Statement of Need

It is desired that the muscle recorder research setup be implemented in an undergraduate class laboratory; the purpose being to expose students to a complete process of measuring, analyzing and modeling real biological signals. The setup must be simplified for use in a junior level class and be cost effective for the number of setups required. The final implementation must allow students perform several functions. Students must first record the time histories for isometric and isotonic experiments from frog gastrocnemius muscle. They must next analyze the signals for peak isometric tension and maximum velocity. These values will then be input into an optimization protocol which will optimize the parameters of the muscle model developed by Dr. John Enderle. Given these parameters, the students must then develop a Simulink implementation of the isotonic experiment, using Dr. John Enderle’s model, to reproduce the length verses time curve.

Introduction and Overview

The finished muscle recorder, for implementation in an undergraduate lab, will be a limited version of the research setup with the functionality only to perform the specific experiments desired. The setup will be optimized for frog gastrocnemius muscle. It will be able to stimulate frog gastrocnemius muscle with power necessary to achieve full activation. Power requirements will be investigated and an appropriate supply implemented. It will be able to perform an isometric experiment protocol over a range of lengths, approximately 25-35mm. It will be able to perform an after loaded isotonic experiment protocol with a range of loads, approximately 0.2-5N. The setup will be controlled via a LabView interface with which the students will interact and data will be written to file for later analysis. In order to run the
experiments the students must enter the physiological range of the muscle measured in vivo. This interface will allow the student to initiate an automated implementation of either the isotonic or isometric experiments and display the data in real time. When finished, the program will provide a summary of the data before allowing the student to write it to file.

The data will then be analyzed for peak isometric tension values and peak velocity values. These values will be input into an optimization protocol which will optimize the parameters of the model developed by Dr. Enderle. The optimization protocol used will be an adapted version of that developed by Dr. Daniel Sierra. A Simulink computer model will then be implemented to simulate the isotonic experiment. The differential equations for the Simulink simulation will need to be derived by the students. The purpose of this simulation is to demonstrate that the muscle model can accurately reproduce the data collected.

The project has specific features which must be considered. The setup must supply a high power, high frequency output. The experimental procedure must be able to be carried out by junior level students. The model parameter determination will require the use of high power computing to run the optimization protocol.

References
