

Voice Control Wheelchair for Physical Challenged Persons

¹Aniket Lahare, ²Aryan Rawool, ³Prasad Yadav, ⁴Prof. Surekha Mahadik

^{1,2,3}B.E Student, Department of Electrical Engineering, A. C. Patil College of Engineering, Kharghar Navi Mumbai, Maharashtra, India

⁴Assistant Professor, Department of Electrical Engineering, A. C. Patil College of Engineering, Kharghar Navi Mumbai, Maharashtra, India

Author for Correspondence: aniketlahare@acpce.ac.in, ssmahadik@acpce.ac.in

Abstract - The main objective of the SMART WHEELCHAIR project is to provide a fully functional system that is helpful for physically disabled people. The system is designed to control a wheelchair using a manual keypad, voice commands, a mobile gyroscope, and a joystick module. The objective of this project is to facilitate the movement of people who are disabled, handicapped, or elderly and are unable to move easily. The goal of this system is to allow such individuals to live a life with less dependence on others for their daily mobility. This can be realized and optimized by using a smartphone device as an intermediary or interface. In this project, interfaces have been designed to develop a program for controlling the movement of the chair and an application that can handle or manage graphical commands. This project uses an Arduino Uno microcontroller circuit and four TT [Traction Motor] DC motors to create the movement of the wheelchair, along with Ultrasonic Sensor sensors to detect obstacles between the wheelchair and its direction of movement. The results and analysis of this innovation are described in this report, and the results show that the module can be used for future research work and to design innovative solutions that meet market needs and public interest.

Keywords: Android Application, Wheelchair, physically Challenged, Ultrasonic Sensor, Voice Command, HC-05 Bluetooth Module, DC Motors, Arduino UNO Micro-controller.

I. INTRODUCTION

In this project, we are using an Android application and a joystick module to control the movement of the wheelchair. However, although many individuals with disabilities who need wheelchairs are satisfied with them, some members of the disabled community find it difficult or impossible to operate a standard power wheelchair. This project falls under the category of assistive technology. It helps handicapped and

dependent disabled individuals to live a more independent, productive, and enjoyable life.

To perform daily activities, a handicapped person with locomotive disabilities needs a wheelchair to move around. He or she can do so manually by pushing the wheelchair with his or her hands. However, many people have weak upper limbs or find the manual mode of operation too tiring. Therefore, it is desirable to provide them with a motorized wheelchair that can be controlled using voice commands. Since a motorized wheelchair is important for independent mobility, it should also be able to avoid obstacles automatically in real time while moving at a reasonable speed. The cost of this motorized wheelchair should be affordable for as many handicapped people as possible, as well as for organizations that support them. With these requirements in mind, we propose an automated wheelchair with real-time obstacle avoidance capability. The power wheelchair control interfaces currently available are still not sufficient to provide mobility for a substantial number of persons with disabilities. Through research and design improvements, the development of wheelchair control systems continues to advance in order to better support users with disabilities and to ensure safe and effective mobility while promoting independence and self-use. This project provides innovative solutions for disabled individuals to control wheelchairs using a mobile device. The project describes a wheelchair that can be controlled using an Android application as well as the user's voice. The main aim of this project is to facilitate the movement of disabled and elderly people who cannot move properly, enabling them to lead better lives without difficulty.

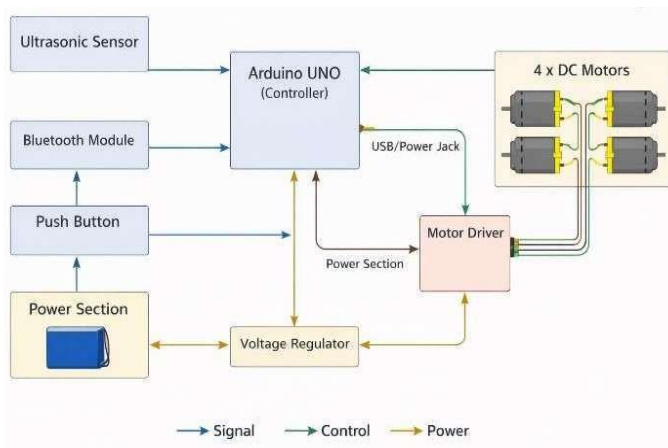
Mobile applications are a key technology that provides human interaction with machines for controlling a wheelchair. This project includes two main parts: software and hardware. For input, an Android phone is used as an intermediary interface. In this project, the Arduino Uno (ATmega328) is used as the controller to manage the movement of the wheelchair based on human voice input. There are five basic movements of the wheelchair that can be controlled by the

user. The five operations performed by the wheelchair are as follows:

- 1) forward
- 2) backward
- 3) right
- 4) left
- 5) Stop condition

II. BLOCK DIAGRAM

The wheelchair has a combination of two back wheels with motors interfaced, which operate according to the input received from the Arduino Uno. The data is transferred to the Arduino from a mobile application, which has the functionality to send commands through a keypad, voice input, and a mobile gyroscope. The movement of the wheelchair is controlled based on these commands, such as forward, backward, right turn, and left turn, etc., which will be explained further in detail.



The system also has features such as location tracking, which allows family members to track the position of the patient, and an emergency stop button to avoid any accidents.

Working

Case 1: When data is transferred using the keypad on the application

For transferring data from the mobile application to the Arduino Uno using the keypad, there are direction keys available in the application. When the front key on the keypad is pressed, the wheelchair moves in the forward direction. Similarly, other keys allow the wheelchair to move in backward, left, or right directions.

Case 2: When data is transferred using voice activation

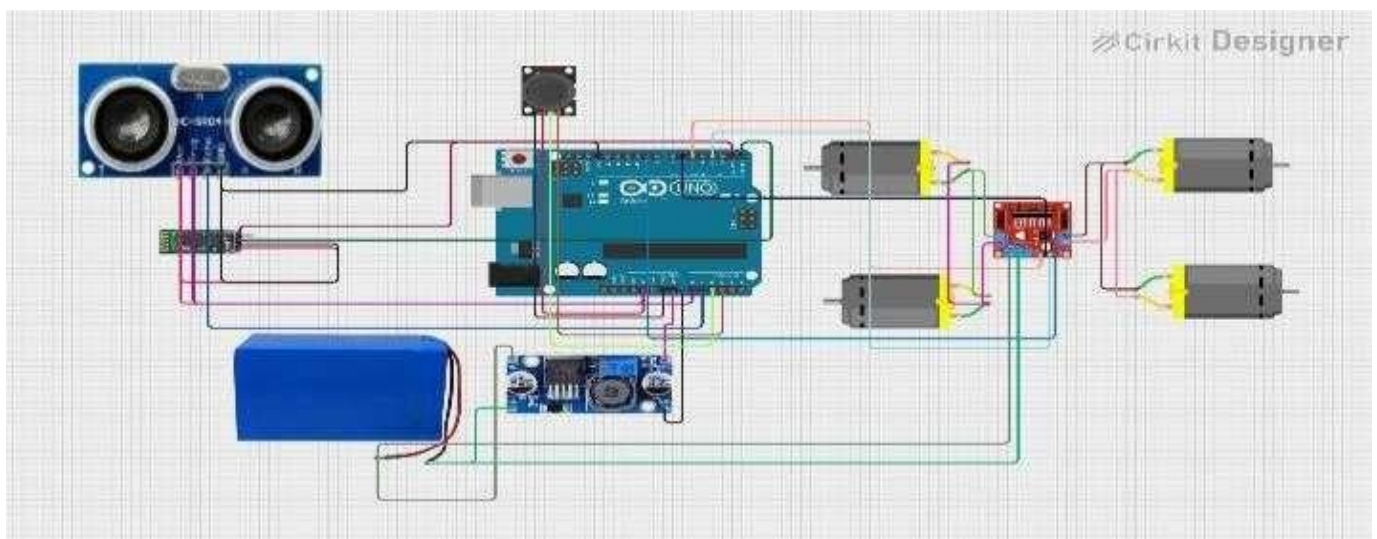
For transferring data using voice commands, the voice feature in the mobile application must first be activated. After activation, when the user gives a command such as Forward, the wheelchair starts moving in the forward direction. Other commands such as Left, Right, and Backward are also recognized.

