Helping Persons with Limb Disabilities: A Robotic System to Restore Arm Function

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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How Technology Can Make a Positive Social Impact for the Disabled in China

Introduction:

What challenges do disabled people face in China today and how can improvements in technology help them?

Although China has experienced rapid economic development and continuous progress over recent years, there remain some areas where progress is still needed. One of these areas relates to the quality of life for disabled persons in China. *Dealing with disabilities is part of the human condition. According to the World Health Organization (WHO) most people will face some form of disability in the course of their lives.* An estimated 1.3 billion people – about 16% of the global population – currently experience significant disability. This number is increasing due in part to population ageing and an increase in the prevalence of noncommunicable diseases (WHO, 2023). *If it does not personally affect them, it will affect their family and friends.*

What is a disability? The Center for Disease Control (CDC) defines a disability as, *"*any condition of the body or mind (impairment) that makes it more difficult for the person with the condition to do certain activities (activity limitation) and interact with the world around them (participation restrictions)" (CDC, 2023). Disabilities can affect various aspects of a person's life and functioning, including vision, movement, thinking, remembering, learning, communicating, hearing, mental health, and social relationships. The disabled community is not monolithic but diverse, reflecting many different kinds of needs. Disabilities will affect different people in different ways. Some disabilities are hidden from view and not easy for others to see or understand.

The CDC adds that disability can be associated with birth, with later development, or with injury. With regards to birth, this may include genetic disorders (like muscular dystrophy), chromosomal disorders (like Down's Syndrome), or the condition of the mother (like rubella, or

alcohol, tobacco, or drug use). With regard to later development, this includes childhood disorders, like autism or attention-deficit/hyperactivity disorder (ADHD). With regard to injury, this can relate to things like traumatic brain injury or spinal cord injury. Disabilities can also be progressive (like muscular dystrophy), static (like limb loss), or intermittent (like some forms of multiple schlerosis).

The World Health Organizion publishes a document providing an International Classification of Functioning, Disability, and Health (ICF) (WHO, 2001). This document suggests three distinct dimensions of disability. The first dimension is **impairment**. This might involve a person's body structure or mental functioning. This would include loss of a limb or vision. The second dimension is **activity limitation**. This would involve difficulty in seeing, hearing, walking, or problem solving. The third dimension involves **public restrictions** in normal daily activities. This involves restrictions on the disabled person's ability to work, travel, engage in social and recreational activities, and obtain access to things like health care services.

Before the year 1980, persons with disabilities in China were referred to as canfei *(残废)*, meaning "handicapped and useless" (Wang, 2016). Their needs were often ignored, and they were treated as second-class citizens. Though there is a growing sensitivity to the needs of disabled persons in Chinese society, there also remain many barriers to their full participation. Perhaps the economic and technological development of the nation will result in practical benefits which address the sociological needs of the disabled. Devises using artificial intelligence, for example, may be developed to address practical needs of the disabled. This research project will explore some of these possibilities.

Background and Significance:

In its 2021 National Bureau of Statistics, China reported 85 million disabled people, including 21 million deaf and 13 million blind (OHCHR, 2022). This means there is one disabled person among every sixteen in China, but this estimate is probably too low. According to statistics in the US, one in four adult persons are disabled (CDC, 2018).

Of those who meet the census definition of being disabled in China, fewer than half receive the government certificates needed to obtain disability support, including exemption from medical expenses. Even among those who have official certificates, only about 12 million receive a living allowance. 85% of disabled people are considered poor (OHCHR, 2022).

We will examine five subjects related to disability in China today: public mobility; education; work-related injury; deafness and hearing impairment, and physical deformity.

First, we will consider public mobility. People with disabilities in China are 51% more likely to be socially isolated than their non-disabled peers. In China disabled people are not very visible (Campbell; Uren, 2011). One of reasons is that there are generally no public accommodations for the disabled (like handicapped parking, tactile pavement, and ramps). China is equipped with one of the most convenient and effective traffic networks in the world, offering subway, metro, magnetic trains, high speed trains, and air travel. It is very difficult, however, to find transportation services which provide access for the handicapped. This also includes building access. As the World Health Organization states, “A person’s environment has a huge effect on the experience and extent of disability. Inaccessible environments create barriers that often hinder the full and effective participation of persons with disabilities in society on an equal basis with others” (WHO, 2023).

The China Disabled Person Welfare Foundation was established in 1984. This foundation actively carries out fundraising activities to improve the conditions of the disabled. It is

committed to many projects, such as “barrier-free construction,” “poverty alleviation,” and “disability prevention.” With the development of internet activism, many campaigners and advocacy groups are now fighting to improve the living conditions of the disabled.

Second, we will consider education. The Chinese Association of People with Physical Disabilities was originally founded in 1953 and has long fought for basic rights in the field of education. In 1954 the Chinese Constitution declared, “Everyone has the right to education.” An unnamed advocate with the Chinese Disabled Persons Federation (CDPF) reported to Human Rights Watch that many schools did not accept persons with disabilities, because they did not want to lower their school’s “ranking” (Human Rights Watch, 2013). It was not until 1990 that the “Law of the People’s Republic of China on the Protection of Disabled Persons” was officially issued. It states that disabled persons should have access to higher education. Current efforts are underway to suggest increased accessibility for disabled students in Chinese universities (Zang et al, 2018).

