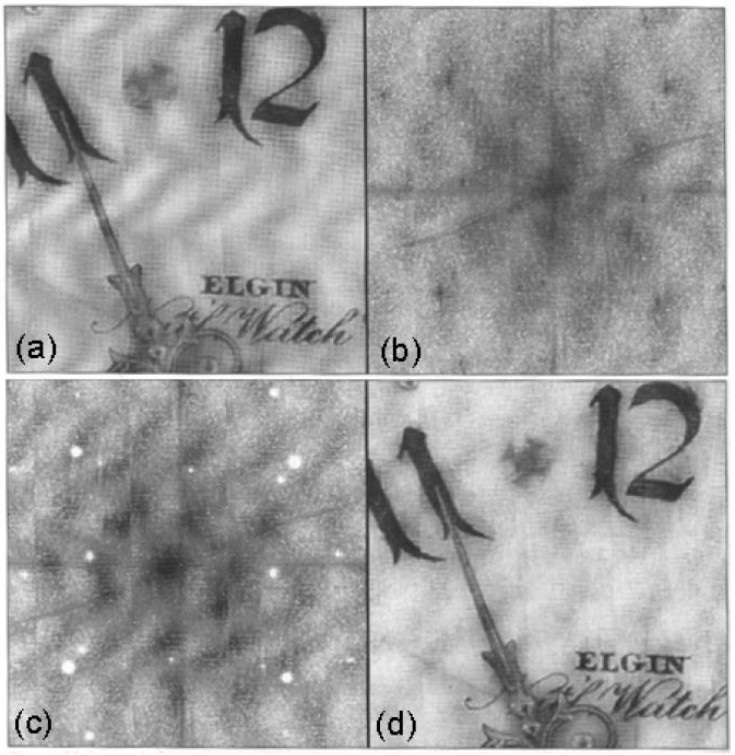
Fourierova transformácia

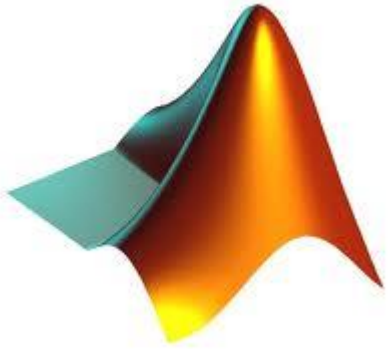
Cvičenia z Počkročilého spracovania obrazu.

FFT

Akákoľvek funkcia f(x) môže byť vyjadrená ako vážený súčet sínusov a kosínusov

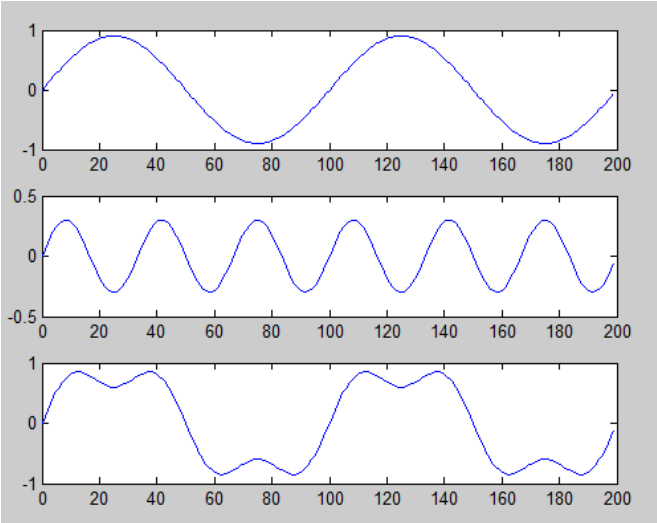
Využitie:
- lowpass filter
- highpass filter
- odstraňovanie artefaktov z obrazu

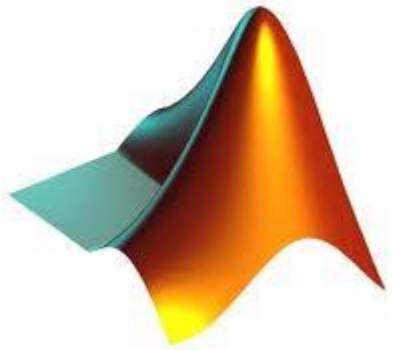




FFT - Skladanie signálu MATLAB

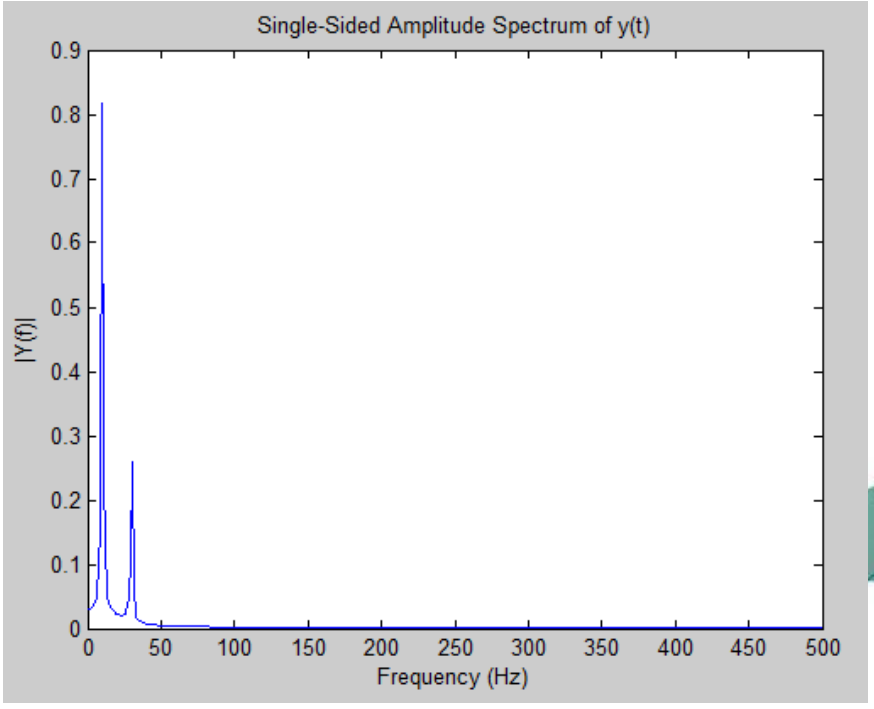
```
Fs = 1000;                          % Sampling frequency
T = 1/Fs;                           % Sample time
L = 1000;                           % Length of signal
t = (0:L-1)*T;                      % Time vector
y1 = 0.9*sin(2*pi*10*t);
y2 = 0.3*sin(2*pi*30*t);
y3 = y1 +y2;

figure, subplot(3,1,1),plot(Fs*t(1:200),y1(1:200));
subplot(3,1,2),plot(Fs*t(1:200),y2(1:200));
subplot(3,1,3),plot(Fs*t(1:200),y3(1:200));
```

