Identifying Accessibility Barriers to Robotics Research

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I. Motivation

The goal of research is to enhance society and improve quality of life through knowledge advancement, problem-solving, informed policy decisions, and skill development. Research is a repeatable and systemic process of discovering new knowledge or using existing knowledge in novel ways. A researcher is someone who conducts research using appropriate methodologies, regardless of institutional affiliation, professional training, certification, or demographics. However, the traditional view of robotics research often assumes academic credentials and access to STEM education and jobs. This view fails to address the under-representation of individuals with disabilities in the STEM workforce. Statistics show that only 3% of STEM workers reported having a disability, compared to 27% of the adult population who are living with a disability. In our workshop poster, we focus on barriers faced by individuals with physical motor impairments in joining the robotics research community and propose steps for current researchers to welcome them as empowered members of our community [5].

II. Policy Considerations

In our discussion, we consider two types of policies that either foster or hinder inclusivity: systemic policies and institutional policies. Systemic policies are defined outside conventional research centers and are often decided through political processes, while institutional policies are de facto or traditionally motivated policies within research centers. Our discussion encompasses both types of policies because institutions exist within a larger socioeconomic and cultural system where individuals with disabilities reside. To participate in research, individuals with neuromotor impairments must navigate both systemic and institutional policies, such as inaccessible transportation, limited accessibility options at universities, and non-adapted modes of communication for research opportunities [3]. Currently, robotics researchers face challenges in implementing meaningful institutional policies to promote accessibility due to larger and more entrenched systemic policy barriers. One byproduct of poor systemic policies is the 'Disability Tax', which refers to the disproportionate cost of living for individuals with disabilities compared to those without. While medical costs may contribute to this disparity, research has shown that it also arises from aspects of daily life, such as transportation fees and expenses for essential goods [2, 7]. The Disability Tax can be compounded by opportunity costs associated with work insecurity and under-utilization of labor. These costs are the result of systemic policies tailored for the non-disabled population, neglecting the needs of individuals with neuromotor disabilities. Systemic policies stem from various sources, including civic and environmental engineering, social psychology, and corporate and partisan interests [6]. While these policies fall outside the scope of our proposal, we believe that understanding them is crucial for designing deliberate and empathetic institutional policies that bridge the accessibility gap.

Larisa Loke, Andrew Thompson, and Mahdieh Nejati Javaremi are Ph.D. students under the supervision of PI Brenna Argall. With an emphasis on assistive and rehabilitation robotics, they have gained extensive experience running studies that involve end users, enabling them to better understand the accessibility barriers faced by individuals with motor impairments in the field of robotics. Michele Lee brings a unique perspective as an end-user of assistive devices. With a background in advocacy for people with disabilities and current work at a startup dedicated to accessibility in self-driving cars, Michele offers valuable insights into the practical implications of addressing accessibility barriers in robotics research. Brian Martinez, another end-user of assistive devices, adds his expertise as an avid maker and prototypist, complemented by his certification in CAD software and additive manufacturing. Brian's skills contribute to the exploration and development of accessible solutions within the robotics research field. Kevin Rowland adds valuable knowledge with his background in technology as an engieer before being diagnosed with ALS. He continues work in technology as an avid coder despite the existing challenges and barriers. This diverse group of researchers and end-users collaboratively wrote this paper, driven by their shared experience and passion for addressing accessibility barriers in robotics research. Their collective expertise and perspectives contribute to shedding light on these barriers and proposing potential solutions to enhance inclusivity and lower the barriers for individuals with motor impairments.

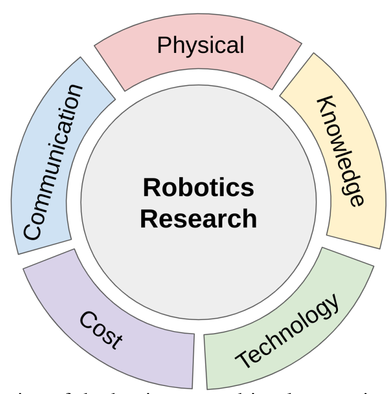

Fig. 1: Visualization of the barriers around involvement in robotics research that are present for individuals with disabilities.

III. Barriers to Research Participation

Before we can reduce barriers to robotics research participation, it is essential to identify these obstacles. Just as the extent of physical motor impairment varies among individuals, the barriers they face also exist on a spectrum. Such barriers are influenced by factors such as severity of a motor impairment and the individual's personal resources and support networks. Through our collective experiences, we have identified five overarching barriers (Figure 1) that hinder the inclusion of end-users in assistive robotics research.

A. ***Physical Barriers***

Physical accessibility presents a salient barrier to conducting robotics research for individuals living with physical motor impairments. Our society, wherein accessibility considerations often remain overlooked, fosters this issue. Such barriers emerge from various aspects: hands-on tasks required for robotic device interaction, limited accessibility in research buildings and labs, and the strenuous demands of travel for collaboration or conferences. Widely-used tools for robot design and control, along with entry-level learning kits, typically lack accessibility-centric designs and necessitate precise hand dexterity. These shortcomings underscore inconsistencies between systemic and institutional policy implementation. The U.S. Fair Housing Act (FHA) illustrates this paradox. The FHA proposes quantitative and qualitative design guidelines for ground-floor and elevator-accessible units in residential buildings constructed post-1991. Despite these guidelines, local policies may undermine their intent, manifesting in a disconnect that perpetuates accessibility barriers [1].

