VOICE CONTROLLED WHEELCHAIR

ECD334 Mini Project: Report Submitted by

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Towards the partial fulfillment of the requirement for the award of B.Tech. degree in

Electronics and Communication Engineering

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DEPARTMENT OF
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CERTIFICATE

Certified that this is a bonafide report of the project work done by **ANN MARY ROY (Reg. No. KNR21EC016)** , **ANURAG R NARAYANAN (Reg. No. KNR21EC017), ANUVINDA SATHYAN (Reg. No. KNR21EC018)** and **ARATHI S NAIR (Reg. No. PKD21EC017)** on the topic **VOICE CONTROLLED WHEELCHAIR**, towards the partial fulfilment of the requirements for the award of the Degree of Bachelor of Technology in Electronics and Communication Engineering under APJ Abdul Kalam Technological University during the academic year 2023-2024.

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Project Supervisor	Project Co-ordinator	Professor & HoD
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DECLARATION

We, the undersigned, hereby solemnly declare that this project report titled **VOICE CONTROLLED WHEELCHAIR**, submitted for the partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Electronics and Communication Engineering from APJ Abdul Kalam Technological University is a bonafide record of our own work carried out under the supervision of **Prof. Ramanand A. C**.

Wherever we have used materials (data, theoretical analysis, and text) from other sources, we have adequately and accurately cited the original sources.

We also declare that this work has not been submitted to any other institution in this University or any other University.

Ann Mary Roy

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ABSTRACT

Individuals with impaired mobility may encounter physical limitations or even insurmountable obstacles in their daily lives. Manual or powered wheelchairs can facilitate their mobility and enhance their quality of life. Conventional wheelchairs rely on manual control using hands and arms, hindering independence for people with upper extremity impairments. To alleviate these burdens, autonomous care-giving devices that do not require human intervention are needed. Voice signals are the primary modality of human communication, used in all conversations and interactions. This project presents the design of a voice-controlled automated wheelchair which is complemented by a mobile application. The voice controlled wheelchair has the potential to significantly improve the quality of life for individuals with limited mobility by:

* Providing a hands-free and intuitive control method
* Enhancing navigational autonomy in unfamiliar environments
* Reducing dependence on caregivers

The system utilizes the HC-05 Bluetooth module, an Arduino UNO microcontroller, Motor driver module(L293N), DC Motors, Ultrasonic sensor, 3.7V battery, Arduino Bluetooth Control Application. The wheelchair system utilizes Bluetooth technology to establish a wireless connection between the wheelchair and a mobile device.

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CHAPTER 1

INTRODUCTION

In worldwide context, it is estimated that 100-130 million people with disabilities are present and they require wheelchairs for their assistance[2].

In a world where technology continually evolves to enhance our lives, the concept of voice-controlled mobility devices stands at the forefront of revolutionizing accessibility for individuals with limited mobility.

Shortly available manual wheelchairs need regular assistance of others for people having severe limitation and are at a high risk of damages to the upper part of the body due to mechanical inability of the wheelchair[1].

This project aims to develop a voice-controlled system for individuals with physical disabilities. By integrating speech recognition technology with a microcontroller, the system will allow users to control a wheelchair using voice commands, enhancing their independence and mobility.

CHAPTER 2

LITERATURE SURVEY

Sumet Umchid and Pitchaya Limhaprasert [3] specified about the development of wheelchair that can be controlled by voice, eye or using joystick according to the severity of disability of handicap person. It also features a warning system that analyses the patient real situation such as heart rate, temperature, etc and notifies the doctor regarding the same. It even has integrated robotic hand which helps the patient for taking medicines and food. This study paper concentrates on the queries of the handicapped individual and tries to resolve them in the best feasible way. The condition is that it ought to be formed independently for each single specified to its austerity which raises its price and time.

Nirmal T M [4] specified about the high costing of the electric wheelchair and modifying the present electric wheelchairs to make it affordable to the common people. It put importance on the utilization of sources open locally to cut the price of wheelchair. It utilizes pair of dc gear motor, PIC microcontroller and h bridge module for commanding the movement of wheelchair. The shortcoming of this research is that expense of the wheelchair is still huge for the ordinary people to afford it.

CHAPTER 3

PROPOSED SYSTEM

The proposed system is designed to enhance the mobility and independence of individuals with physical disabilities, particularly those experiencing limitations in upper body movement.

3.1 Block Diagram

Fig.3.1 shows the block diagram of the Voice Controlled Wheelchair. The block diagram consists of Arduino UNO, Bluetooth module, Motor driver, DC motors. The components are explained in the subsequent subsection. Voice to text conversion is done by Arduino Bluetooth Control Application. This text is sent to the Arduino by Bluetooth module(Voice Module). The Ultrasonic sensor senses any obstacle within 20cms. Arduino is powered by a powerbank(powersupply) and L298N motor driver rotates the motor according to the commands given by the Arduino. Three 3.7V Lithium-ion batteries are used to power the motor driver.

