Alt-Bionics Hobbyist Prosthetics

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Introduction

High-functioning prosthetics are currently incredibly expensive and inaccessible for most people. For instance, myoelectric prosthetics cost $20k-100k per unit and even cosmetic prosthetics cost around $5k. To address this issue, we are collaborating with Alt-Bionics, a Texas-based startup, to create a hobbyist version of their medical-grade prosthetic hand in order to provide communities a financially accessible option that is also easy to use. Our goal is to greatly reduce costs for amputees that can't afford prosthetics, lower the barrier of entry for developers, and provide better functioning prosthetics at a reduced cost. This aligns with EWH's mission of developing solutions for resource-constrained communities, making a global impact on amputees around the world.

Figure 1: Alt-Bionics Prosthetics Hand

We plan to implement this in two stages. We will first build a breadboard prototype to develop the circuits in a flexible way, which we plan to do in our Fall Semester. Once the breadboard prototype is completed and tested, we will design and fabricate PCBs based on the circuits developed in the breadboarding stage. This includes 3 major components: EMG sensors to read muscle signals, motors to actuate fingers on the prosthetic hand based on the signals, and pressure sensors to give feedback to the user when they actuate the hand.

Muscle Sensors

Surface electromyography (sEMG) was utilized to read muscle signals in the forearm. These signals will then be used to control the prosthetic hand. To achieve this, we designed and fabricated sEMG sensors that connected to muscle groups in the forearm using gel electrodes. The sensor then amplifies the action potential from a muscle contraction to a usable value.

The muscle signals will be processed and pattern matched with directories of hand gestures. Signal pattern recognition will be aided by machine learning techniques to identify muscle activation in a diverse range of individuals.

