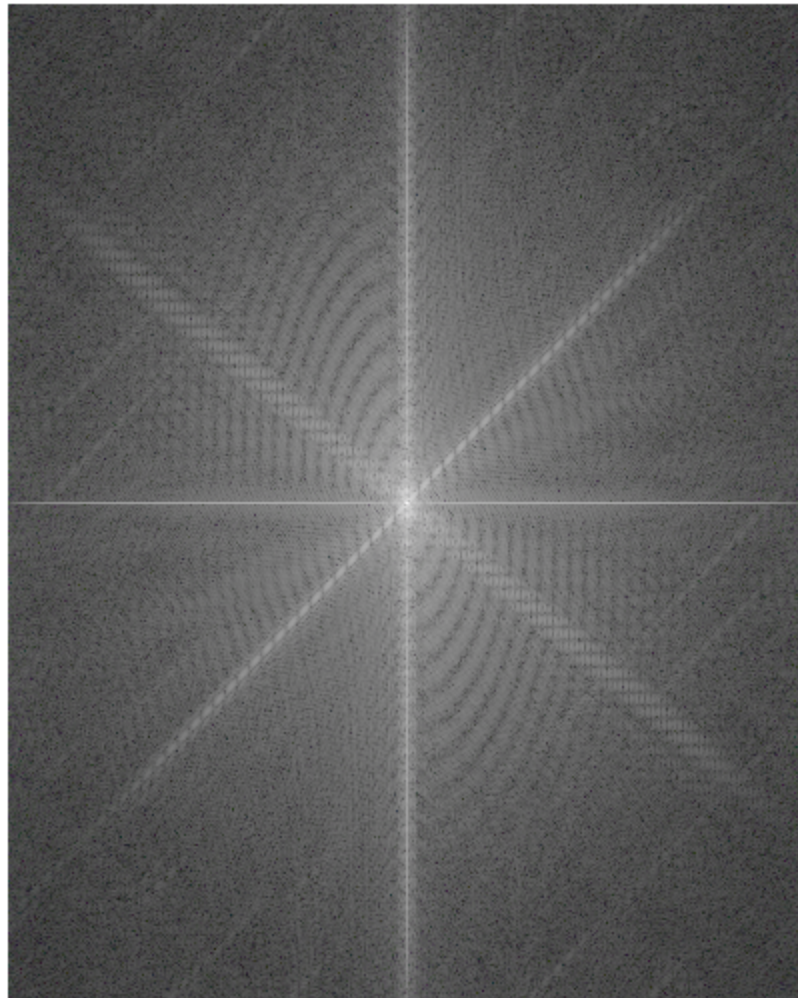

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Normal Image.

Read, convert to fourier domain and display.

```
clc;clear;
tic;
im=single(imread('rupee-symbol.jpg'));
IM = mat2gray(log(abs(fftshift(fft2(im)))+1));
figure;imshow(IM,[]);
```



Scale = 50

```
scale = 2;
```

f[x,y] -> a*f[x,y]

We expect a change in the magnitude spectra
by the factor of 'a'

