Hand Gesture Control Wheelchair for Disabled People

Prafulla Katkade[1], Divya Gunjal[2], Bhagyashri Dangal[3], Sejal Temkar[4], Guide- Prof. Swati Bhoir [5]

[1-4] Department of Computer Engineering AMRIT, Aghai Shahapur University of Mumbai, Maharashtra, India

[5]Department of Computer Engineering, Atma Malik Institute of Technology & Research, University of Mumbai, India

Corresponding Author Email: prafullakatkade700@gmail.com

Abstract—A new assistive technology, called the Hand Gesture Control Wheelchair (HGCW) system, is designed to help individuals with mobility impairments increase their independence and mobility. The system consists of a wearable device with sensors that detect hand movements and Arduino microcontrollers for real-time data processing and wheelchair control. The HGCW system uses gesture recognition algorithms to translate hand gestures into corresponding wheelchair movements, such as forward, backward, left, and right turns, and communicates wirelessly with the wheelchair's control unit. The system is cost-effective, customizable, and intuitive, making it accessible to a wide range of users. The HGCW system has the potential to revolutionize the way disabled individuals navigate their environment, empowering them to lead more independent and fulfilling lives. By changing the head movement, the data is sent wirelessly to the microcontroller-based motor driver circuit to control the rotation of the chair in five different modes: forward, backward, right, left and special standing lock. The proposed system was assembled using products procured from the local market and its performance was tested in the laboratory and the test results are included in this article.

Keywords – Internet of Things, Health Care Industry, Movement Disabled People, Hand Gesture.

I. INTRODUCTION

Mobility improvement is a significant challenge faced by millions of individuals worldwide, greatly affecting their independence and quality of life. For people with disabilities, particularly those with limited upper body mobility, conventional wheelchair controls can be cumbersome and restrictive. However, advancements in technology, particularly in the fields of Internet of Things (IoT) and Arduino, offer promising solutions to enhance mobility and autonomy for disabled individuals This paper presents the development and implementation of a Hand Gesture Control Wheelchair (HGCW) system designed to empower individuals with mobility impairments through intuitive hand gesture-based control. By leveraging IoT and Arduino technology, the HGCW system provides an innovative approach to wheelchair navigation, enabling users to manoeuvre their chairs with simple hand gestures The motivation behind the HGCW system stems from the need to address the limitations of traditional wheelchair controls, which often require precise manual manipulation and may not be suitable for individuals with dexterity issues. By introducing a hands-free control mechanism based on natural hand movements, the HGCW system aims to improve accessibility and usability for users with diverse mobility needs.

Due to this high proportion, there is growing demand for developing technologies that can aid this population group from international health care organization, universities and companies interested in developing and adapting news products**.** One of the most adaptable body parts is the hand. It has the capacity to produce a wider variety of signals than any other limb. Hand signals are viewed as the most effective method of communication that doesn't rely on spoken words, for conveying information between two people. The primary challenge is creating a system that tackles the issue of allowing those with disabilities to access their fundamental requirements. This project aims to develop a wheelchair controlled by hand gestures, proving beneficial for those with physical limitations

Through the successful development and implementation of the HGCW system, this research aims to contribute to the field of assistive technology by offering a user-friendly and innovative solution for individuals with mobility challenges. By harnessing the power of IoT and Arduino technology, the HGCW system has the potential to revolutionize wheelchair navigation, providing greater freedom and independence to users with disabilities.

II. LITERATURE SURVEY

In a published article, G. Bourhis and K. Moumen show that there are currently many navigation systems on the market that make it easier for people with disabilities to navigate. The established system is very competitive in replacing the old system **[1]**

Rakhi A. Kalanthri and D. K. Chitra demonstrated in their work that the wheelchair can be controlled in four directions by tilting the acceleration sensor. Ultrasonic sensors are used to control the movement of the wheelchair, avoiding the possibility of collisions with objects until the user is able to take over some of the responsibility of steering. It simply calculates the degree of inclination and decides which direction to move **[2]**