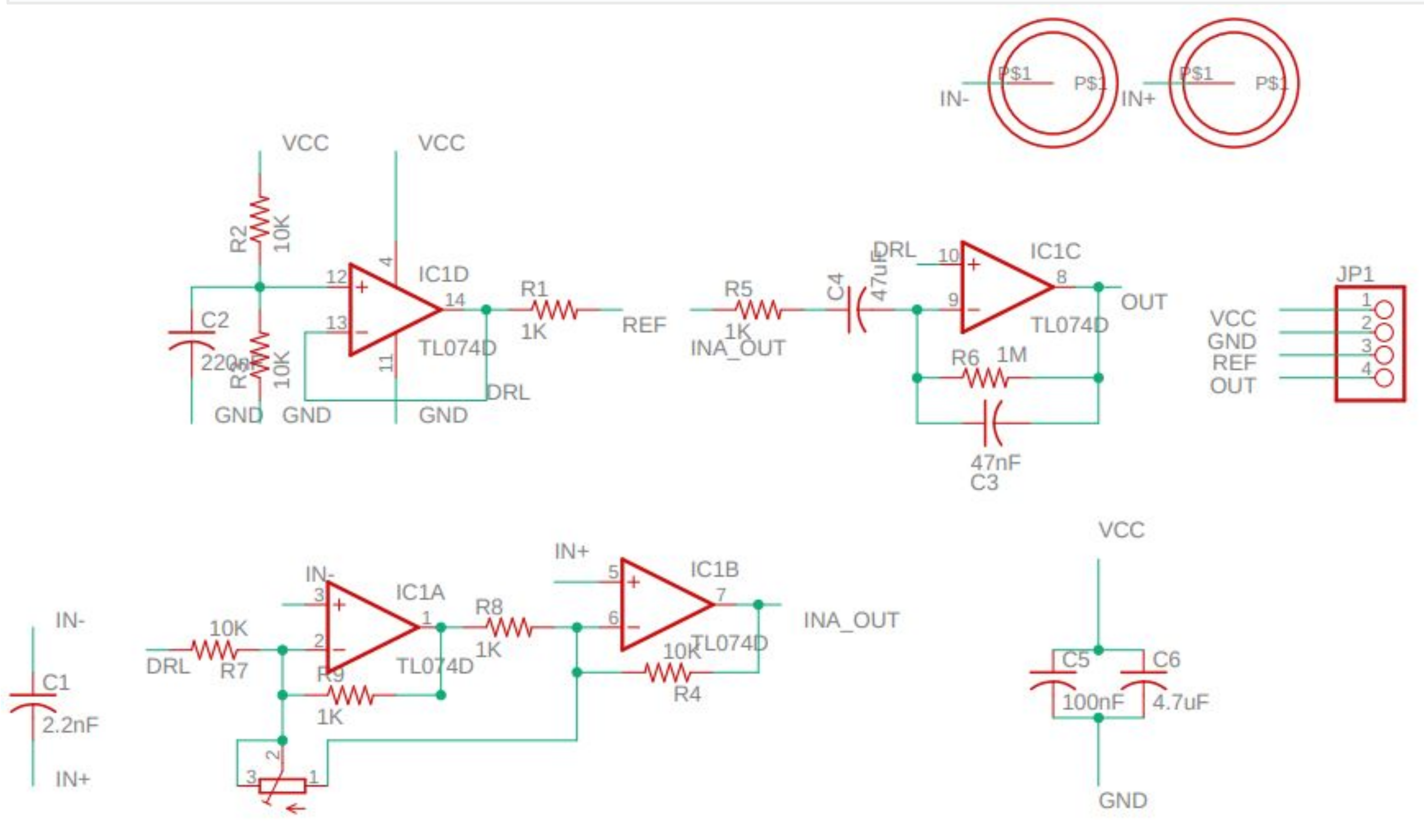

Figure 2: sEMG Sensor Schematics

Figure 3: sEMG Boards

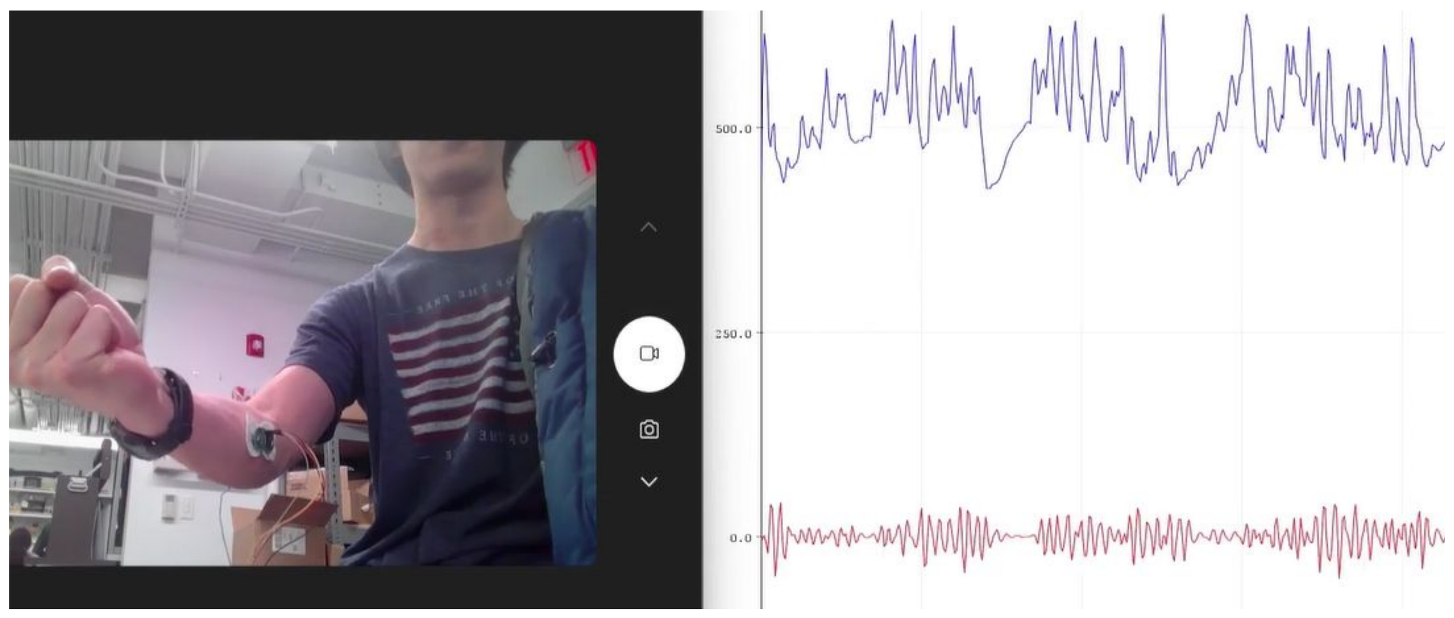

Figure 4: sEMG Sensor being used on a member.
The Blue wave is the raw signal from the sensor. The Red wave is the signal after software filtering and normalizing

Motors

To move the fingers of the prosthetic based on the EMG signals, motors and linear actuators are needed. We will integrate two rotational motors as the thumb, one for the joint in the finger to the palm and the other for the joint further up the thumb. The rest of the four fingers will be associated with four linear servos which will pull up and down as the fingers move.

