Ministry of Education and Science of the Republic of Kazakhstan
Suleyman Demirel University

Akkassin Assel, Akhanova Bagdina, Bolekbayeva Anel,
Yussupova Arailym

Realization of a smart wheelchair with voice control system for people with disabilities

A thesis submitted for the degree of
Bachelor in Computer Systems and Software
(degree code: 5B070400)

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Abstract

This thesis describes a smart motorized wheelchair with voice control using an embedded system. The proposed design supports a voice activation system for people with disabilities, including manual control. This thesis presents the Voice Wheelchair for a physically disabled person, where a voice command controlling the movement of the wheelchair. The voice command is sent through a cellular device with Bluetooth, then the command is transmitted and converted to a string using the Arduino of BT voice control and transmitted to the SR-04 Bluetooth module connected to the Arduino for wheelchair control. For example, when the person says "Forward", then the chair will move forward, and when he says "Back," the chair will move in the opposite direction and, "Left", "Right" to turn left and right, respectively, and "Stop" » to stop. This system has been eloborated to save the cost, time and energy of disabled people. An ultrasonic sensor is also part of our work and helps to discover obstacles in that way of the wheelchair moves which may interfere with the transit of the wheelchair.

Аңдатпа

Бұл құжатта интеграцияланған жүйенің көмегімен дауыстық бақылауы бар моторлы мүгедектер арбасының дизайны сипатталған. Ұсынылған дизайн қолмен басқаруды қоса, мүгедектерге арналған дауыстық іске қосу жүйесін қолдайды. Бұл құжат мүгедектерге арналған "Дауыстық мүгедектер" арбасын ұсынады, онда дауыстық команда мүгедектер арбасының қозғалысын басқарады. Дауыстық команда Bluetooth арқылы ұялы құрылғыға жіберіледі, ал пәрмен Arduino үшін BT дауыстық басқару құралын пайдаланып, жолға айналады және мүгедектер арбасын басқаруға арналған Arduino тақтасына қосылған SR-04 Bluetooth модуліне беріледі. Мысалы, пайдаланушы «Алға» деген кезде, орындық алға қарай жылжиды, ал «Артқа» дегенде, орындық қарсы бағытта қозғалады, сәйкесінше солға және оңға бұрылу үшін «Солға», «Оңға» және «Тоқтату» тоқтау үшін. Бұл жүйе пациенттің құнын, уақытын және энергиясын үнемдеу үшін жасалынған. Сондай-ақ, ультрадыбыстық сенсор дизайнның бөлігі болып табылады және мүгедектер арбасының өтуіне кедергі келтіруі мүмкін кедергілерді анықтауға көмектеседі.

Аннотация

В этом документе описывается конструкция умного моторизованного инвалидного кресла с голосовым управлением с использованием встроенной системы. Предлагаемый дизайн поддерживает систему голосовой активации для людей с ограниченными физическими возможностями, включая ручное управление. Этот документ представляет «Голосовое кресло-каталку» для человека с ограниченными физическими возможностями, где голосовая команда контролирует движения инвалидной коляски. Голосовая команда подается через сотовое устройство, имеющее Bluetooth, а команда передается и преобразуется в строку с помощью голосового управления BT для Arduino и передается в модуль Bluetooth SR-04, подключенный к плате Arduino для управления инвалидной коляской. Например, когда пользователь говорит «Вперед», тогда кресло будет двигаться вперед, а когда он говорит «Назад», то кресло будет двигаться в обратном направлении и, аналогично, «Влево», «Вправо» для поворота влево и вправо соответственно и «Стоп» для остановки. Эта система была разработана для экономии затрат, времени и энергии пациента. Ультразвуковой датчик также является частью конструкции, и он помогает обнаруживать препятствия на пути к инвалидной коляске, которые могут препятствовать прохождению инвалидной коляски.

Contents

Chapter 1

Introduction

1.1 Preface

The problem of helping people with limited physical abilities remains one of the most difficult, requiring society not only to understand it, but also to participate in this process of many specialized institutions and structures. The rehabilitation of people with disabilities is not only treatment and improvement of their state of health, but also the process of achieving a person's maximum independence in society. One of the devices most contributing to this are limb prostheses and electromechanical smart wheelchairs.

