BACHELOR OF SCIENCE (INFORMATION TECHNOLOGY)

By

Yogesh Mohanlal Kumavat

Seat No: ________

Under the esteemed guidance of

Mrs.Calvina Suhas Maharao

Professor

DEPARTMENT OF INFORMATION TECHNOLOGY

ST. GONSALO GARCIA COLLEGE

(Affiliated to University of Mumbai)

VASAI, 401202

MAHARASHTRA

2021-2022

ST. GONSALO GARCIA COLLEGE

(Affiliated to University of Mumbai)

VASAI-MAHARASHTRA-401202

DEPARTMENT OF INFORMATION TECHNOLOGY

CERTIFICATE

This is to certify that the project entitled, **"Ultrasonic Radar System"**, is bonafied work of **Yogesh Kumavat bearing** Seat. No:____________submitted in fulfillment of the requirements for the award of degree of BACHELOR OF SCIENCE in INFORMATION TECHNOLOGY from University of Mumbai.

Internal Guide **Coordinator**

External Examiner

Date: **College Seal**

ABSTRACT

RADAR is an object-detection system which uses radio waves to determine the range, altitude, direction, or speed of objects. Radar systems come in a variety of sizes and have different performance specifications. Some radar systems are used for air-traffic control at airports, and others are used for long range surveillance and early-warning systems. A radar system is the heart of a missile guidance system. Small portable radar systems that can be maintained and operated by one person are available, as well as systems that occupy several large rooms.

The use of such technology has been seen recently in the self-parking car systems launched by Audi, Ford, etc., and even the upcoming driverless cars by Google, like Prius and Lexus. The hardware used is Arduino uno board, ATMega 328k microcontroller, HC-04 ultrasonic sensor, sg90 servo motor and breakout board. The purpose of ultrasonic radar is that the system can monitor an area of limited range and alerts authorities. For this purpose we use a microcontroller circuit that is connected to an ultrasonic sensor mounted on a servo motor for monitoring. The radar keeps monitoring the environment checking the ultrasonic sensor echo. As soon as an object is detected the data of detection is processed of where exactly the object was detected. Thus ultrasonic radar proves to be a very useful system for 24×7 monitoring of a particular area/region.

ACKNOWLEDGEMENT

I have taken efforts in this project. However, it would not have been possible without the kind support and help of many individuals and organization. I would like to express my special thanks of gratitude to **Prof. Calvina Maharao** under whom we executed this project. Her constant guidance and willingness to share her knowledge made me understand this project and helped me to complete the assigned task.

I would also like to thank Head of Department **Prof. Sangita Dubey** and our principal **Dr. Somnath Vibhute** who gave me a golden opportunity to do this wonderful project on the topic “Smart Attendance System”, which also helped me in doing a lot of Research and I came to know about so many new things. Finally yet importantly, I would like to express my heartfelt thanks to my beloved parents for their blessings, my friends and classmates for their support and wishes for the successful completion of the project.

DECLARATION

I here by declare that the project entitled, **"Ultrasonic Radar System"**, done at **St. Gonsalo Garcia College**, has not been in case duplicated to submit to any other university for the award of any degree. To the best knowledge other than me, no one has submitted to any other university.

The project is done in fulfillment of the award of degree of **BACHELOR OF SCIENCE (INFORMATION TECHNOLOGY)** to be submitted as final semester project as part of our curriculum.

Yogesh Mohanlal Kumavat

INDEX

List of Tables

List of Figures

SYNOPSIS

NAME: YOGESH KUMAVAT **ROLL. NO:** 24

CLASS: TY Bsc.IT **SEMESTER:** 5

PROJECT TYPE: IOT BASED RADAR SYSTEM

INTRODUCTION:

IOT based Radar System project is made using Arduino Uno board and a ultra sonic sonar along with a servo motor.

This advanced Arduino radar system can be used in many fields like air traffic control, remote sensing, spacecrafts, satellites, radio telescopes, etc. This system can be used to monitor a specific area and scan suspicious objects. These radar systems are used for saving lives of innocent people.

This system can continuously scan an area and gives output if an object is detected in its range. This system also provides the angle and the distance of object detected so that the danger can be predicted and the necessary measures can be taken to counter it. It helps in finding the speed and tracing the exact location of the object from the radar.

The radar technology is one of the most used in the defense field. This technology has some emerging new things like the quantum radar technology.

The radar system is a system in which the signals are continuously emitted from the devices and as the objects comes in contact with it and gets reflected and the output is received depending on this signal.

Front end:

As it is an IOT based project, the front end will be the Arduino codes to command Arduino board what operations are to be performed.

Back end:

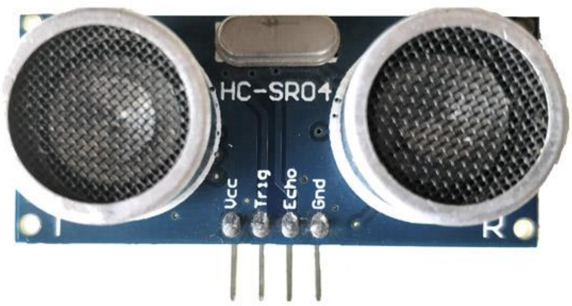
The back end will be the programming in the processing 3 software for the output of the radar system .In this, the output is displayed on the screen of pc/laptop.

Hardware:

1. Nodemcu Esp8266

NodeMCU is an open-source Lua based firmware and **development board** specially targeted for IOT based Applications. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espress If Systems, and hardware which is based on the ESP-12 module.

2. Ultrasonic sensor



As shown above the **HC-SR04 Ultrasonic (US) sensor** is a 4 pin module, whose pin names are Vcc, Trigger, Echo and Ground respectively. This sensor is a very popular sensor used in many applications where measuring distance or sensing objects are required. The module has two eyes like projects in the front which forms the Ultrasonic transmitter and Receiver. The sensor works with the simple high school formula that **Distance = Speed × Time.**

3. Servo motor

A servomotor (or servo motor) is **a simple electric motor**, controlled with the help of servo mechanism. A servomotor is a linear actuator or rotary actuator that allows for precise control of linear or angular position, acceleration, and velocity. It consists of a motor coupled to a sensor for position feedback.

4. Breadboard

5. Jumper wires

6. Laptop/Pc

Software:

1. Arduino software
2. Processing software

Reason for selecting the project:

The reason for creating the project is to create the small representation of the radar systems And understand the working of it as it is used in the world on a large scale in many fields like Defenses, etc.

Scope:

The radar system has a good future. As it is the base of the defense system, air traffic, etc. Many new technologies are inventing in this field.

Chapter 1: Introduction

Background:

"Ultrasonic Radar System" is a detection system that uses radio waves to determine the range, angle, or velocity of objects. It can be used to detect aircraft, ships, spacecraft, guided missiles, motor vehicles, weather formations, and terrain. An "Ultrasonic Radar System" system consistsof a transmitter producing electromagnetic waves in the radio or microwaves domain, a transmitting antenna, a receiving antenna (often the same antenna is used for transmitting and receiving) and a receiver and processor to determine properties of the object(s). Radio waves (pulsed or continuous) from the transmitter reflect off the object and return to the receiver, giving information about the object's location and speed. "Ultrasonic Radar Detector" was developed secretly for military use by several nations in the period before and during World War II. A key development was the cavity magnetron in the UK, which allowed the creation of relatively small systems with sub-meter resolution. The term "RADAR" was coined in 1940 by the United States Navy as an acronym for Radio Detection and Ranging. The term "Ultrasonic Radar System" has since entered English and other languages as a common noun, losing all capitalization.

The modern uses of "Ultrasonic Radar System" are highly diverse, including air and terrestrial traffic control, "Ultrasonic Radar System" astronomy, air-defense systems, antimissile systems, marine "Ultrasonic Radar System" s to locate landmarks and other ships, aircraft anti-collision systems, ocean surveillance systems, outer space surveillance and rendezvous systems, meteorological precipitation monitoring, altimetry and flight control systems, guided missile target locating systems, and ground-penetrating "Ultrasonic Radar System" for geological observations. High tech "Ultrasonic Radar System" systems are associated with digital signal processing, machine learning and are capable of extracting useful information from very high noise levels. "Ultrasonic Radar System" is a key technology that the self-driving systems are mainly designed to use, along with sonar and other sensors. Other systems similar to "Ultrasonic Radar System" make use of other parts of the electromagnetic spectrum. One example is LIDAR, which uses predominantly infrared light from lasers rather than radio waves. With the emergence of driverless vehicles, "Ultrasonic Radar System" is expected to assist the automated platform to monitor its environment, thus preventing unwanted incidents.

Front End and Back End Support:

- Processing version 3.5.3 – Processing as front end support. Processing is a flexible software sketchbook and a language for learning how to code within the context of the visual arts.. There are tens of thousands of students, artists, designers, researchers, and hobbyists who use Processing for learning and prototyping. C language will be used for the coding.
- Arduino version 1.8.9 – Arduino IDE is the back end support. Arduino is an open-source electronics platform based on easy-to-use hardware and software project and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control both physically and digitally. Even though the title says Arduino “Ultrasonic Radar System” Project, technically the project is based on Sonar technology as I will be using an Ultrasonic Sensor to determine the presence of any object in a particular range. The Arduino “Ultrasonic Radar System” Project is more of a visual project than it is a circuit implementation. Of course, I will be using different hardware like Arduino UNO, HC-SR04 Ultrasonic Sensor and a Servo Motor but the main aspect is the visual representation in the Processing Application. Based on the information received, a sketch in Processing will change the orientation of the model aircraft. It will collect the information from the Ultrasonic Sensor with the help of Arduino and pass it to Processing where a simple Graphics application is implemented to mimic a “Ultrasonic Radar System” Screen.
- Thingspeak – Thingspeak as Front end support. According to its developers, "ThingSpeak is an open-source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP and MQTT protocol over the Internet or via a Local Area Network. ThingSpeak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates". ThingSpeak was originally launched by ioBridge in 2010 as a service in support of IoT applications. ThingSpeak has integrated support from the numerical computing software MATLAB from MathWorks, allowing ThingSpeak users to analyze and visualize uploaded data using Matlab without requiring the purchase of a Matlab license from Mathworks.ThingSpeak has a close relationship with Mathworks, Inc. In fact, all of the ThingSpeak documentation is incorporated into the Mathworks'

Matlab documentation site and even enabling registered Mathworks user accounts as valid login credentials on the ThingSpeak website.

Hardware Components used are:

- Ultra Sonic HC-SR04 - The HC-SR04 Ultrasonic (US) sensor is a 4 pin module, whose pin names are Vcc, Trigger, Echo and Ground respectively. This sensor is a very popular sensor used in many applications where measuring distance or sensing objects are required. The module has two eyes like projects in the front which forms the Ultrasonic transmitter and Receiver. The sensor works with the simple high school formula that Distance = Speed × Time
- SG90 Servo board - SERVO MOTOR SG90Tiny and lightweight with high output power. Servo can rotate approximately 180 degrees (90 in each direction), and works just like the standard kinds but smaller. You can use any servo code, hardware or library to control these servos.
- NodeMCU8266 - NodeMCU is an open source LUA based firmware developed for ESP8266 wifi chip. By exploring functionality with ESP8266 chip, NodeMCU firmware comes with ESP8266 Development board/kit i.e. NodeMCU Development board. Since NodeMCU is open source platform, their hardware design is open for edit/modify/build. NodeMCU Dev Kit/board consist of ESP8266 wifi enabled chip. The ESP8266 is a low-cost Wi-Fi chip developed by Espressif Systems with TCP/IP protocol. For more information about ESP8266, you can refer ESP8266 WiFi Module.There is Version2 (V2) available for NodeMCU Dev Kit i.e. NodeMCU Development Board v1.0 (Version2), which usually comes in black colored PCB. For more information about NodeMCU Boards available in market refer NodeMCU Development Boards NodeMCU Dev Kit has Arduino like Analog (i.e. A0) and Digital (D0-D8) pins on its board. It supports serial communication protocols i.e. UART, SPI, I2C etc. Using such serial protocols we can connect it with serial devices like I2C enabled LCD display, Magnetometer HMC5883, MPU-6050 Gyro meter + Accelerometer, RTC chips, GPS modules, touch screen displays, SD cards etc.
- Connecting wires - Connecting wires provide a medium to an electrical current so that they can travel from one point on a circuit to another. In the case of computers, wires are embedded into circuit boards to carry pulses of electricity. Most wires in computers and electronic components are made of copper or aluminum, because copper is cheap and electrically conductive.In a basic circuit, the wire comes from one terminal of a

power source, then connects to a switch that determines whether the circuit is open or closed.

- Breadboard - A breadboard is a rectangular plastic board with a bunch of tiny holes in it. These holes let you easily insert electronic components to prototype (meaning to build and test an early version of) an electronic circuit, like this one with a battery, switch, resistor, and an LED (light-emitting diode).

Objective:

To increase the sensitivity, specificity and versatility of biosensors using nanostructured surfaces and genetically engineered recombinant bio-receptors derived from aquatic organisms.To provide a robust, label-free, remotely-controlled, and portable biosensor platform for cost-effective spot measurements and on-line monitoring with integrated fully automated sample preparation for non-experts.To validate the RADAR biosensor and demonstrate its application for cost-effective spot measurements and on-line monitoring of toxins and pollutants in food processes and in the aquatic environment.

Purpose, Scope And Applicability:

Purpose:

The main purpose of “Ultrasonic Radar System”is that it alarms us from intruder and it is real time system. “Ultrasonic Radar System” is still most familiar as a military technology. “Ultrasonic Radar System” antennas mounted at airports or other ground stations can be used to detect approaching enemy airplanes or missiles, for example. The United States has a very elaborate Ballistic Missile Early Warning System (BMEWS) to detect incoming missiles, with three major “Ultrasonic Radar System” detector stations in Clear in Alaska, Thule in Greenland, and Fylingdales Moor in England. It's not just the military who use “Ultrasonic Radar System”, however. Most civilian airplanes and larger boats and ships now have “Ultrasonic Radar System” too as a general aid to navigation. Every major airport has a huge “Ultrasonic Radar System” scanning dish to help air traffic controllers guide planes in and out, whatever the weather.

Scope:

The first radar was patented 110 years ago. Fast forward to today, radar applications have become ubiquitous in typical applications i.e. speed control, air traffic control, airborne and space-borne missions, military applications and remote sensing. Research for medical radar applications is also progressing well for breast cancer detection and tumor localization. One of the major trends in radar is the continuous increase of operational radar frequency ranges towards applications for broadband Multifunctional RF-Systems. One of the advantages of broadband and wide frequency range applications in radar is that effective jamming and interference with radar signals becomes more difficult, when the available operating frequency range increases, since jammed frequency bands can easier be avoided and more RF power of the jamming signal is needed to cover the larger bandwidth with equal RF power density, thus making jamming of broadband radar systems significantly more difficult. Furthermore, the increasingly complex operational scenarios demand for more detailed ultra-high resolution (UHR) Synthetic Aperture Radar (SAR) images of fixed targets for classification support in all-weather, day and night applications to be acquired from large stand-off ranges

Applicability:

- Marine radars are used to measure the bearing and distance of ships to prevent collision with other ships, to navigate, and to fix their position at sea when within range of shore or other fixed references such as islands, buoys, and lightships. In port or in harbour, vessel traffic service radar systems are used to monitor and regulate ship movements in busy waters.
- RADARs are used for safety controlling of the air traffi c. It is used in the vicinity of airports for guiding airplanes for proper landing in adverse weather conditions. Usually, high resolution RADARis employed for this purpose. RADARs are used with ground control approach (GCA) system for safe aircraft landing.
- RADARs are used for docking and safely landing of spacecrafts. Satellite borne RADARs are also used for remote sensing. Ground based RADARs are used to track and detect the satellites and spacecraft.
- The weather avoidance RADARs and ground mapping RADARs are employed in aircrafts to navigate it properly in all the conditions. Radio altimeter and Doppler navigator are also a form of RADAR. These RADARs provide safety to aircraft from potential collision with other aircraft and objects.

Achivements:

- It is not affected by color or transparency. Basically, the Ultrasonic Sensors transmit the sound off of the object, hence the color and transparency have no effect on the radar reading.
- Any dark environments have no effect on this Arduino radar sensor's detection procedure. So, it can also use at night.
- Easy to design and low price. The ultrasonic sensors are available at the market with very cheap price.
- It has high frequency, high sensitivity, therefore, it can easily detect the external or deep objects.
- This radar sensor is not affected by dust, rain, snow, and many more.
- The Arduino Radar Sensor is easy to use. Also, it is completely safe during the operation to nearby objects, human or equipment.
- The Ultrasonic sensor can easily interface with any types of the microcontroller.

Organization of report:

Radar is normally used to determine velocity, range, and position of an object. In this technical project, we read the distance and angles of detected objects in order to convert these data into visual information. The performance of our project is so good. It works smoothly to detect objects within the designed range. The screen shows the information clearly with enough delay for the user to read it. This project could be helpful for object avoidance/ detection applications. This project could easily be extended and could be used in any systems may need it. It has been made known that there is a variety of applications for RADAR products. Additionally, ongoing research and development is constantly increasing the existing range of applications. One of the most important characteristics of RADARs is their capability to penetrate cloud cover and to obtain data either by day or by night. It is this all-weather capability that has contributed extensively to the various commercial applications of RADAR.

Chapter 2 : System Analysis

2.1 Existing System

Doppler Radar System

A Doppler radar is a special form of radar that employs the use of Doppler Effect to produce velocity data about an object at a given distance. This is achieved by sending electromagnetic signals towards a target and then analyzing how the object motion has affected the frequency of the returned signal. This variation has the capacity to give extremely accurate measurements of the radial component of a target's velocity in relation to the radar. The specific term Doppler Radar System has erroneously become popularly synonymous with the type of radar used in meteorology. Most modern weather radars use the pulse-Doppler technique to examine the motion of precipitation, but it is only a part of the processing of their data. So, while these radars use a highly specialized form of Doppler radar, the term is much broader in its meaning and its applications. One of the premiere technologies which is associated with how faratmospheric science over the past which is based upon the fundamental principle known as theDoppler Effect.

Figure 2.1 10cm Doppler Weather Radar operated by NOAA, c. 1971

Initially, the NSSL acquired a 3 cm Doppler research radar, which, for the first time, was able to measure object motion within a thunderstorm. Using the Doppler Effect, the radar would detect a change in frequency that occurred when its signal was reflected from a moving target, such as a cluster of raindrops — similar to the shift in frequency experienced with a passing sound. However, it was quickly found that 3 cm Wavelength radars were not sufficient for large-scale detection of severe weather. In 1969, the U.S. Air Force donated a surplus Bendix AN/FPS-18 Radar to the NSSL. This radar, equipped with Doppler capabilities, aided in the discovery of a radar phenomena known as a Tornado Vortex Signature, a small-scale Doppler velocity circulation pattern noted before or during tornadic development. After this was built, a second 10 cm Doppler Radar was built in Cimarron County, Oklahoma, establishing Dual-Doppler capabilities for the first time.

