Table of Contents


```
% Lab 3
%%Spatial Freq
fence = imread('fence.jpg');
fence_256 = imresize(fence, [256 256]);
sky = imread('sky.jpg');
sky_256 = imresize(sky, [256 256]);
figure;
imshow(fence_256)
fence_grayscale = rgb2gray(fence_256);
figure;
imagesc(log(abs(fftshift(fft2(fence_grayscale)))))
figure;
imshow(sky_256)
sky_grayscale = rgb2gray(sky_256);
figure;
imagesc(log(abs(fftshift(fft2(sky_grayscale)))))
% 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;
fencelowfilter = imfilter(fence_grayscale, lpf, 'replicate');
fencehighfilter = imfilter(fence_grayscale, hpf, 'replicate');
figure;
imshow(uint8(fencelowfilter))
figure;
imagesc(log(abs(fftshift(fft2(fencelowfilter)))))
figure;
imagesc(angle(fftshift(fft2(fencelowfilter))))
figure;
imshow(uint8(fencehighfilter))
figure;
imagesc(log(abs(fftshift(fft2(fencehighfilter)))))
figure;
imagesc(angle(fftshift(fft2(fencehighfilter))))
%%low high energy fence
energylow = norm(fft2(fencelowfilter),2);
energyhigh = norm(fft2(fencehighfilter),2);
fprintf('Fence HighPassFilter Energy = %d, LowPassFilter Energy = %d
\n', energyhigh, energylow);
skylow = imfilter(sky_grayscale, lpf, 'replicate');
skyhigh = imfilter(sky_grayscale, hpf, 'replicate');
```

```
figure;
imshow(uint8(skylow))
figure;
imagesc(log(abs(fftshift(fft2(skylow)))))
figure;
imagesc(angle(fftshift(fft2(skylow))))
figure;
imshow(uint8(skyhigh))
figure;
imagesc(log(abs(fftshift(fft2(skyhigh)))))
figure;
imagesc(angle(fftshift(fft2(skyhigh))))
% low high energy sky
energy_lpf = norm(fft2(skylow),2);
energy_hpf = norm(fft2(skyhigh),2);