The motors that we will use are the N20 motors with its respective driver and the PQ12 linear actuators for the servos. In order to wire all 6 components onto one Arduino Uno, we must go through a breadboarding process that includes testing individual components separately and slowly integrating them together into one breadboard. The motor driver has capacity for two motors and with proper breadboarding, we were able to manipulate all our components simultaneously to test.

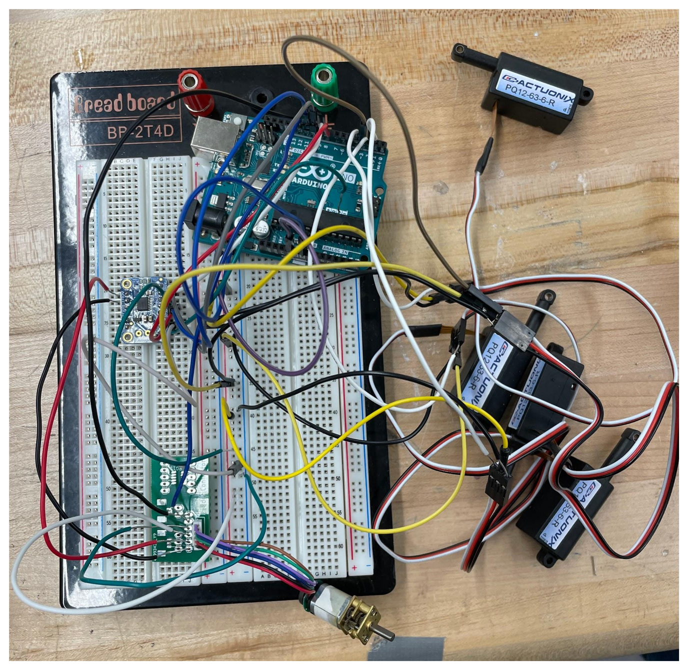

Figure 5: Breadboard of linear actuators and motors

A problem we faced was wiring the N20 motors without the proper header connector. In order to solve this problem, we designed a breakout board for the header.

