Chapter 1
INTRODUCTION

This chapter gives an overview of what the project is ,what all components are required to make the wheelchair functional and what methodologies have been used to accomplish our goals.

1. Project Overview

The idea of using voice activated technology for controlling the motion of the wheelchair is to prove that it can be a unique concept that would stand apart from the rest of the average projects. The use of this new technology in conjunction with a mechanical system in order to simplify everyday life and it would spark interest in an ever growing modern society. Many people with disabilities do not have the dexterity necessary to control a switch on an electrical wheelchair. This can be a great for the quadriplegics who is permanently unable to move any of the arms or legs. They can use their wheelchair easier only using voice commands. The aim of this study is to implement an interesting application using small vocabulary word recognition system. The methodology adopted is based on grouping a microprocessor with a speech recognize development kit for isolated word from a dependent speaker. The resulting design is used to control a wheelchair and home appliances for a handicapped person based on the vocal command [1].

1.1.1 Technical Terminology

The following are the technical terminology which have been used in our project:

1. **Development environment:** It refers to the computer language used for developing the said product. In this case we are using Arduino development environment and python for the project.

2. **Microcontroller :**It refers to a device that can be coded externally to control other peripheral devices such as motors, LED's etc. It consists of a Microprocessor along with memory to implement the code.

3. **Voice recognition module:** It refers to a module which is used to convert user's voice into machine readable form. This machine readable form helps the microcontroller to control the peripheral devices according to the user's demand.

4. **Motor Shield:** This device helps user to control the DC motor's motion according to the input provided to the microcontroller, it can accommodate up to four motors but only two have been used.

5. **DC motors:** This device is used to convert electrical energy into mechanical motion by using magnetization and electric flux conversion.

6. **Chassis:**It refers to the basic structure of the model ,which is made using mild steel. The chassis weighs three kilogram and is forty centimetre in length ,thirty centimetre wide and thirty centimetre high.

7. **Battery:** It stores electrical energy in form of chemical energy. The battery used is 12Volts and gives .34Ampere.

8. **Application Development:** It refers to the development of mobile application for certain purposes such as controlling the wheel chair.

9. **Android Studio:** It is the IDE for android based mobile applications which will then control the wheelchair.

1.1.2 Problem Statement

The problem is the lack of options for physically disabled people to move around. They need to rely on others for help. Research from University of Notre Dame, 2000, suggests that the current power wheelchair control interfaces used may not, be adequate to provide truly independent mobility for substantial number of person with disabilities. The Respondents to the survey reported on average that approximately ten percent of the patients trained to operate a power wheelchair cannot use the chair upon completion of training for activities of daily living or can do so only with extreme difficulty. So, we need a better option for helping these physically disabled people. Not only these but old aged people can also use a solution for this problem.

1.1.3 Goal

The goal of this project is to understand the concepts that lie behind the controlling motion of the dc motors, to develop understanding of microcontroller and how they operate under various circumstances and last but not the least to develop deep understanding of Natural Language and its processing using machine learning.

1.1.4 Solution

The Solution is to create a scaled prototype of a wheel chair that can take user voice as input and use this input to control the motion of the wheel chair. The wheel chair could be only control by a specified person as the chair uses voice recognition system for the use of the voice based commands. Also, a Mobile Application will be developed as a secondary control option.

2. Need Analysis

There are various people who face difficulty in going from place to place be it either due to a physical injury or age factor. These people find it difficult to move around not only outside but inside their own houses too. So the need is there to help these people and help the community because due to this problem these people with some dexterities get cut off from the community. They think of themselves as burden on others. Not only them but the people who have to take care of these people also get nauseated due their continuous needs. Hence, they send their old aged parents or disabled people into care homes away from their close ones. Hence, to prevent these people from all these troubles. Due to this these people can have a life without needing care from others and leading a happy self-serving life[2].

3. Research Gaps

The research these days is focused on how to improve the voice recognition and speech synthesis. Various firms R&D department continuously focus on how to improve the user experience. But none of these ever has imagined how that would result in hardware implementation. Advances in speech synthesis requires dedicated hardware and software system which is not possible for embedded system approach. Rather, we have to settle for most rapidly available and suitable rather than a technically superior one.

Hence, there exists a research gap in between these approaches. This gap leads to underpowered products whichcould be more efficient by using special hardware. Also, this research gap in our country also leads to lagging of our nation behind in terms of hardware based product services. India is a service based industry but if we want to advance our country we should help it by making it a product centric industry, which would lead to development of revolutionary ideas and efficient products for consumers.

4. Problem Definition and Scope

By using the 5W1H approach the voice automated wheelchair problem has been defined as follows:

1. Who does it effect?

The people who are impaired of their limbs, who need an external help in their movement and the people who have aged and are not able to walk without any support are directly affected hence it can help a wide variety of people who are not able to move from one location to another on their own. There also exist people who can walk but are at a risk of losing consciousness while walking or put high amounts of physical strain on their body hence the wheelchair model can help them also.

2. What happens?

The people are not able to do their daily choirs without any help from others. People need caretakers and full time servants whether they can afford them or not. Also, people who are alone and have no caretaker usually have short life span, they are cut off from the community, self-confidence is shaken, hope to live dies. Minimal effort is needed to control the wheelchair while using the voice commands or the mobile application. The power of an electric wheelchair makes it easier for you to go up or down hills.

3. Where and When does it happen?

This is a universal phenomenon; more than a million cases are seen across the world every year. This is a major cause after any injury or trauma disorder. Also the age factor is a main reason behind this problem. The number of people significantly increase every year due natural and mad made disasters.

