International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 11 | Nov - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

Smart Wheel chair using Raspberry pi

Ms. Srilakshmi Nayaka S R, Amrutha V, Balaji M V, Druvan M, Laxmi S N

Ms. Srilakshmi Nayaka S R, ECE & PES Institute of Technology and Management
Ms. Amrutha V, ECE & PES Institute of Technology and Management
Mr. Balaji M V, ECE & PES Institute of Technology and Management Mr. Druvan M, ECE & PES Institute of Technology and Management Ms. Laxmi S N, ECE & PES Institute of Technology and Management

---***---

Abstract – The integration of assistive technologies in healthcare has greatly enhanced the quality of life for individuals with mobility impairments. This project presents the design and development of a smart wheelchair controlled using a Raspberry Pi. The system incorporates sensors such as an accelerometer, ultrasonic sensors, and a camera module to enable intelligent navigation, obstacle detection, and safety monitoring. User commands can be provided through voice recognition, joystick, or gesture control, ensuring flexible operation. The Raspberry Pi acts as the central processing unit, interfacing with motor drivers to control the wheelchair's movement. Additionally, IoT connectivity can be implemented for remote monitoring, emergency alerts, and location tracking. The proposed smart wheelchair offers a cost-effective, customizable, and efficient solution that enhances user independence, safety, and accessibility compared to conventional wheelchairs.

Mobility assistance plays a vital role in improving the quality of life for people with physical disabilities. This project proposes the design and development of a smart wheelchair controlled using a Raspberry Pi with gesture recognition and voice commands. Gesture control is implemented using an accelerometer/gyroscope-based sensor (such as ADXL345), which interprets hand movements to direct the wheelchair stop, forward, backward, left, or right. Voice control is enabled through a microphone module and speech recognition system, allowing users to operate the wheelchair with simple spoken commands. The Raspberry Pi acts as the central controller, processing sensor data and controlling the DC motors via a motor driver. For safety, ultrasonic sensors are integrated to detect obstacles and prevent collisions. The combination of gesture and voice-based control provides flexibility, convenience, and independence for users

In the future, the system will be enhanced with machine learning techniques for speech and speaker recognition, enabling more accurate command interpretation, personalized voice profiles, and improved reliability in noisy environments, making the wheelchair smarter and more adaptive to individual users.

INTRODUCTION

In the rapidly evolving field of assistive technology, smart automation using embedded systems has brought innovative solutions for physically challenged individuals. Traditional manual wheelchairs require physical hand force or joystick control which may not be possible for patients suffering from paralysis, neuromuscular disorders, spinal cord injury, or elderly patients with very limited hand movement. To overcome these limitations, integrating gesture recognition and voice command technology using a Raspberry Pi provides a more intelligent, comfortable, and effortless control interface.

Gesture control uses sensors such as ADXL345 accelerometer to identify hand tilt directions like forward, backward, left, right, and stop. These sensor values are continuously read by the Raspberry Pi and then translated into control commands to navigate a wheelchair or robotic prototype. This allows the user to control movement just by small wrist or finger orientation, making it extremely efficient for users with limited body control.

Voice recognition adds more flexibility where the user can operate the system using verbal commands through a microphone. Using speech recognition algorithms, the Raspberry Pi processes words such as "forward", "stop", "left", and "right". When movement is controlled through voice, the user does not need any physical gesture, making the solution ideal even for fully paralyzed users who can speak but cannot move their hands. Combining both gesture and voice control increases accessibility and reliability, ensuring the user can shift between modes based on comfort and physical capability.

This dual control smart system using Raspberry Pi not only improves independent mobility but also enhances safety, confidence, and quality of life for specially-abled users. Therefore, implementing gesture + voice control technology in assistive devices is a major advancement towards next generation smart intelligent wheelchairs and human machine interaction.

1. LITERATURE REVIEW

Fitri Utaminingrum, Tri Astoto Kurniawan , M Ali Fauzi , Dahnial Syauqy, Randy Cahya Wihandika," Development of Computer Vision Based Obstacle Detection and Human Tracking on Smart Wheelchair for Disabled Patient ", **2017 5th International Symposium on Computational and Business Intelligence (ISCBI)**,11-14 Aug. 2017
The paper focuses on computer vision-based obstacle detection and human tracking for smart wheelchairs, improving navigation for disabled users.. Combining sensor-based detection (e.g., LiDAR or ultrasonic sensors) with vision systems could improve reliability and safety.

