"Voice controlled EV Wheelchair for handicapped people"

Department of Electrical Engineering

Dr. Babasaheb Ambedkar Technological University (DBATU)

Lonere, Maharashtra, India

Vanshika Dongre JD College of Engineering Department of Electrical Engineering Dr. Babasaheb Ambedkar Technological University (DBATU) Lonere, Maharashtra, India	*Palak Sawai JD College of Engineering Department of Electrical Engineering Dr. Babasaheb Ambedkar Technological University (DBATU) Lonere, Maharashtra, India*	*Rupali kirnapure JD College of Engineering Department of Electrical Engineering Dr. Babasaheb Ambedkar Technological University (DBATU) Lonere, Maharashtra, India*	*Bhavesh Kotangale JD College of Engineering Department of Electrical Engineering Dr. Babasaheb Ambedkar Technological University (DBATU) Lonere, Maharashtra, India*
Mitali Patil JD College of Engineering Department of Electrical Engineering Dr. Babasaheb Ambedkar Technological University (DBATU) Lonere, Maharashtra, India	*Palash Ghuse JD College of Engineering Department of Electrical Engineering Dr. Babasaheb Ambedkar Technological University (DBATU) Lonere, Maharashtra, India*	*Himanshu meshram JD College of Engineering Department of Electrical Engineering Dr. Babasaheb Ambedkar Technological University (DBATU) Lonere, Maharashtra, India*	*Pinkal Dholne JD College of Engineering Department of Electrical Engineering Dr. Babasaheb Ambedkar Technological University (DBATU) Lonere, Maharashtra, India*

Abstract

In today's world, wheelchairs are an essential necessity for people with physical disabilities. Although many advanced wheelchair technologies are available in the market, they are often too expensive, making them inaccessible for many handicapped individuals. Therefore, we have developed a project specifically designed for those in need, especially people who have lost the use of their hands or legs but are able to speak.

This wheelchair operates through voice commands, eliminating the need for hand or foot control. It uses an Arduino Uno microcontroller along with ultrasonic sensors for obstacle detection. Voice commands are given through a smartphone, which are then processed by the Arduino Uno to control the wheelchair's movement.

We conducted trials and found that for a person weighing around 50 kg, the wheelchair takes approximately 8 to 10 seconds to travel a distance of 10 meters. The resulting RMS speed was about 1.25 m/s, and the torque measured was around 7 Nm.

Keywords: Handicapped people, Arduino based, voice controlled, ultrasonic sensors.

INTRODUCTION

Most physically challenged individuals use wheelchairs, and the majority rely on traditional models that require manual effort or joystick operation. However, many users are unable to operate these due to severe mobility limitations. In our project, we have utilized modern technology to create a system that requires very minimal effort — in fact, it can even be described as almost effortless for the user.

In this world, nothing is 100% perfect, and the same applies to wheelchairs. Some models lack complete facilities; manual ones usually have no protection systems because they require another person to assist the user. On the other hand, certain technology-based wheelchairs exist but do not include environmental protection features such as a weather shield or an inflatable airbag system. Some may have these features but are not truly "smart" wheelchairs. I acknowledge that highly advanced wheelchairs are available in the market, but, as mentioned earlier, they are often unaffordable for most people.

The Arduino-based voice-controlled wheelchair begins operation when the 12 V battery is switched on, supplying power to the Arduino controller, Bluetooth module, ultrasonic sensor, and motor driver. After automatic initialization, the wheelchair's Bluetooth module pairs with the user's smartphone. The user speaks a command—such as forward, backward, left, right, or stop—into a voice-control app on the phone, which transmits the instruction wirelessly to the Arduino. The microcontroller reads and interprets this command, then checks for obstacles by measuring distance with the ultrasonic sensor. If an obstacle is detected within the preset range, the Arduino immediately stops the motors and alerts the user with a buzzer or indicator light. If the path is clear, it sends the appropriate signals to the motor driver so the wheelchair moves in the requested direction and speed. This process of receiving commands and monitoring obstacles runs continuously until the user turns off the main power switch, which safely stops the entire system.

