

Voice Controlled Smart Car



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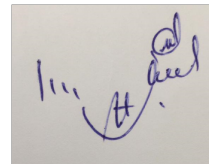
Handed over to the faculty of Department of Electrical Engineering, Military College of Signals, National University of Sciences and Technology, in partial fulfilment for the requirements of B.E Degree in Electrical Engineering

(June), 2021

CERTIFICATE OF CORRECTIONS & APPROVAL

It is verified that the work present in this paper designated “**Voice Controlled Smart Car**”, carried out by **Capt Fahad Masud, Capt Hassan Aslam, Capt Abdul Qadir and Capt Hassan Saif** under the supervision of **Asst Prof Dr Abdul Wakeel** for partial fulfilment of Degree of Bachelors of Electrical Engineering, in Military College of Signals, National University of Sciences and Technology, Islamabad in the course of academic year **2020-2021** is correct and approved. The data that has been utilised from other sources has been recognised.

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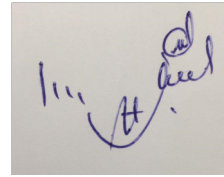
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Abstract

With the rise of artificial intelligence and autonomous devices more and more tasks are being replaced by robots and other automated technologies. These new technologies have made our life more comfortable and easy by replacing human muscles with electronic circuits embedded in robotic devices. Our project aim at creating a versatile vehicle capable of being operated with human voice for ease of operation and manoeuvrability. This smart voice controlled car will not only be controlled by human voice but it will be also used for obstacle avoidance and metal detection. Arduino and various other sensors have been embedded together to create this dynamic vehicle. This vehicle will make use of voice recognition technology to convert human voice into electronic pulses which will further be decoded by Arduino for controlling the motors that will drive the car. Ultrasonic sensor interfaced with Arduino will be used for detecting obstacle in the front. Servo motors will be used for moving the metal detector for better detection. This smart vehicle has diverse applications both in industry and home. Enhanced versions of this vehicle could be used by handicapped people for driving cars in the future. This is the technology of the future which will enable many handicapped people for moving from one place to the other.

Key Words: *Arduino, Ultrasonic sensor, Metal detection, Voice recognition technology*

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CHAPTER 1: INTRODUCTION

Speech is the primary means of communication between humans. The endeavour to perform mechanical realisation of human speech and to automate even small tasks governed by speech, has been a vast topic of research since the 20th century.

Automation through speech has always been an interesting and important area of research since the dawn of modern age. Therefore, automatic speech finds deep roots in the technological curiosity of the researchers, which resultantly made its way to significant advances in this field. Marked advancement in statistical modelling of the speech resulted in a widespread applications in telephone networks especially and other processes as well.

Speech based Human-Machine interfaces are now an attractive area of development. Efforts in speech recognition date back to 1950s and 1960s, when ideas of acoustic phonetics were looked into. Later on, the work made progress manifold with the shift from pattern recognition to statistical modelling of speech. Since then, most of the speech based applications work within statistical framework. Following the speech recognition, came the Automatic speaker recognition in the 1960s and 1970s, a decade later than the speech recognition. Since then, various text independent and text-dependent algorithms have been devised with varying in the sharpness of results. This is an area which is presently under rigorous research and finding optimised methods and techniques is still under-way.

This paper covers the results and explanations of the experimented text-dependent speaker , with an aim to cover pros of the used methods and techniques.

1.1. Scope and Motivation

The world makes a shift towards speech based automation since the last decade. Huge work has been carried out in this regard with a view to automate applications. This standing of speech recognition paved our interest towards automation of a ground surveillance vehicle. This came with the gap in the presence of speech based applications and absence of speech automated surveillance vehicle, which in fact is the need of today's world of warfare and the high demand of security concerns that have been changing dimensions, and this additions

fulfils the dimensional concern of such demands. Figure 1.1 depicts block diagram of our proposed voice control car.

