Electromyographic Prosthetic Hand (OLSN)

TEXAS A&M UNIVERSITY Engineering

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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 Amniotic Band Syndrome (ABS). Due to this disability, Kaeden has faced serious hardship among 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. OLSN has become the sublab within TURTLE specializing in this design and production.

Design Requirements

- Four motorized fingers & one cable-driven thumb.
- Customizable electronics and software with a waterproof casing.
- Prioritizing accessible and affordable components with McMaster and electronics.

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 five static hand gestures (resting, clenching, two finger pinching, one finger pinching, and extension), 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.

Hardware

Sleeve

- The sleeve was designed to house the PCBs and the Myo Band. This protects all components from damage and other external factors.

Palm

- Both variations feature the protective carbon outer shell seen in *Figure 1* bound against rolled silicone chosen for its pliability. Chicago screws combine the layers for minimal protrusions while maintaining tight contact.
- **Mechanical Palm - Basic Function**
  - Implemented a ratchet mechanism to optimize control of finger actuation as opposed to the motors in the electrical design.
- **Electrical Palm - Advanced Control**
  - The palm was designed modularly for ease of maintenance.

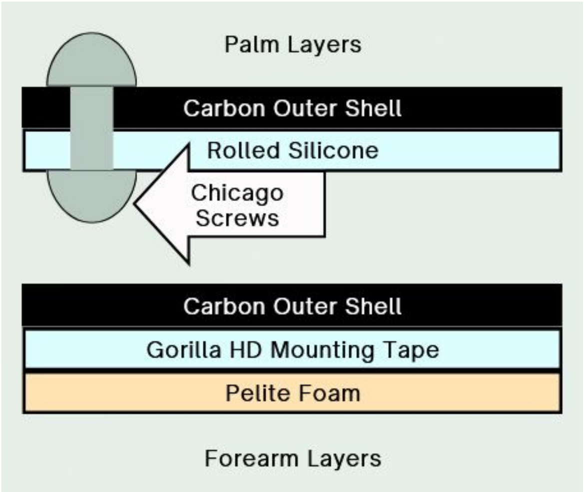

Figure 1. Palm/Sleeve Layering Diagram

Thumb

- The thumb subteam used a weighted decision matrix to balance the primary design concerns of maintenance, simplicity, and cost, resulting in a **cable-driven design** that is simple in structure and implementation.

Fingers

- The finger subteam worked on parameterized modeling, making each finger piece entirely parametrically driven by an excel spreadsheet. This allows for modification easily for Kaeden's growth.
- TPU provides additional grip compliance to all finger and thumb surface contact joints.