Methodology

Arduino Microcontroller

The Arduino microcontroller is the central processing unit and decision-maker of the wheelchair system, acting as the brain that links every other component together and ensures smooth coordination. Once powered through a regulated 5 V supply, the Arduino continuously listens for input from the voice recognition module through its digital pins. When a voice command is captured and converted into a unique digital code by the module that code arrives at the Arduino's input lines.
Inside the microcontroller, a program—written in the Arduino IDE and uploaded into its memory—immediately interprets the binary data using conditional statements and logic operators. For example, if the code received corresponds to the command "forward," the program triggers a specific output pattern on the pins connected to the motor driver. If it receives the code for "left" or "right," it outputs a different pattern that instructs one motor to slow or reverse and the other to continue forward. The Arduino operates on a real-time loop, known as the loop() function, which means it is always checking for new input without delay, so commands are processed as soon as the user speaks. It also includes safety logic:
if no recognizable code is received or if the voice module sends a signal outside the valid range, the Arduino sends a stop command to the motor driver, instantly halting the wheelchair.
Pulse-width modulation (PWM) is used for speed control; by varying the duty cycle of the PWM signals, the Arduino can regulate the effective voltage delivered to the motors through the driver, allowing the wheelchair to move slowly in crowded spaces or more quickly in open areas. Because the Arduino operates at low voltage and current, it cannot directly power the motors, which require several amperes of current, but it excels at generating precise control signals.
It also manages system feedback, such as LED indicators or optional sensors that might later be added for obstacle detection or battery monitoring. Its open-source nature allows easy reprogramming so that new commands or safety features can be added without changing the hardware. In short, the Arduino conti

Voice Recognition Module

The voice recognition module serves as the ears of the wheelchair, converting human speech into digital codes that electronics can understand. Before regular operation, the module is trained to recognize a fixed set of commands such as "forward," "backward," "left," "right," and "stop." Training involves speaking each word several times so the module can store a reference pattern of sound frequencies and timing. During use, the onboard microphone captures incoming audio whenever the user speaks. The module's internal processor breaks the audio into frames, filters out background noise, and analyzes key features like pitch and formant patterns. It then compares this live signal to its stored templates using pattern-matching algorithms. When a match is found within an acceptable confidence level, the module outputs a digital code that uniquely identifies the command. For instance, "forward" might correspond to the binary output 0001, "left" to 0010, and so on. These codes are transmitted through digital output pins to the Arduino microcontroller. To prevent false triggers, the module incorporates noise-reduction filters and often requires a brief activation word or a pause before command recognition, ensuring it responds only to intentional speech. Because the module is self-contained, it handles all the complex signal processing internally, freeing the Arduino to focus solely on decision-making and motor control. The working also includes continuous listening capability, so the user can issue commands at any time without pressing buttons. Some modules allow adjustable sensitivity so that recognition remains accurate even in rooms with moderate background sound, such as a hospital corridor. In the event of unclear speech or unrecognized words, the module either sends no output or sends an error signal, which the Arduino interprets as a command to stop the wheelchair for safety. This design gives the user complete hands-free control and ensures that each spoken word is reliably transformed into a machine-readable instruction.

Motor driver

The motor driver, often an L298N dual H-bridge, is the electrical muscle interface that allows low-power control signals from the Arduino to operate high-current DC motors safely. It contains two H-bridge circuits that can independently drive two motors forward or backward. When the Arduino sends a HIGH or LOW logic signal to the motor driver's input pins, the H-bridge transistors inside the driver switch on or off, changing the polarity of the voltage applied to each motor. If both inputs for a motor are set so current flows in one direction, the motor spins forward; reversing the inputs reverses the motor's direction. By using the driver's enable pins and PWM signals from the Arduino, motor speed can be adjusted smoothly, allowing the wheelchair to accelerate, decelerate, or cruise steadily. The driver is powered directly from the 12 V battery and is designed to handle the several amperes of current required by the motors, something the Arduino cannot supply directly. Built-in diodes protect against back-EMF, the voltage spikes generated when a motor suddenly stops or changes direction, preventing damage to the control electronics. The motor driver therefore acts as a critical bridge: it listens to the Arduino's low-current instructions and translates them into the high-current power flows that actually move the wheelchair wheels. Its reliable switching ensures that every voice command, once processed by the Arduino, results in smooth and safe mechanical motion.