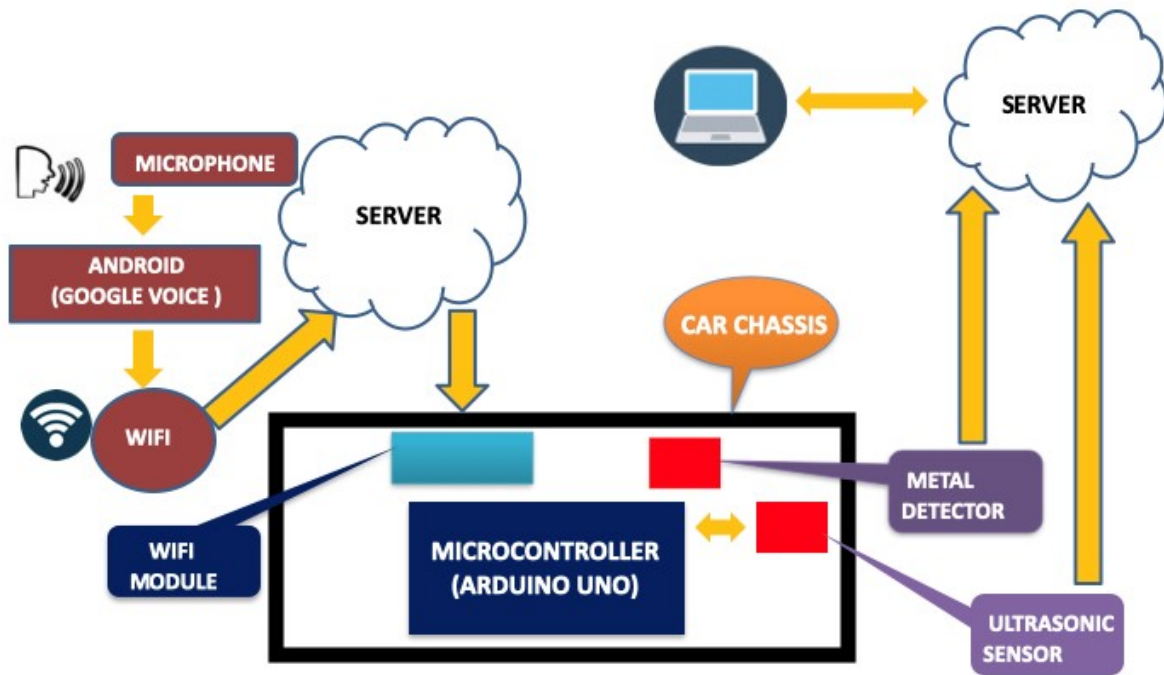


Figure 1.1: Basic block diagram

1.2. Project Outline

The report commences with giving the reader an overview of the speech based applications thus building the basis for the understanding of the project. Going further, the reader is made acquainted with the physics of sound and speech signal processing.

Different concepts and literature survey related to the project are elaborated in chapter 2. Chapter 3 covers the software approaches and hardware software integration used in the project. Application and usage of the project in industry and related fields is discussed in chapter 4

Finally chapter 5 concludes this thesis with conclusion and future cope.

CHAPTER 2: CONCEPTS AND LITERATURE SURVEY

Herein different concepts and technologies related to voice recognition and speech identification have been discussed in detail. It also includes analysis of different aspects of smart vehicle. A brief history of speech recognition and various speech recognition technologies have been discussed to further clarify the concept.

2.1. Background

Speech recognition systems have revolutionised our lives by creating ease and comfort. Apart from that, it has also enabled handicapped people to live life more easily and comfortably. In the past, these technologies were a distant dream, however with the rise of artificial intelligence and quantum computing more and more devices are now voice automated. The idea of combining the speech recognition technology with automobiles has led many people to explore this amazing technology. A smart vehicle which can be remotely controlled through human voice for ease of manoeuvrability and builtin sensors for better exploration has great potential in various phases of life. May it be the agriculture sector or the domain of science, it has diverse applications. A simple brilliant idea can lead to great inventions and innovations. All the great innovations in human history started with a simple idea. Big companies like Google are experimenting with new speech recognition technologies.

2.2. History of Speech Recognition

History of speech recognition dates back to many decades. Since the beginning of 20th century, innovators and thinkers have been trying to find different techniques and methods for converting human speech into electronic signals which will be identifiable by electronic machines or computers.

It was a new concept but it had its roots in many early automated machines and devices because innovation and inventions are just a matter of time and opportunity.

According to Moores Law, our technology and computational speed kept on increasing which created a revolution in electronic world. Since the invention of phonograph by Thomas

Edison various sound recording and speech recognition based machines have been created. The first major breakthrough came in 1950's when researchers at Bell Laboratories created Audrey, the first true speech recognition machine which had the capability to understand the digits 0-9 although a lot of time consuming it attracted the public attention. It was huge in size, required a lot of power to operate and expensive. Due to these shortcomings people resorted to legacy techniques for punching phone buttons. It was also housed in a 6 foot huge rack.

The next breakthrough came in 1960s when in 1962 World fair in Seattle an IBM engineer introduce the “ Shoe Box “ which was capable of understanding 10 digits and 6 words. Then in 1980's, IBM upgraded the original Shoe Box and created “ Tangora ” which was originally connected to a typewriter and can identify approximately 20,000 words. With the rise of personal computers in 1990s, more and more people had access to technology now at their home. The commercialisation of computers opened new doors of opportunity for investors and innovators. Dragon System's first speech recognition product “Dragon Dictate” was very expensive. In 1997, Naturally Speaking software was launched which was more popular. This software could understand human speech and could convert it into a digital document at the rate of 100 words per minute.

