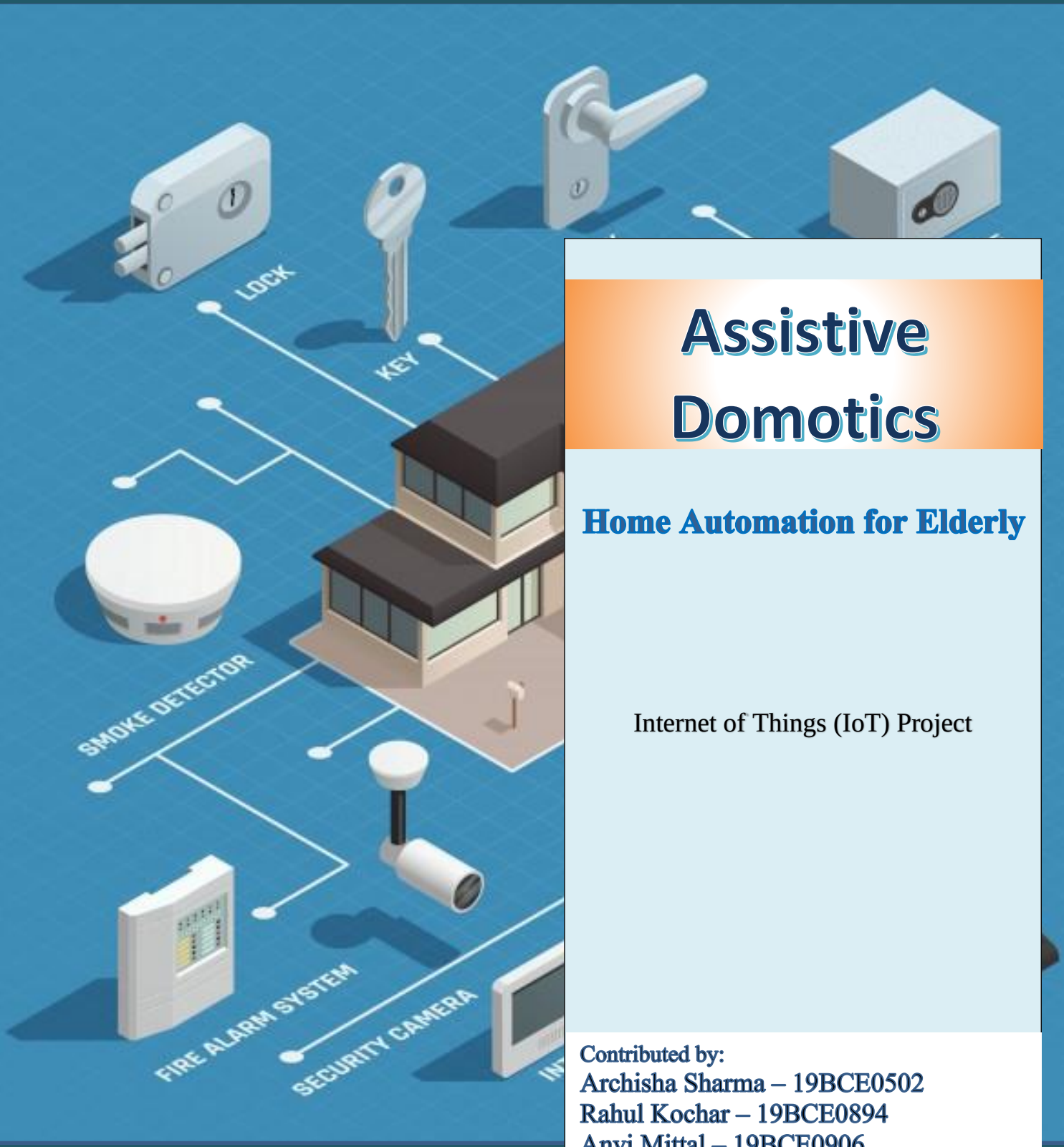
Project Report



Assistive Domotics

Home Automation for Elderly

Internet of Things (IoT) Project

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We take this opportunity to thank all our lecturers who have directly or indirectly helped our project. We would also like to express our gratitude towards our parents and fellow peers for their kind co-operation and encouragement while developing this project which helped us in the completion of this project.

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ABSTRACT

This paper reviews the opportunities to leverage the benefits of technology evolution for the elderly, so that they can live comfortably and securely. Active research is being carried out to extend the benefits of information and communication technologies to the elders so that they are enabled to live independently and promote a sense of overall well-being.

IoT advancement in recent years has helped to bring the cost of hardware significantly down and hence making more accessible for common man. This has also given made possible to think about innovative use-cases for different generation of people.

This project is an attempt to explore the use of IoT for elderly people but nevertheless some use-cases can be of relevance to other generations as well. There are a lot of technologies available, which can be tied together thoughtfully, to make the life of elderly comfortable and safe. The technologies which are available include Wi-Fi, Bluetooth, 4G Cellular, Cloud-native software, voice control with natural language processing, low cost controllers, and sensors, to mention few.

Intention is also to learn the concepts of IoT by utilizing various technologies like Bluetooth and Wi-Fi. The project also is expected to provide insight into various IoT controllers, sensors, and related hardware components. Mobile application development is also part and parcel of this project.

All objectives of the project are successfully met.

1 CHAPTER 1: INTRODUCTION

1.1 Introduction

Home automation technology is increasing in the number of households it is in because of all the benefits it presents. Home automation has also been proved to be a tremendous benefit for the elderly and disabled. A form of home automation systems called Assistive Domotics provides a wide range of features that can aid in those with specific accessibility concerns in their homes. Elderly, handicapped patients, and people with disabilities who have problems with locomotion difficulty can benefit from this smart home to totally operate, with high performance, various appliances, and devices from anywhere in the house. It can help improve a persons' quality of life, especially when combined with other types of technology. These technology systems and assisting equipment have become a viable option for those who would rather stay in their homes. It not only provides the remote control of various appliances but also provided the information about their health like temperature and BPM and also provide insight about the environment around them like air quality/gas leak, rain situation, temperature. It also provides then an easy access to the alarm system, to seek the immediate help in case of any emergency. Home automation has various focal points, for instance, comfort, extended security, and essentialness viability. In a period of remote development, for instance, Bluetooth, Wi-Fi, Zigbee, and GSM, customers need home mechanical assemblies to be related remotely. All of these remote developments has its very own giganticness and subtleties. This project adequately uses Bluetooth which can cover the whole home premises and Wi-Fi which can be accessed from anywhere in the world.

On the host side, the framework should be straightforward, with the objective that the devices can be checked and controlled viably. In the occasion of any issues later on, the interface of the structure should give definite organizations. Finally, the structure should be smart with the objective that it might be commonly used by anyone in the market.

1.2 Internet of Things (IoT)

We are witnessing the dawn of a new era of Internet of Things (IoT; also known as Internet of Objects). IoT refers to the networked interconnection of everyday objects, which are often equipped with ubiquitous intelligence. IoT will increase the ubiquity of the Internet by integrating every object for interaction via embedded systems, which leads to a highly distributed network of devices communicating with human beings as well as other devices. Thanks to rapid advances in underlying technologies, IoT is opening tremendous opportunities for a large number of novel applications that promise to improve the quality

of our lives. In recent years, IoT has gained much attention from researchers and practitioners from around the world.