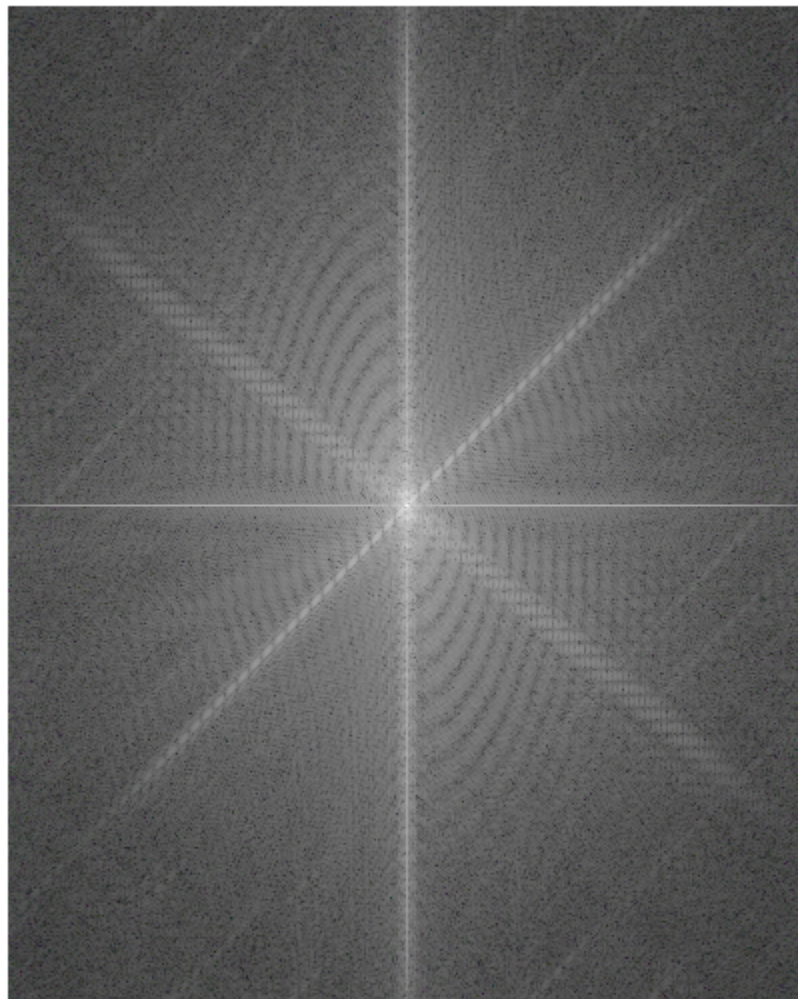
$$F(u, v) = \sum_{n=-\infty}^{\infty} \sum_{m=-\infty}^{\infty} f(m, n) e^{-j2\pi(\frac{mu}{M} + \frac{nv}{N})}$$

$$F'(u, v) = \sum_{m=-\infty}^{\infty} \sum_{n=-\infty}^{\infty} a * f(m, n) e^{-j2\pi(\frac{um}{M} + \frac{vn}{N})}$$

$$F'(u, v) = a * \left(\sum_{m=-\infty}^{\infty} \sum_{n=-\infty}^{\infty} f(m, n) e^{-j2\pi(\frac{um}{M} + \frac{vn}{N})} \right)$$

$$F'(u, v) = a * F(u, v)$$

```
im2=scale*im;
IM2 = mat2gray(log(abs(fftshift(fft2(im2)))+1));
figure;imshow(IM2,[]);
```

