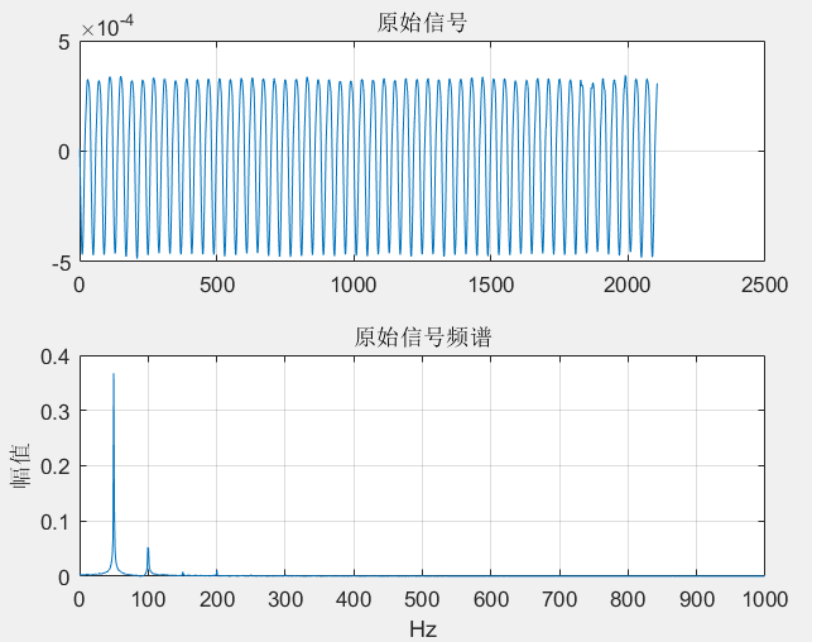
sEMG De-noising and Processing

Miao Wu

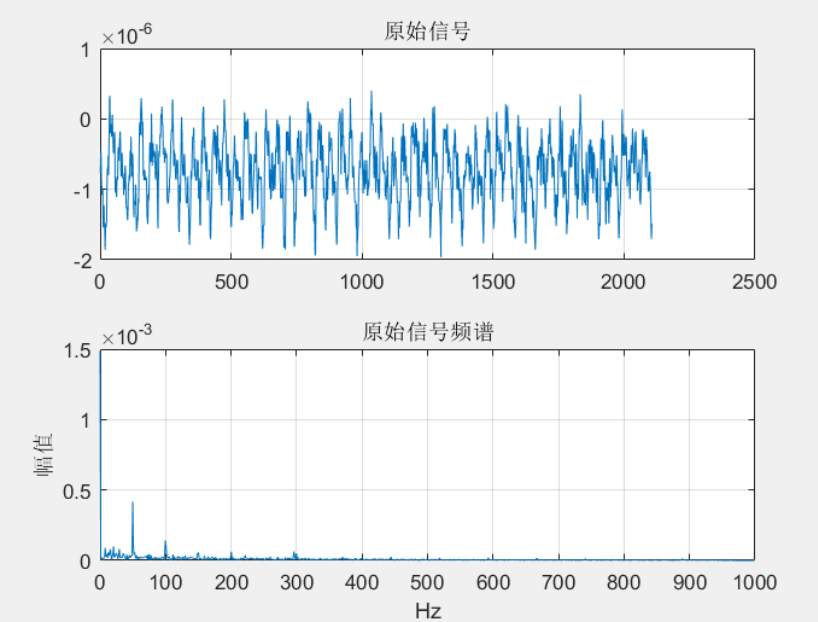
2018.8.10

Adviser: Chenglong Fu

Raw sEMG signal



signal of rest state



signal of motion state

Raw sEMG signal

- Characteristics
  - weak
  - instable
  - randomness
- Noises
  - motion artifacts
  - 50Hz power-line interference
  - 100Hz noise at rest state

