IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

AUTOMATED WHEELCHAIR WITH VOICE RECOGNITION SYSTEM

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***Abstract*:** This paper presents the design and development of an automated wheelchair controlled using a voice recognition system with support for native Malayalam voice commands. The system is designed to assist individuals with severe physical disabilities who cannot operate conventional manual wheelchairs. Users can control the wheelchair through simple commands such as forward, left, right, and stop. The system integrates an ESP32 microcontroller, voice recognition system, ultrasonic sensor for obstacle detection, gyro-accelerometer for tilt monitoring, L298N motor driver, DC motors, and a 12V battery. The ultrasonic sensor detects obstacles to prevent collisions, while the gyro-accelerometer monitors the stability of the wheelchair. The use of Malayalam voice commands enhances accessibility and usability for local users who may not be comfortable with English-based interfaces. Experimental testing demonstrates that the system accurately recognizes commands and controls wheelchair movement with minimal delay, thereby improving mobility, safety, and independence.

Index Terms - Voice Recognition System, Automated Wheelchair, Assistive Technology, Embedded Systems, Ultrasonic Sensor, Malayalam Voice Commands, Native Language Interface.

I. INTRODUCTION

Mobility is essential for the independence and quality of life of individuals with physical disabilities. Conventional wheelchairs require manual effort or joystick controls, which may not be suitable for those with paralysis, spinal cord injuries, or severe motor impairments. Many people depend on caregivers for mobility, which reduces their independence and confidence in daily activities. Recent developments in embedded systems, speech recognition technology, and assistive robotics have opened up new options for smart mobility solutions. Voice-controlled wheelchairs provide a promising way for users to navigate and control movement using natural spoken commands. By removing the need for manual operation, voice-based systems enable physically disabled individuals to move independently and safely.

The proposed automated wheelchair with a voice recognition system that supports native Malayalam commands aims to tackle these challenges by combining voice recognition technology with sensor-based safety features. Users can operate the wheelchair using commands in their own language, making it more accessible, intuitive, and user-friendly. This system also includes ultrasonic sensors for obstacle detection and a gyro-accelerometer for tilt monitoring to ensure safe operation.

The wheelchair runs on a microcontroller that processes voice inputs and sensor data in real time. When a user gives commands like “forward,” “left,” “right,” or “stop,” the system interprets the commands and drives the motors accordingly. The obstacle detection feature helps prevent collisions with nearby objects, while the tilt monitoring system keeps the wheelchair stable on uneven surfaces.

This research aims to create an affordable and dependable assistive mobility device that can greatly enhance the independence of physically disabled individuals. By merging voice recognition in the native Malayalam language, embedded systems, and sensor safety features, this proposed system provides a practical solution for smart wheelchair control.

II. PROPOSED SYSTEM

The proposed system is a voice-controlled wheelchair that enables a user to move using voice commands. A microphone picks up voice commands in the native Malayalam language from the user and transmits them to a controller. The controller processes these commands through a voice recognition system and transmits signals to a motor driver to control two DC motors attached to the wheelchair.

For safety, an ultrasonic sensor is used to detect obstacles and prevent collisions. A gyro-accelerometer is also employed to detect the tilt of the wheelchair, helping maintain stability on uneven surfaces. The ability to operate the wheelchair using voice commands in Malayalam makes the system more accessible and user-friendly for local users, ensuring that even individuals who may not be comfortable with English-based interfaces can use the system independently and safely.

III. SYSTEM ARCHITECTURE

The system architecture of the automated wheelchair with voice recognition has been designed to enable individuals with disabilities to control the movement of the wheelchair using voice commands while ensuring safety through the integration of sensors. The architecture consists of the voice recognition system, microcontroller unit, sensor modules, motor driver circuit, and DC motors. The system starts with the voice recognition system, where the user provides commands in the native Malayalam language, such as forward, backward, left, right, and stop. These commands are processed by the voice recognition system and then sent to the microcontroller unit, which acts as the central control unit of the system.

Based on the recognized commands, the microcontroller processes the inputs and sends signals to the motor driver circuit, enabling the DC motors connected to the wheelchair wheels to move in the desired direction.
For safety, the system integrates sensor modules, including an ultrasonic sensor to detect obstacles and prevent collisions, and a gyro-accelerometer to monitor tilt and maintain stability. The general architecture is shown in Fig. 1

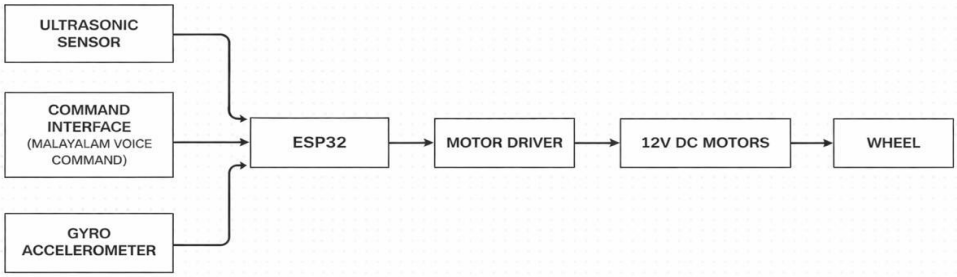

Fig.1.Block diagram

This architecture illustrates the interaction between the voice recognition system, microcontroller, motor driver, and sensor modules, highlighting how commands in Malayalam are processed to provide safe and independent wheelchair operation.