Despite the latest advances in science and technology have radically changed the lifestyle of a normal person, there are certain groups of people who could not benefit from this development. In particular, people with disabilities who move on wheelchairs with limited mobility still live a inferior life. A wheelchair with voice control is aimed at helping people with disabilities and physical disabilities, providing them with some kind of mobility that will help them a lot. Our wheelchair consists of a main control unit that allows the user to enter data in the form of a joystick or voice command. The controller unit then synthesizes the command and takes the necessary actions to move the wheelchair to a specific position.

1.2 Background

The first smart wheelchair was proposed by George Klein in 1953 for World War II veterans. Later, many researchers proposed and developed many designs for wheelchairs depend on image processing, vision control, language control and so on. In addition, an electric wheelchair with a joystick has been developed, which is useless for users with a paralyzed arm or having problems in the arm. After that, a wheelchair based on voice recognition was introduced, because voice is a simple and popular way to communicate. The first wheelchair for voice recognition was advanced and used in 1999 by the University of Siamo, Alcalá, Spain. Some of the proposed systems will be explained later on this basis here:

M. Sentil Sivakumar introduced an automatic wheelchair with voice control, which is an intelligent home navigation system. He encourages older people or people with disabilities to move around the house with voice commands. The wheelchair is also equipped with an obstacle avoidance system using an ultrasonic sensor.

Megha Muralidharan has introduced an intelligent voice recognition chair that uses a voice recognition module to control the wheelchair and recognize the patient's voice. The user can go forward, backward, right, left using his voice.

B. Gokul suggested controlling the speed of a DC motor using voice recognition via Android Bluetooth. This system offers voice recognition through a mobile application. This application receives voice from the patient, which is then transmitted to the Arduino via Bluetooth. Arduino then directs the engine driver chip to the appropriate operation. This system also gives the advantage of knowing engine speed with a speed sensor. Speed information is advertised in the application.

Romil Chauhan proposed system that is called the "Voice Wheelchair Implementation Study"and has not been implemented yet, which suggests using the Raspberry Pi as a data processing unit instead of using an arduino / microcontroller. An obstacle detection sensor can be connected to the Raspberry Pi. This will reduce the amount of equipment needed, such as an engine driver. However, this is only a suggested idea.

1.3 Research

According to the Ministry of Labor and Social Protection, there are 680 thousand disabled people in Kazakhstan and 650 million people in the world, representing about 10 percent of the world's population, are disabled. Therefore, a particularly important task is the development of systems that would help people with disabilities to move freely, and thereby significantly improve their living standards. Existing systems are controlled using a push-button remote control and joystick or using a manual drive. But such systems are not convenient for people with disabilities with muscular dystrophy, severe cerebral palsy and other diseases of the musculoskeletal system. So we want to add a little function – voice recognition. Therefore, it is necessary to develop systems that could be controlled by voice and put these systems into practice. The main requirement for these systems is their versatility, that is, the ability to install on any existing wheelchair with an electric drive, without significant structural changes. The second requirement is accessibility; the system does not have to be expensive.

A smart wheel chair aims to provide aid to those handicapped and physically challenged persons by providing them with some sort of mobility which would greatly help them. Smart wheel chair consists of a major controller unit which allows the user to provide the input in the form of remote controller as application

form or a voice command. The controller unit then synthesizes the command and takes required action so as to move the wheelchair to the particular position.

In the process of implementing the project, we conducted a small survey of people with disabilities and asked to answer our questions that sound like this:

1) What are the inconveniences of using a wheelchair?

2) Did you have to manage, move around without assistance? If answer is "yes", what were the problems?

3) If you could, what features will help you facilitate when using a wheelchair?

We have received such answers:

Object of research: problems of movement of disabled people of 1st and 2nd group

Person A (age 65): Basically, wheelchairs are heavy, and it's hard for me to control on my own at this age, I don't have enough strength to control them, and I have to get help. No one can be with you 24 hours a day and would like to be implemented more convenient wheelchairs to make it easier to control.

Person B (age 19): I had to use a wheelchair when I was abroad, and there were several people with whom I communicate. And the first days it was difficult for me to manage myself, when after the operation I felt bad. It was difficult to ask strangers for help, and then the thought came that it was the 21st century, everyone had a smartphone in their hands, why not do something so that people could control by the phone.