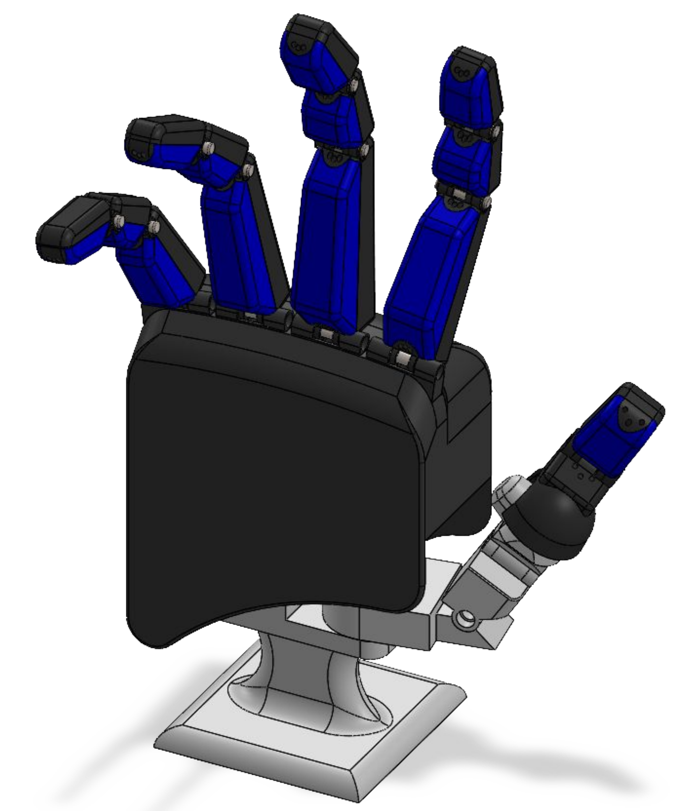

Figure 2. Full Mechanical Assembly

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.

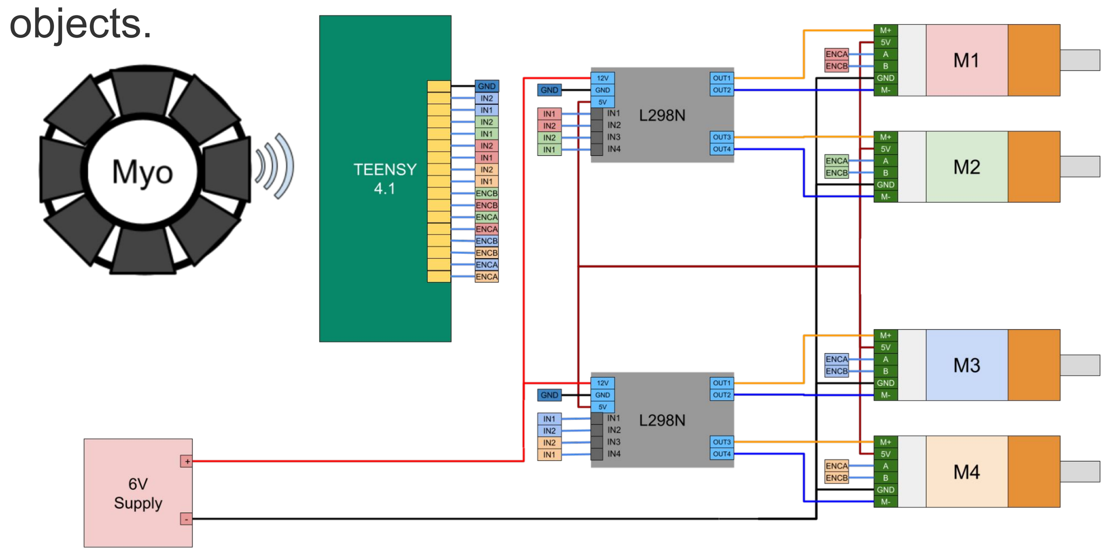

Figure 3. Mobile System

The mobile system connects the Myo wirelessly to a TEENSY 4.1 which controls the full system. By carefully monitoring current output to the motors, we are able to tell when an object has been grasped. This method is not as in depth as haptic methods, but keeps the cost low. L297 IC chips will serve as the final motor control board to reduce the footprint.

Next Steps

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

- **Fingers:** Reiterating finger model with TPU sleeve in place of padding and expanding past 3D printing parts?
- **Sleeve/Palm:** 3D printing the mechanical palm with ratchet mechanism and fabricating the sleeve for both prototypes to implement the BOA system as a tightening securement around the forearm.
- **Thumb:** Developing a lock-up mechanism and parameterizing CAD assembly.
- **Manufacturing & Materials:** Determining the final manufacturing methods for fingers, electronic mounts, and all connections (polycarbonate, carbon fiber composites, aluminum alloys, & nylon).
- **Measurements:** Utilizing 3D scanning equipment from the Aerospace Human Systems Lab (AHSL) to gain high fidelity imaging of Kaedens hand to create final prototypes around.
- **Software & Electronics:** Establishing port communication, classification, and control software to a microcontroller.

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.

Texas A&M University Robotics Team and Leadership Experience (TURTLE) Lab