4. Why and How does it happen?

It mainly happens due to any limb injury where a person has lost the limb or is unable to control it. Also due to paralysis and other neurological diseases leaves a person without the sense of his/her limb. Lastly, people who have aged and cannot lift up their own weight due to various skeletal disorders are the targeted users.

5. Assumptions and Constraints

TABLE 1: Assumptions and Constraints

Sno.	Assumptions & Constraints
1.	The path of the wheelchair will not consist of any pot holes or speed bumps which may cause damage to the DC motors, it may also lead to damage to the circuitry hence we have assumed that there will be no damaging mechanical shocks to the wheelchair.
2.	The wheelchair will have an continuous long clear path so that the wheelchair does not stop frequently causing damage to the wheelchair and causing a rocky motion.
3.	The speed of the wheelchair will limited to a few Kilometres per hour as it would put extreme load on the batteries.
4.	The weight of the user is also not considered as an it would put an immense load on the structure of the wheelchair and the battery of the wheelchair.
5.	The battery will not be able to sustain prolong use hence the wheelchair should be used for short distant usages. The short distant usage include the neighbourhood
6.	The surface on which the wheelchair will not be inclined as increases the load on the DC motor and hence increasing power consumptions and the wheelchair may tilt also.
7.	The background noise while using the microphone will be negligible as it would interfere with the efficiency of the speech to text synthesis module

6. Approved Objectives

The following objectives have been approved by the mentor and capstone panel:

1. Building Hardware for the Wheel Chair Prototype.

2. Using Mobile Application to control the wheel chair.

3. Applying Natural language processing to control wheel chair with voice.

4. Using voice recognition to control the chair.

5. Applying an activation command.

7. Methodology Used

The methodology used in this project is iterative in form of a spiral. In this we are developing the product and iterating it to produce a better product. The spiral model is a risk-driven software development process model. Based on the unique risk patterns of a given project, the spiral model guides a team to adopt elements of one or more process models. The iteration helps in continuous inspection and control of the development of the product. If in this, we face a problem we can go back to the previous stage where the problem can be fixed and then repeated the entire process again. This helps in maintaining the product quality and helps in developing the product with the Agile methodology.

Agile tells us to be flexible and be ready for change because we cannot attain a product in a specific manner. Over the course of development, we have to change some of our techniques to get the desired product. A Tree that does not bend in storm fall down but the one that bends sees the light of another day!![3].

8. Project Outcomes and Deliverables

The outcomes and deliverables from this wheelchair project will be:

1. A Scaled Wheel-chair model (Hardware) designed to work on voice commands as well as commands from mobile application.

2. A mobile application that can control the chair as a secondary controlling option which has been developed using the Android Studio IDE.

3. The main outcome of this project will be the understanding of the concept of project management.

4. Deep learning of the concepts of Language processing using machine learning.

5. Learning of the hardware components like Arduino and how these control the peripheral devices according to the user needs.

6. This project will also help us learn team work and time management during project development.

9. Novelty of Work

Our project has various prototypes already in the market but none of them use Natural language processing to convert audio to text. We also use voice recognition so as only the authorized person will be able to control the chair. Due to this we need not to use other models if a new language is developed to work with the machine. We can add more language support only by software updates making it completely autonomous even for regional languages in the future.

Chapter 2
Requirement Analysis

This chapter deals with the research and the requirement analysis of this project. This describes the theory related to the subject, research currently being performed, problem analysis and the tools and technologies being used.

2.1 Literature Review

This section deals with the literature and research required in this project and the advances that have been made in the hardware section.

2.1.1 Theory Associated with Problem Area

There have been several studies indicating that independent mobility is provided byautomated wheel chair to everyone who are unable to move on their own. Independentmobility increases vocational and educational opportunities for the people who are unable to move and reduces their dependencies on their medical aid, hence promoting feelings of self-reliance. Among the patients of younger age group independent mobility serves as the foundation for early learning. Non ambulatory children lack access to the wealth of stimuli afforded self-ambulating children. Mobility difficulties are also strong predictors of Activities of Daily Living (ADL) and instrumental ADL disabilities because of the need to move to accomplish many of these activities.

In addition, impaired mobility often results in decreased opportunities to socialize, which leads to social isolation, anxiety, and depression. While the needs of many individuals with disabilities can be satisfied with traditional manual or power wheelchairs, a segment of the disabled community finds it difficult or impossible to use wheelchairs independently[4].

While the needs of many individuals with disabilities can be satisfied with traditional manual or powered wheelchairs, a segment of the disabled community finds it difficult or impossible to use wheelchairs independently. This population includes, but is not limited to, individuals with low vision, visual field reduction, spasticity, tremors, or cognitive deficits. These individuals often lack independent mobility and rely on a caregiver to push them in a manual wheelchair.

To accommodate this population, several researchers have used technologies originallydeveloped for mobile robots to create smart wheelchairs. A smart wheelchair typicallyconsists of either a standard power wheelchair to which a computer and a collection of sensors have been added or a mobile robot base to which a seat has been attached. Smart wheelchairs have been designed that provide navigation assistance to the user in a number of different ways, such as assuring collision-free travel, aiding the performance of specific tasks (e.g., passing through doorways), and autonomously transporting the user between locations.

There are several advantages to integrating the smart wheelchair technology into the underlying power wheelchair. Perhaps most important, the user's input can be fed directly into the processor to the wheelchair's motors, bypassing the manufacturer's proprietary control electronics. This eliminates the need to reverse engineer the protocol that the wheelchair manufacturer uses to 11, communicate between the joystick and the motor controller. An additional benefit of tight integration is the ability to add optical encoders to the wheels, which allows the wheelchair to track its velocity. Systems designed as add on units, on the other hand, must connect to the underlying wheelchair through the limited interface options provided by the wheelchair manufacturer.

