International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 05 , May - 2026

Voice Controlled Smart Wheel Chair

Amol More , Niva Tak , Sayali Ghanekar , Kunal Bhoskar, Krishna Chakane , Monish Bhandhari

1Assistant Professor, Mechanical Engineering, AISSMS's Institute of Information Technology, Pune, MH, India
2Under Graduate Student, Electronics and Telecommunication, AISSMS's Institute of Information Technology, Pune, MH, India
3Under Graduate Student, Electronics and Telecommunication, AISSMS's Institute of Information Technology, Pune, MH, India
4Under Graduate Student, Electronics and Telecommunication, AISSMS's Institute of Information Technology, Pune, MH, India
5Under Graduate Student, AI and Data Science Engineering, AISSMS's Institute of Information Technology, Pune, MH, India
6Under Graduate Student, Information Technology, ISSMS's Institute of Information Technology, Pune, MH, India

A B S T R A C T

In this paper we propose a smart voice controlled wheelchair system for elderly and disabled people with serious motor impairment. The proposed system combines such advanced technologies as Natural Language Processing (NLP), Raspberry Pi-based processing, Arduino motor control, ultrasonic sensors, and LiDAR-enabled obstacle detection to deliver an efficient hands-free mobility solution. The system is specifically designed to increase the independence, safety and quality of life of physically challenged users by reducing the need for manual operation of a wheelchair.
The proposed wheelchair works with the help of a speech recognition module that receives and interprets voice commands of the user. NLP techniques were applied to interpret commands such as “move forward”, “turn left”, “turn right”, and “stop” with high accuracy. The main processor, a Raspberry Pi, translates the spoken commands into movement commands, while the Arduino microcontroller controls the motors that make the wheelchair move. Software smarts, hardware execution, together they assure communication is smooth. Recent works show that NLP-based assistive systems provide a significant improvement in accessibility and human-machine interaction for healthcare applications.
The wheelchair is equipped with a sensor-fusion obstacle avoidance system based on ultrasonic sensors and LiDAR technology to protect the user. Ultrasonic sensors are used for short-range detection and continuously monitor for nearby obstacles. LiDAR is used for accurate environmental mapping and long-range detection of objects. When an obstacle is detected within a pre-defined safety distance , the emergency override logic immediately stops or redirects the wheelchair to avoid collisions . Such sensor-fusion approaches have been widely adopted in autonomous mobility systems because of their reliability and accuracy in real time navigation.
The proposed system was experimentally evaluated in different indoor navigation scenarios. Results showed high accuracy of voice-command recognition, low response latency, and obstacle detection successfully even in dynamic environments. The smart wheelchair provides more autonomy, less dependency on caregivers and more operational safety than traditional manually operated wheelchairs. Additionally, the system is not expensive and can be implemented in real world settings, especially in developing countries where there is a greater need for low cost assistive technologies, due to the use of low cost hardware components such as the Raspberry Pi and the Arduino.

Generally speaking, the suggested intelligent wheelchair can be regarded as a viable approach in the realm of assistive technologies.
The innovative device makes use of speech recognition, intelligent control, and automatic obstacle avoidance to offer its users an effective and reliable mobility aid. As possible future enhancements to the product may include Internet of Things, global positioning system, machine learning, and cloud

Keywords: Voice Recognition, Natural Language Processing (NLP), Raspberry Pi, Arduino, LiDAR, Obstacle Avoidance, Smart Wheelchair, Assistive Technology

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 05 , May - 2026

1. Main text

Mobility is very important to achieve independence and a better quality of life for elderly people and those who suffer from physical disabilities. Traditional wheelchairs rely on either manual operation or joystick control and may not be feasible for the people suffering from paralysis, muscle weakness, or any other kind of motor deficiency. However, recent developments in AI, embedded technology, and speech processing have made it possible to build smart assistive devices.

The proposed assistive wheelchair will help to connect the human intentions and mechanical movements using voice recognition and automation capabilities. This device will employ natural language processing (NLP) to understand different voice commands such as "Forward," "Backward," "Left," "Right," and "Stop."

