Pediatric Prosthetic Hand (OLSN)

TEXAS A&M UNIVERSITY Engineering

Project Lead: William McGarity

Members: Zane Akers, Thomas Lopez, Yousuf Shafiu, Caroline Behnke, Jack Bluethmann, Isaac Cabello, Joseph Diarra, Will Donaldson, Gavin Griffin, Dimitris Kalafatis, Arshya Kamrani, Ryo Kato, Haider Mahdi, McKenzie McCain, Yajat Melwani, Preston Nguyen, Dhrumi Shah, Justin Simms, Julia Sopala, Grace Wang, Sabrina Walker, Ximena Woodhead, Renee Zhu

TEXAS A&M UNIVERSITY ROBOTICS TEAM & LEADERSHIP EXPERIENCE

Intro & Problem Definition

Kaedon Olsen, a local boy in Brenham, TX, was born without a major portion of his right hand due to the prenatal defect Amniotic Band Syndrome (ABS). TURTLE has taken up the task of providing a prosthetic hand for Kaedon to help him with his day to day tasks.

Figure 1. Group photo of Kaedon with some of our amazing team after a great day of prototype fitting and testing

Approach & Methods

Our team followed a flexible and iterative design methodology focused on achieving both functionality and form. The goal was to create two custom, affordable prosthetic hands that balance technical innovation with human-centered design. Every design decision was made with Kaedon's comfort, usability, and confidence in mind. Kaedon and his mom have been consulted throughout the whole project, making sure all of his needs were met, including any aesthetic design decision to make the process more enjoyable.

Design Requirements

- One prosthetic hand featuring a mechanical ratchet control system
- One prosthetic hand actuated by electromyography
- Linkage-Driven thumb mechanism for both hands
- Customizable electronics and software housed in a waterproof casing

Mechanical

Socket

- The Socket utilizes a protective carbon outer shell, bound against Pelite foam chosen for pliability and biocompatibility.
- A modified ratchet pulls on a braided steel cord to tension the sleeve to the arm.

Palm

- Previous attempts to model the palm resulted in an overall bulky, unnatural design.
- The new iteration utilizes a biomimetic philosophy.
- 90 degree N20 motors are housed via a modular slot system for space optimization.
- New ways to connect the palm with the socket and the thumb are being prototyped.

Thumb

- With the cable driven design needing modification, the new thumb team has adapted a similar design to that of the Naked Prosthetics Thumb-Driver, which is body driven and linkage-based.
- This new linkage will be adjusted and scaled to fit Kaedon's measurements post-showcase.

Fingers

- New testbeds have been constructed to address shortcomings of the previous finger design.
- One design attempts to reduce joint friction via rolling contact joints (RCJs).
- Another utilizes Snap-fit bearing joints and implements a new string pathing.
- To modify the current design, fused DIP (2-DOF Segmentation) is being prototyped.

Silicone

- Silicone pads were added to the palm and fingers to increase tactility and grip strength.
- Gyroid patterned surfaces were found to be the best way to support the silicone onto the fingers and palm.