Smart wheelchairs have been used to explore a variety of alternatives to the more traditional 4 input methods associated with power wheelchairs. Voice recognition has often been used for smart wheelchairs because of the low cost and widespread availability of commercial voice recognition hardware and software. More exotic input methods that have been implemented include detection of the wheelchair user's sight path (i.e. where the user is looking) through Electro Oculographic (EOG) activity or the use of machine vision to calculate the position and orientation of the wheelchair user's head.

To avoid obstacles, smart wheelchairs need sensors to perceive their surroundings. By far, the sensor most frequently used by smart wheelchairs is the ultrasonic acoustic range finder (i.e., sonar). Sonar sensors are very accurate when the sound wave emitted by the sensor strikes an object at a right angle or head on. As the angle of incidence increases, however, the likelihood that the sound wave will not reflect back toward the sensor increases. This effect is more pronounced if the object is smooth or sound absorbent. Sonar sensors are also susceptible to cross talk, which happens when the signal generated by one sensor produces an echo that is received by a different sensor.

Investigators have taken a variety of approaches to implementing control software for smart wheelchairs based on the functions supported by the smart wheelchair and the sensors it uses. The University of Plymouth and the Chinese University of Hong Kong have both developed smart wheelchairs that use neural networks to reproduce routes. The NavChair, on the other hand, uses an obstacle density histogram to combine information from its sonar sensors with joystick input from the user, and the SWCS and SPAM use rule-based approaches.

Very few smart wheelchair researchers have involved people with disabilities in their evaluation activities. Furthermore, no smart wheelchair has been subjected to a rigorous, controlled evaluation that involves extended use in real-world settings. Conducting user trials with smart wheelchairs is difficult for several reasons. Some wheelchair users do not show any immediate improvement in navigation skills when using a smart wheelchair on a closed course in a laboratory setting.

The primary obstacle to conducting long-term studies is the prohibitive hardware costs associated with constructing enough smart wheelchairs. Long-term studies are necessary, however, because the actual effects of using a smart wheelchair for an extended period of time are unknown.

2.1.2 Existing Systems and Solutions

The already existing systems and solutions for a voice automated wheelchair have been listed below: -

1. **Assistive Devices for Ambulation:**-These are simple devices to help you walk a cane, crutches, and walkers but such systems not meant for paralysed patients.

2. **Manual Wheelchair:** Essentially, a chair with wheels designed to allow you to self-propel or be pushed along by a companion or an attendant.

3. **Power Assist Devices:** These are mechanical devices installed on manual wheelchairs to make it easier for the user to self-propel.

4. **Scooters:** Most are three-wheel designs, although some four-wheel models are available, usually with an electric motor, and a tiller for steering. A scooter is an effective mobility device that does not look like a wheelchair.

5. **Power Wheelchairs:** Front-wheel, mid-wheel, and rear-wheel drive options are available. These chairs operate by an electric motor and are controlled by using a joystick or using an alternate control device. Many offer multiple seating options, including power seating.

2.1.3 The Problem That Has Been Identified

A large population of the world consists of people with some form of disabilities or people who are physically handicapped. They are dependent on others for their daily needs and face problems in their mobility. Previous attempts made to make a medical wheelchair to help such people weren't devoid of defects. This project could be part of an assistive technology, it is for more independent, productive and enjoyable living.

2.1.4 Survey of tools and technologies being used

The following course subjects are being used in order to build the voice automated wheelchair:

1. **Natural Language Processing:** It is required for understanding the meaning of the sentence spoken by the user.

2. **Machine Learning:** It is required for voice and speech recognition of the user.

3. **Computer Networking:** Controlling wheelchair through Android application using Bluetooth interface.

4. **Android Application Development:** Developing a fully functional Android application for controlling wheelchair.

5. **XML:** It is required for creating the front end of the Android application.

6. **C++/C:** It is required for controlling the microcontrollers Arduino Uno and the several sensors that are connected to it.

7. **Electrons Engineering:** It is required for understanding and joining of the various electronic components.

8. **Kotlin/Java:** It is required for creating the android application structure and other software modules which function as the programming logic of the application being used in the project.

9. **Python:** It is required for creating the voice and speech recognition module along with NLP module.

2.2 Standards

The following Institute of Electrical and Electronics Engineers (IEEE) standards have been incorporated in the wheelchair capstone project:

1. The Bluetooth IEEE standard 802.15.6. is being used for wireless communication between the wheelchair and mobile device.

2. Software requirement specification standard IEEE 830 lists down the recommended.

3. software practices required for making the project.

4. The IEEE 260.1-2004 is being used for the representing standard symbols of measurement.

5. The standard IEEE 802.9 has been used integrated voice and data access.

6. The IEEE 29119 standard will be used for software testing and debugging the errors discovered in the software used to drive the voice automated wheelchair.

7. The IEEE 310:1969 standard is used for adjusting the values of resistors having valuesfrom .01ohm to 1 Mega ohm.

2.3 Software Requirements Specification

This section deals with the software requirements of the project with the project scope and the audience the project is targeting.

2.3.1 Introduction

This section introduces us to the purpose and targeted audience of the project. Also, this describes the project perspective including hardware and software perspectives.

2.3.1.1 Purpose

The Solution is to create a scaled prototype of a wheel chair that can take user voice as input and use this input to control the motion of the wheel chair. The wheel chair could be only control by a specified person as the chair uses voice recognition system for the use of the voice based commands. Also, a Mobile Application will be developed as a secondary control option.