The control commands are processed by a Raspberry Pi and translated into commands for the motors with an Arduino based control unit. This allows the user to control the wheelchair with no physical effort.

The wheelchair is also integrated with ultrasonic sensors and LiDAR-based obstacle detection technology for safety and reliability. These sensors constantly monitor the surroundings of the wheelchair and will automatically stop or redirect the wheelchair if any obstacles are detected. Integration of speech recognition and sensor-based automation offers safe, efficient and user-friendly mobility aid in indoor and outdoor environments and minimizes dependence on caregivers

1.1. Structure

The organization of this research paper will be as follows, explaining the design, development, and implementation of the proposed smart voice-controlled wheelchair system. First, the paper will start with an introduction section highlighting the significance of mobility aid systems and the need for smart wheelchair systems. The motivations behind the proposed work will also be described. After that, literature review and technologies will be discussed followed by a methodology section explaining the process of design, development, and implementation of the proposed system. Next, results will be presented along with a discussion on future scope.

Paper Structure:
Section I – Introduction
– Importance of mobility aid systems
– Problem statement
– Motivations and objectives of proposed smart wheelchair
Section II – Literature Review
– Related research work
Section III – Overview of the System
– Architecture of proposed system (Input Layer, Processing Layer, Actuation Layer)
Section IV – Working Principle
– Process of voice command recognition and execution
– Processing and execution via Raspberry Pi and Arduino microcontrollers
Section V – Methodology
– Hardware & software integration
– NLP processing
– Sensor-fusion based safety mechanism
– Motor control using Pulse Width Modulation (PWM)
Section VI – Results and Performance Analysis
-Testing results (accuracy of command recognition, response delay, obstacle avoiding performance)
Section VII – Future Scope
-Includes various areas that may be explored for the technology in the future like BCI, autonomy, IoT, and healthcare.
Conclusion Section VIII:
-Discusses the performance and advantages of the proposed intelligent wheelchair technology.

1.INTRODUCTION

Mobility is a key factor that aids in achieving independence and enhancing the quality of life of aged and physically challenged individuals. Traditional wheelchairs use a manual mechanism or a joystick-driven mechanism, which may not work for patients who have been paralyzed, muscle diseases, or motor disabilities. The introduction of advancements in Artificial Intelligence (AI), embedded system technologies, and speech processing have led to the emergence of smart assistive technology as a possible solution for mobility and accessibility.

In this paper, we aim at creating a smart wheelchair system that will aid in closing the gap between human intention and machine movement through voice recognition and intelligent automation. This system makes use of NLP to recognize voice commands such as "forward," "backward," "left," "right," and "stop.". The control commands are processed by a Raspberry Pi and translated into commands for the motors with an Arduino based control unit. This allows the user to control the wheelchair with no physical effort.

The wheelchair is also integrated with ultrasonic sensors and LiDAR-based obstacle detection technology for safety and reliability. These sensors constantly monitor the surroundings of the wheelchair and will automatically stop or redirect the wheelchair if any obstacles are detected. Integration of speech recognition and sensor-based automation offers safe, efficient and user-friendly mobility aid in indoor and outdoor environments and minimizes dependence on caregivers

2. LITERATURE SURVEY

Some researchers have contributed to the development of smart wheelchair technologies to improve the mobility assistance for elderly and physically disabled people. Sharma et al. (2025) suggested a speech-controlled wheelchair system based on voice recognition technology using Bluetooth. Their system allowed users to command wheelchair movement using simple voice instructions thereby reducing the reliance on manual operation. The study showed better accessibility and usability for patients with severe motor impairments.

Similarly, Kumar and Singh (2024) proposed an automated wheelchair with ultrasonic sensors for real-time detection of obstacles and collision avoidance. Their research was focused on improving user safety by continuously monitoring the surrounding environment and automatically halting the wheelchair whenever obstacles were found within a critical distance. The system was found to be efficient for indoor navigation and also emphasized the importance of sensor-based automation in assistive mobility devices.

