Low Interference Wheelchair Footrest

Team: Bobby Fang, Charles Maysack-Landry, Jayson O'Halloran, Sam Tan

Client: Dan Dorszynski

Instructor: John Puccinelli TA: Sarah Edwards

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Abstract

- This project focuses on developing an electrically powered and controlled footrest tailored to wheelchair users with partial lower body mobility. Constructed from lightweight aluminum plates supported by 3D printed brackets and holders, the footrest aims to minimize interference while providing optimal support. Positioned beneath the seat to ensure user comfort, linear actuators power its movement, enhancing maneuverability and accessibility for users.

Motivation

- Our motivation stems from the recognition that certain wheelchair users face challenges with current footrest designs.
- By developing a comfortable, autonomous footrest, we aim to provide a different approach from traditional mechanical footrests.
- Our goal is to empower users with greater independence and inclusion, ultimately improving their quality of life.

Problem Statement

- Current wheelchair footrest models suffer from drawbacks like bulkiness, weight, and lack of leg mobility.
- Our design improves and expands on user experience.
- The proposed footrest is designed to facilitate outdoor use, further enhancing its versatility and utility for wheelchair users.

Background Research

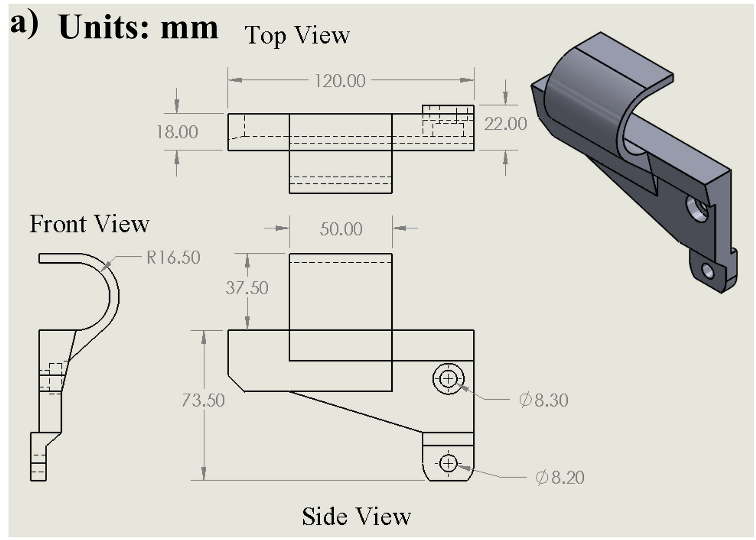
- Becker's muscular dystrophy is a genetic disorder characterized by progressive muscle degeneration, primarily affecting males, with symptoms typically appearing in adolescence or early adulthood.
- In the United States of America there are an estimated 3.3 million wheelchair users, with 2 million new wheelchair users expected every year [2].

Design Specifications

- Does not interfere with user's ability to place feet on the ground
- Support the weight of the patient's lower legs (200N total)
- Footrest is 25.4 cm in length
- Use a durable material for indoor and outdoor use [3]
- Minimize weight to 3-10 kg
- Production cost should not exceed $250
- Footrest does not recline with the seat

Final Design

- Final Design consists of a welded aluminum footrest attached to two linear actuators.
- The actuators are attached to the wheelchair using custom 3D printed PLA holders, two for the front and two for the back.
- The footrests motion is powered by the wheelchairs control system.
- A voltage divider circuit is used to divide the voltage between the actuators.