2.3. Voice Recognition Technologies (Personal Voice Assistant)

Due to recent increase in machine learning techniques, computers were able to train on huge data sets which led to better speech recognition. With the rise of quantum computing and acoustic technology coupled with neural networks, advance devices and softwares were made. A personal voice assistant is a software program which can perform certain actions by recognising and interpreting human voice. It uses different technologies for performing this task. Initially the voice assistants were not available commercially but gradually with time there was a need to incorporate them in smart phones and laptops for ease of use. Big companies like Microsoft Windows, Google , Apple, Amazon etc gradually launched their own versions of Smart voice assistants for speech recognition. Some of the most famous voice assistants are listed below with a brief explanation and history :

Google Voice Assistant

Google Voice Assistant is a personal assistant which is an artificial intelligence based technology developed by Google. It was basically revealed during Google's developer conference on May 18, 2016. It is now available on a diverse range of devices ranging from smart mobile phones, smart tv, smart home appliances, etc. Google started its journey of voice recognition assistants with "Google Now" technology. Gradually with the increase in innovation and application of new concepts better technologies were incorporated. Their next step Google assistant was even better than the earlier version. Unlike the old legacy technology the new Google Assistant also had the feature of two-way conversations. Like many voice assistants, Google Assistant can be used for many different tasks, some of it include opening settings of various devices, setting up alarms, taking notes, playing music or asking questions etc to mention just a few. Due to its widespread popularity and ease of use, it is currently being used in more than 90 countries and is available in over 30 languages. Voice Assistant uses the natural language processing algorithm. Approximately 500 million users use it monthly.

Amazon Alexa

Amazon Alexa is a personal virtual assistant developed by Amazon and was announced on November 2014. The name Alexa was inspired by the Library of Alexandria. Amazon initially used it in the Amazon Echo smart speaker, Amazon Dot, Amazon Studio and Amazon Tap speakers. It is used for a multitude of tasks like voice recognition system, playing music on various devices, taking notes, scheduling alarms, playing audiobooks, and providing news. Alexa also has the capability of acting as a home automation system for controlling various smart devices. Alexa was inspired by the computer voice used on board the fictional Starship *Enterprise* in Star Trek TV series.

Apples Siri

Siri, a personal virtual assistant, is a voice recognition software which Apple uses for iPhone, iPad, Apple Watch and Mac-book. Siri uses an amalgamation of various techniques like voice commands, gesture control, simple user interface for performing different tasks. It can be used for answering questions, making recommendations, and using internet for personalising requests. It has the amazing capability to learn and adapt itself by observing users language usages, searches, and preferences. Its complex and sophisticated algorithm dynamically learns. Nuance Communications, an American Multinational software company, provided its speech recognition engine. Speech recognition system uses a complex set of sophisticated techniques like convolutional neural networks, machine learning, and long short-term memory. All these technologies are part of deep learning where artificial neurons are created which are basically mathematical functions and convolution function is performed. Convolutional neural network is normally used for analysing images.

Since its initial release on October 4, 2011 it has gained widespread popularity and has been integrated into a lot of Apple products. Siri can perform a lot of different functions like searching the internet for information, playing music and podcasts, navigation, entertainment and sports to mention just a few. It can also be used for planning events and setting up alarms and reminders as it has a diverse range of commands and instructions.

Microsofts Cortana

Cortana is a personal virtual assistant which has been developed by Microsoft. It was demonstrated at the Microsoft BUILD Developer Conference in San Francisco in April, 2014. Launched specially as an important component of Microsoft's planned "makeover" of the future operating systems for Windows Phone and Windows. It is available in a variety of languages

which include English, French, German, Portuguese, Italian, Chinese, Japanese and Spanish. It basically makes use of Bing search engine for performing many tasks. Some of the tasks include answering queries and setting reminders.

The name Cortana originates from the Microsofts HALO video game inspired by an intelligent character. Other important tasks include answering questions using Bing search engine, reminders and speech recognition. It also provides music recognition and other entertainment features.

2.4. Voice Recognition in Smart Cars

The future of speech recognition technology lies in the automotive industry. With the rise of neural networks, deep learning and advancements in machine learning speech recognition technology has been incorporated in a variety of smart devices but its main application in the future will be in cars and autonomous vehicles. As we move into the unknown future science is trying to make our lives more comfortable and easy.

The main aim of speech recognition technology in cars was to avoid distractions while on the move. It can also be beneficial for handicapped people who cannot drive. This groundbreaking technology is presently at its early stages but in the future better and more advanced versions will be released. Our project also incorporates a voice recognition in a smart vehicle for ease of manoeuvrability. Companies like Google and Apple have already started revolutionising the in car speech recognition technology.

Personal voice assistants provide a platform for manufacturers to improve user experience for better product sales.

Voice assistants offered by companies like Amazon, Google, IBM, Nuance and many others are trying to improve their in car voice recognition systems.

CHAPTER 3: DESIGN AND WORKING

3.1. Basic Working of Project

The aim of our project is to build a voice controlled smart car with obstacle detection and metal detection. The car would be operated through two methods (voice and remote control). Firstly it will be controlled through voice commands. The commands would be given to the wifi module through Google Voice Assistant. Arduino Uno is being used as the microcontroller in the car. It receives command message after the instruction is given using Android application.

The contemporary world is inundated with manually controlled vehicles. Every action may it be the start and stop, applying brake, gear transmission, acceleration would require an arduous human effort. But the situation is changing drastically with the automatic vehicles and Tesla autopilot. Keeping in view the modern trends, our aim is to build a car which can be controlled by voice. As already explained the vehicle would be controlled wirelessly.