The definition of the Internet of Things has evolved due to the convergence of multiple technologies, real-time analytics, machine learning, commodity sensors, and embedded systems. Awesome advances in sensors, devices and (M2M) or machine to contraption network have made the basic web of things that are especially encouraging and furthermore have the limit epitomizing a phenomenal open entryway for big business that could make it go.

1.3 Why Home Automation for elderly is needed?

Home automation can help accomplish many tasks and will only improve in the years to come.

Figure 1: Home Automation Areas for Elderly

Health Care, Remote Monitoring, daily medical testing, Remote medical consultation, Medical care coordination, Long distance care giving, Family caregiving coordination, Communication, Relationships, Home safety, Fall prevention, Security, Lighting

Following has been successfully demonstrated in the project:

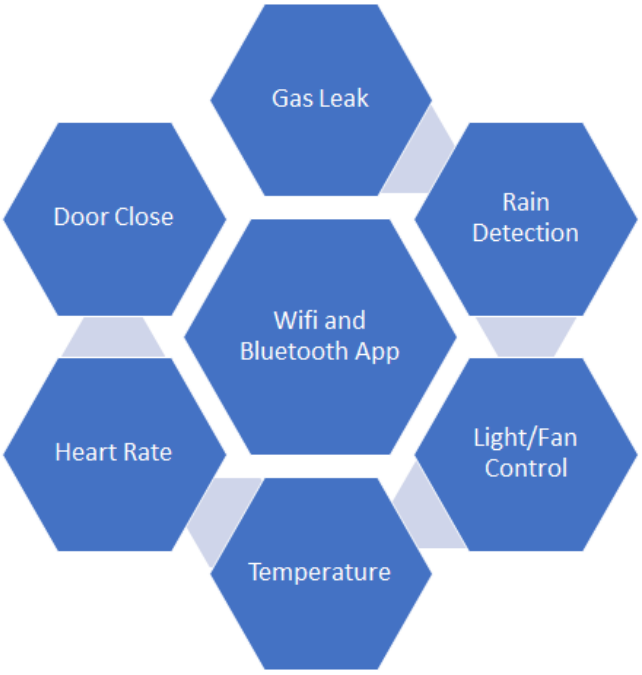


Figure 2: Features Implemented

1.4 Problem Statement

In present day scenario, elderly people have to live alone at their native place while their children have to go to distant places either for studies or for earning livelihood. While elderly do not want to leave their place and move to a new place with their children, the children are worried about the health, safety and security of their parents who are growing old.

Therefore, it is important to have a system in place which equips the elderly with monitoring and control capabilities, while they stay alone. The children get to know the key health and environmental parameters for their parents remotely.

1.5 Objectives

1. To assembling a home automation robotization structure using the gadgets which are associated with Mobile Application, using Wi-Fi and Bluetooth as communication modes.
2. Integrate the gadgets to the controller for the seamless monitoring and control.
3. Write the suitable programs to control the devices.
4. Develop the Mobile applications which can interface with the gadgets thru a controller.
5. Test the set up and analyse the data: After the system is set-up, with the help of a mobile phone and a controller, tests are driven while data is recorded and inspected.
6. Make it work end to end.

2 CHAPTER2 – LITERATURE SURVEY

2.1 Literature Survey

Author, Paper name, Year	Abstract	Result	Drawbacks
A Research on Home Automation for Elderly and Physically Challenged People by using IOT **Year:** 2019 **Authors:** Chaitra N, Ashwini C S, Shyma Zaidi	In this paper the home automation systems to support elderly and physically challenged people in providing them a secure, safe and controlled environment is reviewed. Various technologies like Brain Controlled Interface (BCI) technology, Human Computer Interface system, GSM SMS services, Bluetooth, PIC Microcontroller with ZigBee modulation, Voice controlled home automation, Novel Electrooculogram (EOG), Assistive Visible Light Communication (VLC) etc. are discussed. By using smart home technology, the life of such people becomes easier and comfortable. The proposed paper is dedicated to old age and physically impaired people.	From all the above papers, every smart home system uses different technologies where Android phones play a very important role in all the types of systems. The Brain computer interface system uses the brain signals to control appliances. GSM network systems will enable the user to control things from all around the world whereas Bluetooth network systems will be able to control within a specific range . A Wi-Fi based home automation system can be controlled by using Wi-Fi mode of transmission .	This paper talks about the detailed study of home automation systems to support elderly and physically challenged people, but doesn't speak about the various ways to implement it,hence, the drawback.
Year: 2019 **Name:** **Authors:** Ning An, Tanbir Hassan, Jingyu Yu	This article reports on a pilot study of a smart home for elders (SHfE) designed to continuously monitor senior adults' daily behaviors and the living environment of	The results indicated that the SHfE is a feasible way to analyze the behaviors (e.g., sleeping, cooking, water usage) of the elder and monitor the built environment (e.g.,	It speaks about the ShfE study which gives a jist of the analysis of the adult behaviour in elderly people, which again can help in building a useful tool. Nonetheless,the

	their residential homes using the application of unobtrusive sensors. SHfE users include older adults, their family members, and healthcare staff.	temperature, windows, and doors).	implementation is not shown here.
Name: Smart-Home Technologies to Assist Older People to Live Well at Home **Year:** 2013 **Authors:** Meg E. Morris, Brooke Adair, Kimberly Miller, Elizabeth Ozanne, Ralph Hansen, Alan J. Pearce, Nick Santamaria, Luan Viegas, Maureen Long and Catherine M.	With the rapid population ageing that is occurring world-wide, there is increasing interest in "smart home" technologies that can assist older adults to continue living at home with safety and independence. This systematic review and critical evaluation of the world wide literature assesses the effectiveness and feasibility of smart-home technologies for promoting independence, health, well-being and quality of life, in older adults.A total of 1877 "smart home" publications were identified by the initial search of peer reviewed journals. Of these, 21 met our inclusion criteria for the review and were subject to data extraction and quality assessment. Older adults were reported to readily accept smart-home technologies, especially if they benefited physical activity, independence and function and if privacy concerns were addressed. Given the modest number of	Smart-home technologies included different types of active and passive sensors, monitoring devices, robotics and environmental control systems. One study assessed the effectiveness of a smart home technology. Sixteen reported on the feasibility of smart-home technology and four were observational studies.	This paper gives a summary of what all can be done to assist the elderly using present technologies and it talks about the various devices that can be used in order to build a useful monitor for the elderly. Also it gives a complete analysis as to what problems are faced by the elderly at such a tender age.But, again, it doesn't provide us with a handful solution to the problem ie here the implementation is not taken care of.

