EE7345

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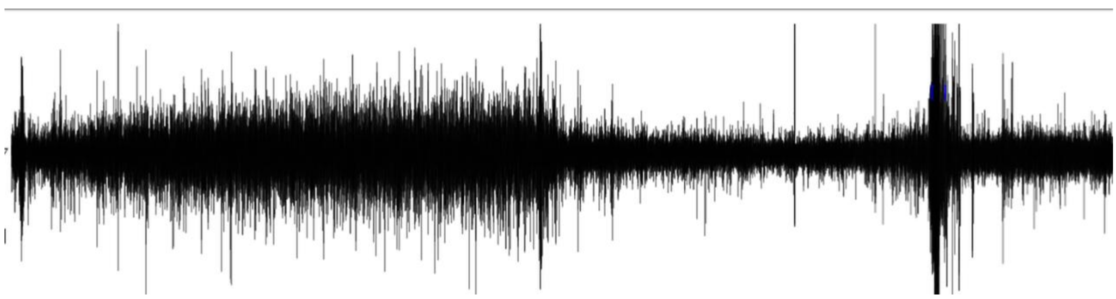
Fourier Spectral Estimation of EEG signal

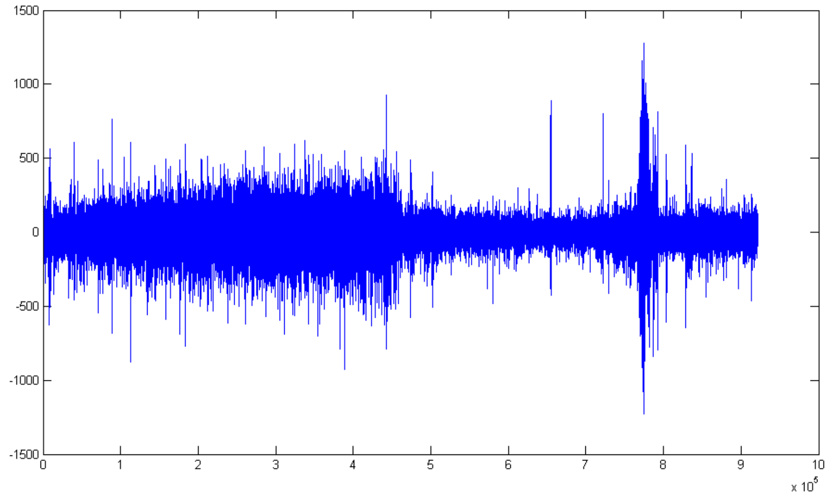
In this assignment, we use EEG data from CHB-MIT Scalp EEG database to analysis the spectral feature of seizure EEG and non-seizure EEG data. We will obtain the result form comparing three pairs of seizure data and non-seizure data. Finally I will discuss the tradeoffs involved in different window type, length and averaging when using different Fourier Spectral Estimation tools and functions in Matlab. In this assignment, we use pwelch function to obtain spectral waveform of these EEG signal records.

I download the 1 hour signal data from CHB-MIT Scalp EEG database. The signal waveform is from chb01_03.edf and the signal is FP1-F7. And I will choose 3 pairs of seizure signal and non-seizure signal.

