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

Akkassin Assel, Akhanova Bagdina, Bolekbayeva Anel,
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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 the design of 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 controls the movement of the wheelchair. The voice command is sent through a cellular device with Bluetooth, and the command is transmitted and converted to a string using the BT voice control for Arduino and transmitted to the SR-04 Bluetooth module connected to the Arduino board for wheelchair control. For example, when the user says "Forward", then the chair will move forward, and when he says "Back," the chair will move in the opposite direction and, similarly, "Left", "Right" to turn left and right, respectively, and "Stop" » to stop. This system has been developed to save the cost, time and energy of the patient. An ultrasonic sensor is also part of the design and it helps to detect obstacles in the way of the wheelchair that may interfere with the passage 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.

This thesis is intended as an idea to make life easier for those who are unfortunate enough to lose ability to move legs due to a significant amount of paralysis, accident, or old age. Many people with different abilities usually depend on others in their daily lives, especially when moving from one place to another. For wheelchair users, they constantly need someone to help them move the wheelchair. Their life is complicated by the fact that they lack an intuitive control system for their wheelchairs, which 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 alone, as this requires a lot of effort and help from others. The problem is that in some cases, disability leads to someone losing their ability to use their hands, so in this case, the method of controlling a mechanical wheelchair can be implemented using speech commands for patients without the help of hands, which leads to an interesting and promising result. But, nevertheless, the availability of intelligent wheelchair solutions is often limited due to the high cost and not very convenient operation. According to the proposed approach described in this document, an inexpensive, simple and friendly solution for the voice platform will be presented, which is user-friendly, fully customizable in accordance with the language the user speaks, and will help to expand the capabilities of the user independent mobility. Using a smartphone as the "brain" of a robot is already an active research area with several open possibilities and promising opportunities. Another highly successful technology, Bluetooth has changed the way digital devices are used at home or in the office, and converted traditional wired digital devices to wireless devices. This study is based on the design of voice-activated wheelchairs based on mobile platforms using Bluetooth technology, the development and implementation of solutions for wireless remote control. The project also includes the use of ultrasonic sensors to detect obstacles, and also notifies the system and stops the wheelchair before receiving further commands. This thesis presents the control of Smart Wheelchair using the Arduino Uno microcontroller and the Bluetooth module through the IOS application.

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. The user speaks the desired command in the BT Voice Control for Arduino voice (AMR Voice Application) software application installed on an android phone that is connected via Bluetooth via the HC-05 Bluetooth module. 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 to an array of strings, and the string is transmitted to the Arduino Uno connected to it. As soon as the Bluetooth module receives the message, the sent command will be retrieved and executed by the microcontroller connected to it, and depending on the commands given to the engine driver, the engines will work accordingly. The system will interpret the commands and control the wheelchair accordingly through the android application AMR Voice. Meanwhile, the ultrasonic sensor works when the circuit is turned on, and makes sure that there are no obstacles on the track, and if there is any obstacle, it notifies the Arduino and stops the

wheelchair until a further command is received from the user. But how we made this?

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)

