3D Printed Assistive Devices

Laney Windlan, Micheal Nolle Mentor: Dr. Arce

FAMU-FSU College of Engineering, Florida State University

Background and Introduction

- 3D printed prosthetics aim to make prosthetic devices more affordable and easier to produce.
- The field is under-researched and current options are not as effective as other prosthetic device options.
- The objective of our research was to make a better model of the 3D printed hand that more closely resembled the mechanics of the actual hand.
- A better 3D printed prosthetic hand will allow more people to access the devices that they need.
- The current options for 3D printed hands have low grip force and poor functionality.
- We studied current models of 3D printed hands to determine what force is lost and aimed to minimize such forces

Methods

A majority of the project was ultimately devoted toward the research and development of a modular, 3D-printed prosthetic hand.

- Create design options that may make a better 3D printed hand.
- Choose a functional design to print and assemble.
- Create a testing rig consisting of a dynamometer laid horizontally and secured to the table via vices.
- Use the hand to generate a force on the dynamometer.
- Weights will then be applied to the mechanism and the grip strength will be tested again.
- These grip forces will then be compared to previous models of 3D printed prosthetic hands, and then to the grip strength of the actual human hand.

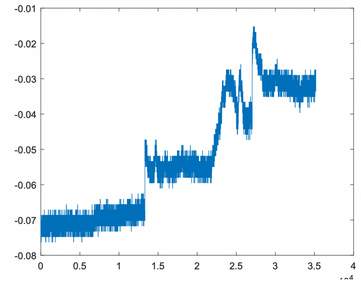
Hypothesis

The addition of a third joint to each finger, as opposed to the current two joint model, will allow our model of the 3D printed prosthetic hand to generate greater grip strength and will also create a greater range on motion.

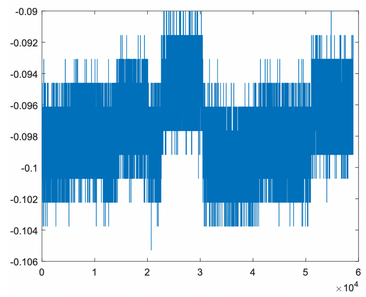
Results

Through the use of a 3D printed mold that fits to the shape of the hand, and fingers that are fit using ring size. We were able to achieve a model of the 3D printed hand that generates greater grip force, has a more effective range of motion, and is overall more functional than other 3D printed options.

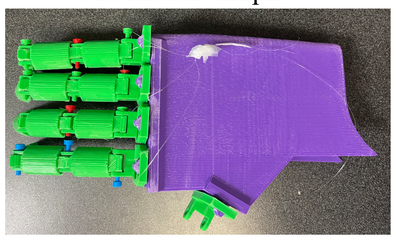
- We found that a significant amount of force is lost in the current model of the prosthetic hand.
- Using our design, the lost forces are minimized and overall grip strength was increased .
- Our graphs show the forces generated (in pounds) by each model of the hand when different weights are applied (100g, 200g, 500g, and 1kg.)
- While we still have not achieved the grip strength of the human hand, our model comes much closer to these values.

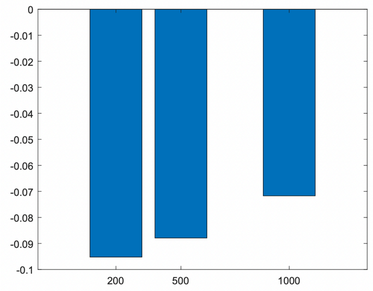


Our Model Graph

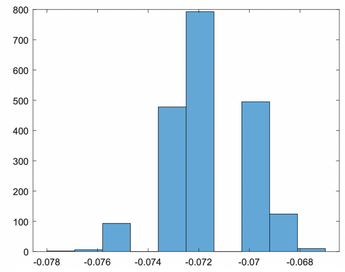


Old Model Graph





Calibration Graph



Human Graph

Discussion

Creating a better option for a 3D printed prosthetic hand makes such devices more accessible and affordable to produce. Therefore allowing more people to get the devices that they need.

- It is key to understand that forces are lost in prosthetic devices which can lead to understanding on how to minimize such forces.
- There may have been error due to the threshold of the dynamometer.
- It is also important to consider the differences in grip strengths between children and adults as well as men and women when analyzing our results and determining an ideal grip strength for our device

Conclusion

- The use of a mold that fits to the patients hand and fingers that are sized based on the patients ring size created a more comfortable and effective design.
- This design maximized the range of motion, grip strength, and more closely resembles the forces generated by the human hand.
- Our model is more effective than other 3D prosthetic hand options available.
- In the future, we hope to further improve this design even more and create a model capable of achieving the same grip strength as a human.

References

Copeland, Christopher, et al. “Functional Performance and Patient Satisfaction Comparison between a 3D Printed and a Standard Transradial Prosthesis: A Case Report.” *BioMedical Engineering OnLine*, vol. 21, no. 1, Jan. 2022, p. 7, https://doi.org/10.1186/s12938-022- 00977-w. PubMed. Accessed 14 Nov. 2023.

Cuellar, Juan Sebastian, et al. “Functional Evaluation of a Non-Assembly 3D-Printed Hand Prosthesis.” *Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine*, vol. 233, no. 11, Sept. 2019, pp. 1122–31, https://doi.org/10.1177/0954411919874523. PubMed. Accessed 14 Nov. 2023.

Dunai, Larisa, et al. “Human Hand Anatomy-Based Prosthetic Hand.” *Sensors*, vol. 21, no. 1, Dec. 2020, p. 137, https://doi.org/10.3390/s21010137. PubMed. Accessed 14 Nov. 2023.

Lu, Haiqing, et al. “Biomimetic Prosthetic Hand Enabled by Liquid Crystal Elastomer Tendons.” *Micromachines*, vol. 12, no. 7, June 2021, p. 736, https://doi.org/10.3390/mi12070736. Accessed 14 Nov. 2023.

Xu, Wen, et al. “Upper Extremity Prosthetics: Current Options and Future Innovations.” *Journal of Hand Surgery*, vol. 48, no. 10, July 2023, pp. 1034–44,