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Design of a Transradial Myoelectric Prosthesis

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Design of a Transradial Myoelectric Prosthesis

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Problem Statement

Our client, thirteen-year-old Lily Inzey, was born without a left forearm and hand. Lily's options for prosthetic assistive devices are limited by high costs, lack of insurance coverage of pediatric prostheses, and the rapid growth of children's limbs.

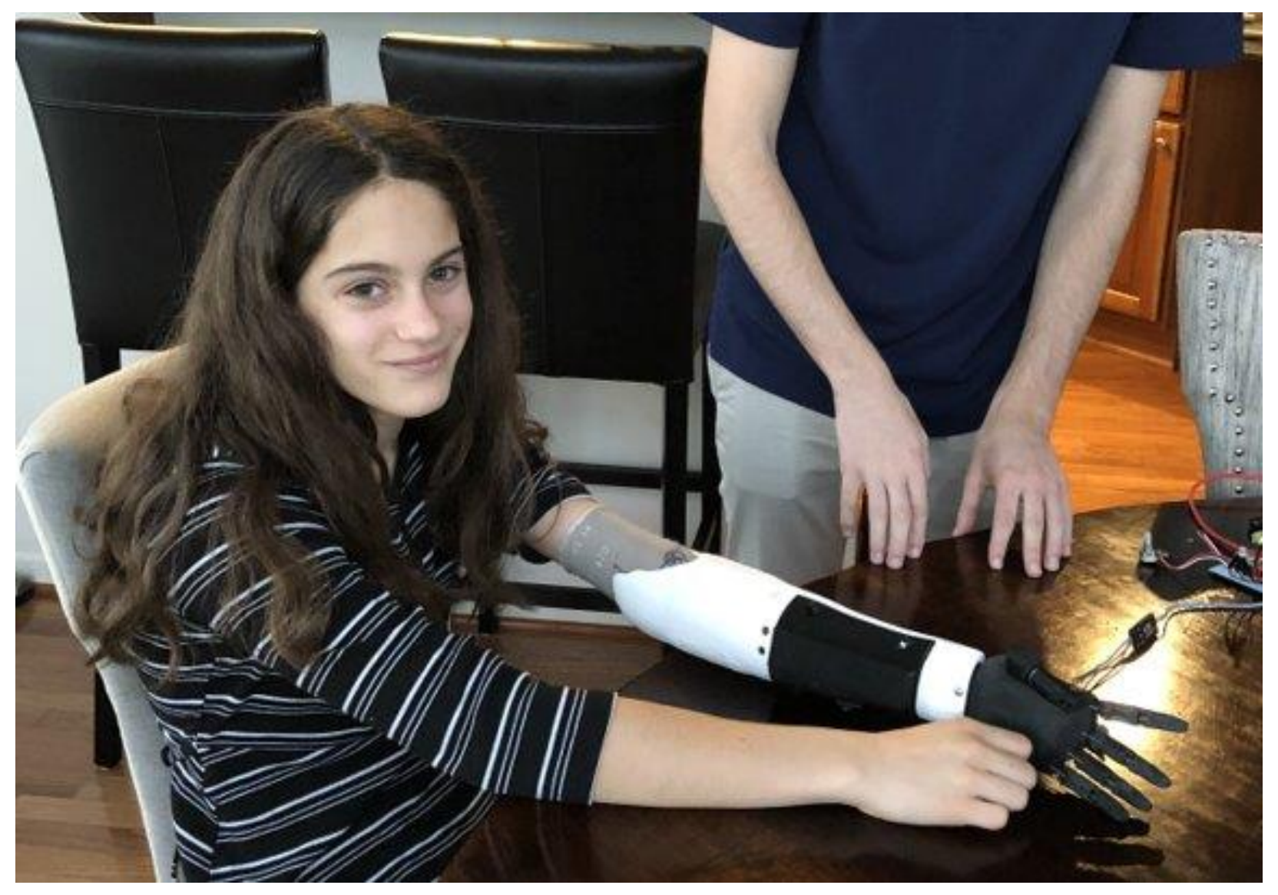


Figure 1: Our client, Lily Inzey, testing a previous prototype

Goals and Specifications

1. To create a custom fitted, easily reproducible, low cost myoelectric transradial prosthesis in which the hand is controlled by muscle contractions in her residual limb
2. To share the love of Christ with our client and her family by gifting her with the hand and praying for her