Case 3: When data is transferred using the mobile gyroscope sensor

For transferring data using the mobile gyroscope sensor, the feature must be activated through the mobile application. The user can tilt the mobile device in different directions such as right or left. According to the tilt detected by the gyroscope, the wheelchair moves in the corresponding direction.

Case 4: Obstacle detection

In this project, we have added an object detection feature using an Ultrasonic Sensor, which helps to detect obstacles in front of the wheelchair and prevents possible accidents during operation.



A. Microcontroller

The Arduino Uno is a widely used microcontroller development board based on the 8-bit ATmega328P microcontroller. In addition to the ATmega328P MCU, the board includes supporting components such as a crystal oscillator, serial communication circuitry, voltage regulator, and other necessary elements to enable stable operation. The Arduino Uno features 14 digital input/output pins (6 of which can be used as PWM outputs), 6 analog input pins, a USB connection, a power barrel jack, an ICSP header, and a reset button, making it versatile and suitable for controlling devices such as motorized wheelchairs.

B. HC-05 Bluetooth Module

The HC-05 Bluetooth Module is an easy-to-use Bluetooth Serial Port Protocol (SPP) module, designed for transparent wireless serial communication. The HC-05 can operate in either Master or Slave mode, making it suitable for a variety of wireless communication applications. It is fully compliant with Bluetooth V2.0 + EDR (Enhanced Data Rate) with 3 Mbps modulation, and includes a complete 2.4 GHz radio transceiver and baseband. The module uses the CSR Bluecore 04 external single-chip Bluetooth system with CMOS technology and supports Adaptive Frequency Hopping (AFH) to reduce interference.

By default, the module is configured as Slave, but its role can be changed to Master using AT commands. A Slave module cannot initiate a connection but can accept incoming connections, whereas a Master module can initiate connections with other Bluetooth devices. The HC-05 module can be used as a simple serial port replacement to establish wireless communication between a microcontroller and devices such as GPS modules, PCs, or other embedded systems, making it ideal for projects like motorized wheelchairs.

C. Ultrasonic Sensor

The Ultrasonic Sensor is used to detect objects in its path by emitting ultrasonic waves. It consists of a transmitter and a receiver, both made of piezoelectric crystals. The transmitter generates ultrasonic waves, which travel until they hit an object and are reflected back to the receiver.

The sensor uses the Time of Flight (TOF) principle to calculate the distance between the sensor and the object. Ultrasonic waves travel faster than audible sound, and the sensor measures the time taken for the wave to travel to the object and back. The distance is calculated using the formula:

$$D = \frac{1}{2} \times T \times C$$

Where D is the distance between the sensor and the object, T is the time interval for the wave to return, and C is the speed of sound (approximately 343 meters/second). This feature allows the sensor to detect obstacles accurately, making it essential for safe operation of motorized wheelchairs.

D. DC Motor

Rhino Heavy Duty Planetary Geared Motor The wheelchair uses Rhino Heavy Duty Planetary Geared DC Motor, which combines a high-quality motor with a 4-stage metal planetary gearbox. It can handle a continuous load of 65–70 kg·cm, with a maximum recommended load of 75 kg·cm for long-term use. The stall torque exceeds 200 kg·cm, but higher loads may damage the gearbox. Compared to other high-torque motors, its metal planetary gearbox provides better durability, efficiency, and reliable movement.

E. 18650mAh Battery and Charger

The 18650 battery is a Li-ion battery named after its 18mm × 65mm cylindrical size (diameter × height). When compared to AA size, its height and diameter both are larger. They are not replacements for AA or AAA size cells.

The battery type 18650 are popular in rechargeable and high current draining devices considering its high-level capabilities like 250+ charge cycle and higher energy density.