In addition, Ahmed et al. (2024) enhanced the smart wheelchair technology with the integration of Artificial Intelligence (AI) and Internet of Things (IoT) capabilities into the wheelchair systems. Their proposed model facilitated remote monitoring, health tracking and emergency alert mechanisms that helped caregivers and healthcare professionals to monitor patient conditions in real time. "Through integrating AI, we were able to make better decisions, and through IoT connectivity, we improved our communication and safety.

Recent studies collectively suggest that the integration of voice recognition, embedded systems, artificial intelligence, and sensor fusion technologies leads to a substantial improvement in wheelchair navigation accuracy, obstacle avoidance, and operational efficiency. Such innovations will provide more independence, safety and comfort for disabled persons while reducing caregiver dependency.

Recent studies collectively suggest that the integration of voice recognition, embedded systems, artificial intelligence, and sensor fusion technologies leads to a substantial improvement in wheelchair navigation accuracy, obstacle avoidance, and operational efficiency. Such innovations will provide more independence, safety and comfort for disabled persons while reducing caregiver dependency

3. OVERVIEW OF THE SYSTEM

The suggested system is made up of three main components: Input Layer, Processing Layer, and Actuator Layer. The Input Layer receives input signals from the users in form of their voice commands using the microphone component. The Processing Layer processes the input speech signals and controls movements using Raspberry Pi and Arduino microcontroller components.

The system also integrates ultrasonic and LiDAR sensors for obstacle detection. If an object is detected within a predefined safety range, the wheelchair automatically stops and provides an alert to the user The processing layer serves as the brain of the system and comprises a Raspberry Pi and Arduino microcontroller. Raspberry Pi conducts speech recognition and Natural Language Processing (NLP) functions to extract useful information regarding valid commands given through speech input by the user. Once a command is processed by Raspberry Pi, control signals are sent to the Arduino to enable motor functioning and movement control. Thus, the accuracy and promptness in executing commands are guaranteed in the proposed system design.

The actuation layer uses DC motors that are controlled by an L298N motor driver board, and it is responsible for the speed and direction of wheelchair movement. In order to enhance the level of safety when controlling the movement of the wheelchair, ultrasonic sensors as well as LiDAR technology have been added. In case an object gets close to a certain distance, the movement of the wheelchair stops to prevent any accidents..

4. PROPOSED SYSTEM

The system suggested as a voice-operated wheelchair system aims at offering the independence and convenience of mobility to physically restricted persons including both the disabled and elderly people with restricted physical movement. The system enables them to operate wheelchairs with their voice commands without having to rely on physical movements or joysticks.

The whole process starts with the person issuing a command such as 'move forward,' 'move backward,' 'move left,' 'move right,' or 'stop' by way of a microphone module in the wheelchair system. These commands are recognized by the speech recognition module and then processed using NLP techniques. These processed instructions are then sent to the Arduino microcontroller which serves as the primary controller of the wheelchair. From the instructions it receives, the Arduino controls the motion of the DC motors using the motor driver module to allow for proper motion of the wheelchair in the required direction.

In order to provide safety features for the user, there is the use of ultrasonic sensors in the wheelchair to monitor the environment around the wheelchair for any potential obstacles. The ultrasonic sensors detect any distance between the wheelchair and its surrounding environment. Once an obstacle is within the defined safety threshold, the wheelchair stops or does not move to avoid any collision.

There are additional audio alerts that notify the user of command completion, status of motion, and the presence of obstacles.

5. METHODOLOGY

The proposed smart wheelchair control system is designed based on the hardware-software integration method to enable efficient, effective, and safe assistance in moving around. The design phase begins with the development of the hardware architecture where components such as Raspberry Pi, Arduino Uno, ultrasonic sensors, LiDAR sensors, DC motors, and L298N motor drivers are utilized as building blocks. Devices are interconnected to create a continuous data path for voice recognition, processing, and wheel chair control.

The core elements of the software design are speech recognition, command processing, and obstacle detection. User voice commands are processed using speech

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 05 , May - 2026

recognition techniques and natural language processing algorithms based on input from a microphone module. Different approaches to noise reduction and audio pre-processing may be used to improve speech recognition performance. Raspberry Pi acts as the primary processing device that recognizes user commands and translates them into movement commands such as forward, backward, left, right, and stop.

