

BMED311 Homework: Chapter 8. Discrete Fourier Transform

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

- 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 goal of this homework is to remove the noise from the ECG signal through filtering in frequency Domain.

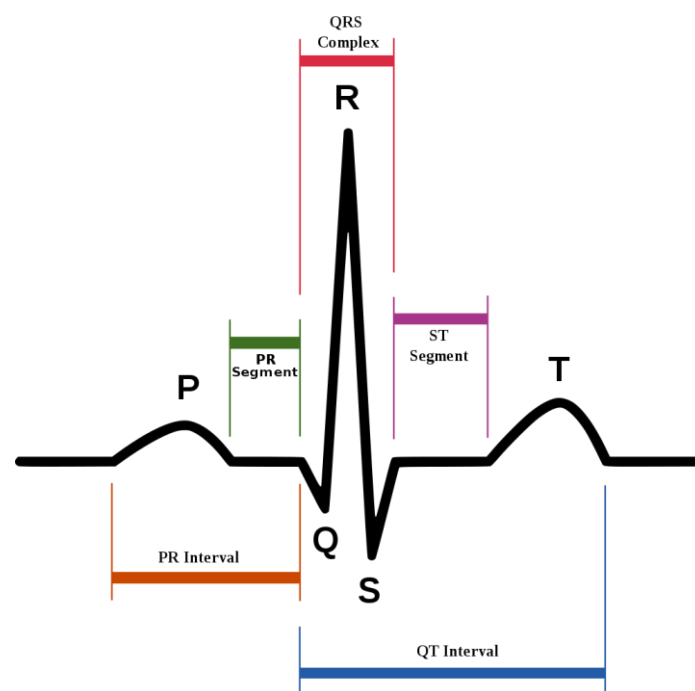


Figure 1. ECG of a heart in normal sinus rhythm

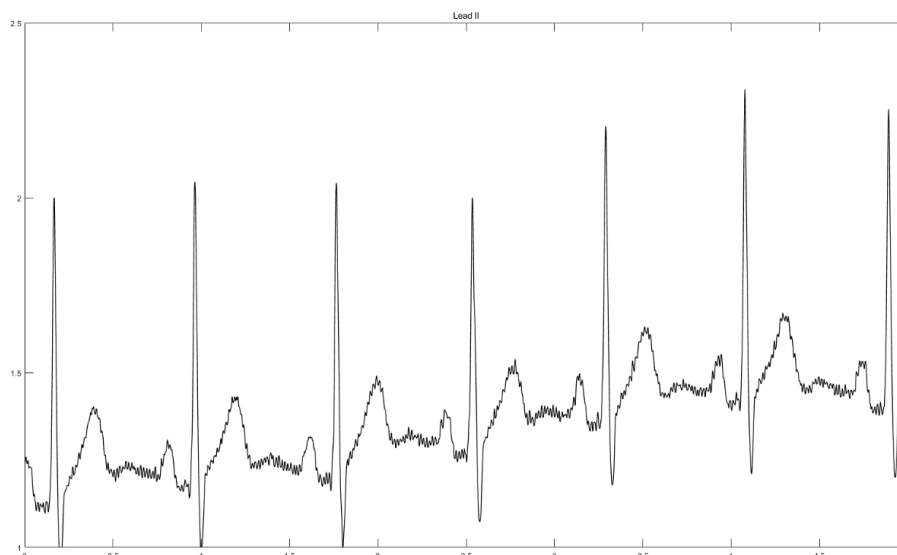


Figure 2. Real ECG Figure with noises

1. Load `ecg_lead2.mat`.

- Sampling frequency of ECG is 500Hz and unit of ECG is mV.
- "`ecg_lead2`" has the Lead-II data of ECG.

2. Make the variable named "`ecg_test`" which has the interval of 1 seconds to 2 seconds of Lead-II signal.

3. Make 16-pt averaging filter and apply averaging filter to "`ecg_test`" in frequency domain without zero padding. you must use "`fft`" and "`ifft`" MATLAB function.

4. Apply 16-pt averaging filter with zero padding. Choose appropriate number of zero padding.

5. Plot the filtering results (with and without zero padding) in time domain and compare each other. Use "`hold on`" to plot two graphs in one figure. Which one has the correct result?

6. DFT whole Lead-II signal (0~10 sec) and plot the single side magnitude spectrum ($0 \leq k \leq \frac{N}{2}$ or $0 \leq \hat{\omega} \leq \pi$). Evaluate the frequency characteristic of the input signal.

7. Apply Ideal LPF to Lead-II and plot the result. Discuss which cutoff frequency produces the best result and compare the results before application.

8. Apply Ideal HPF to Lead-II and plot the result. Discuss which cutoff frequency produces the best result and compare the results before application.