Al-Najah National University

Department of Computer Engineering

Graduation Project II

ChairUp(Smart WheelChair

By:
Majd Hamadneh
Manal Khalili

Supervised by:
Dr.Anas Toma

June 27, 2024

Abstract

The development of a smart wheelchair represents a significant humanitarian advancement, addressing the unique challenges faced by individuals with physical disabilities who possess dreams and ambitions. Our project aims to facilitate greater independence and ease of life for these individuals by integrating advanced technologies into a wheelchair design. Key features include voice-operated control through cutting-edge voice recognition technology, allowing effortless and intuitive control for those who cannot use their arms. The wheelchair is equipped with sophisticated sensors for obstacle detection and avoidance, ensuring safe and uninterrupted movement in all directions. A novel system for smooth stair ascension enables seamless and safe traversal of stairs, expanding mobility across various terrains. Advanced lifting or extension mechanisms provide high-reaching capability, allowing users to access elevated areas such as high shelves or counters. Additionally, state-of-the-art sensors monitor vital signs like heart rate and blood pressure, offering real-time health and safety monitoring, with notifications and alerts in case of abnormal readings. By incorporating these features, the smart wheelchair not only enhances mobility but also empowers users to meet their needs independently, improving their quality of life and enabling them to pursue their goals with greater ease.

In this project, the concept of automation includes several aspects, which is the automatic irrigation process, continuous temperature checks, and the provision of a ventilation system if necessary, in addition to providing protection for the farm in the event of rain, fire, or attempts to steal, and providing appropriate lighting to carry out the photosynthesis process in In the event of a shortage, in addition to providing a fertilization system that works automatically on a weekly basis, continuous examination of water tanks, and sending sms messages in the event of a decrease in the required limit.

Table of Contents

Chapter 1
Introduction

1.1 Problem

The problem here is that people with physical disabilities need more mobility and independence to meet their needs, pursue their goals, and live their lives without relying on traditional and often restrictive forms of control and without asking others to help them as much as possible.

1.2 Purpose

By creating a smart wheelchair, this project aims to improve the independence and quality of life for those with physical limitations. This wheelchair replaces traditional controls with cutting-edge technology, enabling users to autonomously access vital services and navigate their surroundings securely and effectively.

1.3 Objectives and Scope

This system can do the following:

1. **Voice-Operated Wheelchair Design:** Implementing cutting-edge voice recognition technology for effortless control, replacing traditional controls like buttons or joysticks. This allows individ-

uals who cannot use their arms to operate the wheelchair with ease.

2. **Obstacle Detection and Avoidance:** Equipped with sophisticated sensors, the wheelchair can detect and navigate around obstacles, ensuring safe and uninterrupted movement in all directions.

3. **Smooth Stair Ascension Feature:** Crafting a system that enables the wheelchair to ascend stairs seamlessly and safely, expanding its mobility across uneven terrain and overcoming physical barriers.

4. **High-Reaching Capability:** Developing a sophisticated mechanism allowing the wheelchair to access elevated areas with ease, through advanced lifting or extension mechanisms, providing users with the ability to reach high shelves or counters.

5. **Vital Sign Monitoring with Sensors:** Integrating state-of-the-art sensors into the wheelchair to monitor vital signs like heart rate and blood pressure. The system ensures precise health and safety monitoring, sending notifications and alerts in the event of danger.

6. **Mobile application:** that can take all its readings by making a connection with the hardware.

1.4 Importance

The potential for this research to greatly enhance the everyday lives of those with physical limitations is what makes it so important. Greater independence, safety, and access to a variety of locations are encouraged by the smart wheelchair's enhanced mobility solutions and health monitoring functions. In addition to addressing real-world issues, this initiative gives users the tools they need to more easily and confidently accomplish their personal and professional objectives.

1.5 Report Organization

1. The the next chapter - Constraints Earlier Coursework -,We will talk about the challenges we encountered and how we overcame them while working on our project, as well as the courses that were helpful to us.

2. The the fourth chapter - Literature Review -,We will examine some comparable works and projects and discuss how our project differs from them.

3. The the fifth chapter - Methodology -,We will go into detail about the system's operation, the hardware components we utilized, how we connected them and how that worked, as well as how we made communication between the various parts and the program that controls the system.

