Thesis Project Portfolio

W.E.A.R. Bot - Wrist-Elbow Automated Rehabilitation Robot

(Technical Report)

How Ableism Influences the Design of Mobility Assistive Technology

(STS Research Paper)

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Executive Summary

Assistive technology can positively impact the lives of many people with disabilities, allowing them to navigate and engage more comfortably with the world around them. However, it is important to recognize that technologies alone cannot fully address the root causes of accessibility issues and can even further perpetuate ableism. My technical project, involving the development of a wearable exoskeleton device for rehabilitation therapy, is closely intertwined with my STS research, which critically examines the impact of ableist assumptions on the design and effectiveness of assistive technologies. Through these projects, I grappled with both engineering and ethical challenges involved in assistive technology design.

For my technical project, I worked with a team to design and build a wearable exoskeleton to automate passive movements of the upper extremities. This project aimed to work towards creating a device that could be used in a physical therapy regimen to aid patients experiencing certain forms of paresis or paralysis in regaining upper limb mobility. The Wrist-Elbow Automated Rehabilitation Robot (W.E.A.R. Bot) automates flexion and extension of the elbow and wrist to target both fine and gross motor skills. The elbow motion is achieved using a pneumatic artificial muscle (PAM) and the wrist motion is achieved using a servo motor. Both actuators are fixed on a custom 3D-printed brace, which features foam padding between the rigid components and the body and adjustable Velcro straps. These soft materials ensure a more compliant and comfortable interface for the body. The W.E.A.R. Bot operates within a feedback control system that utilizes an Arduino microprocessor as the controller, along with two single-turn 10 kΩ potentiometers placed on the rotational axes of the joints to serve as angular position sensors. The device's angular position boundaries can be programmed to suit the patient's specific range of motion. The W.E.A.R. Bot is intended to be an affordable and highly

customizable option to enhance rehabilitation therapy. The design prioritizes patient comfort, adaptability, and ease of use, making it a promising tool for clinical settings or even at-home rehabilitation, offering a scalable solution tailored to individual patients' specific needs.

While the technical aspects of developing the W.E.A.R. Bot address more of the practical challenges of designing assistive technology, my STS research delves deeper into the ethical and societal implications of assistive technology design, particularly how ableist assumptions may influence the development and effectiveness of these technologies. The STS research project is a case study of two innovative assistive devices to assist users with lower extremity mobility impairments: the iBOT Personal Mobility Device and the ReWalk Personal 6.0 Exoskeleton. Grounded in the framework of Crip Technoscience, introduced by disability justice scholars Aimi Hamraie and Kelly Fritsch, each device is examined focusing on the design intentions, marketing rhetoric, and success of implementation. Technoableism, the notion that technology should be employed to "fix" or eradicate disabilities, is a key lens for examining the underlying assumptions that shape assistive technologies. The findings reveal that both devices prioritize conformity to able-bodied norms over true accessibility, reinforcing ableist ideals that pressure disabled individuals to adapt to an inaccessible world. Furthermore, the high costs and limited user requirements make these devices accessible only to a privileged few. As a result, they not only fail to challenge existing barriers to accessibility but also contribute to the further marginalization of those who cannot access or use these technologies. This research calls for designers and engineers to reject technoableism and underscores the need for systemic solutions that address the root causes of inaccessibility, fostering the development of assistive technologies that genuinely enhance the lives of users.

Working on both the technical development of the W.E.A.R. Bot and the STS research project concurrently provided me with a deeper understanding of the motivations and challenges that drive the development of assistive technology. Engaging with ideas from critical disability studies and examining the social implications of existing assistive technologies allowed me to critically assess and refine my approach to designing the W.E.A.R. Bot. I learned to recognize when my group's design goals were veering toward harmful ableist ideals. Initially, we toyed with the idea of creating a device that could transform the experience of users with upper extremity impairments into one more aligned with able-bodied functionality. I was able to redirect our design goals towards developing a tool specifically for assisted rehabilitation, rather than an ambitious attempt to provide ubiquitous everyday assistance. This shift ensured that the W.E.A.R. Bot was grounded in practical utility, rather than pursuing ableist and unattainable ideals of normalization. Together, these projects enriched my understanding of how technologies can be shaped by harmful societal ideals and perpetuate those ideals, highlighting the importance of aligning technological innovation with critical, ethical considerations.