This System has its Disadvantages that are listed below:

- Range folding: It can cause range folding errors on the image projected on the screen. The lines and the random little streaks in an image are generated by range folding.
- Difficult to measure round trip return: Round trip return timing is very essential for this system. It is very difficult to determine the returns from the targets and other objects located in the same area.
- Limited range: The radars are able to see target objects at a certain range with complete confidence. Anything that is outside the normal range or unambiguous range is unclear.
- Cannot detect wind independently: Unless you have additional remote sensing, the this system cannot detect wind independently.
- High maintenance: This system requires constant maintenance in order to provide accurate information. This may turn out to be expensive.
- Reliability: The system cannot be entirely be relied upon. It lacks some forecasting principles due to certain limitations.
- Prone to failure: Due to its increased sensitivity, the radar is more prone to failure when exposed to severe weather.
- Require expertise to analyze: The measured data require a professional meteorologist to analyze collected data and provide accurate information.

2.2 Proposed System

Ultrasonic Radar Detector is a detection system that uses radio waves to determine the range, angle, or velocity of objects. It uses Microwaves to determine the range, altitude, direction, or speed of objects. The radar can transmit radio waves or microwaves which bounce off any object in their path. So, we can easily determine any object in the radar range. Adruino is a single-board microcontroller to make electronics more discipline. The radar system has different performance specifications and also it comes in a verity of size. An ultrasonic sensor is as sensor which measures the distance of respective object by sending the sound wave of specific frequency. This sound wave is reflected after the collision with respective object and this wave is received by the ultra-sonic receiver. Distance is measured by calculating sending and receiving time of this sound wave.

Most civilian airplanes and larger boats and ships now have radar too as a general aid to navigation. Every major airport has a huge "Ultrasonic Radar System" scanning dish to help air traffic controllers guide planes in and out, whatever the weather. Servomotor is a servomechanism. It is a closed-loop servomechanism that uses position feedback to control its motion and final position. The input to its control is some signal, either analogue or digital, representing the position commanded for the output shaft.The motor is paired with some type of encoder to provide position and speed feedback

Ultrasonic is a non-contact level measurement method that uses sound waves to determine the process material being measured. Ultrasonic transmitters will operate by sending a sound wave, generated from a piezo electric transducer, to the media being measured. To provide a robust, label-free, remotely-controlled, and portable biosensor platform for cost-effective spot measurements and on-line monitoring with integrated fully automated sample preparation for non-experts.

High tech "Ultrasonic Radar System" systems are associated with digital signal processing, machine learning and are capable of extracting useful information from very high noise levels. "Ultrasonic Radar System" is a key technology that the self-driving systems are mainly designed to use, along with sonar and other sensors. Other systems similar to "Ultrasonic Radar System" make use of other parts of the electromagnetic spectrum.

Ultrasonic Radar Detector is a key technology that the self-driving systems are mainly designed to use, along with sonar and other sensors. Other systems similar to Ultrasonic Radar make use of other parts of the electromagnetic spectrum. One example is LIDAR, which uses predominantly infrared light from lasers rather than radio waves. The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware. Basically, the Ultrasonic Sensors transmit the sound off of the object, hence the color and transparency will have no effect on the radar reading.

Any dark environments have no effect on this Arduino radar sensor’s detection procedure. So, it can also use at night. Easy to design and low price. The ultrasonic sensors are available at the market with very cheap price. The Processing language and IDE were the precursor to other projects including Arduino, Wiring and p5.js.

Processing includes a sketchbook, a minimal alternative to an integrated development environment (IDE) for organizing projects. The Ultrasonic sensor can easily interface with anytypes of the microcontroller. This radar sensor will not affected by dust, rain, snow, and manymore. The weather avoidance RADARs and ground mapping RADARs are employed in aircrafts to navigate it properly in all the conditions. Radio altimeter and Doppler navigator are also a form of RADAR. These RADARs provide safety to aircraft from potential collision with other aircraft and objects. The Project is a prototype for radar systems that can be further developed in the future.

2.3 Requirement Analysis

The main components in any ultrasonic radar are the ultrasonic Sensors. Ultrasonic sensors work on a principle similar to radar or sonar which evaluates attributes of a target by interpreting the echoes from radio or sound waves respectively. Radar's information will appear in different ways. Basic and old radar station used sound alarm or LED, modern radar uses LCD display to show detailed information of the targeted object. We use Computer screen to show the information. Ultrasonic radar detector is based on microcontroller board designs. The board provides sets of digital and analog Input/output (I/O) pins that can interface to various expansion boards and other circuits Fig (2-1). The boards feature serial communication interfaces, including Universal Serial Bus (USB) on UNO model, for loading programs from personal computers. The principle of operation of a radar or sonar can be used to under-stand the operation of ultrasonic sensor due to the similarity of operation. CNC machines, robots and automation are a clearly applications of servomotors .

In other words, by evaluating the time required for sending and receiving the ultrasonic wave, several information related to the object or obstacle that causes the reflection of the wave can be measured such as the distance to the sensor, size, figure, etc. The servomotor system for position or distance measurements usually includes a special motor, a sensor for error signal requirements and a controller this work, a servomotor will be used beside both the Arduino board and the ultrasonic sensor HC-SR04 for position determination. Processing (Figure 4) is an Integrated Development Environment (IDE) designed for several purposes such as electronic arts and visualizing the fundamentals of programming. Arduino as an IDE builds in Java language, but uses a simplified syntax and graphics programming model .The measured position of the output is compared to the command position, the external input to the controller. If the output position differs from that required, an error signal is generated which then causes the motor to rotate in either direction, as needed to bring the output shaft to the appropriate position. As the positions approach, the error signal reduces to zero and the motor stops. Processing includes a sketchbook, a minimal alternative to an integrated development environment (IDE) for organizing projects. Every Processing sketch is actually a subclass of the PApplet Java class (formerly a subclass of Java's built-in Applet) which implements most of the Processing language's features. Processing also allows for users to create their own classes within the PApplet sketch.

Hardware and software components used this project are as follows:

- NodeMCU8266: Description. NodeMCU is an open-source firmware and development kit that helps you to prototype or build IoT products. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espress if Systems, and hardware which is based on the ESP-12 module. The firmware uses the Lua scripting language.
- Ultra Sonic HC-SR04: Ultrasonic sensors can be used for many applications, including precise detection of objects and contactless monitoring of fill levels. They generate high frequency sound waves and evaluate the echo which is received back by the sensor.
- SG90 Servo Board: Servo motors are high torque motors which are commonly used in robotics and several other applications due to the fact that it's easy to control their rotation. Servo motors have a geared output shaft which can be electrically controlled to turn one (1) degree at a time. For the sake of control, unlike normal DC motors, servo motors usually have an additional pin asides the two power pins (Vcc and GND) which is the signal pin. The signal pin is used to control the servo motor, turning its shaft to any desired angle.
- Connecting Wires : Connecting wires provide a medium to an electrical current so that they can travel from one point on a circuit to another. In the case of computers, wires are embedded into circuit boards to carry pulses of electricity. Most wires in computers and electronic components are made of copper or aluminum, because copper is cheap and electrically conductive.
- Breadboard : A breadboard is a construction base for prototyping of electronics. Originally the word referred to a literal bread board, a polished piece of wood used for slicing bread. In the 1970s the solderless breadboard (a.k.a. plugboard, a terminal array board) became available and nowadays the term "breadboard" is commonly used to refer to these.
- Arduino IDE : The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++ . It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards.
- Processing IDE : Processing is an open-source graphical library and integrated development environment (IDE) built for the electronic arts, new media art, and visual design communities with the purpose of teaching non-programmers the fundamentals of computer programming in a visual context.

2.4 Hardware Requirements

- **NodeMCU8266 :**

  NodeMCU is a low-cost open source IoT platform. It initially included firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which was based on the ESP-12 module. Later, support for the ESP32 32-bit MCU was added.

  NodeMCU is an open source firmware for which open source prototyping board designs are available. The name "NodeMCU" combines "node" and "MCU" (micro-controller unit).[8]. The term "NodeMCU" strictly speaking refers to the firmware rather than the associated development kits Both the firmware and prototyping board designs are open source.

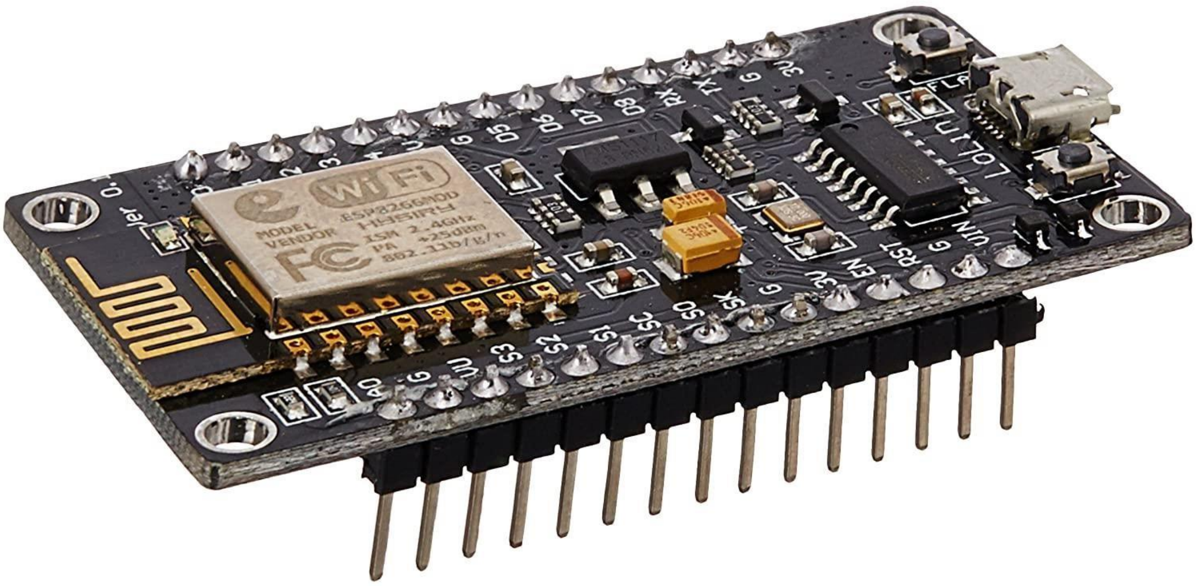


Figure 2.4.1 NodeMCU8266

- **Ultra Sonic HC-SR04 :**

  Ultrasonic sensor is the corner stone of any ultrasonic device. The principle of operation of a radar or sonar can be used to under-stand the operation of ultrasonic sensor due to the similarity of operation. In other words, by evaluating the time required for sending and receiving the ultrasonic wave, several information related to the object or obstacle that causes the reflection of the wave can be measured such as the distance to the sensor, size, figure, etc. Tow parameters usually affect the speed (v) of ultrasonic wave in a specific medium; the medium nature and its temperature.

Figure 2.4.2 HC-SR04 Ultrasonic Sensor

- **SG90 Servo Board :**

  A servo system refers to a feedback control loop system for con-trolling one or several parameters in such system. In case of servomotor that is considered as a linear rotary actuator, the parameters to be controlled are acceleration, speed and/or position. It is a closed-loop servomechanism that uses position feedback to control its motion and final position. Servomotor is a servomechanism. It is a closed-loop servomechanism that uses position feedback to control its motion and final position. The input to its control is some signal, either analogue or digital, representing the position commanded for the output shaft.The motor is paired with some type of encoder to provide position and speed feedback.

Figure 2.4.3 SG90 Servo Motor

- **Connecting wires :**

  Connecting wires allows an electrical current to travel from one point on a circuit to another because electricity needs a medium through which it can move. Most of the connecting wires are made up of copper or aluminum. Copper is cheap and good conductivity. Instead of the copper, we can also use silver which has high conductivity but it is too costly to use.

Figure 2.4.4 Connecting Wires

- **Breadboard :**

  A breadboard is a rectangular plastic board with a bunch of tiny holes in it. These holes let you easily insert electronic components to prototype (meaning to build and test an early version of) an electronic circuit, like this one with a battery, switch, resistor, and an LED (light-emitting diode).

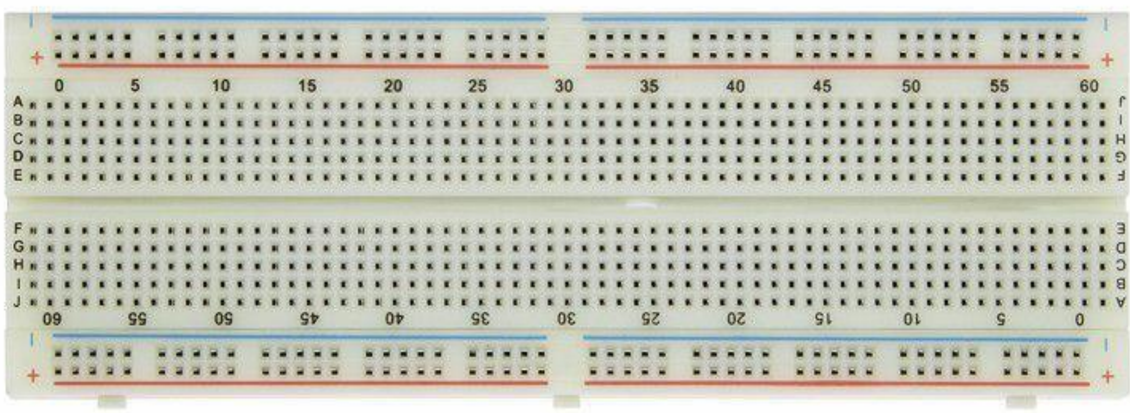


Figure 2.4.5 Breadboard

2.5 Software Requirements:

- **Arduino IDE:**

  Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board. The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware.

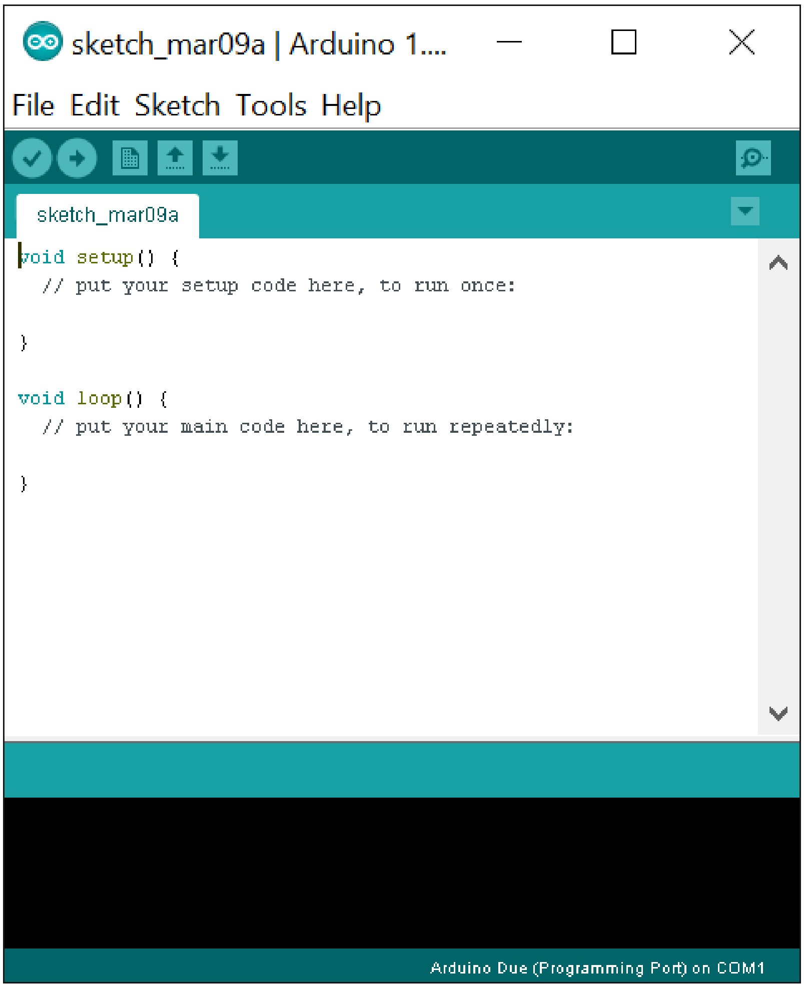


Figure 2.5.1 Arduino IDE

- **Processing IDE:**

  Processing is an open-source graphical library and integrated development environment (IDE) built for the electronic arts, new media art, and visual design communities with the purpose of teaching non-programmers the fundamentals of computer programming in a visual context.Processing uses the Java language, with additional simplifications such as additional classes and aliased mathematical functions and operations. As well as this, it also has a graphical user interface for simplifying the compilation and execution stage.The Processing language and IDE were the precursor to other projects including Arduino, Wiring and p5.js. Processing includes a sketchbook, a minimal alternative to an integrated development environment (IDE) for organizing projects.

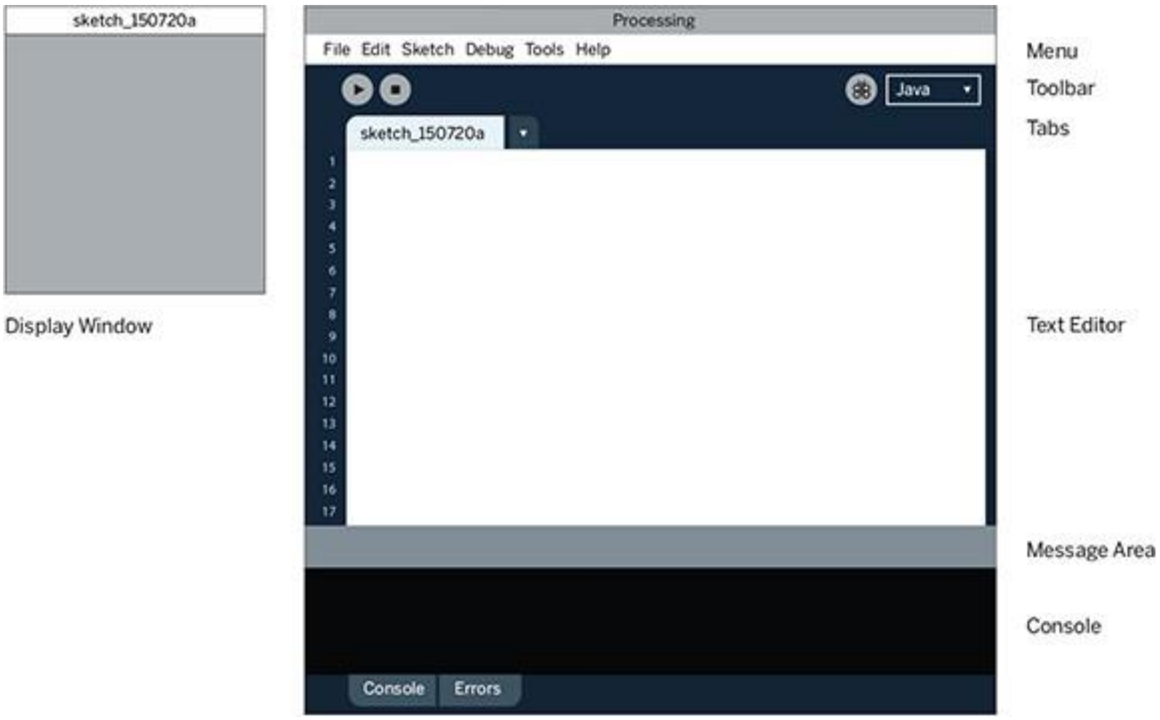


Figure 2.5.2 Processing IDE

Justification of Platform:

Why Arduino to program the microcontroller and not other programming platform?