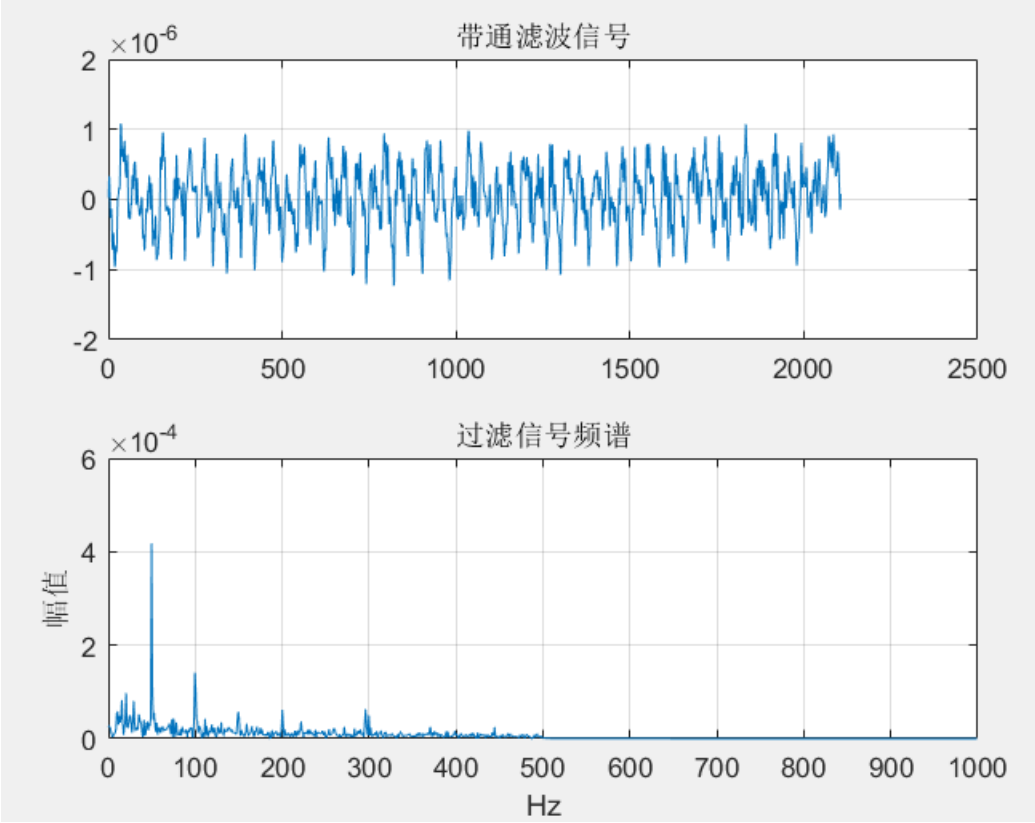
Literature review

- Full-wave rectifier
- Low-pass filter
- Inverting amplifier
- Amplifier
- Band-pass filter
- Notch filter
- Wavelet signal denoising

Band-pass filter

- 5 Hz high-pass filter to remove motion artifacts
  - 吴远皓.自然手势识别方法及可穿戴设备设计[D].北京:清华大学工学硕士学位论文.2017.
- 10-500 Hz band-pass filter
  - 吴冬梅,张欣,张志成,等.表面肌电信号的分析和特征提取[J].中国组织工程研究与临床康复,2010,14(43):8073-8076.
- My plan
  - design a band-pass filter function with adjustable passband frequencies
  - the sensors would be applied to different body parts with different range of frequencies