2.3.1.2 Intended audience and reading suggestions

The following are the intended audience of the voice automated wheelchair:

1. People with amputations due to accidents or birth defects making them unable to walk on their own.

2. Patients with paralysis can also use the wheelchair.

3. Aged people who are unable to put high physical strain on their body can also use the wheelchair.

2.3.1.3 Project Scope

This project is related to the Voice Controlled Wheelchair System by using speech recognition module and an Android application. The objective of this project is to facilitate the movement of people who are disabled or handicapped and elderly people who are not able to move well. The result of this design will allow certain people to live a life with less dependence on others. Speech recognition technology is a key which may provide a new way of human interaction with machines or tools.

The Android application on the mobile device is connected through the Bluetooth interface and replaces the joy stick in most automated wheelchairs. In this project, interface is the program which recognizes a voice that will in turn controls the movement of wheelchairs. This project uses Raspberry pi and Arduino Uno along with Direct Current motors to create the movement of wheelchair. Since the motorized wheelchair can move at a fair speed, it is important that it be able to avoid obstacles automatically in real time, with these requirements in mind we propose an automated wheelchair with real-time obstacle avoidance capability [5].

2.3.2 Overall description

This section describes various perspectives of the intended model and the features and interface requirements of the project.

2.3.2.1 Product perspective

There are two product perspective which include:

1. **Software Perspective:** In software perspective we have a voice recognition module and an activation command module which use user generated voice and they convert that voice to machine readable text. This text is then used to generate commands to control DC motors. The motion of DC motors includes forward, backward, left, right, rotate and no motion. We also use Arduino IDE to control the DC motors.

2. **Hardware Perspective:** It includes hardware components like wheelchair chassis, DC motors, microcontroller, Bluetooth module, motor shield, battery, etc.

2.3.2.2 Product features

The product features of the wheelchair include: -

1. A voice recognition system for identifying the commands given by user.

2. Microcontroller based DC control system for running the chair.

3. DC motors (12V and 300RPM) for running the wheelchair.

4. Arduino Uno R3 microcontroller for executing the instructions.

5. Raspberry pi or Voice module for processing the commands and then passing the instruction to the Arduino.

2.3.3 External interface requirements

This section describes the various user, hardware and software interfaces required in this project.

2.3.3.1 User Interface

The user interface feature includes the following items:

1. Microphone for user based voice input with voice recognition.
2. Mobile based Android application for controlling the wheelchair.
3. Buttons for stopping the wheelchair in emergency conditions.

2.3.3.2 Hardware Interface

The hardware interface includes:

1. Microcontroller (Arduino Uno R3) for performing the programming operations.
2. Raspberry pi or Voice module for processing the voice commands given by the user .
3. DC motors for running the wheelchair in the desired direction.
4. Wheel chassis is the physical structure of the wheelchair.

2.3.3.3 Software Interface

The software interface requirements includes:

1. Speech and Voice recognition system using Python language using the Spyder editor.

2. Communication between voice module and microcontroller.

3. Using Arduino UNO R3 IDE for DC motor control for wheelchair motions.

2.3.4 Other non-functional requirements

The other non-functional requirements of the voice automated wheelchair are:

2.3.4.1 Performance Requirements

The following are the performance requirements of the wheelchair project:

1. The microcontroller should be able to decode the instruction within 4 seconds.

2. The wheelchair ride should be smooth and not be haphazard in nature.

3. The noise immunity of the microphone should be as high as possible.

4. The wheelchair battery should be able to work for long durations and no rechargeable issues should occur.

5. The Android application should be designed for maximum optimization so that the phone does not lag.

6. Instant transmission of data from mobile phone to wheelchair using Bluetooth module.

2.3.4.2 Safety

The safety features of the wheel chair include:

1) SOS button for emergency stopping the wheelchair during malfunction or when user whishes to stop the wheelchair at a certain instance which puts the user at the risk of being harmed.

2) Safely grounding and sealing the electrical connections to prevent electrical shock and using Pulse Width Modulation to change the speed of wheelchair so that the chair travels at moderate speed.

3) Ultrasonic sensor to prevent collision with objects or oncoming people which cause physical damage to the user and the chair.

2.3.4.3 Security

The security features of the wheelchair model include password access to the android application so that user can control the wheelchair along with voice recognition incorporated so that the authorized user can only operate the wheelchair with his voice.

2.4 Cost analysis

The following table shows the cost analysis of the capstone wheelchair project:

Table 2: Cost Analysis

Sno.	Materials	Unit Cost(₹)	Quantity	Total Cost(₹)
1	DC geared Motors	₹ 540.00	2	₹ 1,080.00
2	Chassis	₹ 600.00	1	₹ 600.00
3	Tyres	₹ 100.00	2	₹ 200.00
4	Raspberry pi/Voice Module	₹ 2,800.00	1	₹ 2,800.00
5	Arduino Uno	₹ 500.00	1	₹ 500.00
6	Ultrasonic Sensor	₹ 180.00	2	₹ 360.00
7	LEDs	₹ 2.00	10	₹ 20.00
8	Battery	₹ 1000.00	1	₹ 1000.00
9	Wires	₹ 1.00	20	₹ 20.00
10	Castor Wheels	₹ 165.00	4	₹ 660.00
11	Bluetooth Module	₹ 500.00	1	₹ 500.00
13	Motor Shield	₹ 350.00	1	₹ 350.00
14	Microphone	₹ 300.00	1	₹ 300.00
	TOTAL COST			**₹ 8,390.00**

2.5 Risk analysis

The Risks for the automated voice controlled wheelchair prototype have been listed below in the table:

Table 3:Risk Analysis

S.No.	Risks to the wheelchair
1	The path of the wheelchair will not consist of any pot holes or speed bumps which may cause damage to the DC motors, it may also lead to damage to the circuitry hence we have assumed that there will be no damaging mechanical shocks to the wheelchair.
2	The wheelchair will have an continuous long clear path so that the wheelchair does not stop frequently causing damage to the wheelchair and causing a rocky motion.
3	The speed of the wheelchair will limited to a few Kilometres per hour as it would put extreme load on the batteries.
4	The weight of the user is also not considered as an it would put an immense load on the structure of the wheelchair and the battery of the wheelchair.
5	The battery will not be able to sustain prolong use hence the wheelchair should be used for short distant usages. The short distant usage include the Neighbourhood
6	The surface on which the wheelchair will not be inclined as increases the load on the DC motor and hence increasing power consumptions and the wheelchair may tilt also.
7	The background noise while using the microphone will be negligible as it would interfere with the efficiency of the speech to text synthesis module

CHAPTER 3
Methodology Used

This chapter discusses the tools and techniques used for investigating the problem. This section also deals with the Solution of the problem we propose and work breakdown structure and tools and technologies used for the project development.

3.1 Investigative Technique

Experimental Technique: There are many research papers published related to our project "Smart Automated Voice Control Wheelchair". So, Experimental technique will be used as an investigative technique. In the Experimental Technique, commands will be given as input to wheelchair and their results are recorded. In our project, natural language processing (NLP) is applied in which the user will first give the activation command to the wheelchair. In this mechanism, two processes will take place.

Firstly, the wheelchair will run a voice recognition module to do voice recognition of a person. If voice recognition process is successful, wheelchair authenticates the user and activates the wheelchair to receive further commands or directions for the movement of wheelchair. Further the command will be processed and directions are fetched and converted into text in Raspberry Pi three.

This text is converted into code format and is send to the Arduino and then to motor driver and finally to the left and right motors. If any one of the above given steps failed to execute, wheelchair will not move conveying the fault or failure of some process or tools. In the process of controlling the wheelchair by mobile application, firstly the mobile using the application will have to be paired with the Bluetooth module attached to the Arduino using verification code. After authentication, Mobile is ready to control the wheelchair and directions from mobile is sent through direction buttons embedded in the application.

3.2 Proposed Solution

Physically impaired people finds difficult to use a normal wheelchair as their hands are not capable of operating the normal wheelchair effortlessly. Therefore, voice controlled wheel chair is built to overcome the problems faced by such people and enable them to operate the wheelchair. The wheelchair will be operated using the voice commands through the given input using natural language processing and through mobile application. The Arduino will take care about all the directions the user wants. The instruction for each and every direction is written in the form of program in the Arduino itself. The already written programs in the Arduino helps Arduino to convert the voice commands into considerable output and the wheelchair will move accordingly. By having a wheelchair control system people will become more independent. The wheelchair control system employs a voice recognition system for triggering and controlling all its movements. By using the system, the users are able to operate the wheelchair by simply speaking to the wheelchair's microphone. The basic movement functions include forward and reverse direction, left and right turns and stop. The spoken words are linked to the voice recognition process via a flexible microphone[6].

3.3 Work Breakdown Structure

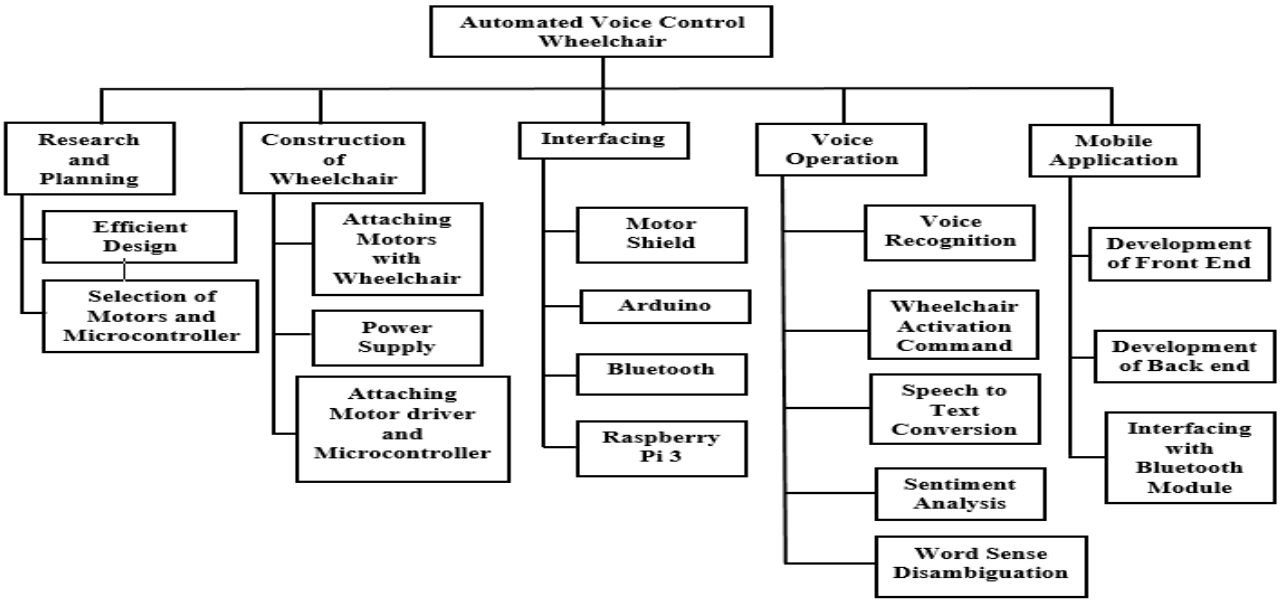

Figure 1: Work Breakdown

3.4 Tools and Technologies used

These are the tools and technologies being used in this project:

1. **Natural language processing:** Used for processing commands provided by the user trough the microphone.