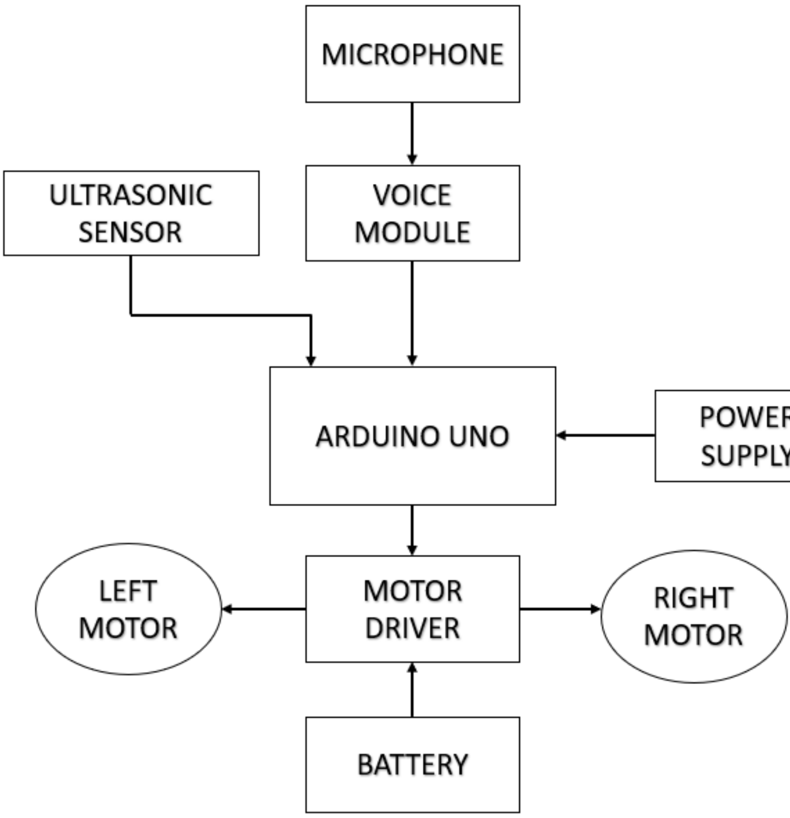

Fig. 3.1: Block Diagram

3.1.1 Arduino

It receives the processed voice commands from the voice module and translates them into instructions for the wheelchair.

3.1.2 HC-05 Bluetooth Module

The Bluetooth module is used to connect the wheelchair to a smartphone or tablet running a custom voice command app. This voice could provide a more user-friendly interface for setting up and issuing voice commands.

3.1.3 Ultrasonic Sensor

If an obstacle is detected within a certain threshold distance, the code would override the original voice command and instruct the motor driver to stop the wheelchair or take evasive maneuvers (like turning) to avoid a collision.

3.1.4 Motor Driver L293N

It receives instructions from the Arduino and controls the speed and direction of the wheelchair's motors (left and right) based on your voice commands.

3.1.5 DC Motor

DC motors have a wide range of speed capabilities that make them ideal for robotics applications that require accurate speed control. The motor driver translates the signal from the Arduino into instructions for the left and right motors, making the wheelchair move accordingly.

3.1.6 Power Supply

The power for Arduino is drawn from powerbank and a separate power source(Li-ion battery) is provided for motor driver.