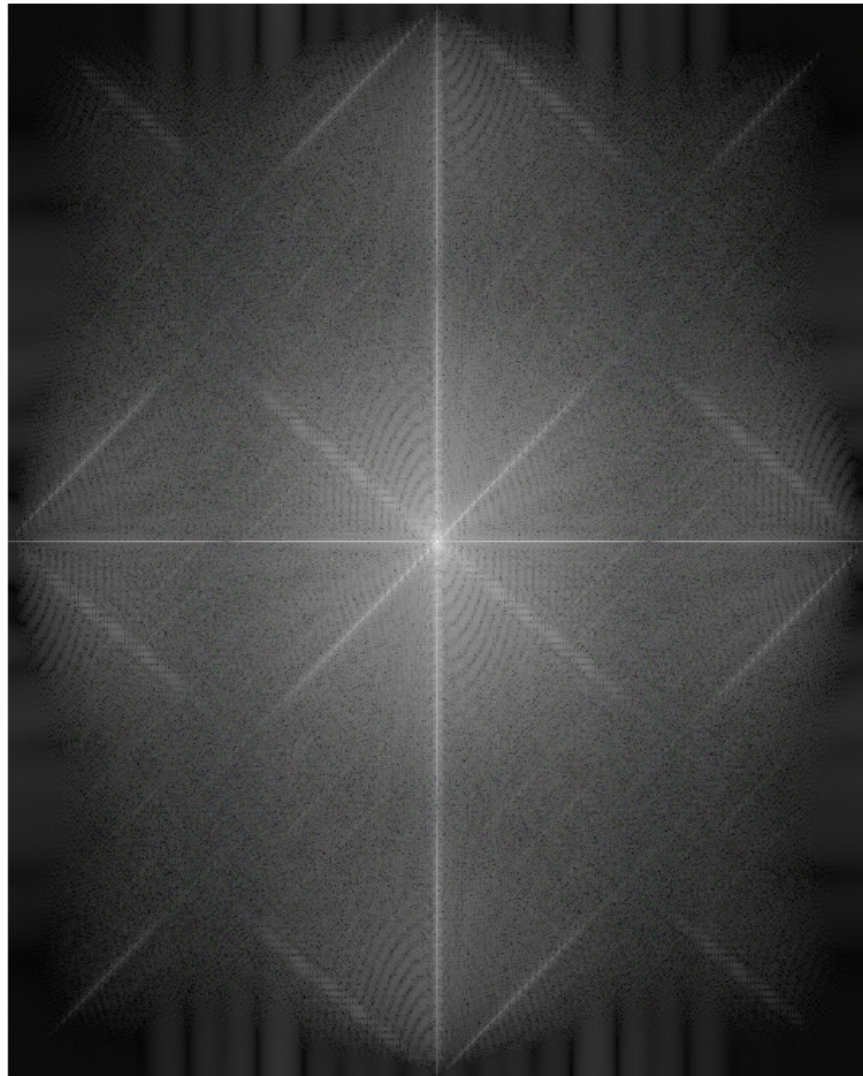


$f[x,y] \rightarrow f[a \cdot x, a \cdot y]$

We resize the image by a factor of 'a'.

```
im3=imresize(im,scale);  
IM3 = mat2gray(log(abs(fftshift(fft2(im3)))+1));  
figure;imshow(IM3,[]);
```

Warning: Image is too big to fit on screen; displaying at 67%



$f[x,y] \rightarrow f[x+x_0, y+y_0]$

We expect no change in the magnitude spectra of the DFT because of the circular shift property

$$F(u, v) = \sum_{n=-\infty}^{\infty} \sum_{m=-\infty}^{\infty} f(m, n) e^{-j2\pi(\frac{um}{M} + \frac{vn}{N})}$$

For the shifted image, say f' ,

$$F'(u, v) = \sum_{n=-\infty}^{\infty} \sum_{m=-\infty}^{\infty} f'(m, n) e^{-j2\pi(\frac{um}{M} + \frac{vn}{N})}$$