fprintf('Sky HighPassFilter Energy = %d, LowPassFilter Energy = %d\n',
 energy_hpf, energy_lpf);

% signals added to fft
sky_fft = fftshift(fft2(sky_grayscale));
figure;
imagesc(log(abs(sky_fft)));
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)));
sky_fft_modified = ifftshift(sky_fft);
sky_gray_modfied = uint8(ifft2(sky_fft_modified));
figure;
imshow(sky_gray_modfied);
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)));
sky_fft_modified = ifftshift(sky_fft);
sky_gray_modfied = uint8(ifft2(sky_fft_modified));
figure;
imshow(sky_gray_modfied);
```

```
Fence HighPassFilter Energy = 2.126862e+05, LowPassFilter Energy =
 3.948228e+06
```

```
Sky HighPassFilter Energy = 3.813044e+04, LowPassFilter Energy =
 9.663096e+06
Warning: Displaying real part of complex input.
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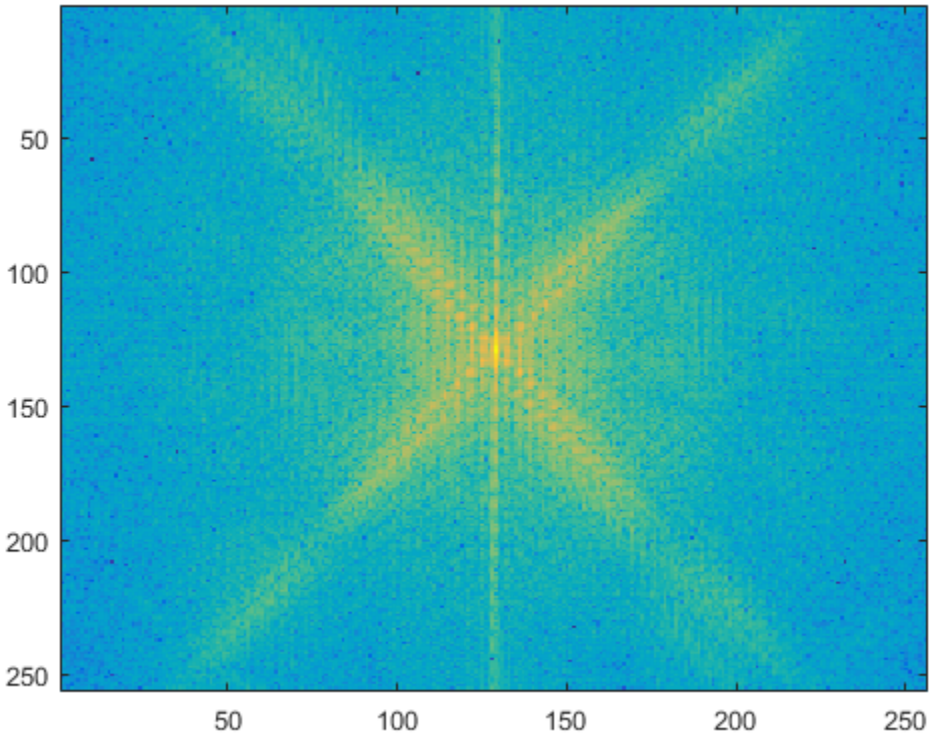

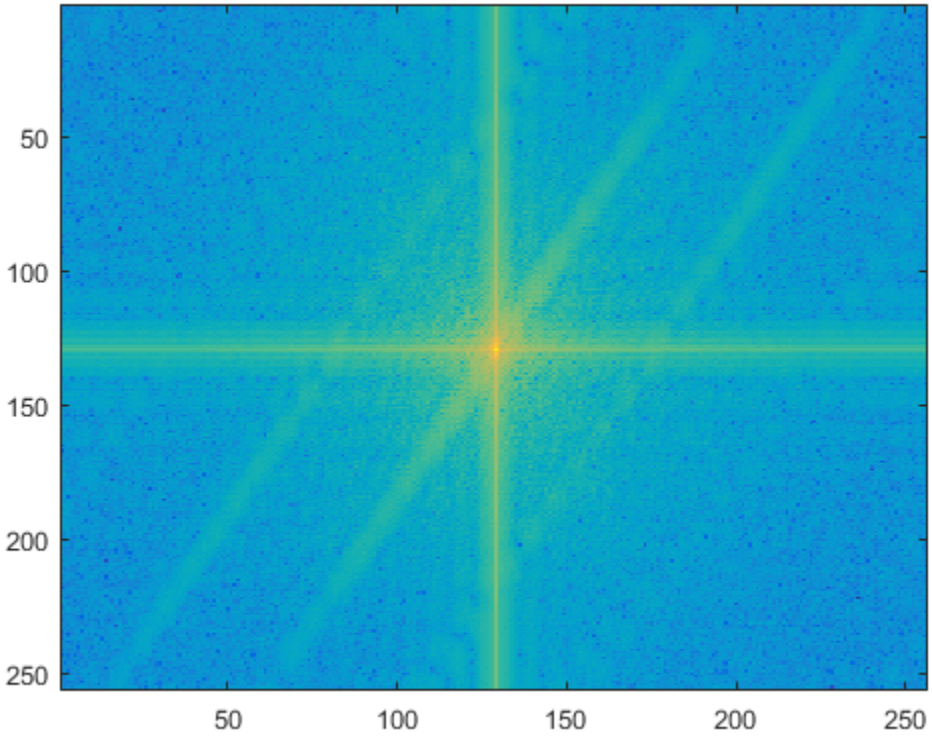
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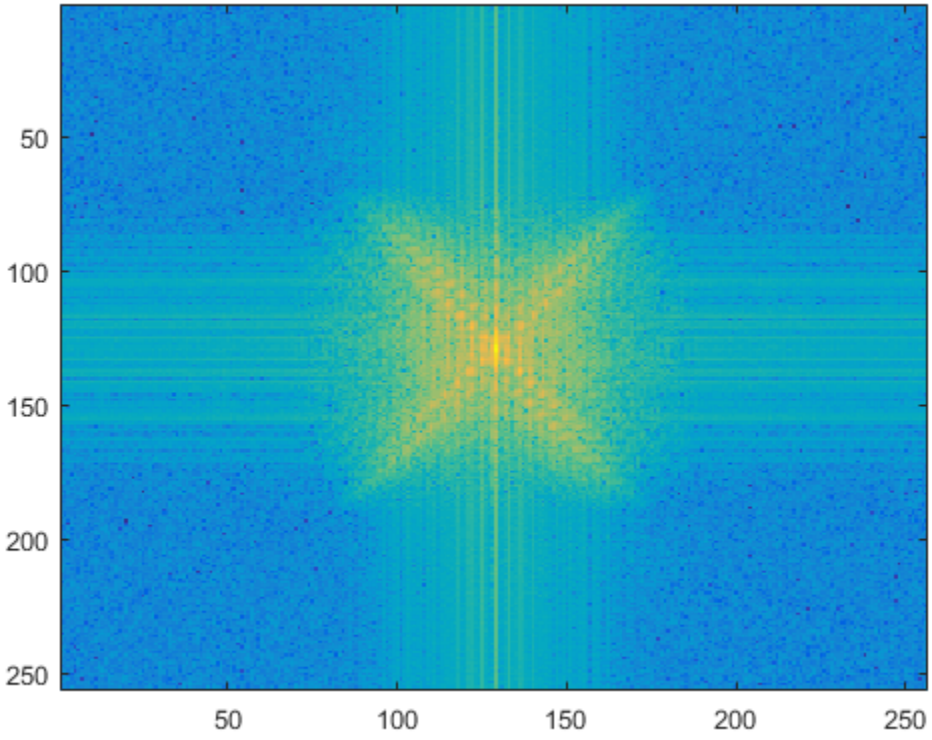
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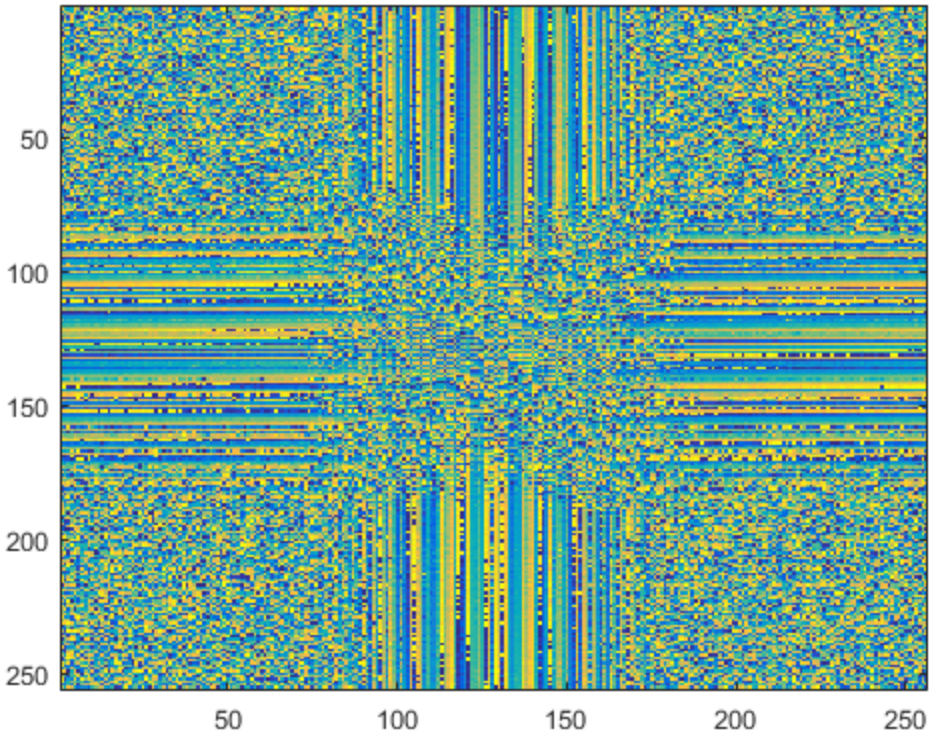
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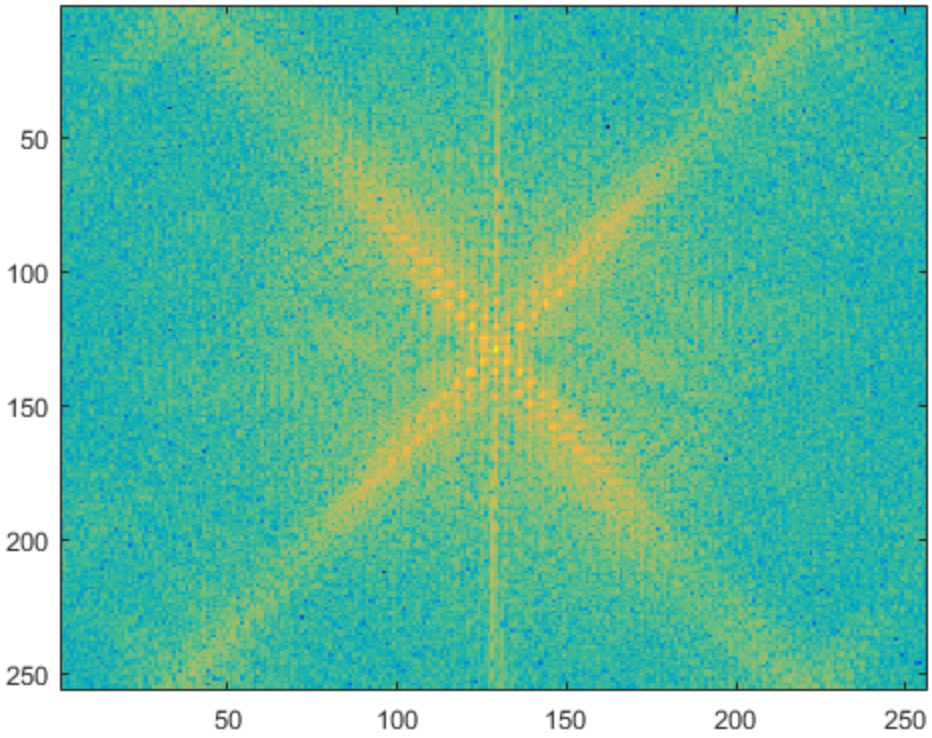
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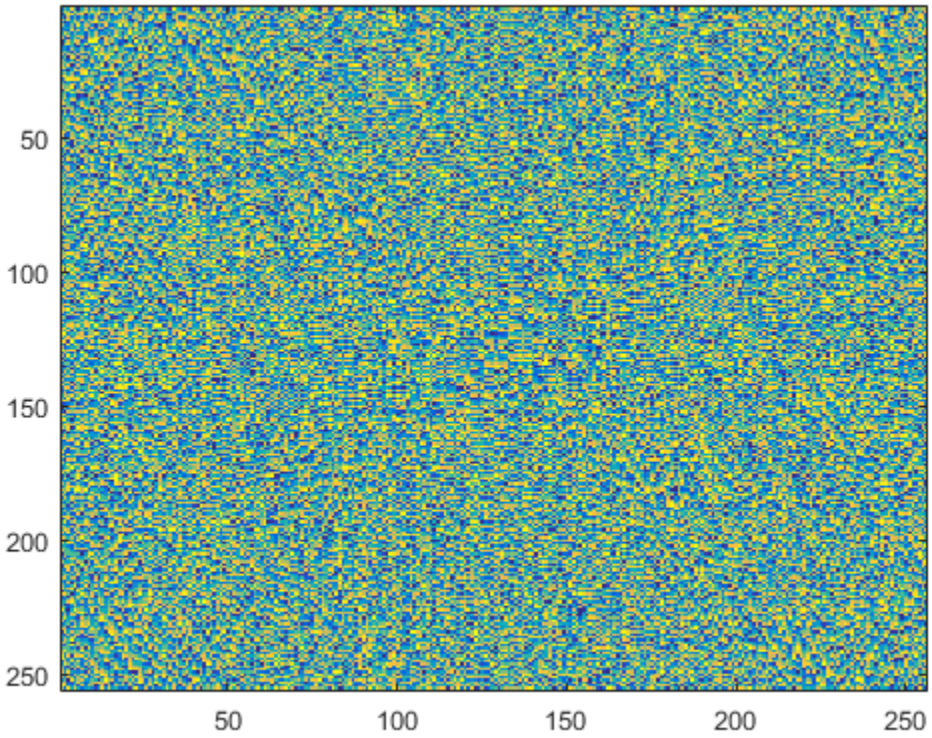
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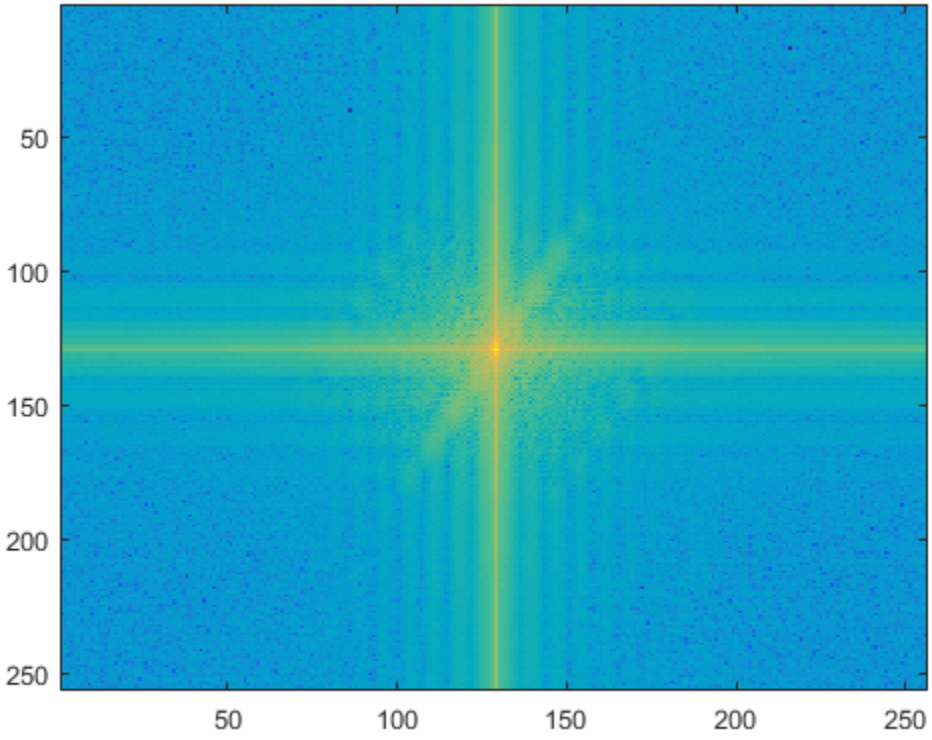
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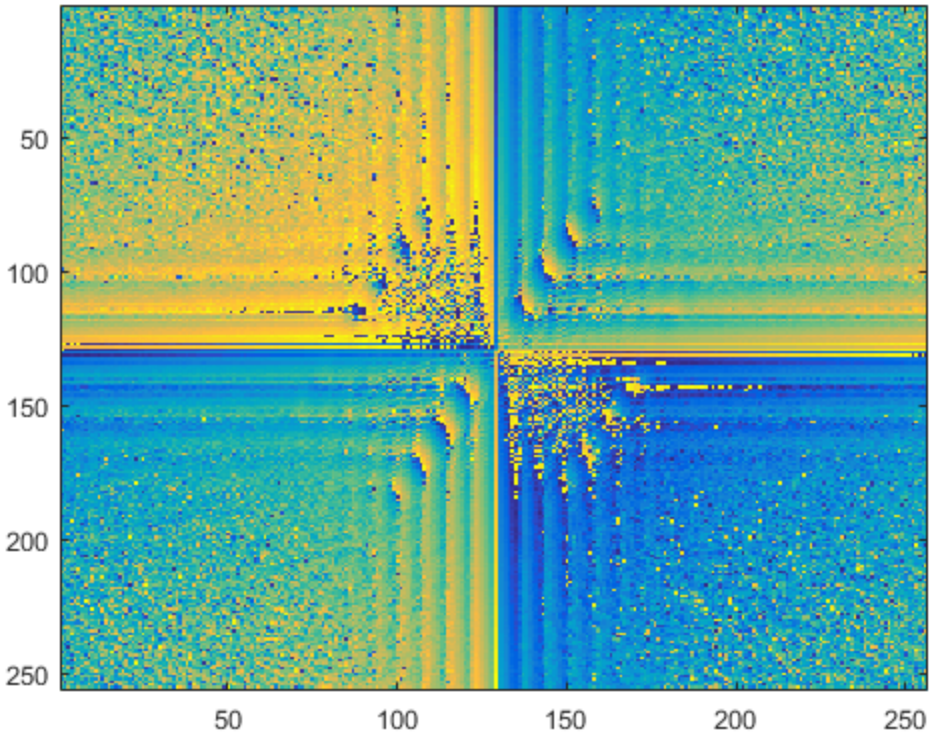
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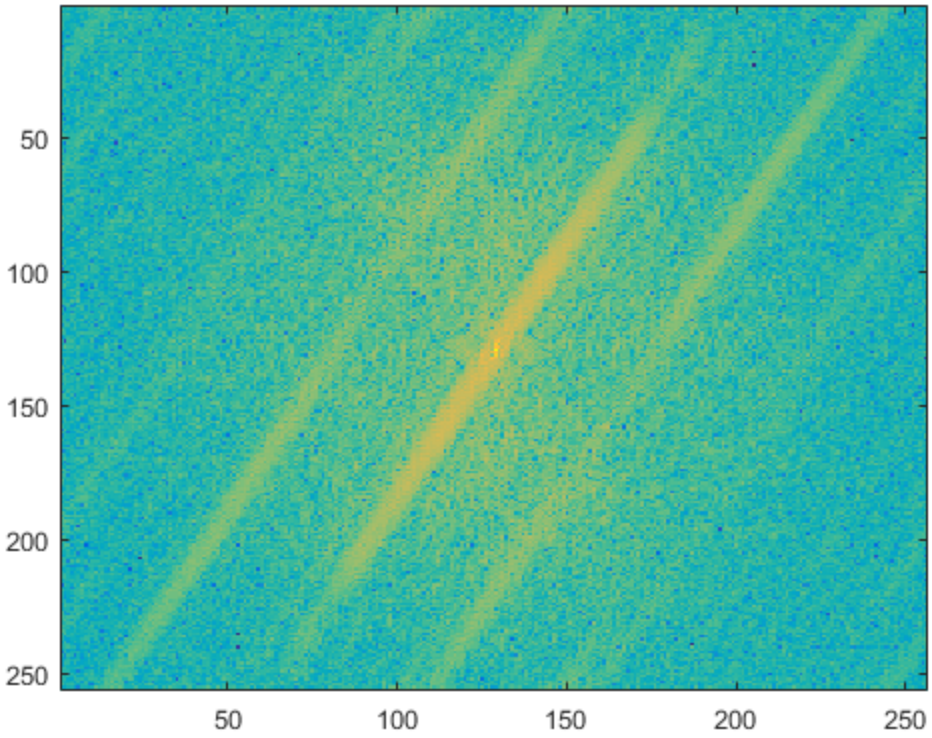