F. L293D motor driver Module

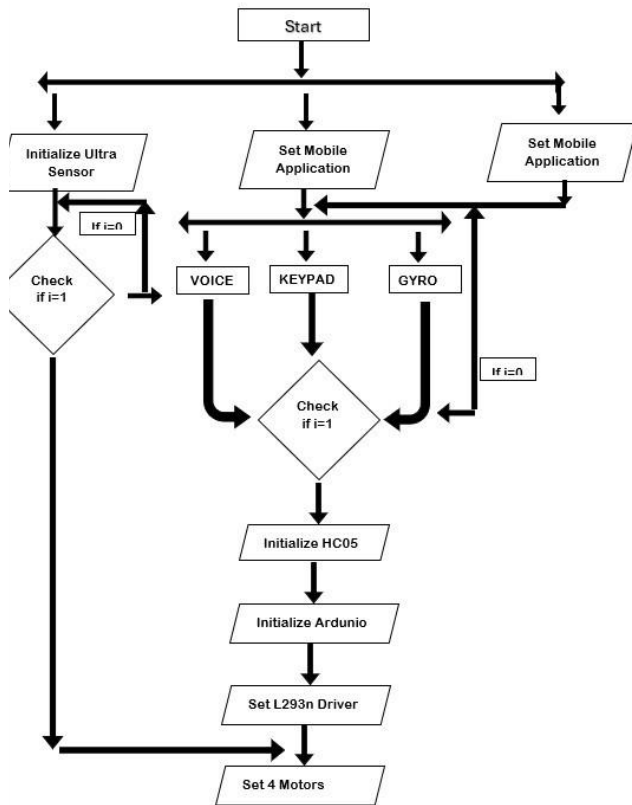
The L293 and L293D are quadruple high-current half-H drivers. These devices are designed to drive a wide array of inductive loads such as relays, solenoids, DC and bipolar stepping motors, as well as other high-current and high-voltage loads. All inputs are TTL compatible and tolerant up to 7 V. Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo-Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN. When an enable input is high, the associated drivers are enabled, and their outputs are active and in phase with their inputs.

III. SOFTWARE FLOW CHART

The software flowchart illustrates the overall operational sequence of the proposed smart robotic control system. The execution begins when the system is powered on and the program starts running on the microcontroller. Initially, the ultrasonic sensor is initialized to enable obstacle detection.

The system continuously monitors the sensor status and checks the condition variable. If an obstacle is detected, the system updates the control condition accordingly; otherwise, it continues normal operation.

3.2.2 Software flow chart



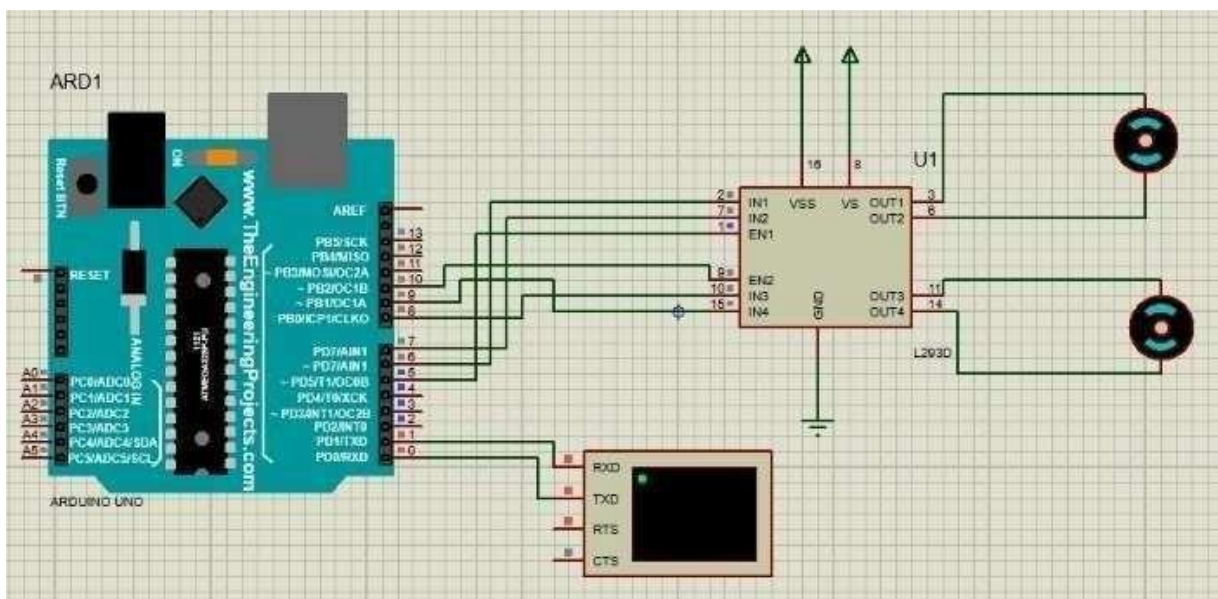
After sensor initialization, the mobile application is configured to establish communication between the user and the hardware unit. The application provides multiple control modes such as voice control, keypad control, and gyroscope control. Based on the user’s selection, the system processes the corresponding input command. The control logic verifies whether a valid input signal is received before proceeding further.

