Project : ECG signal restoration

Special thanks to Professor Honggu Chun for providing this hand-on problems and ECG data

Background

- Electrocardiography records the potential difference in the form of wavelength that occurs with heartbeats as the heart contracts.
- The contraction of the heart muscle is caused by a weak current in the pacemaker cell, which is the current measured at the surface of the body.
- Standard lead is a method of recording an electrocardiogram by connecting an electrode to the right hand, left hand, and left foot. Among them, lead II has the direction of induction coinciding with the axial direction of the largest cross section of the heart. So, it is important in reading ECG because we can see P wave easily.
- The ECG waveform contains, in addition to the QRS complex, P and T waves, 60Hz noise from powerline interference, EMG from muscle, motion artifact from the electrode and skin interface, and so on.

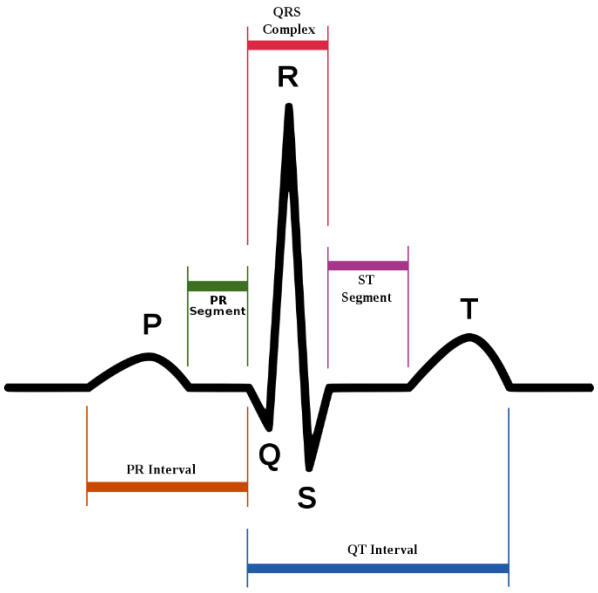

Figure 1. ECG of a heart in normal sinus rhythm

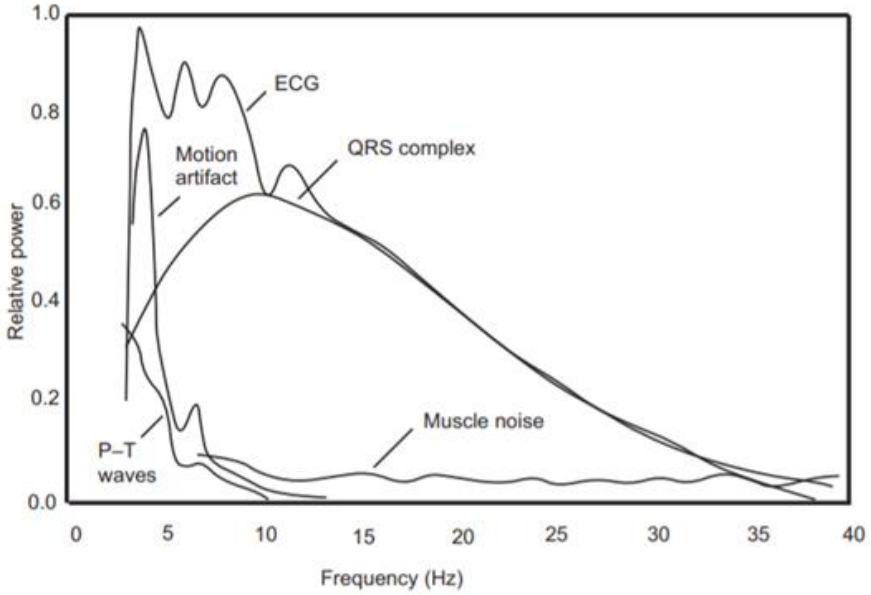

Figure 2. Power spectrum of ECG signal and other noises

Project instructions

1. The goal of this project is to restore the ECG signal through noise removal.

2. Load "ecg_withnoise.mat"

   - Sampling frequency of ECG is 500Hz and unit of ECG is mV.

3. Make the Ideal band pass filter based on figure 2 to maximize the signal-to-noise ratios of ECG, P-T waves, QRS complex. you must remove baseline shift.

4. Apply Ideal band pass filter to whole ECG signal and plot the filtering results in time domain.

5. The baseline shift and high frequency noise have been removed from the ECG signal, but some noise remains.

6. Make the short time frequency spectrogram of "ecg" signal. You can use "spectrogram" MATLAB function or "fft" function. Set the appropriate time interval of spectrogram to analyze the residual noise.

7. Make the Ideal band reject filter for removing the residual noise while preserving other signals as much as possible. Apply ideal band reject filter only to noisy interval of ECG signal.

8. Plot the filtering results of whole ECG signal in time domain.