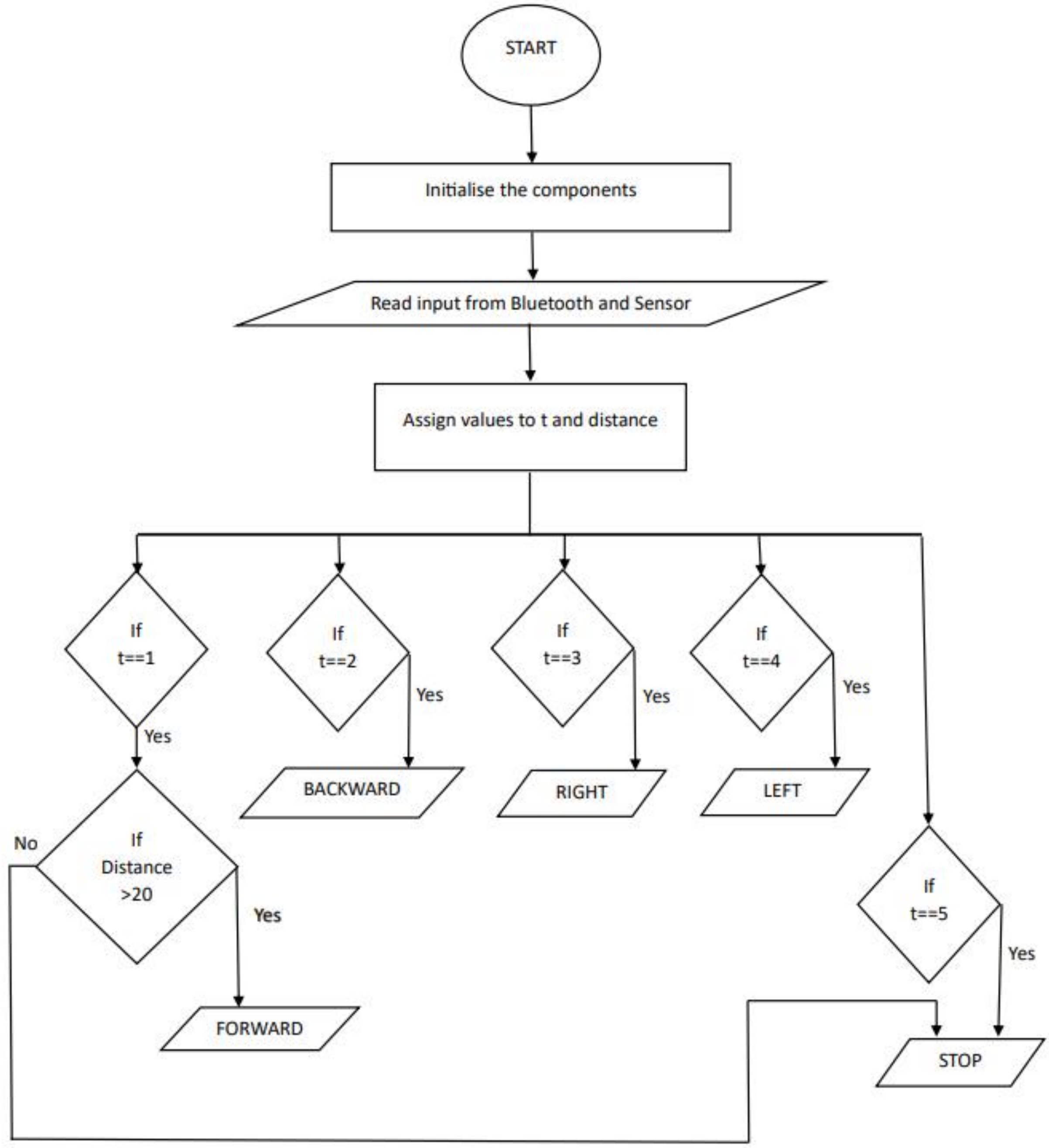

Fig. 3.2: Flow Chart

Fig 3.2 shows the flowchart for a Voice Controlled Wheelchair. The system functions in a continuous loop, actively receiving and interpreting user commands transmitted via Bluetooth (forward, backward, turn left, turn right, stop). Simultaneously, it gathers real-time data on surrounding obstacles using an ultrasonic sensor that measures distance. When a forward command is received, the system assesses the path ahead based on the sensor data (distance exceeding a predefined threshold). If the path is clear, the system transmits control signals to maneuver the wheelchair forward. Conversely, if an obstacle is detected within the threshold distance, the system prioritizes safety and transmits stop signals to prevent a collision. Backward movement, left turns, right turns, and complete stops are all executed based on the corresponding user commands received through the Bluetooth interface. This cyclical process of command reception, environmental monitoring, and action execution ensures the smart wheelchair remains responsive to user control while prioritizing safe navigation within its surroundings.

3.2 Algorithm

Initialization:

- Activate the microphone and speech recognition module.
- Establish communication with the motor driver.

Voice Command Detection:

- Upon detecting valid input, the system transmits the captured audio signal to the speech recognition module.

Voice Command Recognition:

- The speech recognition module analyzes the received audio signal to identify the embedded voice command.

Command Processing:

If a recognized command is identified (forward, backward, left, right, or stop) microcontroller interprets the command and transmits corresponding control signals to the motor driver.

Obstacle Detection:

If an obstacle is detected within a predefined safety threshold, the system immediately transmits an emergency stop signal to the motor controller.

CHAPTER 4

METHODOLOGY

The working of each modules and its integration as well as setup is described in the methodology. The components used are Arduino Uno, HC-05 Bluetooth Module, HC-SR04 Ultrasonic Sensor, L298N Motor Driver, DC Motors and Wheels.

4.1 Arduino UNO

Fig. 4.1: Arduino Uno R3

A basic Arduino consists of a simple base board that has the microcontroller and its support circuitry with connectors to connect to plug in modules and a USB interface to download code from the PC. The Arduino Uno shown in Fig.4.1 is an open-source microcontroller board based on the Microchip

ATmega328P microcontroller and developed by Arduino.cc. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button.

