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VOICE AND JOYSTICK-CONTROLLED MULTIFUNCTIONAL WHEELCHAIR

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Abstract

Our project is designed to address the needs of individuals facing physical disabilities or advanced age, resulting in limited mobility. The core functionality of our project relies on a voice recognition module and joystick controller, meticulously integrated with electric motors, which effectively interpret user-spoken commands to navigate the wheelchair. Furthermore, we will incorporate a sophisticated Android application, compatible with smartphones, to seamlessly interface with the various components of the wheelchair, enhancing its overall control and functionality. Central to our project's operation is an Arduino microcontroller circuit, skillfully interfaced with high-performance DC motors to facilitate precise and reliable movement.

Keywords:
Arduino, Voice recognition module, Joystick Controller, Smartphones, Voice Application

1. INTRODUCTION

In today's world, mobility is not just a convenience, but a fundamental aspect of independence and quality of life. Yet, for many individuals with mobility impairments, the cost of a specialized wheelchair often creates a significant barrier, restricting access to essential equipment. Moreover, existing wheelchairs offer limited functionality, often providing only one mode of operation, be it through voice commands or joystick control.

Recognizing these challenges, our project aims to revolutionize the landscape of mobility solutions by introducing the Voice and Joystick Multifunctional Wheelchair. Our mission is clear: to develop a wheelchair that is not only affordable but also offers a diverse range of operational modes, giving users the freedom and versatility they need.

The current market scenario reveals a clear disparity in accessibility to wheelchairs, particularly for individuals from economically disadvantaged backgrounds. Conventional wheelchairs with exorbitant price tags, remain out of reach for many families belonging to the middle and lower economic backgrounds. This financial barrier encourages a cycle of dependence and limited mobility for those who need it the most.

Furthermore, the prevailing models of wheelchairs are predominantly single-functioned, restricting users to either voice-controlled or joystick-operated mechanisms. This limitation fails to accommodate the diverse needs and preferences of individuals with varying degrees of mobility impairment. It is evident that the existing solutions fall short of addressing the nuanced requirements of users, thereby underlining the urgent need for innovation in this domain.

2. METHODOLOGY

There are 3 main ways of operation in our Multifunctional Wheelchair, Voice control, Joystick Control, and the Accelerometer. The joystick, microphone, and voice recognition module all get a 5V power and the driver circuit will get a 9.9V power source from the battery. For the Voice Control system, the wheelchair uses the verbal commands of the user. The Voice Control system can be used by the user or it can be used by their caretaker. The user can give the wheelchair four basic commands, forward, backward, left, and right. We have coded to convert the voice commands into instructions and the wheelchair will move according to the instructions.

Voice Recognition

For voice recognition, we use an in-built app that comes with our main component, Arduino Uno. Since the app is directly connected to the Arduino Uno microcontroller, the process of voice recognition process is made hassle-free. The speech recognition that comes with the Arduino is controlled through the BT voice-controlled app. The app is connected to the Arduino app using an HC-05 Bluetooth Module.

The commands that are given to the app are digitalized and passed to the HC-05 Bluetooth module. The Bluetooth module is connected to the Arduino Uno microcontroller. The Arduino Microcontroller then processes the voice commands according to the code that is already embedded into the microcontroller.

Accelerometer

In our application, the BT control app is not only used for voice recognition but it can also be used to control the wheelchair using another mode. The wheelchair can be controlled using the Accelerometer, which is integrated into the code of our Arduino Uno microcontroller and can be used easily through the BT app.

Since the accelerometer control is already coded into the microcontroller, the commands given through the app are sent to the HC-05 Bluetooth module which is in turn connected to the microcontroller. The microcontroller then takes action according to the commands resulting in the movement of the wheelchair.

Joystick Control

The third and most popular way of propagationusing a wheelchair is using a joystick. The joystick control is integrated at the front of the wheelchair near the hands of the user to enable easy access. The joystick control along with the other connections is connected to the Arduino Uno microcontroller. The Arduino Uno microcontroller is connected to the L298N Motor Driver module. The motor driver module is connected to the two DC motors, one for the left wheel and another for the right wheel. The motor driver module operates the motors according to the instructions received from the Arduino microcontroller.

