JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Arduino-Based Smart Wheelchair With Wireless Communication And Control Facility

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Abstract : This abstract provides a concise overview of mobile-based and voice controller-based wheelchairs, two innovative assistive technologies designed to enhance mobility and independence for disabled individuals. These systems utilize mobile applications and voice recognition techniques, respectively, to facilitate intuitive wheelchair control and navigation. The mobile-based wheelchair system incorporates a mobile application installed on a smartphone or tablet. The instructions are communicated to the wheelchair control system, enabling users to maneuver their wheelchairs using visual and auditory cues provided by the application. In the voice controller-based wheelchair system, voice recognition technology is employed to interpret spoken commands from the user. Advanced algorithms analyze and process these commands, allowing the system to recognize and respond to specific voice prompts. The wheelchair control module translates these commands into appropriate motorized movements, enabling users to control their wheelchairs through natural voice instructions. Both mobile-based and voice controller-based wheelchairs offer distinct advantages to disabled individuals. The mobile-based system provides flexibility, as it can be used with a range of mobile devices and offers customizable settings for route selection and accessibility preferences. The voice controller-based system offers an intuitive and hands-free control interface, reducing physical exertion and allowing for effortless wheelchair navigation. These assistive technologies significantly enhance the mobility and independence of disabled individuals. By eliminating the need for manual controls, individuals with limited physical capabilities can operate their wheelchairs more efficiently. Both systems prioritize user safety, incorporating collision detection mechanisms and obstacle avoidance features.

***IndexTerms* - Android Application, Wheel chair, Ultrasonic Sensor, HC-05 Bluetooth Module, DC Motors, Arduino UNO Micro-controller.**

I. INTRODUCTION

The field of assistive technologies has witnessed significant advancements in recent years, aiming to enhance the independence and mobility of individuals with disabilities. Mobility plays a vital role in the lives of individuals with disabilities, as it directly impacts their independence and quality of life. Traditional manual wheelchairs have long served as a means of transportation for disabled individuals, but advancements in technology have led to the development of innovative solutions that further enhance their mobility and control. Two such technologies that have gained significant attention are mobile-based wheelchairs and voice controller-based wheelchairs. These assistive systems leverage the power of mobile applications and voice recognition techniques to provide intuitive and efficient control and navigation for wheelchair users.

In this project, we present the design and implementation of an Arduino-based smart wheelchair with Bluetooth connectivity, enabling remote control and enhanced functionality. Mobile-based wheelchairs utilize mobile applications installed on smartphones or tablets to enable users to navigate their surroundings. On the other hand, voice controller-based wheelchairs employ voice recognition technology to interpret spoken commands from the user. The core component of our project is the Arduino microcontroller, a versatile and programmable board that serves as the control unit for the wheelchair. By integrating Bluetooth technology into the system, we enable wireless communication between the wheelchair and a mobile device, such as a smartphone or tablet. This allows users to control the wheelchair remotely, providing them with greater flexibility and independence.

The primary objectives of our project include the development of a robust motor control system, implementation of Bluetooth communication protocols, and integration of user-friendly control interfaces. By leveraging the power of Arduino and Bluetooth technology, we aim to create a smart wheelchair that offers precise maneuverability, obstacle detection, and advanced control functionalities. Both mobile-based and voice controller-based wheelchairs offer distinct advantages for disabled individuals. These technologies promote greater autonomy and independence, empowering wheelchair users to navigate their surroundings more effectively. By eliminating the need for manual controls, these systems reduce physical strain and enhance the overall user experience. Additionally, they prioritize safety by incorporating collision detection mechanisms and obstacle avoidance features, ensuring a secure and protected navigation environment.

Moreover, this project explores the potential of assistive technologies to improve the quality of life for individuals with mobility impairments. By empowering users with greater control and accessibility, smart wheelchairs can enhance their autonomy and participation in daily activities, both indoors and outdoors

II. 2. RESEARCH METHODOLOGY

For developing the system, we need the following hardware materials:

1. **Arduino UNO**: The Arduino board serves as the core microcontroller for the smart wheelchair project. Two popular options are the Arduino Uno and Arduino Nano. The Arduino Uno features an ATmega328P microcontroller, operates at 5V, has 14 digital input/output pins, 6 analog input pins, and 32 KB of flash memory. On the other hand, the Arduino Nano also utilizes the ATmega328P microcontroller, operates at 5V, offers 22 digital input/output pins, 8 analog input pins, and 32 KB of flash memory.