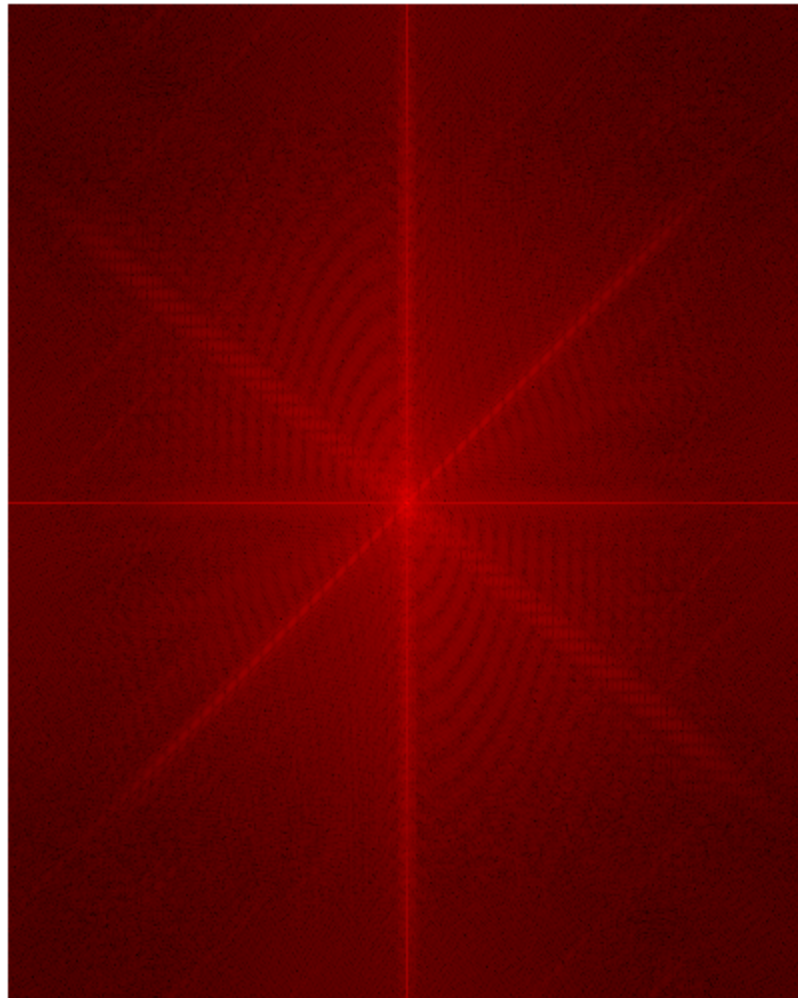
$$F'(u, v) = \sum_{n=-\infty}^{\infty} \sum_{m=-\infty}^{\infty} f(m + m_0, n + n_0) e^{-j2\pi(\frac{u(m+m_0)}{M} + \frac{v(n+n_0)}{N})}$$

$$F'(u, v) = \left(\sum_{n=-\infty}^{\infty} \sum_{m=-\infty}^{\infty} f(m, n) e^{-j2\pi(\frac{um}{M} + \frac{vn}{N})} \right) e^{-j2\pi(\frac{um_0}{M} + \frac{vn_0}{N})}$$

$$F'(u, v) = F(u, v) e^{-j2\pi(\frac{um_0}{M} + \frac{vn_0}{N})}$$

$$|F'(u, v)| = |F(u, v)|$$

```
% let m0 and n0 be 5 and 8 repsectively (any value may be taken)
im4=imtranslate(im,[scale, scale, scale]);
IM4 = mat2gray(log(abs(fftshift(fft2(im4)))+1));
figure;imshow(IM4,[]);
```

f[x,y] -> f[x, M-y]