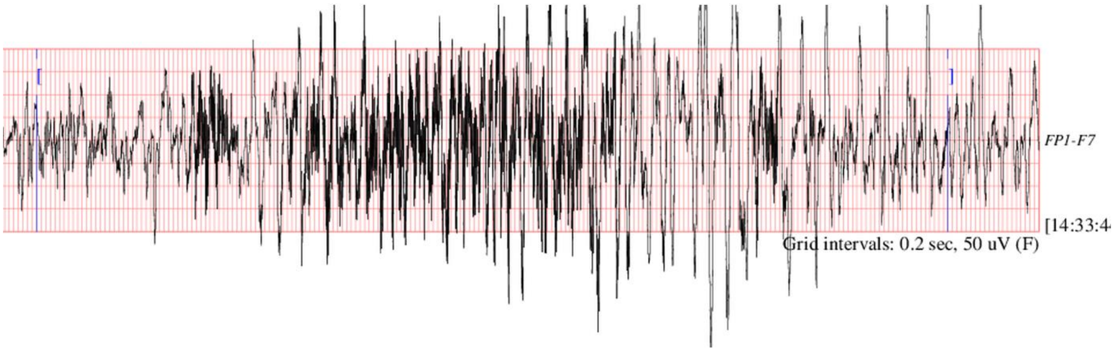


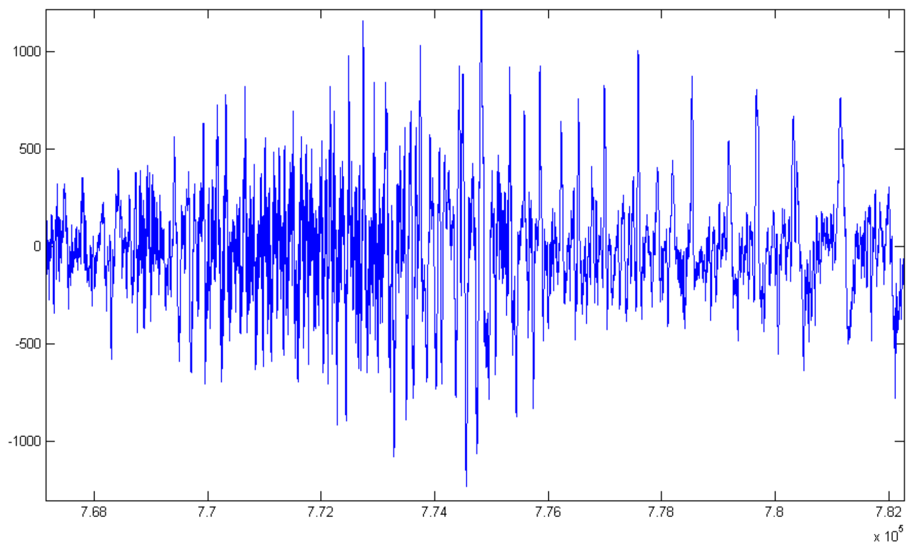
Seizure signal analysis

First of all, I plot the original signal,



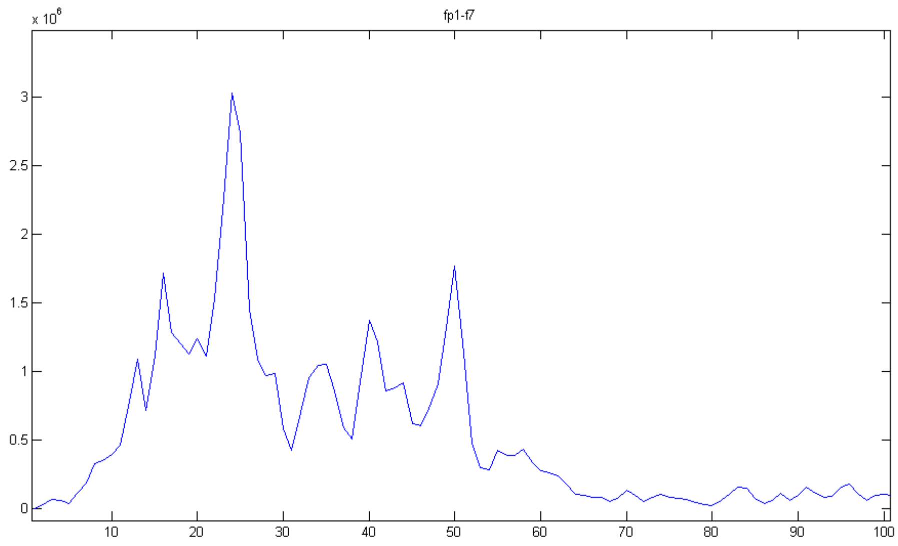
Secondly, we want to get the seizure signal in this EEG data so that we need extract the signal segment involve seizure. Therefore, we zoom the waveform to the seizure part.





Comparing these two diagrams, we can get seizure signal is included in7.678e+5 to 7.809e+5.

