



(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 14, Issue 5, May 2025

⊕ www.ijirset.com 🖂 ijirset@gmail.com 🖄 +91-9940572462 🕓 +91 63819 07438





www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 5, May 2025

|DOI: 10.15680/IJIRSET.2025.1405244|

Head Operated Wheelchair using Raspberry Pico

Prathmesh Ramnath Dhage, Rutuja Santosh Chinuke, Saurav Kumar Mishra, Prof. Dipanjali Padhi

Dept. of ENTC, Dhole Patil College of Engineering, Kharadi, Pune, India

Assistant Professor, Dept. of ENTC, Dhole Patil College of Engineering, Kharadi, Pune, India

ABSTRACT: This project presents the development of a head-operated wheelchair robot aimed at enhancing mobility for individuals with severe physical disabilities, such as quadriplegia and cerebral palsy. Utilizing a Raspberry Pi Pico as the microcontroller, an ADXL345 accelerometer to detect head movements, and an L293D motor driver to control DC motors, the system allows users to navigate their wheelchair intuitively through simple head tilts. The use of affordable and readily available components ensures accessibility for a broader audience, while the integration of safety features enhances user security during operation.

The software is developed using the Arduino IDE, enabling efficient communication between components through I2C protocols. Performance testing validates the system's functionality, responsiveness, and safety. This innovative solution not only empowers individuals with disabilities by promoting independence and mobility but also contributes to the growing field of assistive technology. Future enhancements will focus on addressing limitations, improving precision, and adapting the system to meet diverse user needs, ultimately fostering greater inclusion and autonomy in everyday life.

I. INTRODUCTION

In recent years, assistive technologies have revolutionized the lives of individuals with disabilities, enabling them to gain greater independence and improving their ability to perform daily tasks. One area where this impact is most evident is in mobility aids such as wheelchairs. Traditional wheelchairs, whether manual or motorized, require either physical strength or hand-operated controls, such as a joystick, which may be inaccessible to users with limited hand function. To address these limitations, the development of intelligent, head-operated wheelchairs has become a promising alternative, leveraging advancements in microcontrollers, sensors, and motor control technologies.

This project focuses on the design and implementation of a head-operated wheelchair robot using a Raspberry Pi Pico, ADXL345 accelerometer, L293D motor driver, and DC motors. The goal of this system is to enable users to control the movement of a wheelchair solely through the tilt of their head, offering a hands-free solution for individuals with severe physical impairments, such as quadriplegia, cerebral palsy, or muscular dystrophy. By wearing a headband or cap embedded with the accelerometer, the user's head movements are translated into directional commands that the system can.

II. LITERATURE REVIEW

1) Wheelchair Control by Head Motion Using Accelerometer Abhishek Gupta (2016)

This system is an automatic head tilt movement controlled wheelchair that could operate 16 in any direction using head movements, i.e. Forward, Backward, Left and Right. It stops when the person does not tilt his head in any direction. In this paper, a microcontroller system that enables standard electric wheelchair control by head motion is developed. The project describes a wheelchair for physically disabled people developed using head motion and accelerometer sensor which is interfaced with DC motors. The prototype of the wheelchair is built using a PIC micro-Controller, chosen for its low cost, in addition to its features of easy erasing and programming.

2) Wheelchair Control by Head Motion Aleksandar Pajkanović (2013)

Electric wheelchairs are designed to aid paraplegics. Unfortunately, these can not be used by persons with higher degree of impairment, such as quadriplegics, i.e. persons that, due to age or illness, can not move any of the body parts, except of the head. Medical devices designed to help them are very complicated, rare and expensive. In this paper a microcontroller system that enables standard electric wheelchair control by head motion is presented. The system comprises electronic and mechanic components. A novel head motion recognition technique based on accelerometer





www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 5, May 2025

|DOI: 10.15680/IJIRSET.2025.1405244|

data processing is designed. The wheelchair joystick is controlled by the system's mechanical actuator. The system can be used with several different types of standard electric wheelchairs. It is tested and verified through an experiment performed within this paper.

3) Head Motion Controlled Wheelchair V.Purushothaman (2019)

Traditional Wheelchairs though have certain limitations with the flexibility, heavy weight of the chair and limited functions. Tremendous developments have been made in the field of wheelchair technology. Be that as it may, even these noteworthy advancements couldn't help the quadriplegics to explore wheelchair freely. Medical gadgets intended to support the Paraplegic and Quadriplegic patients are exceptionally muddled, once in a while accessible and costly. We go for planning a straightforward financially effective programmed wheelchair utilizing MEMS technology for quadriplegics with head and neck versatility. The control system interprets the situation of the user's head into speed and directional control of the wheelchair. The system is divided into two main units: MEMS Sensor and programmed Arduino Micro Controller. The MEMS sensor senses the change in direction of head and likewise the signal is given to microcontroller. Depending on the direction of the Acceleration, microcontroller controls the wheel chair directions like LEFT, RIGHT, FRONT, and BACK with the aid of DC motors. The work presented in this paper takes due care of the data which is kept on cloud as it not only provides the integrity check but also security for the data as well. This lets us to test the integrity at the moment of retrieving the stored data from Cloud.