- It is an open-source project, software/hardware is extremely accessible and very flexible to be customized and extended.
- It is flexible, offers a variety of digital and analog inputs, SPI and serial interface and digital and PWM outputs.
- It is easy to use, connects to computer via USB and communicates using standard serial protocol, runs in standalone mode and as interface connected to PC/Macintosh computers.
- It is inexpensive and comes with free authoring software.
- Arduino is backed up by a growing online community, lots of source code is already available and we can share and post our examples for others to use, too.

  The Arduino hardware and software was designed for artists, designers, hobbyists, hackers, newbies, and anyone interested in creating interactive objects or environments. Arduino can interact with buttons, LEDs, motors, speakers, GPS units, cameras, the internet, and even your smart-phone or your TV.

  Why Thingspeak as front end?

  ThingSpeak is an open data platform for the Internet of Things. Your device or application can communicate with ThingSpeak using a RESTful API, and you can either keep your data private, or make it public. In addition, use ThingSpeak to analyze and act on your data. ThingSpeak provides an online text editor to perform data analysis and visualization using MATLAB®. You can also perform actions such as running regularly scheduled MATLAB code or sending a tweet when your data passes a defined threshold. ThingSpeak is used for diverse applications ranging from weather data collection and analysis, to synchronizing the color of lights across the world.

  At the heart of ThingSpeak is a time-series database. ThingSpeak provides users with free time-series data storage in channels. Each channel can include up to eight data fields. This tutorial provides an introduction to some of the applications of ThingSpeak, a conceptual overview of how ThingSpeak stores time-series data, and how MATLAB analysis is incorporated in ThingSpeak.

Chapter 3 : System Design

3.1 Module Design

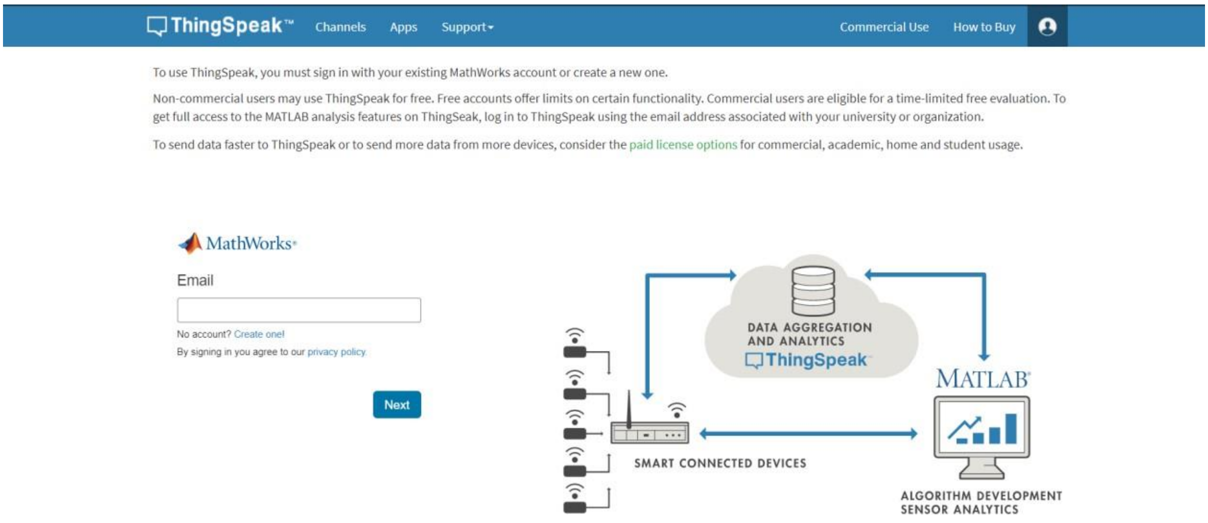


Figure 3.1 Login Page for Thingspeak database website

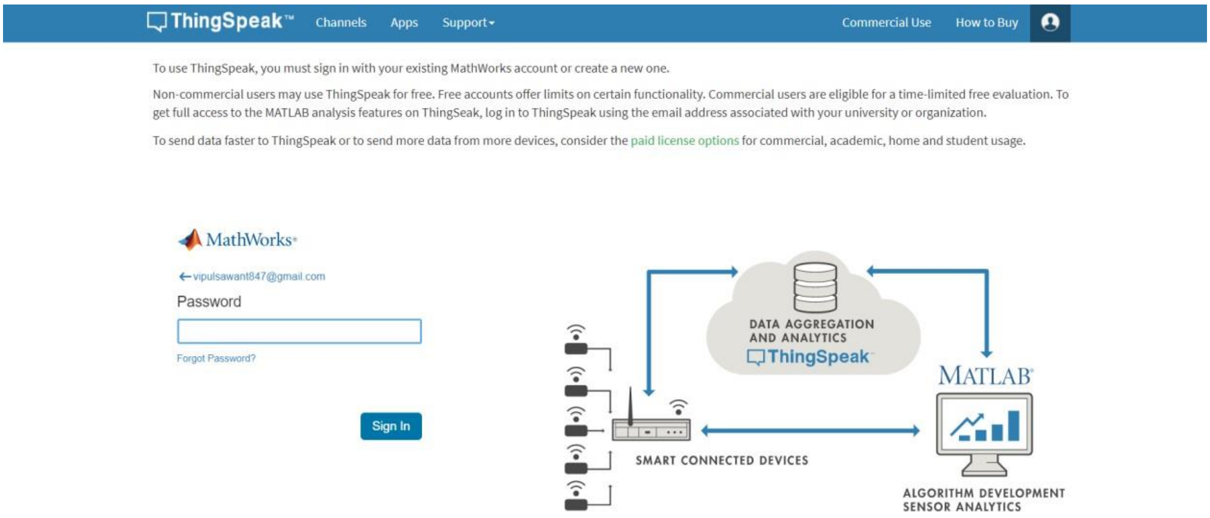


Figure 3.2 Enter Password

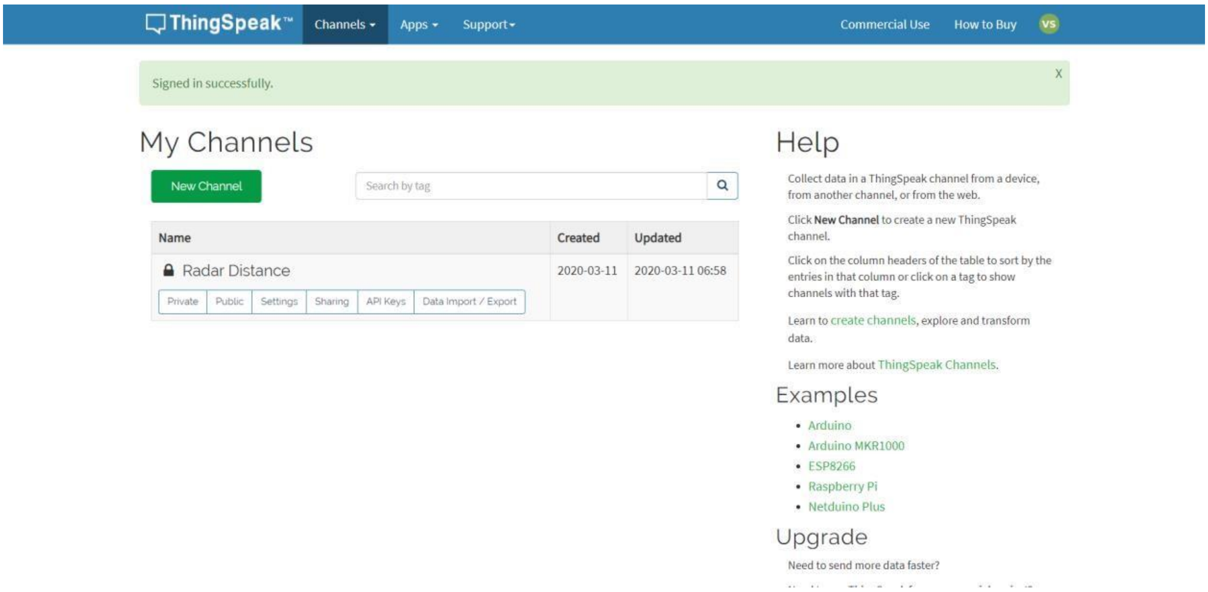


Figure 3.3 Loading Project File

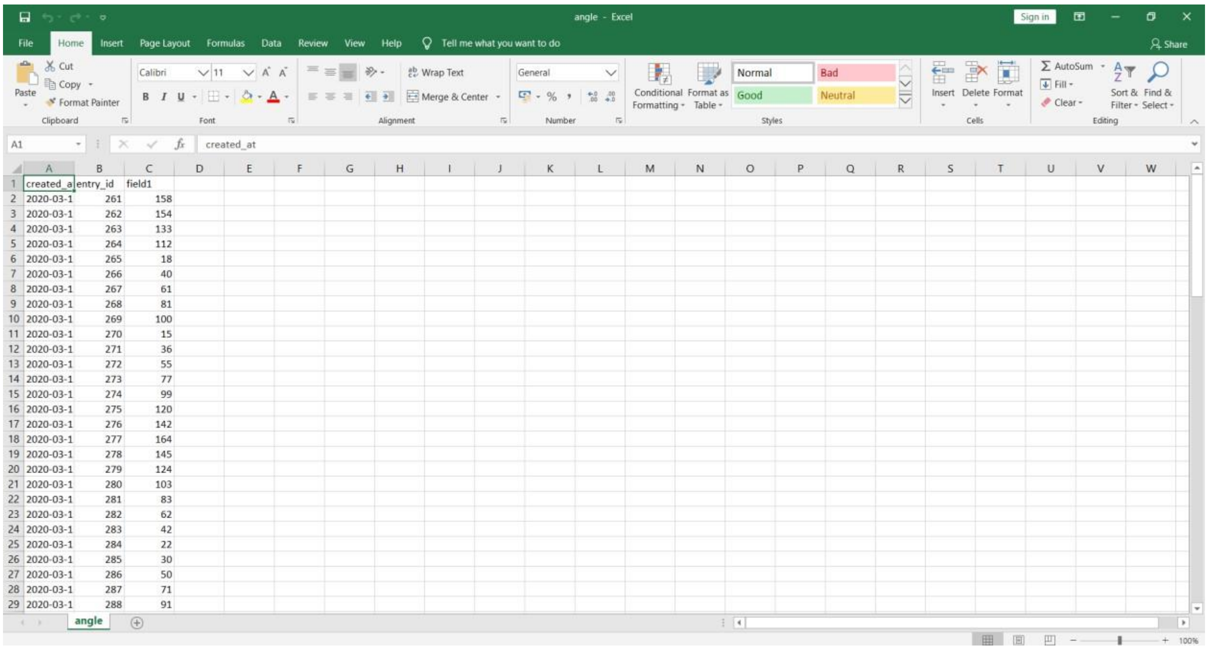


Figure 3.4 Data Entry

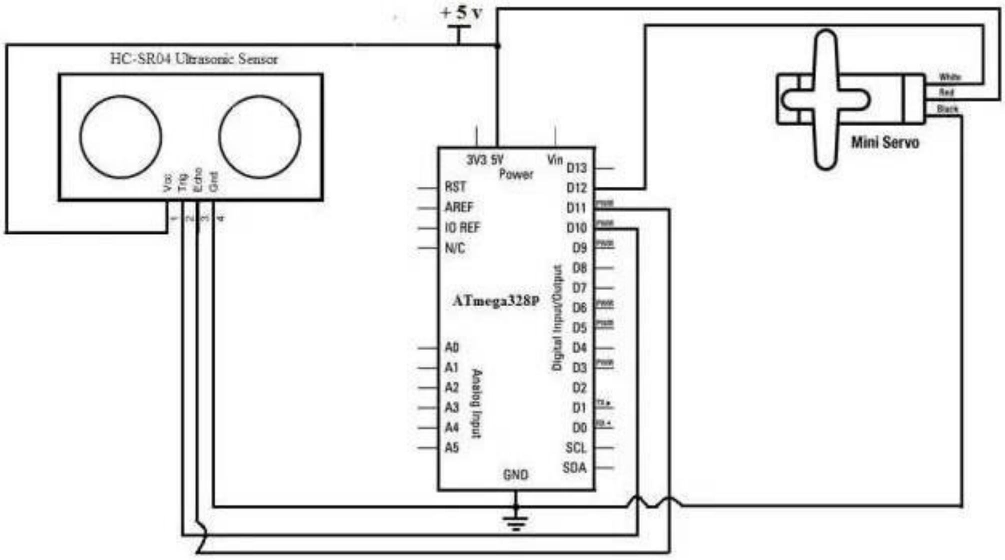


Figure 3.5 Ultrasonic Radar Detector Circuit Diagram

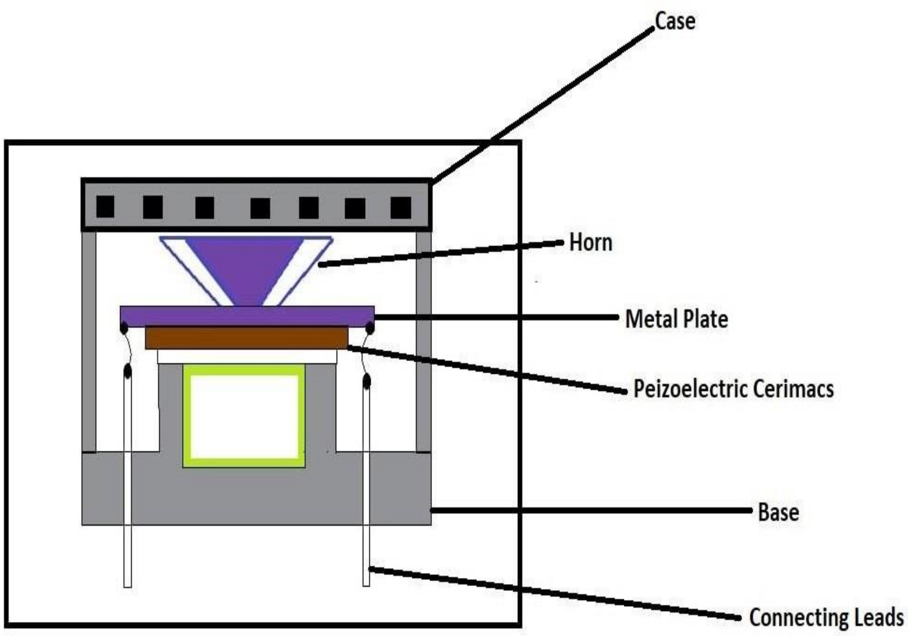


Figure 3.6 Construction of Ultrasonic Radar

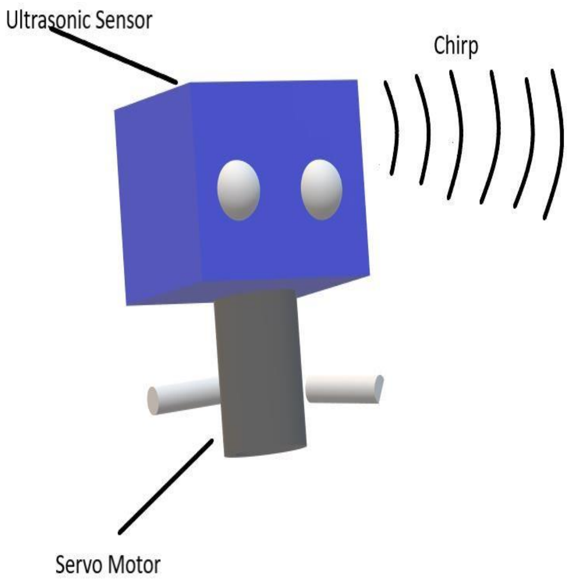


Figure 3.7 Working Of Ultrasonic Radar (Nothing Will Be Detected)

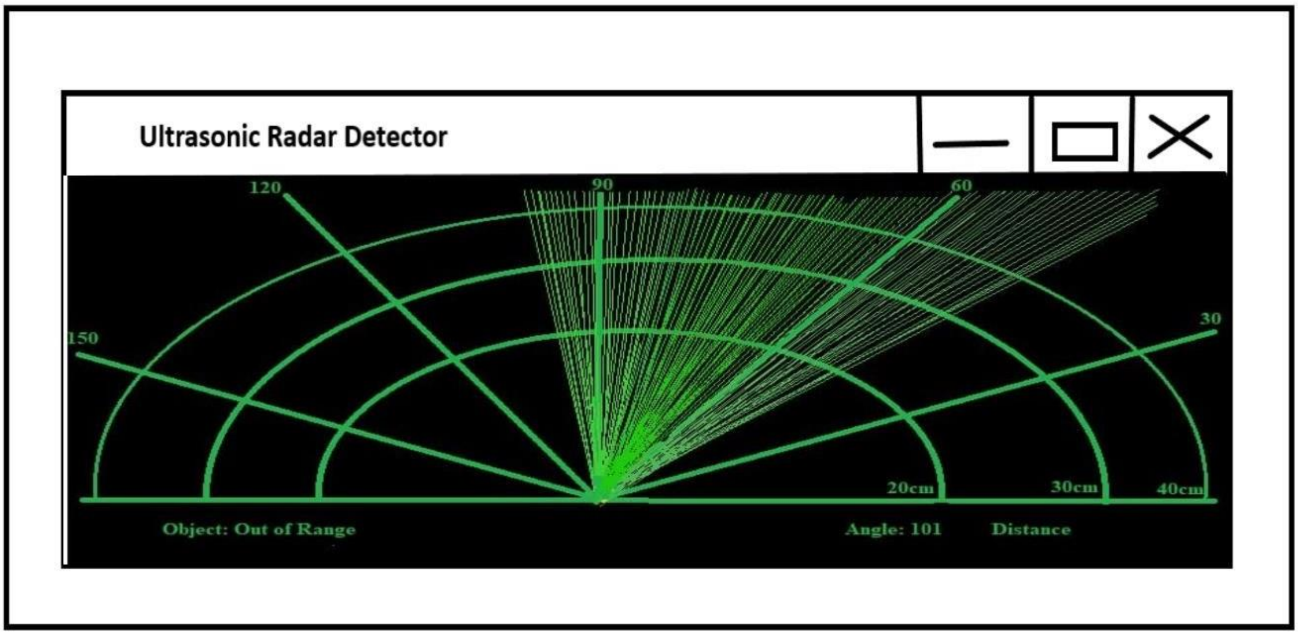


Figure 3.8 Output Page When Nothing Will Be Detected

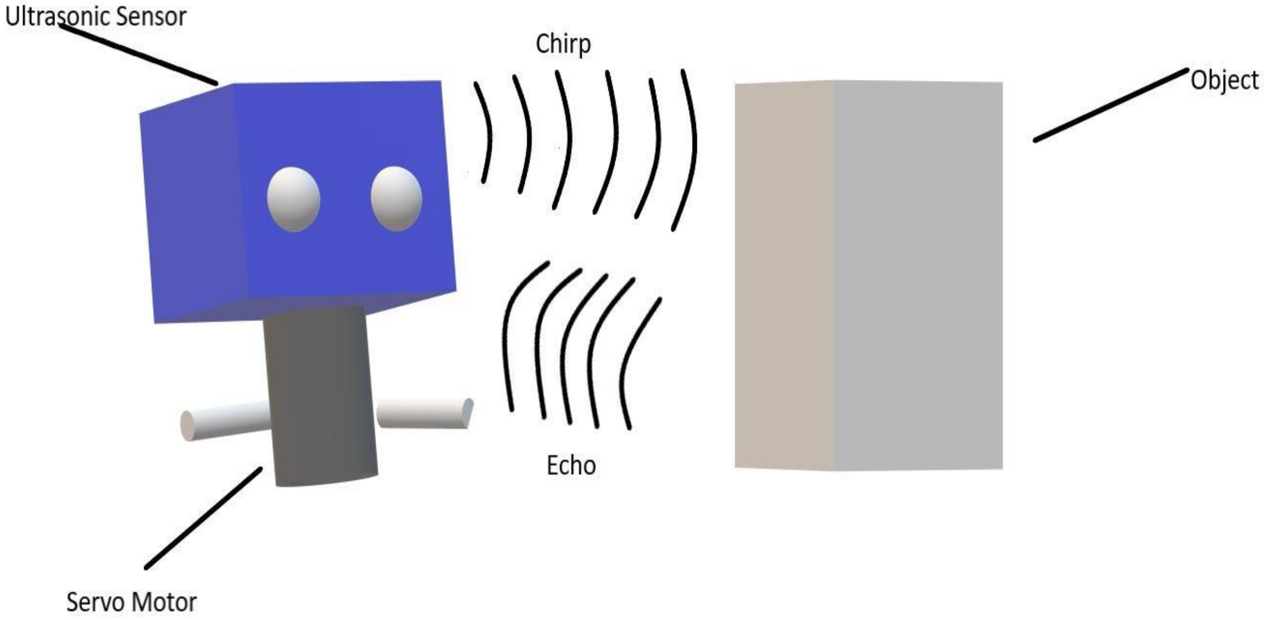


Figure 3.9 Working Of Radar (Object Will Be Detected)