Apart from being controlled by voice commands through an android phone it will also be controlled wirelessly by direction keys on the application as an additional feature. It will also contain built in sensors. Ultrasonic sensor has also been added which will help in detecting obstacles in front of car. A metal detector circuit placed in the front will also detect metals. All these components will be housed in a car chassis. To incorporate the concept of Internet of Things (IoT) wifi module will be linked with the servers. The vehicle will be operated using local wifi but its range could be greatly enhanced if we install a 4G device.

An android phone will be utilised for giving commands to the car for moving and stoping. MIT app inventor has been used for creating an application that will not only control the vehicle but will also show all the updates and sensor data. Vehicle can be use for variety of reasons in hard to reach places.

3.2. Hardware Components

All the important components used are shown in the table below :-

S/No	Name	Descrip/on	Quan/ty
1	Arduino Uno	The brain of the project used for coordinating all the activities	1
2	Ultrasonic Sensor (SR-04)	Used for detecting obstacles	1
3	Servo Motor (SG-90)	Used for moving sensors	1
4	Metal Detector Circuit	For detecting metals in the front of car	1
5	Motor Driver Module (L298N)	Used for driving the car chassis	2
6	Node MCU ESP8266	Wifi module which will be linked with the servers	1
7	Car Chassis	Houses all the components together	1

Table 3.1: Hardware Components

Arduino Uno

It is basically a microcontroller with a set of digital and analog I/O (input / output) pins for connecting a variety of expansion circuits and sensors. It is composed of 6 analog and 14 digital pins. It can be programmed through Arduino IDE (integrated development Environment). Its operating voltage is 5 volts and input voltage is 7 to 20 volts. Clock speed is 16 MHz with a flash memory of 32 KB.