III. METHODOLOGY OF PROPOSED SURVEY

The development of the head-operated wheelchair robot followed a systematic and modular approach, ensuring efficient integration of hardware and software components. The methodology began with defining user needs and identifying suitable components that could translate head gestures into motion commands. A Raspberry Pi Pico was selected as the core microcontroller for its affordability, low power consumption, and ability to handle real-time sensor data processing. The ADXL345 accelerometer was chosen for detecting head movements along the X, Y, and Z axes, enabling the system to recognize directional tilts such as forward, backward, left, and right. These movements serve as intuitive control inputs for the user.



Fig: Block Diagram

The initial phase involved building the sensing mechanism by interfacing the ADXL345 with the Raspberry Pi Pico using the I2C communication protocol. The sensor was mounted on a headband worn by the user to track natural head movements. Custom algorithms were developed in the Arduino IDE to read accelerometer data and interpret specific tilt thresholds corresponding to movement commands. To ensure responsiveness and avoid false triggers, noise filtering techniques and conditional checks were implemented within the software.

Once accurate gesture recognition was established, the control signals were routed to the L293D motor driver, responsible for managing the direction and speed of the DC motors attached to the wheelchair. The motor driver facilitated bidirectional movement, allowing the wheelchair to move forward, reverse, and turn as per the interpreted





www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 5, May 2025

|DOI: 10.15680/IJIRSET.2025.1405244|

head gestures. Motor testing was conducted iteratively to calibrate speed and ensure smooth operation on various surfaces, minimizing jerk and latency in response.

In the subsequent phase, safety features were embedded into the system, including an automatic stop mechanism when no valid gesture is detected or when excessive tilting is observed, to prevent unintentional movement. Provisions were made to integrate ultrasonic sensors in future iterations for obstacle detection and collision prevention. Additionally, user feedback was incorporated to adjust tilt sensitivity and improve ease of use.

The prototype underwent comprehensive testing in controlled environments to evaluate accuracy, usability, and reliability. Real-time performance data was logged and analyzed to refine gesture mapping and motor control logic. Throughout development, modular programming practices and hardware abstraction were followed to allow scalability and future integration with other assistive technologies, such as Bluetooth control or remote monitoring. This step-by-step methodology ensured the final system was robust, user-friendly, and suitable for individuals with severe physical impairments, meeting the project's objective of enhancing independent mobility through intuitive, head-operated control.



Figure: Raspberry pi Pico

The Raspberry Pi Pico is a microcontroller board based on the Raspberry Pi RP2040 chip, designed for a variety of embedded applications. It offers flexibility, affordability, and ease of use, making it a popular choice for hobbyists, educators, and developers



Figure: ADXL345

The ADXL345 is a small, low-power, 3-axis accelerometer with a digital output. It is designed for various applications, including mobile devices, wearables, and robotics, offering precise measurement of acceleration and motion. The device can detect dynamic acceleration (such as movement or vibration) and static acceleration (such as gravity) to determine the orientation of the device.

IJIRSET©2025





www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 5, May 2025

|DOI: 10.15680/IJIRSET.2025.1405244|



The L293D is widely used for driving DC motors and stepper motors in robotics, automation projects, and other applications requiring motor control. Its built-in protections and ability to drive multiple motors make it a popular choice among hobbyists and engineers.



A **DC motor** (Direct Current motor) is a type of electric motor that converts electrical energy into mechanical energy through the interaction of magnetic fields. It operates on the principle of electromagnetism, where current flowing through a coil generates a magnetic field that interacts with a permanent magnet, causing the rotor to spin. DC motors are available in various sizes and designs, typically characterized by their simplicity, reliability, and ease of control.

IV. FLOW CHART







www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 5, May 2025

|DOI: 10.15680/IJIRSET.2025.1405244|

IV. CONCLUSION AND FUTURE WORK

The developed head-operated wheelchair robot presents an effective, affordable, and user-friendly mobility solution for individuals with severe physical disabilities. By leveraging components like the Raspberry Pi Pico, ADXL345 accelerometer, L293D motor driver, and DC motors, the system successfully translates head movements into directional control commands. This intuitive, hands-free design empowers users with limited motor function to regain independence and mobility. The system was tested for responsiveness and accuracy, confirming its potential as a practical assistive technology in both home and clinical environments. Its modular design and open-source compatibility also make it adaptable for various user requirements.

Looking ahead, the project can be significantly enhanced by integrating features such as obstacle detection using ultrasonic sensors, wireless connectivity for remote control or monitoring, and audio feedback for better user interaction. Additional improvements may include battery status monitoring, machine learning-based gesture adaptation, and compact hardware design for increased comfort. These enhancements will not only increase the system's safety and usability but also pave the way for commercial deployment, contributing meaningfully to inclusive technology and quality-of-life improvements for people with disabilities.