	objective analyses, there is a need for further scientific analysis of a range of smart home technologies to promote community living.		
Name: Smart Homes for Elderly Healthcare—Recent Advances and Research Challenges **Year:** 2017 **Authors:** by Sumit Majumder ,Emad. Aghayi ,Moein Noferesti ,Hamidreza Memarzadeh-Tehran ,Tapas Mondal ,Zhibo Pang OrcID andM. Jamal Deen	The elderly may require frequent, immediate medical intervention, which may otherwise result into fatal consequences. Such emergency situations can be avoided by monitoring the physiological parameters and activities of the elderly in a continuous fashion. Such smart homes are outfitted with unobtrusive and non-invasive environmental and physiological sensors and actuators that can facilitate remote monitoring of the home environment (such as temperature, humidity, and smoke in the home) as well as important physiological signs (such as heart rate, body temperature, blood pressure and blood oxygen level), and activities of the occupants.	The primary objective of the smart homes is to allow the elderly to receive continuous, non-invasive and seamless healthcare service while staying in their convenient home environment. It allows the elderly to minimize their frequency of visits to, or length of stay in expensive healthcare centers such as clinics, hospitals and long term care centers, thereby allowing them to lead independent and active lives.	The smart automation in this case is only addressed to a particular domain.A fully and functional comprehensive smart home is required that addresses all aspects. Moreover it should be energy efficient and it should be of low power consumption.
Name: Ageing in place and the internet of things – how smart home technologies, the built environment and caregiving intersect **Year:**2018 **Author:**	Research into Ageing in Place and home environments has focused on built environments and largely ignored the impact of technology in the lives of older people staying at home. Recognizing a gap in acknowledging the potential impact of	smart home technologies are a valuable exploration to complement Ageing in Place interventions including home modifications and existing informal and formal care services by working in the following ways:	Research covered in the paper indicates that impacts on care, independence and wellbeing are likely to take place but there is currently no long-term data available. IoT technologies have been developed in the area of

Phillippa Carnemolla	technology on Ageing in Place theories, the purpose of this paper is to conceptualize a way of framing smart technology within an Ageing in Place model that acknowledges the interaction of smart technology with the built environment and caregiving and to present a framework for visualising the interactions that take place.	1.to facilitate self-care and autonomy by removing the need for third party intervention in order to complete daily tasks 2.to support older people's safety in the home by automating tasks and reducing risk 3.to support confidence levels in conducting daily tasks though increasing safety and reducing risk	appliance automation for smart homes that can be applied to a self-care model of ageing in place, however very little research has been conducted in this area.
Name: Needs and Solutions - Home Automation and Service Robots for the Elderly and Disabled **Year**:2015 **Author:** Panu Harmo, Tapio Taipalus, Jere Knuuttila, José Vallet and Aarne Halme	Research consists of three phases. In questionnaire-study phase opinions and needs for home automation and home robotics are analyzed. Interview-study phase includes interviews with different specialists, the elderly and disabled themselves, and excursions to care houses and other related institutions. Literature-study reveals user needs as well, but it concentrates more on solutions than the other phases. Multiple needs and solutions were found. They have been discussed and the results are presented in an organized table.	The most interesting feature to the visitors was a stove alarm system.The further features were: (1)Delivering messages and controlling equipment with mobile phone (2)Universal remote controller for TV, radio and environmental controls (3)Key reminder, which reminds the user to store the keys in a certain place and take them when going out. (4)Activity monitoring, alerts care personnel if there are changes to normal activity levels. (5) Environmental controls by voice Notification of mail in mailbox	There is no weighting in importance of the problem indicated but only the problems seen as key factors hindering elderly people's lives at home are selected.

3 CHAPTER 3 – METHODOLOGY

3.1 Proposed System Features

As we enter the twenty first century, the transaction among individuals and pc is breaking vintage confinements and coming into another domain. Inside the massively innovation, driven worldwide these days, Mobile phones have become an important asset of our life. Our endeavour attempts to interface mobile phone with the household machines/appliances which have been otherwise controlled through switches. With the introduction of IoT, these gadgets can be turned ON and OFF remotely at whatever point needed. The proposed task is considered systems administration our cell mobile to all machines through a smart trustworthy circuit. The proposed gadget incorporates smart Circuit associated with the home hardware.

3.2 Proposed Home Automation System Use-cases:

The end user, who is elderly in this case can utilize their mobile phone control the appliances. There are following key use cases:

Use-case 1 – Controlling Appliances: As elderly people are weak and cannot always roam around the Home to switch on/off the various appliances example light ot Fan etc. hence the proposed home automation system provides the control of all home appliances thru their fingertips, thru the Mobile application. They can switch on-off the appliances from anywhere in the house or even from some distant location.

Use-case 2 – Monitoring Health Parameters: As key body vitals for elderly keep fluctuating, it is important that key body parameters are monitored by them and also available to be monitored remotely by the remote doctor. The key parameters monitored in this project are Temperature and Pulse Rate but many more parameters can be integrated.

Use-case 3 – Safety: As memory loss is one of the key conditions associated with old age. Elderly may leave the gas stove know turn on without igniting the stove or they may leave the door open, creating the safety issues. This home automation system realizes a monitoring system for:

- Gas leak detection by means of using Gas Sensor
- Door open indication by means of using Magnetic Reed Sensor
- Rain detection by using rain sensor.

Many more similar sensors like PIR etc, can be used to detect the presence of person at a door. All such sensors provide the useful environmental information thru Mobile application and make the elderly take actions based on information.

Use-case 4: Security: In event of any emergency, the provision of alarm is given thru the mobile app. The emergency alarm can be mounted either outside the home door or in the security room of a society, so that elderly can raise alarm in case of any emergency or help.

3.3 Technologies & Hardware Controllers Used:

In order to demonstrate two different communication technologies and the associated capabilities, the project is realized with two different controllers and Mobile applications.

- Bluetooth based home automation
- Wi-Fi based home automation

3.3.1 Bluetooth Based Home Automation:

This implementation uses Arduino UNO as main controller unit which is interfaced with HC05 Bluetooth module for communication with mobile phone.

3.3.1.1 Sensors and actuators used

- Smoke and Air Quality Sensor: MQ-135
- Rain Sensor Module
- Reed Magnetic Sensor

3.3.1.2 Application Platform

MIT App Inventor platform is used to develop the mobile application. MIT App Inventor is a web application integrated development environment originally provided by Google, and now maintained by the Massachusetts Institute of Technology.

It uses a graphical user interface (GUI) very similar to the programming languages Scratch (programming language) and the StarLogo, which allows users to drag and drop visual objects to create an application that can run on android devices, while a App-Inventor Companion (The program that allows the app to run and debug on) that works on iOS running devices are still under development. In creating App Inventor, Google drew upon significant prior research in educational computing, and work done within Google on online development environments.