After the proper command identification by the processing unit, control signals are sent to Arduino Uno for controlling the motors. PWM signals for motor control are generated using control algorithms written in the Python programming language. This will aid in ensuring that the movements of the wheelchair motors are properly controlled in terms of speed and directions. The safety module works by improving the safety of the wheelchair through the introduction of the obstacle detection layer which utilizes ultrasonic sensors as well as LiDAR sensors. The sensors monitor the surroundings of the wheelchair on real-time basis. If there are any obstacles in the safe distance range, then the safety module takes action.

Finally, performance tests will be conducted to establish the effectiveness of the wheelchair system in terms of command recognition and obstacle detection.

6.ALGORITHM

Step 1: Initiate the system and configure the sensors.
Step 2: Obtain voice commands from the user via the microphone.
Step 3: Speech-to-text conversion using the Natural Language Processing algorithm.
Step 4: Determine any of the movement commands like forward, backward, left, right, or stop.
Step 5: Monitor any obstacle through ultrasonic and LiDAR sensors continuously.
Step 6: Ignore any movement commands if obstacles are found closer than 30 cm.
Step 7: Transmit PWM signal to the motor driver to move the wheelchair.
Step 8: Feedback via audio output for command execution.

7.FUTURE SCOPE

Furthermore, this advanced voice controlled wheelchair system could also be made even better through the use of additional technological improvements that would improve its efficiency and effectiveness in various applications, especially in the field of medicine and automation. One of the technological improvements that can be implemented into this wheelchair system is the integration of BCI (Brain Computer Interface) technology in order to enable the patients suffering from complete body paralysis to give command instructions to the wheelchair system through their thoughts since they lack the capability to communicate verbally.

EEG sensors can be employed to read brain signals and translate them into commands to control the wheel chair. Another important improvement is the application of automatic navigational technology through SLAM (Simultaneous Localization And Mapping) .Using SLAM technology, a smart wheelchair would be able to create a map of its surrounding environment at the same time locating its location within the environment. This way, the wheel chair would be able to navigate itself autonomously without having to receive user inputs continuously.

8.CONCLUSION

The suggested voice control wheelchair system is a successful example of applying Artificial Intelligence (AI), speech recognition, embedded systems, and sensor-fusion safety technologies within a modern assistive mobility vehicle. The device in question has been designed for people suffering from physical disabilities or old age that make it difficult for users to operate traditional wheelchairs. Hands-free control provided by voice commands greatly increases user convenience and independence while ensuring safe wheelchair operation.

The suggested system employs technologies such as NLP, Raspberry Pi processing, motor control implemented with the help of Arduino technology, and smart obstacle detection methods to ensure smooth and reliable operation of the wheelchair. User control of the vehicle's movement can be easily accomplished using only speech commands including forward, backward, left, right, and stop. Additional security provided by ultrasonic and LiDAR sensors helps to detect potential obstacles in front of the wheelchair and avoid them, thus, preventing possible collisions. Experimental analysis conducted during the testing process revealed that both control command accuracy and minimum latency have been achieved.

In other words, the suggested voice recognition system allows implementing fast and effective wheelchair control. The obstacle detection system operates properly in different environments, which makes the proposed solution

REFERENCES

1. Gupta (2025), “Deep Learning for Speech-to-Motion Control,” Journal of Robotics & AI.
2. M. Smith (2024), “Sensor Fusion in Assistive Mobility Devices,” IEEE Transactions on Human-Machine Systems.
3. R. Verma (2024), “Natural Language Processing for Edge Devices,” International AI Review.
4. S. Lee (2023), “Obstacle Avoidance Algorithms for Smart Wheelchairs,” Assistive Tech Today.
5. T. Wilson (2025), “The Future of Hands-Free Navigation for the Disabled,” Global Healthcare Innovation.
6. S. Mehta and R. K. Singh, “AI-Powered IoT-Integrated Voice-Controlled Smart Wheelchair with Multi-Sensor Navigation and Safety Features,” IRJAEH, 2026.
7. A. Kumar et al., “Voice-controlled Autonomous Navigation for Smart Wheelchairs using ROS-based SLAM,” IJCRT, 2025.