ECE637 Lab report 2
2-D Random Processes

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Section 1. Power Spectral Density of an Image

Part 1. The gray scale image *img04g.tif*

Part 2. The power spectral density plots for block sizes of 64 $\times$ 64, 128 $\times$ 128, and 256 $\times$ 256

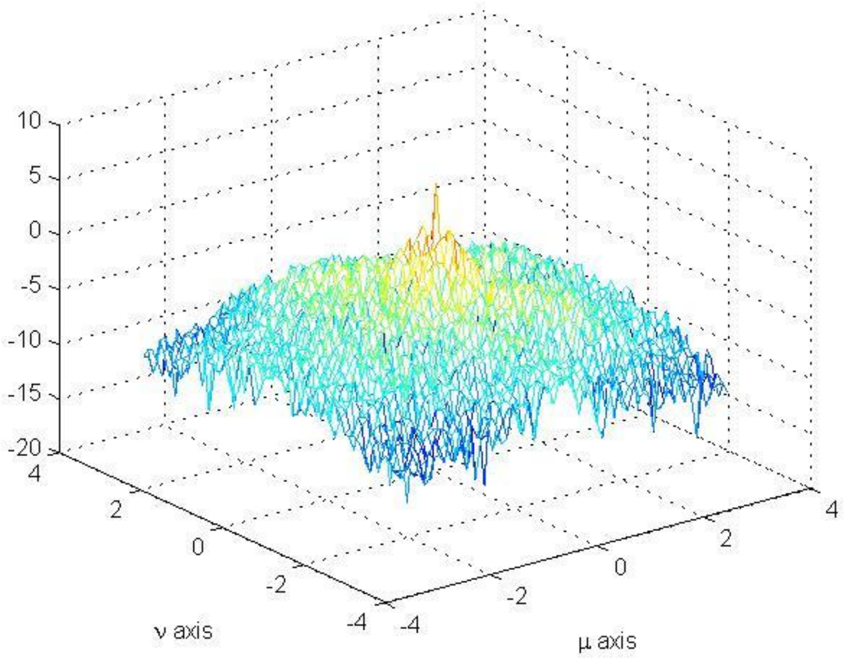

Figure 1. Block size 64*64

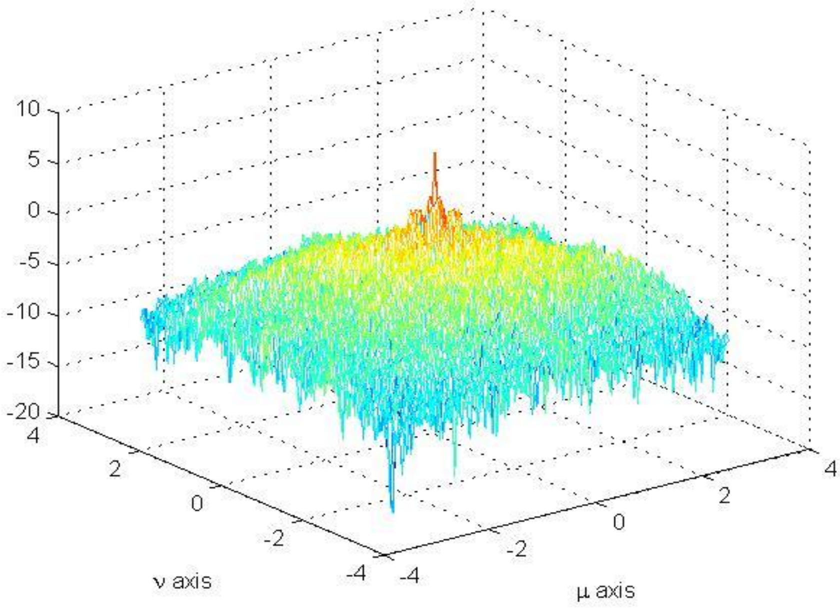

Figure 2. Block size 128*128

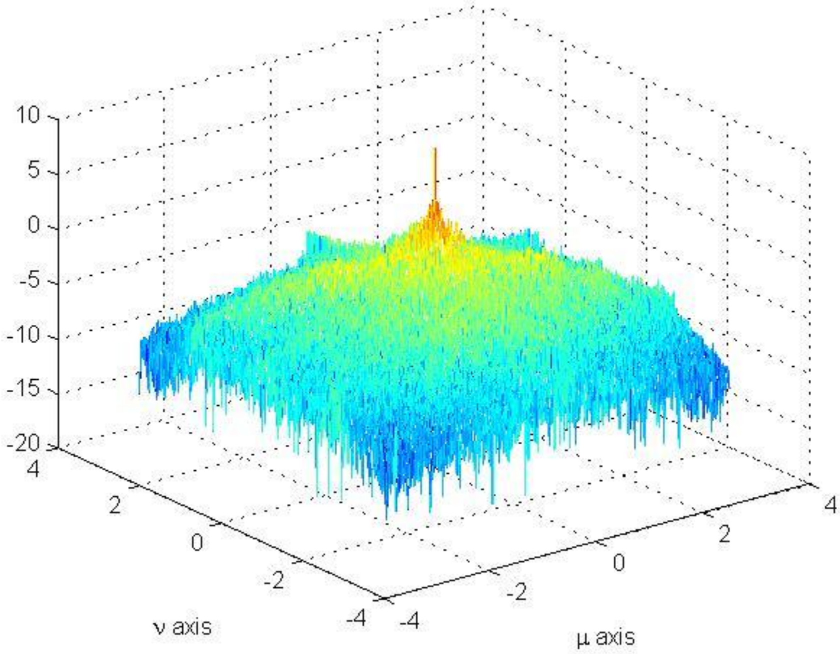

Figure 3. Block size 256*256

Part 3. The improved power spectral density estimate

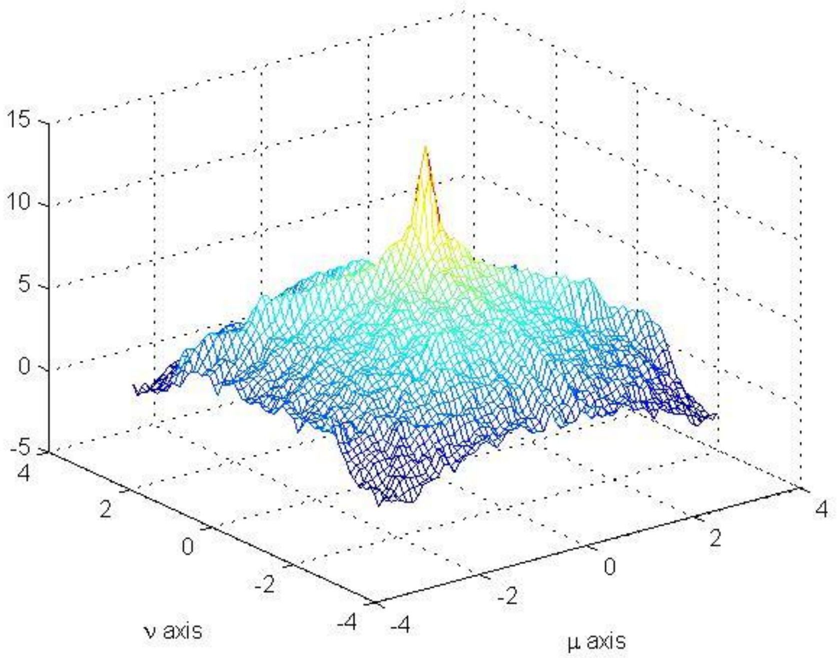

Figure4. The improved power spectral density estimate

Part 4. Code for ***BetterSpecAnal.m***

```
function BetterSpecAnal(img)

N = 64;
z=zeros(N,N);
Z=zeros(N,N);

[m,n] = size(img); %get the size of this img
%Y axis is the row = 512,X axis is the col = 768
stx=m/2-5*N/2;%get the start point of 25 windows at the center
sty=n/2-5*N/2;%this is a dynamic range,varies with different
image size

W = hamming(64)*hamming(64)'; %hamming window
for k=1:5
    for l=1:5
        z =
W.*img((sty+N*(l-1)):(sty-1+N*l),(stx+N*(k-1)):(stx-1 +
N*k));%pick a window and multiply by hamming window
        Z = abs(fft2(z)).^2 + Z; %Sum up
    end
```

```
end
% Compute the power spectrum for the NxN region
Z = (1/N^2)*(Z);
Z = Z/25;

% Use fftshift to move the zero frequencies to the center of
the plot
Z = fftshift(Z);

% Compute the logarithm of the Power Spectrum.
Zabs = log( Z );

% Plot the result using a 3-D mesh plot and label the x and
y axises properly.

x = 2*pi*((0:(N-1)) - N/2)/N;
y = 2*pi*((0:(N-1)) - N/2)/N;
figure
mesh(x,y,Zabs)
xlabel('\mu axis')
ylabel('\nu axis')
```