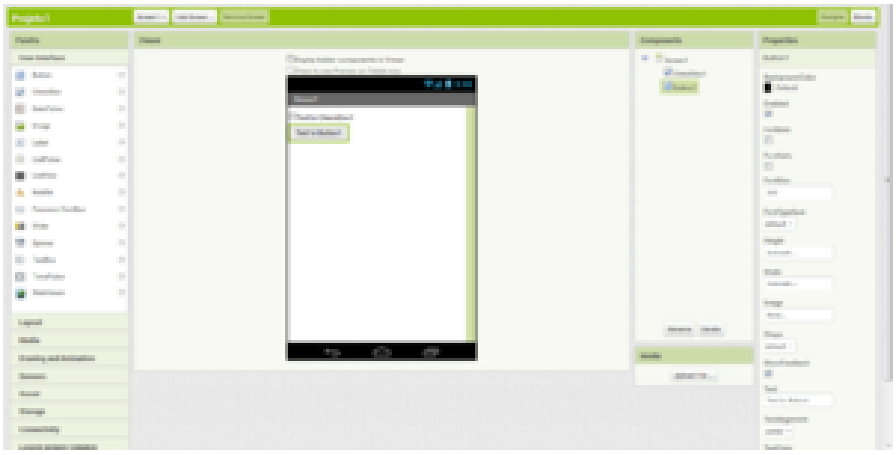


Figure 3: MIT App Inventor Platform

3.3.2 Wi-Fi Based Home Automation:

Wemos D1 R1 controller module based on ESP8266 chip is used to realize the Wi-Fi based home automation system. This controller has the in-built Wi-Fi module and can easily connect to any Wi-Fi network with easy programming. This controller module is used in conjunction with cloud-based Web server provided by Blynk.

3.3.2.1 Sensors and actuators used

- Temperature Sensor – xxx based
- BPM Sensor
- Buzzer
- Relay Driver

3.3.2.2 Application Platform

Blynk which is the platform designed for the Internet of Things is used for this implementation. It can control hardware remotely, it can display sensor data, it can store data, visualize it and do many other things.

There are three major components in the platform:

Blynk App - allows to you create amazing interfaces for your projects using various widgets we provide.

Blynk Server - responsible for all the communications between the smartphone and hardware. You can use our Blynk Cloud or run your private Blynk server locally. It's OpenSource, could easily handle thousands of devices and can even be launched on a Raspberry Pi.

Blynk Libraries - for all the popular hardware platforms - enable communication with the server and process all the incoming and outcoming commands.

Now imagine: every time you press a Button in the Blynk app, the message travels to space the Blynk Cloud, where it magically finds its way to your hardware. It works the same in the opposite direction and everything happens in a blynk of an eye.

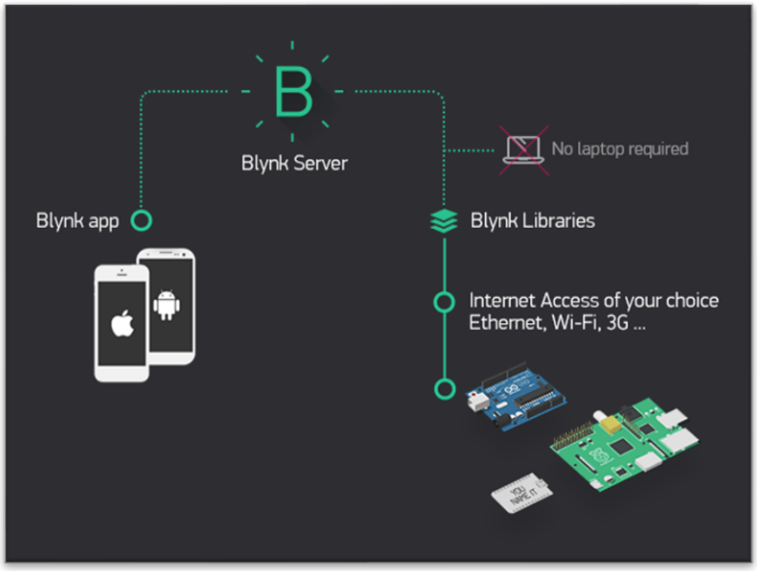


Figure 4: Blynk App Block Diagram

3.4 Technologies Used

3.4.1 Bluetooth Technology

Bluetooth is a wireless technology standard used for exchanging data between fixed and mobile devices over short distances using UHF radio waves in the industrial, scientific and medical radio bands, from 2.402 GHz to 2.480 GHz, and building personal area networks (PANs). It was originally conceived as a wireless alternative to RS-232 data cables.

Bluetooth®

Developed by	Bluetooth Special Interest Group
Introduced	1989; 31 years ago
Industry	Personal area networks
Compatible hardware	Personal computers Smartphones Gaming consoles Audio devices
Physical range	Typically less than 10 m (33 ft), up to 100 m (330 ft) Bluetooth 5.0: 40–400 m (100–1,000 ft)[1][2]

Bluetooth is managed by the Bluetooth Special Interest Group (SIG), which has more than 35,000 member companies in the areas of telecommunication, computing, networking, and consumer electronics. The IEEE standardized Bluetooth as IEEE 802.15.1, but no longer maintains the standard.

The Bluetooth SIG oversees development of the specification, manages the qualification program, and protects the trademarks.

Bluetooth is very widely used technology in space of PAN.

3.4.2 Wi-Fi Technology

Wi-Fi is a family of wireless network protocols, based on the IEEE 802.11 family of standards, which are commonly used for local area networking of devices and Internet access. Devices that can use Wi-Fi technologies include personal computer desktops and laptops, smartphones and tablets, smart TVs, printers, smart speakers, cars, and drones.
Compatible devices can network through wireless access points to each other as well as to wired devices and the Internet. The different versions of Wi-Fi are specified by various IEEE 802.11 protocol standards, with the different radio technologies determining radio bands, and the maximum ranges, and speeds that may be achieved. Wi-Fi most commonly uses the 2.4 gigahertz (120 mm) UHF and 5 gigahertz (60 mm) SHF ISM radio bands; these bands are subdivided into multiple channels. Channels can be shared between networks but only one transmitter can locally transmit on a channel at any moment in time.
An access point (or hotspot) often has a range of about 20 metres (66 feet) indoors while some modern access points claim up to a 150-metre (490-foot) range outdoors.

3.5 Arduino IDE

The Arduino Integrated Development Environment is a cross-platform application 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 third-party cores, other vendor development boards. It is available at www.arduino.cc.

The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware. By default, avrdude is used as the uploading tool to flash the user code onto official Arduino boards.

