Robotic Arm for People Using Wheelchairs

Robotic arm is designed for people using wheelchairs with limb disability. The combination of robotic arm and wheelchair can provide the user with ability to control objects independently and improve their quality of life.

Introduction from ChatGPT.

Target Users:

The primary target users for wheelchair-mounted robotic arms are individuals with **severe physical disabilities** that limit their upper body mobility. This includes:

People with spinal cord injuries (SCI): Those who have lost partial or total function in their arms and hands, making it difficult to perform daily tasks like feeding themselves, picking up objects, or interacting with their environment.

People with neuromuscular diseases: Conditions such as muscular dystrophy or amyotrophic lateral sclerosis (ALS) that progressively weaken muscles, making it hard to use their arms.

Elderly individuals: Older adults who face limited mobility due to aging, arthritis, or other degenerative diseases may benefit from these devices to maintain their independence

Impact:

Such products have impact on both individuals and the society.

Assistive robotic arms on these users can increase independence, enhance quality of life, have psychological benefits and reduce caregiver burden.

On a broader scale, these devices could lead to **greater social inclusion** for people with disabilities by enabling them to participate more fully in work, education, and brecreational activities. This helps in breaking down barriers to accessibility, fostering a more inclusive society.

Overview of Current Studies:

1. Assistive Robotic Arms

Robotic arms are being designed to help individuals with limited upper body mobility perform daily tasks such as eating, drinking, grabbing objects, opening doors, and more. Several assistive robotic arms, both commercially available and experimental, have been integrated with wheelchairs or are designed to work alongside them. Some of the key studies and developments include:

JACO Arm: Developed by Kinova Robotics, the JACO arm is a lightweight, six-degree-of-freedom (6-DOF) robotic arm that can be mounted on wheelchairs. It is designed to help users perform activities of daily living, such as picking up objects, eating, and opening doors. Studies have shown that the JACO arm can greatly enhance the autonomy of users.

DEKA Arm System (LUKE Arm): While primarily developed for amputees, the DEKA Arm System has been studied for potential use by wheelchair users. It offers fine motor control and has sensors that can allow it to be controlled through various means, including muscle signals or external controllers.

Myoelectric and Brain-Computer Interface (BCI) Controlled Arms: Research is being conducted on robotic arms that can be controlled using myoelectric signals from residual muscles or even brain-computer interfaces (BCIs). These technologies are aimed at allowing users with very limited physical movement to control the robotic arms with more precision and ease.

2. Human-Robot Interaction

Studies in human-robot interaction (HRI) focus on developing intuitive and easy-to-use interfaces for wheelchair users to control robotic arms. Since many users may have limited mobility in other parts of their bodies, researchers are exploring different control methods, such as:

Joystick Control: Many robotic arms designed for wheelchair users are controlled via a joystick or similar device, allowing them to perform complex tasks by moving the arm in various directions.

Voice Control: Voice commands are being studied as a method for controlling assistive robotic arms. This can be especially helpful for users with limited mobility in both arms and legs.

Eye-Tracking Control: Eye-tracking systems are being integrated with robotic arms to provide users with the ability to control the arm simply by looking at objects or specific points.

BCI: Research in BCIs involves developing ways for users to control robotic arms using brain activity. This technology is in the early stages of development but shows great promise for individuals with severe mobility impairments.

3. Integration with Wheelchairs

Robotic arms are often mounted directly onto wheelchairs to provide seamless assistance. Studies have focused on making these systems more portable, durable, and power-efficient. Some examples of these studies include:

Power Management: Research has been conducted on optimizing the power usage of wheelchair-mounted robotic arms to extend battery life and ensure reliable operation over a full day.

Modularity and Portability: Efforts have been made to make robotic arms easily attachable or detachable from wheelchairs, giving users more flexibility. Modular systems also allow for easier upgrades and repairs.

Adaptability: Research has focused on creating robotic arms that adapt to different environments and tasks. For example, some robotic arms are designed to automatically adjust their grip or movement based on the object being handled.

4. Social and Emotional Impact

Assistive robotic arms are not just mechanical devices; they also have a profound social and emotional impact on users. Studies have shown that using assistive robotics can:

Increase Independence: Robotic arms allow users to perform tasks that would otherwise require human assistance, fostering a sense of independence and self-reliance.

Enhance Social Interaction: By enabling users to handle objects and interact with their environment, robotic arms facilitate greater participation in social activities.

Improve Psychological Well-Being: Research shows that users experience improved self-esteem and quality of life when they can accomplish tasks independently with the help of robotic arms.

Analysis of the Outcome of GPT

The research about this field can be divided into three part-------Assistive robotic arm, human-robot interaction, and integration with wheelchairs.

JACO Arm is one of the products designed to assist the disabled people. A robotic arm is connected to the wheelchair. The user can control the robotic arm with joystick or OLED display accessory. By selecting different movement mode, the arm can perform tasks such as drinking, finger control.

Figure 1 https://assistive.kinovarobotics.com/product/jaco-robotic-arm

The research also includes aspects about humanities and social sciences. The social and emotional impact of the robotic arm are important part of this field.

However, there are also some limits about the relevant research. Although robotic arm has improved user’s daily life, current product can only perform limited tasks and have weight limitation. The cost of the product too high for most of the disabled people. And due to the limit of battery life, some products can even be hard to perform all day.

Besides, robotic arm is an interdisciplinary area including robotics, BCI, material, and AI. BCI for example, can make the control process easier and faster. However, current BCI research is impossible to support such technology into commercial use.

For this project, I want to learn about current studies on the combination of robotic arm and BCI and explore a possible way to develop a BCI controlled robotic arm.

Papers I Will Focus on Next Week

Gao, Q., Dou, L., Belkacem, A.N. and Chen, C., 2017. Noninvasive electroencephalogram based control of a robotic arm for writing task using hybrid BCI system. *BioMed research international*, *2017*(1), p.8316485.

Tsui, K.M. and Yanco, H.A., 2007, March. Simplifying Wheelchair Mounted Robotic Arm Control with a Visual Interface. In *AAAI spring symposium: multidisciplinary collaboration for socially assistive robotics* (pp. 97-102).

Xu, B., Li, W., Liu, D., Zhang, K., Miao, M., Xu, G. and Song, A., 2022. Continuous hybrid BCI control for robotic arm using noninvasive electroencephalogram, computer vision, and eye tracking. *Mathematics*, *10*(4), p.618.