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Advanced Automated Cost-Effective Wheelchair for Disable Person

Nalini Tiwari
Professor
Department of Electronics And Telecommunication, Ajeenkya D Y Patil School of Engineering Lohegaon
nalinitiwari.dypic.in

Neha Shimpi
Student
Department of Electronics And Telecommunication, Ajeenkya D Y Patil School Of Engineering Lohegaon

Nisha Thakare
Student
Department of Electronics And Telecommunication, Ajeenkya D Y Patil School Of Engineering Lohegaon

Yashita Pachauri
Student
Department of Electronics And Telecommunication, Ajeenkya D Y Patil School Of Engineering Lohegaon

ABSTRACT

For people with physical disabilities, improving mobility and independence requires the development of sophisticated, automated, and reasonably priced wheelchairs. Conventional powered and manual wheelchairs frequently have drawbacks in terms of cost, usability, and environmental adaptability. In order to provide better performance at a lower cost, this paper describes the design and development of a new generation of automated wheelchairs that incorporates cutting-edge technologies like robotics, smart sensors, and energy-efficient systems. With automated navigation, obstacle avoidance, and adjustable user control, the suggested wheelchair offers improved usability and terrain adaptability. The goal of this wheelchair is to close the gap between high-tech solutions and affordability by using creative design and effective manufacturing techniques, which will increase accessibility for a larger group of users.

The potential benefits of this advancement include greater user autonomy, improved quality of life, and increased inclusivity in mobility assistance technology.

General Terms
Affordable Smart Wheelchair with Advanced Facilities and Securities.

Keywords
Arduino Mega, Motor Driver, Bluetooth model, joystick, GPS Module, Ultrasonic sensor

INTRODUCTION

For people with physical disabilities, wheelchairs are necessary mobility aids that can improve their quality of life and increase their independence. Although conventional manual wheelchairs provide rudimentary mobility, they frequently lack sophisticated features that can meet the wide range of user needs. Although powered wheelchairs have shown promise, their high price and difficulty of use continue to be major obstacles to their widespread use. The need for creative solutions that combine the advantages of automation, affordable pricing, and user-friendly design is increasing as technology develops. [1] By combining state-of-the-art technologies like robotics, machine learning, and smart sensors, an advanced automated wheelchair seeks to solve these issues while maintaining affordability. These wheelchairs are appropriate for a broad spectrum of users with differing degrees of mobility impairment because they can provide increased maneuverability, improved adaptability to various terrains, and greater ease of control. Automation also makes it possible for features like voice control, obstacle avoidance, and automated navigation, which give users even more freedom to move around with little effort.[2]

Even though high-tech solutions are developing quickly, many people still find the cost of these systems to be a major barrier, which restricts their access to these cutting-edge gadgets. Thus, developing a solution that is both technologically sophisticated and reasonably priced is crucial to this innovation in order to make it available to a wider range of users. The design and development of a sophisticated automated wheelchair that blends cutting-edge features with economical manufacturing techniques is examined in this paper. [3]

In order to provide people with mobility impairments with a more economical, effective, and secure mode of transportation, the objective is to close the gap between accessibility and state-of-the-art assistive technology. However, an alternative and intuitive method is voice control, as it aligns with the human's natural mode of communication. Many researchers have been working on voice-controlled wheelchairs.For example, utilizes a smartphone connected via Bluetooth and integrates with Google API. [4] However, this system requires an internet connection, leading to operational delays. The average response time is approximately 2.856 seconds. [5] It's important to note that this wheelchair is limited to five predefined commands and lacks an obstacle detection feature for user safety. explain the text in more advanced words. [6]

