BMED311 Homework: Chapter 10. IIR Filters

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

- A common heart test is an electrocardiogram (ECG or EKG) which records electrical activity that changes during the cardiac cycle. Metal electrodes placed at several locations on the body "pick up" these cardiac electrical signals. Unfortunately, the electrodes also pick up signals from other electrical sources, most notably harmonics of the 60-Hz power signal (or 50-Hz in some other countries).

- The objective of this short lab is to show that you can remove a sinusoidal interference from a corrupted ECG signal and produce a cleaned-up signal.

- An IIR notch filter will null out one frequency, while having a frequency response that is relatively flat across the rest of the frequency band. It has one complex-conjugate zeros and poles: Zeros at $e^{\pm j\theta}$, Poles at $re^{\pm j\theta}$ where r is a number slightly less than one.

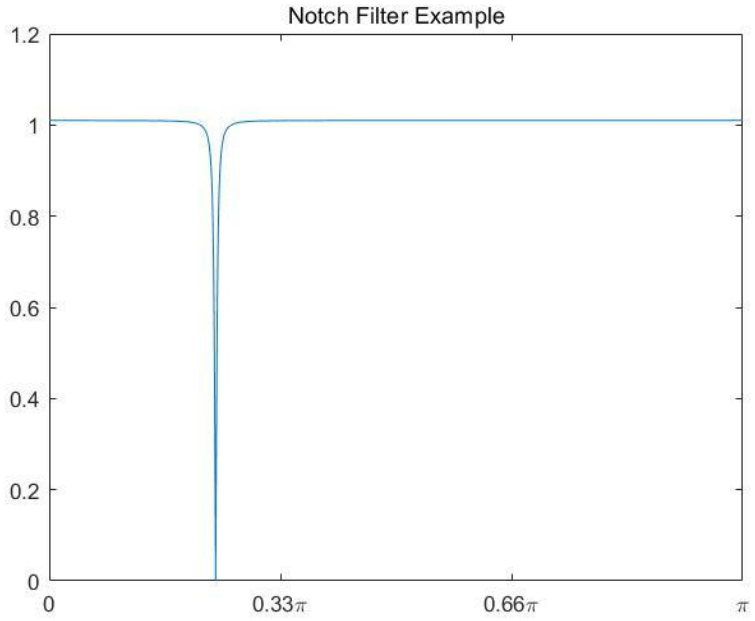

Figure 1. Notch Filter

- Thus, the system function is:

$$H(z) = \frac{B(z)}{A(z)} = G\frac{\left(1 - e^{j\theta}z^{-1}\right)\left(1 - e^{-j\theta}z^{-1}\right)}{\left(1 - re^{j\theta}z^{-1}\right)\left(1 - re^{-j\theta}z^{-1}\right)}$$

1. load lead2.mat file into MATLAB.

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

2. DFT lead2 and plot magnitude spectrum at $0 \leq k < \frac{N}{2}$ (DTFT $0 \leq \hat{\omega} < \pi$). Which is the frequency of the power signal?

3. Design Notch filter to remove the noise by the power signal.

4-1. Make the variable named zeros and poles which have the zeros values and pole values of Notch filter. In this case, the value of r should be less than 1 and very close to 1. (ex. r = 0.95 ~ 0.99)

4-2. Calculate the coefficients of B(z) and A(z) using poly() or pezdemo and store them in bb, aa, respectively.

4-3. Perform notch filtering using the filter coefficients created in 4-2.

4-4. Plot the filtered lead2 in time domain and frequency domain.