2. **Raspberry Pi 3:** Used for natural language processing like voice recognition and activation command.

3. **Arduino:** Used for controlling the motors of the wheelchair through L293 IC and also controlling the various sensors attached to the wheelchair.

4. **Motor driver:** Implementing directions given by Arduino through left and right motors using L293D IC.

5. **Android Studio:** An IDE used for building android based mobile applications.

6. **Bluetooth module:** Connecting the mobile application with Arduino.

7. **Microphone:** Command input from user to Raspberry Pi 3.

CHAPTER 4
DESIGN SPECIFICATION

This chapter discusses the architecture and various design level and interface diagrams which describe the project in detail.

4.1 SYSTEM ARCHITECTURE

Component diagrams are used to visualize the organization and relationships among components in a system. These diagrams are also used to make executable systems. In the above diagram we have shown how different physical components have attached to each other to form a fully functioned system which will drive our voice automated wheelchair [7].

1. **Microphone:** Here the input is taken from the user in the form of voice data which is in analog form.

2. **Raspberry pi:** As the raspberry pi takes digital input hence we apply A-D converter to form a digital signal for raspberry pi. The raspberry pi is the main computation unit which will give all the commands to other components to generate the desired result for the user.

3. **Arduino:** The Arduino works as a platform for all the hardware components. It gets instructions from Raspberry pi and executes it on all the hardware components.

4. **Motor:** It is the driving force of the system. It receives instruction from Arduino and gives motion to the wheelchair.

5. **LED:** It is used to display the battery content of the wheelchair.

6. **Obstacle Detection Sensor:** It is a sensor which is used to detect obstacle in front of the wheelchair. It requires digital input hence we apply A-D converter to generate digital signals.

7. **Mobile:** Here Mobile as used to run the app which is used for remote controlling of the wheelchair.

COMPONENT DIAGRAM

The following diagram shows the component diagram of the project:

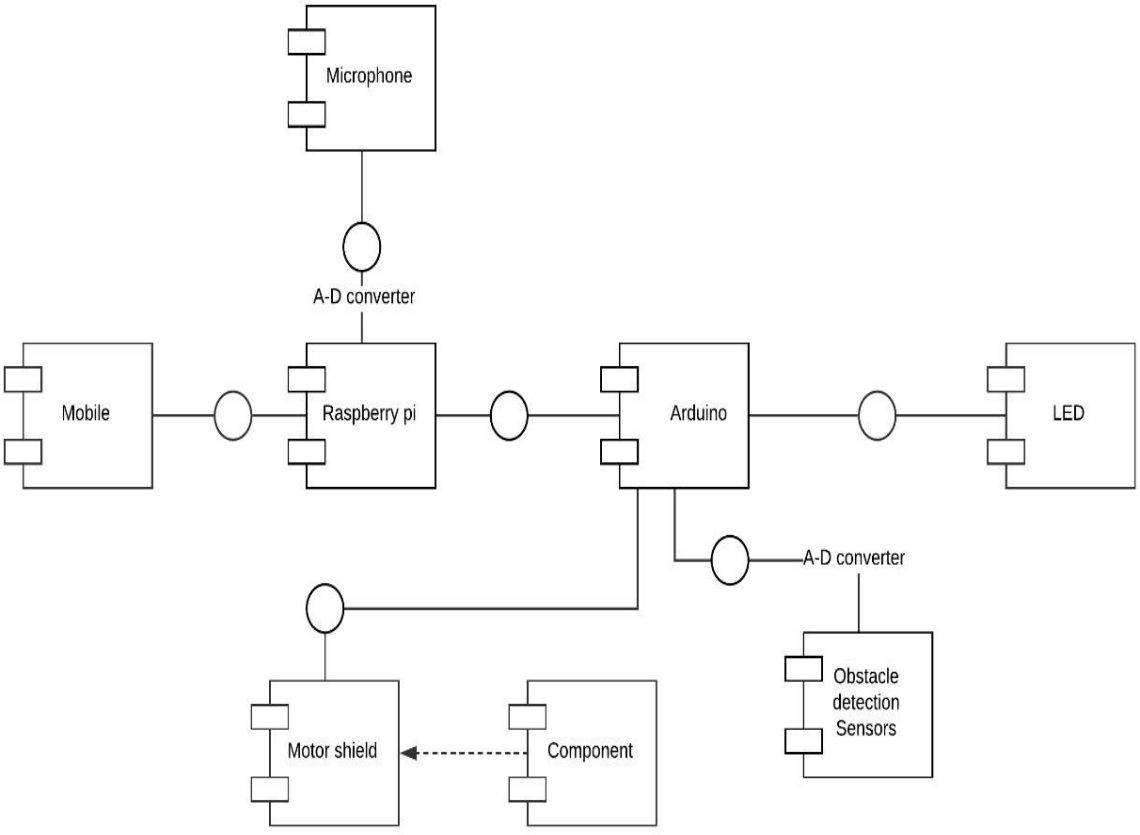

Figure 2: Component Diagram

4.2 DESIGN LEVEL DIAGRAMS

The **Model View Controller** (MVC) design pattern specifies that an application consist of a data model, presentation information, and control information. MVC mostly relates to the UI or interaction layer of an application. The diagram given below shows the design we used to regulate the command, from user, for working of the wheelchair.

1. **Views (Raspberry pi):** The Raspberry pi comes under the Views section. It sends the input from the user to the controller for generating the action.

2. **Controller:** It manipulates the Model section of the diagram to generate the desired result and updates it to the Views section.

3. **Model(Motor):** The motor comes under the Model section which is manipulated by the Controller to generate the desired result. It updates the Views after generating the output.