Mahipal Manda and B Shankar Babu developed a wheelchair using MEMS technology, can be integrated to develop a useful wheelchair control system using hand movements.
The electric chair with a high steering seat can be considered a great success in terms of the integration of physically and mentally disabled individuals into society. **[3].**

The concept developed by Shreedeep Gangopadhyay ensures that it works completely independently without any wires or restrictions. The ability to avoid obstacles is kept within certain limits from the wheelchair. The wheelchair is configured to turn in a different direction if it detects obstacles while moving **[4].**

A study by Kannan Megalingam, Srikanth and Raj shows that the combination of displays and Bluetooth technology allows peopl e with disabilities to control movement by swiping the screen. In addition, even when the disabled person cannot move his hands, the second person can control the movement without pushing the chair. **[5].**

According to the founder, Dr. Stewart James Hildebrand, a wheelchair project. A brief survey of research on the development of autonomy in wheelchairs is presented, and AAI's R&D for the construction of a series of intelligent autonomous wheelchairs is discussed. The modular autonomous control system can be installed in a power chair, having been carefully designed, developed and tested over the years. It is a course of action that will reduce the use and cost of equipment in a way that will create the suitability of the ship and ensure performance, adequate protection, uniformity of appearance and design capacity. To date, the add-on system has been installed and tested on two common wheelchair power models. The initial findings are very promising **[6]**

II.I. PROPOSED SYSTEM

The main objective of this proposed system is to find an alternative option for wheelchairs present in the market and to do by creating the affordable model. The study of our team shows the benefits of our proposed system. The proposed system **"HAND GESTURE CONTROL WHEELCHAIR",** Was design to cater patients with various kind of physical disabilities. The chair moves according to the hand movement with the wearable device which can send the signals to chair for going forward taking back.

We envisioned this system can be better alternative to joystick & remote-control wheelchair model as well as automated costly chairs. As for future work, a statistical analysis is taken by our end and find new feature for making this system more comfortable to the peoples with disabilities. The methodology section outlines the plan and method that how the study is conducted.
This includes the scope of the study, research design, data and sources, variables, and methods of analysis.

III. METHODOLOGY AND IMPLEMENTATIONS

A. Arduino UNO

The Arduino UNO is a popular microcontroller board that serves as the core component in numerous electronic projects, including the Hand Gesture Control Wheelchair (HGCW) system. Developed by Arduino LLC, the UNO board is based on the ATmega328P microcontroller and features a simple yet powerful design, making it ideal for prototyping and experimenting with various sensors and actuators. In the context of the HGCW system, the Arduino UNO serves as the control unit responsible for processing sensor data, interpreting hand gestures, and generating commands to drive the wheelchair motors. Through its flexible I/O capabilities and extensive community support, the Arduino UNO facilitates the seamless integration of various components and enables the realization of a reliable and efficient control system for individuals with mobility impairments.

Figure 1 Arduino UNO

B. L293D Motor Driver

The L293D is a popular motor driver integrated circuit (IC) widely used in robotics and automation projects, including the Hand Gesture Control Wheelchair (HGCW) system. Developed by Texas Instruments, the L293D is specifically designed to control the direction and speed of DC motors, making it an essential component for driving the wheelchair's motors based on user hand gestures

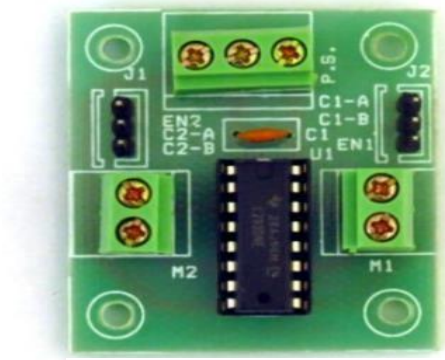


Figure 2 L293D Motor Driver

C. Transmitter Receiver Module

The Transmitter Receiver Module, often referred to as a wireless communication module or RF (Radio Frequency) module, plays a crucial role in facilitating communication between the wearable hand gesture detection device and the Hand Gesture Control Wheelchair (HGCW) system. These modules enable the transmission of control signals wirelessly from the wearable device to the wheelchair's control unit, allowing for seamless and intuitive operation without the need for physical connections.