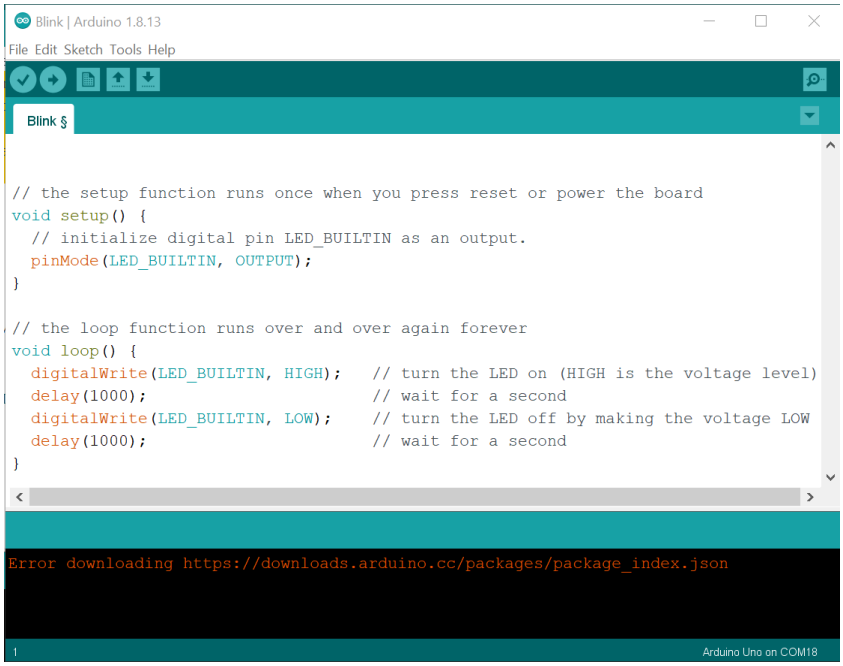


Figure 5: Arduino IDE

4 CHAPTER 4 – SYSTEM DESIGN

4.1 Bluetooth Based Implementation

Bluetooth based application utilizes the Arduino UNO as a controller along with HC-05 Bluetooth Module. As Bluetooth only provides P2P connectivity over a limited range over wireless, the usage of Bluetooth based application is intended to be used within the house premises.

Following is the list of components needed to realize the circuit:

Component	Quantity	Purpose
Arduino UNO Board	1	Used as main controller for the project.
HC-05 Bluetooth Module	1	Used with Arduino UNO for serial communication with Mobile Phone.
MQ35, Air Quality and Gas Sensor	1	Used to monitor the impurities in the air and can also detect the smoke or gas leak. Provides Analog output which can be connected to Analog pin of Arduino.
Rain Detection Module	1	Detects presence of water (assumed rain) and report to Arduino board thru the Analog Input pin. Automatic actions can be triggered after detection of rain.
Magnetic Reed Sensor	1	This sensor is used to detect the presence of magnet and reports high to Arduino when magnet is detected. Magnet is supposed to be fixed to door and sensor on the door frame so that door open/close status can be monitored.
Breadboard	1	Used to connect the components easily and flexibly.
Wires	As needed	Used to connect the components thru breadboard.
Battery Bank – 9V	1	Used to power-up the Arduino board.
Android Phone with Mobile App.	1	Used to interface with Arduino board thru Bluetooth module.

Table 1: Component List – Bluetooth based implementation

The block diagram below represents the connectivity:

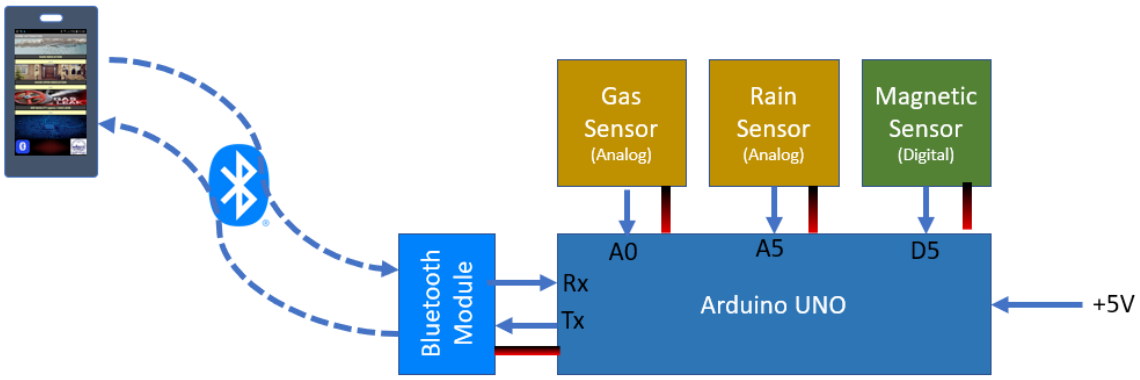


Figure 6: Block Diagram – Bluetooth Implementation

4.2 Wi-Fi Based Implementation

Wi-Fi based implementation utilizes the Wemos R1 D1 module which is based on ESP8266 Wi-Fi chip. It has capability to directly connect to Wi-Fi access point after appropriate programming. The Wi-Fi provides the access beyond boundaries of home premises as it connects to Mobile application thru the web-server in cloud, which can be accessed from anywhere in the world.

Following is the list of components needed to realize the circuit:

Component	Quantity	Purpose
Wemos R1 D1 (ESP8266)	1	Used as main controller for the project.
DS18B20 Temperature Sensor Module	1	Dallas temperature sensor with one-wire digital interface is used to detect the body temperature. This is connected to digital input of controller.
Heartbeat/Pulse Sensor	1	Pulse sensor detects the presence of Pulse and reports the same thru the analog output.
Buzzer Module	1	Piezo-electric buzzer is used to sound the emergency alarm and hence connected to digital output pin of controller
5V, 1 Channel Relay Module	1	The relay when connected to digital output of controller can be used to switch on-off any appliance running on a different voltage. It is used to run a motor in this project.
DC Motor, 6V	1	DC Motor used as fan.
LED	2	LED used to show the light and fan respectively.
Resistance 4.7 KΩ	2	Current limiting resistors used with the LEDs.
Resistance 470 Ω	1	Resistor used to pull up the digital output pin of temperature sensor.
Breadboard	1	Used to connect the components easily and flexibly.
Wires	As	Used to connect the components thru

	needed	breadboard.
Battery Bank – 6V	1	Used to power-up the Wemos R1 D1 board.
Battery Bank – 9V	1	Used to run Motor as it cannot get enough current from the Wemos board.
Phone with Blynk Mobile App.	1	Used to interface with Wemos Wi-Fi board Blynk Cloud.

Table 2: Component List – Wi-fi based implementation

The block diagram below represents the connectivity:

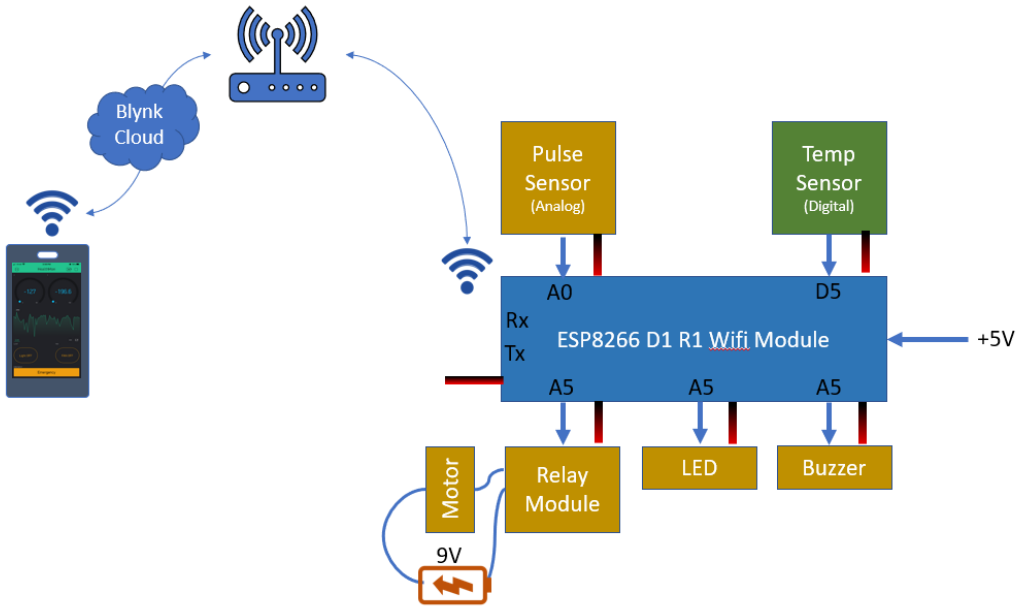


Figure 7: Block Diagram – Wi-fi Implementation

5 CHAPTER 5 – SYSTEM DEVELOPMENT: BLUETOOTH BASED

5.1 Hardware Components

5.1.1 Arduino UNO R3

Arduino Uno is a microcontroller board based on the ATmega328P with a small enough form factor and easily available in market.