4. The sixth chapter - Results Discussion -,is a discussion of the project's outcomes and what is anticipated from it.

5. The final chapter - Conclusion -,We will briefly go through the most crucial aspects of the project, what we learnt from it, and any recommendations that might be made for future use.

Chapter 2

Constraints and Earlier work

2.1 Limitations

We had a lot of challenges to overcome on the route to completing this project. The following limitations are the most significant ones:

1. Design and Implementation: We had to start from scratch while creating the model, which called for a lot of creativity and hands-on labor.

2. Cost-Effective Design: It was difficult to come up with a suitable design concept that included all essential elements and was still financially viable.

3. Exorbitant Hardware Costs: Due to shipping challenges and inspections, the exorbitant cost of hardware components—many of which had to be imported—caused delays.

4. Sensor Integration Problems: A number of sensors gave false readings when combined, and a number of parts frequently broke down.

5. Unexpected Defects and Troubleshooting: Unexpected defects frequently happened, resulting in a large amount of effort spent determining if the problem was caused by damaged components, coding flaws, voltage fluctuations, or network issues.

2.2 Previous work

In the beginning, we learned the basics of programming parts in the BIC course, then we applied that practically through the projects of that course. After that, we followed short YouTube videos related to Arduino programming by Mr. Wael Abu Hamza Click Here To Show Arduino Course In Arabic.

Chapter 3

Literature review

An inventive strategy to improve the independence and quality of life for people with physical limitations is the creation of smart wheelchairs. Through the integration of cutting-edge technologies, this initiative greatly enhances users' mobility and autonomy by making it easier for them to accomplish necessary tasks. The creation of smart assistive devices for people with mobility problems has been the focus of numerous similar projects in the past:

1. Voice-Controlled Wheelchair for Disabled Persons: This University of Texas project used voice recognition technology to enable voice instructions to operate the wheelchair. To comprehend and carry out commands, the system combined voice processing units, microphones, and a microprocessor.

2. Navigation and Obstacle Detection in a Smart Wheelchair: This project was showcased at the 2020 IEEE International Conference on Robotics and Automation (ICRA) and included a smart wheelchair with sensors to identify obstacles, GPS to guide, and machine learning algorithms to determine the best way. The system's goal was to give passengers a smooth trip experience by allowing it to independently navigate complicated environments.

3. Wheelchair Health Monitoring and Alert System: This project,

which was presented at the 2019 International Conference on Biomedical Engineering and Technology (ICBET), included a wheelchair that was equipped with a number of sensors for monitoring health, including blood pressure, heart rate, and SpO2. To ensure the user's safety and wellbeing, the data was constantly checked, and in the event of any aberrant readings, alarms were sent to caretakers or medical specialists.

Together, these initiatives expand the area of smart assistive technology and show how cutting-edge technology may be incorporated into wheelchairs to enhance independence, safety, and user experience.

Chapter 4

Methodology

The system process, the hardware components we utilized, how we connected them, and how we made communication between the components and the program that read the sensor value will all be covered in detail in this chapter.

4.1 Hardware Components

1. **Arduino Mega2560**:It is a microcontroller board based on the ATmega2560 which contains 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 hardware serial ports (UARTs), a 16 MHz crystal oscillator, a USB connector, a power jack, an ICSP header, and a reset button. It comes with everything needed to support the microcontroller.[1]

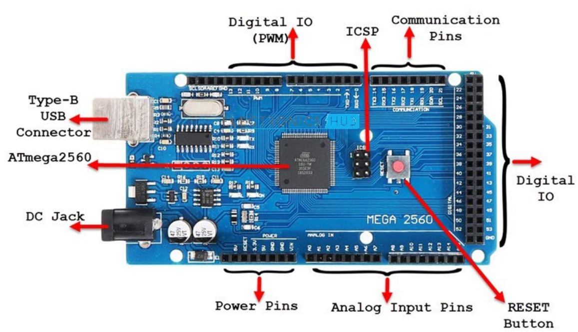


Figure 4.1: Arduino Mega2560

2. **ESP 8266**:There are integrated antenna switches, RF baluns, power amplifiers, low-noise receive amplifiers, and power-management modules in a range of low-cost, low-power system on a chip microcontrollers. Dual-mode Bluetooth and integrated Wi-Fi are also included.[2] We selected the ESP8266 for our system since it comes with a built-in Wi-Fi module that enables remote control and data transmission.