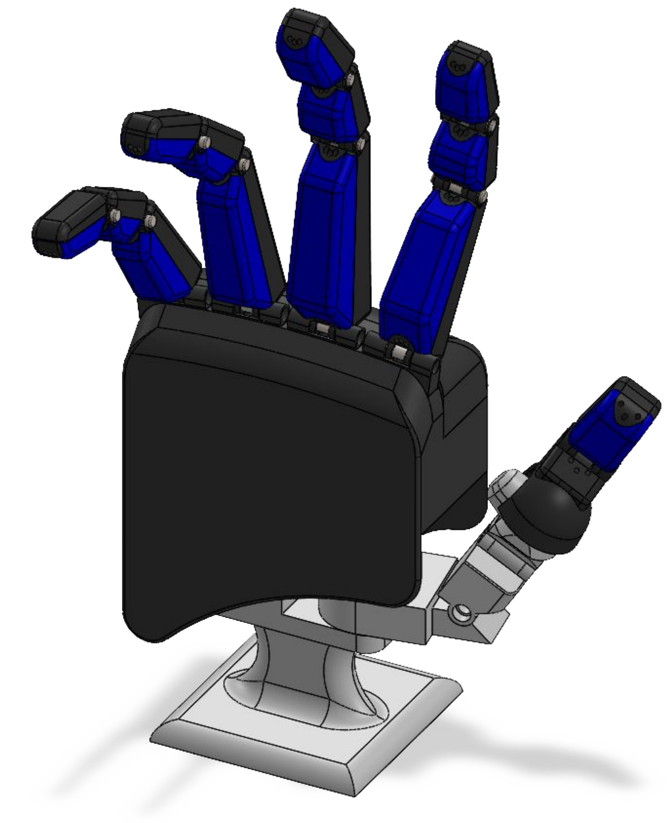

Figure 2. OLD Palm with OLD Fingers Design

Electrical & Control

Each finger of the robotic hand is actuated by a 12V motor with an encoder, managed via a PID control system through 2 H-Bridges for precise positional accuracy. Gestures are inputted via the Bitalino EMG sensors to the ESP32 microcontroller. Additionally the encoder allows for variation in positioning of each finger.

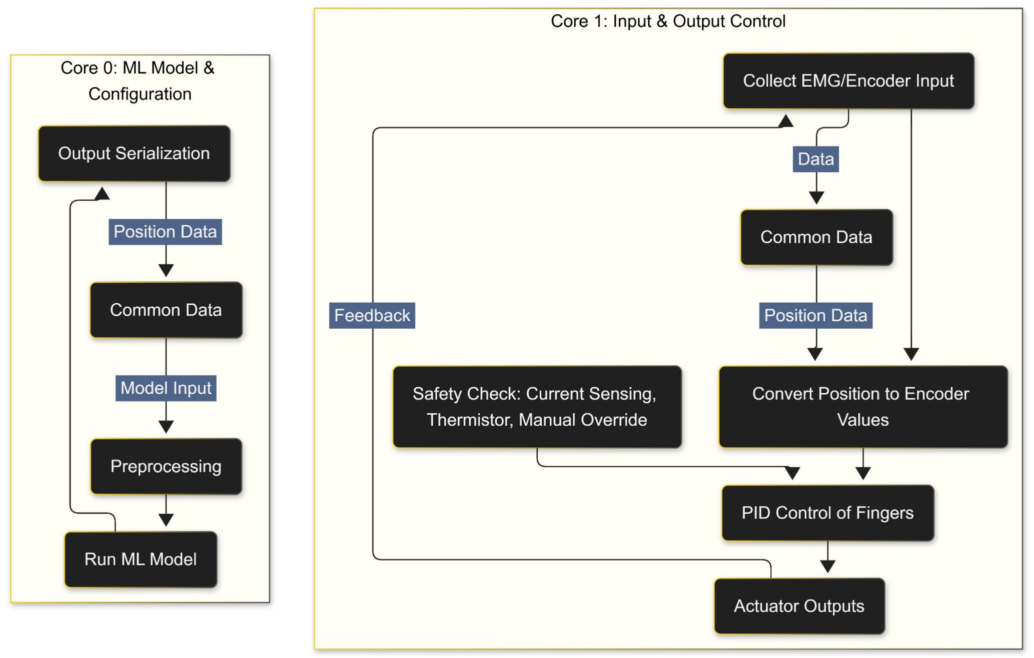

Figure 3. Data Pipeline utilizing dual cores of ESP32

EMG Placements

The arm uses four EMG Channels for control, with the eletrodes being placed on the extensors and flexors of the ulnaris and radialis muscles (see *Figure 5*). This EMG data is to be used to classify and actuate the bionic arm to different preset grip patterns.

Photos

Figure 4. Kaedon test fitting the silicone developed by 14th Element

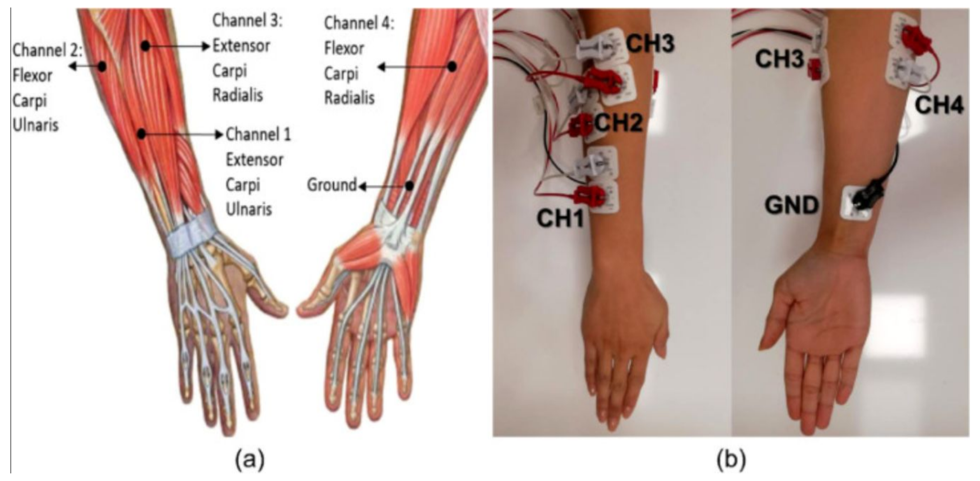

Figure 5. EMG Electrode placement
Link: https://pubmed.ncbi.nlm.nih.gov/35198693/