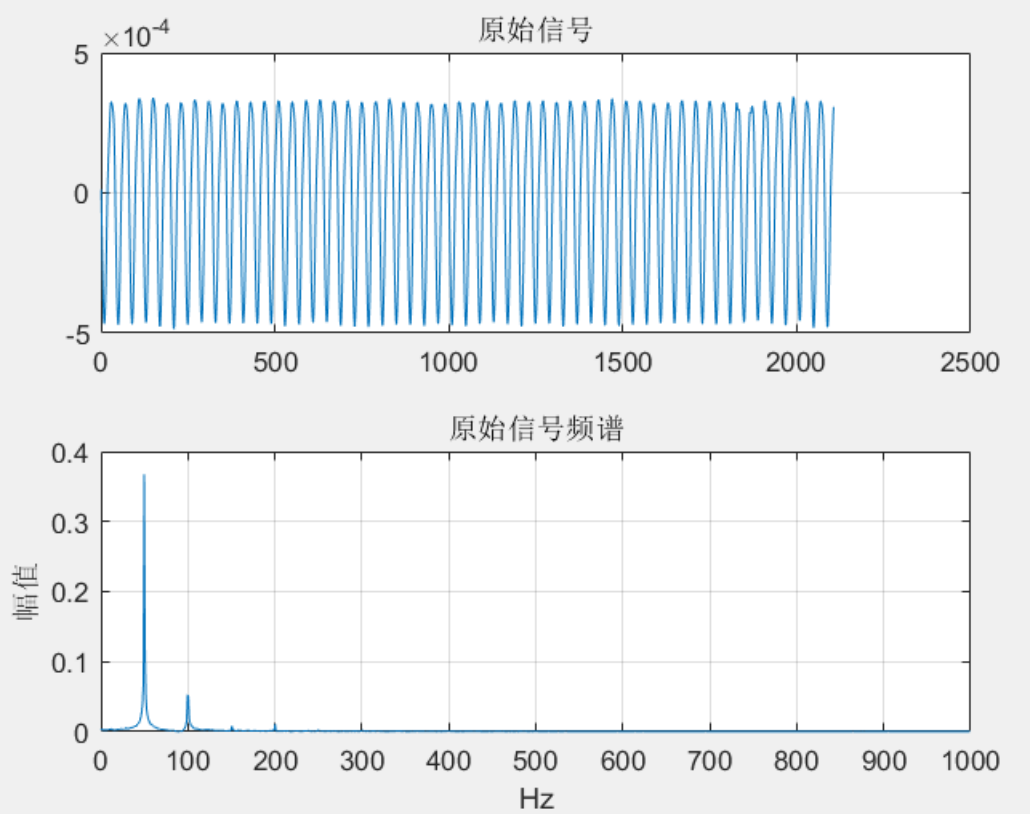
Band-pass filter



signal processed by 10-500 Hz band-pass filter

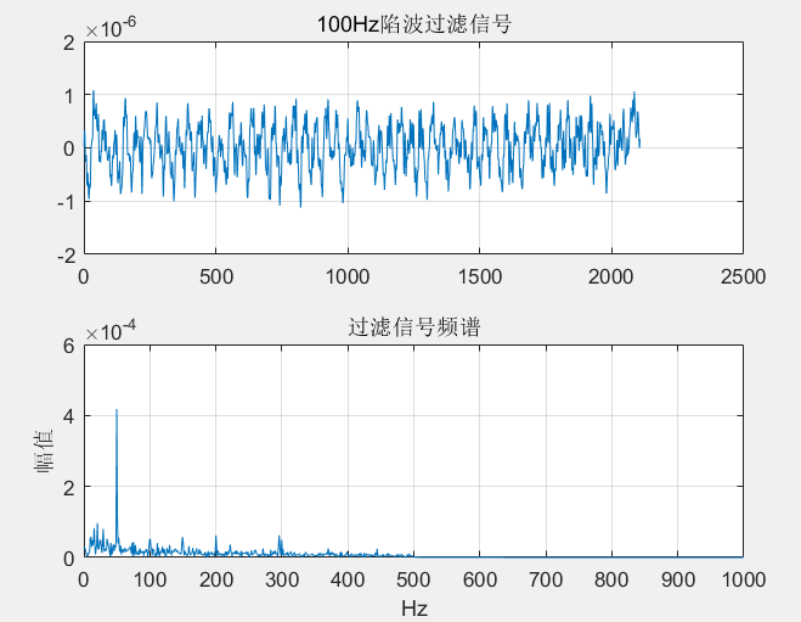
Notch filter

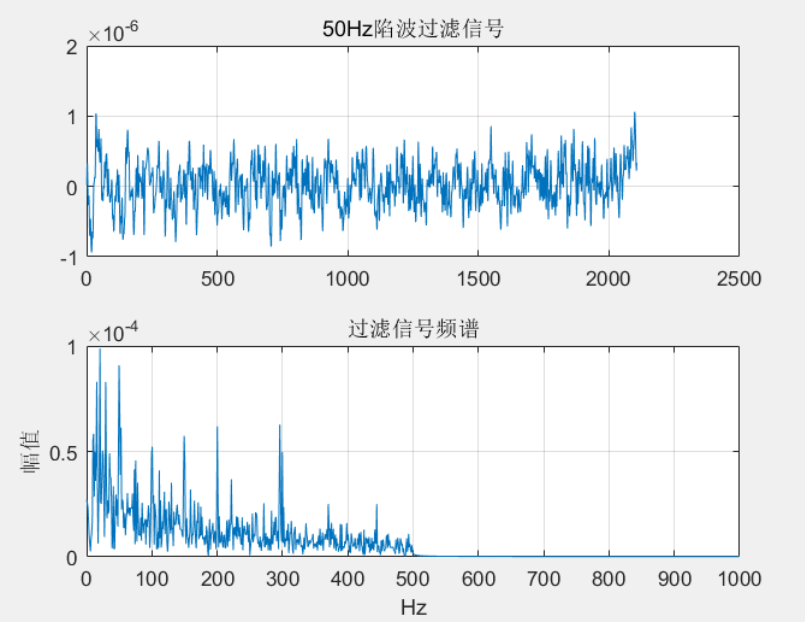
- remove 50 Hz power interference and 100 Hz noise



signal of rest state

Notch filter