Fig 3.1 Arduino Uno

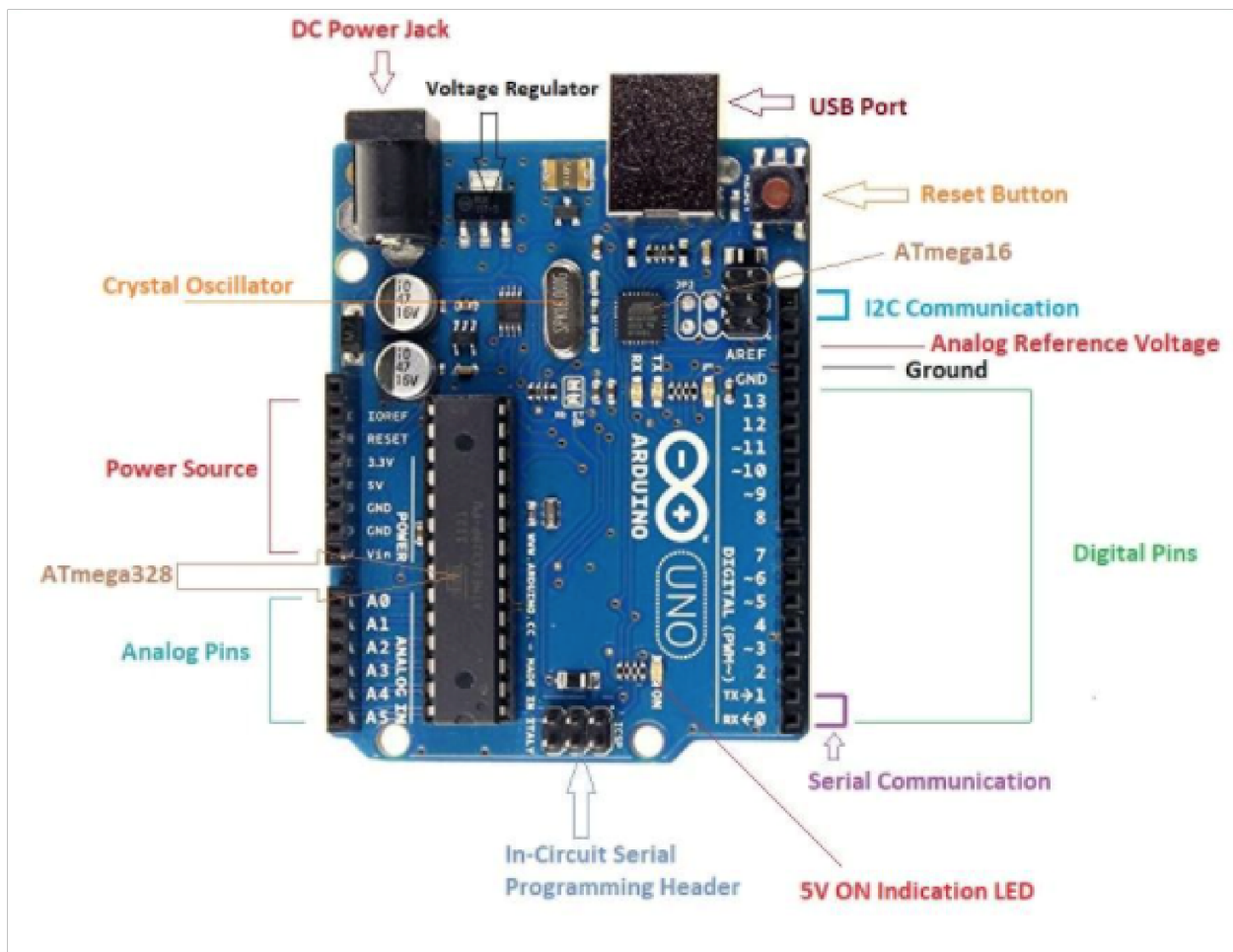


Fig 3.2 Arduino Uno Circuit Diagram

Operating Voltage	5 V
Input voltage	7-12 V
Analog Pins	6
Digital Pins	14
Flash Memory	32 KB
SRAM	2 KB
EEPROM	1 KB
Frequency	16 Mhz

Table 3.2: Arduino Specifications

Ultrasonic Sensor (SR-04)

It basically works on the principle that when a transmitted ultrasonic wave gets reflected back by an object in its path it receives that transmitted wave, calculates its distance by using the formula $\text{distance} = \text{speed} \times \text{time}$. It has two components which are basically a transmitter and a receiver. Its working voltage is 5 volt DC.

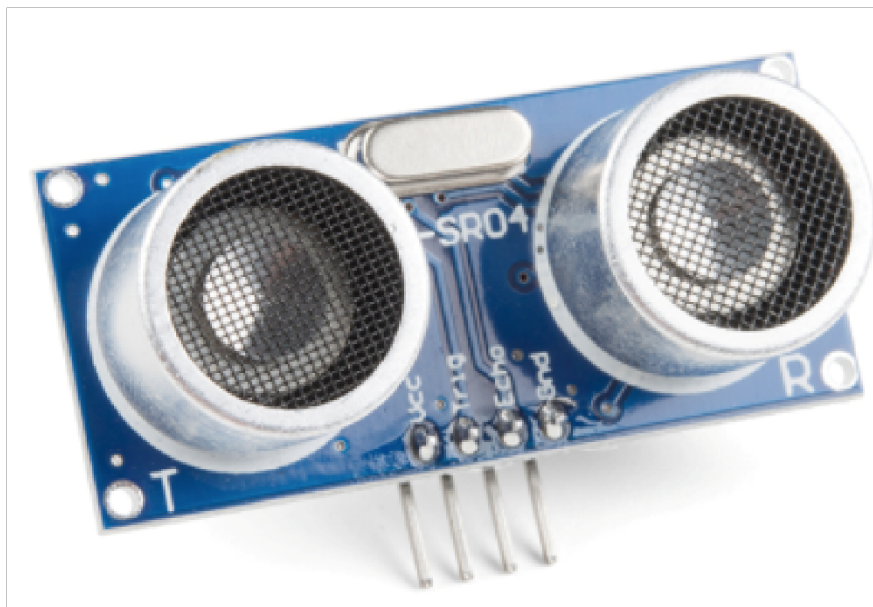


Fig 3.3 Ultrasonic Sensor (SR-04)

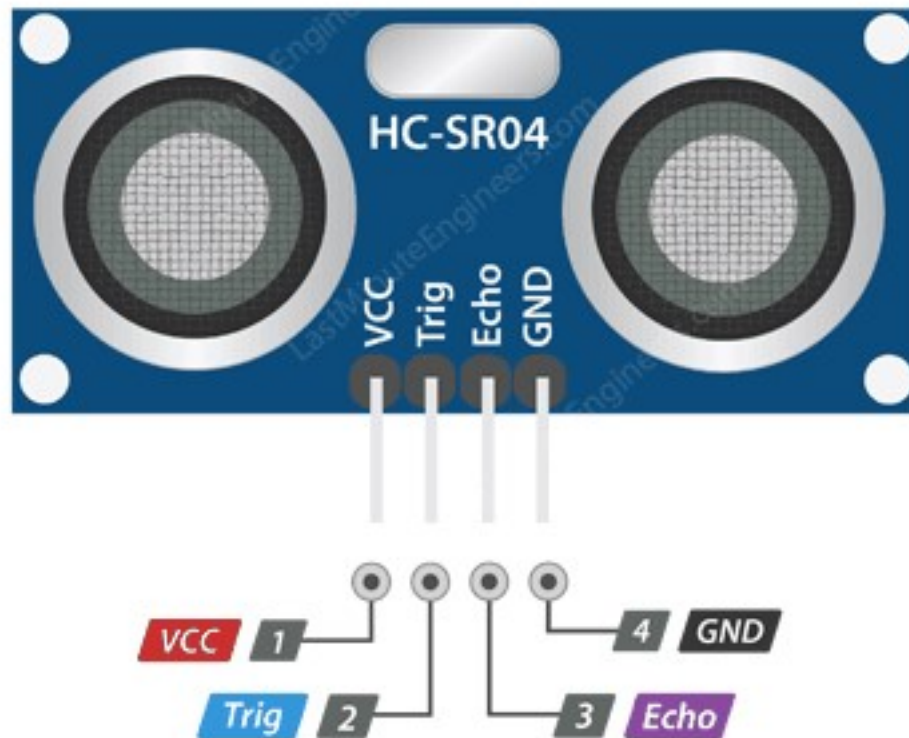


Fig 3.4 SR-04 Circuit Diagram

Operating voltage	DC 5V
Operating current	15 mA
Operating frequency	40 KHz
Maximum range	4 m
Minimum range	2 cm