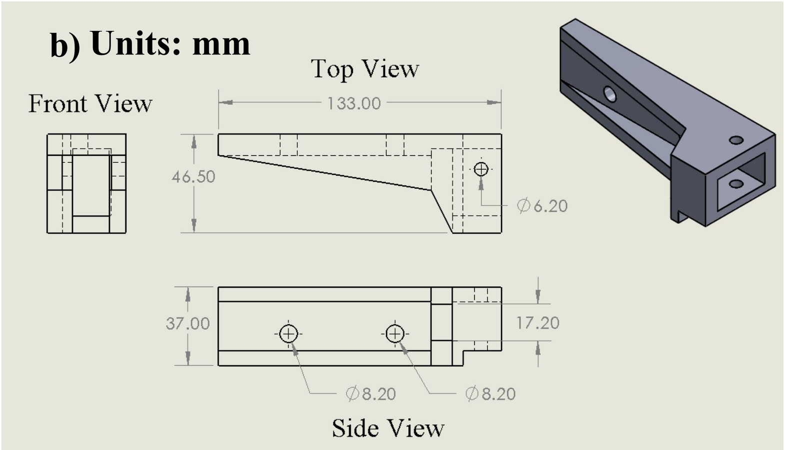


Figure 1. Drawings: a) front holder, b) back holder

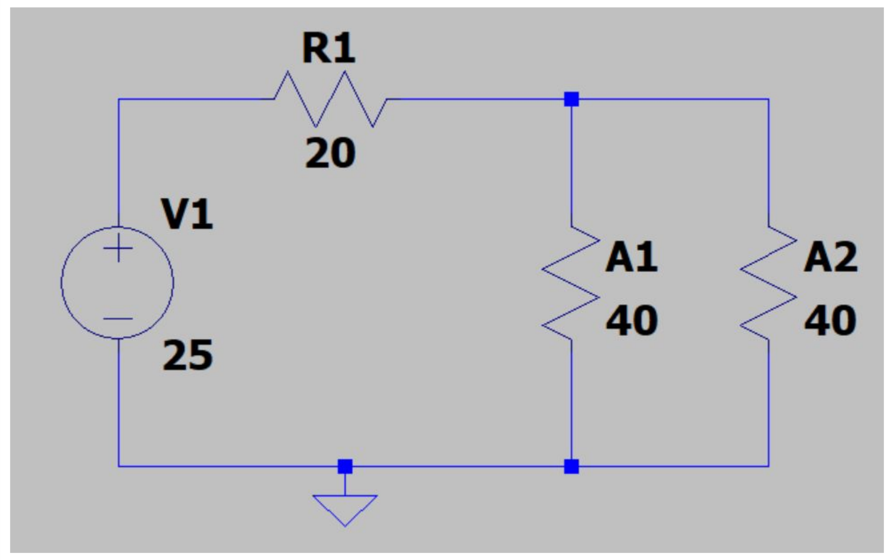


Figure 3. Simplified voltage divider schematic

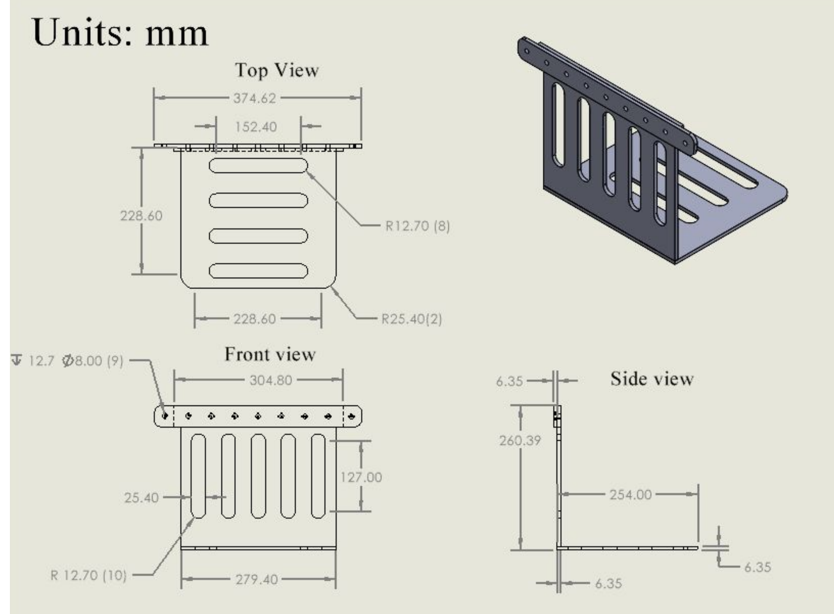


Figure 2. Drawing of footrest

Figure 4. Linear actuator support/attachment to wheelchair

Material Costs

Linear Actuators	2x $35.68
Raw Materials (Aluminum, Screws, Brackets)	$121.9
MakerSpace (3D printings and Hardware)	$29.35
Total	**$222.61**

Testing

- Deflection measured using increasing weights with a maximum of 223N applied to the footrests extended at 250mm.
- Footrest has internal bending, causing most of the deflection observed and rotation at the joints between actuator and footrest.
- Time measurement vs distance with various weights and voltages.
- The average velocity can be seen with distance over time.
- Results used to determine the power of the actuators along with the change in speed between the testing conditions.

