Electromyographic Prosthetic Hand (OLSN)

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ROBOTICS TEAM & LEADERSHIP EXPERIENCE

Intro & Problem Definition

Kaeden Olson, a local boy in Bryan, TX was born without a major portion of his right hand due to the prenatal defect, ABS (Amniotic Band Syndrome). Due to this defect, Kaeden has had to live a life of torment from his peers, resulting in mental health and behavioral issues. TURTLE has taken up the task of providing an affordable and custom prosthetic hand for Kaeden.

Approach & Methods

The design methodology that the team adopted was one of flexibility and form. With the intent of being able to reproduce and create custom prosthetics for individuals and start a sublab within TURTLE that specializes in such.

Design Requirements

- Four motorized fingers, one linkage driven thumb.
- Customizable electronics/software with waterproof casing
- Must be cheap and easily replaceable with McMaster components and relatively inexpensive motors and electronics.

Sleeve Design

- Provide casting model of hand [Figure 1], to assist in the design process for the sleeve and the mechanical components of the hand.
- Use model as a finger prototyping stand.

Figure 1. A mold of the underdeveloped hand

Hardware

To produce a functional four finger assembly [Figure 2], this semester was spent designing and refining the finger models. Our design decisions were to:

- Use built in finger joints rather than COTS hinges to meet size and strength requirements.
- Use springs built into the finger joints rather than elastic bands to provide restoring force.
- Use braided fishing line to provide strength with low deformation in the string (keeps cost low as opposed to metallic options).
- Prototype a hand with the mold and common household objects to test the size and durability of the printed fingers.

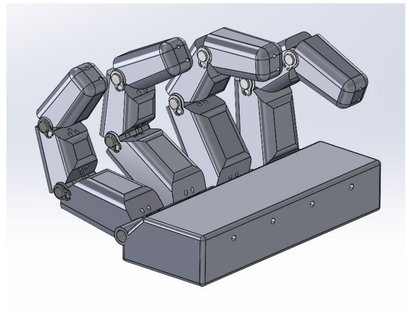

Figure 2. The four finger assembly.

Software

Over the course of the semester, data for training machine learning models was collected from the members of team OLSN. Using a data set of three static hand gestures (resting, clenching, and pinching), a Random Forest Classifier was trained and used for live gesture recognition.

The myo armband currently connects to a laptop via bluetooth LE (low energy) for classification which is then sent to a microcontroller for controls.

Future iterations of software strive to include calibration sequences intended to combat the error associated with daily sensor positioning as well as training modes to adapt to a growing child/different patients.

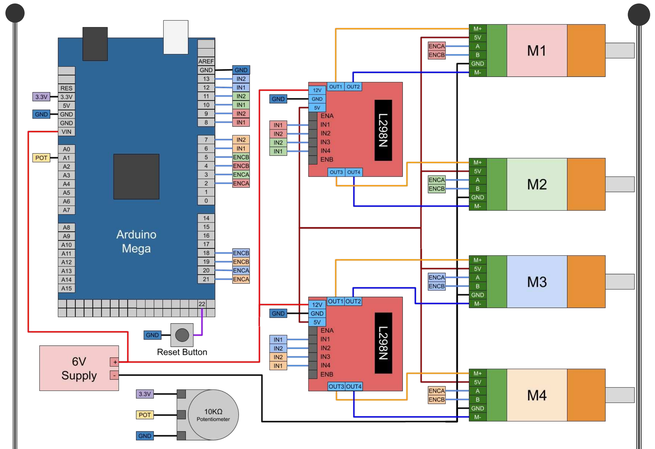

Figure 3. PID Testing System

Electrical & Control

Each finger of the robotic hand is actuated by a 6V motor with an encoder, managed via a PID control system through an H-Bridge for precise positional accuracy. Gestures are inputted via the Myo band and transmitted through UART from a laptop. Additionally the potentiometer allows for dynamic positioning of each finger. The reset button recalibrates the default position. Currently the system is reactive and grip force is strong enough to handle small objects.

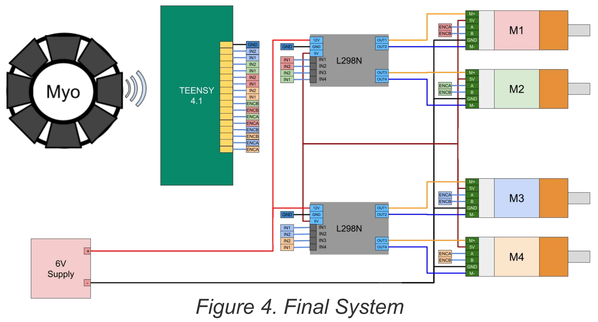

Figure 4. Final System

The final system will connect to the Myo wirelessly to a TEENSY 4.1, which controls the full system. Load sensing can be implemented to verify whether a finger has made contact with an object, and to ensure appropriate grip force is applied. Impedance control will also be explored.

Next Steps

In the coming semester, our team plans to continue improving our project by:

- **Fingers:** Reduce the existing finger model into a skeleton to incorporate an external & replaceable casing (TPU, TPE, SLA Resin Solutions).
- **Palm:** Creating a more human-form finger attachment platform that isn't as flat as Figure 2 and more correctly represents the curvature of the human hand
- **Manufacturing & Materials:** Decide on final manufacturing methods for fingers, electronic mounts, and all connections (carbon fiber composites, aluminum alloys, polycarbonate, nylon).
- **Measurements:** Utilize 3d scanning equipment from the AHSL (Aerospace Human Systems Lab) to gain high fidelity imaging of Kaedens hand to create final prototypes around.
- **Software & Electronics:** Port communication, classification, and control software to a microcontroller and explore other models of interest (LSTM, SVM).

Documentation

In hopes of keeping this project going while Kaeden grows and his prosthetic needs changing, scaling, and upgrading, The documentation of this project will be sent to Kaeden with detailed maintenance instructions and contact information of every team member.