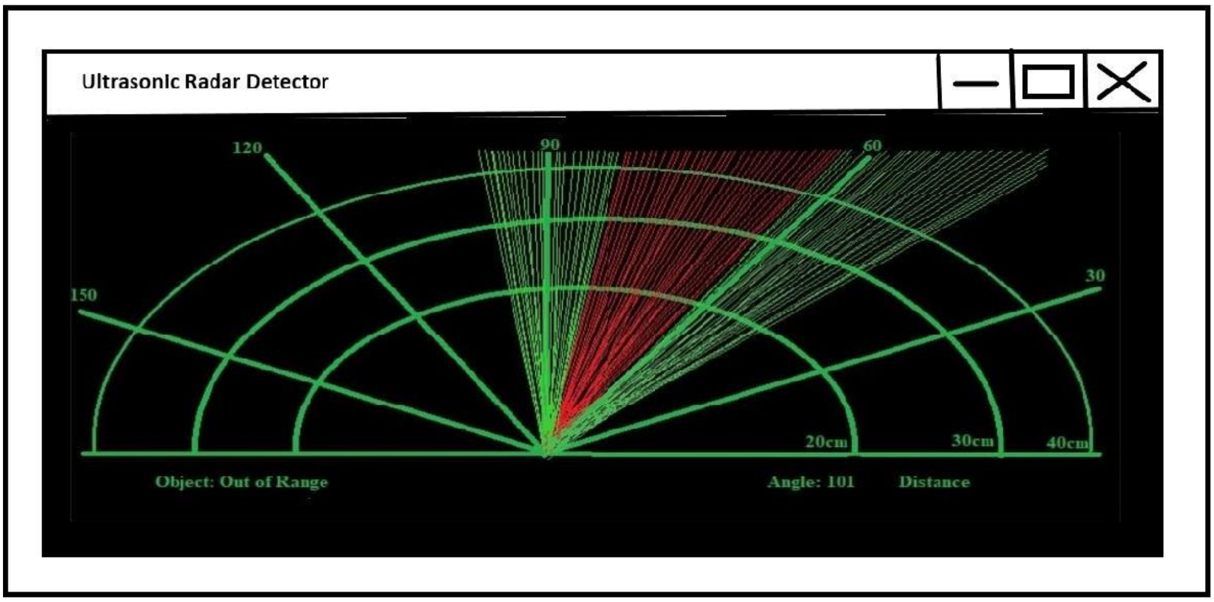


Figure 3.10 Outputs When Object Will Be Detected

3.2 Data Dictionary

Table 3.1 Data Dictionary

Notation	Description
USB	Universal Serial Bus
IOT	Internet of Things
KB	Kilo bytes
GB	Giga bytes
IC	Integrated Circuit
SIP	Session Initiation Protocol
API	Application Programming Interface
USB	Universal Serial Bus
IDE	Integrated Development Environment
PIP	Processing Language Project
RAM	Random Access Memory
ROM	Read Only Memory
SRAM	Static Random-Access Memory
EEPROM	Electrically Erasable Programming Read Only Memory
ADC	Analog to Digital Converter
IOS	iPhone Operating System
GSM	Global System for Mobile
GUI	Graphical User Interface

3.3 UML Diagram

3.3.1 Activity Diagram

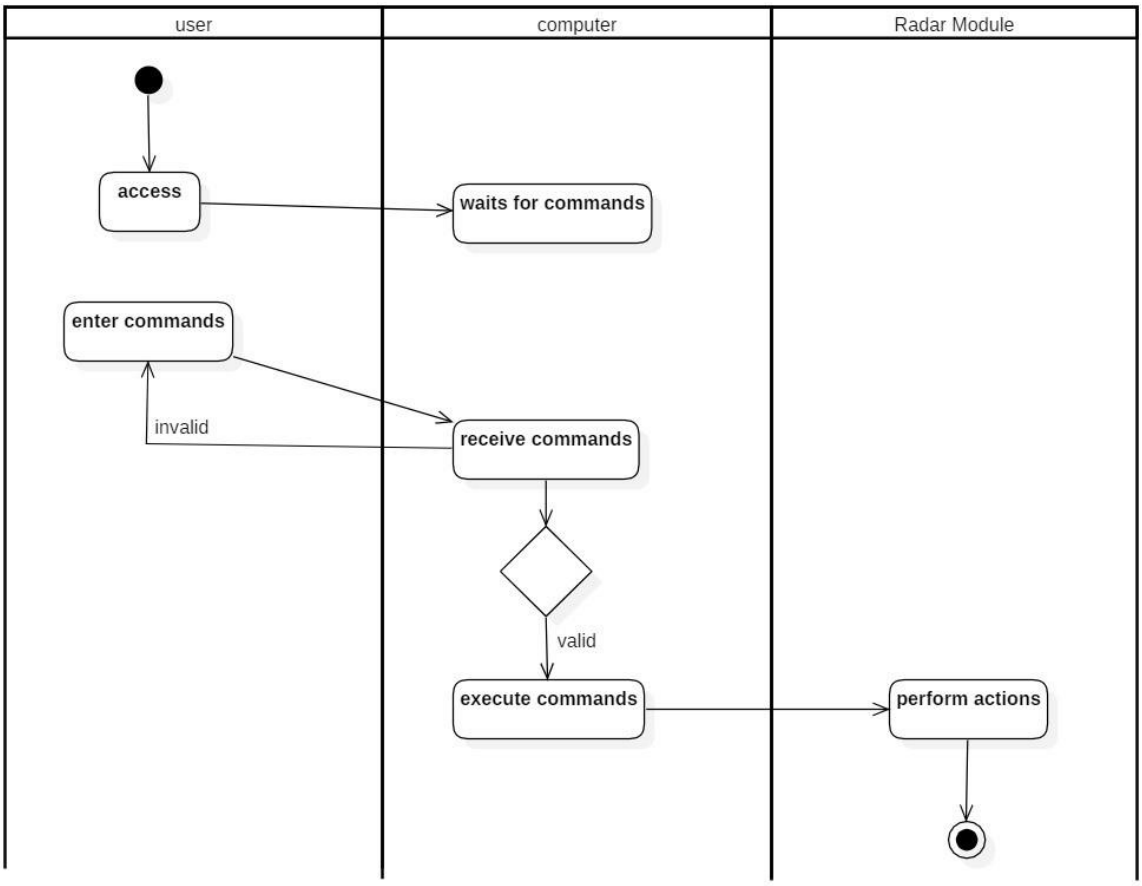


Figure 3.11 Activity Diagram

3.3.2 Class Diagram

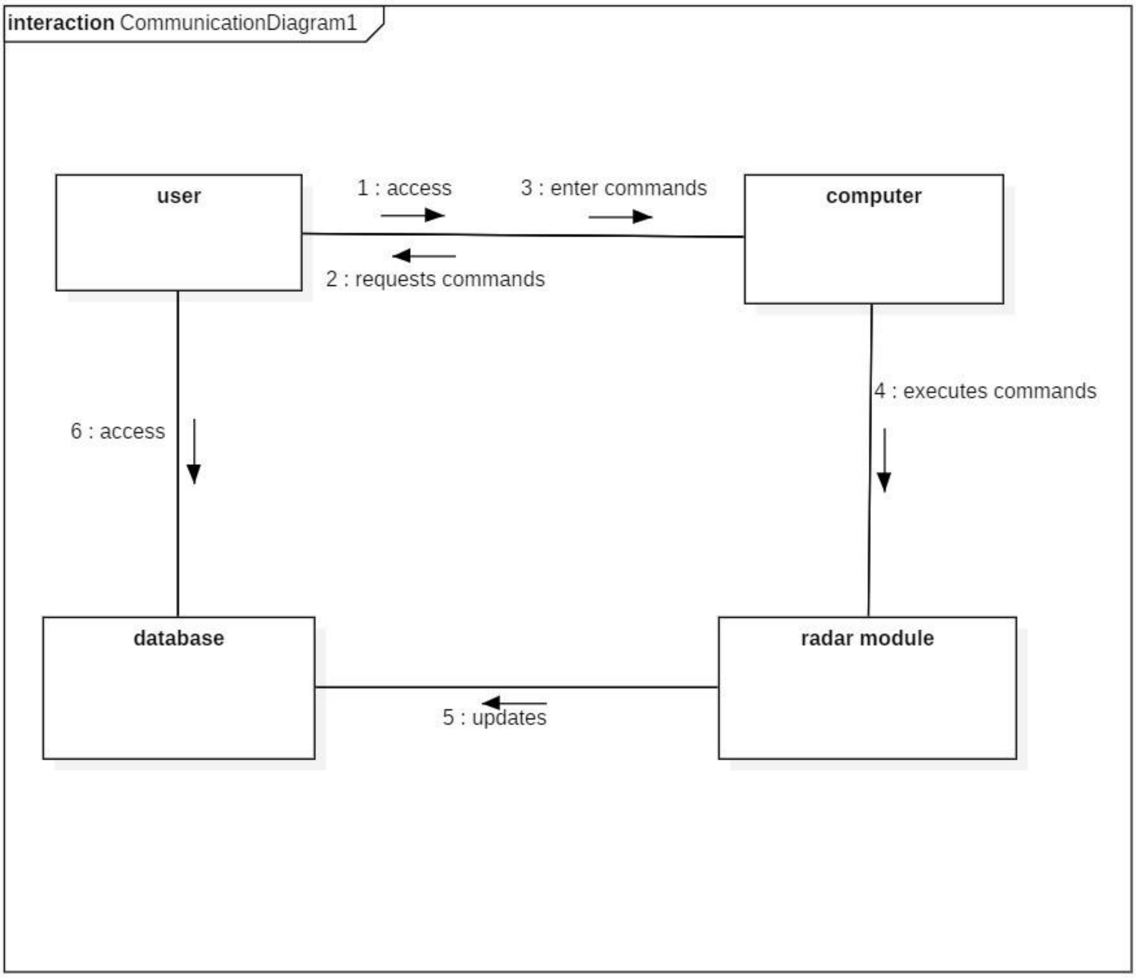


Figure 3.12 Class Diagram

3.3.3 Collaboration Diagram

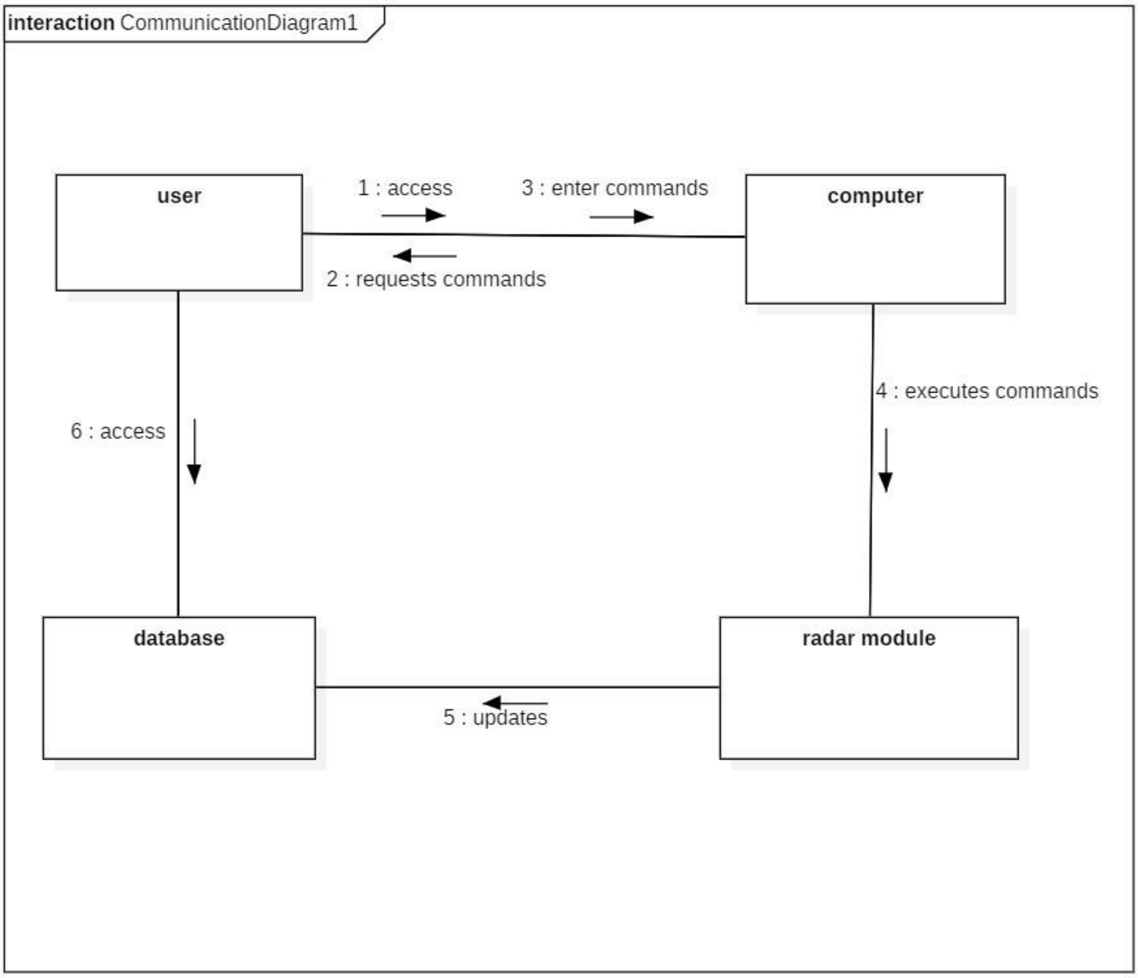


Figure 3.13 Collaboration Diagram

3.3.4 Component Diagram

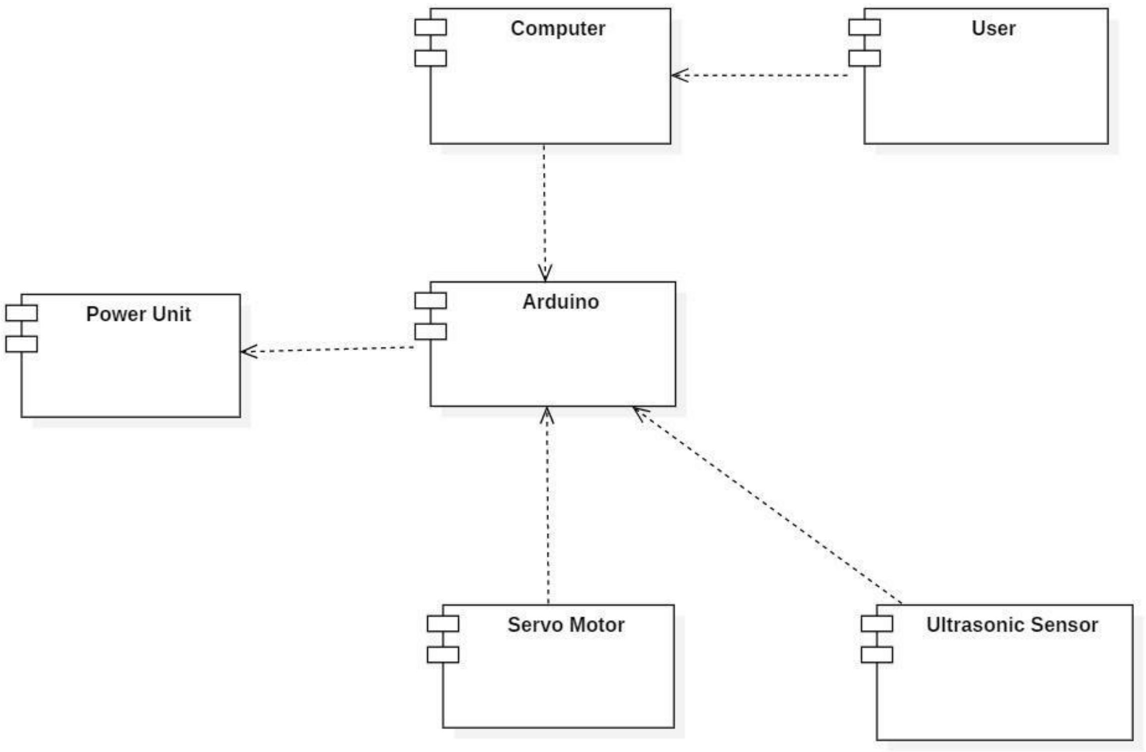
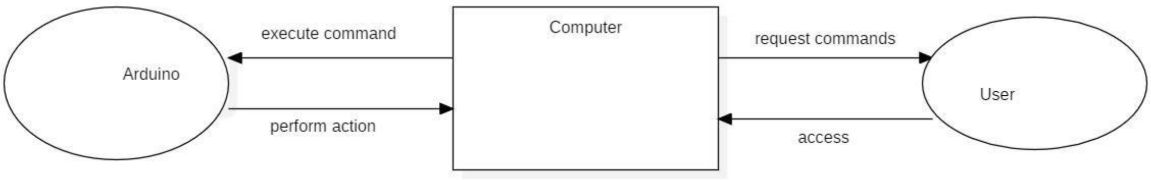


Figure 3.14 Component Diagram

3.3.5 Dataflow Diagram

level 0 :



level 1 :