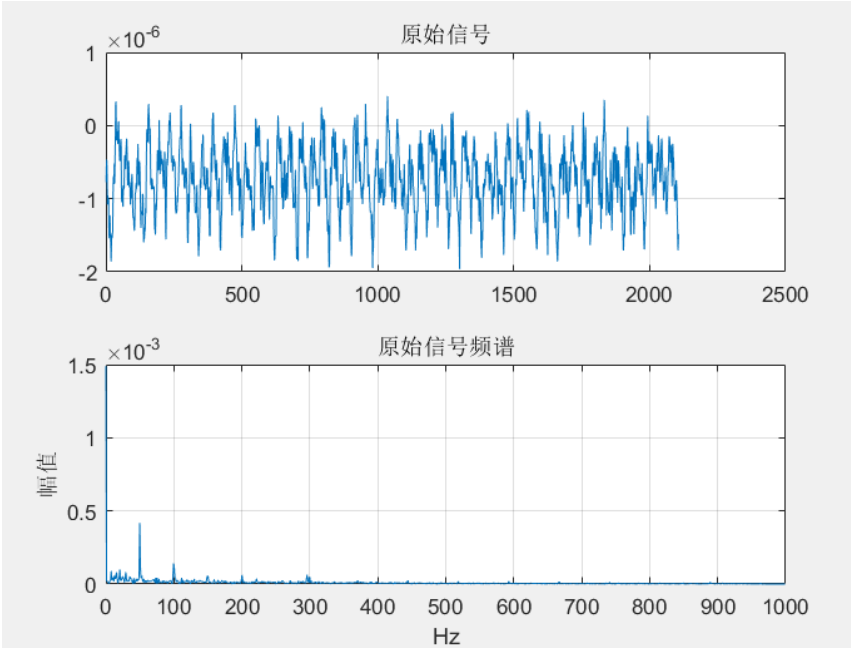



```
f0=100;
Q=100;
wo=f0/(Fs/2);
bw=wo/Q;
[b1,a1]=iirnotch(wo,bw);%设计100赫兹陷波滤波器

EMG_filter1=filter(b1,a1,EMG);%100赫兹过滤信号
```

```
f01=50;
Q=35;
wo=f01/(Fs/2);
bw=wo/Q;
[b2,a2]=iirnotch(wo,bw);%设计50赫兹陷波滤波器

EMG_filter3=filter(b2,a2,EMG_filter2);%50赫兹过滤信号
```