Table 3.3: Ultrasonic Sensor (SR-04) Specifications

Servo Motor (SG-90)

Servo Motors are used for moving different objects as they can move 180 degrees. They are powerful small motors suitable for projects. It has a lot of applications in robotics.



Fig 3.5 Servo Motor SG-90

WIRE COLOUR	DETAILS
ORANGE	PWM SIGNAL FOR DRIVING THE MOTOR
RED	5V FOR POWERING THE MOTOR
BROWN	GROUND WIRE

Table 3.4: Servo Motor Wire Configuration

Motor Driver Module (L298N)

It is a high powered driver module used for controlling motors. A dual-channel H-Bridge motor driver it is very much capable of driving two DC motors and one stepper motor. It has diverse applications in robotics, drill machine etc.

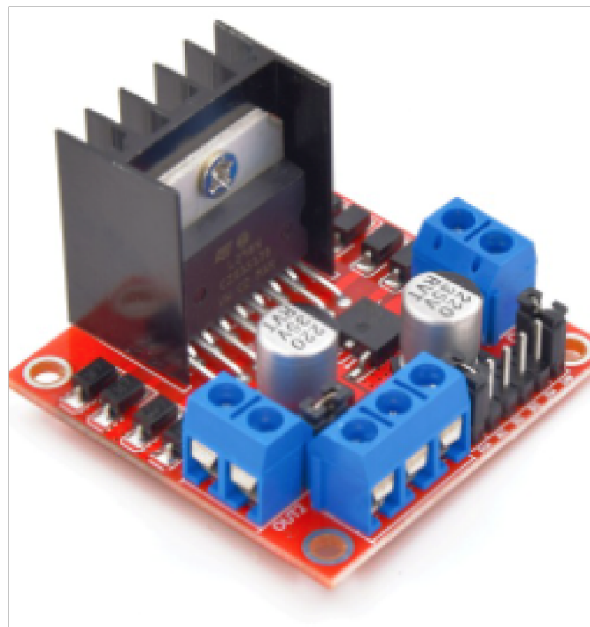


Fig 3.6 Motor Driver L298N

Logical voltage	5 V
Logical current	0-36 mA
Maximum power	25 W
Supply voltage	46 V
Supply current	2 A

Table 3.5: Motor Driver L298N

Node MCU ESP8266

It is basically used as an IoT platform. It is a wifi module for connecting the car to the servers. An open-source firmware for which many configurations are available in the industry . “NodeMCU” is composed of “node” and “MCU” (micro-controller unit). ESP8266 is being used in more than 50% IoT based projects today. It is a great choice for IoT based projects. The scripting language is Lua.

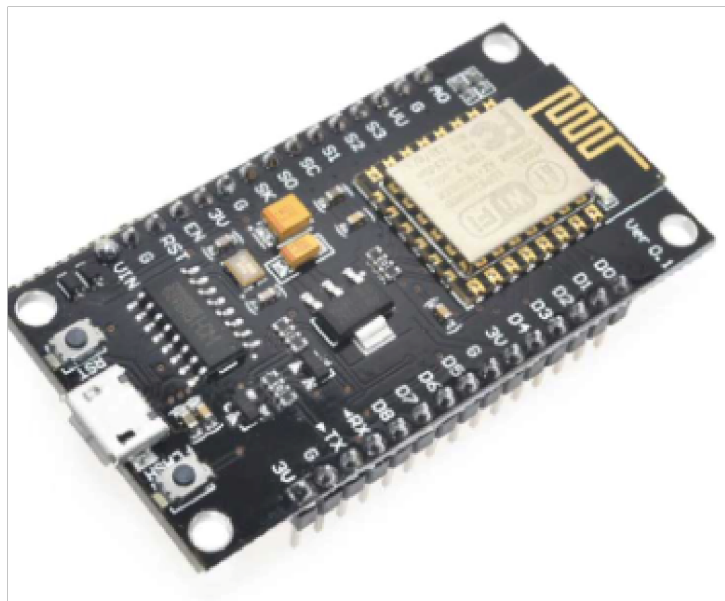


Fig 3.7 ESP 8266

Operating voltage	3.3 V
Input voltage	7-12 V
Analog pins	1
Digital pins	16
Flash memory	4 MB
Clock speed	80 Mhz
SRAM	645 KB

Table 3.6: Node ESP 8266 MCU

3.3. Software Requirements

The basic PCB design has been done using Proteus software. Blynk server has been used for interfacing with google voice assistant for giving commands to the vehicle. Blynk is a famous IoT (Internet of Things) based platform for connecting with different sensors, modules and microcontrollers like Arduino for creating great projects. It is composed of Blynk application, server and libraries. Blynk acts as a platform for connection between a smartphone and a hardware (like Arduino, ESP 8266). Blynk can be utilized for variety of different important tasks like saving information and showing data from different sensors. Blynk server acts as a gateway between smartphone and the Microcontroller. Firebase server has been used for connecting with an application which has been made through MIT app inventor. MIT app inventor is a visual application building platform. It can be used for both Android and IOS. All the sensor readings will be sent to Firebase server through wifi module and finally to the application. Arduino Uno has been programmed using IDE Arduino.