Person C (age 25): I've been using a wheelchair for 5 years and I can say that today our country is inconvenient for people with disabilities. Transport is not adapted so that a disabled person can easily enter or exit the transport. The houses are not equipped, porches, especially for wheelchairs. I look at my porch - there are no conditions at all, no elevator. In the future I would like to eliminate all these problems, and at least somehow feel like a full-fledged person.

Based on these answers, we think that our smart wheelchair, which has few functions, can at least make life easier for people with disabilities.

1.4 Relevance of the topic

Among the products intended for people with physical disabilities, technical equipment is allocated to a special class, compensating disorders of the human musculoskeletal system, for example, canes, crutches, lower limb prostheses and wheelchairs. The wheelchair, unlike the others, is designed to control the disabled person independently, and not by an accompanying person. Wheelchairs can have a mechanical drive, in which the wheels are driven by hand force, as well as an electric drive, which includes: a battery, power converter, microcontroller, input device and gearbox. Such wheelchairs are designed to move not only indoors, but also on the street, so it is important that a convenient and reliable control system is incorporated in the microcontroller.

Our project is designed as an idea to make life easier for those who unhappily lose the ability to move their legs due to a large amount of paralysis, accident or age. People with different abilities tend to rely on others in their daily lives, especially when moving from one place to another. Wheelchair users are constantly in need of someone to help them move the wheelchair. Their lives are complicated by the fact that they lack an intuitive wheelchair control system that allows them to move independently. The use of an electric wheelchair provides a greater degree of independence for people with disabilities who cannot walk or drive a mechanical wheelchair on their own, as this requires a lot of effort and help from others. The problem is that in some cases, disability leads to someone losing the ability to use their hands, so in this case, the method of operating a mechanical wheelchair can be performed using voice commands for patients without the help of hands, leading to an interesting and promising result . Nevertheless, the availability of intelligent wheelchair solutions is often limited due to high costs and not exactly convenient operation. In line with the proposed approach described in this document, a low-cost, simple and user-friendly solution for a voice platform that is user-friendly, fully adaptable to the language spoken by the user and will help expand the user's independent mobility will be presented. Using a smartphone as the "brain" of a robot is already an active research area with more open possibilities and promising opportunities. Bluetooth is another very successful technology that has changed the way digital devices are used at home or in the office and turned traditional wired digital devices into wireless devices. This study is based on the design of voice wheelchairs based on mobile platforms using Bluetooth technology, the development and implementation of wireless remote control solutions. The project also includes the use of ultrasonic sensors to detect obstacles, as well as notifying the system and stopping the wheelchair before receiving additional commands. Our thesis presents the control of a smart wheelchair using an Arduino system and a Bluetooth module via the IOS platform.

1.5 Aims and Objectives

The purpose of the our degree work is to study existing wheelchairs with electric wheels and develope prototype of a wheelchair with voice control system based on the Arduino microcontroller. We want to add voice recognition using Arduino, IOS program systems.

Present problem : the lack of wheelchairs for the disabled, which are controlled by voice.

Subject of study : devices based on voice-controlled microcontrollers.

To achieve this goal it is necessary to solve the following tasks:

1) To study the existing electric drive systems on modern electric wheelchairs;

2) Select the hardware components of the system (controller, power converter, sensors, input device);

3) Develop a code for a wheelchair voice control system;

4) Develop an executable program for the controller in IOS;

5) Development of a wheelchair prototype based on the Arduino microcontroller, which converts a voice signal into a click of a button or movement of a joystick.

6) Program an automated wheelchair in an Arduino IDE

7) Check the performance of the implemented system and test the automated wheelchair for people with disabilities by voice control;

Chapter 2

Hardware Units and Programming Language

2.1 Connection between application and robot

This project needs collaboration between two different domains. Therefore this chapter will introduce two different concepts. The first, which is the hardware part, will describe the main components that were used while the second will introduce software tools used for development applications.