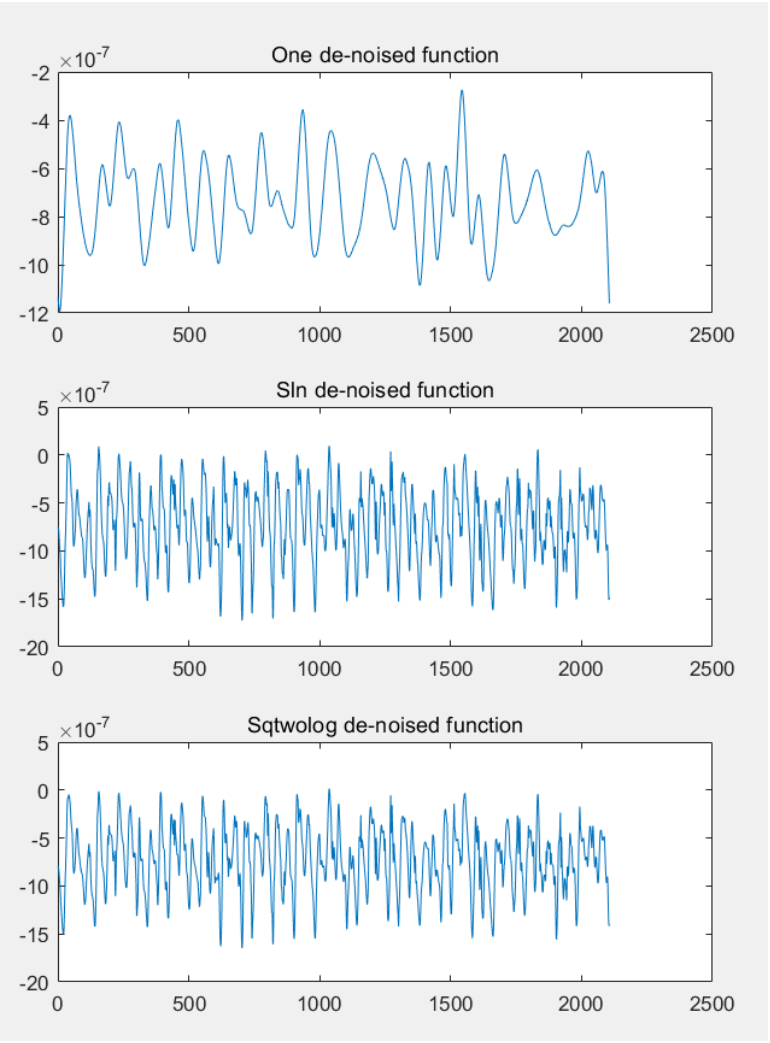
Wavelet signal de-noising

- Advantages
  - combine feature extraction and low-pass filter
  - keep characteristics of original signal