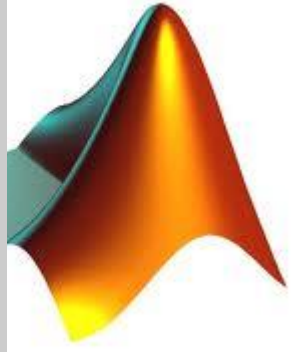




FFT - Skladanie signálu MATLAB

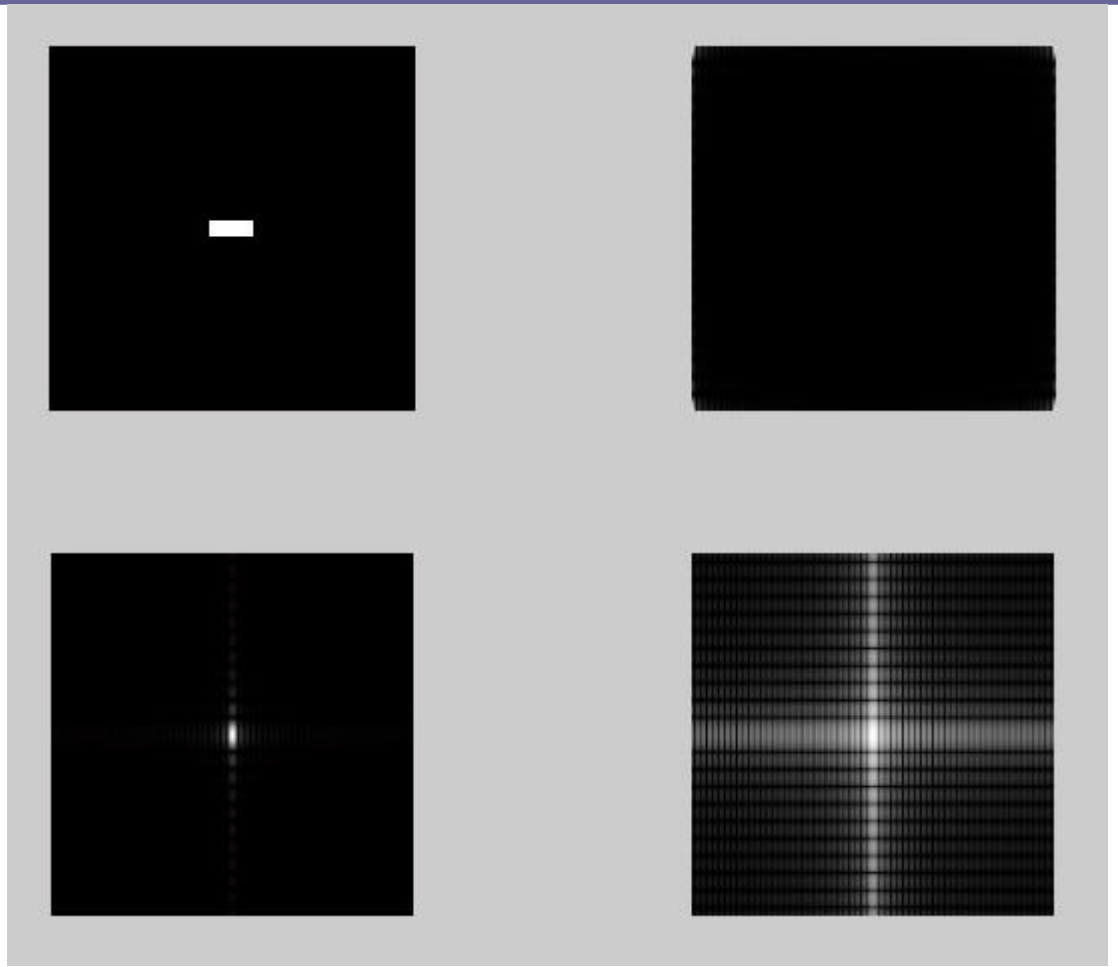
```
NFFT = 2^nextpow2(L); % Next power of 2 from length of y
Y = fft(y3,NFFT)/L;
f = Fs/2*linspace(0,1,NFFT/2);

% Plot single-sided amplitude spectrum.
figure
plot(f,2*abs(Y(1:NFFT/2)))
title('Single-Sided Amplitude Spectrum of y(t)')
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
```

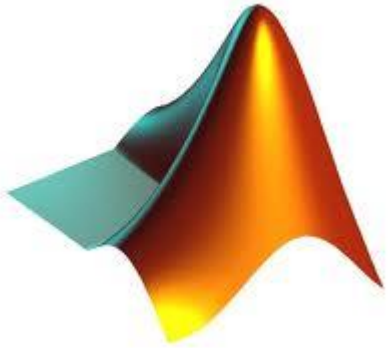




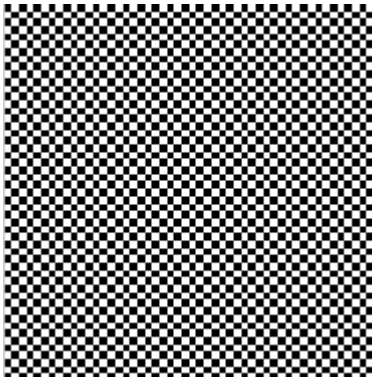
fftshift

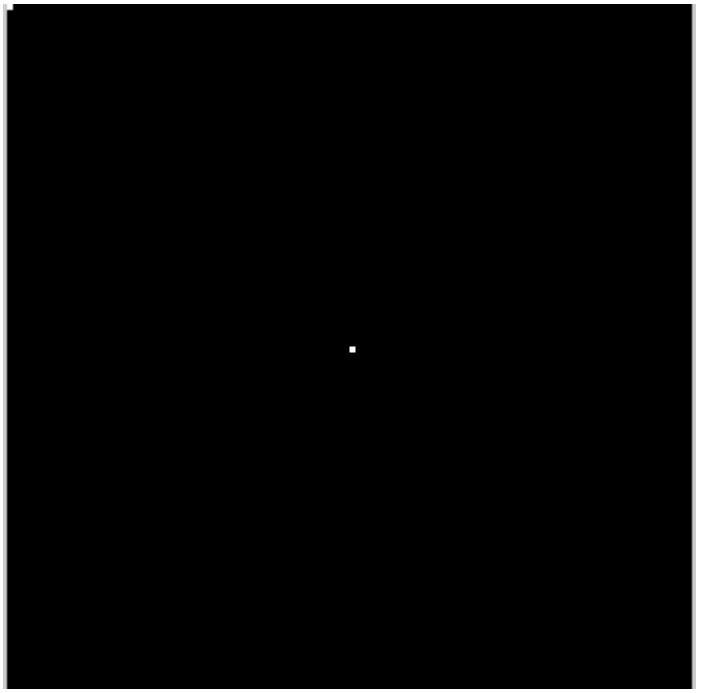
```
siz=512;
siz2=floor(siz/2);

f1 = zeros(siz);
f1(siz2-10:siz2+10,siz2-30:siz2+30) = 1;
subplot(2,2,1);imshow(f1,[]);

F = fft2(f1, siz,siz);
S = abs(F);
subplot(2,2,2); imshow(S,[]);

Fc = fftshift(F);
S1 = abs(Fc);
subplot(2,2,3); imshow(S1,[]);

S2 = log(1+S1);
subplot(2,2,4);imshow(S2,[]);
```