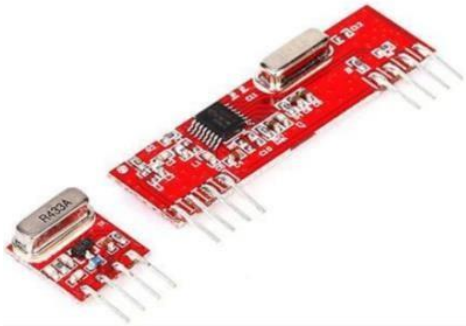


Figure 3 Transmitter Receiver Module

D. ADXL335 Accelerometer

The ADXL335 is a small, low-power, 3-axis accelerometer sensor manufactured by Analog Devices. It is widely used in various applications, including the Hand Gesture Control Wheelchair (HGCW) system, to detect and measure acceleration along three orthogonal axes. It is efficient to control the acceleration of the motor of wheelchair

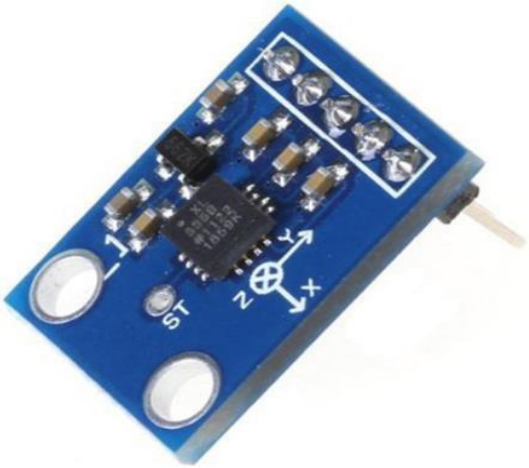


Figure 4 ADXL335 Accelerometer

E. DC Motor

In the context of the Hand Gesture Control Wheelchair (HGCW) system, DC (Direct Current) motors play a critical role in driving the movement of the wheelchair in response to the user's hand gestures. These motors are responsible for propelling the wheelchair forward, backward, and steering it left or right based on the commands received from the control unit.

Figure 5 DC Motor

F. Ultrasonic Sensor

Ultrasonic sensors are often used as proximity sensors. They can be found in automobiles' autonomous parking systems and collisi on avoidance systems. Ultrasonic sensors are used in robotic obstacle detection as well as in manufacturing technology. An ultraso nic sensor is a device that uses ultrasonic waves to measure the distance to an object. Ultrasonic sensors use transducers to send an d receive ultrasonic pulses, thereby transmitting information about the proximity of objects.