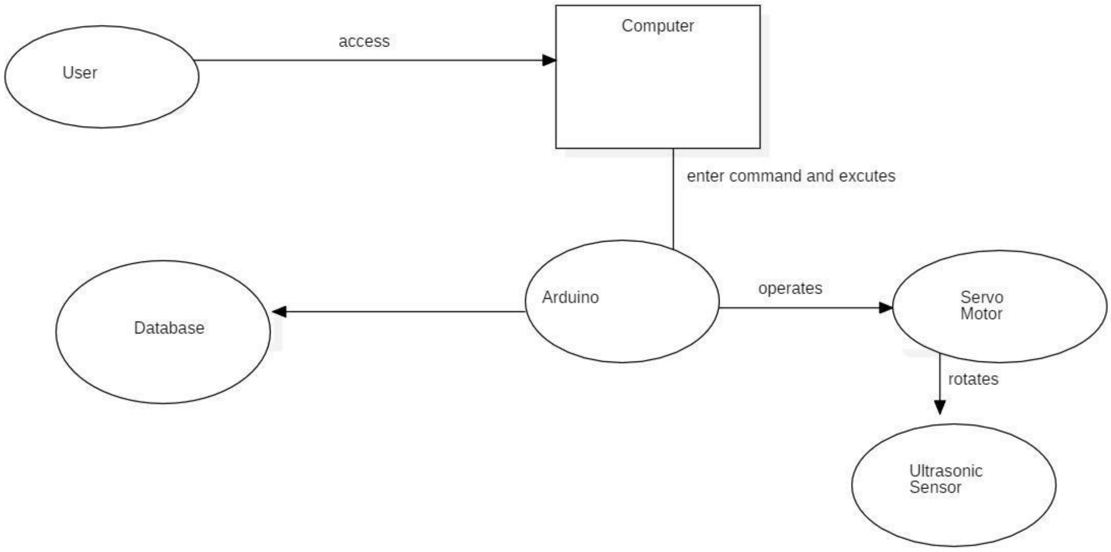


Figure 3.15 Dataflow Diagram

3.3. 6 Deployment Diagram

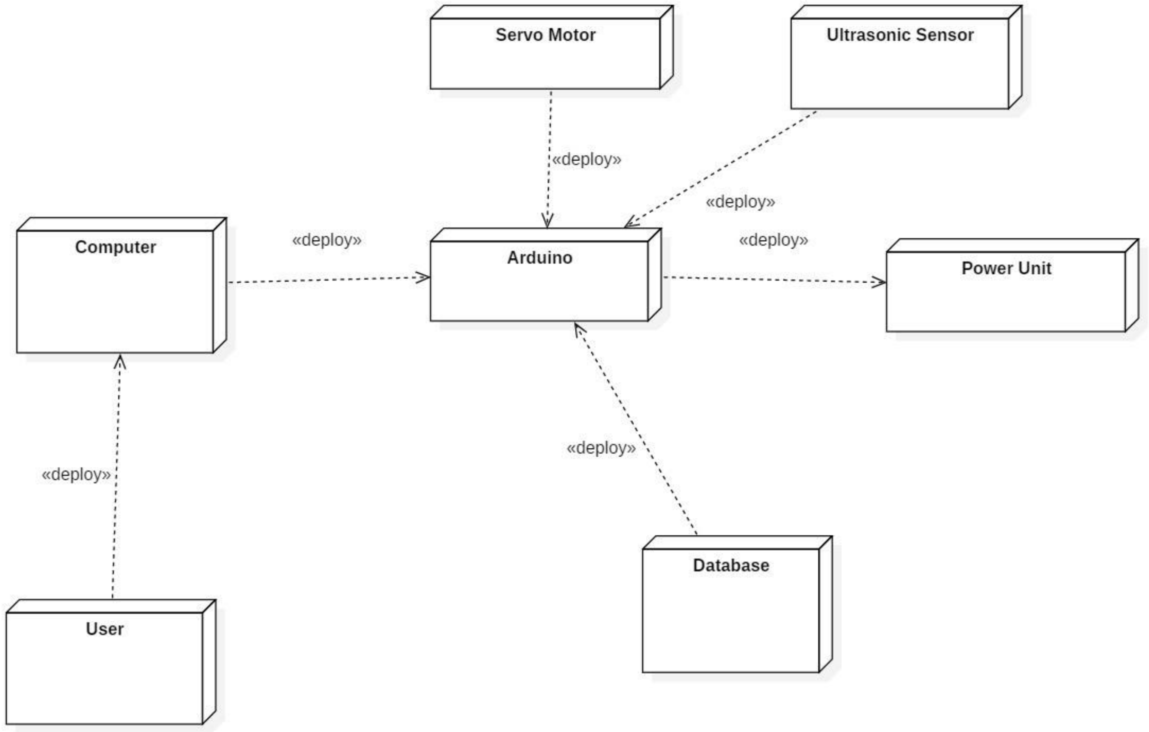


Figure 3.16 Deployment Diagram

3.3.7 ER Diagram

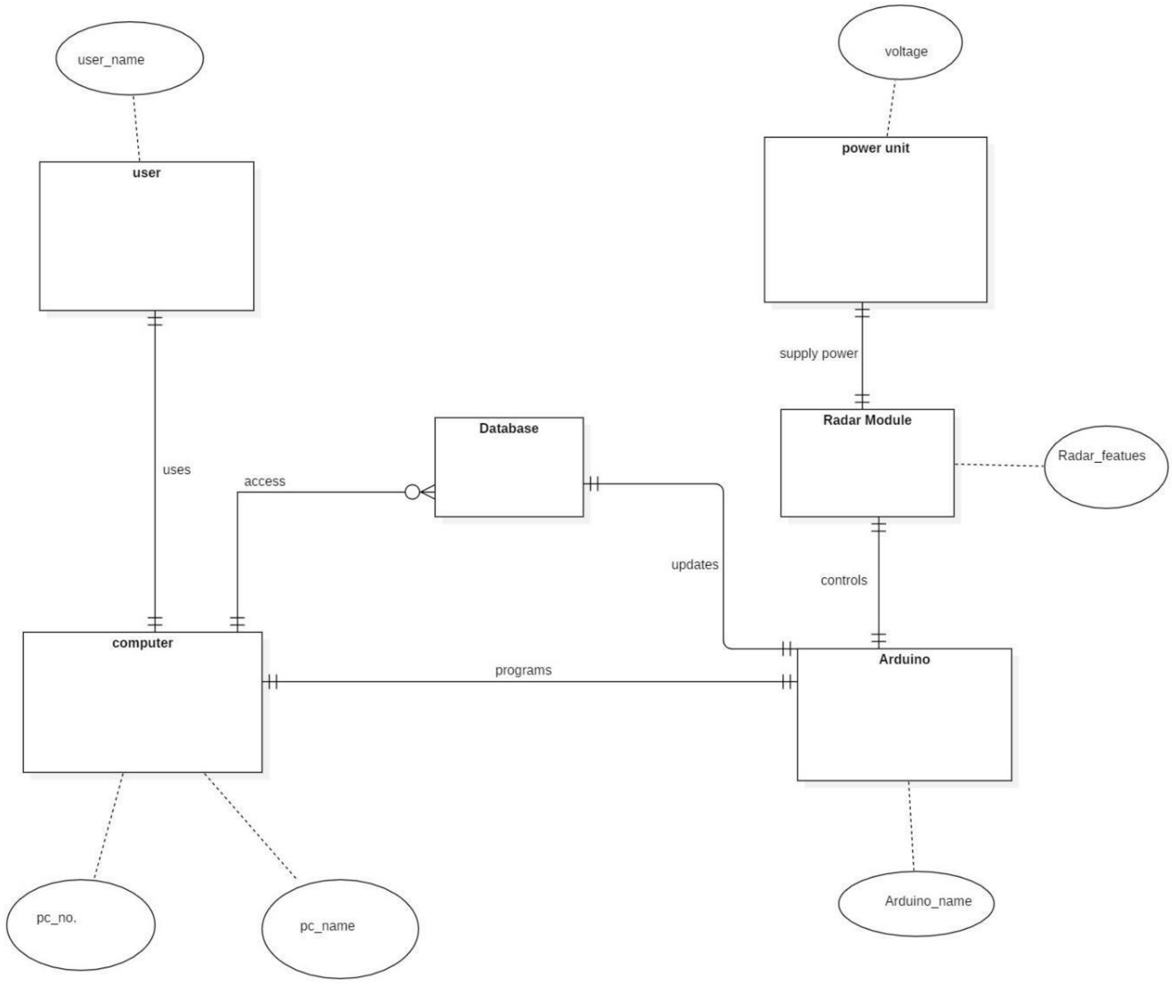


Figure 3.17 ER Diagram

3.3.8 Sequence Diagram

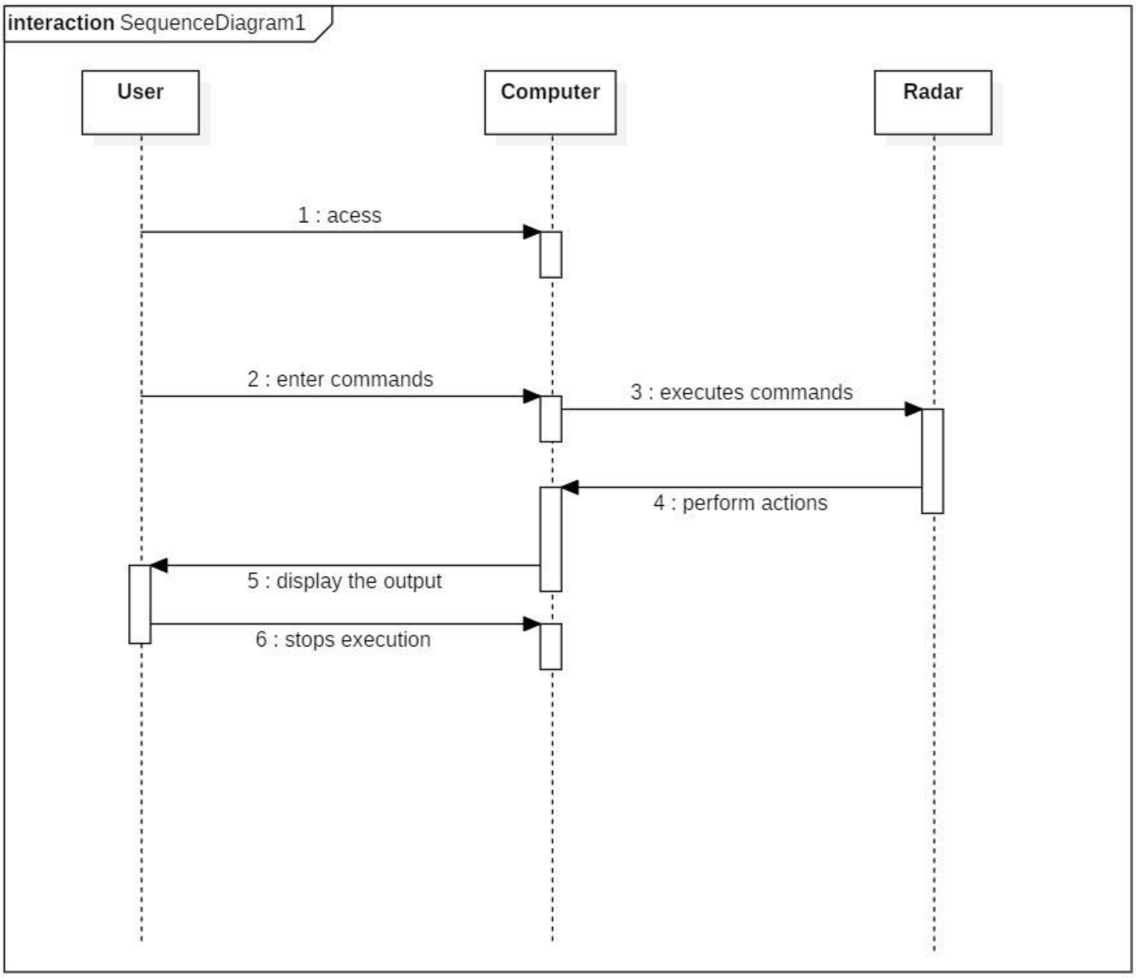


Figure 3.18 Sequence Diagram

3.3.9 State Transition Diagram

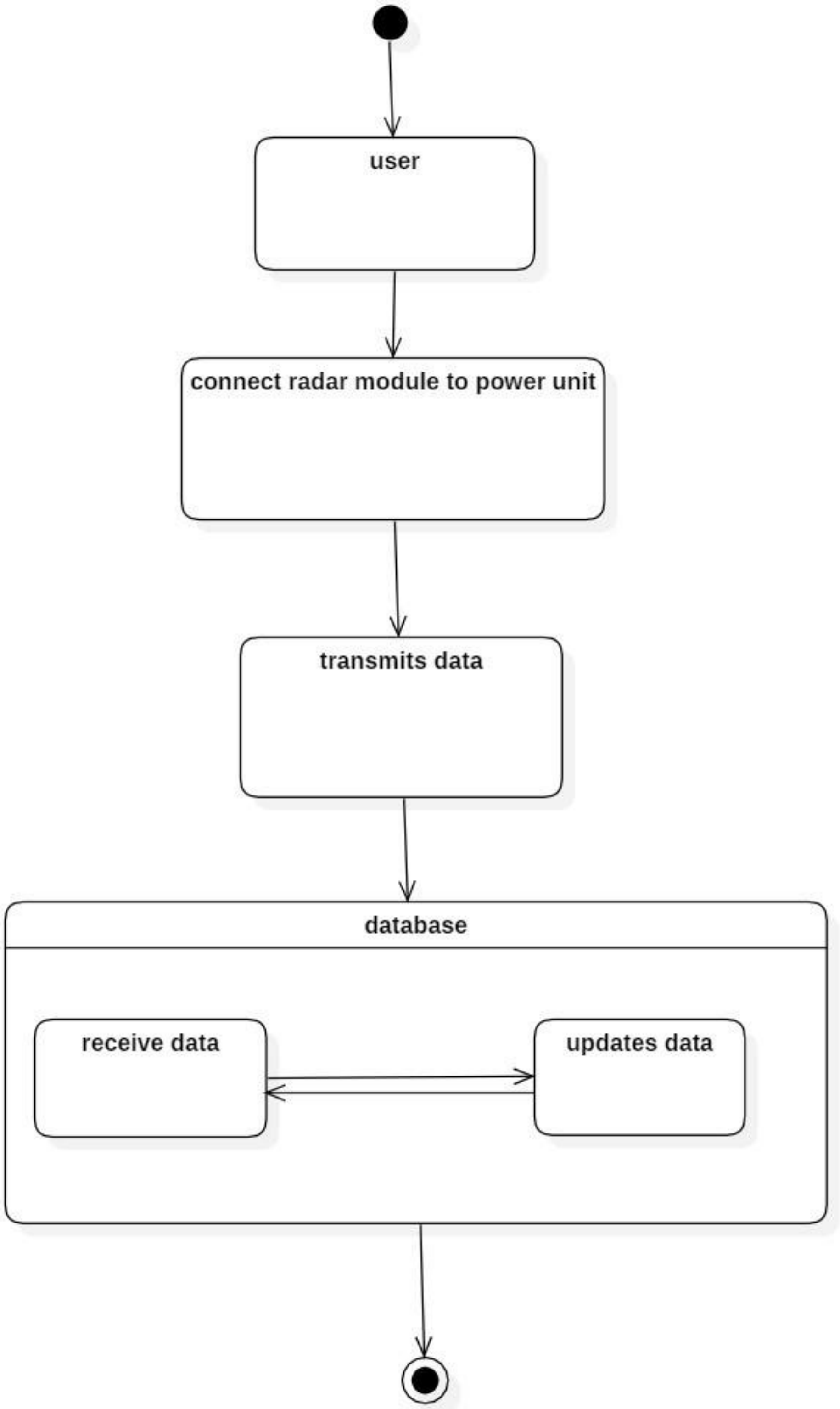


Figure 3.19 State Transition Diagram

3.3.9 Use-Case Diagram

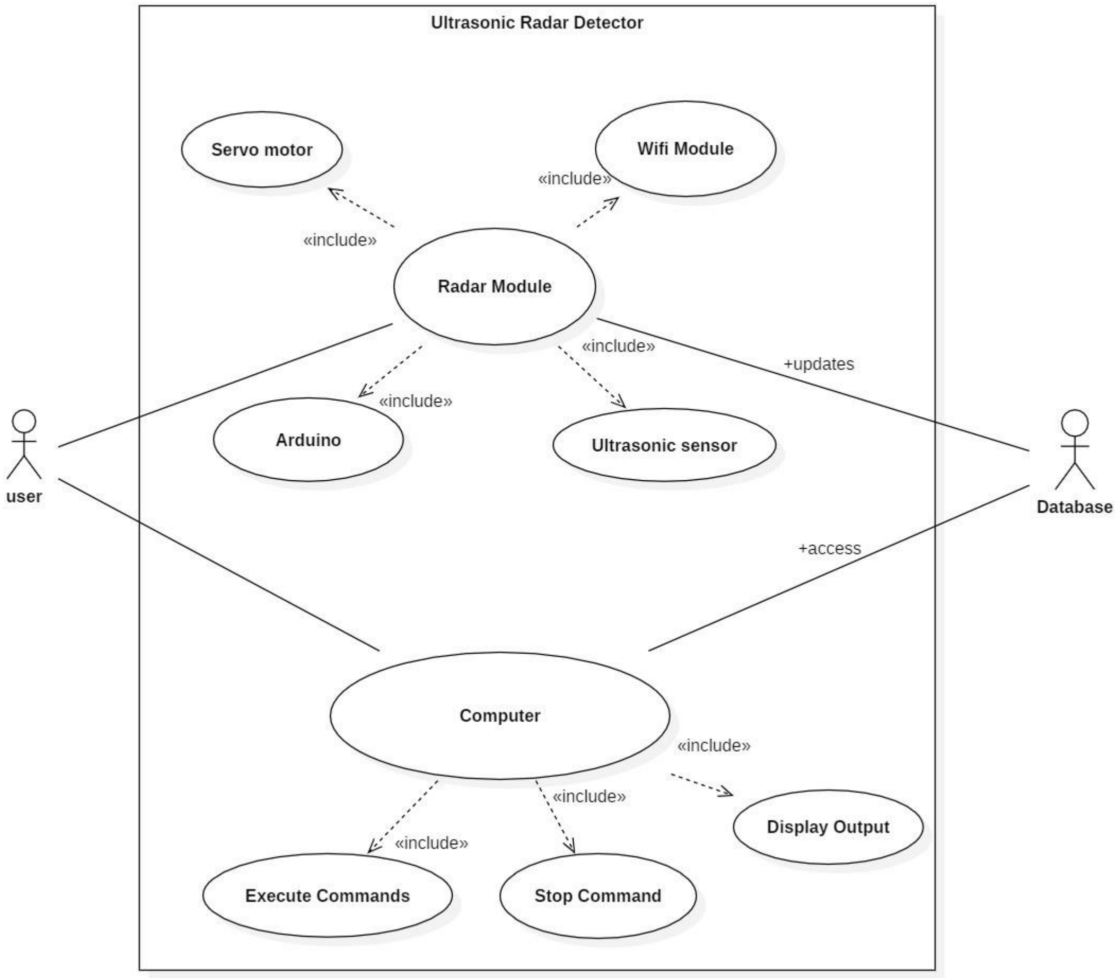


Figure 3.20 Use-Case Diagram

Chapter 4: Implementation And Testing

Coding

NodeMCU Code : Radar_Arduino_Code.ino

```
#include <Servo.h>.
const int trigPin = D6;
const int echoPin = D7;
long duration;
int distance;
Servo myServo;
void setup() {
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  Serial.begin(9600);
  myServo.attach(16);
}
void loop() {
  for(int i=15;i<=165;i++){
  myServo.write(i);
  delay(30);
  distance = calculateDistance();

  Serial.print(i);
  Serial.print(",");
  Serial.print(distance);
  Serial.print(".");
  }
```

```
  for(int i=165;i>15;i--){
  myServo.write(i);
  delay(30);
  distance = calculateDistance();
  Serial.print(i);
  Serial.println(",");
  Serial.print(distance);
  Serial.println(".");
  }
}
int calculateDistance(){

  digitalWrite(trigPin, LOW);
  delayMicroseconds(1000);
  // Sets the trigPin on HIGH state for 10 micro seconds
  digitalWrite(echoPin, HIGH);
  delayMicroseconds(1000);
  digitalWrite(trigPin, LOW);
  duration = pulseIn(echoPin, HIGH); // Reads the echoPin, returns the sound wave travel time
in microseconds
  distance= duration*0.034/2;
  return distance;
  Serial.print(distance);
}
```