Figure 4.2: ESP8266

3. **Relay**:It A relay is an electrically operated switch that uses an electromagnet to mechanically operate a switch. It allows for the control of a high-power circuit by a low-power signal. A typical relay might have a 5V or 12V coil voltage, can switch currents up to 10A, and includes normally open (NO) and normally closed (NC) contacts. takes a signal from Arduino and connect the electrical circuit, We selected it to control Air Top [3]

Figure 4.3: Relay

4. **Arduino Uno:**:The Arduino Uno is a microcontroller board based on the ATmega328P. It features 14 digital input/output pins (6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller. In our project, we used two Arduino Uno boards: one to connect the touch screen and the other to connect vital signs monitoring sensors.[4]

Figure 4.4: aurduino uno

5. **DC Gear Motor:**:A DC motor with a gear is a motor that has an integrated gear mechanism to reduce the speed and increase the torque of the motor. It typically features a range of specifications, including operating voltage, torque, speed, and current draw. For example, a typical DC motor with a gear might operate at 12V, produce a torque of 10 kg-cm, have a speed of 100 RPM, and draw a current of 1.5A under load. These motors are essential for applications requiring precise control of motion and high torque,

such as in robotics and automated systems. a HIGH signal or VCC.[5]

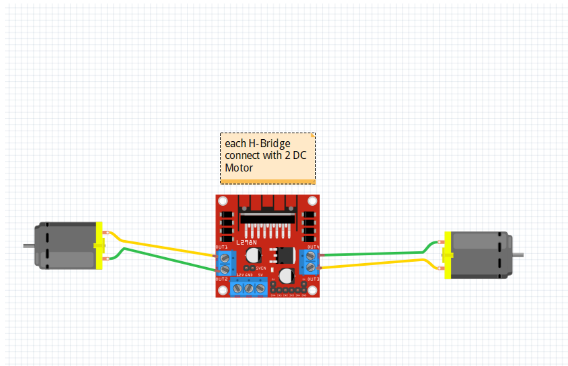


Figure 4.5: DC Gear Motor

6. **H-Bridge:**:An electrical circuit known as an H-Bridge allows voltage to be applied across a load in either direction. It is frequently used to regulate the direction of DC motors so that they can go both forward and backward. A well-liked H-Bridge IC that can operate one stepper motor or two DC motors is the L298N. It can provide a continuous output current of 2A per channel and operates within a voltage range of 5V to 35V. The L298N has two enable pins for turning on the motors, four input pins for directing the motors, and output pins for connecting the motors. Along with having a ground pin and a 5V logic supply pin, it may be used with Arduino and other microcontrollers. We used an H-Bridge in our project to link the two developers together. With the use of three H-Bridges and six motors, we are able to effectively control

the direction and speed of each motor.[6]

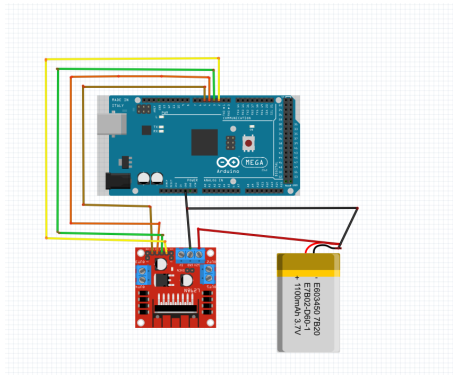


Figure 4.6: H-Bridge

7. **IR Sensor:** An electrical gadget that analyzes and picks up infrared radiation in its surroundings is called an infrared (IR) sensor. Its detector and emitter cooperate to detect motion or the presence of things. Obstacle detection and avoidance systems often use these sensors. In our project, we employed infrared sensors to identify and steer clear of obstructions, guaranteeing the smart wheelchair's safe passage. The IR sensor module is simple to integrate into a variety of electronic projects since it usually runs at a voltage between 3.3V and 5V and produces an output signal that an Arduino or other microcontroller can read.[7]