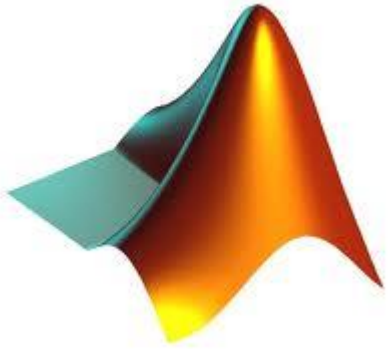


FFT2

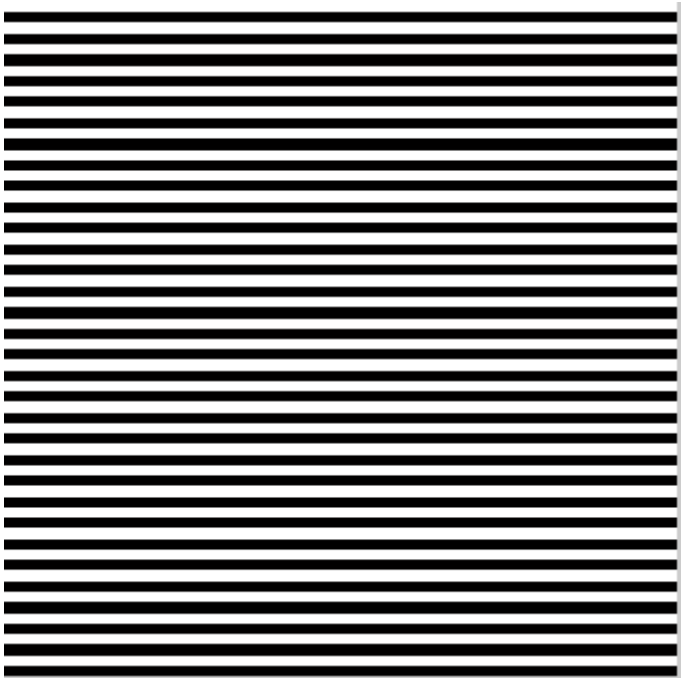


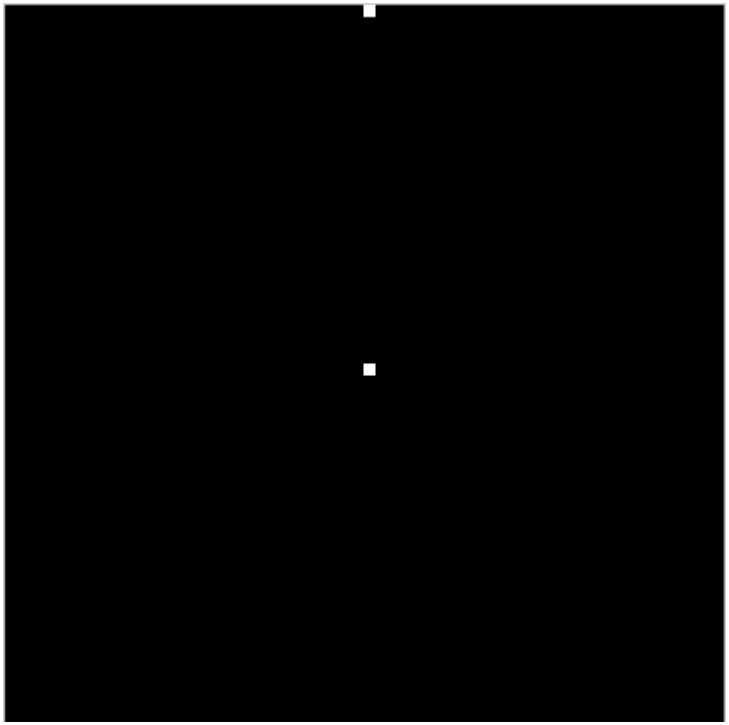


```
y=double(checkerboard(1,64,64)>0.5);
figure, imshow(y)

Y=fft2(y);
figure
imshow(abs(fftshift(Y)) ,[], 'InitialMagnification','fit')
```

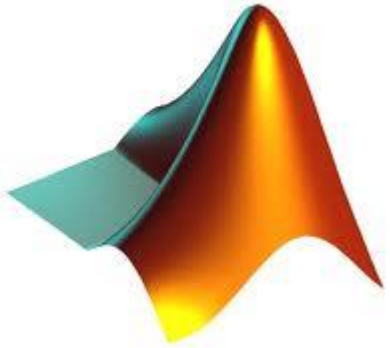


FFT





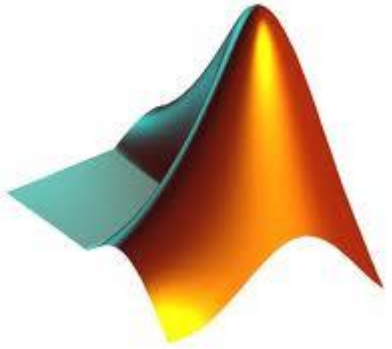
```
y=zeros(64);
y(1:2:end,:)=1;
```



FFT

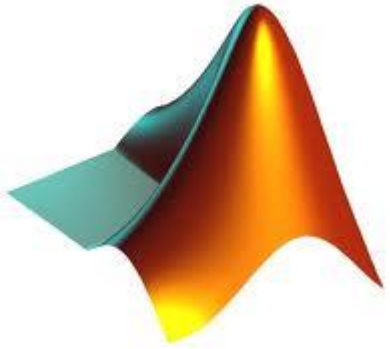
```
y=zeros(64);
y(1:4:end,:)=1;
y(2:4:end,:)=1;
```

```
y=zeros(64);
y(1:4:end,:)=1;
y(:,1:4:end)=1;
```



FFT

```
Fs = 256;                   % Sampling frequency
T = 1/Fs;                    % Sample time
L = 512;                     % Length of signal
t = (0:L-1)*T;                % Time vector
y = (0.5+0.5*cos(2*pi*t)')*ones(1,L);
```