   To control the wheelchair's motors, a motor driver is necessary. Two commonly used options are the L298N and L293D. The L298N motor driver supports a maximum motor voltage of 46V, can handle a maximum continuous current of 2A per channel, and can provide a peak current of 3A per channel. It operates at a logic voltage of 5V. The L293D motor driver, on the other hand, can accommodate a motor voltage range between 4.5V and 36V, supports a maximum continuous current of 600mA per channel, and can provide a peak current of 1.2A per channel. It also operates at a logic voltage of 5V.

2. **L293D Motor Shield:** The L293D Motor Shield is a commonly used motor driver module designed for Arduino boards. It simplifies the control of DC motors by providing an all-in-one solution. The shield utilizes the L293D chip, which is a dual H-bridge motor driver IC capable of independently controlling two DC motors. It supports bidirectional control, allowing the motors to rotate in both forward and reverse directions. Each motor output can handle a continuous current of up to 600mA and a peak current of 1.2A, making it suitable for small to medium-sized DC motors.

   It offers control pins for motor operations and includes built-in protection features like diodes for voltage spike suppression, thermal shutdown, and current limiting. Additionally, the shield provides extra I/O pins for expanding the project's functionality and connecting other sensors or devices. Overall, the L293D Motor Shield is a user-friendly and versatile solution for driving DC motors with Arduino.

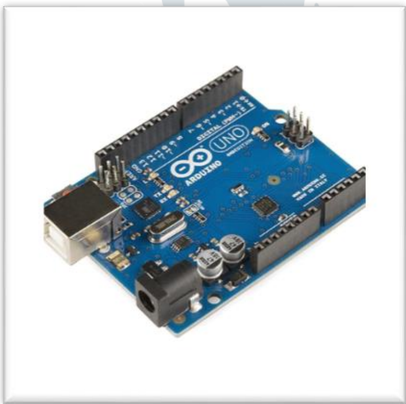

Fig1: Arduino UNO

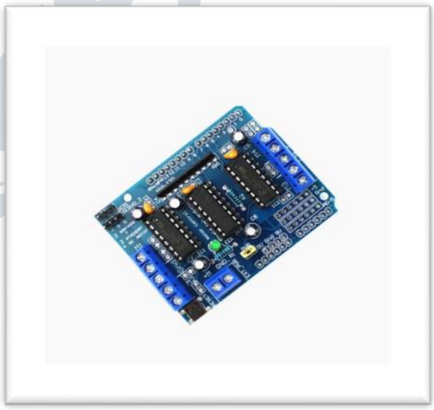

Fig2: L293D Motor Shield

3. **BO Motors with Wheels:** BO (Brushed DC) motors with wheels are commonly used in robotics and automation projects. These motors consist of a rotor and a stator that generate a magnetic field. By attaching wheels to the output shafts of these motors, they can produce rotational motion that translates into linear motion. This allows for the movement of wheeled robots, vehicles, and other motorized devices. BO motors are popular due to their simplicity and widespread availability. The wheels attached to these motors provide traction and enable the motor to propel the vehicle or device forward. Various types of wheels can be used depending on the specific application requirements.

4. **Bluetooth Module:** Bluetooth modules are electronic devices that allow wireless communication between devices using Bluetooth technology. They are commonly used in applications like IoT devices, smart homes, wearables, and robotics. Bluetooth operates in the 2.4 GHz frequency range and eliminates the need for cables by enabling devices to connect and exchange data wirelessly. Bluetooth modules act as transceivers, allowing devices to send and receive data packets. They support serial communication protocols like UART, making integration with microcontrollers and other devices straightforward. Popular Bluetooth modules include HC-05 and HC-06, which differ in Bluetooth versions and features. The range of communication varies depending on the module, typically spanning from a few meters to around 100 meters. Physical obstacles and interference can affect the range.