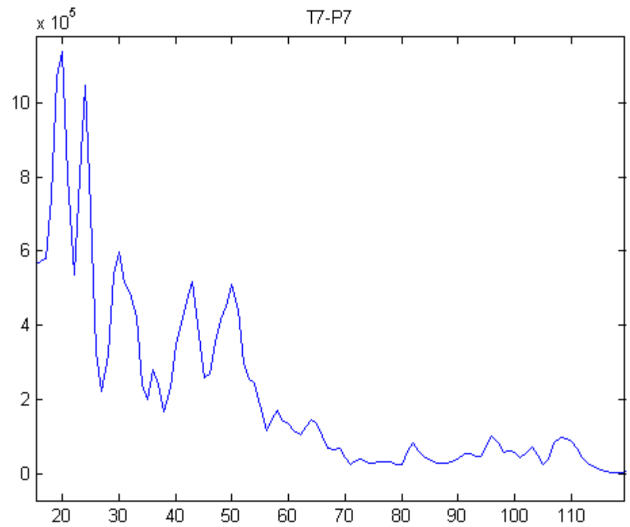
And then I use pwelch() function to obtain Fourier spectral estimation of this EEG signal. The waveform shows below: we can observe that the power spectral density in the seizure part is extremely high than normal part.



As the steps above, we can get the Fourier Spectral estimation waveform for other seizure signal such as, T7-P7 and FP1-F3.

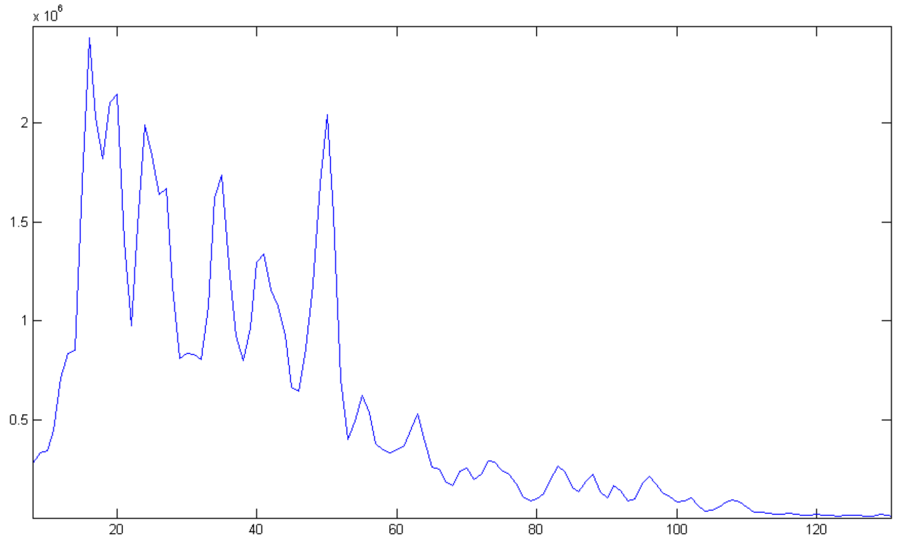
T7-P7:

Seizure data is from 4200 to 14400.



FP1-F3:

Seizure data is from 4121 to 14590.

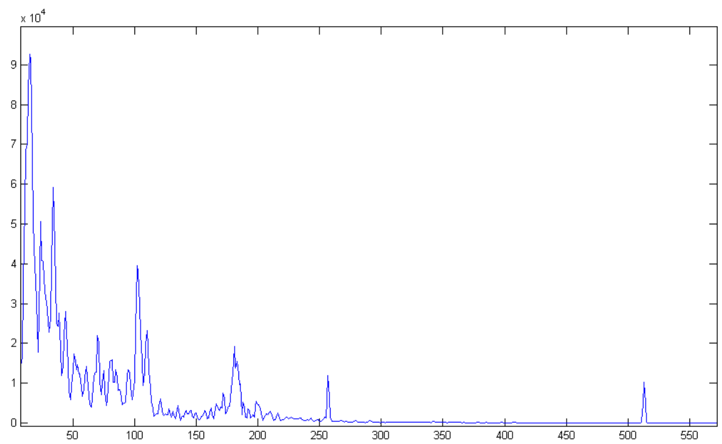


Finally, by analyze these three spectral estimation waveforms, I find that the power is higher in the signal of seizures.