FFT

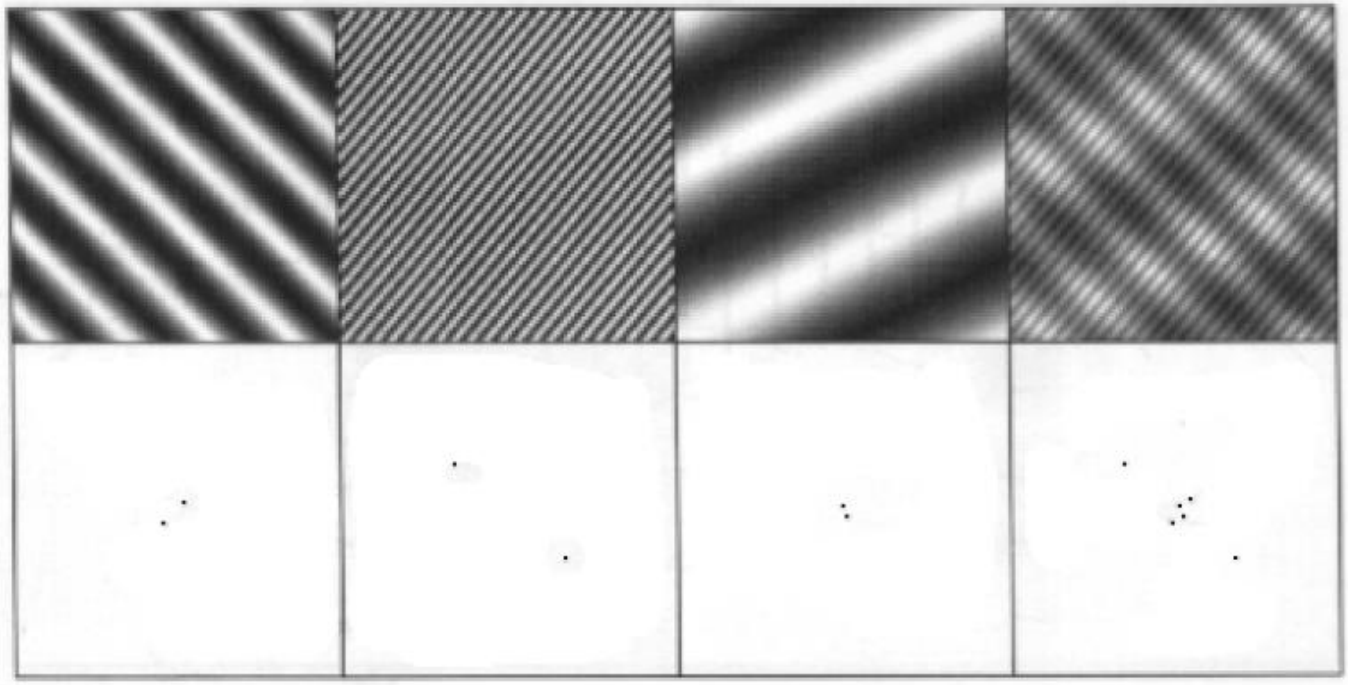
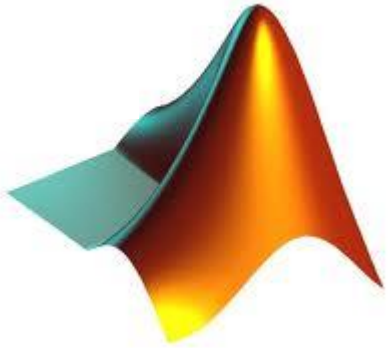
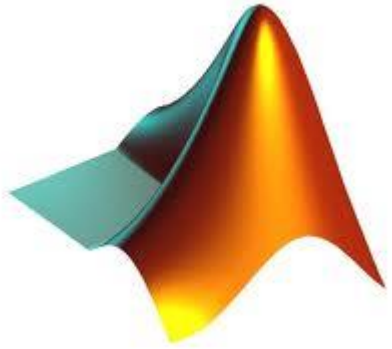


Figure 2: Images with perfectly sinusoidal variations in brightness: The first three images are represented by two dots. You can easily see that the position and orientation of those dots have something to do with what the original image looks like. The 4th image is the sum of the first three.
(Taken from p.177 of [1].)



FFT

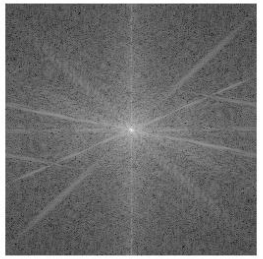
```
imSize = 256;
X = 1:imSize;                    % X is a vector from 1 to imageSize
X0 = (X / imSize) - .5;          % rescale X -> -.5 to .5
[Xm Ym] = meshgrid(X0, X0);
theta = 45;                      % grating orientation
lamda = 40;                      % wavelength (number of pixels per cycle)
phase = .25;                     % phase (0 -> 1)
freq = imSize/lamda;             % compute frequency from wavelength
phaseRad = (phase * 2* pi);      % convert to radians: 0 -> 2*pi
thetaRad = (theta / 360) * 2*pi; % convert theta (orientation) to radians
Xt = Xm * cos(thetaRad);         % compute proportion of Xm for given orientation
Yt = Ym * sin(thetaRad);         % compute proportion of Ym for given orientation
XYt = [ Xt + Yt ];               % sum X and Y components
XYf = XYt * freq * 2*pi;         % convert to radians and scale by frequency
y = sin( XYf + phaseRad);        % make 2D sinewave

figure, imshow(y,[], 'InitialMagnification','fit')

Y=fft2(y);
F2=abs(fftshift(Y));
figure, imshow(F2 ,[], 'InitialMagnification','fit')
```



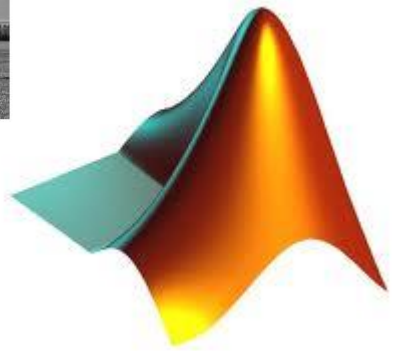
FFT rekonštrukcia

```
a = imread('cameraman.tif');
figure; imshow(a,[]);
```

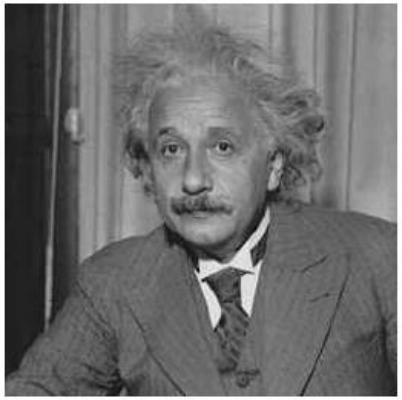
```
Da = fft2(a);
figure; imshow(log(abs(fftshift(Da))),[]);
```