II. PROPOSED SYSTEM

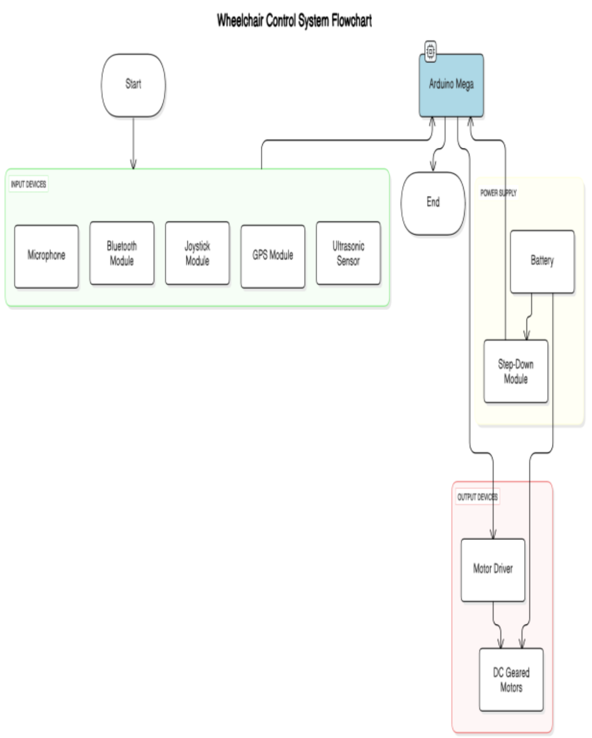


Fig.1 Block Diagram of Automated wheelchair control system

The system for controlling wheelchairs, a flowchart shows how various input, processing, and output components of an Arduino Mega-based wheelchair control system operate. Here is a thorough explanation:

1. **Get started** (initialization)

The Start node is where the system starts up.

2. **Input Devices** (Sensors and User Inputs)

Several input devices send signals to the wheelchair:

a. Voice commands are detected by the microphone.

b. Wireless control through a smartphone app or other Bluetooth-enabled devices is made possible by the Bluetooth module.

c. The joystick module enables manual wheelchair movement control.

d. GPS Module: Offers location monitoring for emergency support or navigation.

e. Ultrasonic Sensor: Prevents collisions by detecting obstacles.

3. Arduino Mega processing

After processing all of the inputs, the Arduino Mega decides how to move the wheelchair and adjusts the output devices accordingly.

4. System Battery Power Supply: Provides energy to the whole system.

Step-Down Module: Adjusts battery voltage so that Arduino and other components can use it.

5. Motion Control Output Devices

Motor Driver: Manages the motion of DC geared motors by receiving signals from Arduino.

DC geared motors: Move the wheelchair in the direction you want it to go.

6. End (Completion of Operation)

Until the system is shut down, the procedure keeps running in a loop.

Overall Performance

Voice, joystick, and Bluetooth input devices are used to give commands to the wheelchair. The motor driver receives signals from the Arduino after it has processed the data. The wheelchair can move thanks to the motor driver, which regulates the DC motors. The wheelchair is stopped or redirected by the ultrasonic sensor to avoid collisions. Stable operation is guaranteed by the power supply. This block diagram represents an intelligent wheelchair system with multiple control methods for flexibility and safety.

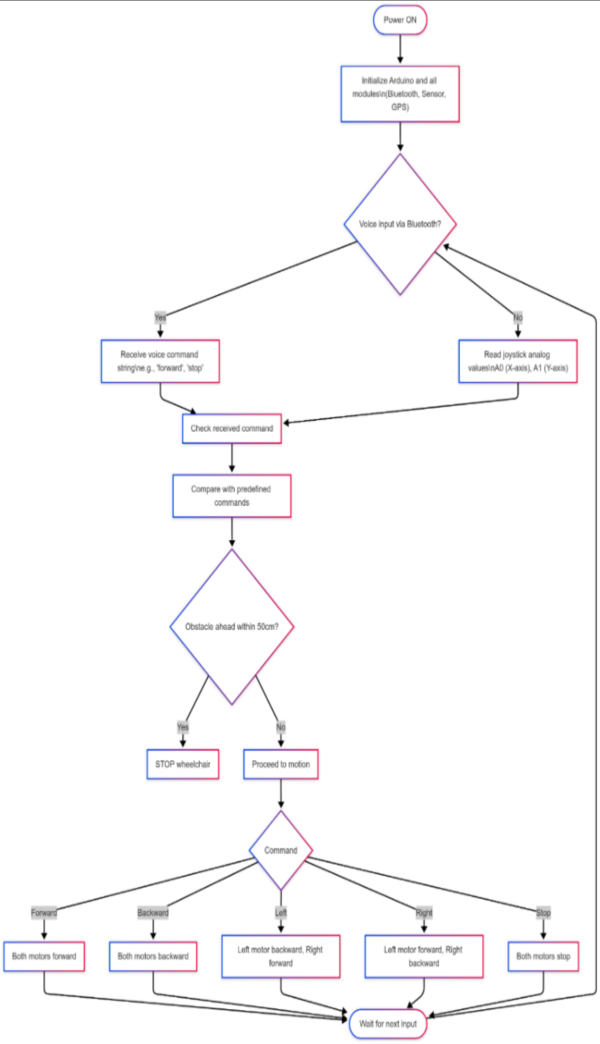


Fig.2 Operational Flowchart of The System

Steps in Flowchart

1. Turn on the power and initialize

When the system turns on, the Arduino and all linked modules are initialized, including:

