

# **Undergraduate Thesis Prospectus**

**Helping Persons with Limb Disabilities: A Robotic System to Restore Arm Function**  
(technical research project in Mechanical Engineering)

**How Groups in China Advocate for Disabled Persons**

(sociotechnical research project)

By

Dongmei Xu

October 27, 2022

Technical project collaborators:

Ellianna Bailey  
Nicholas Yantiss  
Patrick Evans  
Priti Patel  
Willis Williams

**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.**

**Dongmei Xu**

Technical advisor: Sarah Sun, Department of Mechanical Engineering

STS advisor: Peter Norton, Department of Engineering and Society

## Prospectus

### General Research Problem

*How can disabled persons in China live better lives?*

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. Before the year 1980, persons with disabilities in China were referred to as *canfei* (残废), meaning “handicapped and useless” (Wang, 2016).

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. Devices using artificial intelligence, for example, may be developed to address practical needs of the disabled. This research project will explore some of these possibilities.

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

*How may a wearable robotic system restore proper arm function to a person with a disabled arm?*

The goal of this project is to design a wearable, upper limb, soft robotic device, also called a soft exoskeleton. The project will seek to produce a device that will help a disabled person to have some arm function. It will integrate sensor, actuator, and feedback control systems to maximize biocompatibility, operability, and comfort. This soft exoskeleton would be an improvement compared to a rigid robotic arm. These exosuits will have some intrinsic

limitations. A cable-based actuation system must provide durability and safety. It must also be lightweight and flexible. This device will have pneumatic artificial muscles operated by pressurized air. The device will use a control method based on non-human biological signals, using electromyography (EMU) to transmit electrical signals that cause muscles to contract and relax. Arduino microcontroller interfaces with EMU will generate signals and data to analyze. Analysis of forces and motions will need to be processed by SolidWork and MATLAB. Many experiments will need to be conducted to test actuators, controllers, and signals.

This project will be actualized in several stages. First, it will require developing a model for how such a device will work. Next, it will require building and testing a prototype of this device. If every step goes smoothly, at the end of the project the soft robotic exoskeleton can assist a person with a limb disability to do basic things like drink a cup of water. It could eventually be manufactured and produced for commercial use.

### ***How Groups in China Advocate for Disabled Person***

Disabled persons can be found throughout the world, including in China, the world's most populous nations. In its 2021 National Bureau of Statistics, China reported 85 million disabled people. This means there is one disabled person among every sixteen in China. 75% of disabled persons live in rural areas. 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. Of those with official certificates, only about 12 million receive a living allowance.

We will examine four subjects related to disability in China: public mobility; education; work-related injury; and autism.

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 reason is that there are generally no public accommodations for the disabled (like handicapped parking, tactile pavement, and ramps). 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.” This organization continues to fight for the basic rights of these workers.

Finally, we will consider autism. Autism is a widely recognized condition across the world. The Chinese government reports that there are about 10 million persons with autism in China, including over 2 million children. Those children are often discriminated against in their schools, communities, and even in their homes (Clark et al, 2019; Huang, et al, 2013). Lu Yong, chairman of the Chinese Disabled Persons Federation (CDPF) has acknowledged that “current social resources are insufficient” and that there is a “big gap between the demand [of those with autism] and service” (Li, 2018). Professional care for the autistic in China is still a developing discipline. “China Autism Net” is a nonprofit organization founded in 2004 by autism researchers. They are working with patients, families, and other agencies to develop better care.

### References

- Campbell, Anne; Uren, Marie (2011). "The Invisibles"...Disability in China in the 21st Century. *International Journal of Special Education*, vol. 26, No. 1, 12-24. Google Scholar.
- Clark, Elaine; Zhou, Zeng; Du, Lin (2019). Autism in China: Progress and challenges in addressing needs of children and families. *International Journal of School & Educational Psychology*, Vol. 7, No. 2, 135-146. Google Scholar.
- Huang, Ann X; Jia, Meixiang; Wheeler, John J. (2013). Children with Autism in the People’s Republic of China: Diagnosis, Legal Issues, and Educational Services. *Journal of Autism and Developmental Disorders*, Vol. 43.
- Huang, Dianlin (2017). *Social Media of Grassroots NGOs in China: A Case Study*

*of Love Save Pneumoconiosis (LSP)*. Routledge Press.

Human Rights Watch (2013). As Long as they let us stay in class: Barrier to Education for Persons with Disabilities in China. HRW.org (July 15, 2013). <https://www.hrw.org/report/2013/07/15/long-they-let-us-stay-class/barriers-education-persons-disabilities-china>.

Li, Fang. Autism Services for Children. People.cn. May 28, 2018.

Wang, Y. (2106). A Glance at People with Disabilities in China. ChinaSource.org (March 7, 2016). <https://www.chinasource.org/resource-library/articles/a-glance-at-people-with-disabilities-in-china/>.

Zhang, Yuexin; Rosen, Sandra; Cheng, Li; Li, Jingshan (2018). Inclusive Higher Education for Students with Disabilities in China: What Do the University Teachers Think? *Higher Education Studies*, Vol. 8, No. 4, 104-115. Google Scholar.