Transradial Prosthetic

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ABSTRACT

Prosthetic hands have the potential to increase the number of daily tasks possible for people with amputations. However, many amputees are still unable to receive access to prosthetics. The number of people experiencing limb loss in the United States is approaching 2 million; However, a high proportion of prosthetic products are rejected. Current prosthetics have many limitations that contribute to these high rejection rates. These include a lack of detailed control and degrees of freedom, inability to control without visual monitoring, user discomfort due to sweat build up, and weight due to heavy batteries. Other limitations include high cost, breaking fingers, and limited speed and power of movement. The goal of this project is to improve as many of the aforementioned areas as possible.

Due to Intellectual Property restrictions, limited pictures and details of the design are shown.

OBJECTIVES

The objective of this project is to improve the **accessibility, functionality, and comfortability** of current trans-radial (between wrist and elbow) prosthetic technology.

Results

Human Machine Interface (HMI) - The connection to the residual limb

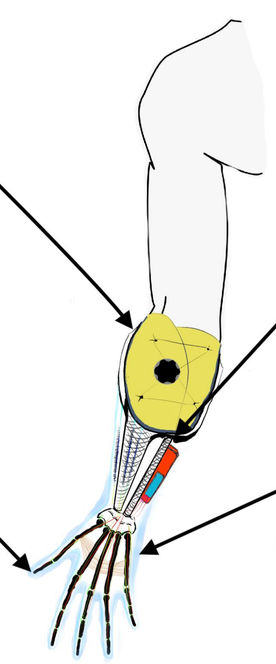
Goal – Comfortable secure fit that allows sweat dissipation

Results – Sweat wicking dry times where improved and dried 60 times faster.

Sensing & Haptics – Provides the user with tactile feedback from the prosthetic

Goal – Decrease need for visual monitoring of hand by sensing pressure

Results - Power usage: < 1 Watt
Min Force: < 0.1 Newton
Feedback intensity varies with force magnitude.



Joints & Structure

Goal – Strong joints that minimize wear and allow natural movement

Results - Achieved all 26 degrees of freedom in the human hand.
An expected strength increase 20 times the human bone.

Actuation – Finger and wrist movement

Goal – Improve strength and speed of prosthetic

Results – Pneumatic muscles can lift 13.3lbs each. Unloaded contraction time < 0.5 second.

Conclusion

The prosthetic created improved a variety of the customer needs including degrees of freedom, overall weight, and cost of prosthetics. These outcomes mirror the original mission of producing a transradial prosthetic that exceeds current prosthetic technology in the areas of affordability, comfortability, and accessibility.

References

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Research

The team investigated customer needs and current technologies through:

- Online research of current Prosthetics
- Social media listening and messaging
- Interviews
- Patent research
- Qualtrics survey

Important areas to improve were identified

- Overall weight and distribution
- Cost of Materials and manufacturing



Figure 1. Prosthetic specialist connecting team member to current myoelectric prosthetic control

Design

Four Subsystems

- HMI
- Structure
- Sensing/Haptics
- Actuation

Brainstorming

- Hundreds of ideas generated
- 1 to 2 concepts picked for prototyping for each subsystem

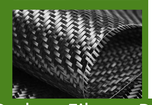
Materials

PLA



Teflon tubing





Carbon Fiber



Pneumatic tank

Prototyping

Iterative prototyping and testing conducted

Ruled out:

- Nitinol or servo motor muscles
- Mechanical pressure transmitting sensing system

Refined:

- Joint geometry
- Sweat management system
- Adjustable HMI surfaces





Figures 2 and 3: Prototypes created

Tests

Tests conducted include

Sweat drying time, actuation speed, and sensing power usage. Results of muscle strength are below.

Durability of muscles and tendons was tested on an Instron.

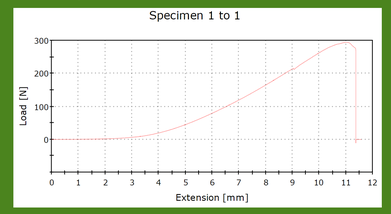


Figure 4: Load vs extension of muscle and tendon until breakage

Displacement of a single muscle compared to pressure applied.

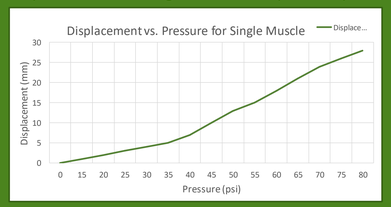


Figure 5: Displacement of weight vs. pressure in a single pneumatic muscle