Bluetooth Module (for voice commands)

Sensors (like an ultrasonic sensor)

GPS Module (for navigation and tracking)

2. **Bluetooth Voice Input**

The system determines if the joystick or voice commands are being used for control:

a. It receives the voice command (such as "front" or "stop") if "Yes" (voice control is active).

b. If "No" (joystick control is engaged), then To determine movement, it reads the analog values on the X and Y axes of the joystick.

3. **Handling the Input**

If voice control is turned on:

The received command is examined by the system and contrasted with pre-established commands.

In the event that joystick control is engaged:

The motion command is prepared by the system by directly reading the joystick input.

4. **Identifying Obstacles**

The ultrasonic sensor is used by the system to determine whether an obstruction is within 50 cm:

If so, the wheelchair comes to a stop.

If not, the system moves forward.

5. **Commands for Motion**

After movement is permitted, the system uses the input it has received to determine the direction:

Front: Both motors rotates forward.

Back: The two motors move backward.

Left: The right motor advances while the left motor retreats.

Right : The left motor advances while the right motor retreats.

Stop: Both motors come to a halt.

6. **Await the Next Input**

Real-time response and flexibility are ensured by the system's constant waiting for the next command.

Working of the system:

The system is implemented using Arduino Mega, once the power is turned on it will begin the process. Motor driver is used to step down the voltage form 12V to 5V. To use joystick put "j" in serial Bluetooth app. It will make the wheels activate and according to directions it goes front and back. For F1 command it will go front, for F2 it will moves back similarly for left and right.

Once the command "h" is given the voice controller turns on. If the command is "Front" the Arduino Mega gives command to motor and front two wheel starts rotating. If the command is "Back" the motor starts moving backward. If the command given is Left right motor starts rotating front while left motor downs the speed and moves along the same direction.

While the system is in process GSM tracker works in background it senses the location and updates it longitude and latitude on the device. If there is obstacle in front of chair, ultrasonic sensor senses the obstacle and sends electrical signals to memory and as per commands chair will stop

Ultrasonic sensor continuously senses the obstacle till it don't receive the signals. Once the signal is received the wheelchair will again begin the loop. It requires commands from the user, once command is received from user the wheelchair will begin its process.

To work the wheelchair efficiently lithium-ion batteries are used. The batteries used are of 12V and batteries are rechargeable. Batteries should be charged at continuous period for its efficient working.

III. METHODOLOGY

a**) Joystick**: To use joystick put the Bluetooth connection on "j" then joystick will turn on. By moving joystick front it will move forward, back it will move backward left it will turn left right it will turn right, stop it will stop suddenly. If there is any object in front of chair ultrasonic sensor will sense it and it will stop at its position. Practice in open spaces for better control.

b) **Voice Command:** To perform operation using voice commands "h" command is given to serial Bluetooth app then it will activate for commands. Different voice commands are used to operate the wheelchair. The wheelchair consists of five commands; it can be increased or decreased as per need. By giving command front wheelchair will move forward, by giving command back wheelchair will move backward, similarly for left and right turn it performs accordingly. If there is obstacle in front of wheelchair it senses it and chair will stop. The commands takes 2.86 seconds to perform the operation.

c)**GSM:** A lot of contemporary wheelchairs come with GPS trackers that can connect to a GSM network. Through mobile phones or other GSM-based devices, users can operate their wheelchair remotely thanks to GSM. Wheelchairs with GSM primarily use it for emergency alerts, tracking, monitoring, and remote control. Through real-time communication, it increases user independence, helps caregivers deliver timely support when needed, and improves safety.

Uservoice command	**Working Status of Motors**
Front-(F)	Both left and right motors move forward.
Back-(B)	Both left and right motors move backward.
Left-(L)	The left motor moves backward, while the right motor moves forward.
Right-(R)	The left motor moves forward, while the right motor moves backward.
Stop-(S)	Both motors cease movement.

