Alternative Design 3

3.1 Overview

Similar to the previous designs, the same setup will be used except for certain methods for conducting the experiments will differ. The differences will be in how the muscle is electrically stimulated, as well as the means of recording and conducting the isotonic experiment. The remaining lab procedure will remain intact and is the same as the previous designs.

3.2 Electrical Activation

The electrical stimulation will be conducted through a Power amplifier. The amplifier will be the DC source in figure 3.2.

![Circuit Diagram](image)

**Figure 3.2:** circuit diagram for power amplifier usage

The National Instruments Data acquisition board is used in design 1 to stimulate. This DAQ board can generate its own electrical current for stimulation however it might not be powerful enough to stimulate the entire muscle adequately. In this case the power amplifier would be utilized. This would also add additional cost into building the prototype as the NI DAQ board is already
present in the undergraduate labs whereas the power amplifier would have to be bought for each unit setup.

3.3 Isometric Experiment

The isometric experiment will be the same setup as in design #1. This is due to the flexiforce force sensor being fairly cheap and easy to implement. This will keep the costs down for this relatively simpler experiment in comparison to the isotonic. The budget then can be utilized for better accuracy in the isotonic experiment as well as adequate electrical stimulation of the muscle via the power amp.

The setup will be the same as described in figure 1.1.

3.4 Isotonic Experiment

The isotonic experiment setup will vary in comparison to the other two designs. Instead of using a rotational sensor, the setup will utilize a servomechananism. More specifically a servo arm. The setup will be similar to that in figure 1.2 however instead of utilizing a mass and a lever to provide constant load, the servo will use its error feedback correcting system to provide a constant load to attempt to hold its lever arm at a constant position. The muscle will respond to stimulation by contracting against the provided force and will pull on the servo lever. If the tension of the muscle on the lever is greater than the force provided by the servo, then the servo lever will be pulled down towards the muscle. The servo can utilize this motion and calculate the change in distance of the lever. This calculated length would be equal to the change in length of the muscle and hence the contraction length can be calculated. The servo must be force controlled and have the capabilities of recording length and position of the servo lever. It must also be able to record force measurements otherwise an input to LabVIEW with additional pre-calibration and programming would be required.
to perform the calculations necessary. The setup is shown in figure 3.2, as seen in figure 1.2 it is very similar except for the servo arm instead of the mass and lever setup.

![Servo Arm Setup](image)

Figure 3.2: Servo arm setup.

### 3.5 National instruments and LabView

This method of the lab setup will remains intact throughout the alternative designs, and has already been detailed in the previous designs. The students will write their own labVIEW or matlab code to determine the relationships between the mechanical and electrical characteristics of skeletal muscle. The force-velocity and length-tension relationships.

### 3.6 Model Optimization

The optimization of the data from the relationships previously found would be the same as the previous designs. The model currently only takes the data from the isotonic data, so it would be
modified to take both the isotonic and isometric data. The model is shown in figure 1.3. As described previously the software utilized for this optimization is Matlab.

3.7 Simulation

As previously described the parameters optimized by the model will be given to the students so they may simulate the isotonic experiment using Simulink to model the muscle relationship between force and velocity.