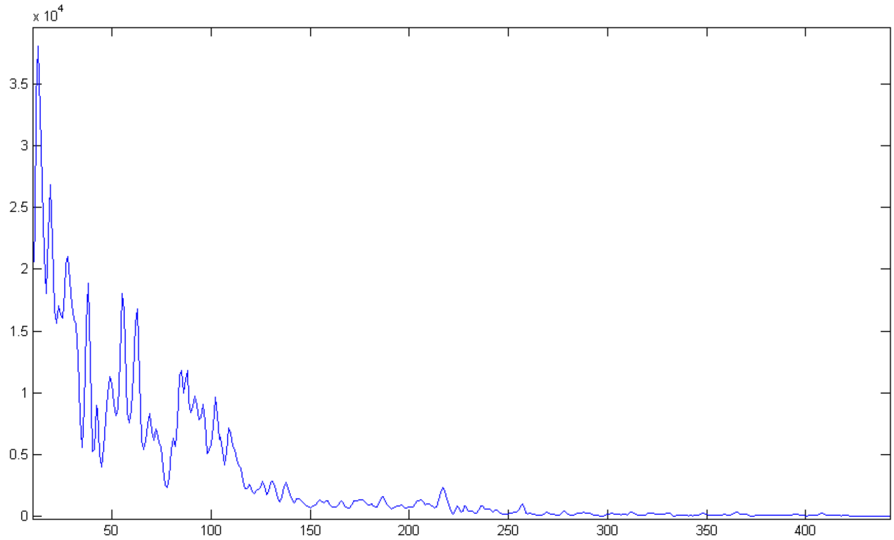
Non-seizure analysis

I choose chb01_02.edf as my non-seizure signal analysis. And I use the same time of data for comparing the difference of seizure signal and non-seizure signal.

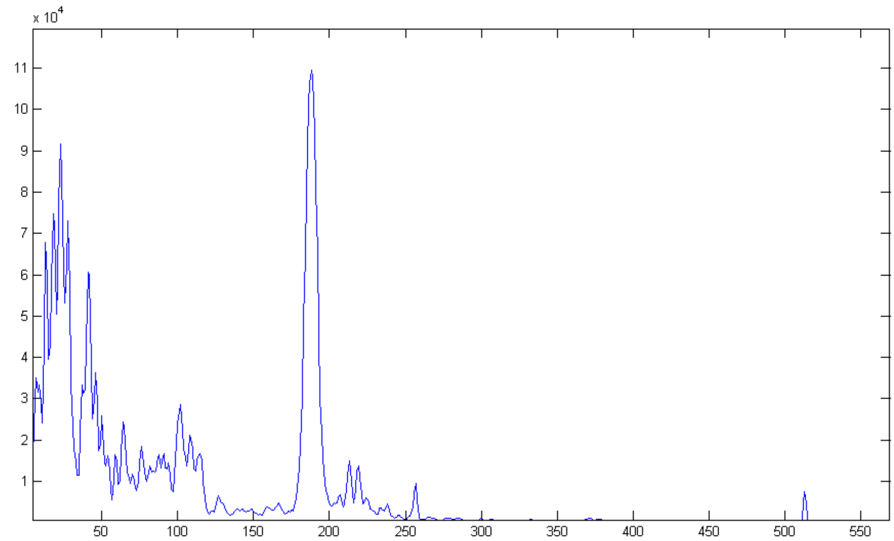
FP1-F7:



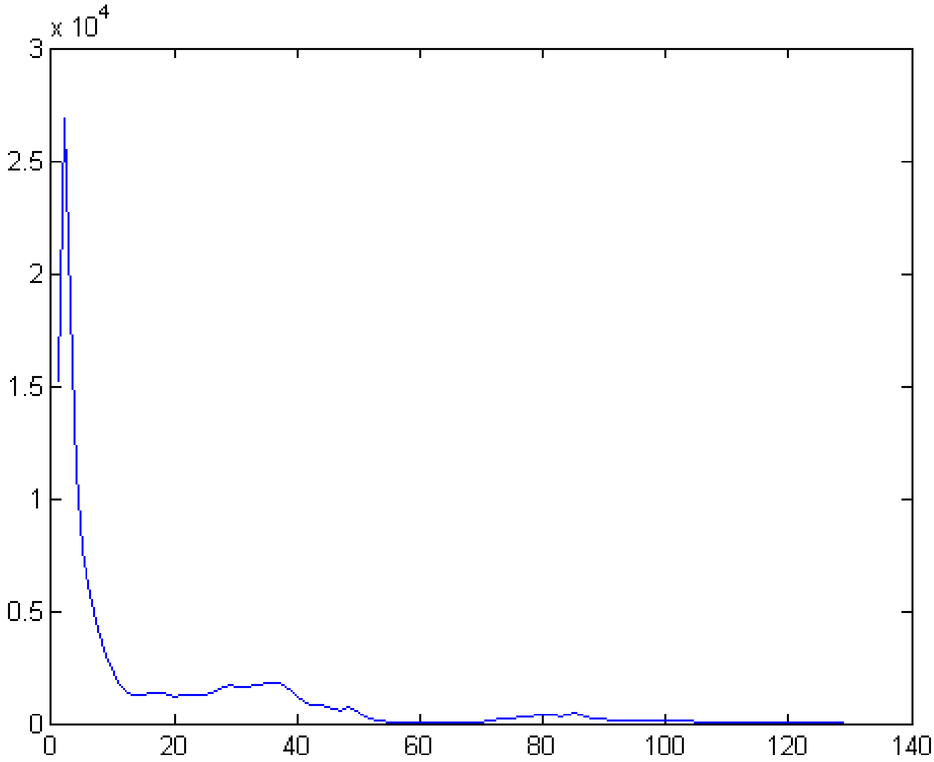
T7-P7:



FP1-F3:



By the way, we can use code likes pwelch(x,256) to divide the whole signal to 15360/256 parts. We can find that the waveform will more clear. For example, T7-P7 signal



Conclusion

Comparing the result of each waveform, we can focus on the amplituate of each pwelch() waveform:

	Fp1-f7	T7-p7	Fp1-f3
Seizure	3*10e+6	12*10e+6	2.5*10e+6
Non-seizure	0.092*10e+6	0.038*10e+6	0.11*10e+6
S/Ns	32.6	315.7	23.7

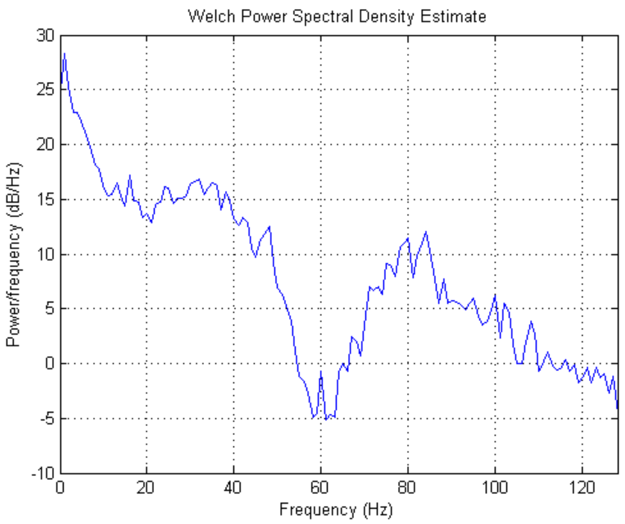
According to the amplitude data in the form, we can observe that the Seizure signal's amplitude of Fourier spectral estimation waveform is 23.7 times than non-seizure signal at least. Specially, in T7-P7 signal, the multiply arrives to 315.7. Therefore, we can discover seizure in Fourier Spectral Estimation.

The tradeoffs involved in tools of Fourier spectral analysis

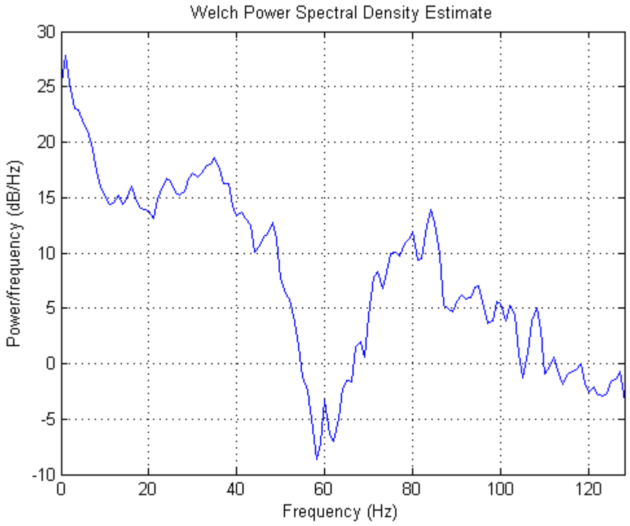
I choose the file chb01_01_02edfm.mat as my example and comparing the feature of several windowing methods such as: rectangular window, hanning window, hamming window, and Bartlett window.