Section 2. Power Spectral Density of a 2-D AR Process

Part 1. The image $255 * (x + 0.5)$

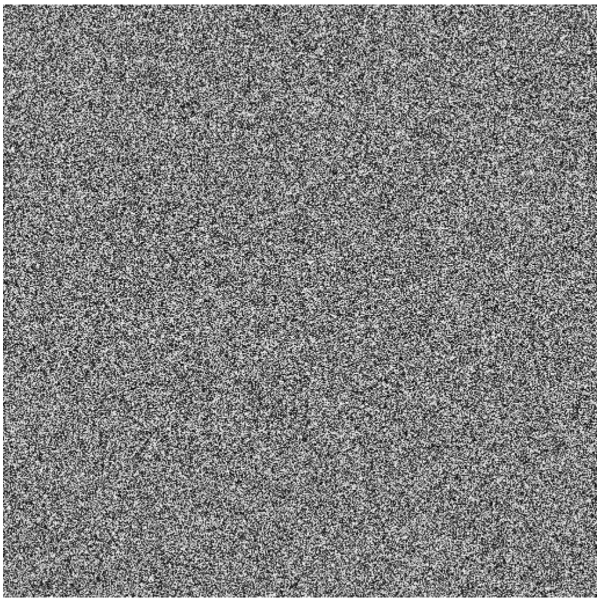

Figure 1. Random image 512*512

Part 2. The image y + 127

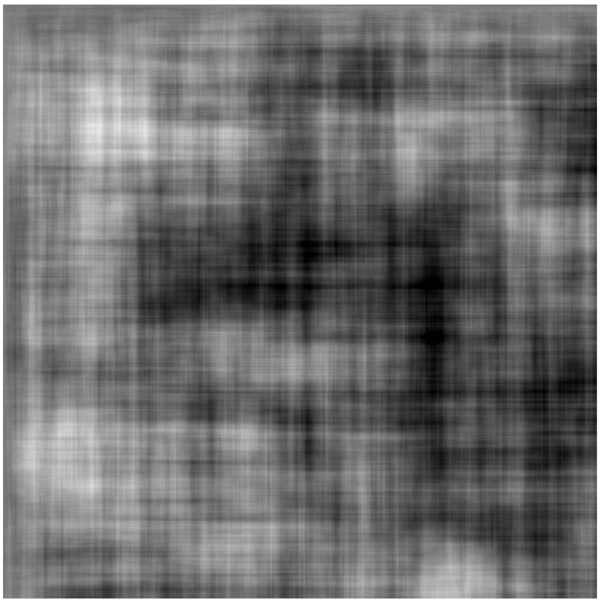

Figure 2. Filtered image(y+127)

