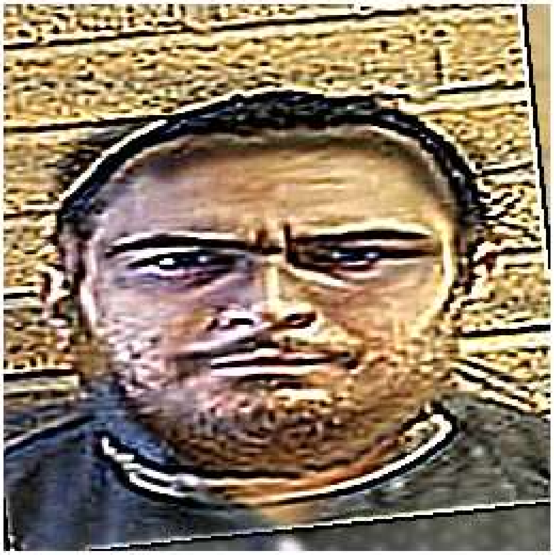


More Fun with Frequencies

```
gogol = imread('fg2.jpg');
%gogol = imcrop(gogol, [194 290 333 538]);
gogol = imcrop(gogol, [194 290 139 248]);
gogol = imresize(gogol, [256 256]);

jesse = imread('Jesse.jpg');
%jesse = imcrop(jesse, [163 177 260 351]);
jesse = imcrop(jesse, [163 177 97 174]);
jesse = imresize(jesse, [256 256]);

fixedPt = [82 118; 172 120];
movingPt = [90 128; 176 139];

tform = fitgeotrans(movingPt,fixedPt,'NonreflectiveSimilarity');

Jregistered = imwarp(jesse,tform,'OutputView',imref2d(size(gogol)));

figure;
imshowpair(gogol,Jregistered)
title('Images of Jesse and Me after being reg');

lpf = fspecial('gaussian',5,10);
hpf = [0 0 0 0 0;
       0 0 0 0 0;
       0 0 1 0 0;
       0 0 0 0 0;
       0 0 0 0 0] - lpf;

gogol_lpf = imfilter(double(gogol), lpf, 'replicate');
Jregistered_hpf = imfilter(double(Jregistered), hpf, 'replicate');

figure;
imshow(uint8(gogol_lpf + 15*Jregistered_hpf));
title('High freq of Jesse and Low freq of Gogol');
```



Images of Jesse and Me after being reg

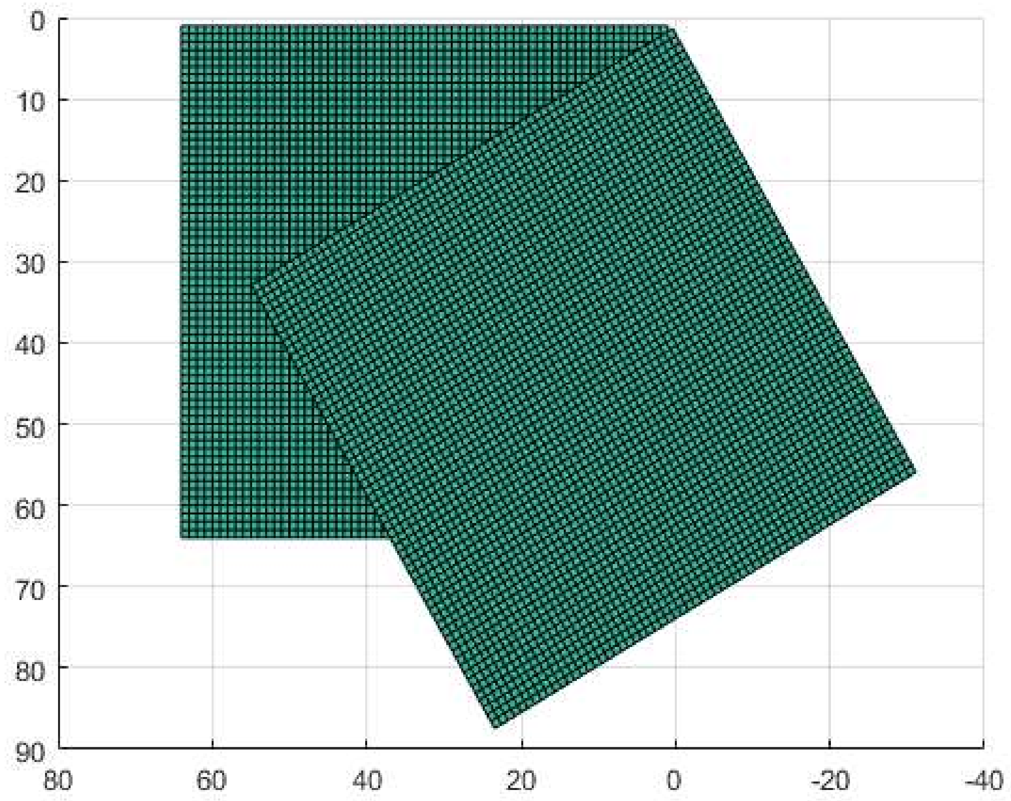


High freq of Jesse and Low freq of Gogol

Geometric Transforms

Rotation a mesh

```
theta=-30;
theta=deg2rad(theta);
R = [cos(theta) -sin(theta);
    sin(theta) cos(theta)];


[x,y] = meshgrid(1:64);
C = 0.*(x + y);

rot_x = zeros(64,64);
rot_y = zeros(64,64);
for i = 1:1:length(x)
    for j = 1:1:length(y)
        temp = R*[x(i,j);y(i,j)];
        rot_x(i,j) = temp(1);
        rot_y(i,j) = temp(2);
    end
end

figure;
surf(x,y,C);
hold on
surf(rot_x,rot_y,C);
hold off
view(-90,-90)
```



Now do it for the image

```
gogol_g = rgb2gray(gogol);
[x,y] = meshgrid(1:256);


[u,v] = meshgrid(1:256);
rot_u = zeros(256,256);
rot_v = zeros(256,256);
for i = 1:1:length(u)
    for j = 1:1:length(v)
        temp = R*[u(i,j);v(i,j)];
        rot_u(i,j) = temp(1);
        rot_v(i,j) = temp(2);
    end
end

rot_gogol = interp2(u,v, im2double(gogol_g), rot_u, rot_v, 'cubic');
figure;
imshow(rot_gogol);
```

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