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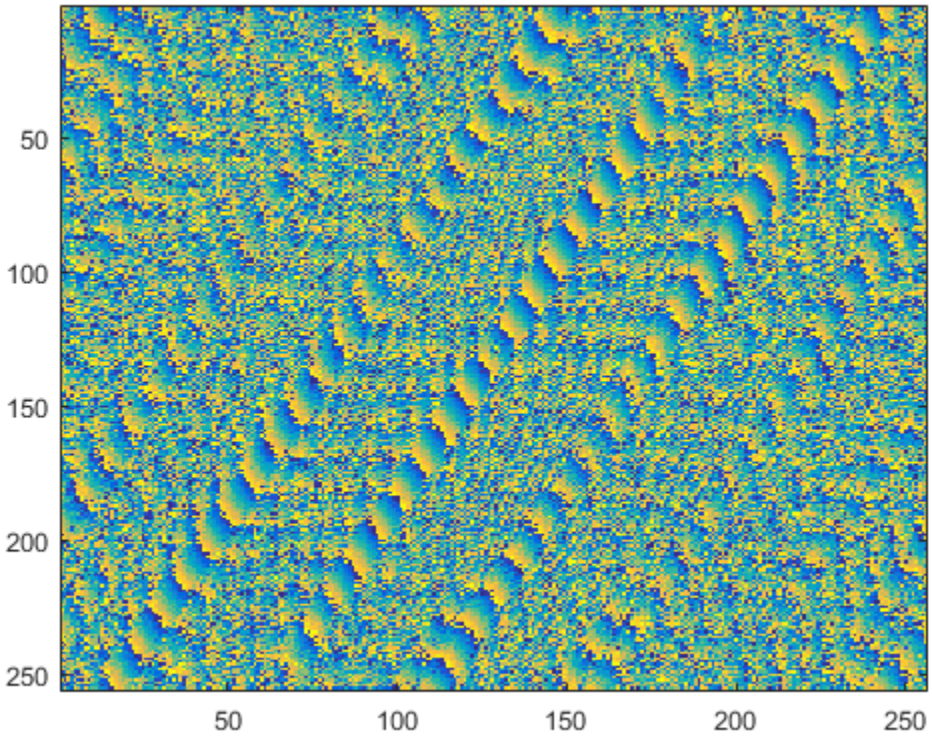
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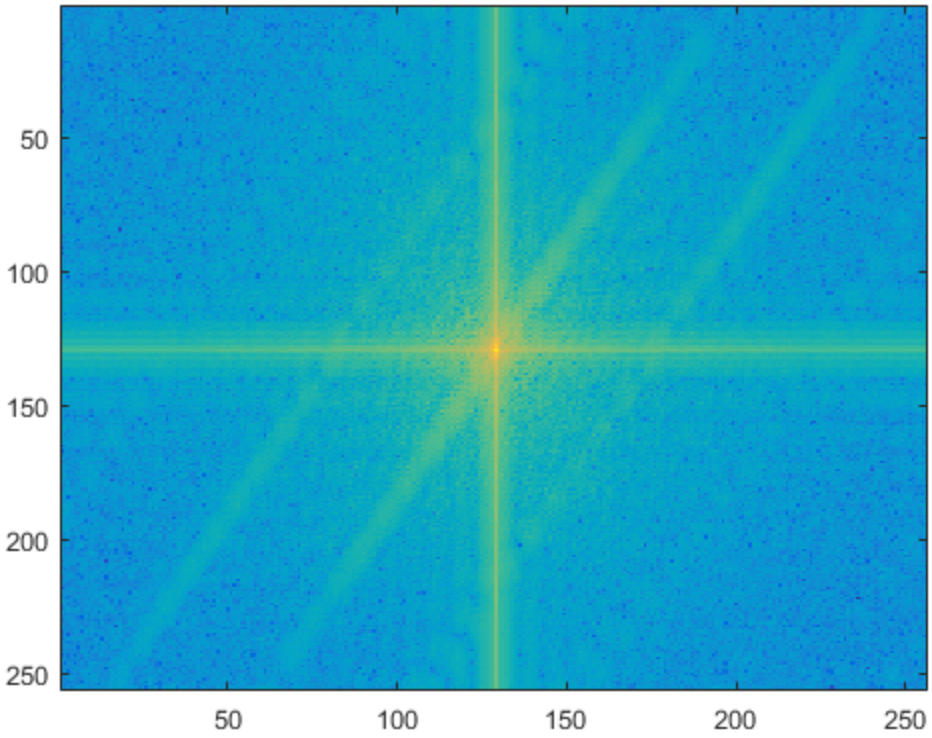
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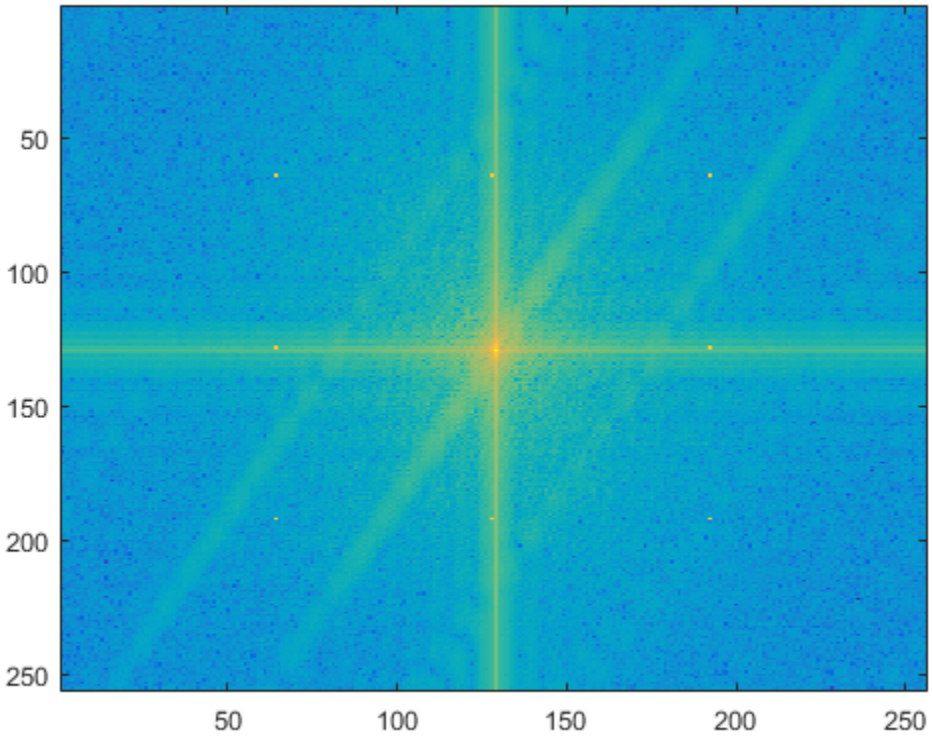
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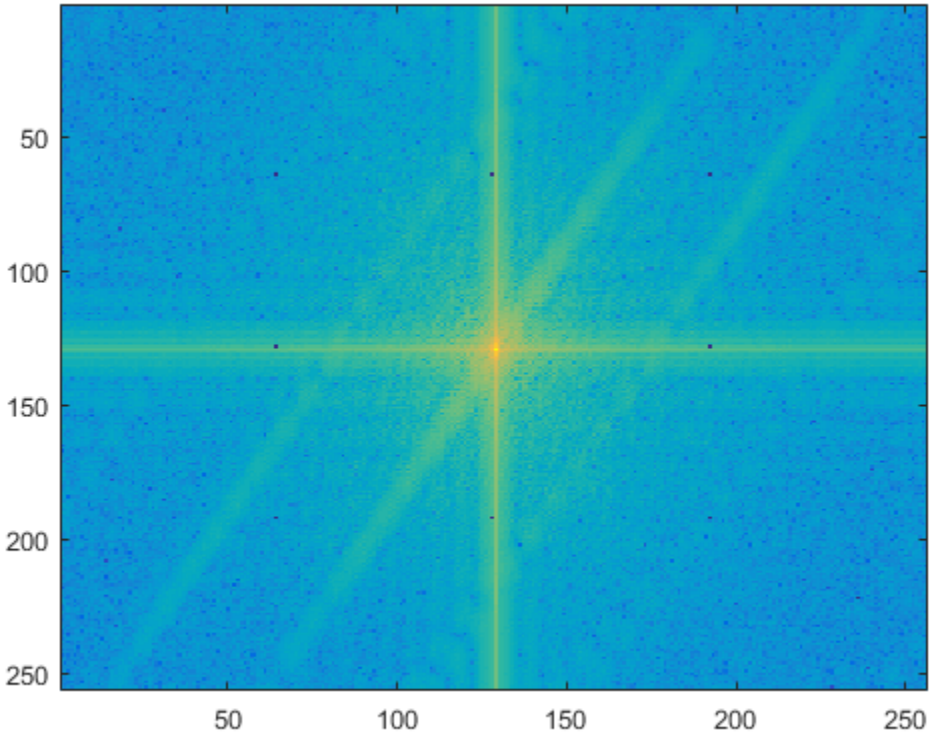
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Spatial Frequencies 2

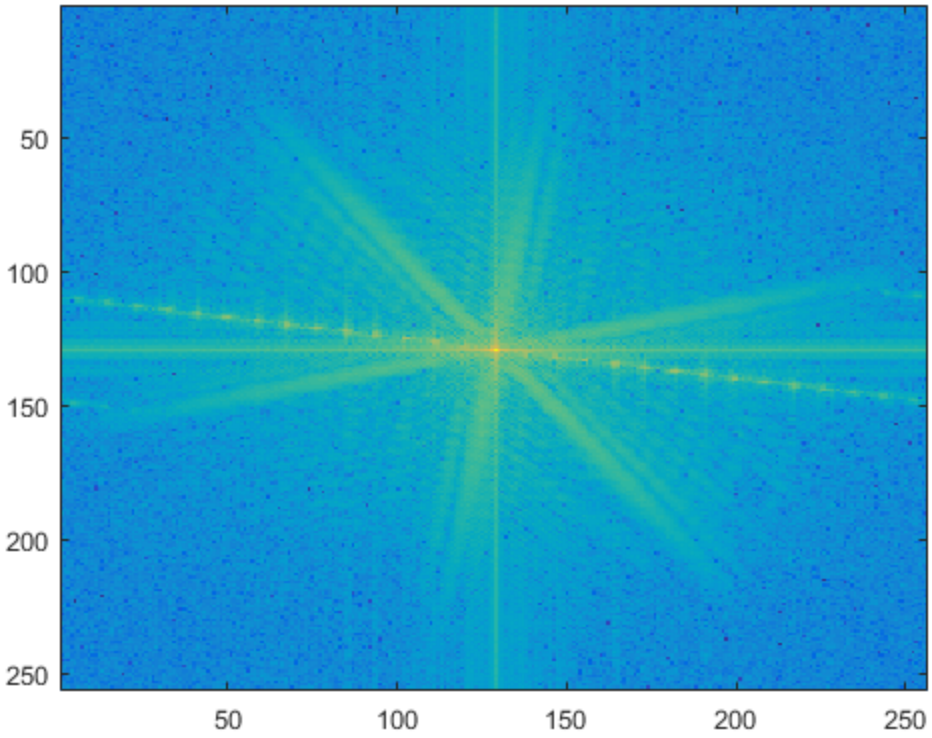
Load in the images

```
letterA = imread('letter_A.jpg');
letterB = imread('letter_B.jpg');

letterA_256 = imresize(letterA, [256 256]);
letterB_256 = imresize(letterB, [256 256]);
letterA_gray = rgb2gray(letterA_256);
letterA_gray = imrotate(letterA_gray, 90);