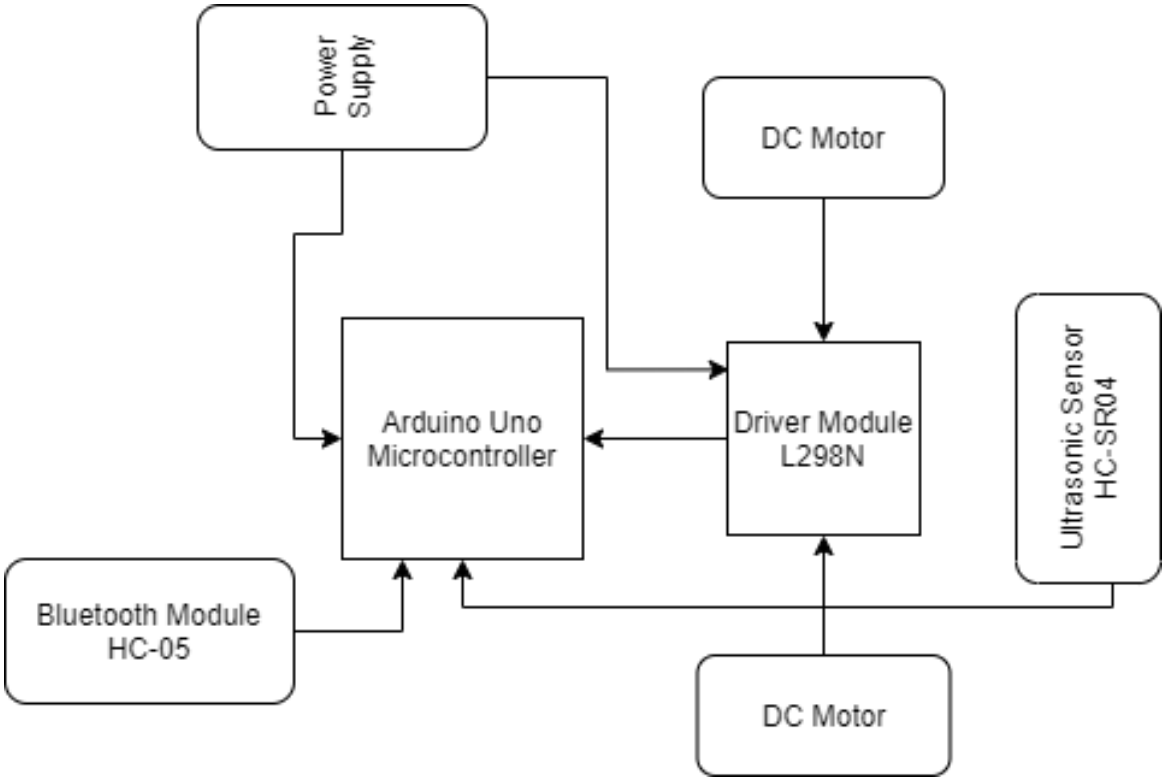


Figure 2.1: Block Diagram of the project

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

Figure 2.2: Step 1

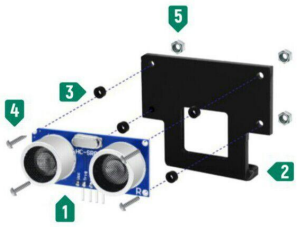


Figure 2.3: Step 2

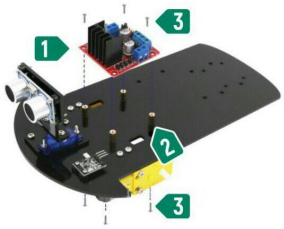


Figure 2.4: Step 3

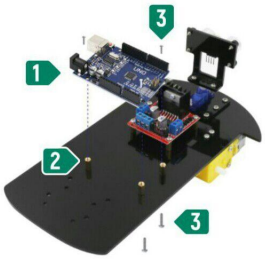


Figure 2.5: Step 4

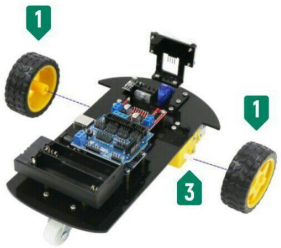


Figure 2.6: Step 5

-DC Motor and wheel
-Set of fasteners
-Screwdriver
-Ultrasonic Sensor
-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 set trigPin on a LOW State for just 2 s, for generating the Ultra sound wave we have to set the trigPin on HIGH State for 10 s. Using the pulseIn() function program reads the travel time and put that value into the variable "diatance". This function has 2 parameters, the first one is the name of the echo pin and for the second one you can write either HIGH or LOW. In this case, HIGH means that the pulsIn() function will wait for the pin to go HIGH caused by the bounced sound wave and it will start timing, then it will wait for the pin to go LOW when the sound wave will end which will stop the timing. At the end the function will return the length of the pulse in microseconds. For getting the distance we will multiply the duration by 0.034 (because speed of the sound is 340 m/s) and divide it by 2 (because Echo pin will be double that number because the sound wave needs to travel forward and bounce backward). 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()

- we can display app's navigational controls in a bar along the top of the iOS device's screen.