On the peripherals there will be 2x8-bit Timer/Counter with a dedicated period register and compare channels, 1x16-bit Timer/Counter with a dedicated period register, input capture and compare channels, 1x USART with fractional baud rate generator and start-of-frame detection, 1x controller/peripheral Serial Peripheral Interface (SPI), 1x Dual mode controller/peripheral I2C, 1x Analog Comparator (AC) with a scalable reference input, Watchdog Timer with separate on-chip oscillator, Six PWM channels, Interrupt and wake-up on pin change. The USB port on the board, which could both be a power and data port, a barrel jack for the power supply, a LED power indicator, a reset button, a voltage regulator, and TX/RX LEDs. There is also a set of labelled pins for 5V, 3.3V, GND, Analog, Digital, PWM, and AREF. These pins are mainly used to attach expansion cards, or SHIELDS, to Arduino for extra functionalities like network connection, LCD, and joysticks. The pins can also be used to attach components from a breadboard for prototyping.

Arduino boards are available at low cost and they are super easy to learn. There is no need for any external hardware, multiple projects can be made using single Arduino boards which cut overall project cost by a great margin. While most of the microcontrollers can only be programmed using Windows Arduino is not only limited to Windows it is also available across multiple platforms like Linux and macOS.

Arduino’s accessibility, easy-to-understand hardware design, and simple software make it appealing to different types of users. Programming an off-the-shelf microcontroller is often messy, and the code is not easy to comprehend, especially for newbies. Arduino provides a simple and easy-to-understand coding platform through the Arduino IDE. It is friendly to students and to those who are still new in electronics projects, simplifying coding and compiling and uploading codes to the board, eliminating the need for an external programmer or burner. Even professionals and experienced programmers are using Arduino IDE because of its uncomplicated interface.

4.2 HC-05 Bluetooth Module

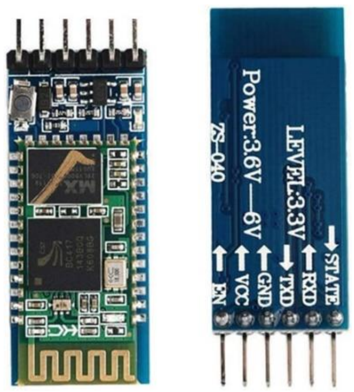

Fig. 4.2: HC-05 Bluetooth Module

The HC-05 is a class 2 Bluetooth module designed for transparent wireless serial communication. It is pre-configured as a slave Bluetooth device. Once it is paired to a master Bluetooth device such as PC, smart phones and tablet, its operation becomes transparent to the user. All data received through the serial input is immediately transmitted over the air. When the module receives wireless data, it is sent out through the serial interface exactly at it is received. No user code specific to the Bluetooth module is needed at all in the user microcontroller program.

4.3 HC-SR04 Ultrasonic Sensor

Fig. 4.3: HC-SR04 Ultrasonic Sensor

Ultrasonic sensors are electronic devices that measure distance by emitting ultrasonic sound waves, and converting the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e. the sound that humans can hear).

Specification	Description
Model	HC-SR04
Operating Voltage	5V
Operating Current	<15mA
Operating Frequency	40kHz
Measuring Range	2cm to 400cm
Measuring Angle	30 degrees
Resolution	0.3cm
Trigger Input Signal	10µs pulse
Echo Output Signal	Output pulse width proportional to distance
Trigger Pulse Duration	10µs
Echo Pulse Duration	Width corresponds to the distance

Table 4.3 Specifications of HC-SR04 Ultrasonic Sensor

The Ultrasonic Sensor is used to measure the distance with high accuracy and stable readings. It can measure distances from 2cm to 400cm or from 1 inch to 13 feet. It emits an ultrasound wave at a frequency of 40KHz in the air, and if an object comes in its way, it will bounce back to the sensor. By using the time it takes for the wave to strike the object and return, you can calculate the distance using Equation

$$\text{Distance} = \frac{\text{Time} \times \text{ sound speed}}{2}$$

Where Time is the time between receiving and transmitting the ultrasonic wave.

The Ultrasonic Sensor has four pins. Two are VCC and GND, which should be connected to the 3.3V and GND of the Arduino, respectively. The other two pins are Trig and Echo, which will be connected to any digital pins of the Arduino. The Trig pin sends the signal, and the Echo pin receives the signal. To generate an ultrasound signal, make the Trig pin high for about 10us, sending an 8-cycle sonic burst at the speed of sound. After striking the object, the signal will be received by the Echo pin.

4.4 L298N Motor Driver

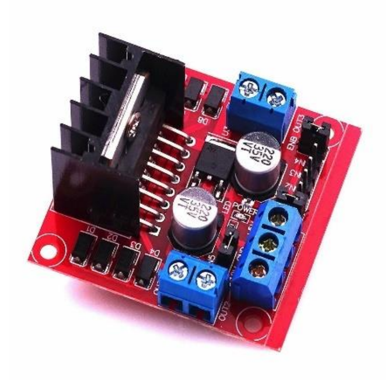

Fig. 4.4: L298N Motor Driver

This L298N Motor Driver Module is a high power motor driver module for driving DC and Stepper Motors, resistors, capacitor, Power LED, 5V jumper in an integrated circuit. This module consists of an L298 motor driver IC and a 78M05 5V regulator. L298N Module can control up to 4 DC motors, or 2 DC motors with directional and speed control. The L298N is a dual H-Bridge motor driver which allows speed and direction control of two DC motors at the same time. The module can drive DC motors that have voltages between 5 and 35V, with a peak current up to 2A.