3.4. Hardware Software Integration (Arduino Interfacing)

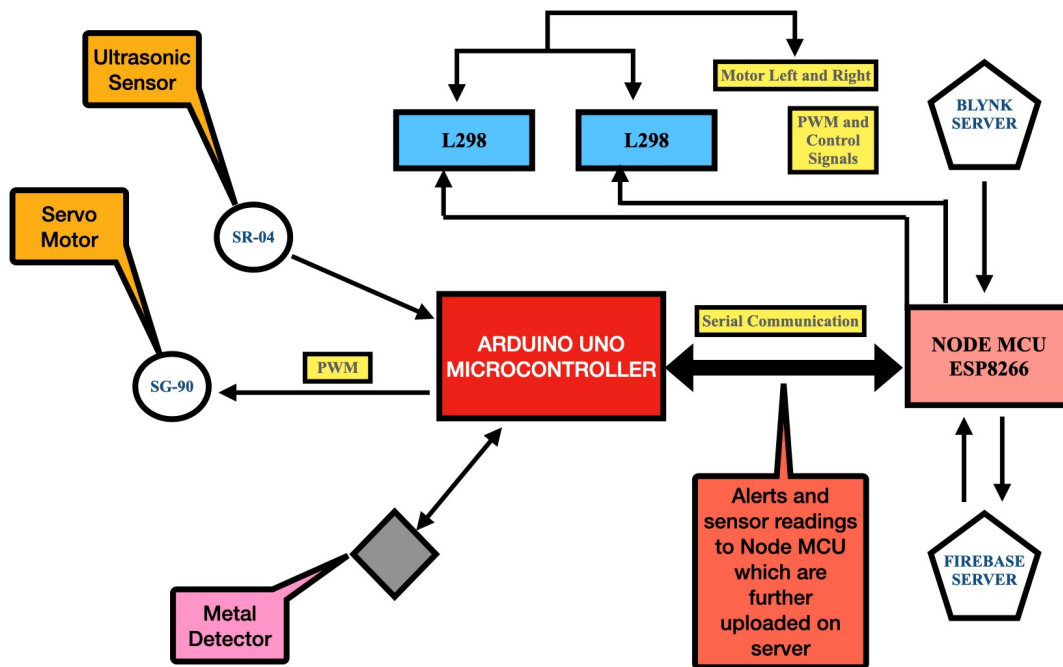


Figure 3.8: Hardware software fusion

As shown in the diagram above the smart vehicle will be centrally controlled using an Arduino Uno which will act as the brain of the project. All the electronic components have been installed on a car chassis which is running using 2 x L298 motor drivers for controlling the both sides of the vehicle. A metal detector has been installed on the front of the vehicle which will detect any metal in the front and send its update on the android application. An ultrasonic sensor (SR-04) has also been installed for detecting obstacles in the front of the vehicle and sending its update to the application. Motor drivers will be controlled by ESP8266. Pulse width modulation signals are used because we want to control an analog device (motor) using a digital microcontroller. There will also be a servo motor (SG-90) for controlling the ultrasonic sensor (front left right). Arduino Uno will be connected serially with Node MCU ESP8266. ESP8266 will be further connected with Firebase and Blynk server. When a voice command like forward , stop, left is given using an android application by utilising the microphone (google assistant) the commands are further sent to the blynk server. Blynk server is interfaced with the wifi module. The command then travels from ESP 8266 to the Arduino uno which instructs the motor driver to move the vehicle. All the sensor readings like metal detection and obstacle detection are sent to the firebase server from there they are shown on the mobile application. Vehicle will also be controlled using buttons on the applications and commands will travel from firebase to the car.