Dr.R.Priyatharshini , Muthu Selvam.S , Kausic Narayanan M.N , M.Ajai Kumar ," A Voice Controlled and Vision based Smart Wheel Chair for Paralyzed People "**2021 2nd Global Conference for Advancement in Technology (GCAT)**,1-3 Oct. 2021
The paper introduces a voice-controlled, vision-based smart wheelchair for paralyzed users, enhancing accessibility . Integrating gesture control and improved obstacle detection could enhance adaptability and safety.

Dr.T.Sethukarasi , A Abdur Rahman, S Angu Hari Hara Karthi, J Karthikeyan," Voice and Gesture Controlled Wheel Chair", **2022 International Interdisciplinary Humanitarian Conference for Sustainability (IIHC)**,18-19 Nov. 2022
The paper presents an innovative dual-control system for a smart wheelchair using gesture (MPU6050) and voice (Google Speech Recognition), with ultrasonic obstacle detection for safety. While effective, it has response delays in voice control, which could be improved with offline models.

Deekan S , Manjula S, M Pown , C M Velu, K A S Aadarsh ," Smart Wheelchair Based on Voice Recognition for Physically Disabled P,eople "**2024 International Conference on Power, Energy, Control and Transmission Systems (ICPECTS),**8-9 Oct. 2024
This paper emphasizes the incorporation of advanced voice control systems for ease of use and aims to provide a cost-effective solution that enhances both mobility and independence for users.

Nutt Jaturat , Pun Dissorn, Chuchart Pintavirooj, "SMART WHEELCHIAR FOR DISABLED PERSON", **2023 15th Biomedical Engineering International Conference (BMEiCON),**28-31 Oct. 2023

This paper describes a smart wheelchair designed to enhance mobility for disabled individualsThe project aims to offer a cost-effective and efficient solution to assistive mobility, addressing the needs of disabled persons with innovative technology.

2. PROBLEM STATEMENT

Develop a smart wheelchair that can be controlled through voice commands and hand gestures, using a Raspberry Pi. This will help people with mobility challenges navigate more easily and independently, without the need for physical movement.

3. METHOLOGY

The smart wheelchair integrates gesture control, voice control, and obstacle detection for efficient and safe navigation.

I. Gesture Control (ADXL345 Accelerometer):

Uses the ADXL345 MEMS accelerometer sensor to detect tilt angles of the user's hand or wearable device. Interprets hand tilt in five directions: Forward, Backward, Left, Right, and Stop. Each gesture is translated into an electrical signal that is processed by the Raspberry Pi/Arduino and sent to the L298N motor driver. Enables real-time movement control without physical effort, making it ideal for users with limited mobility. Compact MEMS technology ensures high sensitivity, low power consumption, and lightweight integration.

A USB microphone captures the user's voice commands. Commands like Forward, Backward, Left, Right, Stop are given by the user. The Google Speech Recognition API converts voice to text. The system processes the command and sends control signals to the motor driver. The motor driver moves the robot according to the recognized command.

II. Voice Authentication (CNN Model):

The system records my voice for authentication. Librosa extracts unique features like tone, pitch, and frequency. MFCC features and spectrograms are created to represent my voice pattern. A CNN (Convolutional Neural Network) model is trained using these voice features. The CNN identifies only my voice and rejects others automatically. Ensures secure and personal access to the system. Model achieved 88% validation accuracy, proving reliability.