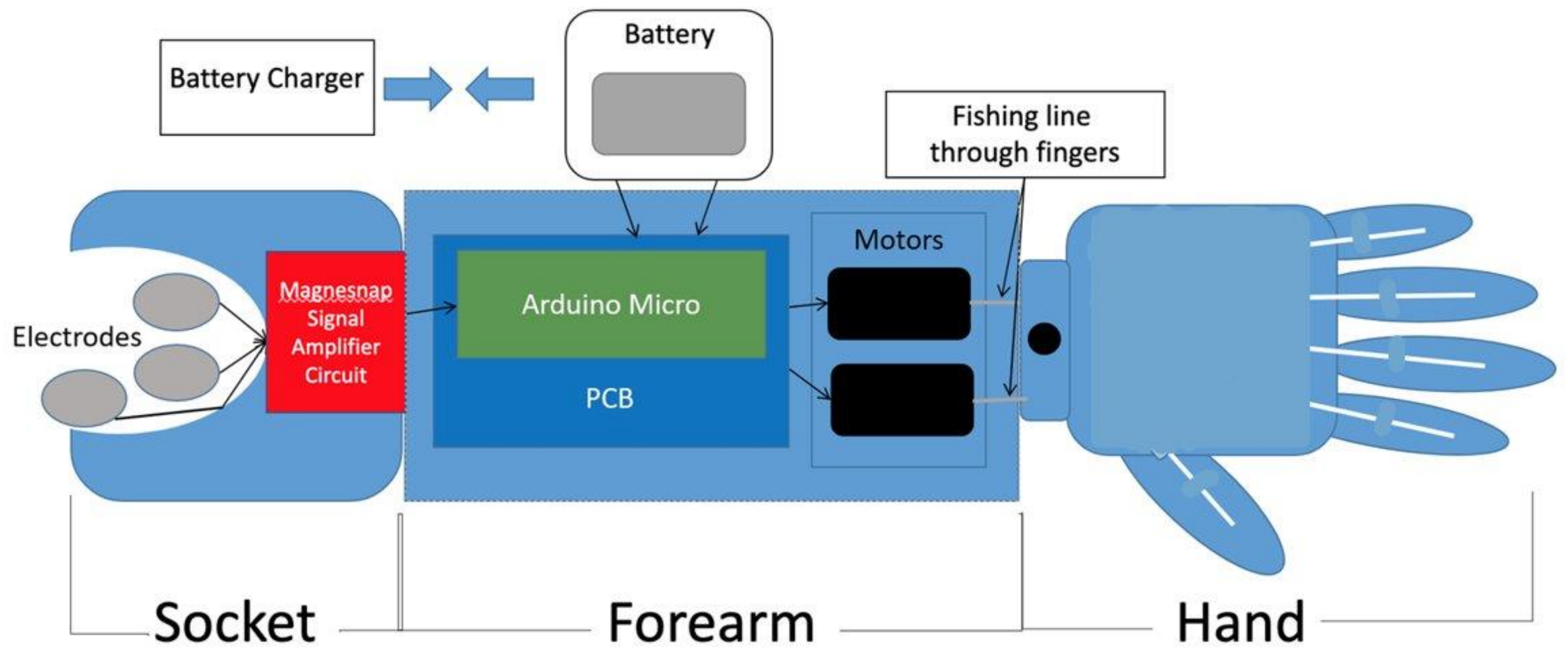


Figure 2: High-level block diagram illustrating prosthesis components

Criteria	Goal
Weight	< 500 g
Grasps	Power/Cylindrical (Fig 3)
Grip force	5 N
Grasp Speed	Close in 1.2 s
Feedback	Safety Switch
Cost	< $1,000
Life of Daily Use	1-2 hours continuous use
Lifetime	1 year