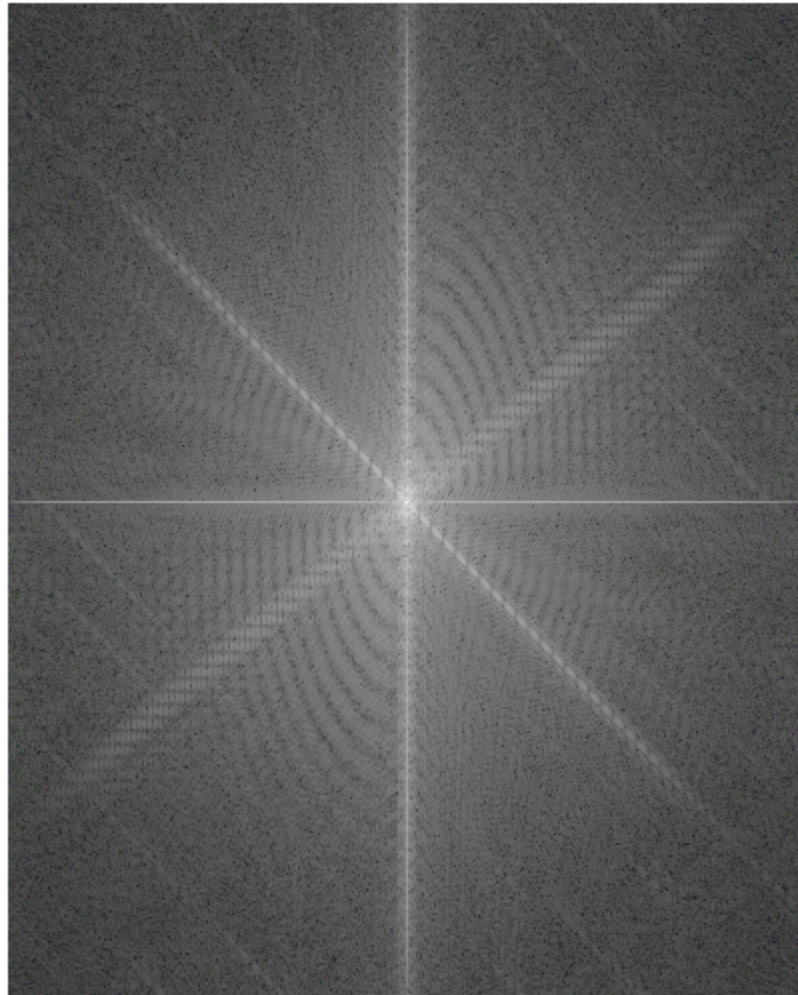
The DFT is expected to be reflected along the vertical line too.

$$F(u, v) = \sum_{n=-\infty}^{\infty} \sum_{m=-\infty}^{\infty} f(m, n) e^{-j2\pi(\frac{um}{M} + \frac{vn}{N})}$$

$$F'(u, v) = \sum_{n=-\infty}^{\infty} \sum_{m=-\infty}^{\infty} f(m, N - n) e^{-j2\pi(\frac{um}{M} + \frac{v(N-n)}{N})}$$

```
for i=1:size(im,3)
    im5(:, :, i)=fliplr(im(:, :, i));
```

```
end  
IM5 = mat2gray(log(abs(fftshift(fft2(im5)))+1));  
figure;imshow(IM5,[]);
```



Difference between scaled and original image.

```
figure;imshow(abs(IM2-IM),[]);
```