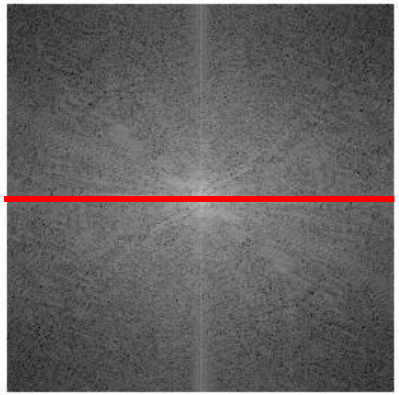


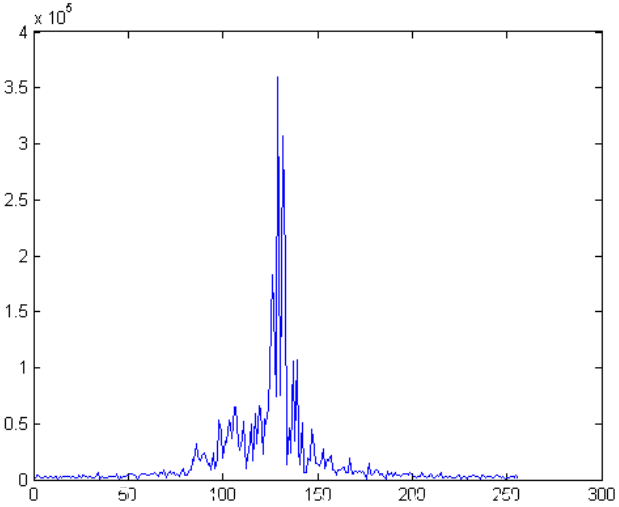
```
b = real(ifft2(Da));
figure; imshow(b,[]);
```

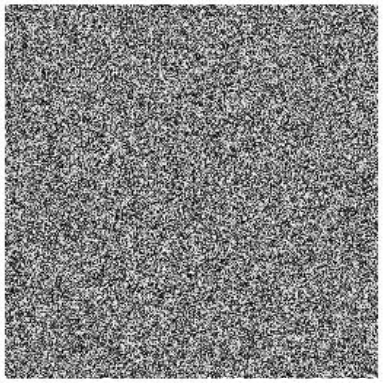


FFT odstránenie šumu

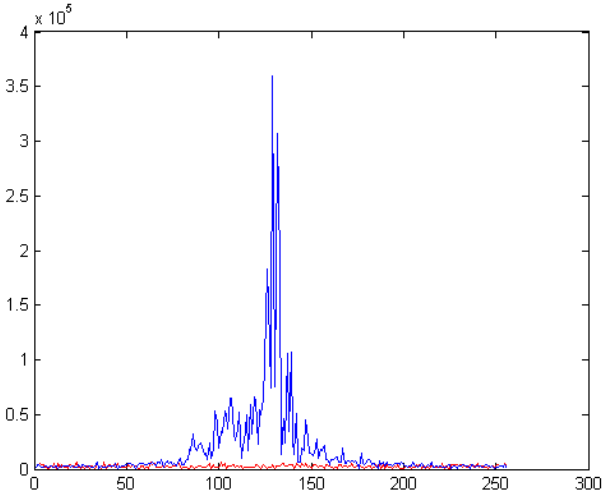




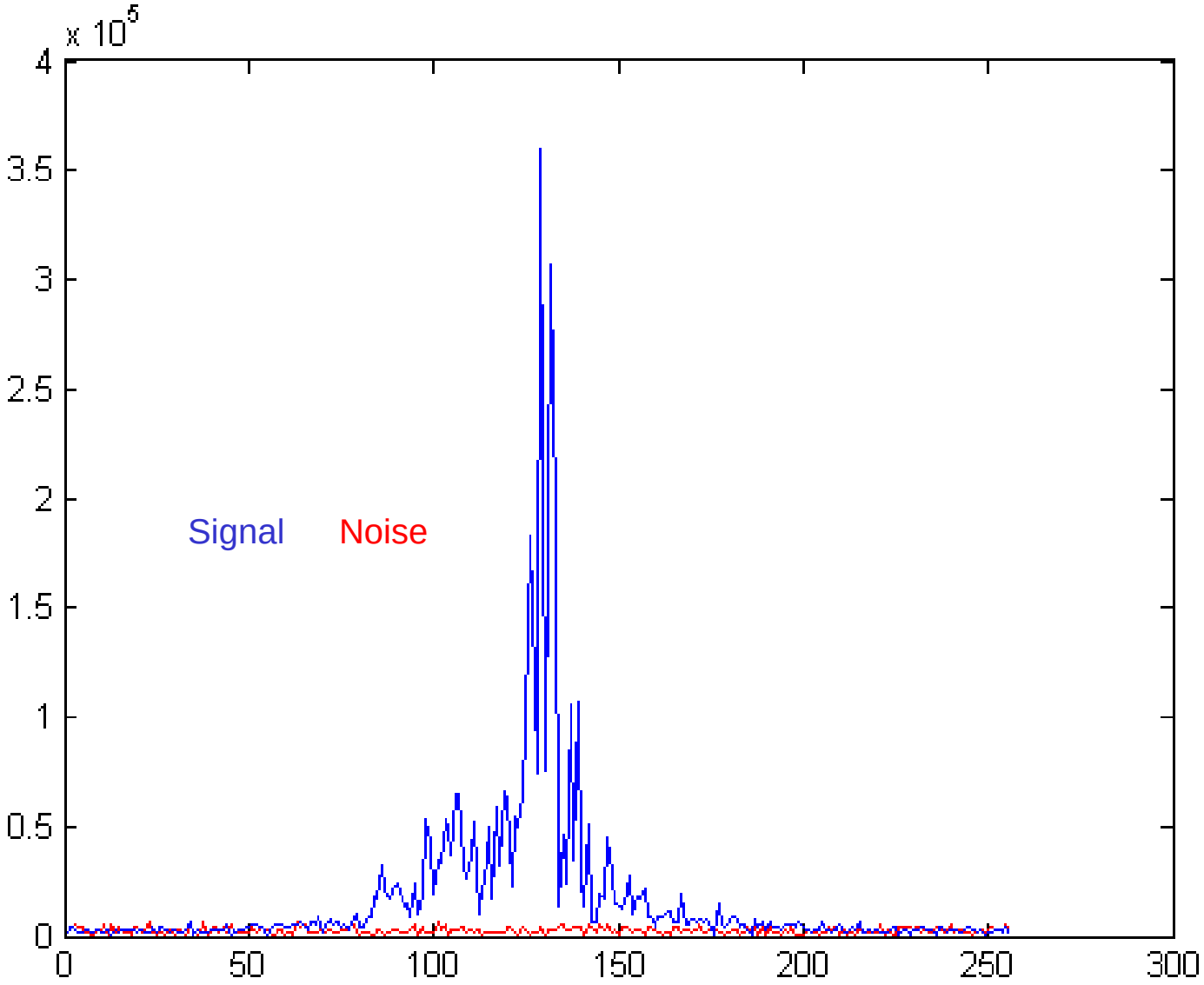


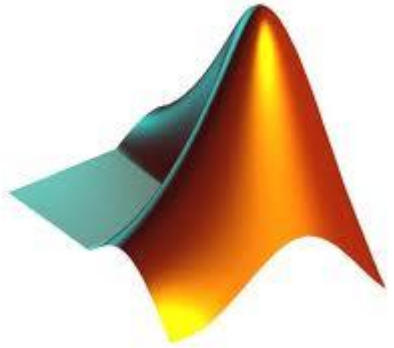


Signal Noise



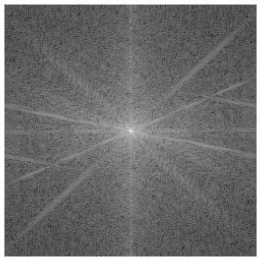
FFT



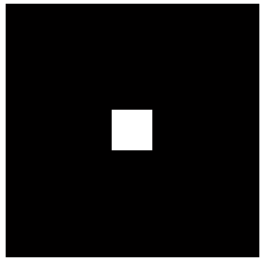


FFT dolnopriepustný filter

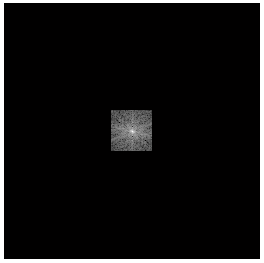
```
a = imread('cameraman.tif');
Da = fft2(a);
figure; imshow(log(abs(fftshift(Da))),[]);
```