How does our project work? First of all, we need to connect the robot to the mobile phone via Bluetooth and an application we made to control the device or the one from play market. Let's look at the mechanism of connection and the instructions of the second case. First of all, user must send any command by AMR voice application (Android). Let us explain this process step by step. First step is turning on the robot and Bluetooth on mobile phone. Then user should find new device in Settings —> Bluetooth and connect to it. The name of robot's Bluetooth is «HC-05» and the password is «0000» or «1234». After successful connection run the application and tap the button that is located in the upper right corner. There user should select the HC-05 and the application will try to make contact with the robot. And the last step is to push the button that is located in the centre of the page and pronounce the command you like wheelchair to do. The voice command is converted into an array of strings and the Arduino Uno receives this word that contains the command. When Bluetooth module receives the message the command will be compared to stored ones. If commands match, the engines start to work according to the instruction that were sent by user. The system understands the instructions and controls the chair using the AMR voice app on Android. Also the ultrasonic sensor is always active when the circuit is turned on, and ensures that there are no restrictions on robot's way, and if there are any obstacles, sensor tells Arduino to stop and the whole system will wait for next instructions from user. But how did we made it?

2.2 Arduino connection

The hardware architecture consists of an embedded system based on the Arduino Uno board, Bluetooth module HC-05, driver module L298N, 2 DC Motors, Ultrasonic Sensor HC-SR04 and 2 batteries as power supply. DC Motors are connected to driver module L298N's OUT1, OUT2, OUT3, OUT4 pins and module's IN1, IN2, IN3, IN4 pins are connected to Arduino uno's second (pinLB), fourth (pinLF), seventh (pinRB) and eighth (pinRF) pins respectively. This pins are used to control the motors' rotational directions, for example, if pinLB is high left DC Motor will rotate counterclock-wise which means forward, if pinLF is high it rotates clock-wise - backward. Also Module has pins named ENA na ENB that control the DC Motors' rotational speed, the are connected to board's fifth and tenth pins. Ultrasonic Sensor HC-SR04 send information to board's A0 and A1 pins and it is also connected to 5V and ground. Also we placed the batteries into the special case and connected to the Arduino uno and driver module L298N. Bluetooth module HC-05 is connected to board's 3.3V, ground, TR and RX.

(see Figure in Appendix B)