4.5 DC Motor and Wheels

Fig. 4.5: DC Motor

A DC motor is an electrical machine that converts electrical energy into mechanical energy. In a DC motor, the input electrical energy is the direct current which is transformed into the mechanical rotation.

4.6 Lithium-Ion Battery

Fig. 4.6: 3.7V Lithium-ion battery

This rechargeable Lithium-ion (Li-ion) battery features a cylindrical design for easy integration into various devices. Offering a reliable and long-lasting 1200mAh capacity, it can be conveniently recharged for multiple uses. Encased in a durable plastic shell for insulation, the battery boasts a high-carbon steel core that safeguards against overcharging and potential bursting, ensuring safe and extended operation.

4.7 Arduino Bluetooth Control App

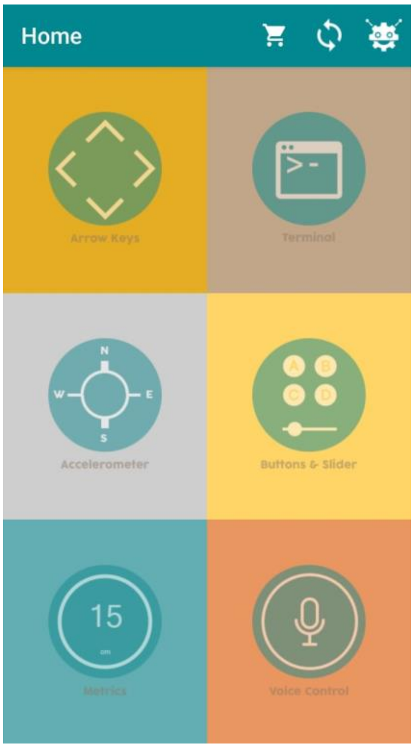

Fig. 4.7: Arduino Bluetooth Control App

Arduino Bluetooth control applications offer a streamlined approach for achieving wireless user interaction with physical projects. This technology stack leverages the ubiquity of smartphones and Bluetooth connectivity to provide a user-friendly control interface. The core functionality revolves around pairing a smartphone with a Bluetooth module attached to the Arduino board. Subsequently, a custom-developed mobile application or a pre-built Bluetooth terminal app facilitates the transmission of control commands (buttons, sliders, joysticks) to the Arduino. The Arduino's onboard processing power interprets these commands based on pre-defined logic within the code.

Here the app converts the Voice signal to a corresponding text and sends it to Arduino.

CHAPTER 5

RESULTS

The project ‘Voice Controlled Wheelchair’ is developed using Arduino module. Voice controlled wheelchair is the modified version of the manual wheelchair. We developed the code for the movement of the wheelchair. When the voice commands are given, the Arduino Bluetooth Control Application converts voice to text and sends it to Arduino. Wheels move forward, backward, left, right or stop according to the commands given. Ultrasonic sensor checks the presence of obstacle within 20cm.