Fig3: BO Motors with Wheels

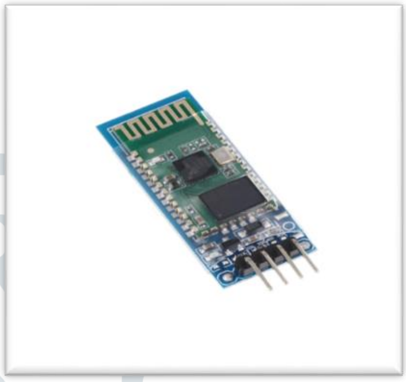

Fig4: Bluetooth Module

5. **18650 Battery:** The 18650 battery is a rechargeable lithium-ion battery that is commonly used in a wide range of electronic devices. It has a cylindrical shape with a diameter of approximately 18mm and a length of 65mm. This form factor makes it easy to handle and compatible with various devices. The 18650 battery utilizes lithium-ion chemistry, which offers a high energy density and a long cycle life. It has a nominal voltage of 3.6V or 3.7V and a capacity that typically ranges from 2000mAh to 3500mAh or higher. The battery can be recharged using a compatible charger designed for lithium-ion batteries. It finds applications in devices such as laptops, flashlights, power banks, electric vehicles, and portable electronics.

6. **MDF Board:** MDF (Medium Density Fiberboard) is a type of engineered wood product widely used in construction, furniture manufacturing, and interior design. It is made by breaking down hardwood or softwood residuals into wood fibers, which are then combined with a synthetic resin adhesive and compressed under high pressure to form panels. The resulting boards have a dense and uniform composition without visible wood grain. MDF comes in various densities and thicknesses, allowing for versatility in different application.

Fig5: 18650 Battery

Fig6: MDF Board

III. WORKING PRINCIPLE

The Arduino-based voice-controlled wheelchair with Bluetooth connectivity works by integrating various components and utilizing programmed instructions to enable remote control and movement of the wheelchair. Here's a general overview of how the project works:

- **Hardware Setup**: The project involves connecting the Arduino board to various components such as a Bluetooth module, motor driver (e.g., L293D Motor Shield), DC motors, and a power source. The Bluetooth module enables wireless communication between the wheelchair and a remote device, such as a smartphone or computer, using Bluetooth technology. The motor driver facilitates control of the DC motors, allowing the wheelchair to move in different directions.

- **Voice Control**: The project incorporates voice recognition capabilities using a voice recognition module or speech recognition library. The voice recognition module or library interprets voice commands spoken by the user. These voice commands are processed and converted into specific instructions or signals that the Arduino can understand.

- **Bluetooth Connectivity**: The Bluetooth module on the Arduino board establishes a connection with a remote device. This connection allows the Arduino to receive voice commands wirelessly from the remote device. The Arduino receives the voice commands transmitted over Bluetooth and processes them for further action.

- **Motor Control:** Based on the received voice commands, the Arduino board triggers corresponding actions on the motor driver. The motor driver interprets the instructions from the Arduino and controls the DC motors accordingly. For example, specific voice commands can be programmed to make the wheelchair move forward, backward, turn left, or turn right.

- **Power Supply**: The project requires a suitable power supply, such as a battery pack or power adapter, to provide the necessary power to the Arduino board, motor driver, and DC motors.

By combining voice recognition, Bluetooth connectivity, and motor control, the Arduino-based voice-controlled wheelchair enables users to control the wheelchair's movement using voice commands wirelessly. The Arduino board acts as the central controller, processing the voice commands received via Bluetooth and sending corresponding signals to the motor driver to initiate the desired movements of the wheelchair.