Processing IDE Code : Processing.pde

```
import processing.serial.*;
import java.awt.event.KeyEvent;
import java.io.IOException;
Serial myPort;
String angle="";
String distance="";
String  data="";
String  noObject;
float pixsDistance;
int iAngle, iDistance;
int index1=0;
int index2=0;
PFont orcFont;
void setup() {

 size (1200, 700);
 smooth();
 myPort = new Serial(this,"COM3", 9600);
 myPort.bufferUntil('.');
}
void draw() {

  fill(98,245,31);
  noStroke();
  fill(0,4);
  rect(0, 0, width, height-height*0.065);

  fill(98,245,31); // green color
  drawRadar();
  drawLine();
  drawObject();
```

```
  drawText();
}
void serialEvent (Serial myPort) {
  data = myPort.readStringUntil('.');
  data = data.substring(0,data.length()-1);

  index1 = data.indexOf(",");
  angle= data.substring(0, index1);
  distance= data.substring(index1+1, data.length());
  iAngle = int(angle);
  iDistance = int(distance);
}
void drawRadar() {
  pushMatrix();
  translate(width/2,height-height*0.074);
  noFill();
  strokeWeight(2);
  stroke(98,245,31);
  arc(0,0,(width-width*0.0625),(width-width*0.0625),PI,TWO_PI);
  arc(0,0,(width-width*0.27),(width-width*0.27),PI,TWO_PI);
  arc(0,0,(width-width*0.479),(width-width*0.479),PI,TWO_PI);
  arc(0,0,(width-width*0.687),(width-width*0.687),PI,TWO_PI);
  line(-width/2,0,width/2,0);
  line(0,0,(-width/2)*cos(radians(30)),(-width/2)*sin(radians(30)));
  line(0,0,(-width/2)*cos(radians(60)),(-width/2)*sin(radians(60)));
  line(0,0,(-width/2)*cos(radians(90)),(-width/2)*sin(radians(90)));
  line(0,0,(-width/2)*cos(radians(120)),(-width/2)*sin(radians(120)));
  line(0,0,(-width/2)*cos(radians(150)),(-width/2)*sin(radians(150)));
  line((-width/2)*cos(radians(30)),0,width/2,0);
  popMatrix();
}
void drawObject() {
  pushMatrix();
  translate(width/2,height-height*0.074);
```

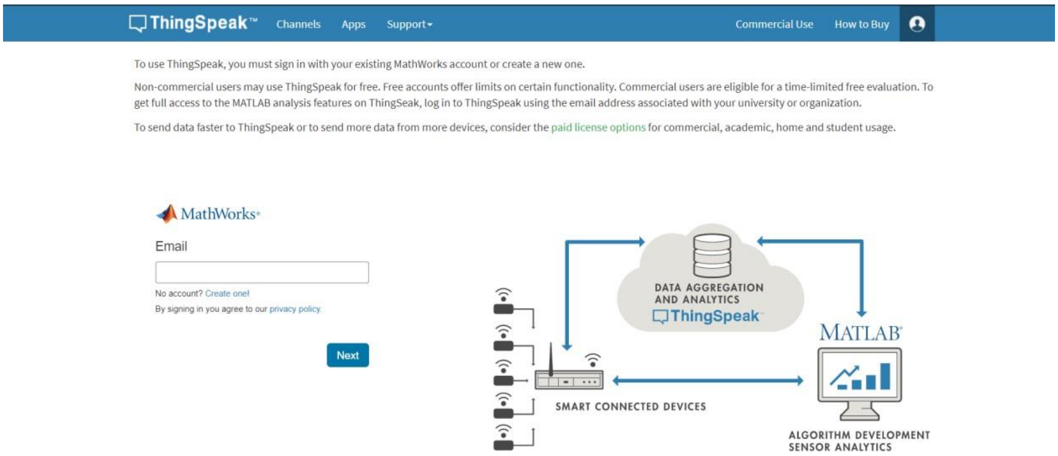
```
  strokeWeight(9);
  stroke(255,10,10);
  pixsDistance = iDistance*((height-height*0.1666)*0.025);
  if(iDistance<40){
  line(pixsDistance*cos(radians(iAngle)),-pixsDistance*sin(radians(iAngle)),(width-
width*0.505)*cos(radians(iAngle)),-(width-width*0.505)*sin(radians(iAngle)));
  }
  popMatrix();
}
void drawLine() {
  pushMatrix();
  strokeWeight(9);
  stroke(30,250,60);
  translate(width/2,height-height*0.074);
  line(0,0,(height-height*0.12)*cos(radians(iAngle)),-(height-
height*0.12)*sin(radians(iAngle)));
  popMatrix();
}
void drawText() {

  pushMatrix();
  if(iDistance>40)  {
  noObject = "Out of Range";
  }
  else {
  noObject = "In Range";
  }
  fill(0,0,0);
  noStroke();
  rect(0, height-height*0.0648, width, height);
  fill(98,245,31);
  textSize(25);

  text("10cm",width-width*0.3854,height-height*0.0833);
```

```
  text("20cm",width-width*0.281,height-height*0.0833);
  text("30cm",width-width*0.177,height-height*0.0833);
  text("40cm",width-width*0.0729,height-height*0.0833);
  textSize(40);
  text("Project by: Y K ", width-width*0.875, height-height*0.0277);
  text("Angle: " + iAngle +" Â°", width-width*0.48, height-height*0.0277);
  text("Distance: ", width-width*0.26, height-height*0.0277);
  if(iDistance<40) {
  text("        " + iDistance +" cm", width-width*0.225, height-height*0.0277);
  }
  textSize(25);
  fill(98,245,60);
  translate((width-width*0.4994)+width/2*cos(radians(30)),(height-height*0.0907)-
width/2*sin(radians(30)));
  rotate(-radians(-60));
  text("30Â°",0,0);
  resetMatrix();
  translate((width-width*0.503)+width/2*cos(radians(60)),(height-height*0.0888)-
width/2*sin(radians(60)));
  rotate(-radians(-30));
  text("60Â°",0,0);
  resetMatrix();
  translate((width-width*0.507)+width/2*cos(radians(90)),(height-height*0.0833)-
width/2*sin(radians(90)));
  rotate(radians(0));
  text("90Â°",0,0);
  resetMatrix();
  translate(width-width*0.513+width/2*cos(radians(120)),(height-height*0.07129)-
width/2*sin(radians(120)));
  rotate(radians(-30));
  text("120Â°",0,0);
  resetMatrix();
  translate((width-width*0.5104)+width/2*cos(radians(150)),(height-height*0.0574)-
width/2*sin(radians(150)));
```

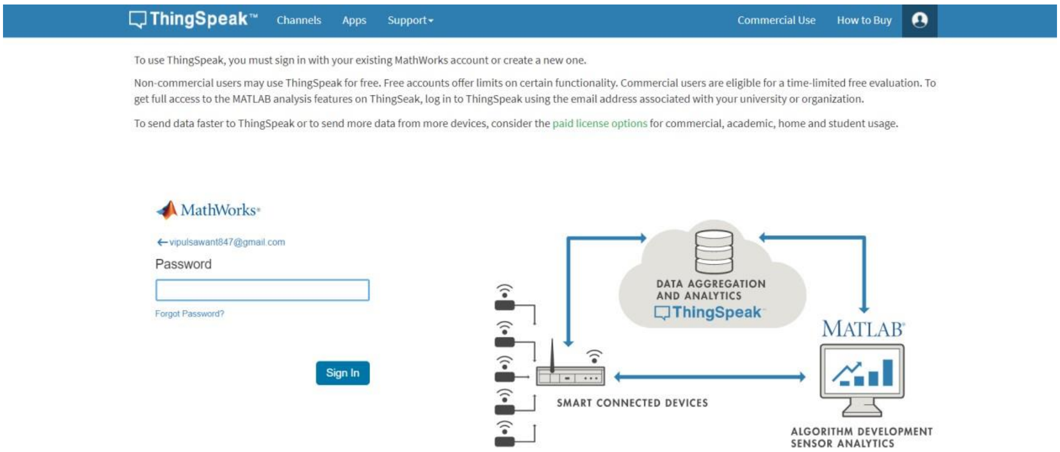
```
  rotate(radians(-60));
  text("150Â°",0,0);
  popMatrix();
}
```

Test Cases

1. **Testcase ID :** TEST01
2. **Testcase Description :** Loging in the front end site(thingspeak)
3. **Initial State :** idle
4. **Given Input :**login details
5. **Actual Output :**

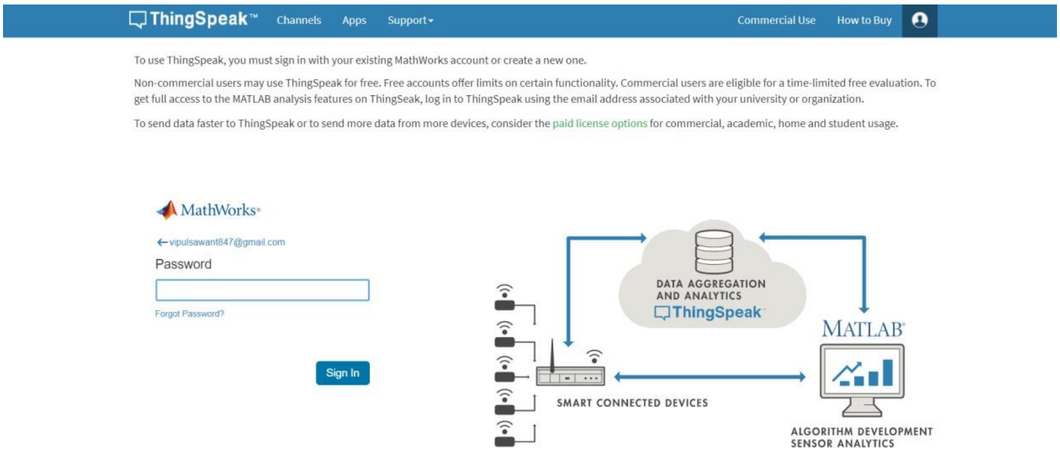


6. **Expected Output :**

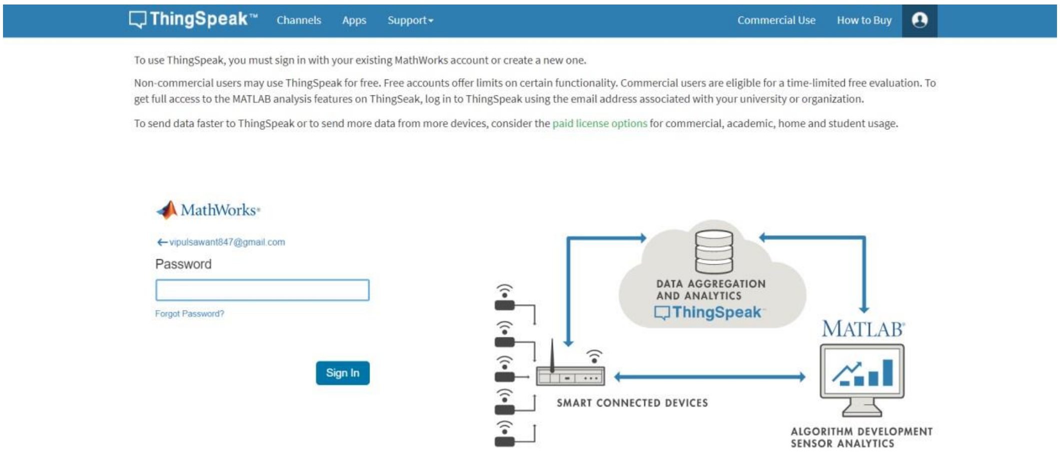


7. **Result :** Unsuccessful

1. **Testcase ID :** TEST02
2. **Testcase Description :** Retry log in
3. **Initial State :** idle
4. **Given Input :** login details
5. **Actual Output :**

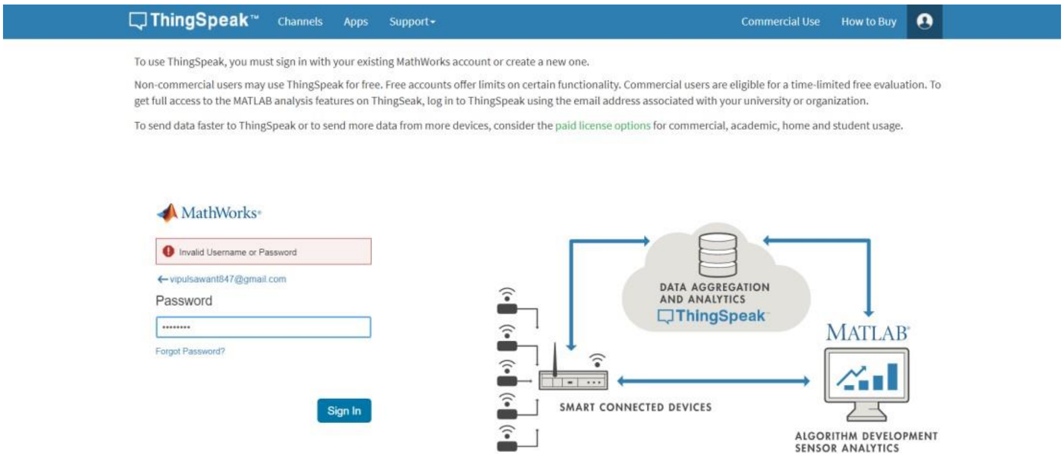


6. **Expected Output :**

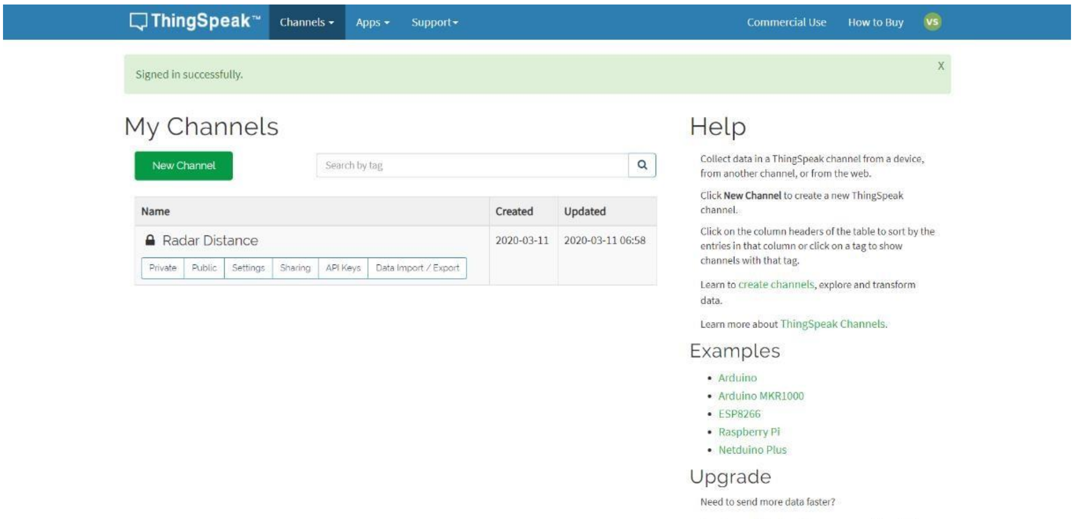


7. **Result :** Successful

1. **Testcase ID :** TEST03
2. **Testcase Description :** Enter Password
3. **Initial State :** Login
4. **Given Input :** Password
5. **Actual Output :**

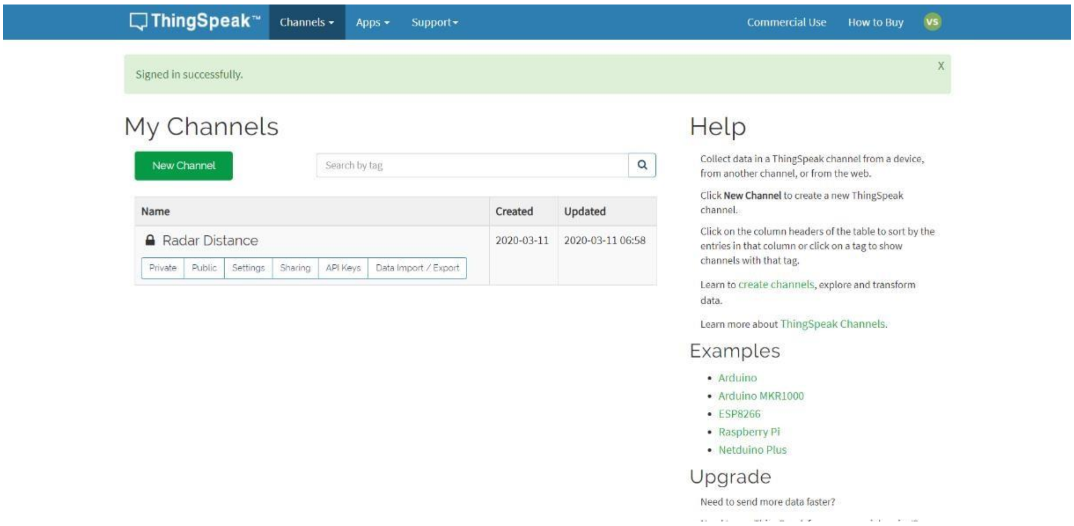


6. **Expected Output :**

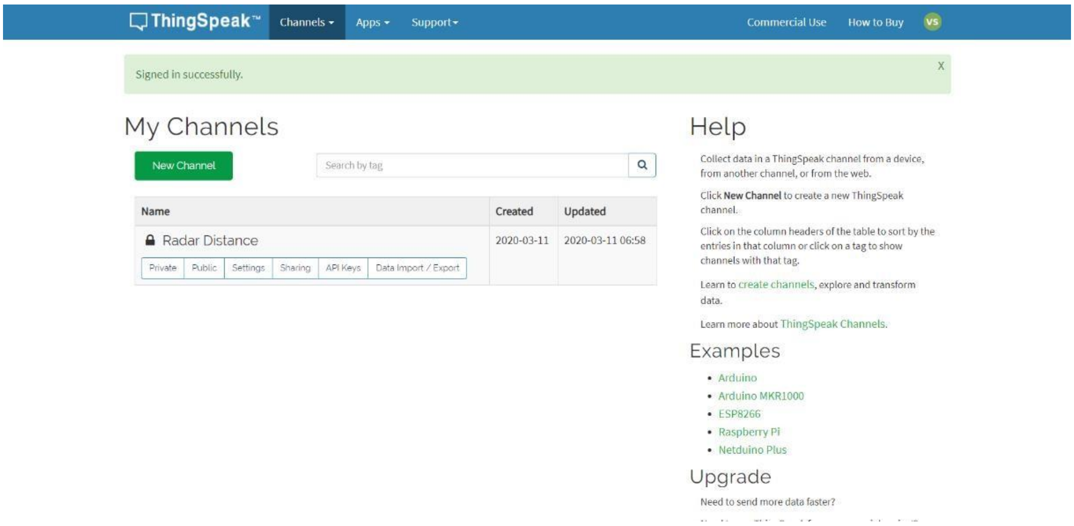


7. **Result :** Unsuccessful

1. **Testcase ID :** TEST04
2. **Testcase Description :** Retrying Password
3. **Initial State :** Login
4. **Given Input :** Password
5. **Actual Output :**

