Electronic Controlled Exoskeletal Hand (ECEH)

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ECEH Objective

The ECEH team's goal was **to create a wirelessly controllable robotic hand whose movements mimicked a wearable exoskeletal controller worn on the hand of the user while simultaneously providing the user with real-time haptic feedback.** We designed this system to allow for multiple applications both in an industrial/practical and a commercial setting. These applications can include:

- Handling of harmful chemicals and materials
- End of Arm Tool for a bomb diffusal robot
- Weightlifting for exercises requiring match-grip

Market Research

Looking into the markets of **end of arm tools** (EOAT) and prosthetic hand markets, the two markets most similar to ECEH, the team was able to **determine many places for improvements** in these products on the market. There exists no robotic hands within the current market that possess the following characteristics:

- ❖ **Cost Effectiveness While Maintaining Quality Assurance**
- ❖ **Real-Time Remote Control Mimicking Capability**

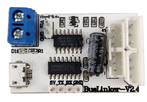
Electrical Components

Through extensive research and testing with different electrical components, the **electrical components we selected** were:

- 5x 10K Resistance Potentiometers (per system)
- 5x LX-224 Digital Bus Servo Motors (per system)
- 1x Arduino Mega 2560 (per system)
- 1x LX-224 Servo Motor Driver Board (per system)

Arduino

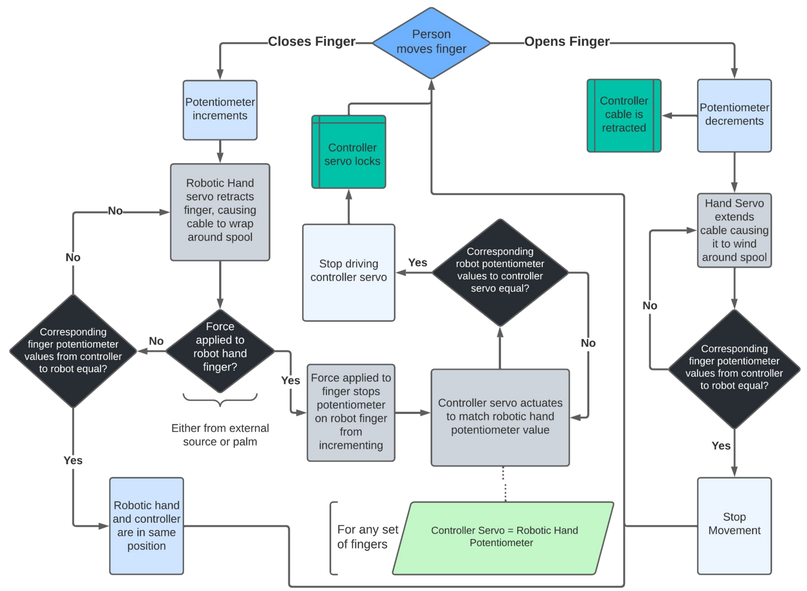
Potentiometer



Driver Board

LX-224 Servo

Control/Feedback Loop Diagram

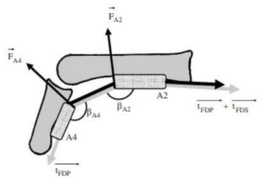


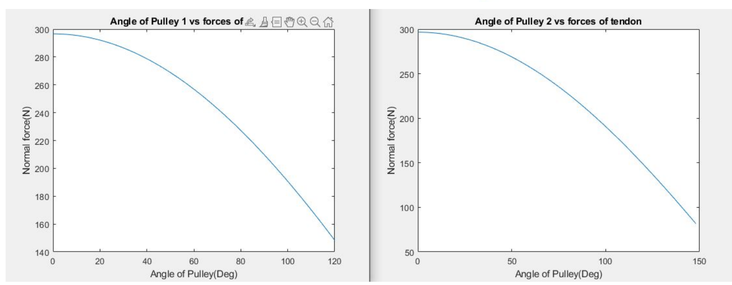
Force Capabilities

ECEH used **LX-224 TowerPro Servo Motors** to achieve the desired amount of torque for each finger. We **calculated** the necessary torque for each finger on the human hand to ensure we were meeting our goal of achieving **human-like capabilities.** Using the equations for F_{A4} and F_{A2} with arrays in matlab, we came across these graphs:

$$F_{A2} = 2(t_{FDP} + t_{FDS})\cos\left(\frac{\beta_{A2}}{2}\right),$$

$$F_{A4} = 2(t_{FDP})\cos\left(\frac{\beta_{A4}}{2}\right),$$



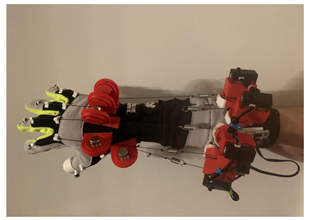


Silicone Molding

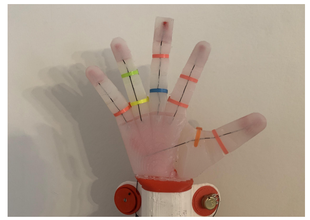
To ensure the robotic hand's fingers returned to their original position, **we molded the robotic hand** in silicone using a 3D silicone mold.

Cable System

We **created a system of cables and pulleys** using 100 lbs Kevlar braided line. We also used constant force springs taken from badge reels. This system was installed in both the controller and the robotic hand.



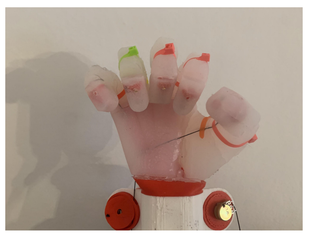
Controller with cable system



Silicone molded hand

Results

Throughout the development of our proof of concept, we were able to successfully **actuate the fingers** on the robotic hand with the controller. Additionally, we were able to create a preliminary haptic feedback system.



Robotic hand fully actuated

Future Outlook

We believe we have fulfilled our initial goal of designing a system that can mimic the motion of a human hand and provide a user with haptic feedback all while being wirelessly controlled. Potential future improvements should include:

- Creating a more compact system
- Implementing reliable wireless communication
- Adding a wrist feature