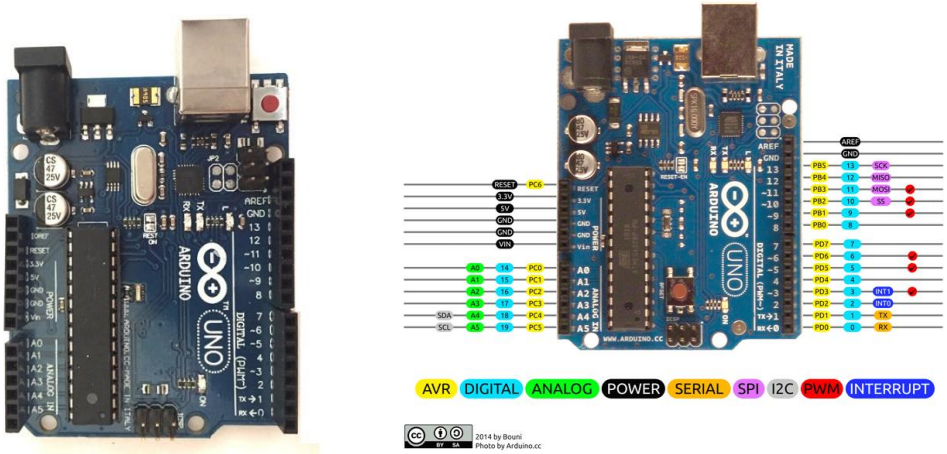


Figure 8: Arduino UNO R2 Pinout

It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. You can tinker with your Uno without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

5.1.1.1 Pin Description:

Pin Category	Pin Name	Details
Power	Vin, 3.3V, 5V, GND	Vin: Input voltage to Arduino when using an external power source. 5V: Regulated power supply used to power microcontroller and other components on the board. 3.3V: 3.3V supply generated by on-board

		voltage regulator. Maximum current draw is 50mA. GND: ground pins.
Reset	Reset	Resets the microcontroller.
Analog Pins	A0 – A5	Used to provide analog input in the range of 0-5V
Input/Output Pins	Digital Pins 0 - 13	Can be used as input or output pins.
Serial	0(Rx), 1(Tx)	Used to receive and transmit TTL serial data.
External Interrupts	2, 3	To trigger an interrupt.
PWM	3, 5, 6, 9, 11	Provides 8-bit PWM output.
SPI	10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK)	Used for SPI communication.
Inbuilt LED	13	To turn on the inbuilt LED.
TWI	A4 (SDA), A5 (SCA)	Used for TWI communication.
AREF	AREF	To provide reference voltage for input voltage.

Table 3: Pin Description - Arduino

5.1.1.2 Technical Specifications

Microcontroller	ATMega328P – 8-bit AVR family microcontroller
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50 mA
Flash Memory	32 KB (0.5 KB is used for Bootloader)
SRAM	2 KB
EEPROM	1 KB
Frequency (Clock Speed)	16 MHz

Table 4: Technical Specifications - Arduino

5.1.1.3 Other Arduino Boards

Arduino Nano, Arduino Pro Mini, Arduino Mega, Arduino Due, Arduino Leonardo

5.1.1.4 Board Usage

The 14-digital input/output pins can be used as input or output pins by using pinMode(), digitalRead() and digitalWrite() functions in Arduino programming. Each pin operates at 5V and can provide or receive a maximum of 40mA current and has an internal pull-up

resistor of 20-50 K Ohms which are disconnected by default. Out of these 14 pins, some pins have specific functions as listed below:

- Serial Pins 0 (Rx) and 1 (Tx): Rx and Tx pins are used to receive and transmit TTL serial data. They are connected with the corresponding ATmega328P USB to TTL serial chip.
- External Interrupt Pins 2 and 3: These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- PWM Pins 3, 5, 6, 9 and 11: These pins provide an 8-bit PWM output by using analogWrite() function.
- SPI Pins 10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK): These pins are used for SPI communication.
- In-built LED Pin 13: This pin is connected with a built-in LED, when pin 13 is HIGH – LED is on and when pin 13 is LOW, its off.
- Along with 14 Digital pins, there are 6 analog input pins, each of which provide 10 bits of resolution, i.e. 1024 different values. They measure from 0 to 5 volts, but this limit can be increased by using AREF pin with analog Reference() function.
- Analog pin 4 (SDA) and pin 5 (SCA) also used for TWI communication using Wire library.

Arduino Uno has a couple of other pins as explained below:

- AREF: Used to provide reference voltage for analog inputs with analogReference() function.
- Reset Pin: Making this pin LOW, resets the microcontroller.

5.1.1.5 Communication

Arduino can be used to communicate with a computer, another Arduino board or other microcontrollers. The ATmega328P microcontroller provides UART TTL (5V) serial communication which can be done using digital pin 0 (Rx) and digital pin 1 (Tx). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The ATmega16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. There are two RX and TX LEDs on the Arduino board which will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (not for serial communication on pins 0 and 1). A SoftwareSerial library allows for serial communication on any of the Uno's digital pins. The ATmega328P also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus.