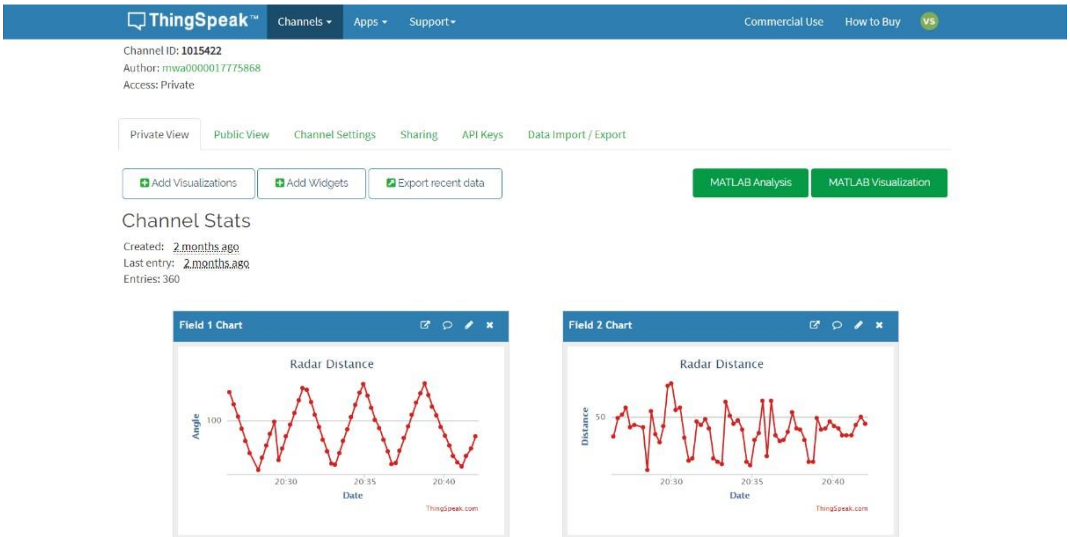


6. **Expected Output :**

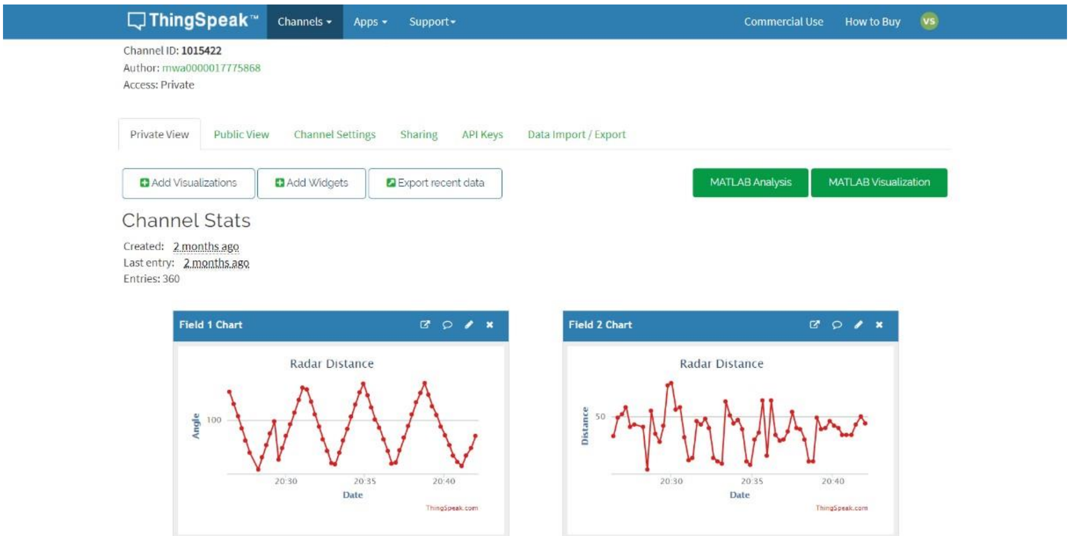


7. **Result :** Successful

1. **Testcase ID :** TEST05
2. **Testcase Description :** Load Project file
3. **Initial State :** log in
4. **Given Input :** select file
5. **Actual Output :**

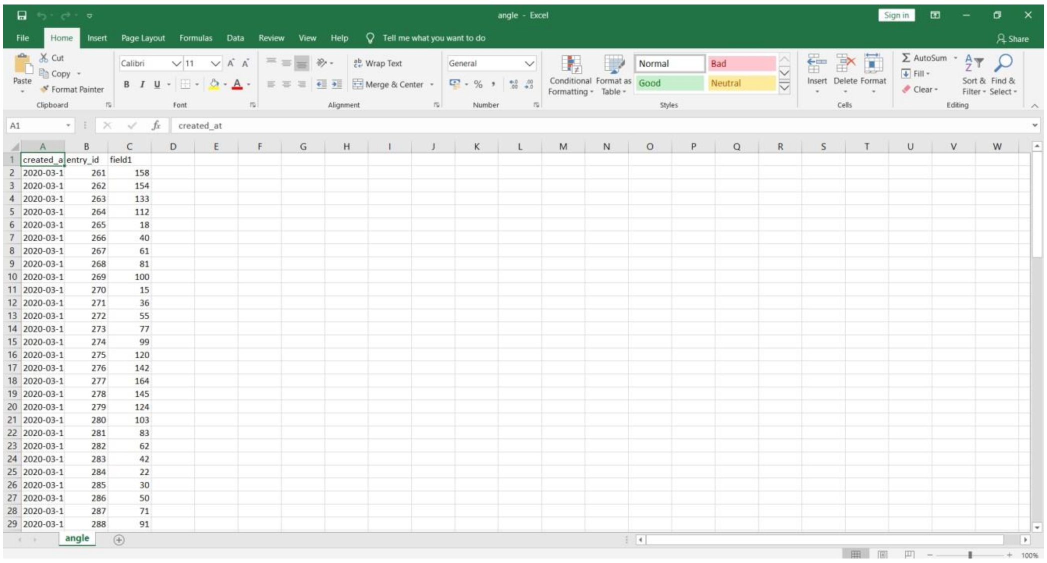


6. **Expected Output :**

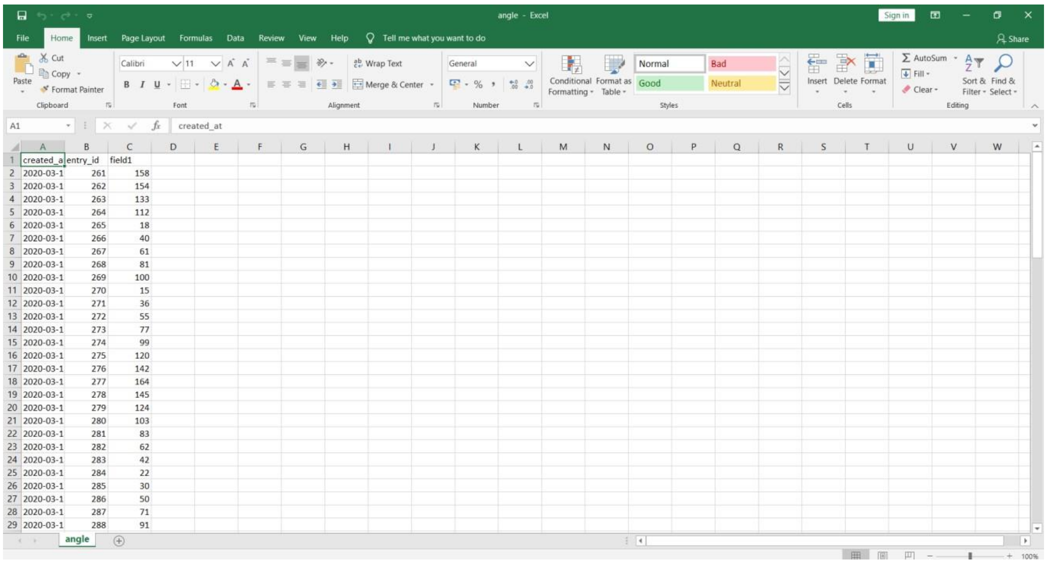


7. **Result :** Successful

1. **Testcase ID :** TEST06
2. **Testcase Description :** Access Database
3. **Initial State :** Load File
4. **Given Input :** download datasheet
5. **Actual Output :**

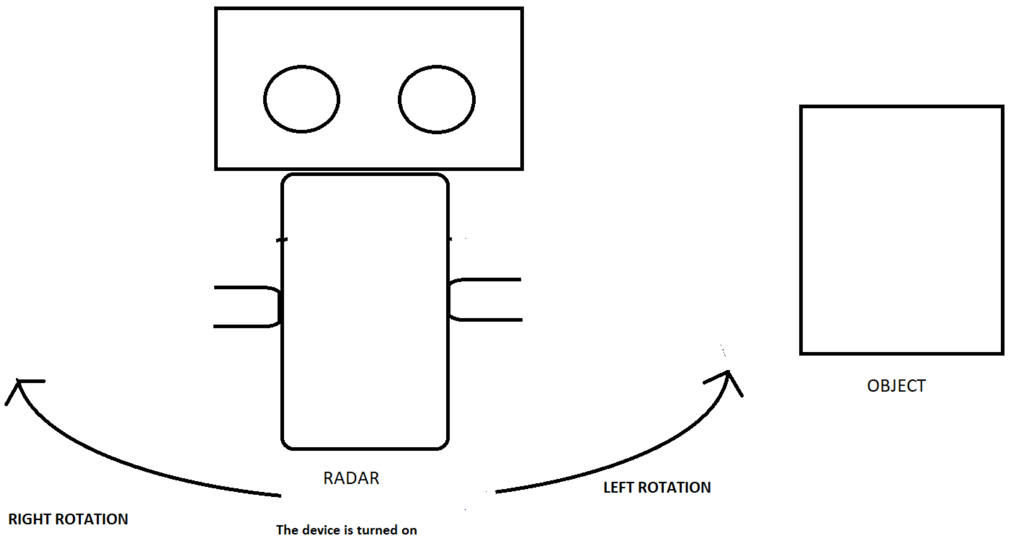


6. **Expected Output :**

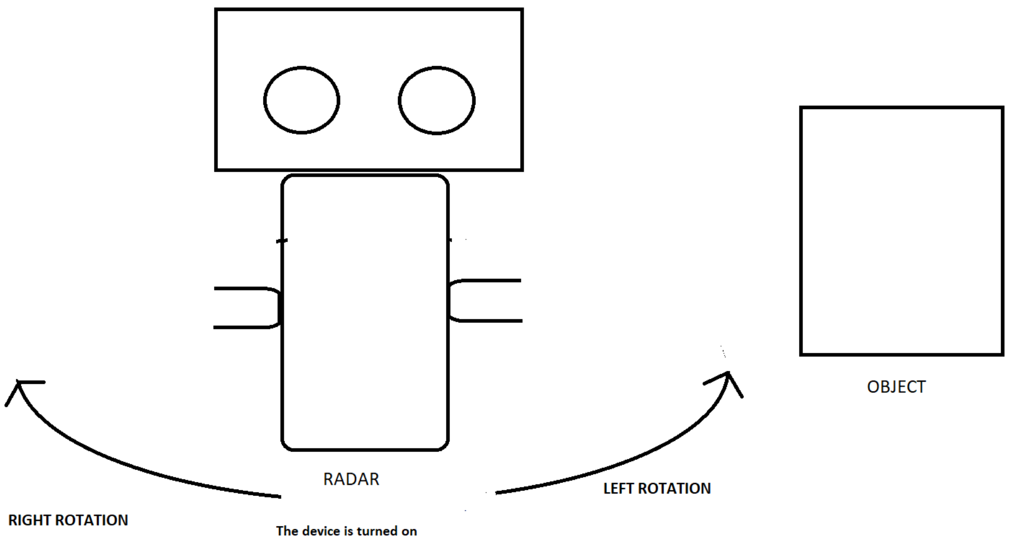


7. **Result :** Successful

1. **Testcase ID :** TEST07
2. **Testcase Description :** Turning on radar module
3. **Initial State :** idle
4. **Given Input :** on
5. **Actual Output :**

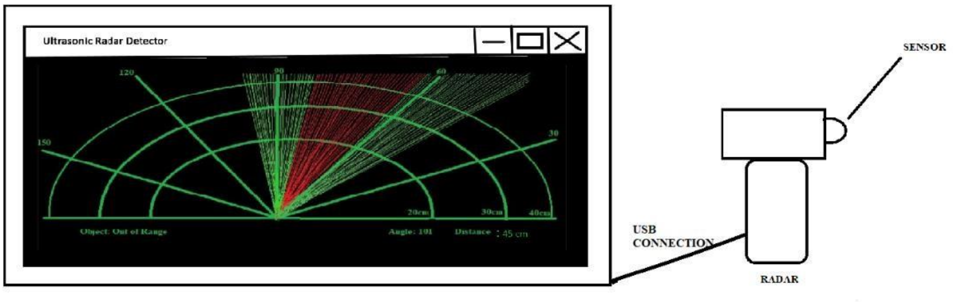


6. **Expected Output :**

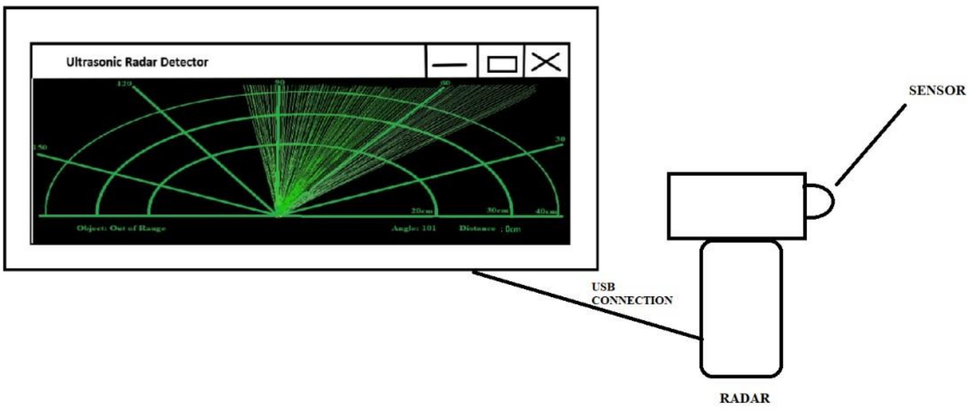


7. **Result :** Successful

1. **Testcase ID :** TEST08
2. **Testcase Description :**
3. **Initial State :** At 0 degrees
4. **Given Input :** Start
5. **Actual Output :**

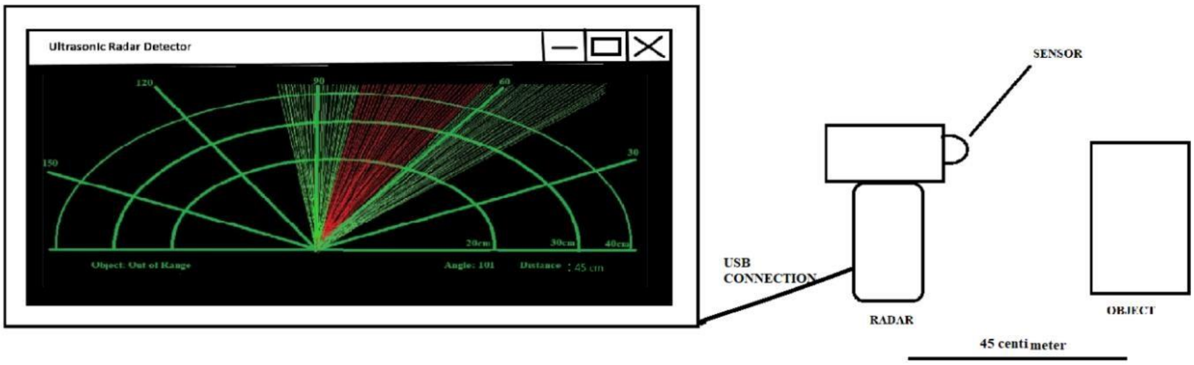


6. **Expected Output :**



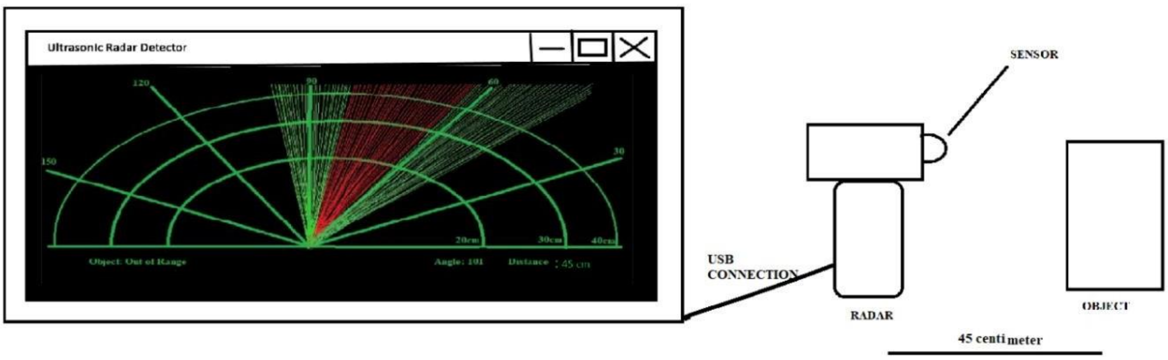
7. **Result :** Unsucessful

1. **Testcase ID :** TEST09
2. **Testcase Description :** Detecting direction and sensing the distance of the object
3. **Initial State :** At 0 degrees
4. **Given Input :** Start
5. **Actual Output :**



Distance is measured and direction of the object is detected

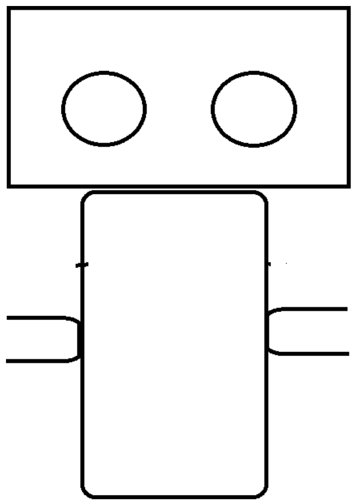
6. **Expected Output :**



Distance is measured and direction of the object is detected

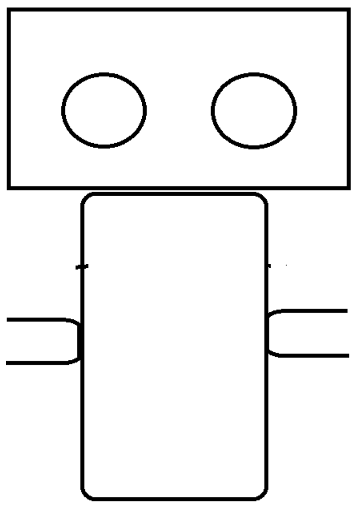
7. **Result :** Successful

1. **Testcase ID :** TEST10
2. **Testcase Description :** Turning off the device
3. **Initial State :** Scanning objects
4. **Given Input :** Stop
5. **Actual Output :**



DEVICE IS TURNED OFF

6. **Expected Output :**



DEVICE IS TURNED OFF

7. **Result :** Successful

Chapter 5 : Results And Discussions

The Ultrasonic radar system is working fine and with minimum error. Angle and Distance between the radar module and the object/intruder is displed on the processing ide and is also uploaded on the database thingspeak as well and can be downloaded in spreadsheet format.