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:

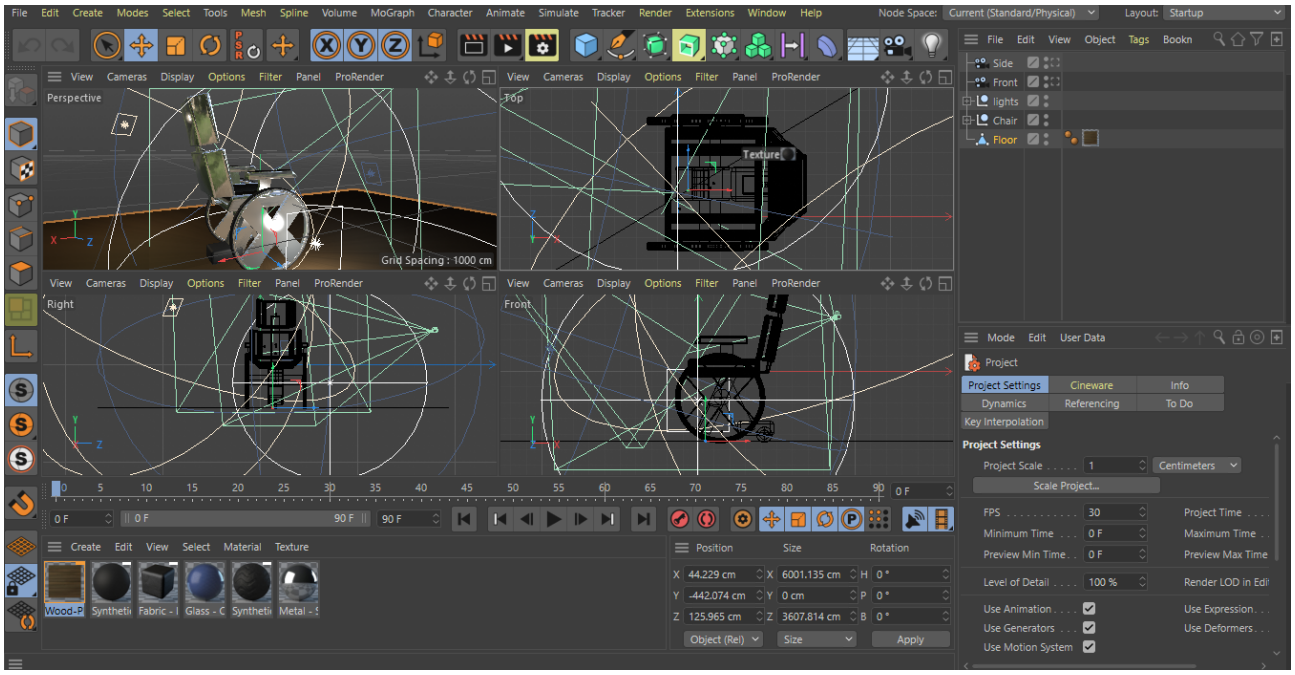
- delegate.self - delegates send messages. We have to say where we want the messages to go. In our storyboard it goes directly back, so in this case we simply say x.delegate=self.

- 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

To make the world a better place, it is essential to reduce the sufferings of living human being. Smart Wheel Chair is mechanical devices designed to provide self-mobility with the help of a user command. This reduces the user's human effort and power to drive wheels for a wheelchair. In the past, various types of smart wheelchairs have been developed, but new generations of wheelchairs are being developed and used that use artificial intelligence and, therefore, it remains to tinker a bit with a user who uses a wheelchair. Scientists and researchers have been trying for many years in the field of technology to bring something new for a better surveillance.

In this project, we have represented an assistive system of Smart Wheel chair using the Bluetooth module for physically disabled persons who can't move their wheelchair without assistance. The system offers movement of wheelchair using voice command. Speech recognition technology is a key which may provide a new way of human interaction with machines or tools. Thus the problem that they are faced can be solved by using speech recognition technology to move the wheelchair. The detection of any obstacle is successfully controlled by the microcontroller. When a person turns on the circuit and starts moving, the ultrasonic sensor will detect any obstacle. This proposed system promotes the autonomy of people with disabilities and the elderly. Also, patient can control with application as remote controller. A additional functions have also been developed that makes our system user friendly, speedy and cost effective using IOS application. The results and analysis of this innovation will describe in this report. The results of this project show that this project can be used for future research works and to design excellence innovation that meets market need and public interest.

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

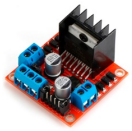


Figure B.6: Driver Module L298N

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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