BME 687- Medical Instrumentation March 12, 2008
Laboratory Assignment 3
Subject: Evoked Potentials and Spike-Triggered Averaging Technique

1. Take a Petri dish and tape the stimulation and recording electrodes on the bottom inside the dish as demonstrated by the instructor.
2. Fill the Petri dish with saline (make sure not to spill. It is best to assign a group member to work with the Petri dish away from the computer while others are taking care of data acquisition, etc.)
3. Run LabVIEW 8.2 and download *trigger&acquire3.vi* from web.njit.edu/~sahin/BME687 . Set the data acquisition board to RSE mode using Measurement & Automation software. If the *trigger&acquire3.vi* does not load properly, download lvdaq.dll from the same link and save it in the same folder. Try loading and running *trigger&acquire3.vi* again.
4. Chose zero for the input and output channel numbers. Please save your data on the desktop (not in any National Instrument folder) and delete them after this studio.
5. Stimulation parameters: pulse width=0.5ms, pulse frequency=10Hz, stimulus amplitude=1.0V. Leave other parameters unchanged.
6. Acquisition parameters: acquisition time=5ms, number of acquisitions=400, sampling rate=100,000, and input range=±10.0V.
7. Run the VI and enter a file name for the data to be saved (*.dat) and for the comments to be saved (*.txt). Collect the signal while observing the data on the display. *Vary the stimulus amplitude from 1.0V until you can see a noisy square pulse. The noise level should be significant but not too high to prevent measurements of the pulse amplitude.*
8. Run Matlab and load the data using "load *filename*.dat" command and then plot it using "plot(*filename*)". The signal should look noisy. Can you make out the quantization steps? (That is the amplitude resolution of the data acquisition board PCI 6024E for the input range you are using). Is the resolution equal to what you find from Vrange/2^{12}V?
9. Change the input range down to a smaller value to improve the resolution, but not smaller than the signal amplitude on the positive and negative extremes. Recollect the singal+noise and transfer into Matlab. Plot the signal and measure the peak-to-peak voltage from the figure using the magnifier function. Keep this file for averaging later at home.
10. Change the input range to ±0.05V in LabVIEW, acquire only the noise with signal amplitude=0, and transfer it into Matlab under a different filename. What is the size of the quantization steps (resolution) now? Can you tell how many decimal points are used to represent the data in the ASCII output file from LabVIEW?
11. Take the standard deviation of the noise using "std(*filename*)". This is the root-mean-square (rms) value of the thermal noise generated in the recording electrodes without the signal component present.
12. Now, you are ready to calculate the signal-to-noise ratio (SNR). Just divide the measured peak-to-peak amplitude of the square pulse in step 9 by the rms value of the noise from step 11.
13. Do the following part at home later to show that as the number of averaged cycles increases in the spike-triggered averaging method, the SNR also increases: In Matlab, write a small m.file to average a number of pulses acquired (for instance 100, 225 or 400 cycles) into one pulse (Hint: you need to figure out how many samples each cycle (5ms) consists of at the sampling frequency that was used; 100,000samples/s). Measure the averaged signal amplitude (peak-to-peak) and divide it by the standard deviation of the noise (use a flat part of the averaged signal to calculate this). How many times is this SNR better (higher) than the one calculated in step 12, which is the SNR for the original signal.

Important Question: Does the amount of improvement in SNR have a correlation with the number of acquisitions averaged?

14. In your report, remember to talk about the following in the theory section:
    a. The theory on spike-triggered averaging,
    b. Potential usage of spike-triggered averaging technique for evoked biological signals.
    c. Thermal and Quantization noise; where are they generated?