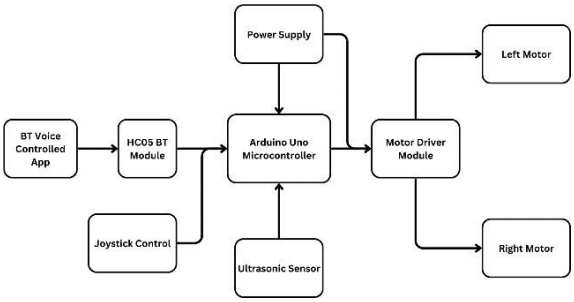
3. MODELING AND ANALYSIS

The components used are as follows:

Hardware components:
1. Arduino UNO Board with Cable
2. Joystick Module
3. Wheelchair with caster wheels and 2 wheels
4. L298D Motor driver
5. LM2596 Buck Converter
6. Bluetooth Module (HC-05)
7. Android BT Robot Controller App
8. Power Adapters or Battery
9. DC Motors – 2

Software Used:
Arduino IDE

Block Diagram of the proposed system:



The suggested design includes a Joystick and a Bluetooth module. The HC-05 Bluetooth Module is a serial Bluetooth module for Arduino and other microcontrollers operating at 5V. It has a way two-way wireless functionality which is compatible with a laptop or mobile. The Bluetooth module has a Baud Rate of 9600 and is readily available in most electronic shops.

DC Motors:

The DC motors are undoubtedly one of the most important components in this design. The power and specs of the DC motor here have to be chosen carefully since the torque output of the motor has to perfectly align with the requirements. Overpowered motors generate inability and waste the already restrained supply of energy from the batteries onboard. If the motors are underpowered, the torque generated might not be enough to enable locomotion.

Hence, the DC motors used here in our design and wheelchair are operated at 24V and enable a speed of 40rpm to the wheels. The DC motor generates enough power to enable locomotion for a person of average weight around 100 kg.

The below figure represents the Interfacing of the 2 DC motors & power supply to the wheelchair using a connector.

Motors and Motor Driver Module of the project

Android BT Robot Controller App:

In our wheelchair, since we are using the BT Robot Controller App, it becomes very easy and straightforward for the user to use it. The BT Robot Controller App comes integrated with the Arduino. Hence, the user can easily download it using the Play Store or App Store. Once installed, the user can easily connect his/her wheelchair using the App. As said already, the app opens up multiple ways of using the wheelchair. The wheelchair can be operated using either the Voice Control or the Accelerometer.

App Interface

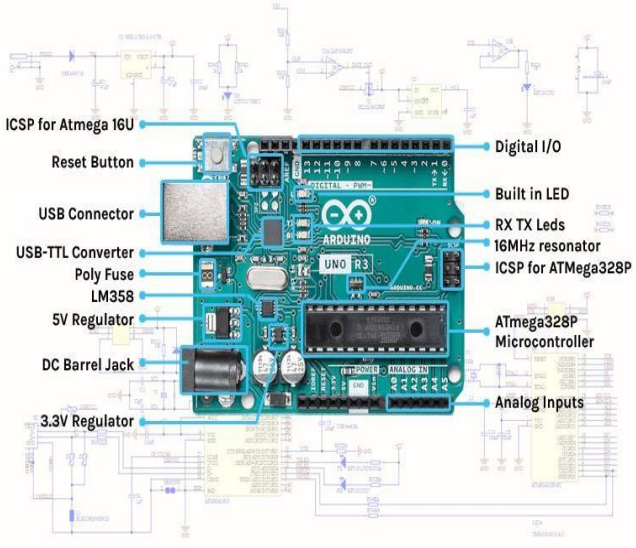
Configuration

To control the direction of the Wheelchair, we assign unique keys for each direction. For the BT Robot Controller App, there are some default keys that are assigned to the corresponding direction as shown in the figure below. For the ease of the user, they can even modify the keys. In the BT Robot Controller App, the voice and accelerometer controllers use the same configuration.

Arduino Uno Board:

Arduino Uno is an open-source electronic prototyping base for simple-used hardware and software in the field of micro-controlling.