Fig. 5.1: Final Prototype

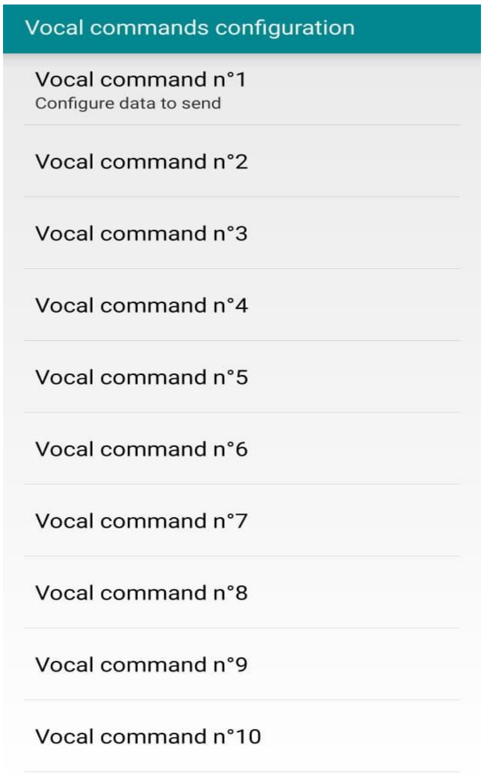

Fig. 5.2: Selecting commands to be given

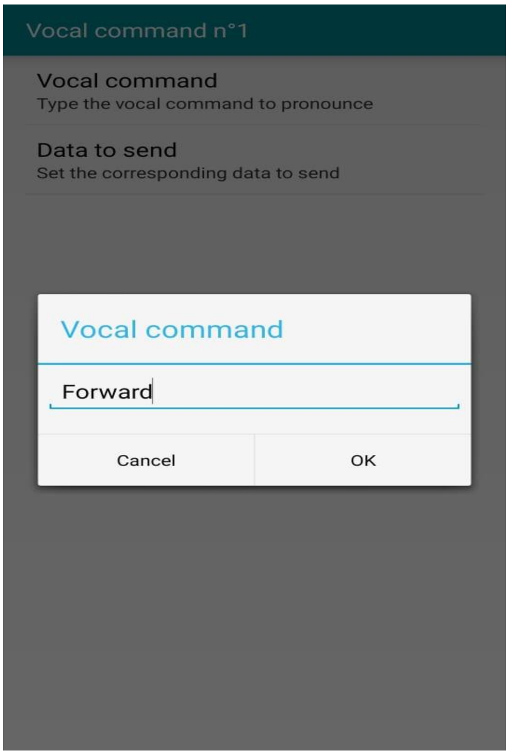

Fig. 5.3: Identification of Voice Command

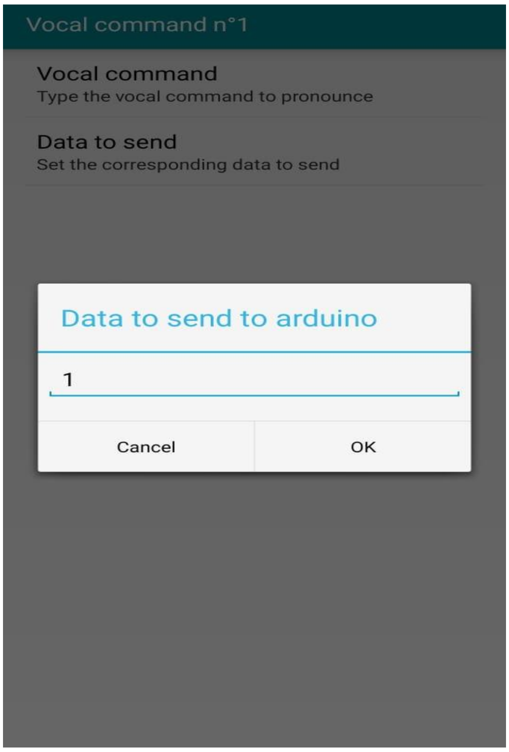

Fig. 5.4: Character data sent to Arduino

Figure 5.2 shows the set of voice commands that can be given as inputs. Here we have given five commands namely, Forward, Backward, Left, Right, and Stop.

Figure 5.3 illustrates an example of the "Forward" voice command being used as input to the system.

Figure 5.4 depicts the user interface prompting for a single character to be entered. This character likely corresponds to a pre-selected voice command and will be transmitted as input to the Arduino for processing.

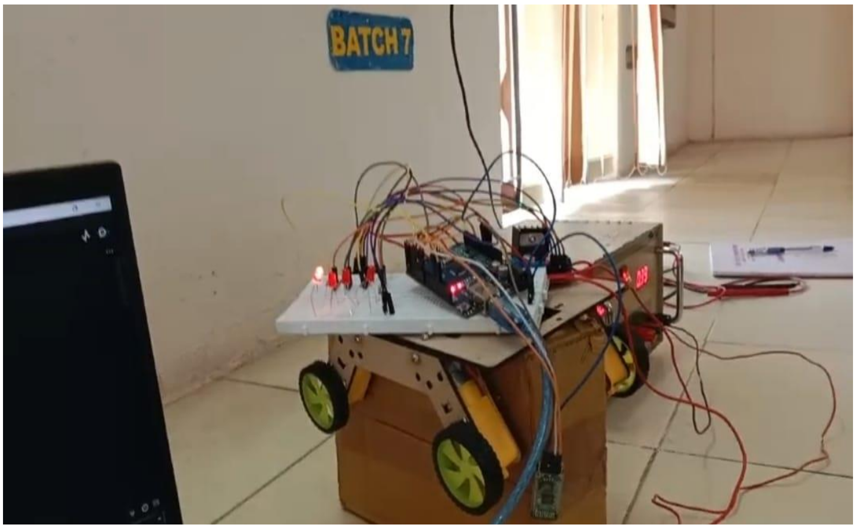

Fig. 5.5: Left Movement

Figure 5.5, the system executes a leftward turn. This is achieved by suspending the left-side motors. Conversely, the right-side motors are activated to propel the wheelchair in a counter-clockwise direction, resulting in a leftward turn. This is also indicated by the blinking of LED connected to pin 3 of Arduino.