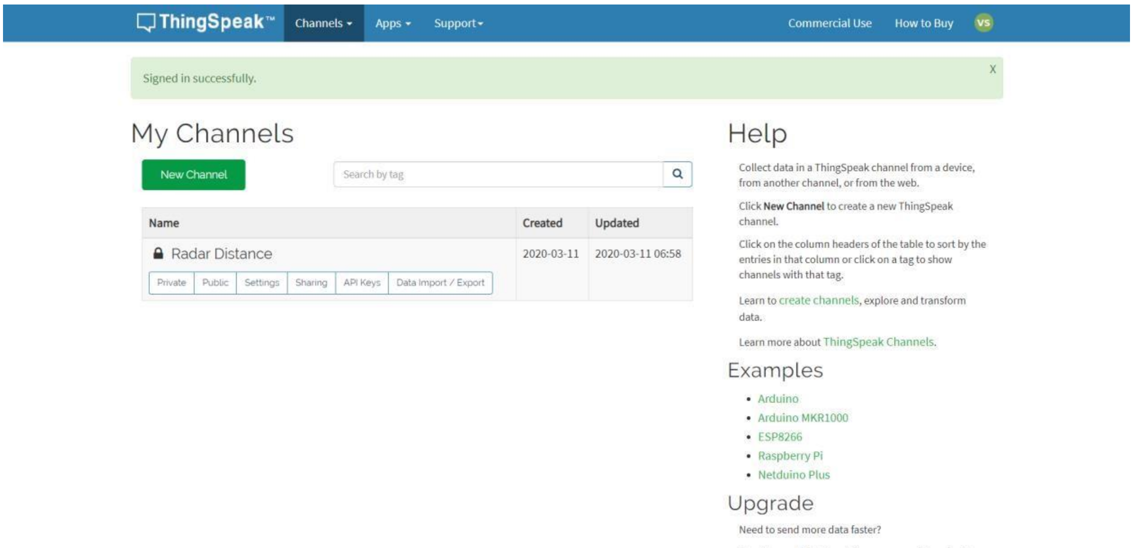


Figure 5.1 Project Load file

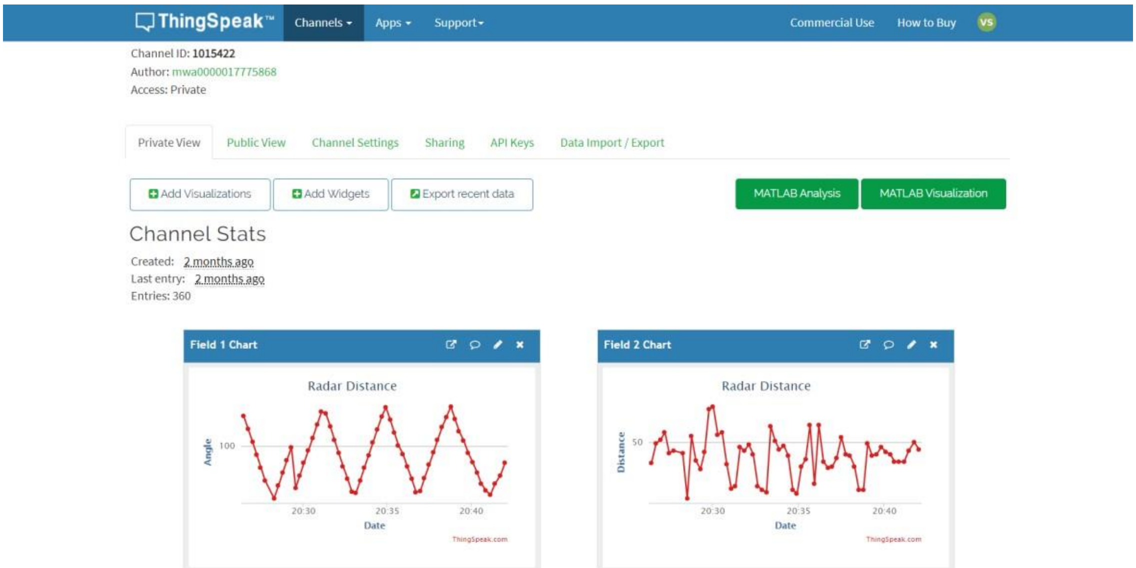
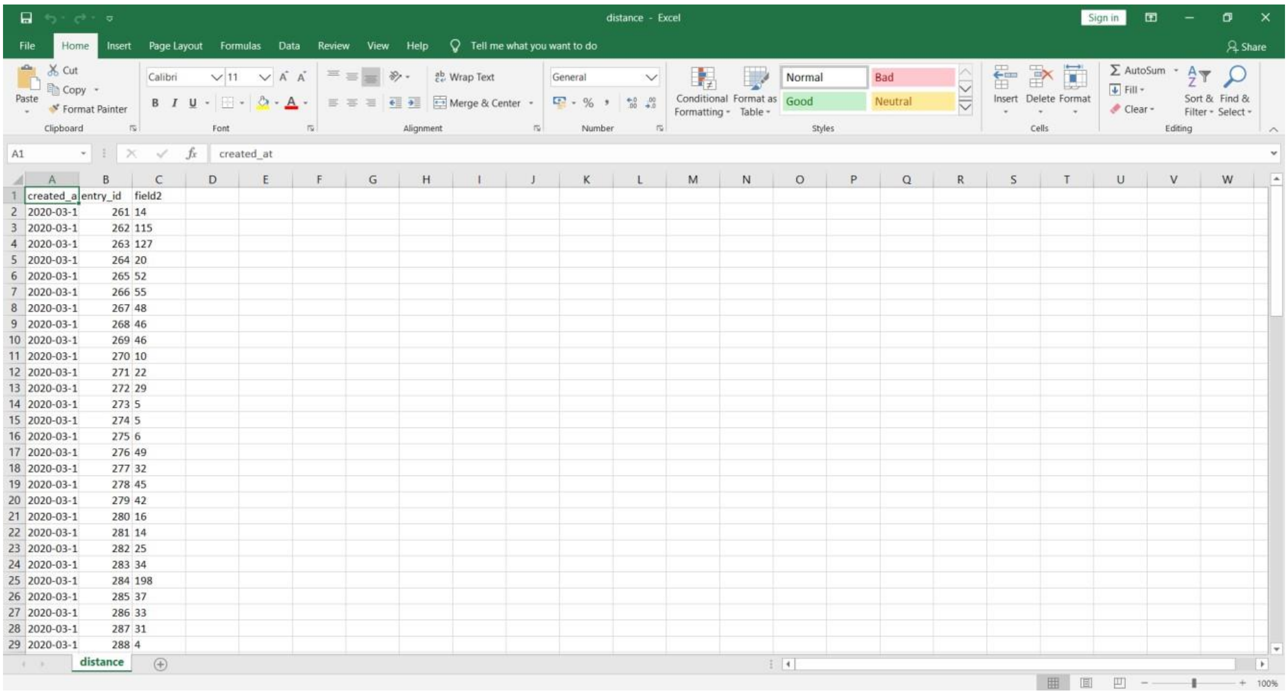
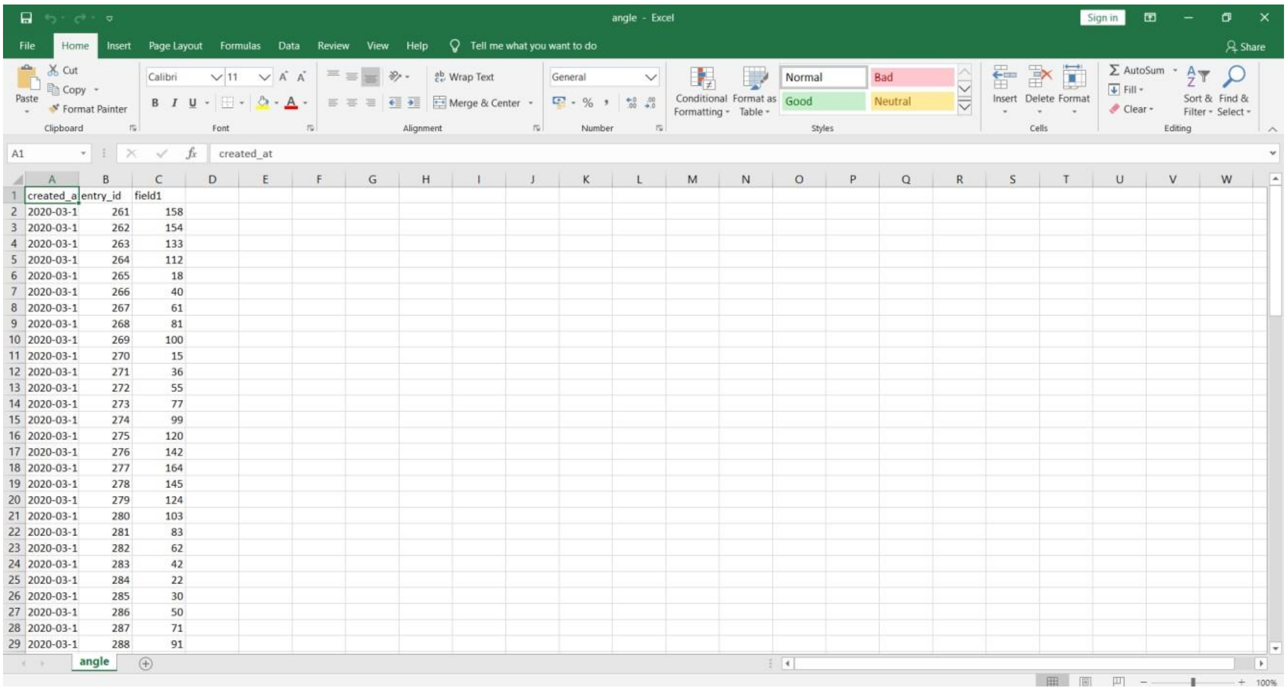


Figure 5.2 record of distance an angle detected on the radar module with date and time



created_a	entry_id	field2
2020-03-1	261	14
2020-03-1	262	115
2020-03-1	263	127
2020-03-1	264	20
2020-03-1	265	52
2020-03-1	266	55
2020-03-1	267	48
2020-03-1	268	46
2020-03-1	269	46
2020-03-1	270	10
2020-03-1	271	22
2020-03-1	272	29
2020-03-1	273	5
2020-03-1	274	5
2020-03-1	275	6
2020-03-1	276	49
2020-03-1	277	32
2020-03-1	278	45
2020-03-1	279	42
2020-03-1	280	16
2020-03-1	281	14
2020-03-1	282	25
2020-03-1	283	34
2020-03-1	284	198
2020-03-1	285	37
2020-03-1	286	33
2020-03-1	287	31
2020-03-1	288	4

Figure 5.3 excel spreadsheet record of the distance detected on the radar module with date and time downloaded on the computer



created_a	entry_id	field1
2020-03-1	261	158
2020-03-1	262	154
2020-03-1	263	133
2020-03-1	264	112
2020-03-1	265	18
2020-03-1	266	40
2020-03-1	267	61
2020-03-1	268	81
2020-03-1	269	100
2020-03-1	270	15
2020-03-1	271	36
2020-03-1	272	55
2020-03-1	273	77
2020-03-1	274	99
2020-03-1	275	120
2020-03-1	276	142
2020-03-1	277	164
2020-03-1	278	145
2020-03-1	279	124
2020-03-1	280	103
2020-03-1	281	83
2020-03-1	282	62
2020-03-1	283	42
2020-03-1	284	22
2020-03-1	285	30
2020-03-1	286	50
2020-03-1	287	71
2020-03-1	288	91

Figure 5.4 excel spreadsheet record of the Angle detected on the radar module with date and time downloaded on the computer

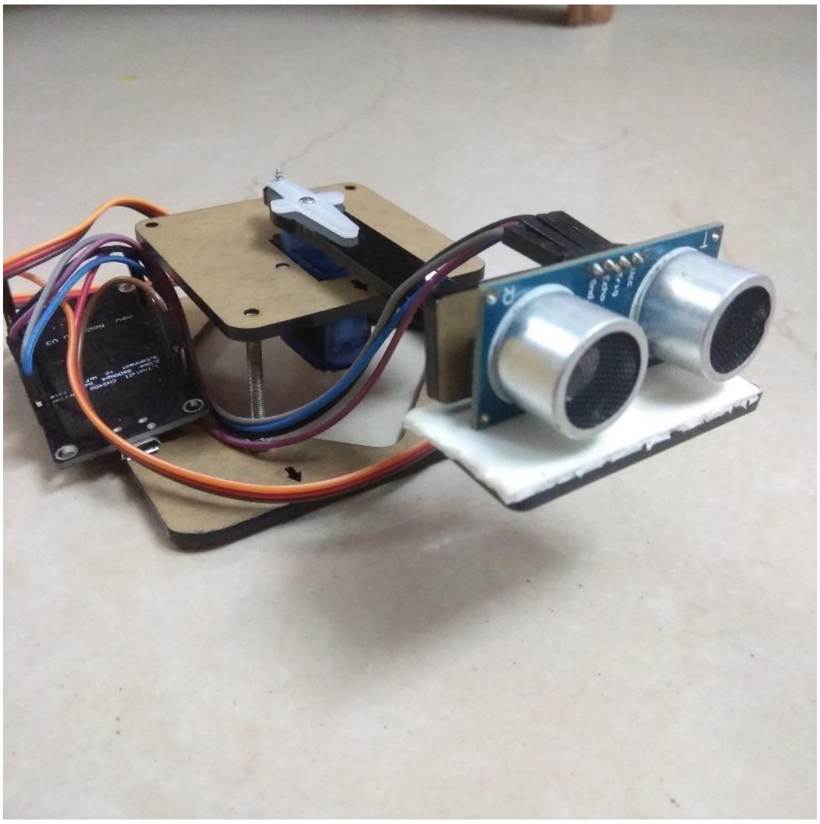


Figure 5.5 Project on completion

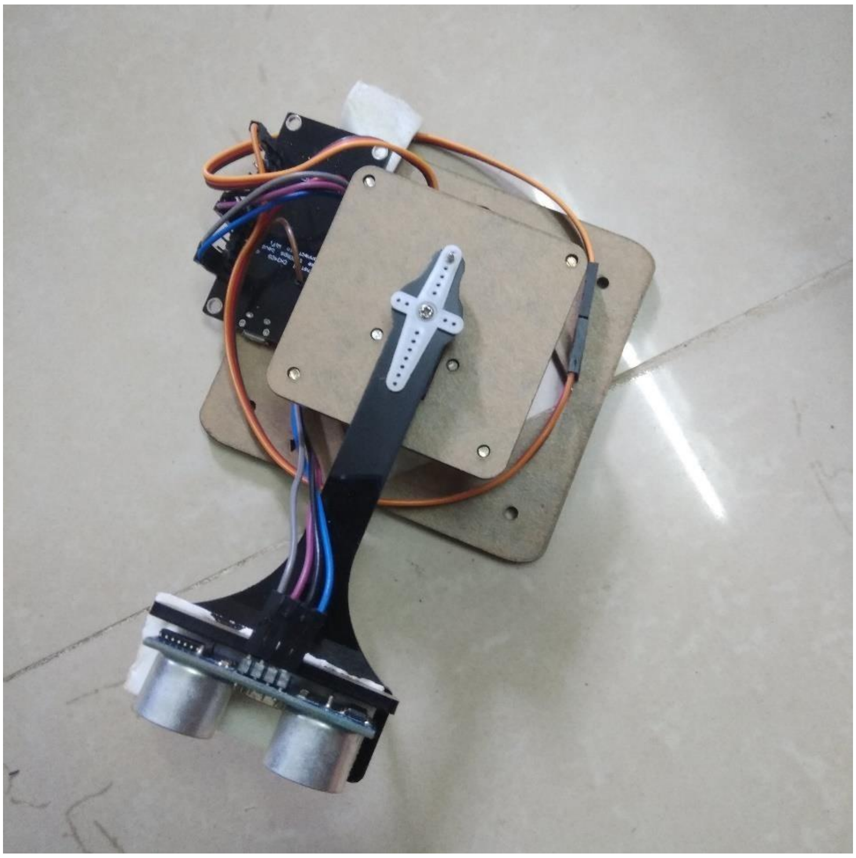


Figure 5.6 Top Angle view of project

Chapter 6 : Conclusion And Future Work

The Project Ultrasonic Radar System works fine as it detects object that is in its field of vision. It provides data the angle at which the object/intruder is detected and the distance between the object/intruder and the ultrasonic radar system at the angle the object/intruder is detected. The graph is plotted on the processing ide and data that is represented is precise. The data generated is uploaded by the NodeMCU8266 microcontroller to the database/front end site Thingspeak. The access to for the thingspeak site is simple and log in process is success The Data is Uploaded with date and time and can be downloaded in .csv(Microsoft excel spreadsheet) format or xml(extensive markup language) format with ease. This data can be downloaded from the site. The Project is working fine.

The idea of making an Ultrasonic RADAR appeared while viewing the technology used in defense, be it Army, Navy or Air Force and now even used in the automobiles employing features like automatic/driverless parking systems, accident prevention during driving etc. The applications of such have been seen recently in the self parking car systems launched by AUDI, FORD etc. And even the upcoming driverless cars by Google like Prius and Lexus.

This advanced Ultrasonic Radar system can be used to monitor local patch area and can also scan suspicious object. One can remotely control a car having explosive material in it. With the help of this Ultrasonic radar system project we can prevent the enemies to reach the public and thus many lives can be saved. This Ultrasonic Radar project system continuously scans the area and gives a beep sound on detecting an object, simultaneously, the radar provides the angle as well as distance of the object from our source. This system helps in tracking the exact position and trace the path followed by the object. The project made can be used in any systems you may want to use like in a car, a bicycle or anything else. The use of Arduino in the project provides the flexibility of usage of the above-said module according to the requirements.

Chapter 7 : References

https://www.wikipedia.org

https://www.arduino.cc

https://nevonprojects.com/ultrasonic-radar-project/

www.electronics-notes.com/articles/electronic_components/

https://www.electronics-lab.com/project/using-sg90-servo-motor-arduino/

https://www.electronicsforu.com/electronics-projects/hardware-diy/microcontroller-based-ultrasonic-radar-atmega128

https://www.microcontrollertips.com/principle-applications-limitations-ultrasonic-sensors-faq/