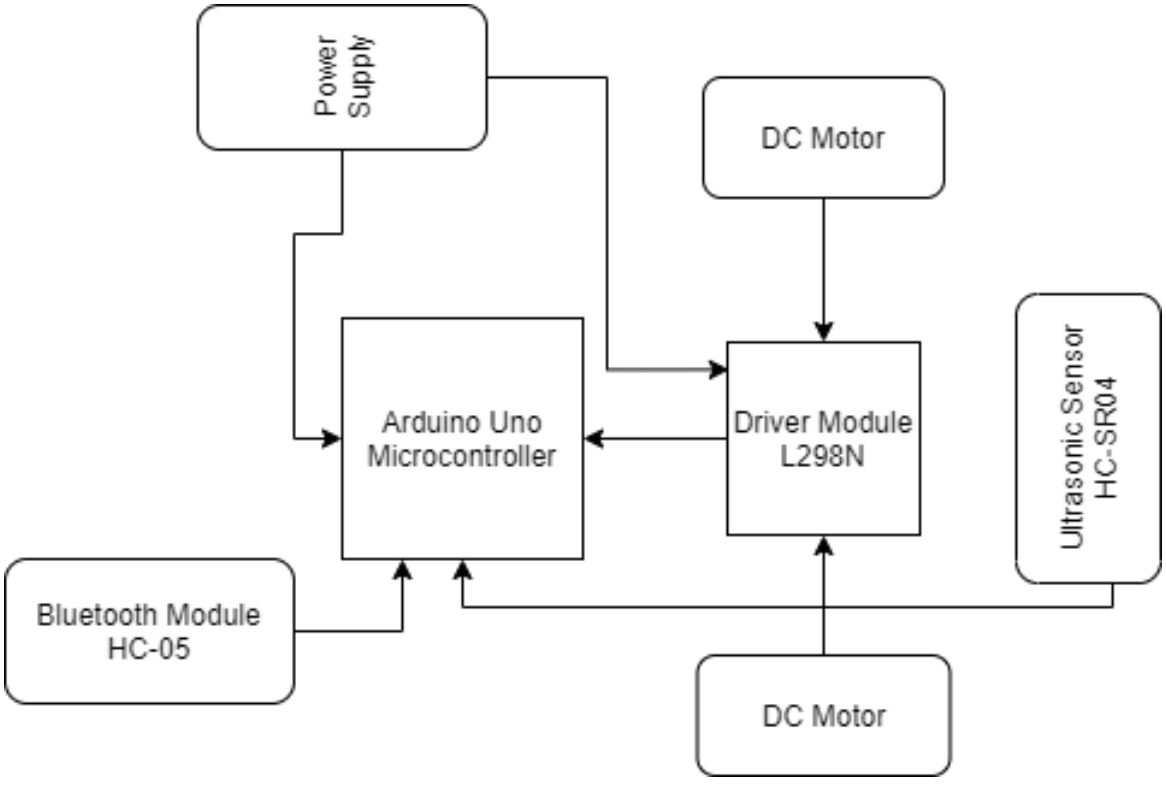


Figure 2.1: Block Diagram of the project

2.3 Assembly the robot prototype

In the previous part we introduced you hardware equipments of our Arduino project, and now using that components we will show you how we build our mini

hardware robot prototype.

1 step: Our assembly begun with the installation of DC motors (1) on an acrylic platform (2) with the screws $M3 \times 6$ mm (3) to the platform. Then screws were tightened into aluminum blocks (4) through special holes on the platform. (See in Figure 2.2)

2 step: Next, we attached Ultrasonic Distance Sensor HC-SR04 (1) to the bracket (2). Racks (3) are placed between the sensor and the bracket. The module is attached using $M1.6 \times 12$ mm (4) screws and M1.6 nuts (5). Screws are threaded through mounting holes and racks.

(See in Figure 2.3)

3 step: The Driver Module L298N (1) was mounted on brass racks (8 mm) using $M3 \times 6$ mm screws (3). The racks themselves are attached to the platform using $M3 \times 5$ mm screws, but on the other hand.

(See in Figure 2.4)

4 step: The Arduino UNO [analog] (1) board was attached, like the Driver Module L298N , to brass racks (8 mm) (2) using the $M3 \times 6$ mm screws (3), but in this case only three stands were used. The racks themselves are also attached to the platform using $M3 \times 5$ mm screws, but on the other hand. The bearing wheel was also attached on with brass racks (8 mm) using the$M3 \times 6$ mm screws in the same way.

(See in Figure 2.5)

5 step: In a known manner, a battery compartment was installed on brass racks. The assembly ended with the installation of the wheels (1) on the axis of the DC motors (2).

(See in Figure 2.6)

Our robot hardware is complete, now we need to give it its brains. In the next part we will show the robot software in C++.

2.4 Hardware equipments

We collected our robot wheelchair prototype using
-Arduino UNO cable
-Battery
-Bearing Wheel
-Acrylic Platform
-Bluetooth Module HC-05
-Driver Module L298N
-Battery case
-DC Motor and wheel
-Set of fasteners
-Screwdriver
-Ultrasonic Sensor

Figure 2.2: Step 1

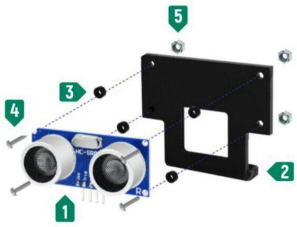


Figure 2.3: Step 2

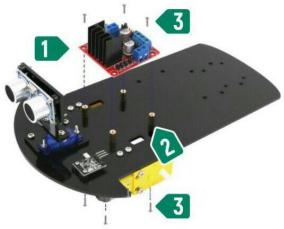


Figure 2.4: Step 3

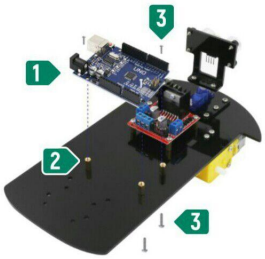


Figure 2.5: Step 4

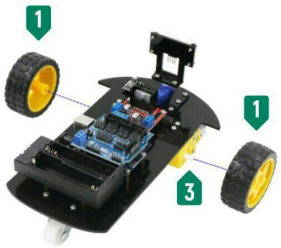


Figure 2.6: Step 5

-Wires MAMA-MAMA
-Plastic clamps
All these used equipments you can see in Appendix B.