MVCArchitecture Design Diagram

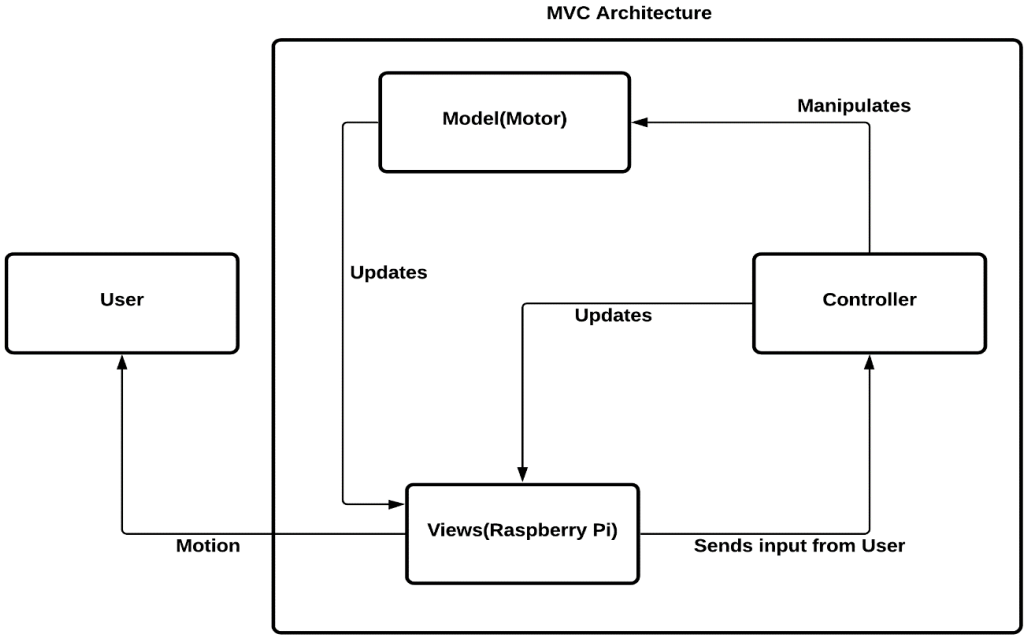

Figure 3: MVC Architecture

Context Data Design Diagram

A system context diagram is adiagram that defines the boundary between the system, or part of a system, and its environment, showing the entities that interact with it. This diagramis a high level view of a system. The above diagram shows the data flow design we used for showing the movement of data among different components.

1. **User:** The User gives the voice/speech data to the automated wheelchair system.

2. **Microcontroller Raspberry pi:** It gives interpreted data to the automated wheelchair system from the interpretation of the User command.

3. **Arduino:** It is the system platform which gives the hardware component data to the automated wheelchair system.

4. **Motor:** It is the driving force of the system and provides with the movement data to the automated wheelchair system.

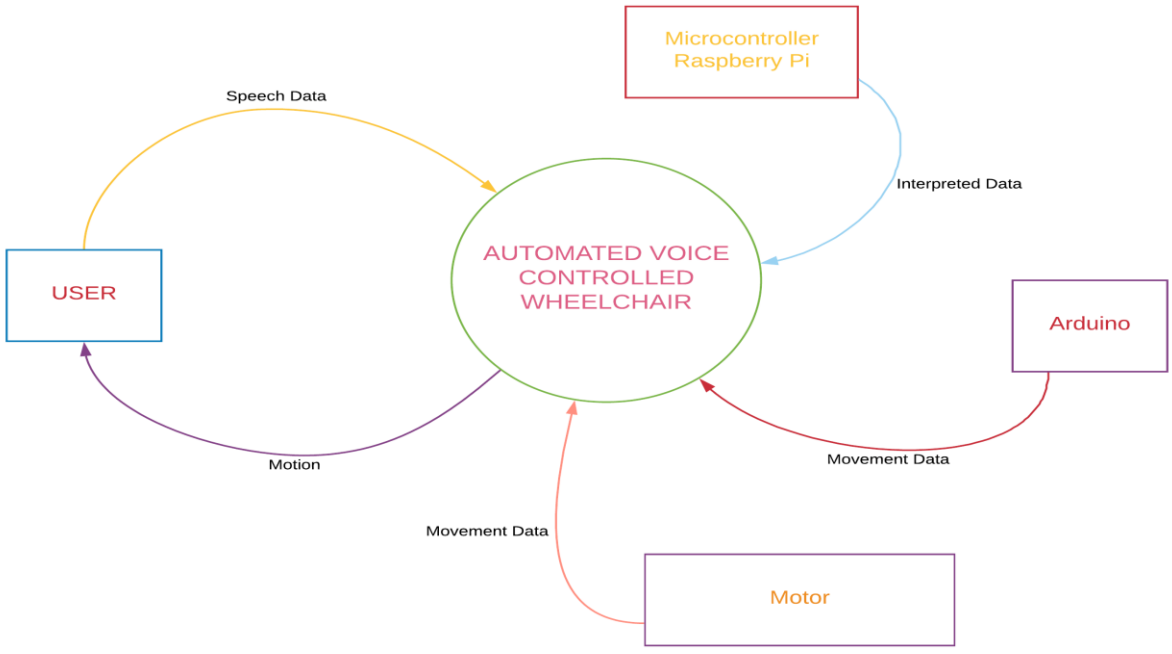

Figure 4: Context data design

3-Tier Architecture Design Diagram

A 3-tier architecture is a type of software architecture which is composed of three tiers or "layers" of logical computing. They are often used in applications as a specific type of client-server system. 3-tier architectures provide many benefits for production and development environments by modularizing the user interface, business logic, and data storage layers. The above diagram shows the overview of our system which is divided into three layers as:

1. **Presentation Tier:** It consist of the User Interface which will used by the user for interacting with the system. It is the top layer and it consist of Mobile app (using Android Studio) for interaction with the system.