REFERENCES

[1] U. Cortés, C. Urdiales, R. Annicchiarico, C. Barrué, A.B. Martinez, C. Caltagirone: Assistive Wheelchair Navigation: A Cognitive View, Studies in Computational Intelligence: Advanced Computational Intelligence Paradigms in Healthcare – 1, Vol. 48, 2007, pp. 165 – 187.

[2] A. Landi: Update on Tetraplegia, Journal of Hand Surgery, Vol. 28, No. 3, June 2003, pp. 196 – 204.

[3] N.I. Katevas, N.M. Sgouros, S.G. Tzafestas, G. Papakonstantinou, P. Beattie, J.M. Bishop, P. Tsanakas, D. Koutsouris: The Autonomous Mobile Robot SENARIO: A Sensor Aided Intelligent Navigation System for Powered Wheelchairs, IEEE Robotics and Automation Magazine, Vol. 4, No. 4, Dec. 1997, pp. 60 – 70.

[4] G. Bourhis, O. Horn, O. Habert, A. Pruski: An Autonomous Vehicle for People with Motor Disabilities, IEEE Robotics and Automation Magazine, Vol. 8, No. 1, March 2001, pp. 20 – 28.

[5] A. Lankenau, T. Rofer: A Versatile and Safe Mobility Assistant, IEEE Robotics and Automation Magazine, Vol. 8, No. 1, March 2001, pp. 29 – 37.

[6] M. Mazo: An Integral System for Assisted Mobility (Automated Wheelchair), IEEE Robotics and Automation Magazine, Vol. 8, No. 1, March 2001, pp. 46 – 56.

[7] H.A. Yanco: Wheelesley: A Robotic Wheelchair System: Indoor Navigation and User Interface, Lecture Notes in Artificial Intelligence, Vol. 1458, Assistive Technology and Artificial Intelligence, Applications in Robotics, User Interfaces and Natural Language Processing, Berlin, Springer, Germany, 1998, pp. 256 – 268.

[8] C.H. Kuo, H.H.W. Chen: Human-oriented Design of Autonomous Navigation Assisted Robotic Wheelchair for Indoor Environments, IEEE International Conference on Mechatronics, Budapest, Hungary, 03 – 05 July 2006, pp. 230 – 235.

[9] J.M. Detriche, B. Lesigne: Robotic system MASTER, European Conference on the Advancements of Rehabilitation Technology, Maastricht, Pays-Bas, Holland, 05 – 08 Nov. 1990, pp. 12 – 15.

[10] J.L. Jaffe: A Case Study: The Ultrasonic Head Controlled Wheelchair and Interface, OnCenter: Technology Transfer News, Vol. 1, No. 2, 1990.

[11] R.C. Simpson, S.P. Levine: Voice Control of a Powered Wheelchair, IEEE Transactions on Neural Systems and Rehabilitation Engineering, Vol. 10, No. 2, June 2002, pp. 122 – 125.

[12] P. Pino, P. Amoud, E. Brangier: A More Efficient Man Machine Interface: Fusion of the Interacting Telethesis and Smart Wheelchair Projects, 2nd International Conference on Knowledge-based Intelligent Electronic System, Adelaide, Australia, 21 – 23 April 1998, pp. 41 – 45. Wheelchair Control by Head Motion 151

[13] H.A. Yanco: Integrating Robotic Research: A Survey of Robotic Wheelchair Development, AAAI Spring Symposium on Integrating Robotic Research, Stanford, CA, USA, March 1998.

[14] M. Slavkovic, D. Jevtic: Face Recognition using Eigenface Approach, Serbian Journal of Electrical Engineering, Vol. 9, No. 1, Feb. 2012, pp. 121 – 130.

[15] S. Mitra, T. Acharya: Gesture Recognition: A Survey, IEEE Transactions on Systems, Man, and Cybernetics, Part C: Applications and Reviews, Vol. 37, No. 3, May 2007, pp. 311 – 324.

[16] L.R. Rabiner: A Tutorial on Hidden Markov Models and Selected Applications in Speech Recognition, Proceedings of the IEEE, Vol. 77, No. 2, Feb. 1989, pp. 257 – 286.





www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 5, May 2025

|DOI: 10.15680/IJIRSET.2025.1405244|

[17] S.K. Pal, S. Mitra: Neuro-fuzzy Pattern Recognition: Methods in Soft Computing, John Wiley and Sons, NY, USA, 1999.

[18] J. Liu, L. Zhong, J. Wickramasuriya, V. Vasudevan: uWave: Accelerometer-based Personalized Gesture Recognition and Its Applications, Pervasive and Mobile Computing, Vol. 5, No. 6, Dec. 2009, pp. 657 – 675.









INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY





www.ijirset.com