Part 3. A mesh plot of the function $log\, S_y(e^{j\mu}, e^{j\nu})$

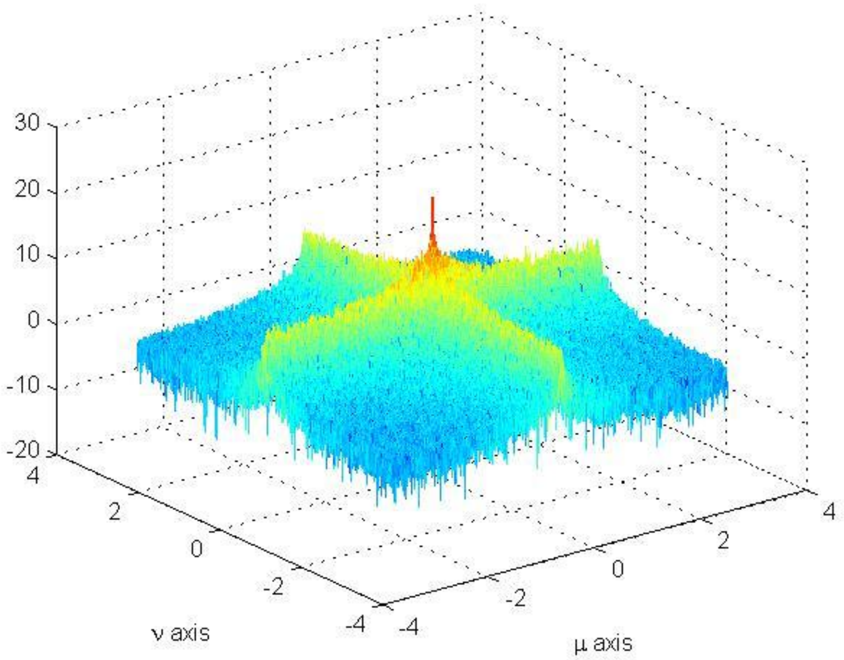

Figure 3. power spectral density

By doing the calculation on $H(z_1, z_2)$, the difference equation can be interpreted as

$$y(m,n) = 3 * x(m,n) + 0.99 * y(m-1,n) + 0.99y(m,n-1) -$$

$$0.9801 * y(m-1,n-1)$$

Part 4. A mesh plot of the log of the estimated power spectral density of y using *BetterSpecAnal(y)*

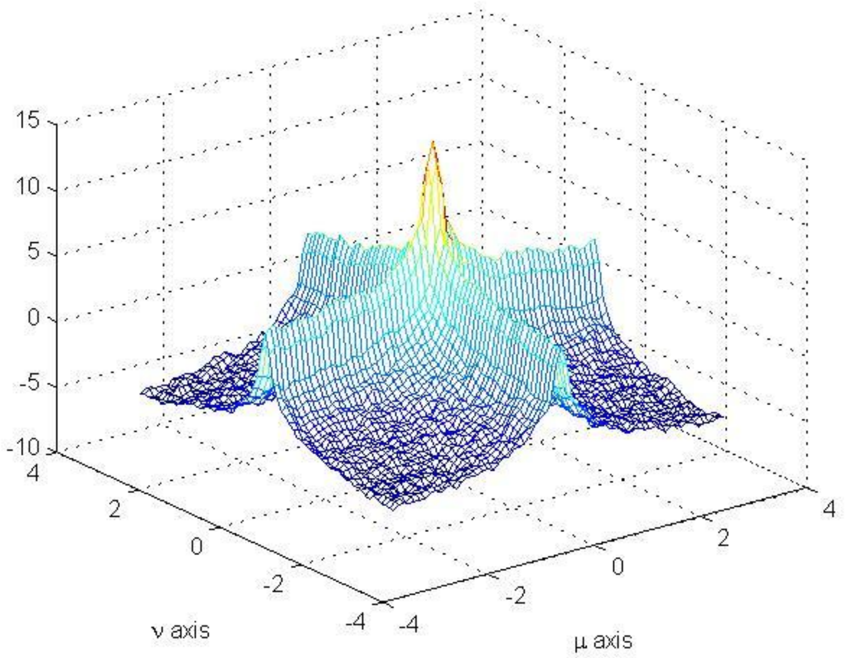

Figure 4. a better power spectral density

Part 5. MATLAB code

```
clc
clear
close

img = rand(512);%generate a 512X512 matrix on (0,1)
img = img - 0.5;%map the matrix into (-0.5,0.5)
img_scaled=255*(img+0.5);
imwrite(uint8(img_scaled),'rand_img.tif');%generate the
actual image

y = zeros(513,513); %adding a zero col and zero row for
calculation
yf = zeros(512,512); %image after filtered

for k = 1:512 %k cols, for x axis
    for l = 1:512 %l rows, for y axis
        y(k+1,l+1) =
3*img(k,l)+0.99*y(k,l+1)+0.99*y(k+1,l)-0.9801*y(k,l);
```

```
        yf(k,l) = y(k+1,l+1) + 127;
    end
end

imwrite(uint8(yf),'rand_filterd.tif')

N = 512;
% Compute the power spectrum for the NxN region
Z = (1/N^2)*abs(fft2(yf)).^2;

% Use fftshift to move the zero frequencies to the center of
the plot
Z = fftshift(Z);

% Compute the logarithm of the Power Spectrum.
Zabs = log( Z );


% Plot the result using a 3-D mesh plot and label the x and
y axises properly.

x = 2*pi*((0:(N-1)) - N/2)/N;
y = 2*pi*((0:(N-1)) - N/2)/N;
figure
mesh(x,y,Zabs)
xlabel('\mu axis')
ylabel('\nu axis')

BetterSpecAnal(yf)
```