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Development of a Voice - Controlled Intelligent Wheel Chair System Using Raspberry PI

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Abstract: *An intelligent wheelchair is designed to help physically disabled patients by using speech recognition system to control the movement of wheelchair in different directions. Automatic obstacle detection done using an ultrasonic sonar system which helps the patient to apply a momentary brake in case any obstacle suddenly comes in the way of the wheelchair and also vocally inform patient about obstacle distance from wheelchair.*

The intelligent wheelchair is designed in such a way that it can be controlled easily with minimum effort from the patient and also provides protection from obstacle collision if any voice mistake happens. The extra features like voice search and news listening mode is also available. The leading improvement is the low cost design and more features which allows more number of patients to use this wheelchair.

This project presents the development of a voice-controlled intelligent wheelchair system using Raspberry Pi, aimed at enhancing mobility for individuals with physical disabilities. The system interprets voice commands to control the wheelchair's movements—such as forward, backward, left, right, and stop—offering a hands-free navigation solution. It integrates speech recognition technology, motor drivers, and ultrasonic sensors to ensure safe and intelligent maneuvering. Obstacle detection is incorporated to prevent collisions, thereby ensuring user safety. The proposed system is cost-effective, user-friendly, and serves as a reliable assistive device, with potential for future enhancement through GPS, IOT, and machine learning integration.

Keywords*:* voice control; wheelchair; Raspberry Pi; speech recognition; motor control; assistive robotics

I. INTRODUCTION

In todays world, There are patients who have lost control of both arms and legs, as a result of higher level spinal cord injury or brain and nervous system there are patients that have lost their legs in an accident use the standard wheel chair. These wheelchairs are propelled by the use of hands of the patient sitting on it or by some other person by applying external force. There is a complexity in the use of these wheelchairs because it requires some physical effort. A joystick controlled wheelchair is a replacement of standard wheelchair. These wheelchairs are powered by the eclectic current and the direction of wheel chair controlled by use of joysticks. It removes the effort of the patient or some other person for propelling the wheel chair. A new advancement in the development of the wheelchair is voice controlled wheelchair. Voice recognition depends on converting a particular spoken word to an electrical signal which is further digitized in order to be processed by a computer or microcontroller The voice recognition not works very well in all conditions due to the noise of environment and incorrect accent.

II. LITERATURE SURVEY

Research in IoT applications shows that moisture sensors with Esp8266 provide reliable real-time monitoring for resource management. Studies on face-recognition systems using OpenCV and machine learning demonstrate improved accuracy and reduced manual errors in attendance tracking. Similarly, literature on QR- based navigation highlights its effectiveness as a low-cost, easy-to-deploy solution for guiding users in complex environments.

These findings from previous studies support the integration of IoT, AI, and QR technologies, showing that such systems enhance automation, accuracy, and overall management efficiency in campuses.

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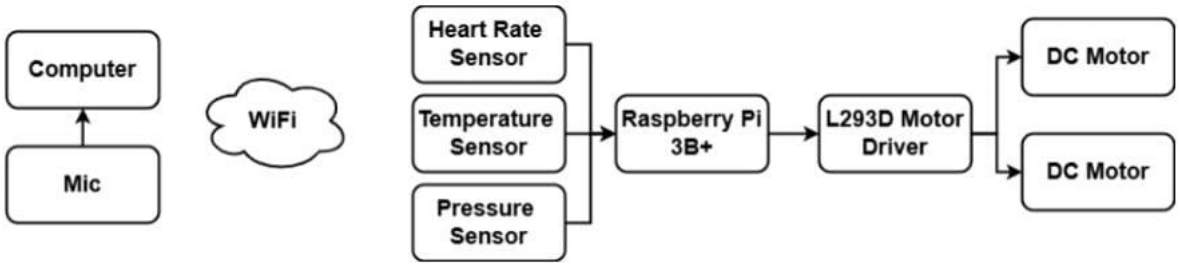
III. OBJECTIVES

- To understand the fundamentals of voice-controlled systems and their relevance in assistive technologies. To understand the ability to work with Raspberry Pi for building embedded applications.
- To understand the integration of speech recognition and sensor technologies for realtime control.
- To understand the intelligent wheelchair prototype that responds to voice commands and navigates safely. To understand the ethical, practical, and societal impacts of assistive robotics in healthcare

IV. METHODOLOGY

- Identify user requirements for voice-based wheelchair control and safety needs.
- Design the system architecture integrating Raspberry Pi, motors, sensors, and microphone.
- Select components such as Raspberry Pi, motor driver, ultrasonic sensors, microphone, and DC motors.
- Assemble the hardware by connecting Raspberry Pi to motor driver, sensors, and power supply.
- Develop software for voice recognition, command processing, and motor control.
- Implement obstacle detection using ultrasonic sensors to avoid collisions.

V. BLOCK DIAGRAM



- Microphone: Captures the user's voice commands and sends them to the Raspberry Pi for processing. Speakers: Provide audio feedback to the user, such as confirmation messages or system alerts.
- Raspberry Pi: Acts as the main controller that processes voice input, interprets commands, and controls the motor drivers and display.
- LCD Status Display : Shows real-time system status, such as command feedback or obstacle warnings.
- Ultrasonic SONAR (Obstacle Detection): Detects obstacles in the wheelchair's path and sends distance data to the Raspberry Pi for decision-making.
- Motor Driver H-Bridge (Left and Right): Receives control signals from the Raspberry Pi to drive the left and right motors accordingly. Left & Right Motors: Drive the wheelchair’s wheels based on the signals from their respective motor drivers.
- Power Board (Battery 12V 48A): Supplies power to the entire system including Raspberry.