Figure 6 Ultrasonic Sensor

G. Universal Buzzer

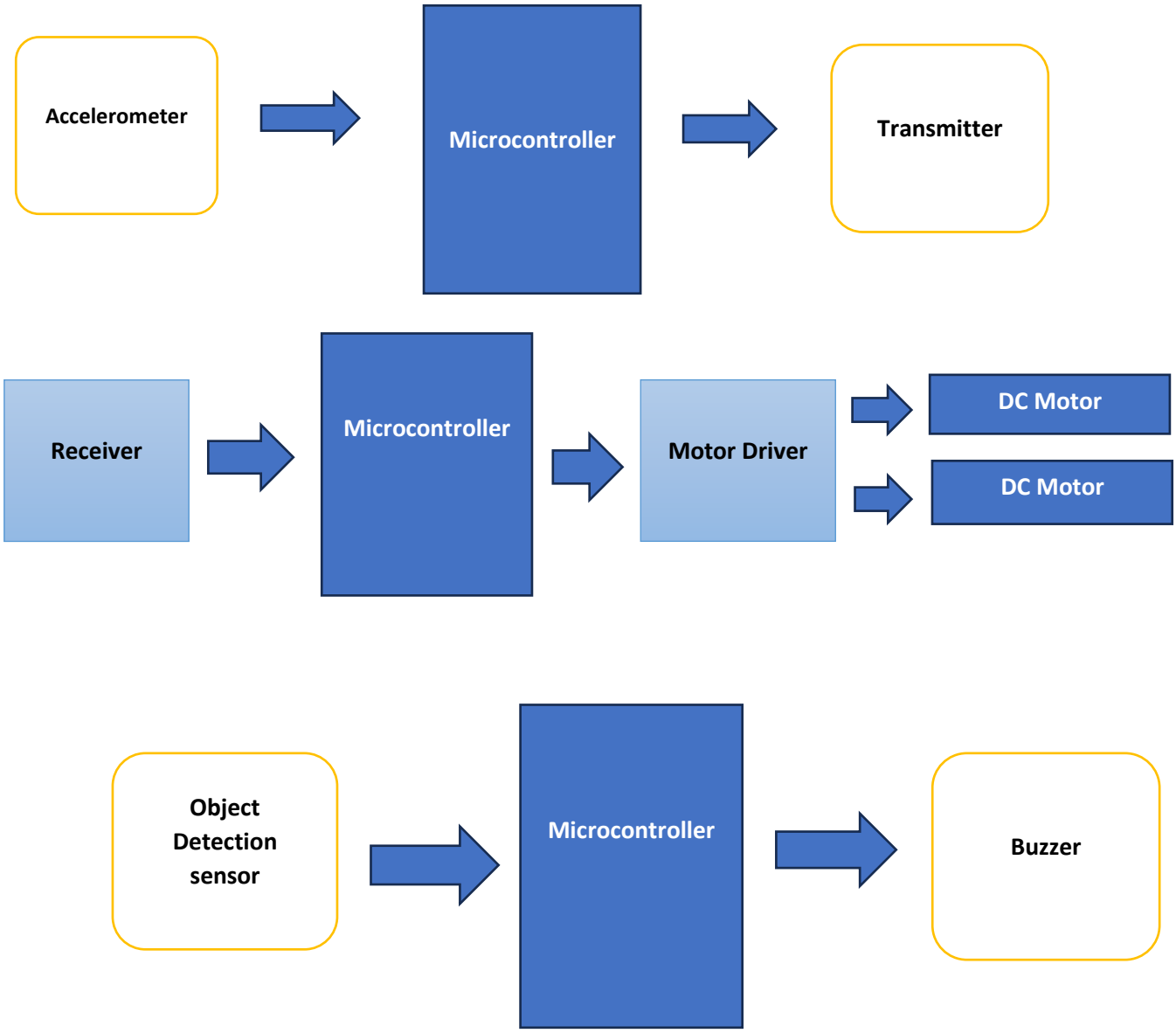
A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. The use of buzzers and bells includes alarm devices, timers, trains, and recognition of user input such as mouse clicks or keystrokes.

Figure 7 Universal Buzzer

Component and functionality

Sr. No	Component	Function	Description
1	**Gesture Recognition Unit**	Capture hand gesture	Tracks hand movements and translates them into control signals using image processing. **Data Glove:** Equipped with sensors to detect finger and hand movements for a more comfortable user experience.
2	**Microcontroller/Single-board Computer (SBC)**	Process sensor data and control wheelchair	**Arduino:** A popular option for simple gesture recognition and control. **Raspberry Pi:** Offers more processing power for complex algorithms and additional functionalities like IoT integration.
3	**Wireless Communication Module**	Enables communication and data transfers	**Wi-Fi/Bluetooth:** Allows remote monitoring, data transmission to cloud platforms for gesture refinement, or communication with additional IoT devices.
4	**Motor Driver**	Controls the movement of the wheelchair motors	**H-Bridge:** Bi-directional control for forward and backward movement
5	**Electric Motors**	Provide power for wheelchair movement	**DC Motors:** Common choice for wheelchairs, consider power rating based on weight and desired speed.
6	**Battery**	Power Source for the entire system	**Rechargeable Battery:** Ensures long-lasting operation, consider capacity based on usage and motor requirements.
7	**Sensors**	Enhance Safety and functionality	**Ultrasonic Sensors:** Detect obstacles for collision avoidance. **Gyroscope/Accelerometer:** Improve gesture recognition accuracy.
8	**User Interface (Optional)**	Provide user feedback and control	Alternative control method for users who might have difficulty with gestures. **LCD Screen:** Displays information like battery level or error messages.