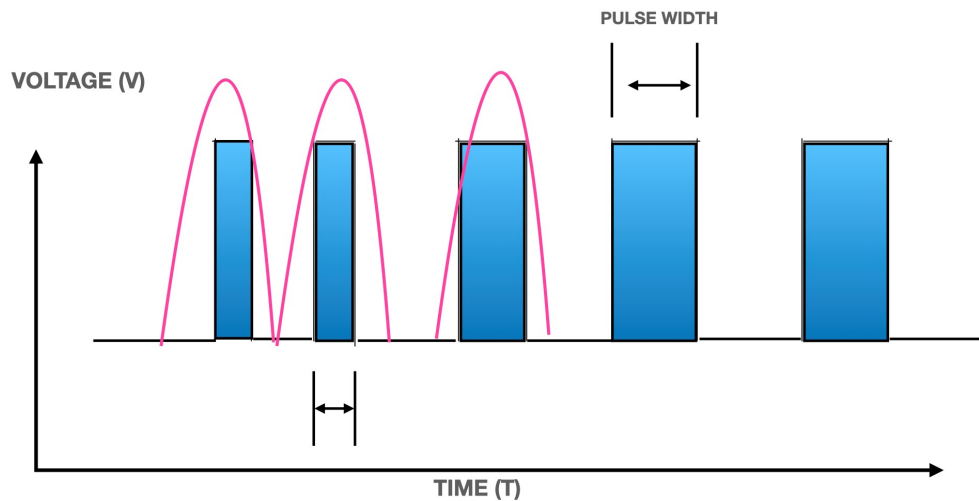


Figure 3.9: Pulse Width Modulation

CHAPTER 4: APPLICATIONS

4.1. Applications

There are diverse applications of voice controlled smart car various fields. Some of those are as follows:

1. The voice controlled smart car can be developed into a real world vehicle. It can be used to locate, transfer and place different objects.
2. The smart car could be very efficacious for disabled and handicapped people. It can be installed with the wheelchairs. Individuals can navigate their way by simply giving the requisite commands to the system. They can carry out any house hold task from their chair by simply instructing the smart car using the basic commands.
3. The system can be utilised in a number of ways for home automation. Appliances can be controlled by using the speech recognition system even from a far off distance. A person would give the command using his cell and the system would perform the requisite action after interpreting the instruction. For example, the speaker could place the book at the shelf using the smart car as a transportation medium by following the simple procedure.
4. With the webcam mounted on the voice control smart car for observation and surveillance, it could come in handy for archaeologists in a country like Pakistan which is inundated with ancient sites. Archaeologists still haven't been able to decipher the language spoken by the inhabitants of Indus Valley civilisation which formed part of the territory of modern day Pakistan.

5. It can also assist in different chemical labs in handling dangerous chemicals without endangering the human lives.
6. Apart from this it can be employed in hospitals and medical facilities for transporting medicines from one location to another which will save time and reduce the amount of people working round the clock.
7. It can be deployed on a transportation role within a factory to move items from one place to another by using the simple commands.
8. As Pakistan is an agricultural country where most of the land is fertile. Improved versions of these type of vehicles could be employed for checking the quality of soil by giving voice commands.

CHAPTER 5: CONCLUSION AND FUTURE SCOPE

5.1. Conclusion

With the revolution in Artificial intelligence and Quantum computing and rise of machine learning automated robots and voice controlled smart vehicles have taken over the scientific community. 21st century is full of examples in which voice recognition systems have changed the dynamics of day to day life. Voice automated vehicles are the tools of the future. By utilising the power of smart algorithms and faster processing speed these smart vehicles will be more advanced in the future. As of today NASA has already been employing a lot of rovers on Mars for studying its atmosphere and conducting research on its surface. In the future their versions will be more advanced with better speed and technology. In Pakistan a lot of importance should be given to automation and speech recognition technologies as it will pay rich dividends in times to come. As more and more things are becoming wireless people are getting accustomed to these types of technologies. As already discussed our project has great applications in various fields like exploration, agriculture, industry etc. Improved versions of this car will be used for transportation purposes. Like the autopilot in an aeroplane the cars of the future will be fully automatic with built in voice control system. We have come a long way starting from the earliest technologies of speech recognition to the more sophisticated versions available today in the market. To excel in the field of technology and innovation and compete with the leading countries we have to invest more time and resources on Artificial Intelligence (AI) and Quantum computing. Automation is the technology of the future. As we move towards a more automated and wireless society we need to introduce and inculcate this technology in the universities and educational institutions for better learning.

5.2. Future Scope

It's evident from the myriad of applications discussed in the preceding paragraph that there's an immense scope of voice controlled smart car especially in a country like Pakistan, where it could be utilized in various sectors, such as medical, agriculture and industry e.t.c .It can also be used by archaeologists for their excavations by improving the metal detector and camera of the smart car. It can pay huge dividends since archaeology is a field that ought to be explored because of the rich heritage of Pakistan. The smart car would encourage the students to further improvise it by trying to make a robot. The various tools of Artificial Intelligence could be incorporated. After all, AI is the future. It's deployment is likely to add \$15.7 trillion to global GDP by 2030. The Chinese are expected to earn \$7 trillion out of that. Pakistan with her close ties with China should create opportunities for students and entrepreneurs to learn from the Chinese model of using Artificial intelligence in every field. Due to advancements in technology, advanced versions of these type of systems could be incorporated in different autonomous devices for exploration. As we advance further into the unknown future, we are sure about one thing and that is the gigantic impact these voice controlled smart vehicles will have in our lives. In the near future, most of the cars driven on the road will be voice automated with built in obstacle detection. A dawn of a new age is coming, which will bring more revolution in our lives. These technologies will give rise to new fields of scientific exploration.

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