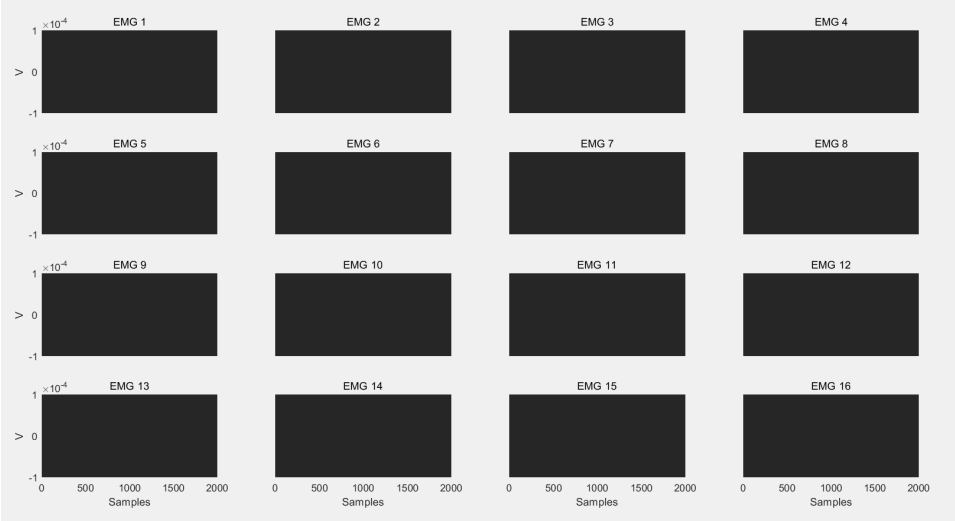
Wavelet signal de-noising

```
figure(2)
lev=5;
xd=wden(EMG,'heursure','s','one',lev,'sym8');%启发式SURE阈值选择算法
subplot(3,1,1)
plot(xd)
title('One de-noised function')

xd=wden(EMG,'heursure','s','sln',lev,'sym8');%软SURE阈值选择算法
subplot(3,1,2)
plot(xd)
title('Sln de-noised function');

xd=wden(EMG,'sqtwolog','s','sln',lev,'sym8');%固定阈值选择算法
subplot(3,1,3)
plot(xd)
title('Sqtwolog de-noised function');
```

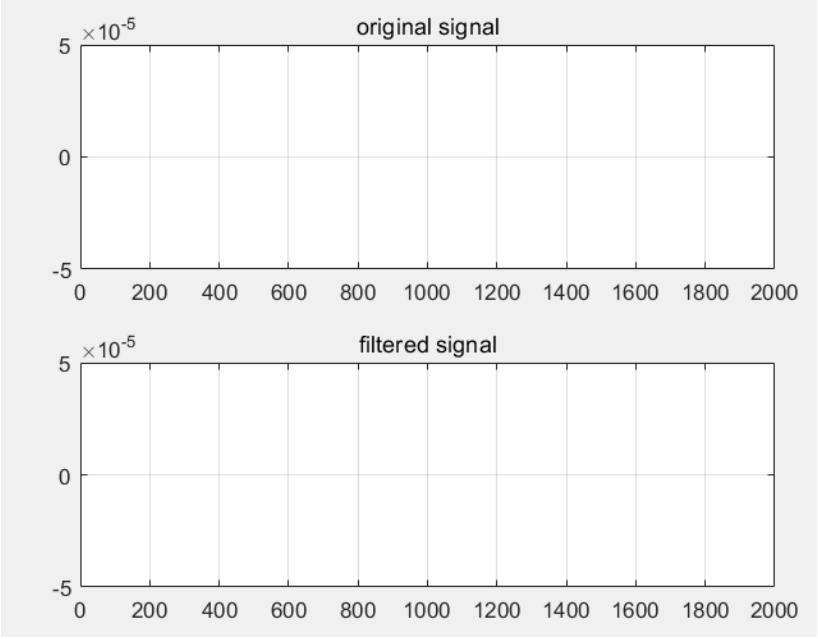


Real-time data ploting

- Revise the plots layout
  - compare original signal with filtered signal



original figure



revised figure

Real-time data ploting

- Delete channels without signal input
  - improve speed

```
if counter==1
    for n=1:16
        if data_arrayEMG(n)==0
%             ch=[ch,n];
           close(figures(n));
           ch(n)=[];%删除第n个通道
        end
    end
%     setUpPlots();
end%根据第一次读取的data_arrayEMG数据，删除掉不显示数据的通道
```

Future work

- Design EMG filters
  - notch-filter
  - band-pass filter
  - wavelet signal filter
- Realize real-time signal ploting
  - data stream
  - plot
  - speed
- Extract signal features
  - valid signal extraction and assessment

Thanks