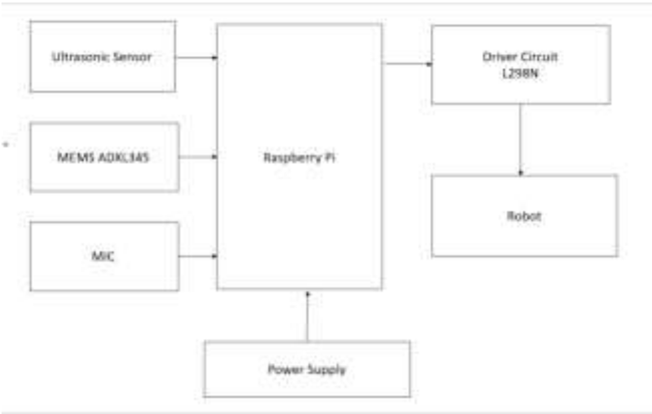

Figure 1:Block Diagram of smart-wheel-chair

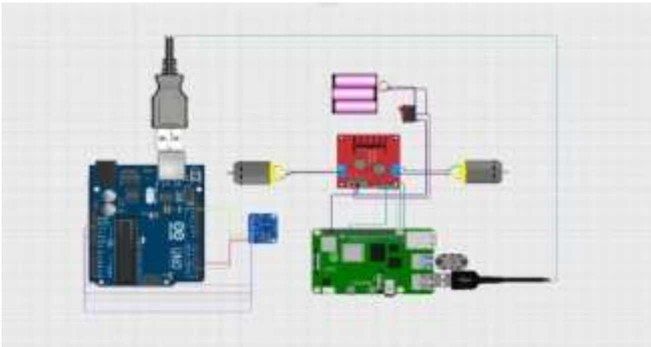

Figure 2: Circuit Diagram of voice control and Gesture control

4. OBJECTIVES

Objectives of Stand up Smart Wheels chair using Raspberry Pi:

I. Improve mobility and independence
II. Implement obstacle detection and avoidance
III. Integrate voice command and gesture control
IV. Provide real-time navigation and guidance
V. Enhance user experience and comfort

5. APPLICATIONS

I. Support for Paralyzed / Neuro Disorder Patients: This smart wheelchair helps patients who cannot control their limbs properly due to paralysis, stroke, spinal cord injury, or muscular weakness. Using voice and gesture control, the user can move independently without depending physically on others which improves self confidence and daily life comfort.

II. Hospital & Rehabilitation Mobility:

Smart wheelchairs can be used inside hospitals, rehab therapy centers and physiotherapy units to safely move patients from one department to another. Accurate gesture and voice control avoids strain on staff and reduces the manpower required for shifting patients frequently.

III. Indoor Smart Navigation for Elderly: Elderly people who have very weak motor control can also operate this system very easily. With obstacle detection sensors, the wheelchair can safely move inside houses, old age care centers or nursing homes without collisions, improving safety and reducing risk of accidents.

IV. Personalized Secure Mobility Using Voice Authentication:
Since voice authentication rejects unknown users, only the authorized patient can control the wheelchair. This prevents misuse and ensures safety in public environments like airports, malls, smart buildings, campuses where personalized mobility systems are required.

V. Assistive Technology Research & Future Automation:
This system can be a base platform for future AI based assistive mobility research such as autonomous navigation, ML based smart path planning, and remote monitoring through IoT. It can be extended for robo-assist care units, military injury rehab, and advanced human-machine interaction applications.

6. RESULTS – SYSTEM DEMONSTRATION

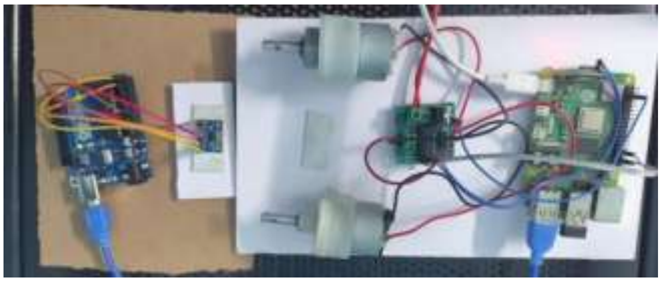

Figure 3: Hardware setup.