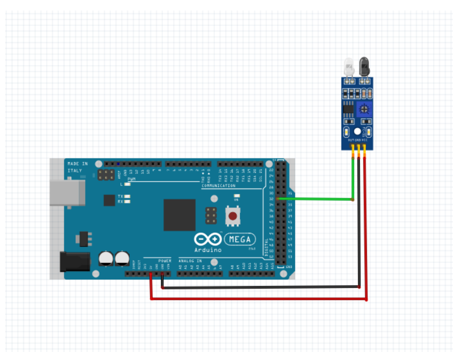


Figure 4.7: IR Sensor

8. **Tempreture Sensor:** An apparatus that senses the temperature of its surroundings and transforms the information into electronic impulses is called a temperature sensor. Thermocouples, thermistors, and semiconductor sensors such as the LM35 are common types. For instance, the linear output voltage of the LM35 is precisely proportional to the temperature in Celsius. In our project, we took the patient's body temperature using a temperature sensor. The information from the sensor is subsequently sent to the application, where it is shown in real time to enable ongoing patient health monitoring. The sensor is suitable with the majority of microcontroller platforms because it usually runs at a voltage range of 4V to 20V.[8]

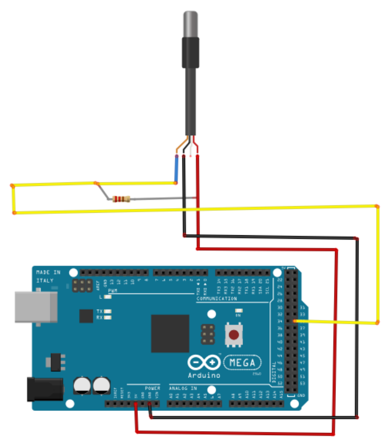


Figure 4.8: Tempreture Sensor

9. **Oximeter (GY-MAX30102):** Based on an optical sensor, the GY-MAX30102 is an integrated pulse oximetry and heart-rate monitor module. Because it uses the I2C protocol, integrating it with microcontrollers such as Arduino is simple. By illuminating skin blood vessels with red and infrared light and measuring the amount of light absorbed by them, the module is intended to detect

heart rate and oxygen saturation (SpO2). It has high-resolution ADCs, precise sample timing, and built-in ambient light cancelation. It runs at a voltage range of 1.8V to 3.3V. In our project, the SpO2 and heart rate data are read by the GY-MAX30102, which then shows this information on the application to provide real-time patient health monitoring.[9]

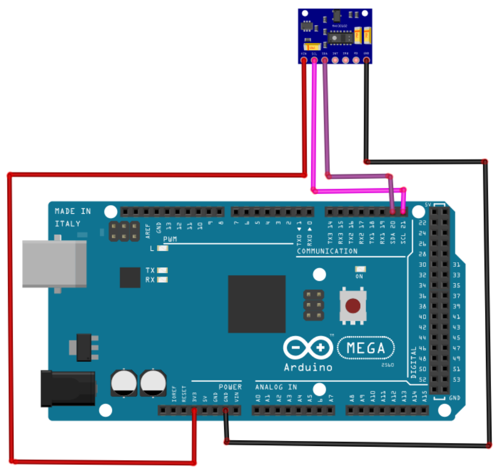


Figure 4.9: Oximeter

10. **Voice Recognation V3:**Up to 80 voice commands can be recognized by the simple-to-use Voice Recognition V3 speech recognition module. It has an integrated voice recognition processor and uses UART to interface with microcontrollers. The module can be used with a range of microcontrollers and runs at a 5V supply power. In our project, we employed the Voice Recognition V3 to improve the independence and usability of patients with hemiplegia by enabling them to operate the wheelchair more naturally.

This included the ability to give voice commands for navigation and other purposes.[10]

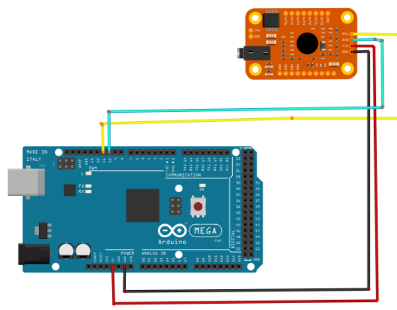


Figure 4.10: Voice Recognation

11. **Touch Screen (TFT LCD Shield 2.4):** Touch screens are input devices that let people connect directly with a computer or other device through touch. For touch input detection, capacitive or resistive technology is usually used. With a resolution of 240x320 pixels, the TFT LCD Shield 2.4 touch screen type offers crisp and detailed display capabilities. It typically uses interfaces like I2C or SPI to communicate with microcontrollers. In our project, we programmed and displayed directions on the touch screen to operate the DC motor, making it easy for the patient to maneuver the wheelchair. By connecting this touch screen to an Arduino Uno independently, the control system's user interface was improved and made more understandable and accessible for the patient.