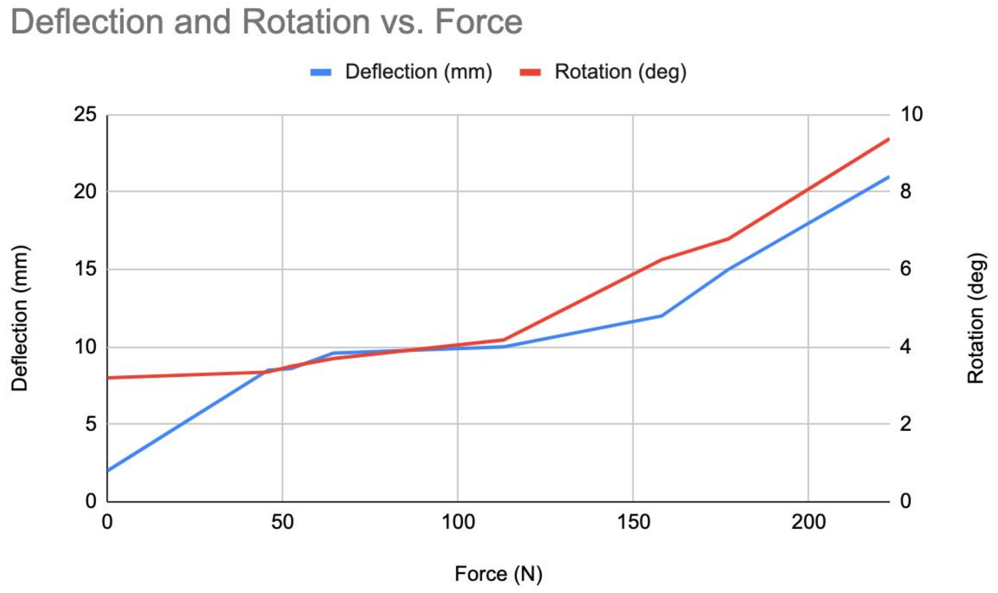


Figure 5. Deflection/Rotation vs. Force

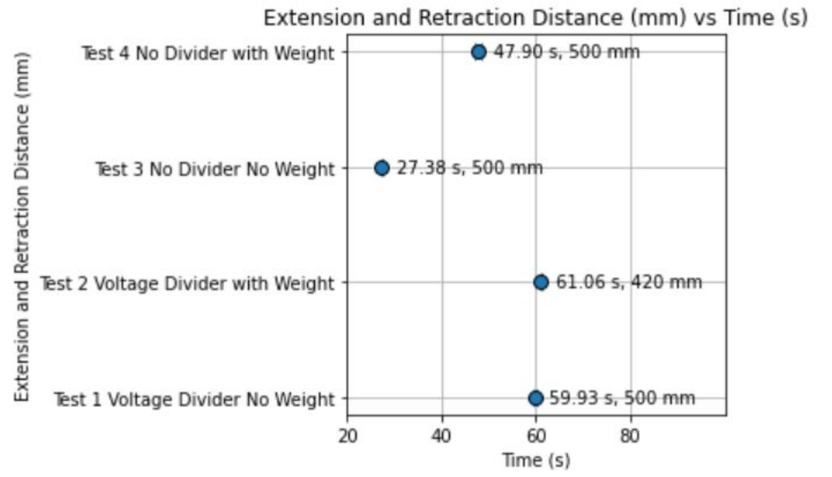


Figure 6. Extension & Retraction vs. Time

Future Work & Discussion

- Create metal actuator holders and make the fit tighter to minimize any movement.
- Order more powerful linear actuators to account for load distribution and to maximize speed.
- Use a rubber coating on the footrest to allow for more user comfort.
- Change the footrest design to support more direct weight either with a rail on the actuator or more support near the bottom.
- Create a folding mechanism for the footrest.
- Continue to look into how to make the design more universal for other wheelchairs.

Acknowledgements & References

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[1] "Quickie Q700 M power wheelchair," Sunrise Medical, https://www.sunrisemedical.com/power-wheelchairs/quickie/mid-wheel-drive/q700-m (accessed Feb. 24, 2024).

[2] "North America Wheelchair Market Report 2021 - ResearchAndMarkets.com," *www.businesswire.com*, Aug. 13, 2021. https://www.businesswire.com/news/home/20210813005309/en/North-America-Wheelchair-Market-Report-2021 ResearchAndMarkets.com (accessed Apr. 26, 2024).

[3] AZoM, "Aluminium - Specifications, Properties, Classifications and Classes," azom.com, May 17, 2005. Htt ps://www.azom.com/article.aspx?ArticleID=2863 (accessed Mar. 10, 2024)