Third, we will consider work-related injury. In China, there was a practice of importing rural peasants as “migrant workers” for coal companies. Many of these worked in underground coal pits and developed work-related lung disease (pneumoconiosis). Their struggles were reported to the public for the first time by a non-profit organization called “Love Save Pneumoconiosis,” founded in 2011 (Huang, 2017). In a 2014 article posted to ChinaDaily.com, Wang Kequin, the founder of this organization, noted, “Every hour in China, 1.5 patients are diagnosed with black lung disease…. Most of them are aged between 30 and 40” (China Daily, 2014). This organization continues to fight for the basic rights of these workers.

Another significant problem in China has been a problem with work-place safety regulations and enforcement that have resulted in various kinds of limb (hand, arm, feet, leg)

injuries. A 2013 study noted that China issues new laws and regulations on workplace injuries in 2002, but these guidelines have been enforced with a lack of rigor and lax implementation (Cui, et al, 2015). The result has been continuing instances of workplace injuries. Many of those injured then are left without adequate medical care and rehabilitation services.

Next we will consider issues related to deafness and hearing impairment in China. According to 2008 study by Xi-bin Sun, a scholar at the China Rehabilitation and Research Center for Deaf Children in Beijing, 27.8 million people in China suffer from some form of hearing impairment. Among these 20.04 million would be classified as profoundly deaf. Hearing impairment is especially prevalent among the elderly with 11% of the elderly population suffering hearing problems to some degree. Most of those suffering hearing loss work in agriculture and have a poor educational background. More than 70% of those with speech disabilities under age six have this problem due to hearing impairment. Causes of deafness include presbycusis, heredity, pregnant virus infection, neonatal asphyxiation, drug-induced deafness, premature delivery, and low birth avoirdupois, as well as unknown causation.

A study in the *American Annals of the Deaf*, the oldest and most widely read journal in the world related to deaf education, notes that Chinese national policy focuses primarily on oral/aural education and hearing rehabilitation (Lytle, 2005/2006). In practical terms, however, various forms of Chinese language are taught, but primary focus is given to speech and hearing in childhood education. There are limited opportunities for the deaf in China for higher education. There are no support services such as interpreters for main-stream students which are provided. There are no deaf teacher or interpreter programs in China. Jobs for the deaf are few. The result is that the vast number of the deaf employed in China.

Finally, we will consider disabilities related to physical deformity. Physical deformity is a common disability. Some physical disabilities come from birth defects, while some are acquired by disease or injury. Inadequate physical development, scoliosis, and rachitis are common forms of deformity, covering about eighty percent of all identified disabilities. Dealing with physical deformity usually creates great stress on family members. Patients often experience long-term suffering, significantly reducing their quality of life. It especially affects younger children in their access to educational services and the building of social relationships. Loneliness, hopelessness, and mental depression, alongside physical pain, can significantly affect their daily lives.

With health insurance coverage becoming more comprehensive, especially in contrast to past years, however, the family's financial burdens have generally decreased to some degree. In recent years, some social organizations have started to pay closer attention to the needs of those with physical deformities. Several charity organizations have even been created. A popular singer in China, for example, founded the Sunnan Special Fund For Reshaping the Future (Chong Su Wei Lei, 2023). This singer hosts benefit concerts to raise funds for this organization. Donations then support younger children, between the ages of two and eighteen, with limb disabilities to receive orthopedic surgery.

Research Methods:

The goal of my research is to understand the needs of disabled persons, especially in my home nation of China, and to examine potential ways that technology might be used to address their needs. In order to gather evidence I have primarily relied on the collection and reading of secondary literature. I have also examined websites and policy documents from various governmental and non-governmental agencies. I have analyzed this information using various

comparison techniques, including comparing the needs and status of the disabled within China and outside of China, especially in the developed Western world. My theoretical framework assumes that technology can be positively used to address the needs of the disabled.

Results and Discussion (Evidence, Arguments, Framework):

Technology is changing every day. Various technological advancements have proven to be important breakthroughs for those with dis*abilities, opening access for the disabled to various activities in which they had not previously been able to partake. A 2021 article on a website devoted to tracking compliance to the Americans with Disabilities Acts, cited ten life-changing technologies for people with disabilities (adasitecompliance.com*,2021*). These includes screen readers, screen magnification software, Braille embossers (printers), refreshable Braille displays for the visually impaired; the footmouse, alternative keyboards, and trackballs for those with low mobility in their hands or wrists; text-to-speech software for those with difficulty reading, whether due to vision impairment or conditions like dyslexia; and assistive listening systems for hearing impaired.*

The Arc (formerly known as the Association for Retarded Citizens) is the largest national, community-based organization in the United States dedicated to advocacy for the intellectually and developmentally disabled. This organization has spearheaded several important initiatives related to the use of technology to assist the disabled (The Arc, 2023). It notes that in today's world technology is a vital part of community participation. We live in a "plugged-in world." Technology is integrated into various aspects of daily life, including transportation, employment, recreation, and social interaction.