These elements work together to provide a flexible and sophisticated smart wheelchair system that integrates a range of features to improve safety and user experience. [11]

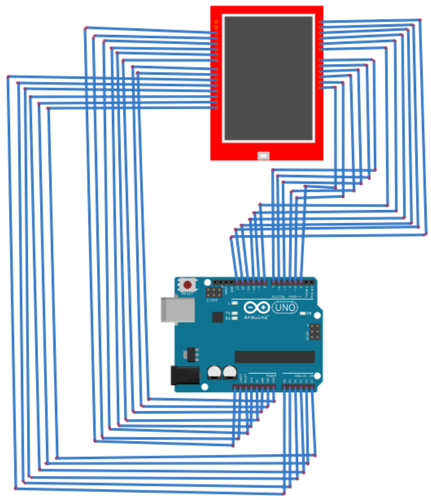


Figure 4.11: Touch Screen

12. **Linear Actuator:** Unlike a traditional electric motor, which rotates in a circular path, a linear actuator moves in a straight line. When linear motion is needed in a machine, as in the extension and retraction mechanisms, linear actuators are employed. In our project, we raised the wheelchair's seat using a linear actuator to give the user access to high shelves and other elevated surfaces. By using air pressure, this actuator allows for regulated and smooth movement, improving the smart wheelchair's usefulness and adaptability.

Figure 4.12: Linear Actuator

13. **Air Top E:**:Most likely, the Air Top E is a sensor for measuring and tracking air quality, which includes factors like particulate matter (PM2.5/PM10), volatile organic compounds (VOCs), and other contaminants. Certain models will have different accuracy criteria and sensing ranges.

Figure 4.13: Air Top E

14. **Valve:**A valve is an apparatus that, through opening, closing, or

partially obstructing different passageways, regulates, directs, or controls the flow of a fluid (gases, liquids, fluidized solids, or slurries). For example, solenoid valves have a set voltage (e.g., 12V or 24V) and a set flow rate and pressure rating. In our invention, the linear actuator—which is driven by air pressure—is linked to the valve to regulate its movement. The wheelchair seat can be smoothly extended and retracted, enabling the patient to reach high shelves and other elevated regions. The valve precisely controls the air pressure delivered to the linear actuator.cations.[**?**]

Figure 4.14: Valve

4.2 System Design

This project aims to improve the quality of life and independence of those with physical limitations by offering a smart wheelchair with cutting-edge capabilities. To enable users to traverse their surroundings confidently and with the least amount of assistance, the system design places a high priority on user safety, usability, and comprehensive functionality. People who have little to no use of their arms will especially benefit from the wheelchair's Voice Recognition V3 module, which enables users to operate the device with voice commands. The wheelchair can identify and navigate around obstructions in its path using infrared (IR) sensors, which improves user safety by eliminating collisions and guaranteeing safe and uninterrupted movement.

With the help of a linear actuator, the wheelchair's seat can be raised to help users reach high shelves and other elevated areas. The actuator is controlled by a valve that regulates air pressure to provide the necessary force, enhancing the user's ability to perform tasks independently. The wheelchair's custom design enables it to ascend stairs seamlessly and safely using a DC motor. The GY-MAX30102 oximeter is built into the wheelchair to measure the user's heart rate and oxygen saturation (SpO2). Real-time data presentation of this information is available on a mobile application, enabling continuous health monitoring and prompt notifications in the event of abnormal results. To track the user's body temperature, a temperature sensor is integrated , with data also displayed on the application to ensure that any significant changes in the user's condition are promptly detected. DC motors with integrated gears provide precise control and high torque to the wheelchair's movement, which is managed by three L298N H-Bridge modules for forward and backward motion. Wheelchair mobility is controlled by the TFT LCD touch screen via arrows that are presented;

users can interact with the interface to navigate the wheelchair and change settings as necessary. Apart from identifying obstacles, the system is engineered to transmit notifications in the event of system failures or when the sensors identify anomalous circumstances, guaranteeing that the wheelchair's state and the wheelchair user's well-being are consistently communicated to caretakers.

The smart wheelchair provides a holistic solution that improves mobility, safety, and freedom for those with physical limitations by including these elements and independence for individuals with physical disabilities, allowing them to navigate their environment with ease and confidence.