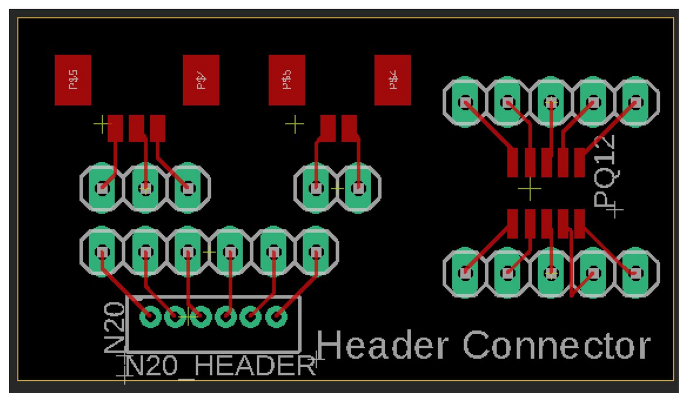

Figure 6: Header connector

Pressure Sensors

Force Sensitive Resistors (FSRs), integrated with an LED ring for feedback, allow the user to tell how much pressure is being applied with the prosthetic hand. To simulate the LED feedback ring, we created a circuit with three LEDs of different colors, each of which corresponds to a certain range of pressure, that act as feedback for an FSR. We further optimized the values of the resistors used in the circuit and the pressure ranges corresponding to each LED. Currently, we have code to select the maximum value from multiple FSRs to light up the LEDs, and will be testing its function.

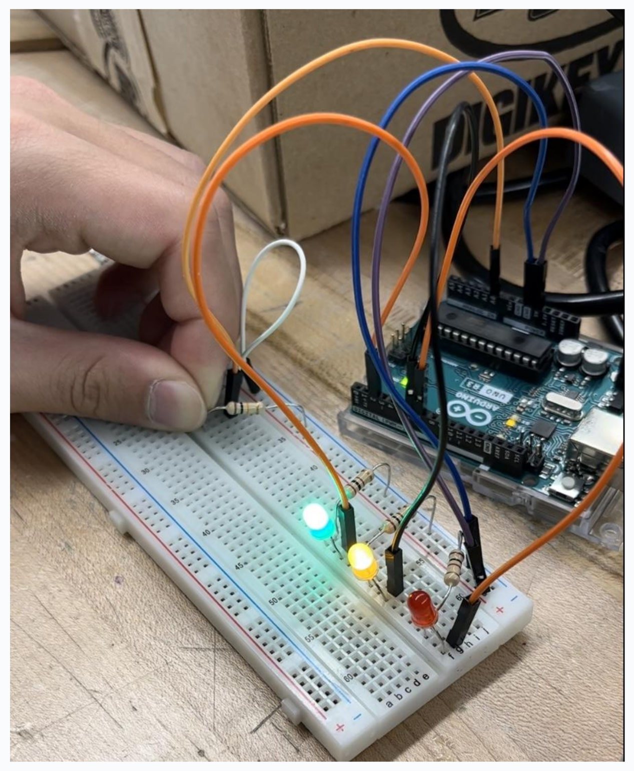

Figure 7: LED feedback for FSR

Conclusion

In accordance with our Statement of Work developed in the beginning of the collaboration, we are making a lot of progress and are on schedule with our deadlines. To finish our project, our subteam must take our respective parts and implement them into the mechanics of the physical hand, using muscle activation information from the EMG sensors to actuate the fingers into hand gestures. Additionally, the force sensitive resistors will give visual feedback via the hex ring to indicate the level of pressure being applied on each fingertip. We also must design the PCB that integrates motors and force sensor resistors that will connect to the EMG sensors. Our goals are to hand off a working product to our partners by the end of May for commercialization. This will fulfill our mission of creating an accessible device for those in need of a manageable prosthetic.

Some limitations that our subteam have come across include getting parts from different websites delivered on time and shipping parts between us and our partner, who is based in Texas. Also, integrating the progress already made by our partners with our own took some time as there were parts and mechanical systems that we were given to use. In order to make the EMG sensor ergonomic and wearable, we needed to make the PCB as small as possible, which added additional challenges during layout and routing.

We were able to and will continue to exercise collaboration with our partners. Through designing the hobbyist prosthetic hand, we hope to exemplify EWH's mission of creating meaningful impact for resource-limited communities by providing a low-cost design in the market of prosthetics.

Acknowledgements

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