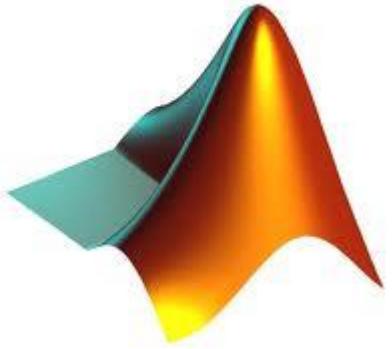
```
[m n]=size(Da);
H = zeros(m,n);
H(floor(m/2)-20:floor(m/2)+20,floor(n/2)-20:floor(n/2)+20) = 1;
figure; imshow(H,[]);
```



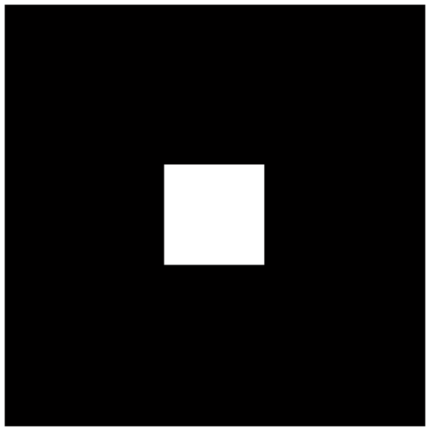
```
Db = fftshift(fftshift(Da).*H);
```



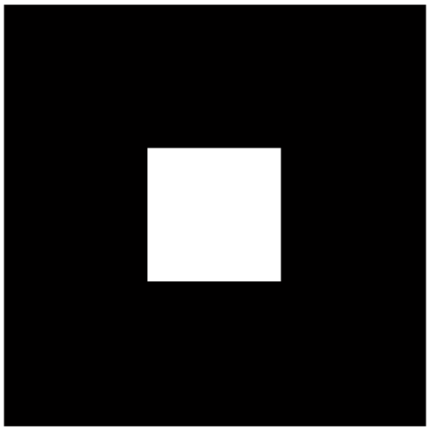
```
b = real(ifft2(Db));
figure; imshow(b,[]);
```