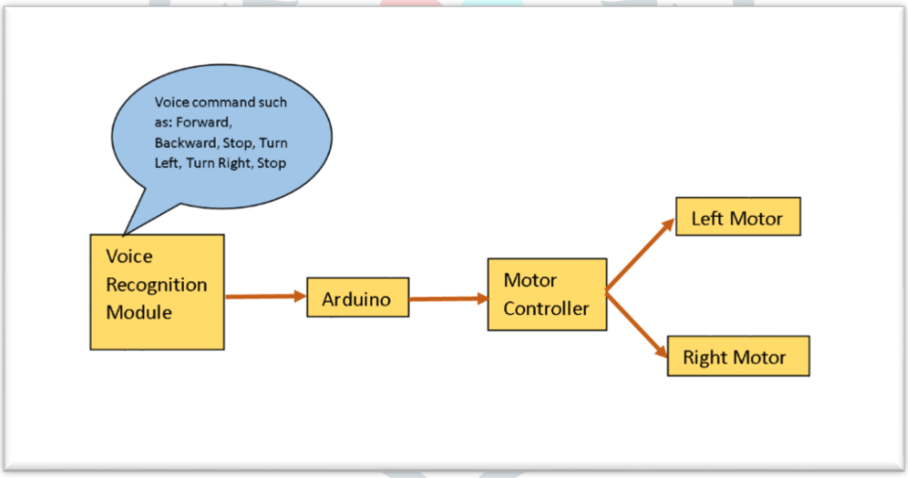

Fig 7: Workflow Diagram

Here are the advantages of the Arduino-based voice-controlled wheelchair with Bluetooth connectivity:

- **Accessibility**: Enables easy wheelchair control for individuals with limited mobility or physical disabilities through voice commands.

- **Convenience**: Wireless Bluetooth connectivity offers flexibility and eliminates the need for physical wires or direct contact with the wheelchair.

- **Intuitive Interaction**: Voice commands provide a natural and intuitive control method, simplifying navigation and maneuvering.

- **Hands-Free Operation**: Allows for hands-free wheelchair operation, benefiting individuals with limited dexterity or motor skills.

- **Customization and Adaptability**: The system can be personalized and tailored to individual user preferences and needs.

- **Real-Time Responsiveness**: Provides immediate response to voice commands, ensuring timely and accurate wheelchair control.

- **Potential for Expansion**: Offers opportunities for incorporating additional features and integration with other devices or systems.

- **Cost-Effective Solution**: Arduino-based projects are often more affordable compared to commercial alternatives, making it accessible to a wider range of users.

In summary, the Arduino-based voice-controlled wheelchair with Bluetooth connectivity offers accessibility, convenience, intuitive interaction, customization, real-time responsiveness, expansion potential, and cost-effectiveness for wheelchair users.

IV. RESULTS AND DISCUSSION

Table 1: Experimental result analysis of success rate of both voice recognition and mobile control:

Command/Control	**Success Rate of Voice Recognition**	**Success Rate of Mobile Control**	**Overall Success Rate**
Forward	100%	100%	**100%**
Backward	98%	100%	**99%**
Turn left	94%	98%	**96%**
Turn right	95%	99%	**97%**
Stop	97%	99%	**98%**
Overall Success Rate –	**96.8%**	**99.2%**	**>98%**

In this proposed model we have taken 50 persons and based on their mobile controlling or voice command to the system, we have taken total 50 readings. We have concluded that not all the times every sensor will work properly but, in most cases, our system gives accurate value and alerts properly. The accuracy of this proposed work is more than 98%.

V. CONCLUSION

In conclusion, both mobile-based and voice controller-based wheelchairs offer significant benefits for disabled individuals, enhancing their mobility and independence. Mobile-based wheelchairs utilize smartphones or tablets as control devices, allowing users to navigate their wheelchairs using touchscreen interfaces. These systems provide a familiar and intuitive control mechanism, leveraging the widespread adoption of mobile devices. Mobile-based wheelchairs often offer additional features such as customizable control interfaces, mapping capabilities, and the potential for integrating with other smart home devices or applications. They can be particularly advantageous for individuals who are already comfortable with using mobile technology.
On the other hand, voice controller-based wheelchairs utilize voice recognition technology to interpret verbal commands and translate them into wheelchair movements. This technology enables users with limited physical dexterity or mobility to operate their wheelchairs effectively. Voice control offers hands-free operation, allowing individuals with limited or no upper limb function to navigate their surroundings independently. Voice-controlled wheelchairs can be particularly useful for individuals with conditions such as spinal cord injuries, muscular dystrophy, or amyotrophic lateral sclerosis (ALS).

In concluding the words of our project, mobile-based and voice controller-based wheelchairs represent significant advancements in assistive technology for individuals with disabilities. By harnessing the capabilities of mobile applications and voice recognition, these innovative solutions offer intuitive control, seamless navigation, and increased independence for wheelchair users. They empower individuals to overcome physical limitations, enhancing their overall quality of life and fostering a more inclusive society.

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