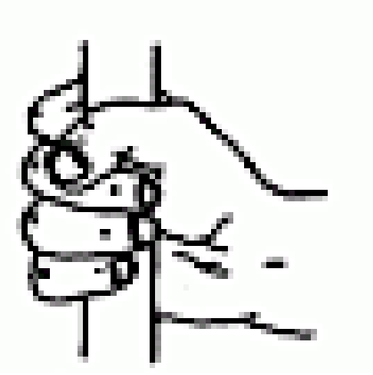


Figure 3: Power/ cylindrical grip pattern

Electrical Design

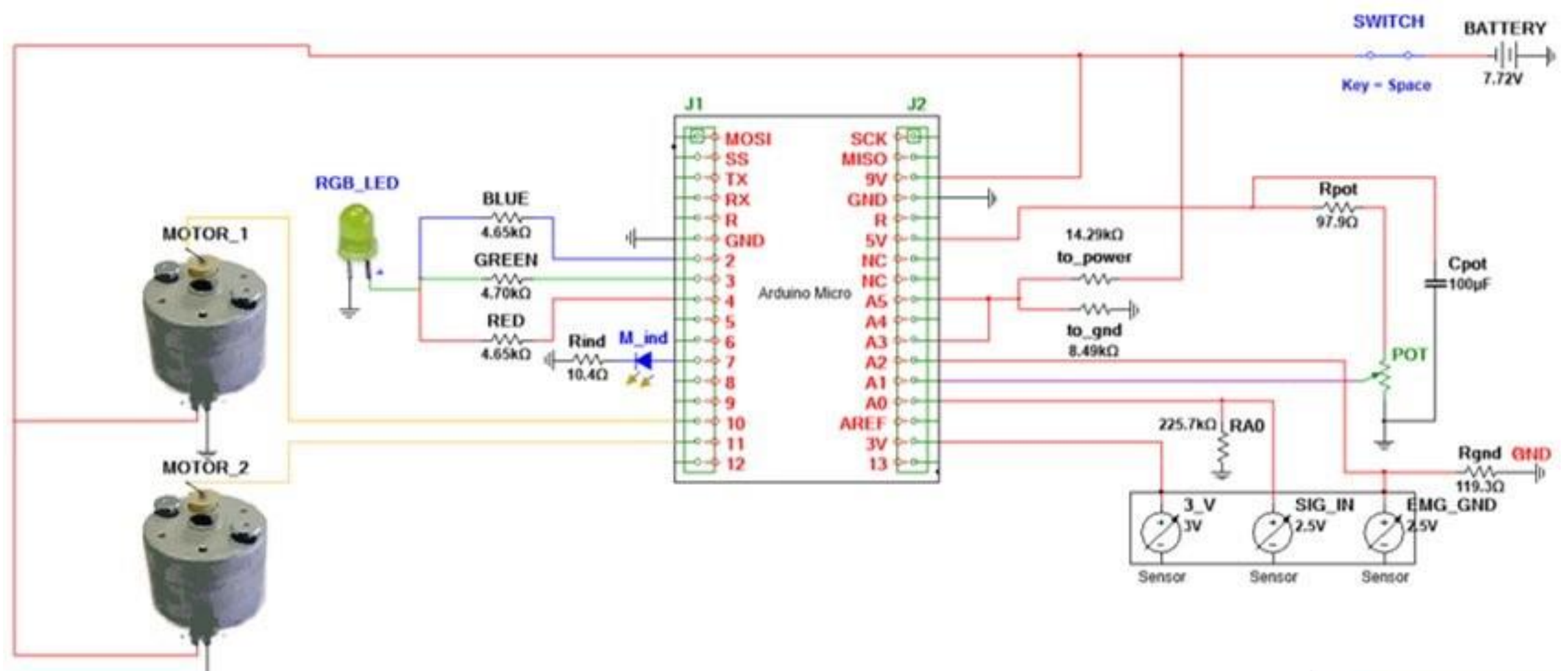


Figure 4: Diagram of the main circuitry for the hand.