5.1.1.6 Software

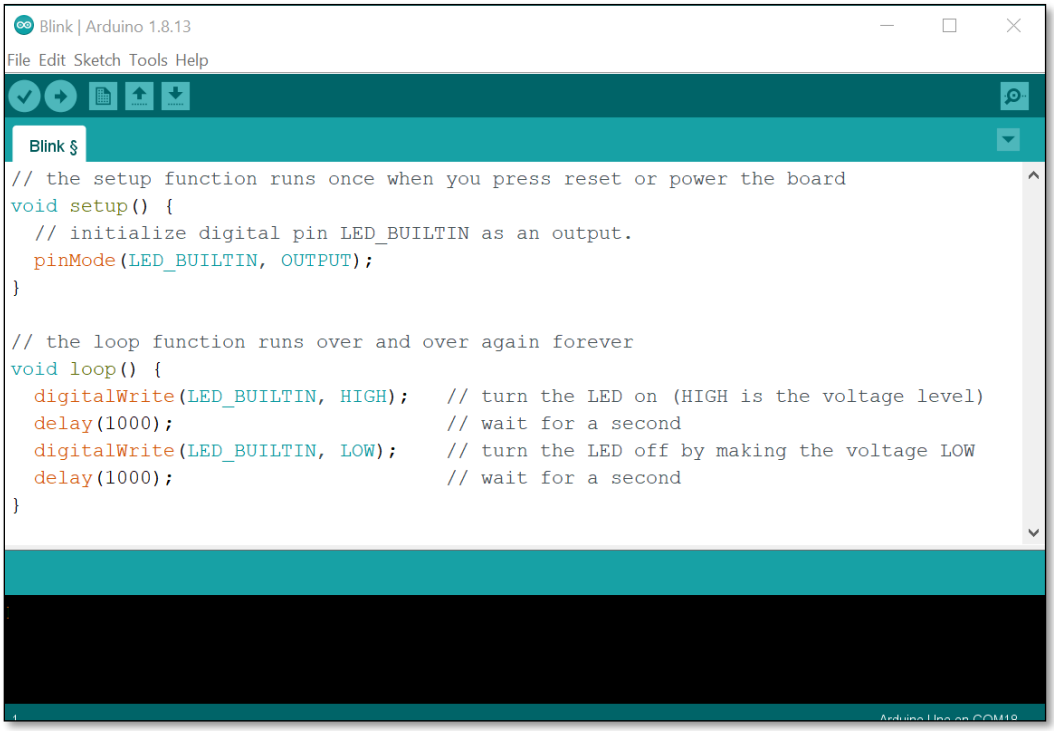
Arduino IDE (Integrated Development Environment) is required to program the Arduino Uno board. It is available at www.arduino.cc.

5.1.1.7 Programming Arduino

Once Arduino IDE is installed on the computer, connect the board with computer using USB cable. Now open the Arduino IDE and choose the correct board by selecting

Tools>Boards>Arduino/Genuino Uno and choose the correct Port by selecting Tools>Port. Arduino Uno is programmed using Arduino programming language based on Wiring. To get it started with Arduino Uno board and blink the built-in LED, load the example code by selecting Files>Examples>Basics>Blink. Once the example code (also shown below) is loaded into your IDE, click on the 'upload' button given on the top bar. Once the upload is finished, you should see the Arduino's built-in LED blinking.

Below is the example code for blinking:



5.1.2 HC-05 Bluetooth Module

HC-05 is a Bluetooth module designed for establishing short range wireless data communication between two microcontrollers or systems. The module works on Bluetooth 2.0 communication protocol and it can only act as a slave device. This is cheapest method for wireless data transmission and more flexible compared to other methods and it even can transmit files at speed up to 2.1Mb/s.

HC-05 uses frequency hopping spread spectrum technique (FHSS) to avoid interference with other devices and to have full duplex transmission. The device works on the frequency range from 2.402 GHz to 2.480GHz.

5.1.2.1 Pin Description

Pin Number	Pin Name	Description
1	Enable / Key	This pin is used to toggle between Data Mode (set low) and AT command mode (set high). By default it is in Data mode
2	Vcc	Powers the module. Connect to +5V Supply voltage
3	Ground	Ground pin of module, connect to system ground.
4	TX – Transmitter	Transmits Serial Data. Everything received via Bluetooth will be given out by this pin as serial data.
5	RX – Receiver	Receive Serial Data. Every serial data given to this pin will be broadcasted via Bluetooth
6	State	The state pin is connected to on board LED, it can be used as a feedback to check if Bluetooth is working properly.
7	LED	Indicates the status of Module Blink once in 2 sec: Module has entered Command Mode Repeated Blinking: Waiting for connection in Data Mode Blink twice in 1 sec: Connection successful in Data Mode
8	Button	Used to control the Key/Enable pin to toggle between Data and command Mode

Table 5: Pin Description – HC-05

5.1.2.2 Default Settings

- Default Bluetooth Name: “HC-05”
- Default Password: 1234 or 0000
- Default Communication: Slave
- Default Mode: Data Mode
- Data Mode Baud Rate: 9600, 8, N, 1
- Command Mode Baud Rate: 38400, 8, N, 1
- Default firmware: LINVOR

5.1.2.3 Technical Specifications

- Serial Bluetooth module for Arduino and other microcontrollers
- Operating Voltage: 4V to 6V (Typically +5V)
- Operating Current: 30mA
- Range: <100m
- Works with Serial communication (USART) and TTL compatible
- Follows IEEE 802.15.1 standardized protocol
- Uses Frequency-Hopping Spread spectrum (FHSS)
- Can operate in Master, Slave or Master/Slave mode
- Can be easily interfaced with Laptop or Mobile phones with Bluetooth
- Supported baud rate: 9600,19200,38400,57600,115200,230400,460800.

5.1.2.4 Other Bluetooth Modules

HC-02, HC-04, HC-06, HM-11, ESP32, CSR8645

5.1.2.5 Where to use HC-05 Bluetooth module?

The HC-05 is a very cool module which can add two-way (full-duplex) wireless functionality to your projects. You can use this module to communicate between two microcontrollers like Arduino or communicate with any device with Bluetooth functionality like a Phone or Laptop. There are many android applications that are already available which makes this process a lot easier. The module communicates with the help of USART at 9600 baud rate hence it is easy to interface with any microcontroller that supports USART. We can also configure the default values of the module by using the command mode. So, if you are looking for a Wireless module that could transfer data from your computer or mobile phone to microcontroller or vice versa then this module might be the right choice for you. However, do not expect this module to transfer multimedia like photos or songs; you might have to look into the CSR8645 module for that.

5.1.2.6 Module Usage

The HC-05 has two operating modes, one is the Data mode in which it can send and receive data from other Bluetooth devices and the other is the AT Command mode where the default device settings can be changed. We can operate the device in either of these two modes by using the key pin as explained in the pin description.

It is very easy to pair the HC-05 module with microcontrollers because it operates using the Serial Port Protocol (SPP). Simply power the module with +5V and connect the Rx pin of the module to the Tx of MCU and Tx pin of module to Rx of MCU as shown in the figure below

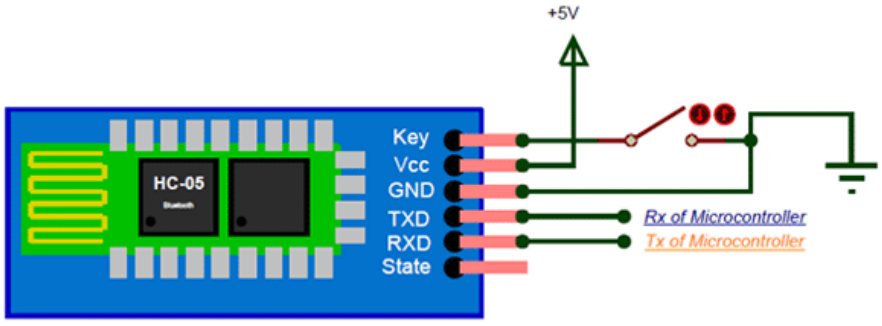


Figure 9: HC-05 Pinout

During power up the key pin can be grounded to enter into Command mode, if left free it will by default enter into the data mode. As soon as the module is powered you should be able to discover the Bluetooth device as “HC-05” then connect with it using the default password 1234 and start communicating with it.