Arduino has an ATMega328 microcontroller built on it. It has a 16MHz crystal, 6 analog input and output pins, and 14 digital input and output pins. Out of the 14 digital pins, 6 pins can be used as PWM pins that are pretty accommodating in motor applications. It also comes with a USB connector that can be used to attach Arduino to a PC for uploading the code. When Arduino is connected to the PC, it draws the power constantly that is required for its operation.



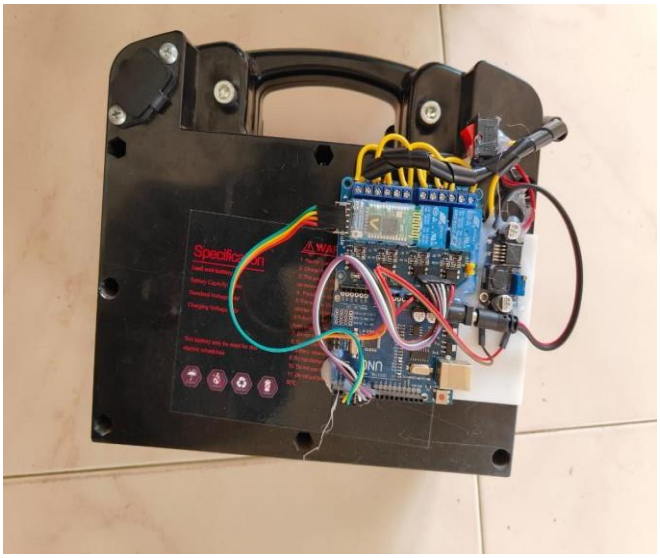
Arduino Uno Microcontroller

Power Supply:

The Power Supply is given through a battery. Batteries are another way to produce electricity. They are classified into two categories primary and secondary batteries. Here we use secondary batteries. Secondary batteries must be charged before use; they are usually assembled with active materials in the discharged state. Rechargeable batteries or secondary cells can be recharged by applying electric current, which reverses the chemical reactions that occur during its use. Here 24V power is given to the motor driver module and LM2596 Buck Converter.

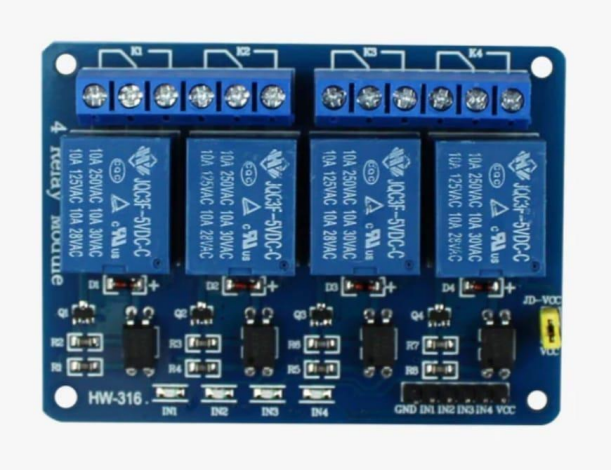
Specs: 24V / 250W / 40rpm /13.4 A

Power Supply



Motor Driver Module:

The sole purpose of the motor driver module is to control the 2 DC motors using the help of Arduino Uno Microcontroller. The Motor Driver Module used here, L298D, is a standard Motor Driver IC that enables the DC motor to drive either ways. The L298D IC is a 16-pin IC that can be used to command a set of DC motors concurrently.



Motor Driver Module

Output Motor Driver Module (L298D):

S.No	Direction	R1	R2	R3	R4
1	Forward	High	Low	High	Low
2	Backward	Low	High	Low	High
3	Right	High	Low	Low	High
4	Left	Low	High	High	Low
5	Stop	Low	Low	Low	Low

Joystick Module:

The joystick module is key to enabling us a third mode of operation. A wheelchair joystick controller is a device that enables people with limited mobility to control their wheelchair. It is usually placed on one of the armrests of the wheelchair.