2.5 Arduino Source code Explanation

Let's look at main methods we used to make a voice controlled robot. We have five methods that control the DC Motors, the movement of the robot. They are advance(), back(), stop(), turnL() and turnR() methods.

(see Figure A.1 in Appendix A)

Here we make wheelchair move forward. As we said in the previous «Arduino connection» chapter pinLF makes left DC motor move forward (counterclockwise) and pinLB does vice versa. In turnL() method we marked pinRF and pinLB as HIGH and pinRB and pinLF as LOW, for turnR() it works on the contrary. For stop method we marked all pins as HIGH, for back pinLB and pinRB set on HIGH. We also have Ultrasonic Ranging() method that returns integer value.

(see Figure A.2 in Appendix A)

We placed trigPin for 2 seconds on a low state and then to achieve the sound waves we switch this pin on True value for 10 seconds. We used here PulseIn () function to read the time of sound flight and placed the value to the «distance» variable. As you can see this function needs 2 parameters, the first is the name of the echo pin and the second is either True or False or high or law. The pulse () function waits for the pin to be True caused by the sound wave and the ruction starts to count time, then vise versa it waits pin to be False when sound wave ends which will cause counting. In the result function provides the pulse length in the microseconds. To find the distance, we have to multiply the duration by 0.034 (the speed of sound is 340 m / s) and divide it by two (the echo pin increase this number by two, because the sound wave must move forward and return back). We need this method to calculate the distance between robot and environment.

Let us explain void loop() method of our Arduino sketch where the main logic is stored. First line of the code which says "while (BT.available())" checks if there is an available byte to read which is came from the Bluetooth(BT) port via android application. "delay(10);" added to make thing stable. Then there is a "char c" which takes the result of the BT.read() method and adds to "readvoice" to form a message.

(see Figure A.3, A.4 in Appendix A)

The main logic here is that if "readvoice" has a message, the program should check the string and compare with stored commands which are forward, back, right, left, back for 1 second, back for 2 seconds and etc. The most complicated part of checking the message was the "forward" part, because robot should avoid obstacles. So we say if the command is "forward" the program have to always check the distance, if the distance is small, the robot stops, else it goes ahead. Also in while loop there is a Bluetooth message check, so the program will know if human changed the command. readvoice=; In the end of the loop the message overwrites to an empty string.

Chapter 3

Software Units

3.1 IOS application

iOS is subsidiary application for our main project. It represents another way to control the wheelchair. As nowadays all people using technology, we found our application definitely necessary. When disabled people are working or using smartphone, it would be easier or simpler to move with the help of this iOS application. Also, we added useful features to our application. There are Calendar, Contacts and Location features.Calendar helps our users to set the reminder. For example, our users can write notes to not forget to take medicines or to go the medical checking and so on.And Location page helps users to send their location to the people from Contacts page. If there would be some reasons to send location to other people, it will be much easier to send right away with the help of our application. So by doing this application, we thought million times about convenience and comfort of people for whom we did this whole project. We are really hoping that our little idea to help people, will make their life a little bit easier, simpler and happier.

Our iOS application is called «WeConnect» which fully reflects the essence of our project.We believe that our project is something that connects people with disabilities with their lives and gives them the opportunity to enjoy every moment.

3.2 Description of iOS part

The process of making the application starts from discussion of all the functionalities and features of our application.The first idea that came to our mind was making the remote control to our Arduino Wheelchair.The fact that people in our century use their mobile phones every time and everywhere encouraged us to make something useful.

At first, we worked on designing the entire application and tried to make user friendly UI.So that each person, despite of their age, can use and understand our application. We have developed something simple but bright and effective.

Figure 3.1: Design of application

Next part was making remote control page, which had main buttons to control our Arduino Wheelchair.Also, in the way of developing our project we realized that adding such functionalities as Contacts,Location and Calendar would be valuable for all the users of our application.

3.3 View Controllers

Generally, it has 10 View Controllers that are designed to make the usage of application as comfortable as possible to our users. Now let's consider every view controller one by one and clarify more about their functionalities.

1) Launching Page: It is the first Main Controller that launches automatically when user opens our application.The first thing that our users notice is tagline which reflects the idea and inspiration of our project.

«We Connect People. We Connect Lives.»

These lines are empowering and giving us a hope that we are creating the right thing.