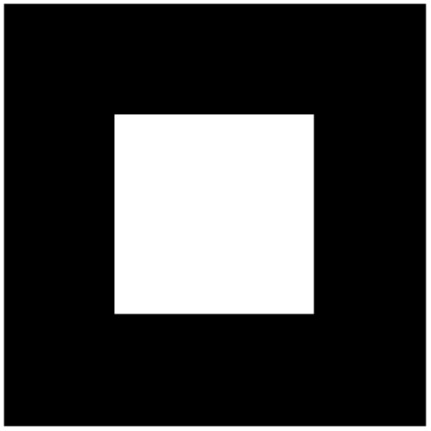
FFT rekonštrukcia



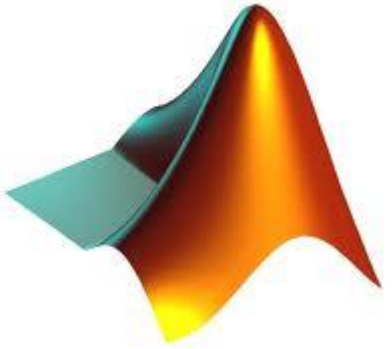
61x61



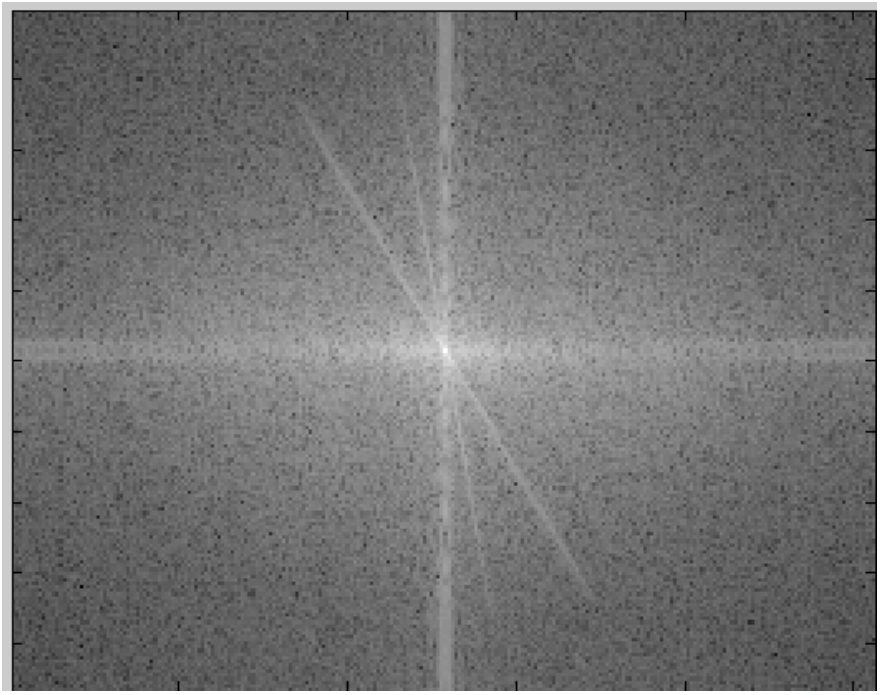
81x81

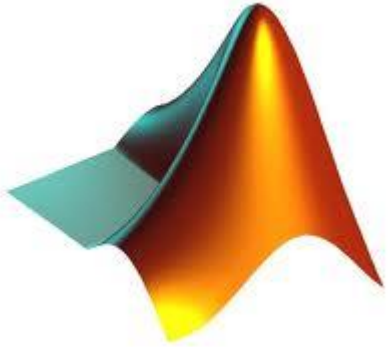


121x121



FFT

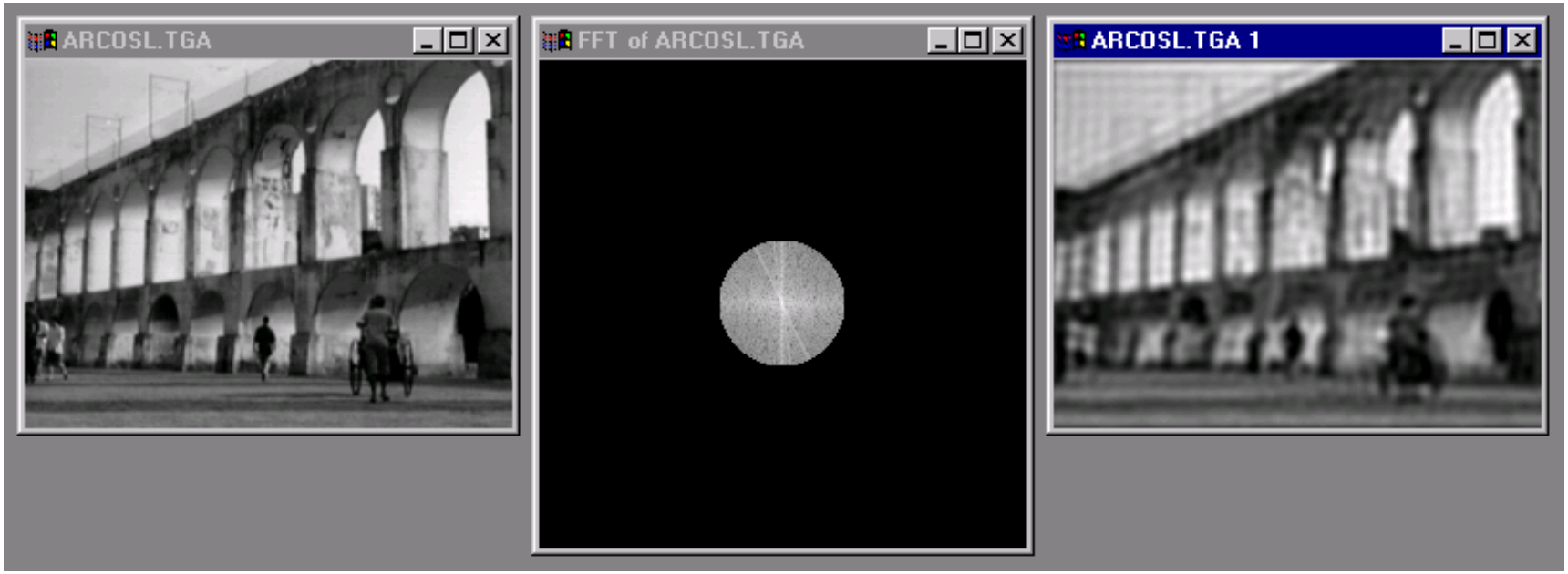


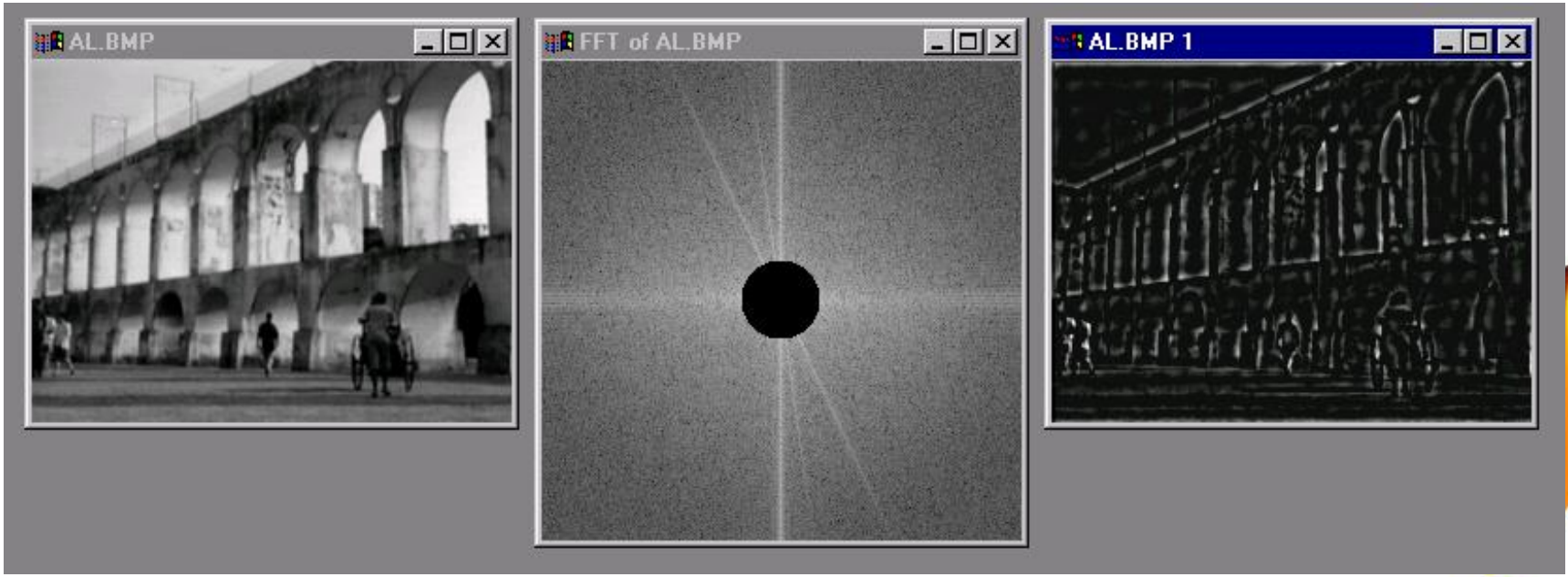


FFT

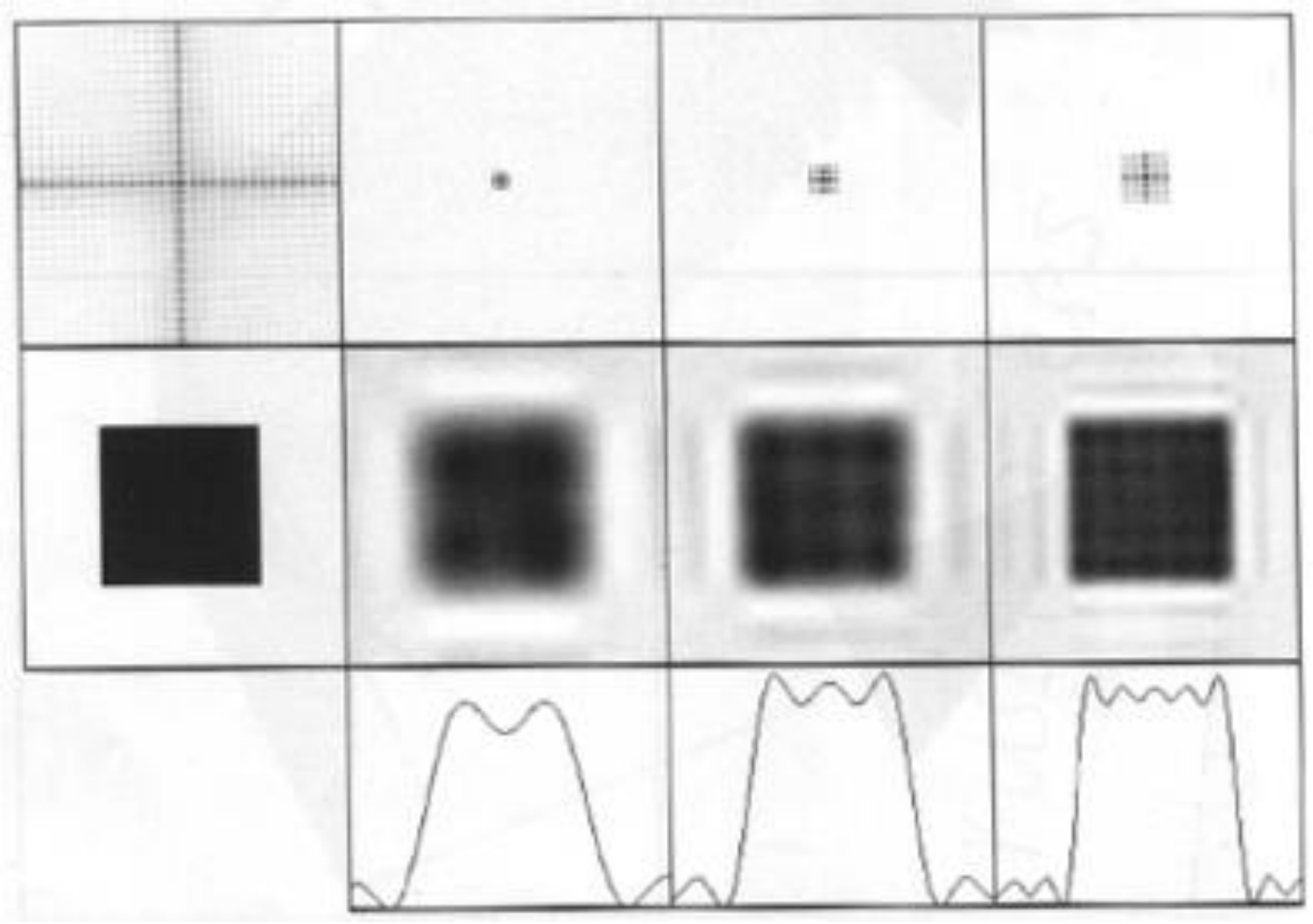

FFT of ARCOSL.TGA
ARCOSL.TGA 1
FFT of ARCOSL.TGA