Once the input is validated, the HC-05 Bluetooth module is initialized to ensure reliable wireless communication between the mobile device and the Arduino microcontroller. The Arduino then initializes its input and output pins and prepares to execute control instructions. Following this, the L293D motor driver is configured to control motor direction and movement. Finally, the four DC motors are activated according to the received commands, enabling the robotic system to move in the desired direction.

Thus, the software flow ensures synchronized operation between obstacle detection, wireless communication, control mode selection, and motor actuation, resulting in smooth and efficient system performance.

Simulation diagram

Figure illustrates the simulation diagram for the development of the voice-controlled wheelchair system. The system uses an Arduino controller, motor driver, and DC motors to execute movement commands received through a voice recognition module.



To evaluate the performance of the system, the relationship between user voice commands and the corresponding motor actions was analyzed. During the testing

phase, the wheelchair was lifted slightly above the floor to simplify the observation of motor behavior without physical movement interference.

The distance sensor and obstacle alert system were also tested by placing an obstacle at a predetermined distance of 50 cm. Voice commands were delivered through a microphone to the voice recognition module, instructing the wheelchair to move toward the designated point. This test was conducted to verify the functionality of the distance sensor and obstacle detection mechanism.

When the wheelchair approaches an obstacle within the predefined distance, the system automatically stops the motors and generates an alert signal. Two main commands, “moving forward” and “moving backward,” were used during the obstacle detection test. When the wheelchair stops after detecting an obstacle, the measured stopping distance is recorded.

Additionally, the performance of the obstacle detection system is evaluated by listening for an alert sound generated when the wheelchair stops after encountering an obstacle.

User Voice Command	Working Status of Motor
Forward	Both left and right motors move forward.
Backward	Both left and right motors move backward.
Left	The left motor moves backward, while the right motor moves forward
Right	The left motor moves forward, while the right motor moves backward.
Stop	Both motors cease movement.

IV. RESULT

In this system, the Arduino Uno serves as the main controller. It sends control signals to the L293D motor driver, which in turn drives two DC motors.



Two separate 9V batteries provide sufficient power and torque to the motors, ensuring stable operation. The system successfully controls both motors independently in forward, reverse, and stop modes. Because the Arduino enables precise control through software, the overall system performance is stable, responsive, and reliable. This setup is efficient and suitable for small robotic or automation applications.

The circuit is designed to control two DC motors using an Arduino Uno and an L293D motor driver IC. A virtual terminal in Proteus is used to simulate a Bluetooth module (HC-05). When commands such as F, B, L, R, and S are entered in the virtual terminal, they are sent to the Arduino via serial communication. The Arduino reads these commands and controls the L293D motor driver accordingly.

The L293D receives signals from the Arduino on its input pins (IN1–IN4). Depending on which pins are set high or low, the L293D controls the motors’ direction: forward, backward, left, right, or stop.

V. CONCLUSION

The voice-controlled wheelchair system was successfully designed and tested to assist physically disabled individuals in mobility. The system uses voice commands to control the movement of the wheelchair through a microcontroller and motor driver. Commands such as forward, backward, left, right, and stop were accurately recognized and executed by the motors.

The integration of a distance sensor improves safety by detecting obstacles and automatically stopping the wheelchair when an object is within a predefined distance. This feature helps prevent collisions and ensures safer navigation for the user.

Experimental testing demonstrated that the system responds effectively to voice commands and that the obstacle detection mechanism functions reliably. The proposed system provides a low-cost, efficient, and user-friendly mobility solution for people with limited physical abilities.

Future improvements may include enhanced voice recognition accuracy, integration with mobile applications, and the addition of GPS or IoT features for remote monitoring and navigation.

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