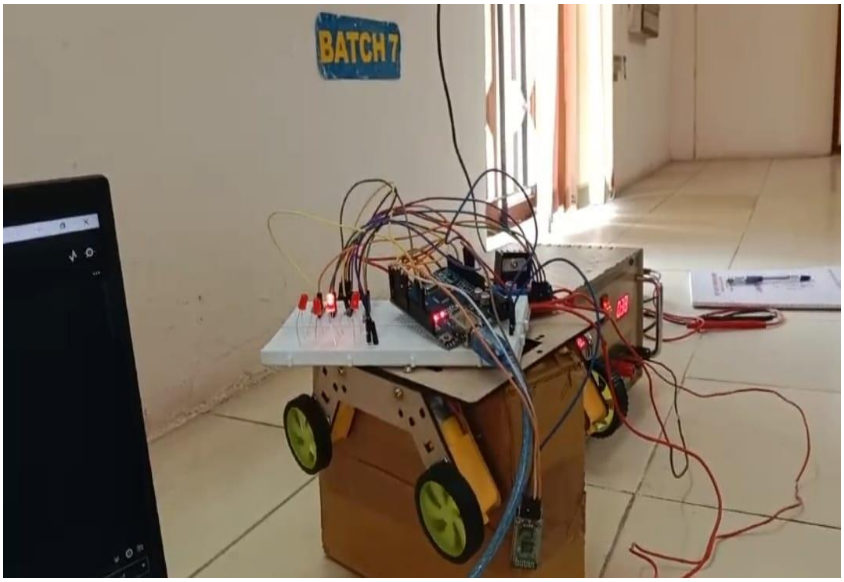

Fig. 5.6: Right Movement

Figure 5.6, the system executes a rightward turn. This is achieved by suspending the left-side motors. The left-side motors are activated to propel the wheelchair towards right. Here the LED connected to pin 5 of Arduino blinks indicating rightward movement.

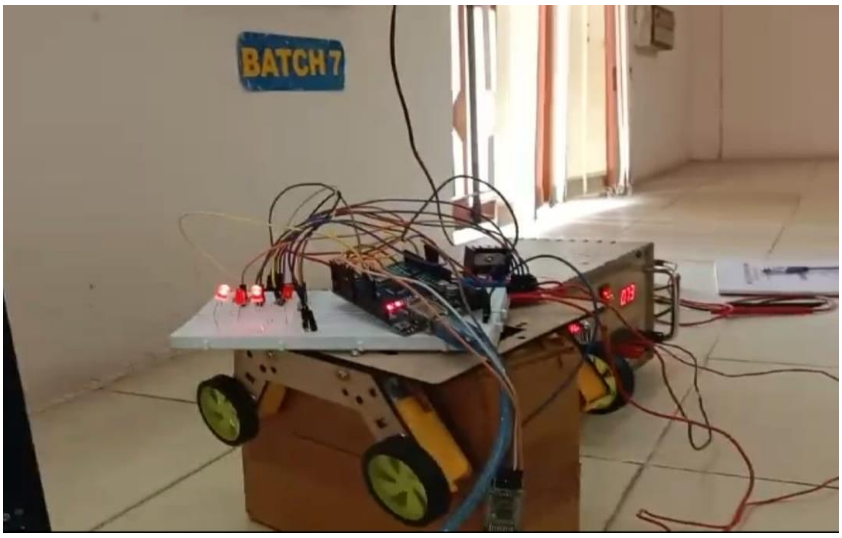

Fig. 5.7: Forward Movement

Figure 5.7 represents Forward movement. Forward movement is initiated only when the ultrasonic sensor confirms the absence of obstacles within a 20cm. Upon such confirmation, all DC motors are activated and programmed for forward rotation, propelling the wheelchair in a linear trajectory. LED connected to pin 3 and pin 5 of the Arduino blinks.

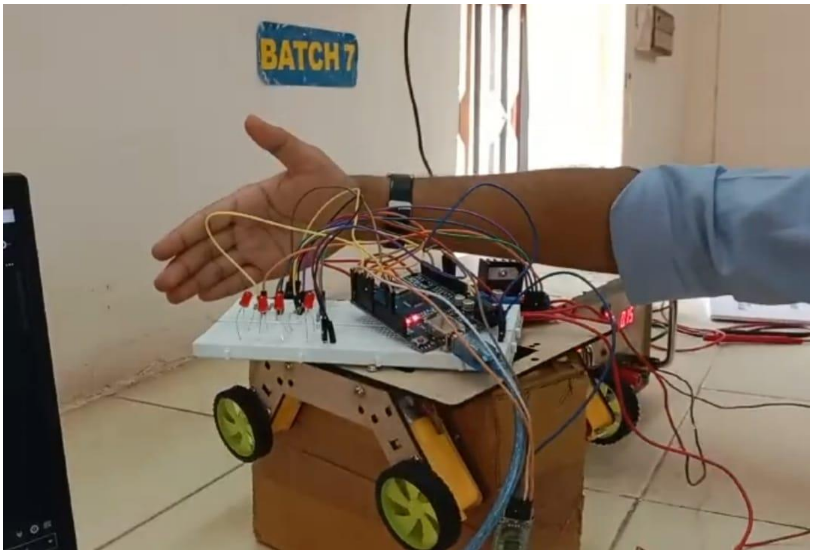

Fig. 5.8: Stopping after detecting obstacle within 20cm

Figure 5.8, the system implements obstacle detection using a sensor with a 20 cm range. Upon obstacle detection, the wheelchair initiates an emergency stop to ensure safety. All the LEDs are thus turned off.