IV. RESULTS

By examining the interactions between the motor driver, relay modules, and user voice commands, the developed smart wheelchair's performance is assessed. Voice Command Activation is the testing process. Lifting the wheelchair off the ground is how it is tested. This method guarantees that environmental influences and external friction won't obstruct the observation of the movement mechanisms. A voice command from the user activates the relay modules, which then turn on the motor driver. This makes it simple to check if every part reacts appropriately to the instructions. Joystick is used for movements of wheelchair it is having simple process just by moving the knob of joystick in different directions wheelchair starts moving. The ultrasonic sensors, which are crucial for detecting obstacles and preventing collisions, are tested separately.To verify their accuracy, distance measurements are taken at 10 cm, 15 cm, and 20 cm.Each distance is tested 10 times to ensure consistency and reliability in sensor performance. The collected data helps determine whether the sensors can accurately measure distances and effectively contribute to the wheelchair's safety system.

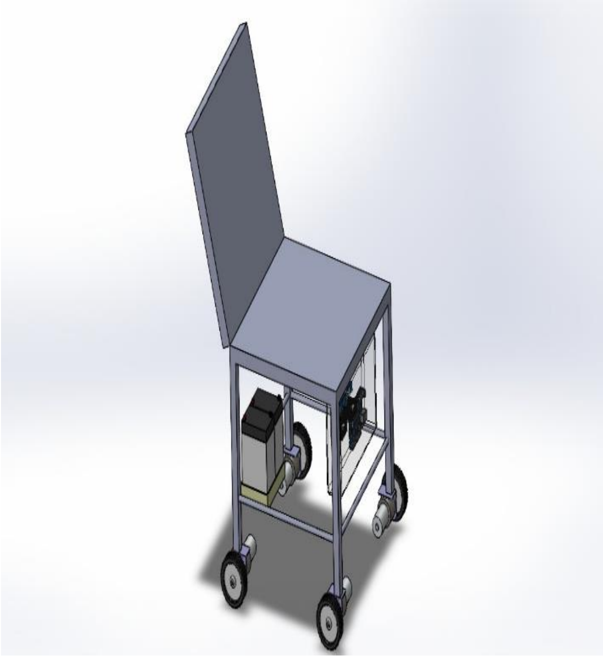
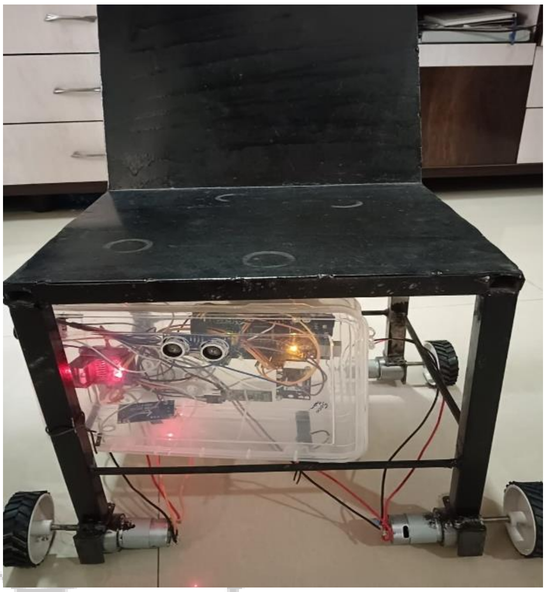


Fig. 3. Schematic of Wheelchair



V. CONCLUSIONS

In conclusion, the development of a voice-activated wheelchair for people with physical disabilities has been accomplished. It has the capacity to operate effectively and can be used as a prototype for the creation of voice-activated wheelchairs that will be useful in everyday settings. There is still room for improvement, though. As previously stated, variations in its movement may result from the weight distribution. To improve the wheelchair's movement, more testing with individuals of different masses is required. Furthermore, combining ultrasonic sensors with other technologies like LiDAR, Kinect, or infrared sensors can increase obstacle detection accuracy and boost system performance. Additionally, incorporating a turn detection system that uses extra sensors, such as accelerometer or gyroscope sensors, to detect wheelchair movement. Currently, the rechargeable battery has a battery life of 2 hours per charge. To increase battery life, reducing energy consumption in the circuit and utilizing a larger battery can improve how the energy is managed. Finally, enhancing the microphone with noise cancellation to minimize external disturbances are also potential areas for development of the advanced voice-controlled wheelchair.

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