

## **1. PROBLEM STATEMENT**

Everyday tasks are difficult for manual wheelchair users, and electric wheelchairs are expensive. Consequently, many manual wheelchair users are unable to afford electric wheelchairs, leaving them to endure frequent physical strain. There is a need for a low-cost product for manual wheelchair users that improves mobility and mitigates pain.

### **1.1. Need Statement**

According to the U.S. Department of Transportation, “An estimated 5.5 million Americans use wheelchairs” [1]. Wheelchair users and, more broadly, people with disabilities face many obstacles with mobility. The U.S. Bureau of Labor Statistics states that only 24.2 percent of disabled people are employed [2]. One healthcare clinic asserts that electric wheelchair prices start in the range of \$1000-\$3000, while manual wheelchair prices start in the range of \$100-\$500 [3]. Though manual wheelchairs are less expensive, they can cause strain on upper extremities. This physical strain can lead to fatigue, stress injuries, and even long-term health problems, such as joint and back pain. Studies show that the risk of developing musculoskeletal disorders increases significantly with prolonged manual wheelchair use [4]. A research article exploring treatments for shoulder pain details that 71 percent of manual wheelchair users have shoulder pain [5]. The low employment rate among the disabled and the high starting cost for basic electric wheelchairs are barriers to a pain-free, independent lifestyle. A product is needed to increase mobility and decrease pain for manual wheelchair users at a low cost.

### **1.2. Objective Statement**

The objective of this project is to provide a conversion kit that allows the user to integrate electronic capabilities into a manual wheelchair. This would help increase mobility and reduce the stress in their arms that comes from propelling the wheelchair. The user is able to change the wheelchair from acting as a manual wheelchair to an electric wheelchair at the push of a button. The electric mode deploys electronic wheels, and the user is able to propel the wheelchair in different directions using a joystick-like controller. The device also communicates information related to the battery status to the user through an LED screen.

### **1.3. Background and Related Work**

Free Wheelie aims to widen the user’s degree of freedom with the integration of a hybrid wheelchair conversion kit. There are currently other conversion kits on the market, but they are missing some core functions that are present in Free Wheelie. One of these kits is the Permobil’s Smartdrive, which is a single motorized wheel attached to the back of the wheelchair and controlled by their speed control dial, which allows the user to control the speed of the Smartdrive [6]. The speed control dial has a limiting factor for users who have limited hand motion and may have trouble operating the dial. Free Wheelie surpasses other control platforms because of its ergonomic design. It allows users to change the mode of their wheelchair, giving an increased degree of freedom in their everyday lives.

## References

- [1] P. O. USDOT, “Secretary Buttigieg Announces Proposed Rule to Ensure Passengers Who Use Wheelchairs Can Fly with Dignity | US Department of Transportation,” *Transportation.gov*, Feb. 29, 2024. <https://www.transportation.gov/briefing-room/secretary-buttigieg-announces-proposed-rule-ensure-passengers-who-use-wheelchairs-can> (accessed Feb. 05, 2025).
- [2] USBLS, “Labor Force Participation Rate 24.2 Percent for People with a Disability in 2023,” *Bureau of Labor Statistics*, Oct. 01, 2024. <https://www.bls.gov/opub/ted/2024/labor-force-participation-rate-24-2-percent-for-people-with-a-disability-in-2023.htm> (accessed Feb. 10, 2025).
- [3] T. Hazen, “How Much Does a Wheelchair Cost?” *BetterCare*, Nov. 06, 2024. <https://better-care.com/costs/wheelchair-cost> (accessed Feb. 05, 2025).
- [4] Liampas, A., Neophytou, P., Sokratous, M., Varrassi, G., Ioannou, C., Hadjigeorgiou, G., and Zis, P., “Musculoskeletal Pain Due to Wheelchair Use: A Systematic Review and Meta-Analysis,” *Pain and Therapy*, vol. 10, Aug. 13, 2021, doi: 10.1007/s40122-021-00294-5.
- [5] B. Mason, M. Warner, S. Briley, V. Goosey-Tolfrey, and R. Vegter, “Managing Shoulder Pain in Manual Wheelchair Users: A Scoping Review of Conservative Treatment Interventions,” *Clinical Rehabilitation*, vol. 34, no. 6, pp. 741–753, May 2020, doi: <https://doi.org/10.1177/0269215520917437>.
- [6] Permobil, “Permobil SmartDrive,” *hub.permobil.com*, 2022. <https://hub.permobil.com/smartdrive> (accessed Feb. 10, 2025).