If people with intellectual and developmental disabilities (I/DD) are going to be fully integrated in society, they must have access to devises, services, and training that promote and

enhance independence, mobility, communication, control of environment, and self-determination. They encourage technology designers and manufacturers, as well as service providers, educators, and person with I/DD, as well as their families to educate and promote the benefits of technology and offer training in how to use it. It would be helpful for such organization to develop on a grassroots level in countries across the world, including in China.

We will now return to the five subjects related to disability in China today (public mobility; education; work-related injury; deafness and hearing impairment, and physical deformity) and examine how technological innovation has helped address the needs of the disabled or will address them in the future.

First, with respect to public mobility, one area of improvement would be the addition of motorized lift systems on public buses, wheelchairs equipped with stair climbing devices (see Figure 1), handicap door opening devices, and elevator installations in public buildings and at public transportation locations. The use of various video meeting platforms are also a useful tool to assist the disabled to be able to work from home without requiring extensive travel or the overcoming of physical barriers.

Second, with respect to education, the development of online learning has great potential for providing access to education for those who are disabled and may have difficulties with travel or building access (see Figure 2). By the early 2000s various initiatives to promote online education were being put forward in China by the Ministry of Education (MOE) (Zhu, 2003).These efforts have only increased in the pandemic era. The expansion of online classrooms has great potential for providing access to education for the disabled in China.

Third, with respect to work related injury, thus far no specific technological innovations have yet arisen to address disabilities created by lung injuries. Yet, by controlling the respirable

coal dust level to prevent or reduce the development of coal worker's pneumoconiosis. Various technologies, using multiple methods of control can be sued to successfully reduce respirable dust level. In addition, using automatic equipment to replace or limit mine worker. The loss of limb functions, however, might be addressed through some of the technologies addressed above, such as the footmouse, the altnerative keyboard, and trackballs. In addition, this is an area where the development of exoskeleton technology may also prove useful.

Fourth, with respect to deafness and hearing impairment, one significant advancement in this field is the development of Cochlear Implant Technology. This technology has been under development in China since 1979 (Zeng, 1995). By the late twentieth century there did not appear to be "any emergent deaf culture" in China (Zeng, 1995). As noted previously Chinese treatment of the deaf focused less on things like sign language than on therapeutic and medical treatments to improve hearing and speech among the deaf and hearing impaired. The use of Cochlear implants fits with this overall strategy of addressing the needs of the deaf and hearing impaired in China (Lytle, 2005/2006).

Fifth, with respect to disabilities causes by physical deformities, some of the technologies noted above relating to work-related limb injuries might be noted, including things like computer aids (e.g., the footmouse) and exoskeletons. In addition, in recent years with the development of both clinical research and computer science applications such as the Brain-Computer Interface (BCI) treatment, which provides closed-loop rehabilitation, significant statistically verifiable improvement has been achieved for those suffering from upper limb dysfunction occurring after a stroke. This BCI therapy, or BCI therapy combined with other types of therapies such as conventional rehabilitation training and motor imagery training, has undoubtedly proved effective in many cases to improve or even to fully restore typical limb functions. Technology

has played a significant role in the medical field to bring about societal change at a rate of exponential growth.

The disabled, their families, and their advocates across the world, including China, have good reason to be encouraged and optimistic about the future. With increasing exposure to the global community the government and citizens of China are beginning to exhibit a more sympathetic view of the disabled within their nation. No longer do they look at the disabled as canfei. With corresponding increasing economic prosperity and the rise of a sophisticated business, technology, and manufacturing sector in China, there is both more capital to fund efforts to assist the disabled and more tangible products that might be applied in assistance to those with needs that might be addressed through technological innovations. In fact, one might well argue that the Chinese are uniquely situated to provide improvements for the disabled within their own nation that might one day also prove beneficial to persons all over the world.

Conclusion:

It seems that there is a universal human impulse to provide assistance to our fellow human beings and to treat others as we would like to be treated. This is sometimes known as the "Golden Rule." It is present in the East in the teaching of Confucius who in his Analectics said, "What I do not wish others to do to me, that I also I wish not to do to them." It is present in the West in the teaching of Jesus of Nazareth, who said, "do to others what you would have them do to you" (Matthew 7:12). If we see disabled persons in need, we can use technology to help them, just as we would wish to be helped if we had this same kind of need.

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Figure 1

Smart Stair Climbing Wheelchair

Note: These Smart devises include sensors, rear cameras, and a joystick control that allow movement on uneven surfaces, including stairclimbing, while maintaining upright and stable posture for the user to remain in a seated position.

Figure 2

Students with intellectual disabilities making use of online technology.

Note: The physically and intellectually challenges face various barriers to learning. These include physical barriers that might not allow them to enter a traditional classroom. For the intellectually disabled there may be social barriers that do not allow them to participate in traditional classroom settings. Online learning helps to overcome these barriers and gives these student access to education suited to their needs.