ARCOSL.TGA 1
FFT of ARCOSL.TGA
ARCOSL.TGA 1
FFT of ARCOSL.TGA
ARCOSL.TGA 1

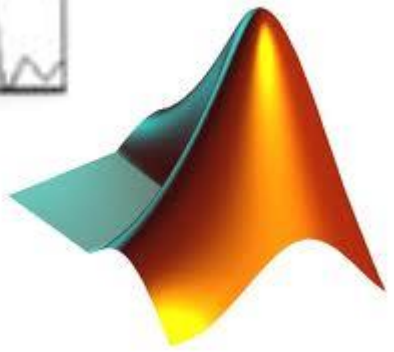
FFT


ARCOSL.TGA
FFT of ARCOSL.TGA
ARCOSL.TGA 1


AL.BMP
FFT of AL.BMP
AL.BMP 1

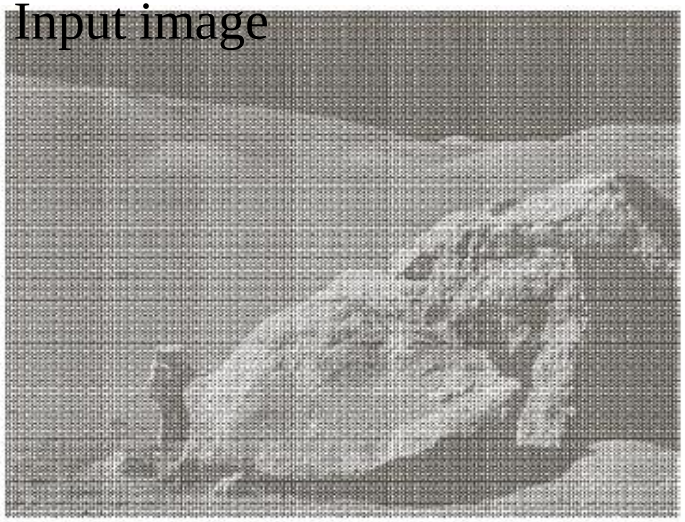
FFT



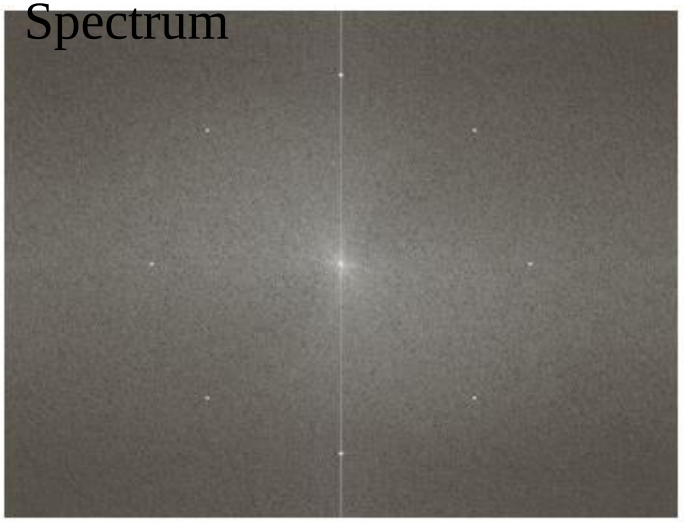


FFT

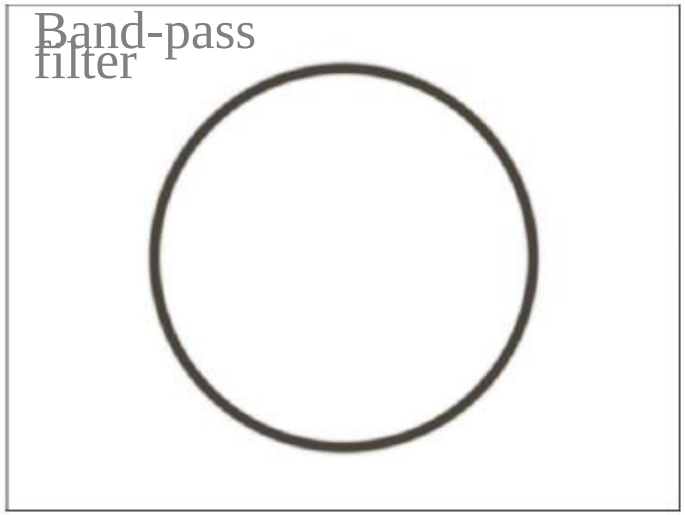
Input image



Spectrum



Band-pass filter



Output image