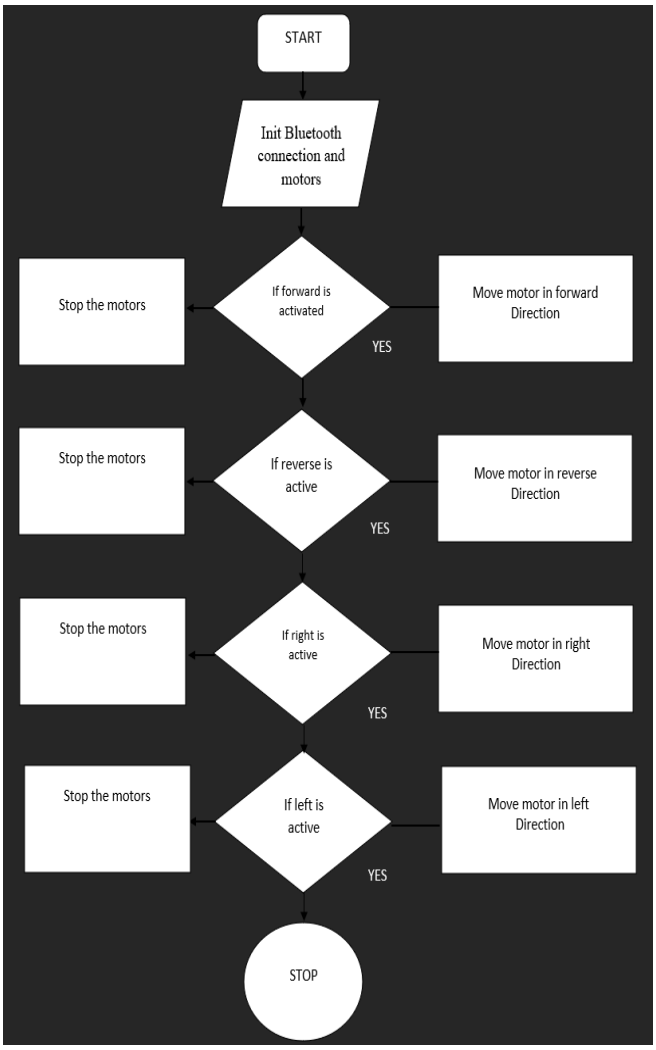
INPUT (Joystick/ Android App):

S.No	Direction	IN_1	IN_2	IN_3	IN_4
1	Forward	Low	High	Low	High
2	Backward	High	Low	High	Low
3	Right	High	Low	Low	High
4	Left	Low	High	High	Low
5	Stop	Low	Low	Low	Low

Control Algorithm:

A control Algorithm is defined as the Algorithm or a way of describing the flow of operation in the application.

Step-1: Initialization of Motors
Step-2: Waiting for the signal from the application(i.e., from the voice recognition module.)
Step-3: Decoding and recognizing the signal for direction.
Step-4: Movement of the wheels in the direction given according to the instructions.
Step-5: Stop



Control Algorithm Flowchart

4. RESULTS AND DISCUSSION

After the design and development of the self-automated wheelchair with its many interfacing modules, the project was tested for wheelchair movement using trained speech and also the joystick movement.

- This design is tested based on two important aspects: first, how accurate is the voice module and second, how the wheelchair moves w.r.t the commands given. Now the switch is on. The voice recognition system will first be put to the test in a quiet environment with only one user, the results are successful. It takes commands accurately.

- After that, the project was put to the test in a disturbing environment by a few people nearby. When the noise was mild, the voice module had no trouble recognizing, but when the noise was too loud, the recognizer struggled to recognize the user's voice and didn't take any commands. Sometimes it mistook the command and executed another one.

- Now the switch is low, The feature switches to the joystick. We used a joystick to move in all directions and it is successful with no obstacles.

5. CONCLUSION

The mechanism was successfully installed, allowing the wheelchair to move left, right, forward, backward, or remain stationary. This project aims to assist disabled people by giving alternative methods of controlling technology, such as a joystick or voice commands, which will benefit a wide range of disabilities. As a result, the wheelchair recognizes the signals from the control system and responds appropriately.

We've created a smart wheelchair that uses voice and joystick control. It is simple to comprehend and process. It has two components that allow the wheelchair to move in response to human commands. If a patient is unable to move his or her hands, voice commands can be utilized to navigate the wheelchair on their own. The joystick assists with manual control. Voice commands can be given with the use of a microphone. This technology gives the growing disabled population independent mobility as well as a variety of sophisticated features. Implementing neural network-based algorithms can boost the efficiency of the voice command control system even more.

6. REFERENCES

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