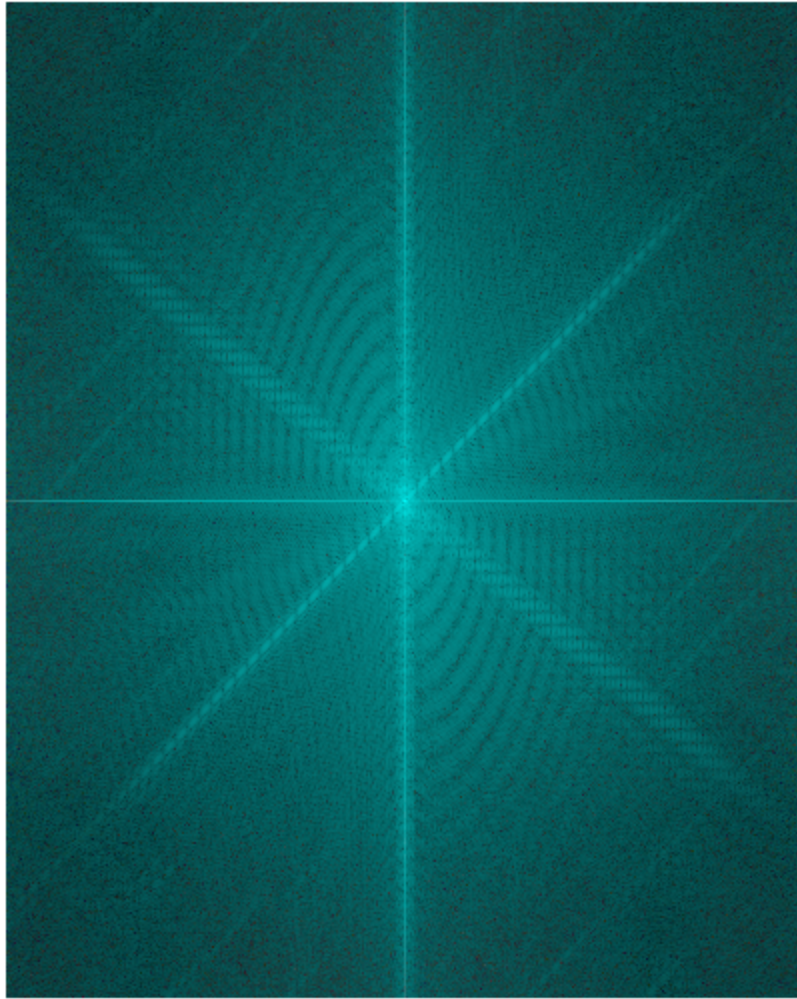


Difference between resized and original image.

```
%figure;imshow(abs(IM3-IM),[]);
```

Difference between translated and original image.

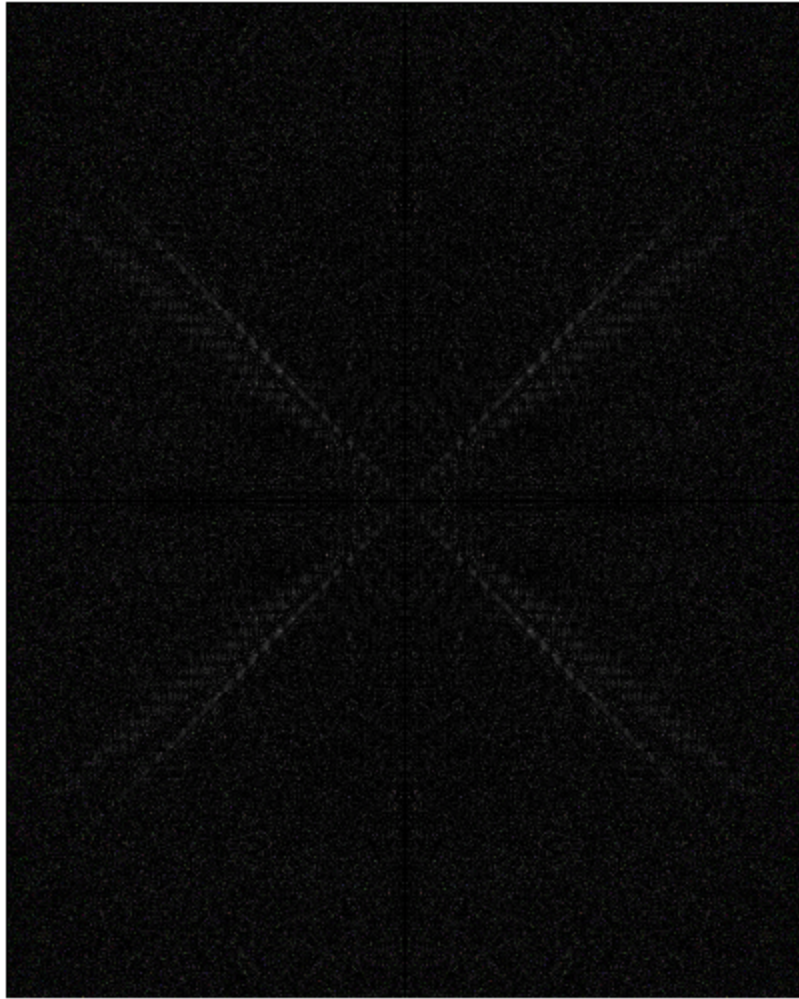
```
figure;imshow(abs(IM4-IM),[]);
```

Difference between flipped and original image.

```
figure;imshow(abs(IM5-IM),[]);  
toc;
```

Elapsed time is 7.656954 seconds.



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