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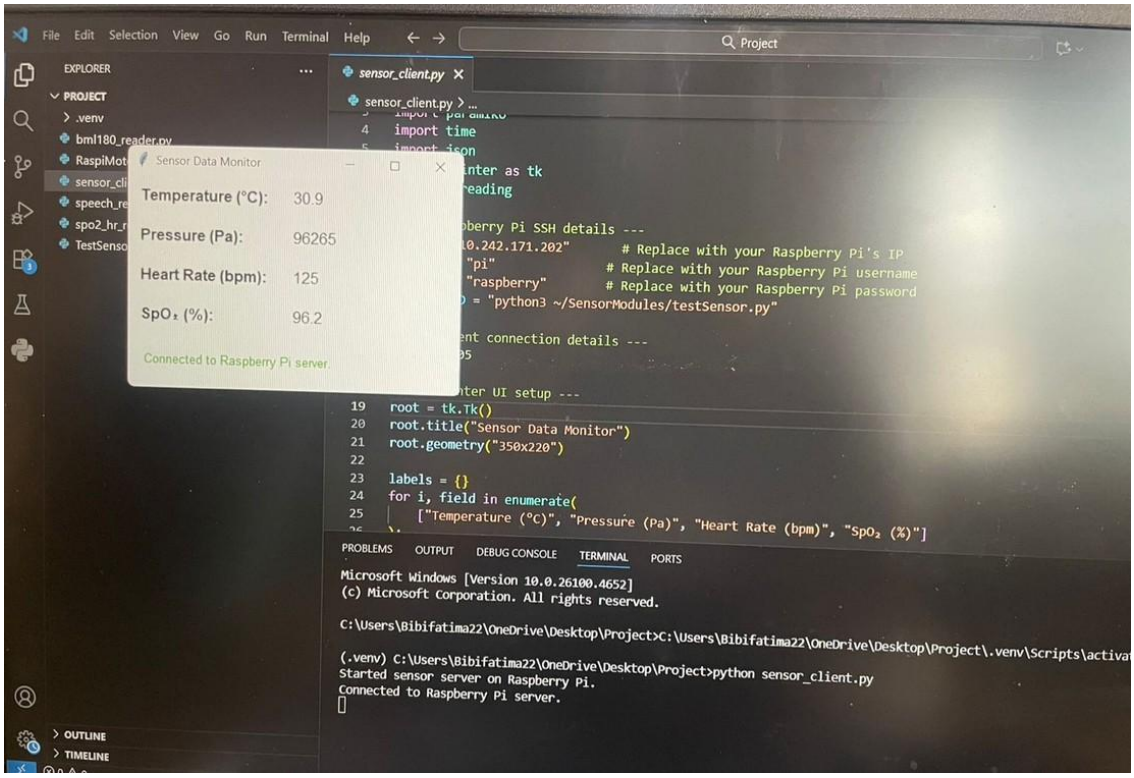
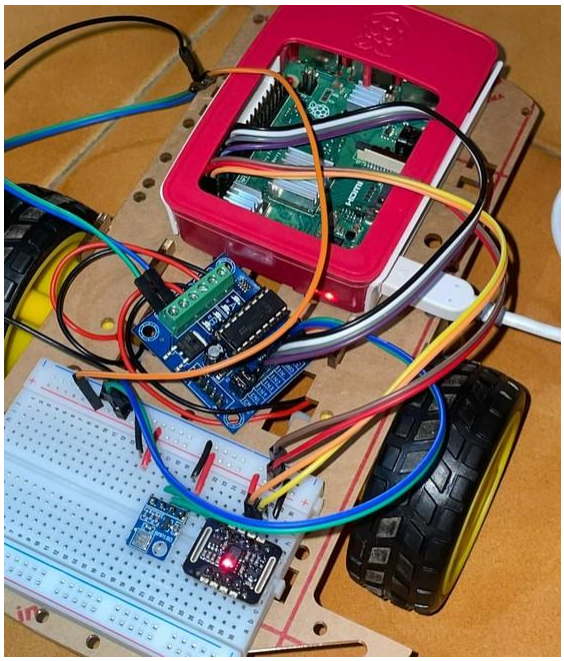
VI. RESULTS AND DISCUSSION



The developed system successfully recognised basic voice commands such as “forward,” “backward,” “left,” “right,” and “stop.”

The wheelchair responded accurately to commands with minimal delay, showing smooth motor control through the Raspberry Pi.



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The ultrasonic sensors effectively detected obstacles within the predefined range and stopped the wheelchair to prevent collisions.

The obstacle avoidance function increases user safety, but it can be further improved with better sensors or AI- based detection.

Raspberry Pi proved to be efficient for real-time processing, handling both speech recognition and motor control smoothly.

The system is suitable for basic indoor navigation; however, adapting it for outdoor use may require GPS, stronger motors, and advanced sensors.

VII. CONCLUSION

Voice Controlled Intelligent wheelchair, with voice control, obstacle detection, speech synthesizer, news reading and Google voice search is developed .The wheelchair we developed is more useful for the patient who paralyzed from waist down and even can't move their finger. This wheelchair can be controlled in many languages with any prior training and there is not limitation of number of commands. Most interesting thing of this wheelchair is Google voice search. Aim behind this product is to develop a cost effective and user friendly' wheelchair so maximum patient can use this and make their life easy..

VIII. FUTURE SCOPE

- Support for multilingual voice commands for wider usability.
- Implementation of autonomous navigation using computer vision and AI.
- IoT and mobile app connectivity for remote monitoring and emergency alerts.
- GPS-based outdoor navigation and real-time tracking.
- Inclusion of health monitoring sensors for user safety.

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