ER Diagram HGCW



IV. RESULT

When the user moves their hand, accelerometer sensors detect these motions. The system interprets this data to control movement. Figure 8 illustrates the completed hand gesture control gloves. The physically challenged peoples are easily move from one place to another.

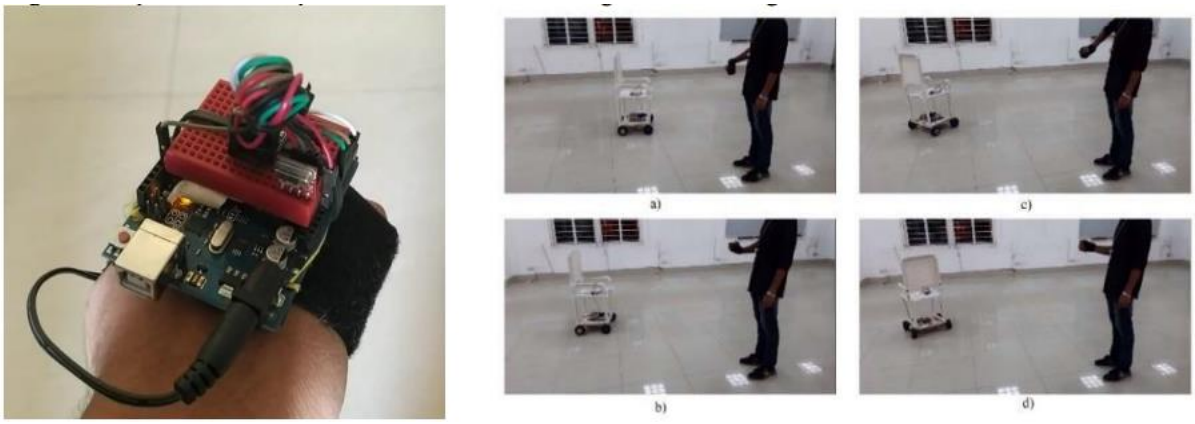


Figure 8 Implemented prototype Hand Gesture control gloves

V. CONCLUSION

Our research effectively enables wheelchair control for individuals with disabilities through hand gestures. It incorporates object and fall detection for enhanced safety. Further advancements could utilize diverse body movements like eye tracking, leg motions, voice control, or head tilts, for personalized user experiences.

Future scope

The future scope for hand gesture wheelchairs for disabled people is quite promising, with potential for increased functionality, personalization, and accessibility. Here are some exciting areas for development.

Advanced Gesture Recognition:

- **Multiple Gestures:** Expanding the range of hand gestures beyond basic movements to include complex combinations for more intuitive control.
- **Customization:** Allowing users to personalize the gestures used for specific commands, catering to individual needs and preferences.

Multimodal Integration:

- **Fusion with Other Sensors:** Combining hand gestures with eye gaze tracking, head movement, or voice commands for a more nuanced control experience.
- **Brain-Computer Interfaces (BCI):** Exploring BCI technology to potentially control wheelchairs directly through brain signals, offering a powerful option for individuals with severe limitations.

Enhanced Intelligence and Safety:

- **Environmental Recognition:** Incorporating object and obstacle detection with real-time path planning for safer navigation.
- **Fall Prevention:** Utilizing sensors and algorithms to predict and prevent falls, improving user safety.
- **Smart Features:** Integrating features like voice assistants, environmental controls, and self-docking capabilities for greater independence.

Accessibility and Affordability:

- **Cost Reduction:** Focusing on cost-effective designs and materials to make hand gesture wheelchairs more affordable for a wider range of users.
- **Standardization:** Establishing industry standards to ensure compatibility and ease of use across different wheelchair models.
- **Accessibility Features:** Exploring designs that cater to diverse physical abilities, ensuring everyone can benefit from this technology.

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