letterB_gray = rgb2gray(letterB_256);
letterA_fft = fft2(letterA_gray);
letterB_fft = fft2(letterB_gray);
figure;
imshow(letterA_gray);
figure;
imagesc(log(abs(fftshift(letterA_fft))));
figure;
imshow(letterB_gray);
figure;
imagesc(log(abs(fftshift(letterB_fft))));
unsharpA = imsharpen(letterA_gray);
unsharpB = imsharpen(letterB_gray);
figure;
imshow(unsharpA);
figure;
imshow(unsharpB);

% phase of images
```

```
A_mag = abs(letterA_fft);
B_mag = abs(letterB_fft);
A_phase = angle(letterA_fft);
B_phase = angle(letterB_fft);
swapped1 = A_mag .* exp(1i*B_phase);
swapped2 = B_mag .* exp(1i*A_phase);
s1_img = uint8(ifft2(swapped1));
s2_img = uint8(ifft2(swapped2));
figure;
imshow(s1_img);
figure;
imshow(s2_img);
```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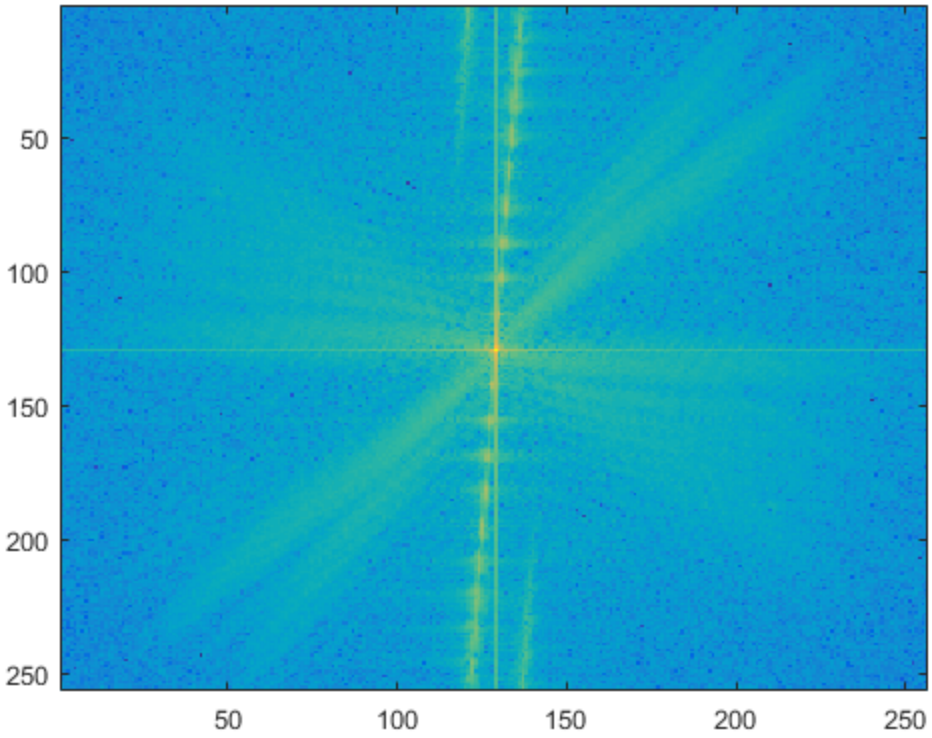