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

6.1 Conclusion

This project has successfully demonstrated the development of a voice-controlled wheelchair. This assistive technology has the potential to significantly improve the lives of people with disabilities by providing them with a greater degree of autonomy and improved mobility. The voice-controlled interface offers a hands-free method for controlling the wheelchair, which is particularly beneficial for users with limited dexterity.

6.2 Future Scope

Voice customization in local languages will offer personalized control options, empowering users to interact with their wheelchairs in a familiar and intuitive manner. Users will benefit from customizable seat adjustment options, allowing them to optimize comfort and posture while using the wheelchair. Integration with home automation systems will allow voice-controlled wheelchairs to interact with smart devices, enhancing user experience and accessibility within their living spaces. Equipped with biometric sensors and health monitoring systems, these wheelchairs will provide real-time health data and ensure users' well-being during daily activities.

REFERENCES

[1]"Design and Implementation of an Electric Wheel-Chair to Economies it with Respect to Bangladesh" , Humaira Salmin, Hafiz Rakibul, Pratik Kumar Kundu, B.M. Fahmid Jahur , International Journal of Multidisciplinary Sciences and Engineering, Vol. 5, No. 2, pp: (17-22), February 2014

[2]"Voice Controlled Motorized Wheelchair with Real Time Location Monitoring", Nikunj Janak Gor, Amrutha Jeyakumar International Conference on Energy, Communication, Data Analytics and Soft Computing 2017

[3]"Voice Controlled Automatic Wheelchair", Sumet Umchid, Pitchaya Limhaprasert , The 2018 Biomedical Engineering International Conference

[4]"Wheelchair for Physically and Mentally Disabled Persons", Nirmal T M, International Journal of Electrical and Electronics Research, ISSN 2348-6988 (online), Vol. 2, Issue 2, pp: (112-118), April - June 2014

APPENDIX

PROGRAM

```
char t;

const int trigPin = 12;
const int echoPin = 13;
byte GetValue;

void setup() {
pinMode(4,OUTPUT); //left motors forward
pinMode(3,OUTPUT); //left motors reverse
pinMode(5,OUTPUT); //right motors forward
pinMode(6,OUTPUT); //right motors reverse
pinMode(trigPin,OUTPUT);
pinMode(echoPin,INPUT);

Serial.begin(9600);

}

byte ReadOneByte()
{
int ByteRead;
while(!Serial.available());
ByteRead =Serial.read();
return ByteRead;
}
void loop()
{
  digitalWrite(trigPin,LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin,HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin,LOW);
  long duration=pulseIn(echoPin,HIGH);
```

```
  long distance=duration*0.034/2;
  Serial.println("Distance: ");
  Serial.println(distance);

 if(Serial.available()){
  t = Serial.read();

  Serial.println(t);

}

if(t == '1'){
  if(distance < 20)
  {
  digitalWrite(4,LOW);
  digitalWrite(3,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6,LOW);
  Serial.println("Stop All");
}


  else{//move forward(all motors rotate in forward direction)

  digitalWrite(4,LOW);
  digitalWrite(3,HIGH);
  digitalWrite(5,HIGH);
  digitalWrite(6,LOW);
  Serial.println("Forward");
  }
}

else if(t == '2'){ //move backward (all motors rotate in reverse direction)
  digitalWrite(4,HIGH);
  digitalWrite(3,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6,HIGH);
  Serial.println("Backward");
}
```

```
else if(t == '3'){ //turn right (left side motors rotate in forward direction, right side motors doesn't rotate)
  digitalWrite(4,LOW);
  digitalWrite(3,LOW);
  digitalWrite(5,HIGH);
  digitalWrite(6,LOW);
  Serial.println("Right");
}

else if(t == '4'){ //turn left (right side motors rotate in forward direction, left side motors doesn't rotate)
  digitalWrite(4,LOW);
  digitalWrite(3,HIGH);
  digitalWrite(5,LOW);
  digitalWrite(6,LOW);
  Serial.println("Left");
}

else if(t == '5'){ //STOP (all motors stop)
  digitalWrite(4,LOW);
  digitalWrite(3,LOW);
  digitalWrite(5,LOW);
  digitalWrite(6,LOW);
  Serial.println("Stop All");
}


delayMicroseconds(100);
}
```