IV. MODULE DESCRIPTION

The automated wheelchair system consists of several modules that work together to perform voice recognition, obstacle detection, and wheelchair movement. Each module has a specific function that contributes to the overall operation and safety of the system.

A. ESP32 Microcontroller

The ESP32 microcontroller acts as the central control unit of the system. It receives input from the voice recognition system and sensor modules, and processes the data accordingly. Based on the received voice commands, the ESP32 sends control signals to the motor driver to operate the wheelchair motors. The ESP32 is widely used in embedded systems because of its low power consumption, high processing capability, and built-in wireless communication features. It enables real-time processing of voice commands in the native Malayalam language and sensor data, ensuring smooth and responsive operation of the wheelchair.

B. Ultrasonic Sensor

The ultrasonic sensor is used for obstacle detection. It works by transmitting ultrasonic sound waves and measuring the time taken for the reflected waves to return after hitting an object. Using this time delay, the distance between the wheelchair and the obstacle is calculated. When an obstacle is detected within a certain range, the system alerts the user or prevents the wheelchair from moving forward. This feature helps avoid collisions and ensures safe navigation for the user.

C. Gyro-Accelerometer Sensor

The gyro-accelerometer sensor monitors the tilt and orientation of the wheelchair. It combines both gyroscope and accelerometer functionalities to detect changes in movement and position. The accelerometer measures linear acceleration and tilt, while the gyroscope detects rotational movement. This sensor helps identify abnormal tilting or unstable conditions, ensuring the wheelchair remains balanced during operation.

D. Motor Driver (L298N)

The L298N motor driver controls the speed and direction of the DC motors. Since the microcontroller cannot directly drive the motors due to power limitations, the motor driver acts as an interface between the microcontroller and the motors. It receives control signals from the ESP32 and supplies the required current and voltage to the motors, allowing the wheelchair to move forward, backward, or turn left and right according to the user's Malayalam voice commands.

E. DC Motors

The DC motors drive the wheels of the wheelchair. These motors convert electrical energy into mechanical motion, enabling movement. The direction of rotation of the motors determines the direction of the wheelchair, and the motor driver controls the motors according to signals from the microcontroller.

F. Battery

A 12V battery is used as the main power source for the system. It supplies electrical power to the microcontroller, sensors, motor driver, and DC motors, ensuring that the wheelchair operates continuously and reliably without requiring external power sources.

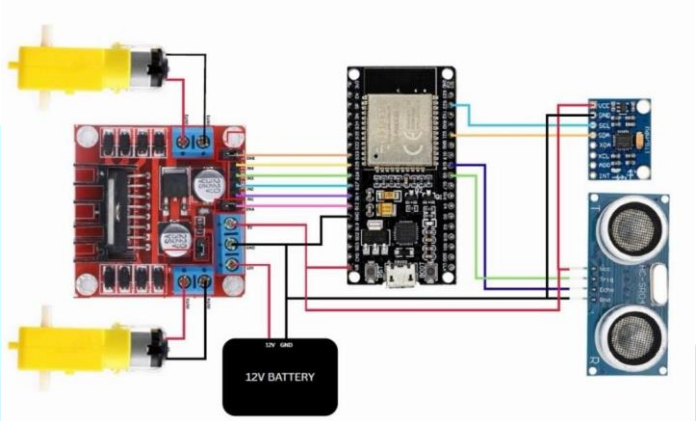

Fig.2.Circuit diagram

III. RESULTS AND DISCUSSION

The performance of the suggested automated wheelchair with voice recognition system has been tested under various conditions of operation. The key areas considered are voice command recognition, obstacle detection, and control of wheelchair movement.

For voice recognition, various commands were given in the native language Malayalam, and it was observed that the system recognized them accurately and operated accordingly. The response time was minimal, ensuring smooth and efficient operation for the user.

For ultrasonic sensor testing, various obstacles were placed at different intervals, and it was observed that the sensor detected them within the specified range and helped in preventing collisions, ensuring safe operation.

The gyro-accelerometer sensor was also tested, and it was observed that it effectively monitored the tilt and orientation of the wheelchair, providing stability during movement.

The motor driver and DC motors were also tested, and it was observed that they operated properly and ensured smooth movement of the wheelchair in all directions. Thus, it can be concluded that the system has shown reliable performance and ensured smooth and safe operation, while also providing the advantage of voice control in the native Malayalam language, making it more user-friendly and accessible for local users.

IV.ACKNOWLEDGMENT

We would remember with grateful appreciation, the encouragement and support rendered by the authority of Eranad Knowledge City Technical Campus, especially **Dr. ADARSH T K**, principal, Eranad Knowledge City Technical Campus, Manjeri, to successfully complete this Project. We express our deepest sense of gratitude to **Ms. NEETHU P M**, Head of the Department of Electronics and Communication Engineering and Project Coordinator **Ms. NEETHU P M**, Assistant Professor, Department of ECE for their keen interest and constant encouragement with our work during all stages. We wish to reveal my profound thanks to our Project Guide **Mr. THASNIMOL K**, Assistant Professor, Department of ECE, for her valuable advice and guidance. We greatly acknowledge all other staff members of the department and all our friends and well-wishers, who directly or indirectly contributed to this work. My heartfelt thanks to my family members for their kind cooperation in completing this Project and last but not least, we are indebted to God Almighty for being the guiding light throughout this Project and helped me to complete the same within the stipulated time.

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