MagneSnap Electrode System - Reads and amplifies muscle impulses from arm. Connected to socket liner via magnets.

Printed Circuit Board (PCB) – Customized to connect electrical components including the microprocessor, the Arduino Micro.

Batteries – One 7.4 V Lithium Polymer.

Motors – Two motors power the hand: one for the thumb, and one for the index, middle, ring, and pinky fingers.

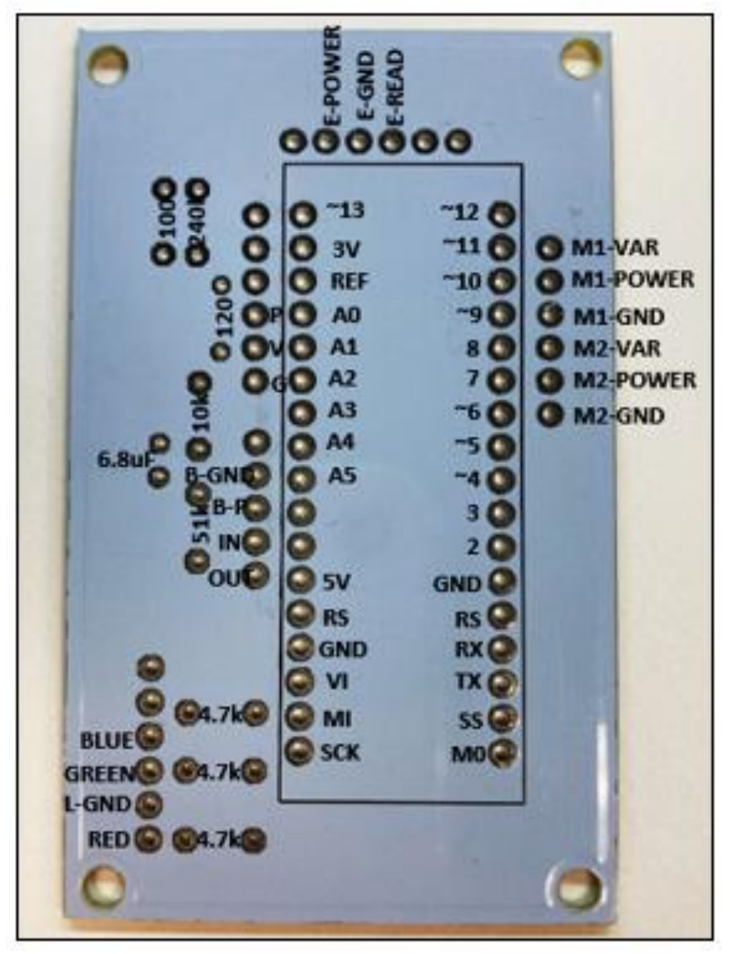
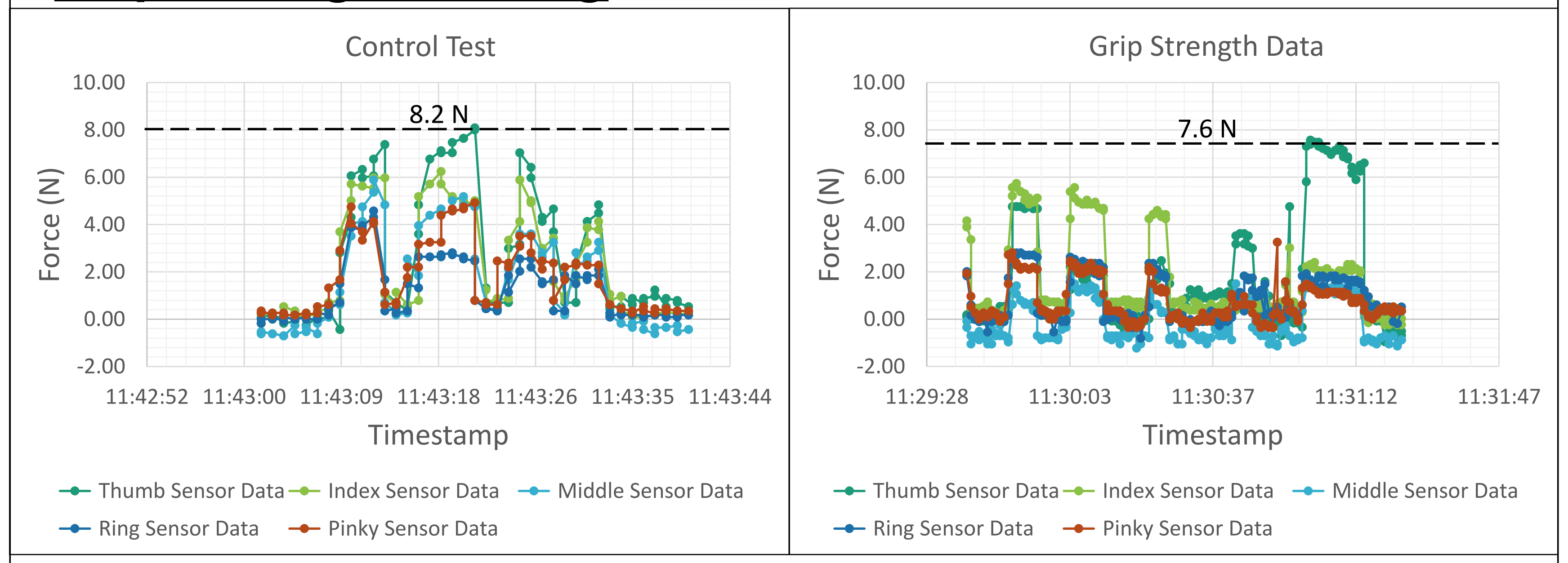