2) Remote Control Page : In Main View Controller we added buttons to control the motion of our Arduino wheelchair. The 5 different directions are possible here: left, right, forward, backward and stop. And in this page we have additional 4 buttons: Location Page, Contacts Page, Calendar Page and About App Page.

Functions that were used in this View Controller:

- Application function - controls and sets the storyboard when it launches.

- requestAccess(for:completionHandler:)

- Requests access to the user's contacts at the launching. - UINavigationBar.appearance()

- UINavigationBar.appearance() - by this method we can set or change appearance of navigation bar in our application.

3) Table View Prototype View Page : This page was created to access users' contacts and get the information as phone numbers and emails.Also, we added emergency contacts which will help people to prevent different situations.We inserted contacts of Fire Department and Police Department,Ambulance and Medical Call Centre. Also, our users can add their own favorite contacts to our application and access them whenever they want.

- extension Friend - to fetch all contacts of the user.User Contacts contain such information as email, phone number, name and surname.

4) Navigation Controller Page : The Navigation Controller helps to define users' location and shows the map of the current location.It works with MapKit that allows us to access the user location.The idea of adding location came to our mind when we were developing our wheelchair that worked with different directions.

Functions:

- let initialLocation - to set up the initial location

- mapView.centerToLocation - center the map in the initial location that we defined

- CLLocationDistance - the distance measurement from an existing location.

-init(center:latitudinalMeters:longitudina lMeters:)-Creates a new coordinate region from the specified coordinate and distance values.

5) Calendar Page : In routine of daily events we always forget about such important things as taking medication and going to doctor's appointment.So, in our Calendar View Controller we decided to add calendar that will show important occasions to our users.

Functions:

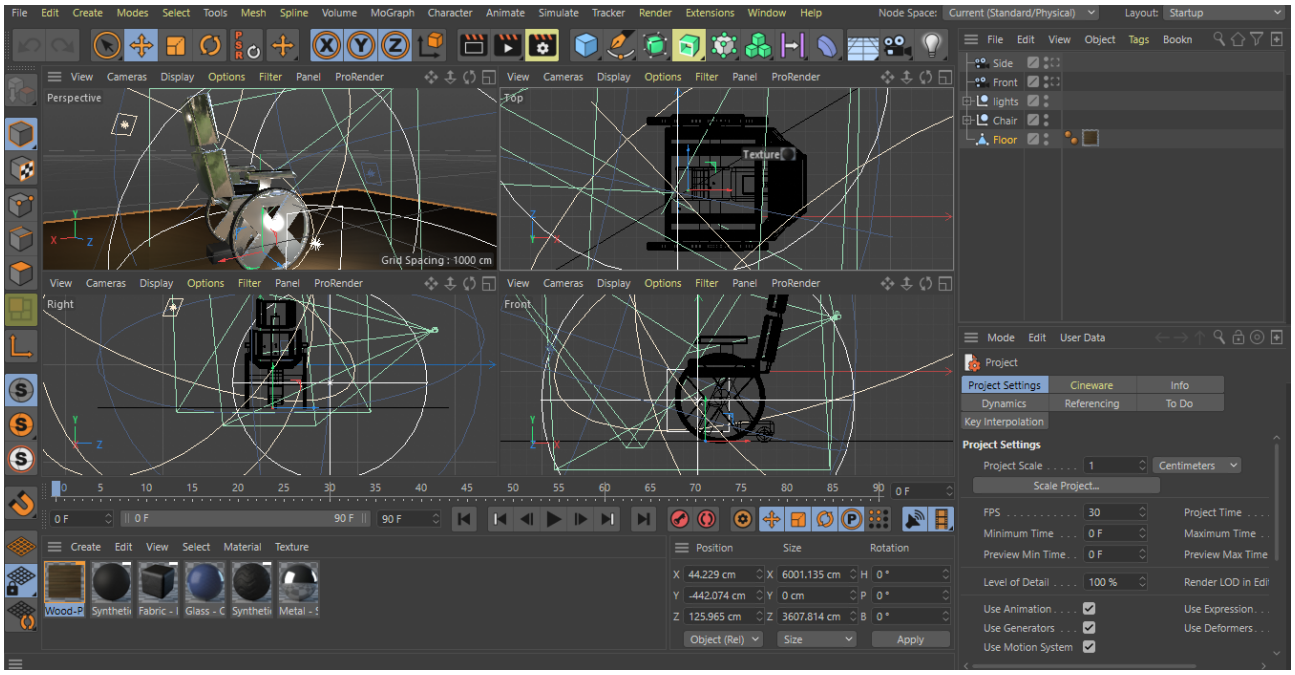
- delegate.self - delegates send messages. We have to say where we want the messages to go. In our storyboard it goes directly back, so in this case we simply say x.delegate=self.