2. **Logic Tier:** It consist of the logic framework/design which is implemented to work according to the user command. It is the middle layer which is not visible to the user and is used to run the system. Here it consists of Raspberry pi, Arduino and Obstacle detecting sensor.

3. **Data Tier:** It consist of the Database which is used to store the data generated in the middle layer. It is the bottom layer and as we are storing the voice data hence we use the NLP database.

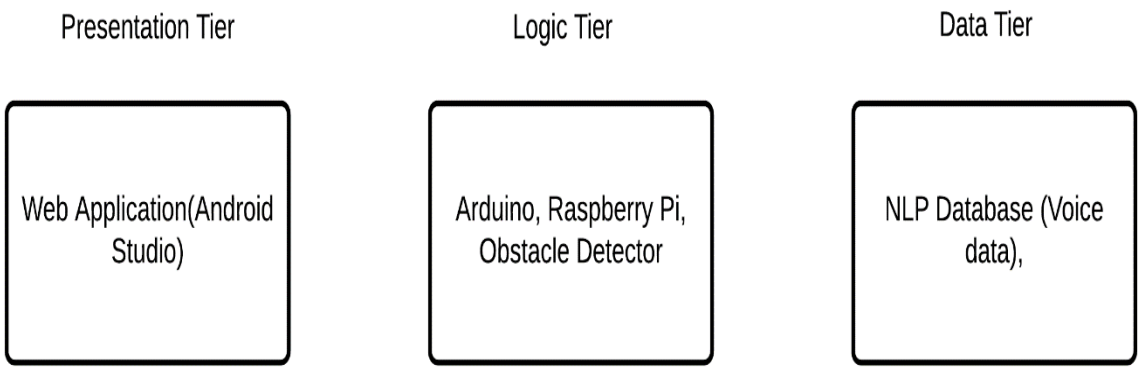

Figure 5: Tier Architecture

4.3 USER INTERFACE DIAGRAM

The following diagram is a high-level view diagram that representsinterfaces as annotated components. This diagram is similar to a data-flow diagram and is referred to as a Component Interface or Interconnection Viewdiagram. The above diagram represents the interface design we implemented for making our user interface.

1. **Response Time:** It tells about the response time of the user interface and after seconds of input data the system becomes operational.

2. **Command and Action structure:** It defines the commands and the related actions which the user interface can imply on the system.

3. **Error Handling:** It defines the exceptions or error occurs during the normal execution of commands. Here there are two exceptions occurring, the obstacle detection in path which is handled by the obstacle detecting sensor and the multiple commands which is handled by the database which contains command inputs.

Interface Diagram

The following diagram shows the interface diagram for the project:

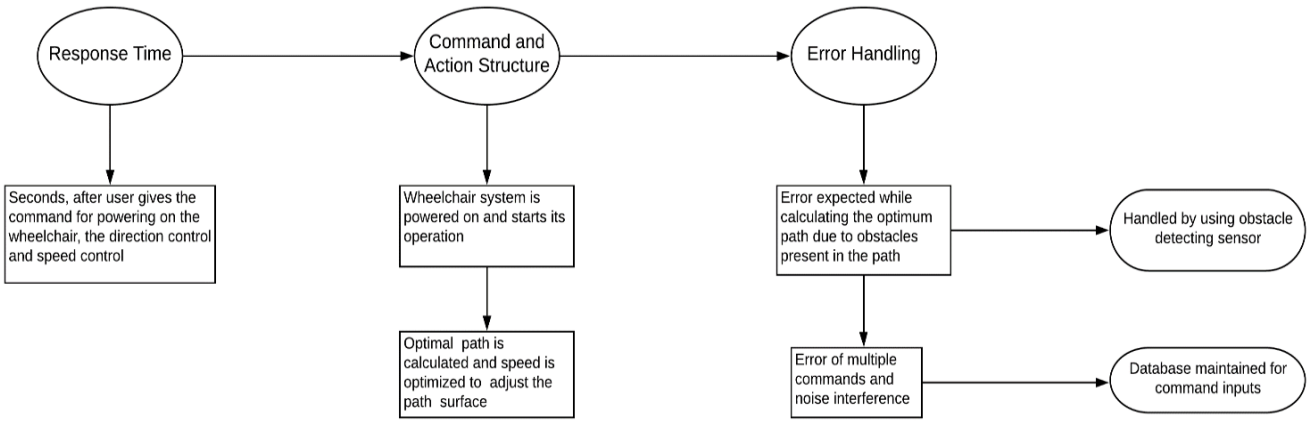

Figure 6: Interface Diagram

4.4 SYSTEM SCREENSHOTS

The following collection of photographs have been taken in order in to show the physical layout of the wheelchair:

Figure 7: Chassis top view

Figure 8: Chassis side view

Figure 9: Chassis with motors attached

CHAPTER 6
CONCLUSIONS AND FUTURE DIRECTIONS

6.1 Conclusion

As a conclusion of our work in this semester we designed the body(Chassis) of the Wheel-chair and also we built the model from scratch. We used hollow metal tubes to build the chassis and poly carbon material for holding the dc motors. Also we used the DC geared motors for motion of the chair. We have collected the items for the future use and also we have developed our design idea for the implementation of the different kinds of motion to control the movement of the wheel chair in real life. The challenges we faced include the friction in between the tubes and tyres, Structure integrity of the chassis etc. All in all we have worked to complete the hardware objectives of our project so that we can work on our software component in the next semester.

Appendix A
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