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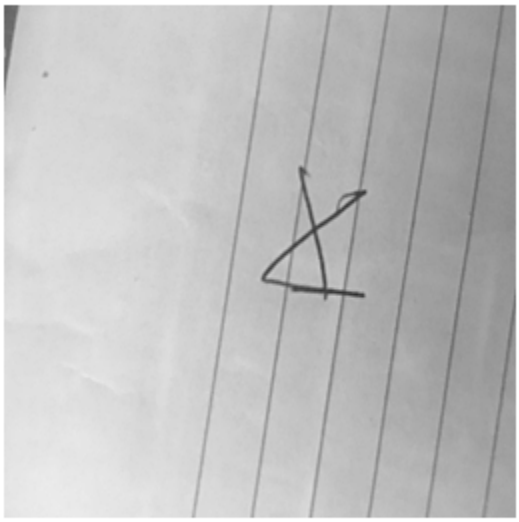
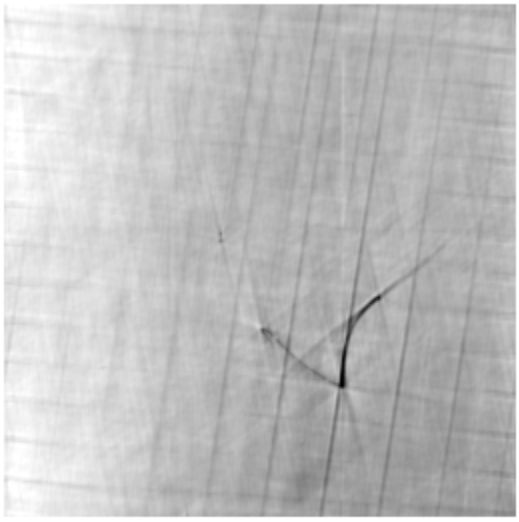
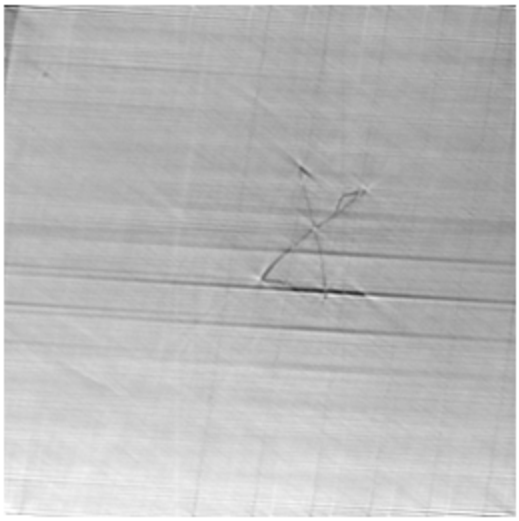






More Fun with Frequencies

```
anthony = imread('anthonyface.jpg');
imshow(anthony);
anthony = imcrop(anthony, [554 90 1500 2400]);
anthony = imresize(anthony, [256 256]);
imshow(anthony);
figure();
jacky = imread('jackyface.jpg');
imshow(jacky);
jacky = imcrop(jacky, [454 90 1500 2400]);
jacky = imresize(jacky, [256 256]);
imshow(jacky);
figure();

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

tform = fitgeotrans(movingPt,fixedPt,'NonreflectiveSimilarity');
Jregistered = imwarp(anthony,tform,'Output',imref2d(size(anthony)));
figure;
imshowpair(anthony,Jregistered)