- tableView.reloadData() - reloadData() : Reloads the rows and sections of the table view.

6) About App Page : This page shows our users full information about our application and diploma project.We believe that every person would like to know more about developers and history of our application

3.4 Realization in 3D

As we did the prototype of our wheelchair, we decided to show you how our project will look in real life in the future. We realized it by using 3D modeling. So in the image below you can see our working area and 4 viewports of our wheelchair.



So to display our wheelchair and give visual effects we did rendering. Rendering simulated realistic lighting, shadow, texture and optical effects to our project. So in the image below you can see how our modern smart wheelchair will look in real life.

Chapter 4

Conclusion

For a better life, it is important to reduce the suffering of a living person. Smart Wheel Chair are mechanical devices designed to provide mobility with the help of a user team. This reduces human effort and power to operate wheelchair wheels. Various smart wheelchairs have been developed in the past, and new generations of wheelchairs using artificial intelligence are being developed, so there is still a bit to steal from wheelchair users. Scientists and researchers have been working for years to bring something new to technology for better observation.

In this project, we introduced a smart wheelchair auxiliary system that uses a Bluetooth module for people with disabilities who cannot move a wheelchair without assistance. The system offers wheelchair movement using a voice command. Voice recognition technology is the key that can enable people to interact with machines or tools in a new way. Thus, the problem they face can be solved with the help of speech recognition technology for wheelchair movement. The detection of any obstacle is successfully monitored by a microcontroller. When the person turns on the circuit and starts moving, the ultrasound sensor will detect any obstruction. This proposed system promotes the autonomy of people with disabilities and the elderly. The patient can also control the program as a remote control. In addition, additional features have been developed to make our system convenient, fast, and economical with IOS. The results and analyzes of this innovation will be described in this report. The results of this project show that this project can be used for future research and development of innovations of excellence that meet market needs and public interests.

Appendix A

Source Code

```
void advance()
    {
     digitalWrite(pinRB,LOW);
     digitalWrite(pinRF,HIGH);
     digitalWrite(pinLB,LOW);
     digitalWrite(pinLF,HIGH);
     Car_state = 1;
    }
```

Figure A.1: Ultrasonic Method

```
int Ultrasonic_Ranging()
{

  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);

    int distance = pulseIn(echoPin, HIGH);

    distance= distance*0.034/2;

    return distance;
}
```

Figure A.2: Ultrasonic Ranging() method

```
void loop()
{
  while (BT.available()){
    delay(10);
    char c = BT.read();
    readvoice += c;
  }
```

Figure A.3: Void loop() method 1

```
if(readvoice == "*forward#"){
  while (readvoice == "*forward#"){
    H = Ultrasonic_Ranging();
    delay(300);
    if(H < 50){
      stopp();
    }
    else{
      advance();
    }
    while (BT.available()){
      delay(10);
      char c = BT.read();
      readvoice += c;
    }
  }
}else if(readvoice == "*back#"){
  back();
```

Figure A.4: Void loop() method 2

Appendix B

Hardware Equipments

Figure B.1: Arduino UNO with cable

Figure B.2: Battery

Figure B.3: Bearing Wheel

Figure B.4: Acrylic Platform

Figure B.5: Bluetooth module HC-05

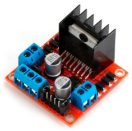


Figure B.6: Driver Module L298N

Figure B.7: Battery case

Figure B.8: DC Motor and wheel

Figure B.9: Sensor mount HC-SR04

Figure B.10: Set of fasteners

Figure B.11: Screwdriver

Figure B.12: Ultrasonic Sensor

Figure B.13: Wires MAMA-MAMA

Figure B.14: Plastic clamps

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