Figure 5: Layout of the PCB

Grip Strength Testing



a) Control test with human hand **b)** Test with Lily's hand

Figure 6: Grip strength testing

The MAP team performed Grip Strength Testing on a water bottle with five 45 N SingleTact force sensors. Each of the sensors were used to measure grip forces for the thumb, index, middle, ring, and pinky fingers. Based on the results, Lily's hand had a maximum grip force of 7.6 N in the thumb which was 93% of the control (20-year-old male thumb force).

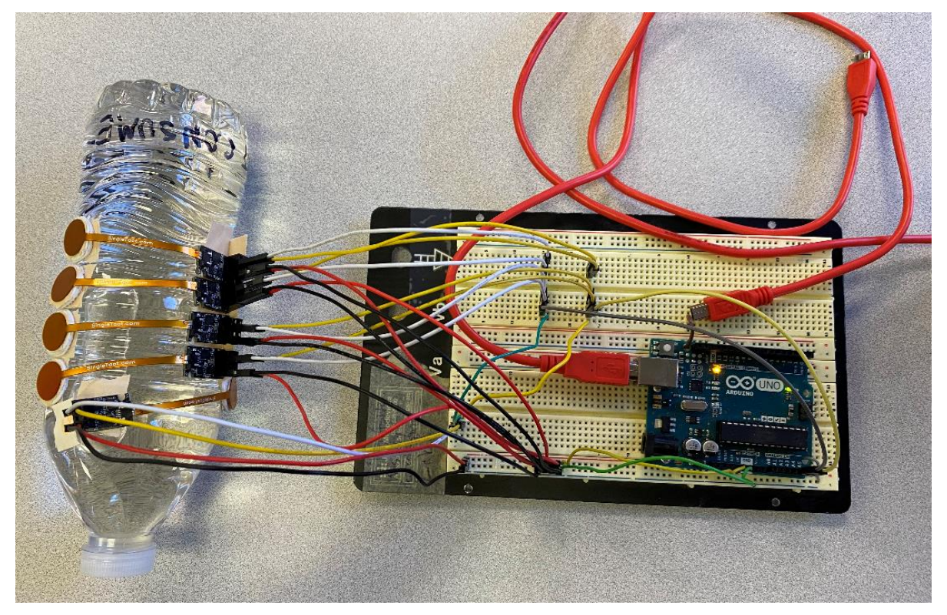


Figure 7: Testing Model

Mechanical Design of Current Prototype

The team chose to upgrade from the Open-Bionics hand model to the Unlimbited arm's hand model from eNABLE. The Unlimbited Hand's pin joint design increases the fatigue resistance of the interphalangeal joints and maintains its natural appearance with the OpenBionics palm superimposed on top.

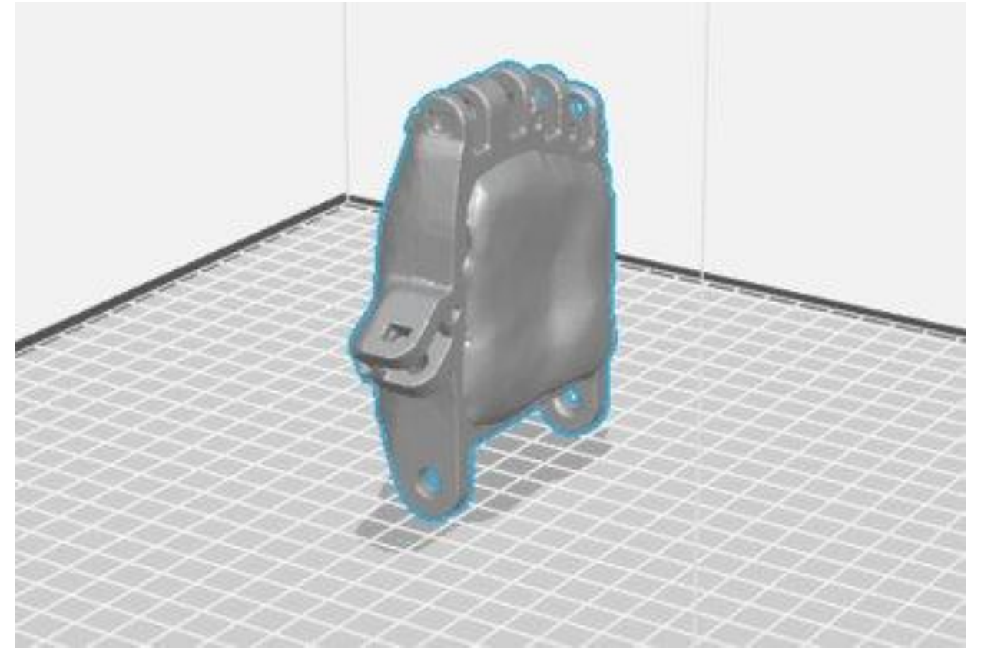


Figure 8: Unlimited hand

The 3D models are printed on an Ender 5 Pro 3D printer. Pins connect the phalanges to the palm and the palm to the wrist. Four fingers are crimped to the ulnar-side linear actuator, and the thumb is crimped to the radial-side linear actuator; the cables are 80 lb braided fishing line. The EMGs are secured in the socket wall with wood putty, and the Velcro loops through the socket to pull the socket liner into a snug fit.