The waveforms are:

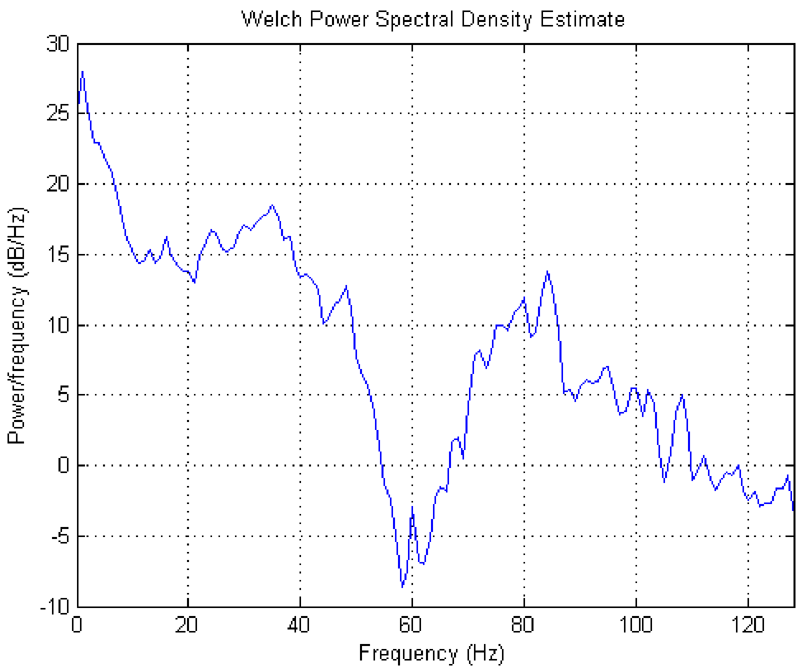
Rectangular



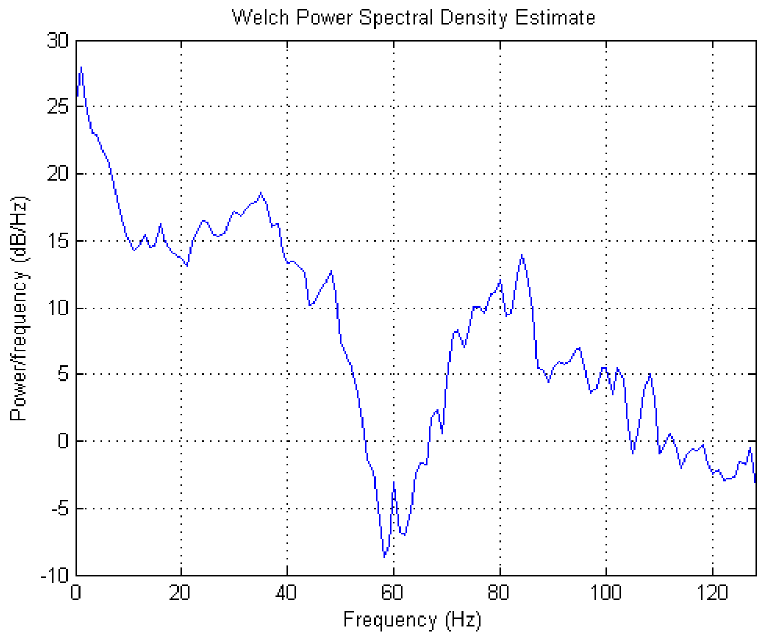
Hanning



Hamming



Bartlett



From the properties of these 4 windows, we know that rectangular window has thinner main-lobe with higher frequency resolution, but its side-lobes is large; hamming window's side-lobes is smaller that can maintain more low-amplitude frequency, while its main-lobe width is wider and leading to poor frequency resolution. In hanning window, the side lobe cancels each other. In Bartlett windowing method, I find that the amplitude is lower around 60Hz and the curve is smoother than rectangular method.

The code I use

```
clear all;
load('chb01_01_02edfm.mat');
z=val;
Fs=256;
x0=z(4200:14400);
figure(1)
pwelch(x0,boxcar(256),40,[],Fs)
figure(2)
pwelch(x0,hamming(256),40,[],Fs)
figure(3)
pwelch(x0,hanning(256),40,[],Fs)
figure(4)
pwelch(x0,bartlett(256),40,[],Fs)
```