Here below is a picture of the complete system networking:

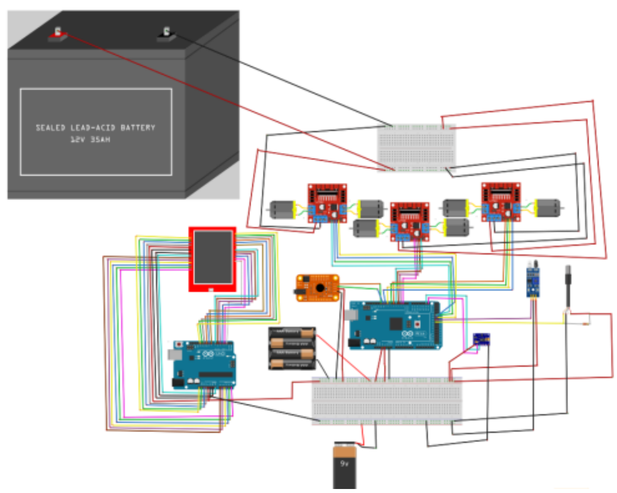
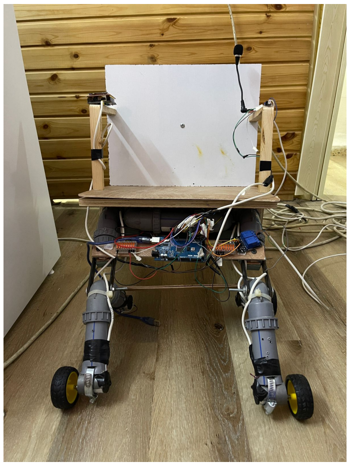
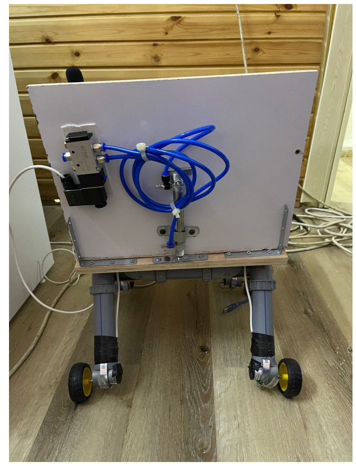


Figure 4.15: System Connection with arduino



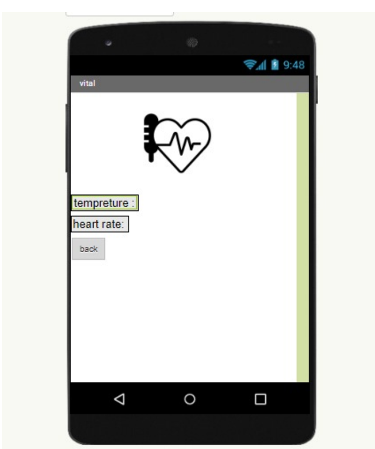
(a) chairup1



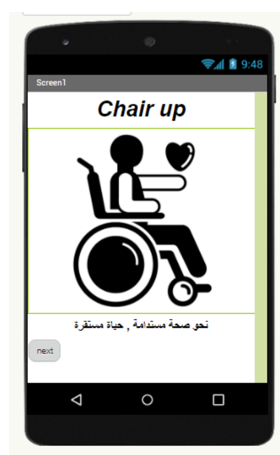
(b) chairup2

4.3 Software

This project includes a mobile application that displays the values of vital signs measured for the patient. The application provides real-time monitoring and enhances the user's interaction with the smart wheelchair Through the application, the patient can choose how to control the wheelchair, whether he wants the touch screen or via voice:



(a) mobile application



(b) screen1

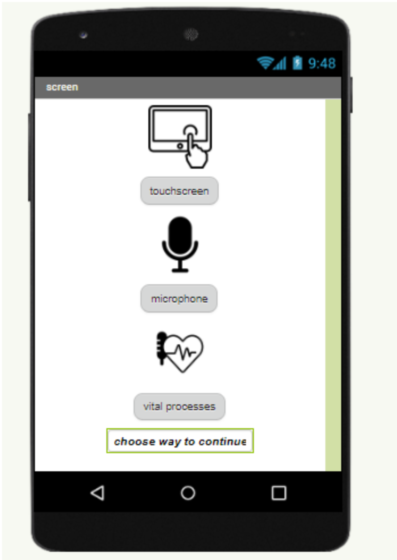


Figure 4.18: screen2

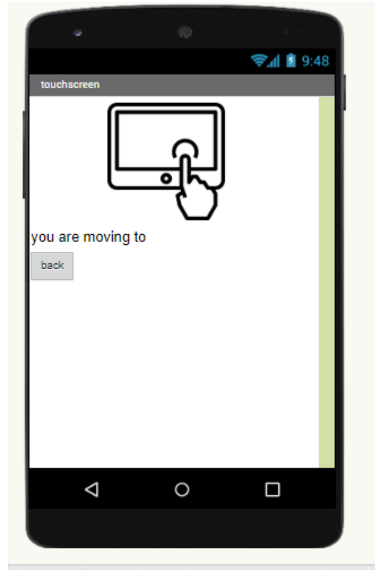


Figure 4.19: touch

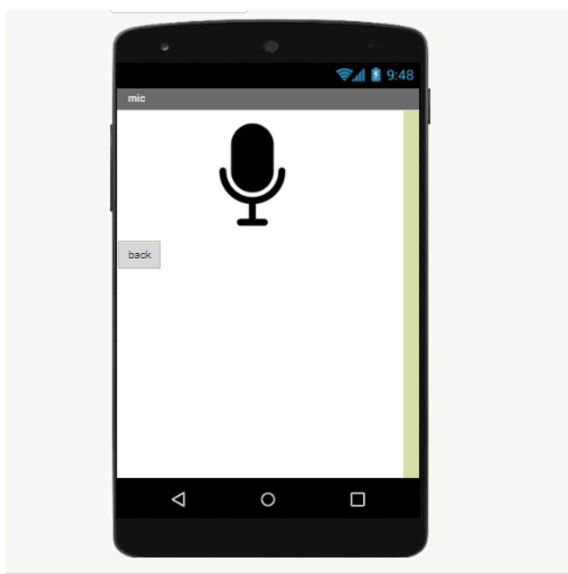


Figure 4.20: mic

Chapter 5

Conclusion and Results

The aim of this project was to demonstrate an efficient smart wheelchair system designed to enhance the independence and quality of life for individuals with physical disabilities. The wheelchair features advanced technologies such as voice-operated control, obstacle detection and avoidance, and stair ascension. It also includes a mechanism to raise the seat, enabling users to reach elevated areas and perform tasks independently. Vital sign monitoring and temperature sensing ensure continuous health monitoring, with data displayed on a mobile application. The wheelchair's movement is precisely controlled, allowing for smooth navigation. A touch screen interface simplifies control and adjustments. Safety features include alerts for system issues and abnormal sensor readings. This project provided valuable lessons in working with electronic components, following instructions to prevent damage, and coding to control various parts. It highlighted the importance of integrating technologies to improve the quality of life for individuals with physical disabilities.

Chapter 6

Future work

This project can have a lot more features added to it to increase its potential. Installing a camera, for instance, could help with obstacle recognition, navigation, and visual feedback. Furthermore, adding cutting-edge health monitoring capabilities like blood pressure or ECG sensors could enhance patient care even more. Machine learning algorithms might also be added to the system to improve its ability to anticipate and adapt to user needs. For example, the system could be trained to automatically navigate to frequently used destinations or modify the wheelchair's posture for maximum comfort.

Chapter 7

Acknowledgements

First and foremost, praises and thanks to the God, the Almighty, for His showers of blessings throughout our graduation project work to complete it successfully. We would like to thank our great doctor Dr.Anas Toma for her huge support, guidance and help for suc- cessfully achieving this project. A special thank for our parents and family for their support. we also want to thank our friends for the encouragement.

References

[1] arduino mega2560 click here to see arduinomega2560 data sheet.

[2] esp32 click here to see esp32 data sheet.

[3] relay click here to see relay data sheet.

[4] aurduino uno click here to see aurduino uno data sheet.

[5] dc gear motor click here to see dc gear motor led strip data sheet.

[6] h-bridge click here to see h-bridge data sheet.

[7] ir sensor click here to see ir sensor data sheet.

[8] tempreture sensor click here to see tempreture sensor data sheet.

[9] oximeter click here to see oximeter data sheet.

[10] voice recognation click here to see voice recognation data sheet.

[11] touch screen click here to see touch screenr data sheet.