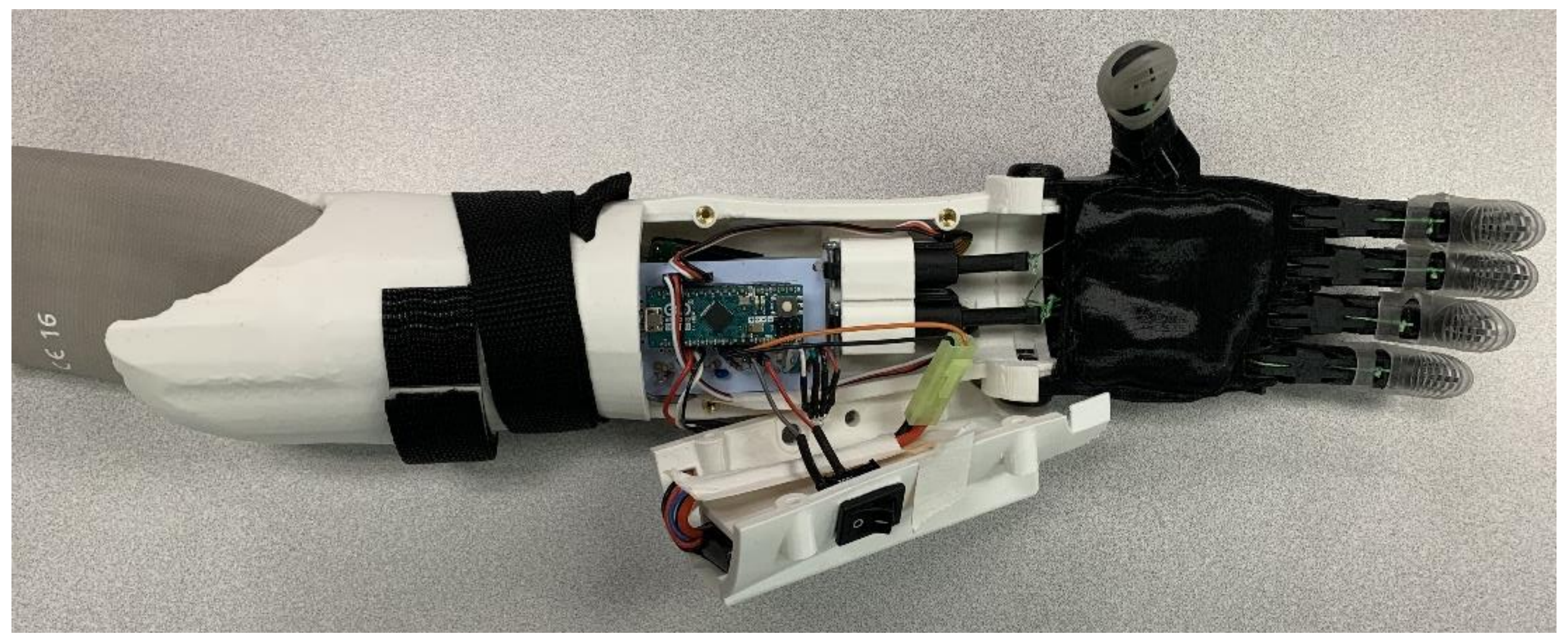


Figure 9: Current prototype fully assembled

Second Prototype and Longterm Outlook

Pending feedback from the client after testing the prototype over Summer 2021, the team will adjust the prototype to meet Lily's needs with regards to size, functionality, durability, and strength.

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After receiving and addressing Lily's feedback, the team will transition to working with CURE International to develop a similar 3D-printed dynamic transradial prosthesis for patients at CURE International's Kijabe, Kenya hospital.

Conclusion

The MAP team has completed and delivered a functional 3D printed myoelectric transradial prosthesis capable of gripping objects resembling a water bottle or deodorant stick from laboratory testing. The prototype has been approved by our partner, Ability Prosthetics, but will be improved with the client's feedback and fatigue testing in the coming school year.

Team Members

- Sam Whittle
- Lindsay Haseltine
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- Jaymie Monday
- Paige Campbell

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the Collaboratory
for strategic partnerships and applied research

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