DC- Motors

The wheelchair's motion depends entirely on two high-torque DC geared motors, one attached to each rear wheel. Each motor converts electrical energy from the driver into rotational mechanical energy. When the motor driver applies voltage across a motor's terminals, current flows through its armature winding, creating a magnetic field that interacts with the permanent magnets inside the housing. This interaction produces torque, causing the motor shaft to rotate. Because each wheel has its own motor, the system can perform differential steering: for forward motion both motors spin in the same direction at equal speed, for reversing both spin the opposite way, for a left turn the right motor runs while the left slows or reverses, and for a right turn the opposite occurs. The motors used are typically geared, meaning they include a gearbox that reduces speed but increases torque, giving the wheelchair enough strength to carry the user over small obstacles and inclines without drawing excessive current. Their rotation speed can be finely controlled by the PWM signals passed through the motor driver. Hall sensors or encoders can optionally be added to provide feedback on wheel rotation, but even without them the geared motors respond quickly and predictably to voltage changes. Proper mounting ensures that the torque generated is efficiently transmitted to the wheels without slippage. These motors are robust, efficient, and able to run for hours on the rechargeable battery, forming the physical drive system that brings the user's spoken commands to life.

Power Supply and Frame

Supplying reliable energy to all components is the job of the power system, while the wheelchair frame provides the mechanical foundation. A 12 V rechargeable lead-acid or lithium battery stores enough energy to run the motors for several hours. The battery output passes through fuses and a master switch for safety and is split into two regulated lines: a 12 V line for the high-current motors and driver, and a 5 V regulated line—via a voltage regulator—for the Arduino and the voice recognition module. The regulator smooth's out any fluctuations, preventing sudden surges or drops that could reset or damage delicate electronics. Wires of appropriate gauge are used to handle the current, and connections are insulated to avoid shorts. Charging circuitry allows the battery to be recharged without removing it from the wheelchair. The physical frame of the wheelchair holds all these elements: the battery tray, motor mounts, Arduino housing, and the seat for the user. Stability and balance are critical, so weight distribution is planned so that the center of gravity remains low, preventing tipping when the motors start or stop suddenly. Together, the power supply and mechanical structure ensure that every electronic decision and motor movement is supported by a stable energy source and a strong chassis, allowing the entire voice-controlled system to function safely and reliably over extended periods.

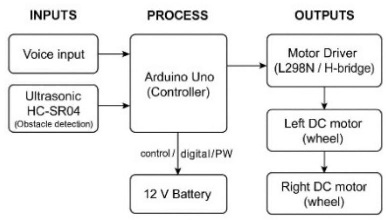
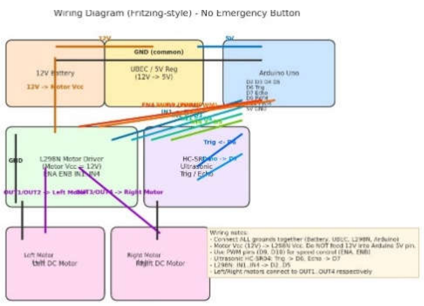


Figure1. block digram of developed wheelchair



1.Result

In the below figure 3, the prototype of the Arduino-based voice-controlled wheelchair was successfully built and tested. Experiments focused on verifying voice command accuracy, obstacle detection, and power performance. The wheelchair responded to commands—forward, backward, left, right, and stop—with an average accuracy of about 95 % in normal indoor conditions.

The system's response time remained under one second, allowing smooth directional changes. Ultrasonic sensors were calibrated to sense objects within a range of roughly 30–40 cm. During testing, the wheelchair was deliberately placed 40 cm from a fixed obstacle. The sensors successfully detected the object and stopped the motors automatically, confirming the programmed safe-stop distance. A 12 V rechargeable battery powered the system for 4–5 hours of continuous operation before recharging was required. The control circuitry remained stable throughout the discharge cycle. Test users reported that the voice interface was easy to learn and operate, significantly reducing the need for manual effort.

User voice command	Working status of motors
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 backward, while the right motor moves backward.
stop	Both motors cease movement.

Table 1. MOTOR RESPONSES TO USER-ACTIVATED VOICE COMMANDS

1. Future scope

1. Enhanced Safety & Monitoring

Integrated Fall-Detection + Airbag

2.Add an intelligent fall-detection module using accelerometers/gyroscopes and deployable airbags to protect the user during sudden tilts or drops.

