Homework 4

BE/EE/MedE 189a: Design and Construction of Biodevices

Fall 2017

Due October 26, 2017

1. Develop a virtual low pass filter using DAQ analog input and output. Use the DAQ assistant to first output a triangle waveform with a peak-to-peak voltage of 2 V and a frequency of 100 Hz. Then using a single wire, connect the analog output on the NI ELVIS II system to one of the analog inputs. Then use the DAQ assistant to acquire the voltage signal. Apply a moving average filter and then output the filtered signal to a waveform chart. Use a `while` loop for continuous generation and acquisition of signals. Write the filtered voltage values to a file after you stop the while loop. To verify that it wrote correctly, you can plot the signal using some other software.

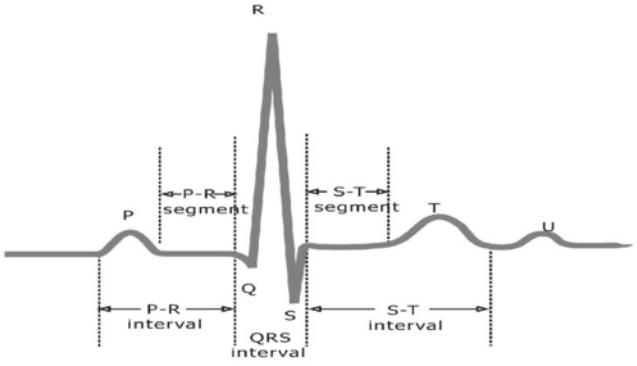
   You can test the input side of your VI by filtering the output of a triangle wave from the FGEN port on the NI ELVIS II system. You can control the FGEN port using the **NI ELVISmx Function Generator**, which can be accessed via `Start » All Programs » National Instruments » NI ELVISmx Instrument Launcher`. The **NI ELVISmx Instrument Launcher** contains other instruments that could be useful for your design projects.

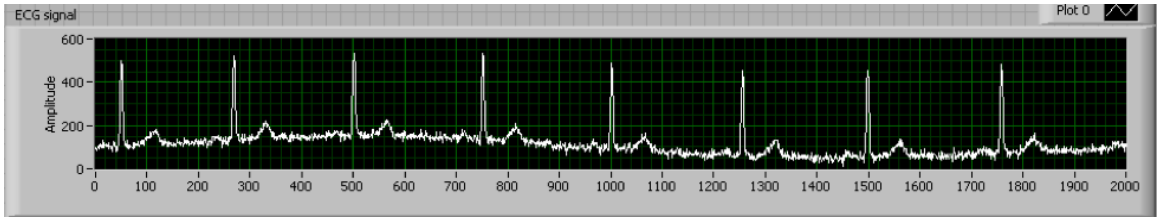
   The moving average filter is defined by the following equation

$$y[n] = \sum_{k=0}^{N-1} \frac{x[n-k]}{N} \tag{1}$$

   where $x[n]$ is the raw signal, $y[n]$ is the filtered signal, and N is the filter window size.

2. Design a VI that processes an electrocardiogram (ECG) signal. A typical one-cycle ECG signal is shown below. The following figure shows an example of the electrocardiogram (ECG) signal. Design a filter to remove the baseline wander and the high-frequency noise that can be observed in the figure. After denoising, design and implement an algorithm to find the R-peaks, and calculate the heart rate according the peaks positions. An ECG trace can be found in ecg.txt, which includes 2000 data points. The entire trace is taken within a 5-second time window.




ECG signal
Plot 0
Amplitude
600
400
200
0
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000