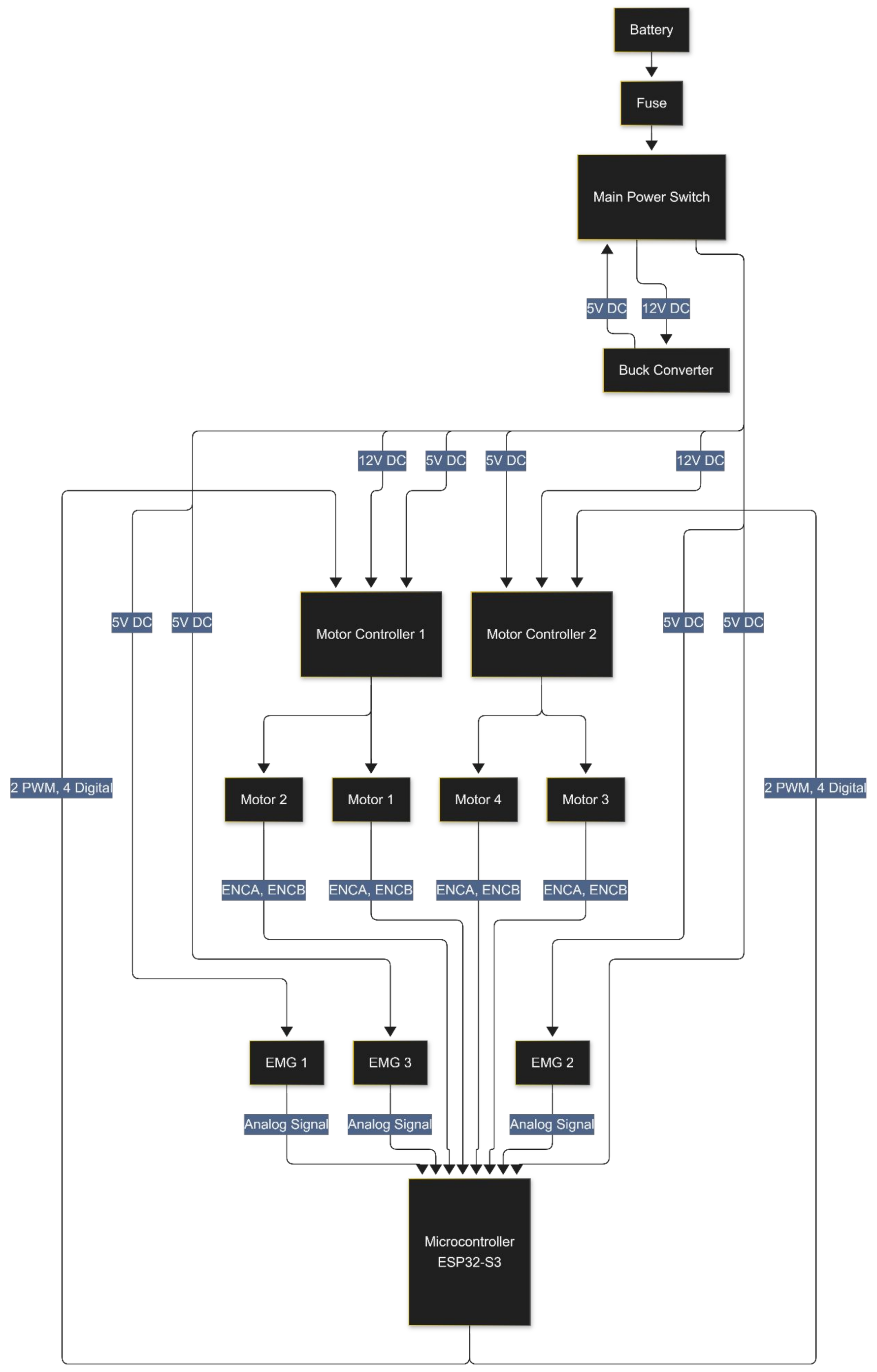

Figure 6. Electrical block diagram