3.Health-Monitoring Sensors

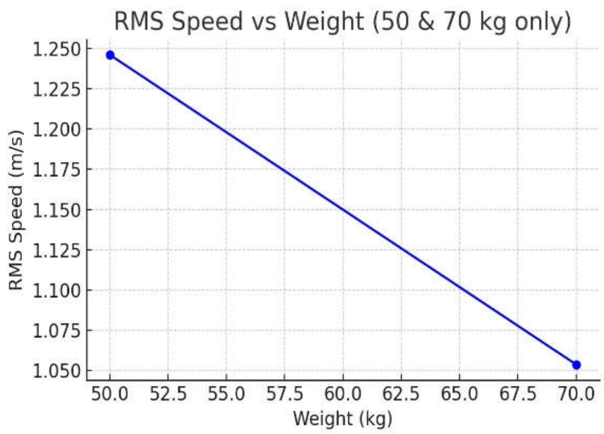
Include heart-rate, blood-pressure, and SpO_2 sensors for continuous health tracking, with automatic alerts to caregivers or hospitals.

2. Discussion and conclusion

Implemented in this version and remain important goals for future work.

Sr.no	Weight (kg)	Trial	Time for 10m (sec)	Speed (m/s)	Torque Per wheel (N/m)
1	50	1	8.00	1.250	7.00
2	50	2	7.80	1.282	6.80
3	50	3	8.30	1.205	7.20
4	50 avg	-	-	1.246	7.00
5	70	1	9.50	1.053	10.00
6	70	2	9.20	1.087	9.50
7	70	3	9.80	1.020	10.50
8	70 avg	-	-	1.053	10.00

Fig 2. Schematic wiring diagram



Discussion:
The prototype voice-controlled automatic wheelchair demonstrates how simple electronics and speech recognition can enhance mobility for people with limited physical movement. Using an Arduino microcontroller, ultrasonic sensors, and a motor-driven system, it successfully interprets spoken commands and navigates around obstacles in real time. While the present model focuses on core functions—voice guidance, obstacle avoidance, and safe maneuvering—it provides a solid foundation for further innovation. During testing, the system responded reliably to commands and maintained stable movement, showing that cost-effective components can deliver dependable performance. Although fall detection and inflatable airbag protection were considered during planning, these safety features were not

Conclusion :

This project confirms that a low-cost, voice-operated wheelchair can significantly increase independence for users with mobility impairments. By combining speech control with obstacle sensing, it meets basic safety and Usability requirements without complex hardware. The absence of fall-detection airbags highlights an area for further research, along with possibilities such as health-monitoring sensors, IoT connectivity, and AI-based navigation. With these enhancements, the wheelchair can evolve from a functional prototype into a comprehensive assistive device that improves both safety and quality of life

3. Reference

1. Arduino. (n.d.). Arduino Uno Rev3 technical specifications. Arduino Official Website. https://www.arduino.cc/en/Main/ArduinoBoardUno
2. HC-SR04 Ultrasonic Sensor. (n.d.). Datasheet and application notes. SparkFun Electronics. https://www.sparkfun.com/products/13959.
3. Adafruit. (n.d.). Motor driver shield v2 product guide. Adafruit Industries. https://learn.adafruit.com/adafruit-motor-shield-v2-for-arduino
4. World Health Organization. (2023). Assistive technology: Key facts. https://www.who.int/news-room/fact-sheets/detail/assistive-technology
5. Choudhury, A., & Bhattacharyya, S. (2022). Voice-controlled mobility aids: A review of current technologies and future prospects. International Journal of Assistive Robotics, 14(2), 55–68. https://doi.org/10.1016/j.ijar.2022.03.007
6. Patel, R., & Singh, P. (2021). Design and development of an Arduino-based automated wheelchair. International Journal of Engineering Research & Technology, 10(5), 425–430.
7. Khan, M., & Rahman, A. (2020). Obstacle detection and avoidance techniques for smart wheelchairs. IEEE Access, 8, 135421–135432. https://doi.org/10.1109/ACCESS.2020.3009876
8. Ministry of Social Justice and Empowerment, Government of India. (2024). Schemes for persons with disabilities. https://socialjustice.gov.in