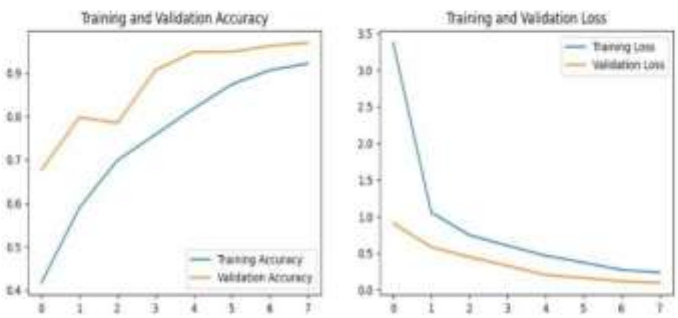

Figure 4: Graphical representation

This project is a voice and gesture-controlled system using Raspberry Pi 4, ADXL345 MEMS accelerometer, L298N motor driver, and DC motors. A USB microphone captures voice commands while the ADXL345 detects hand tilt gestures. The Raspberry Pi processes these inputs and controls the motors via GPIO pins, enabling hands-free and intuitive movement.

7. CONCLUSION

The Smart Wheel Chair developed using Raspberry Pi successfully demonstrates how advanced embedded systems, speech processing, sensor technology and human–machine interaction can transform mobility for specially abled individuals. By integrating gesture control through ADXL345 accelerometer and voice commands using microphone and speech recognition, the user can control the wheelchair easily without physical strain. The system also incorporates obstacle detection, real-time processing and voice authentication for safe, secure and reliable navigation. This reduces dependency on caretakers, improves confidence of patients, and gives them greater independence in day-to-day movement inside hospitals, homes and rehabilitation centers. Compared to traditional wheelchairs, this smart prototype is more flexible, cost-effective and adaptable for different levels of disability. In future, machine learning can be added for more accurate command prediction, IoT can enable remote monitoring and GPS tracking, and fully autonomous movement can be achieved which will make the wheelchair even smarter and more user friendly. Overall, this project proves how technology can create a big social impact in healthcare and enhance the quality of life of disabled and elderly people through smart assistive mobility systems.

8. REFERENCES

1) Saebu, Martin. (2010). Physical Disability And Physical Activity: A Review Of The Literature Corelates And Associations. European Journal of Adapted Physical Activity. 3. 37-55. 10.5507/euj.2010.008.

2) I. W. Nudra Bajantika Pradivta, A. Arifin, F. Arrofiqi and T. Watanabe, "Design of Myoelectric Control Command of Electric Wheelchair as Personal Mobility for Disabled Person," 2019 International Biomedical Instrumentation and Technology Conference (IBITeC), 2019, pp.112-117,doi:10.1109/IBITeC46597.2019.9091682.

3) Q. Huang, S. He, Q. Wang, Z. Gu, N. Peng, K. Li, and Y. Zhang, "An EOG-Based Human-Machine Interface for Wheelchair Control," vol. 9294, no. c, pp. 1–11, 2017.

4) V. Ramaraj, A. Paralikar, E. J. Lee, S. M. Anwar, and R. Monfaredi, "Development of a Modular Real-time Shared-control System for a Smart Wheelchair," *Journal of Signal Processing Systems,* pp. 1-12, 2023.

5) Anuradha Jayakody, Asiri Nawarathna, Indika Wijesinghe, Sumeera Liyanage and Janith Dissanayake."Smart Wheelchair to Facilitate Disabled Individuals", International Conference on Advancements in Computing (ICAC),2019.

6) Y. Asai; R. Enomoto, Y. Ueda, D. Iwai, K. Sato, "Virtual Hand Representation and Motion Control for Smart Wheelchair with Touch- Based Extended Hand Projection," In IEEJ Transactions on Electronics, Information and Systems, Vol. 139, No. 5, pp. 662-669, 2019.

7) Parikh, S. P., Grassi, V., Kumar, V., & Okamoto, J. (2018). Integrating human inputs with autonomous behaviuors on an intelligent wheelchair platform. *IEEE Intelligent Systems*, *22*(2), 33-41.

8) C. Wahyufitriyani, S. Susmartini, I. Priadythama. "Review of Intelligent Wheelchair Technology Control Development in the last 12 Years". Proc. 2nd International Conference of Industrial, Mechanical, Electrical, Chemical Engineering (ICIMECE), Yogyakarta Indonesia 6-7 Oct. 2016. DOI:10.1109/ICIMECE.2016.7910458.