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;

anthonylowfilt = imfilter(double(anthony), lpf, 'replicate');
```

```
Jregisteredhighfilt = imfilter(double(Jregistered), hpf, 'replicate');
figure;
imshow(uint8(anthonylowfilt + 15*Jregisteredhighfilt));
```

Warning: Image is too big to fit on screen; displaying at 25%
Warning: Image is too big to fit on screen; displaying at 25%

Geometric Transforms

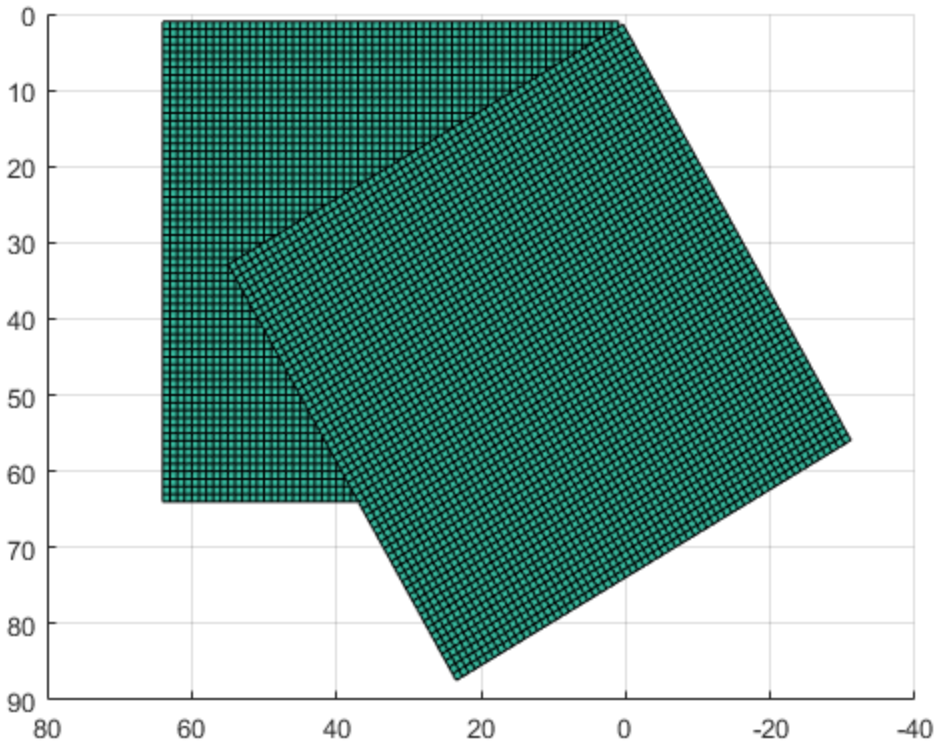
Rotation a mesh

```
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

```
anthonygrayscale = rgb2gray(anthony);
[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_anthony = interp2(u,v, im2double(anthonygrayscale), rot_u,
 rot_v, 'cubic');
figure;
imshow(rot_anthony);
```

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