B. ***Communication Barriers***

The communication chasm that exists between individuals who are acquainted with or themselves living with a physical disability and those who aren't often leads to misunderstandings and biases. This in turn can inadvertently result in discrimination against and the further marginalization of this demographic. Despite advancements in robotics development tools, such as accessible coding languages and interfaces, many individuals with disabilities remain unaware of these tools and their potential to facilitate participation in research. Even the participation of an individual living with a disability in a research study serves as a testament to their capabilities and contribution to the field; however, these communication gaps may often overshadow such involvements. The burden here lies on the traditional academic research community to implement solutions that overcome individual obstacles while alleviating feelings of insecurity.

C. ***Knowledge Barriers***

Knowledge barriers to participating often stem from a limited awareness about research opportunities for individuals without ties to established research institutions, and a lack of understanding of what robotics research involves, both factors influenced by an individual's background and interests [3]. Engagements between researchers and end-users, usually through studies evaluating new hardware or software, may inadvertently obscure understanding of robotics research due to limited technical explanations designed to prevent participant bias. This strategy, while aimed at achieving unbiased findings, unintentionally distances end-users from academic discourse and obscures the research process.

D. ***Cost Barriers***

The financial burden of participating in robotics research is heightened for those with motor impairments due to the extra costs, or 'disability tax', associated with their disability. This includes expenses for private transportation, prepared food, and additional healthcare and accessibility devices. This financial strain often forces some individuals to prioritize employment over higher education, perpetuating a cycle that limits their access to STEM careers.

E. ***Technology Barriers***

While advancements have been made with assistive technologies, there is a significant need for innovative tools that empower individuals with disabilities to actively engage in assistive robotics research beyond mere participation, and not only to enhance their quality of life. Presently, accessible software and tools often lack complete functionality (as opposed to their less accessible counterparts, for example some CLIs versus GUIs), restricting those reliant on these versions from fully utilizing these resources.

IV. Inclusive Robotics: Strategies and Solutions

We have underscored various systemic and societal barriers. We propose that none of these are insurmountable; rather that they present a promising opportunity for a cycle of novel research directions that encourage and attract this demographic of new researchers, in turn leading to further novel research. Universal Design is a well-established set of tenets which demonstrates that designing with inclusivity and accessibility in mind improves access and usability for all [4]. Upholding its seven principles (Equitable Use, Flexibility in Use, Simple and Intuitive Use, Perceptible Information, Tolerance for Error, Low Physical Effort, Size and Space for Approach and Use) [8] can broaden access to robotics. Physical barriers can be alleviated with personal resources or support networks, and the use of assistive technologies, like alternative interfacing systems and robotic assistance. Advocacy groups can help bridge communication gaps by promoting awareness about the abilities of individuals with disabilities within the robotics community and conveying the advancements in robotics to those with motor impairments. To reduce the knowledge gap, researchers must equally prioritize disseminating findings to the public and academic circles. For studies involving individuals with disabilities, informative newsletters and regular follow-ups can deepen their connection to the scientific community. Extending outreach to K-12 education and using non-academic platforms like social media can raise awareness about potential research involvement among people with disabilities, broadening knowledge dissemination and empowering these individuals to engage in scientific exploration. The cost barrier can be mitigated through open-source and shared resources like community-funded maker spaces. These resources can lower the initial cost of entry into robotics research for people with physical motor impairments.

Accessible educational robotic kits provide a significant opportunity to involve individuals with disabilities in robotics research, fostering creativity and self-confidence. Crucially, these kits should be both affordable (under $100) and physically accessible. Assembly should be straightforward, utilizing snap-on, click-in, or pressure-fit fittings, cables, and connections, thus eliminating the need for complicated hardware such as nuts and bolts. The inclusion of magnetic data-capable USB cables and user-friendly rechargeable batteries, such as Lithium-ion cells instead of their Lithium-polymer counterparts, further improves the usability and longevity of these kits. These kits should be programmable via commonly available devices, like smartphones or tablets, to promote intuitive engagement and increased accessibility, and designed to be engaging, fun, and rewarding, thereby fostering a sense of accomplishment that transcends the effort or ingenuity required to use them. It is also crucial for users to see how the learned outcomes from the kit can be directly applied to their everyday lives, thereby enriching their experience and increasing their desire to participate in further research. Highlighting the connection between their disabilities and the research is essential to involving individuals fully. To facilitate this, kits should be modular, allowing users to work on different projects by reassembling the blocks, such as motors, in various configurations. By maintaining this constant, we can foster a more profound connection between users and the research, thereby promoting inclusivity and accessibility in robotics.

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