5.1.2.7 Applications

- Wireless communication between two microcontrollers
- Communicate with Laptop, Desktops and mobile phones
- Data Logging application
- Consumer applications
- Wireless Robots
- Home Automation

5.1.3 MQ-135 Sensor

The MQ135 Air Quality Sensor Module are used in air quality control equipment and are suitable for detecting or measuring of NH3, NOx, Alcohol, Benzene etc.

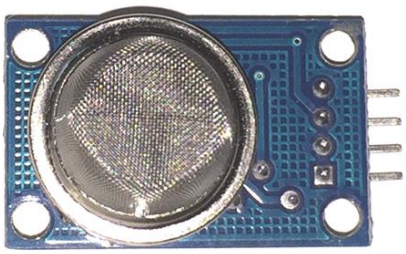


Figure 10: MQ-135 Gas Detection Module

5.1.3.1 Pin Description:

Pin No:	Pin Name:	Description
1	Vcc	Used to power the sensor, Generally the operating voltage is +5V.
2	Ground	Used to connect the module to system ground.
3	Digital Out	You can also use this sensor to get digital output from this pin, by setting a threshold value using the potentiometer.
4	Analog Out	This pin outputs 0-5V analog voltage based on the intensity of the gas.

Table 6: Pin Description – MQ135

5.1.3.2 Technical Specifications

- Wide detecting scope
- Fast response and High sensitivity
- Stable and long life
- Operating Voltage is +5V

- Detect/Measure NH3, NOx, alcohol, Benzene, smoke, CO2, etc.
- Analog output voltage: 0V to 5V
- Digital output voltage: 0V or 5V (TTL Logic)
- Preheat duration 20 seconds
- Can be used as a Digital or analog sensor
- The Sensitivity of Digital pin can be varied using the potentiometer

5.1.3.3 Sensor functioning for gas detection

You can either use the digital pin or the analog pin to do this. Simply power the module with 5V and you should notice the power LED on the module to glow and when no gas it detected the output LED will remain turned off meaning the digital output pin will be 0V. Remember that these sensors have to be kept on for pre-heating time (mentioned in features above) before you can actually work with it. Now, introduce the sensor to the gas you want to detect and you should see the output LED to go high along with the digital pin, if not use the potentiometer until the output gets high. Now every time your sensor gets introduced to this gas at this particular concentration the digital pin will go high (5V) else will remain low (0V).

You can also use the analog pin to achieve the same thing. Read the analog values (0-5V) using a microcontroller, this value will be directly proportional to the concentration of the gas to which the sensor detects. You can experiment with this value and check how the sensor reacts to different concentration of gas and develop your program accordingly.

5.1.3.4 Sensor use to measure PPM

MQ-135 gas sensor applies SnO2 which has a higher resistance in the clear air as a gas-sensing material. When there is an increase in polluting gases, the resistance of the gas sensor decreases along with that. To measure PPM using MQ-135 sensor we need to look into the (Rs/Ro) v/s PPM graph taken from the MQ135 datasheet.

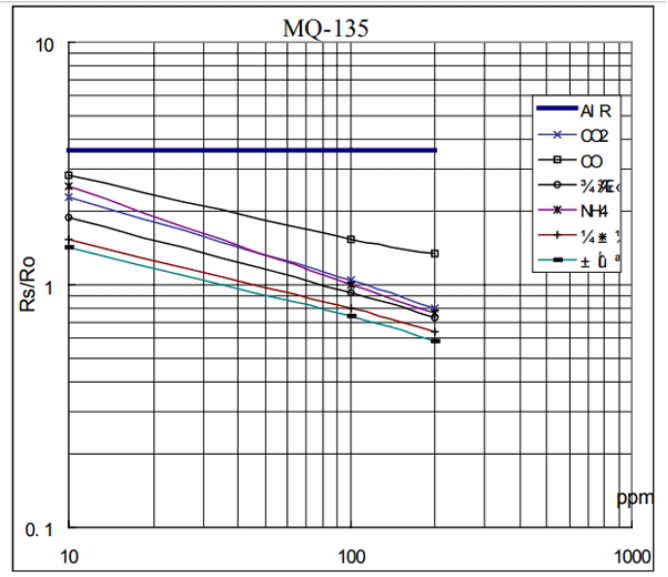


Figure 11: MQ-135 Sensitivity

The above figure shows the typical sensitivity characteristics of the MQ-135 for several gases. in their: Temp: 20°, Humidity: 65%, O2 concentration 21%, RL=20kΩ,
Ro: sensor resistance at 100ppm of NH3 in the clean air.
Rs: sensor resistance at various concentrations of gases.

The value of Ro is the value of resistance in fresh air (or the air with we are comparing) and the value of Rs is the value of resistance in Gas concentration. First you should calibrate the sensor by finding the values of Ro in fresh air and then use that value to find Rs using the below formula:

Resistance of sensor(Rs): Rs=(Vc/VRL-1)×RL

Once we calculate Rs and Ro we can find the ratio and then using the graph shown above we can calculate the equivalent value of PPM for that particular gas.

5.1.3.5 Alternative MQ Gas sensors

Sensor Name	Gas to measure
MQ-2	Methane, Butane, LPG, Smoke
MQ-3	Alcohol, Ethanol, Smoke
MQ-4	Methane, CNG Gas
MQ-5	Natural gas, LPG
MQ-6	LPG, butane
MQ-7	Carbon Monoxide
MQ-8	Hydrogen Gas
MQ-9	Carbon Monoxide, flammable gasses
MQ131	Ozone
MQ135	Air Quality
MQ136	Hydrogen Sulfide gas
MQ137	Ammonia
MQ138	Benzene, Toluene, Alcohol, Propane, Formaldehyde gas, Hydrogen
MQ214	Methane, Natural Gas
MQ216	Natural gas, Coal Gas
MQ303A	Alcohol, Ethanol, smoke
MQ306A	LPG, butane
MQ307A	Carbon Monoxide
MQ309A	Carbon Monoxide, flammable gas

Table 7: Other Gas Sensors

5.1.4 Reed Switch Sensor

A reed switch is a sensor that closes the circuit in the presence of a magnetic field. Reed sensors can be used in many applications where contactless on/off is required. However, reed switches can be fragile to use directly, hence this module can make it easier to handle and mount the sensor in various applications.

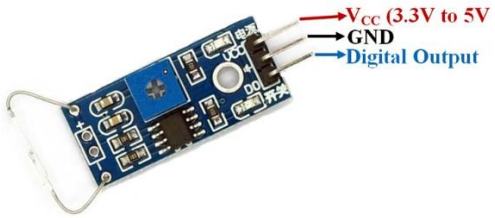


Figure 12: Reed Switch Pinout

5.1.4.1 Pin Description:

Pin Name	Description
VCC	The Vcc pin powers the module, typically with +5V
GND	Power Supply Ground
DO	Digital Out Pin for Digital Output.

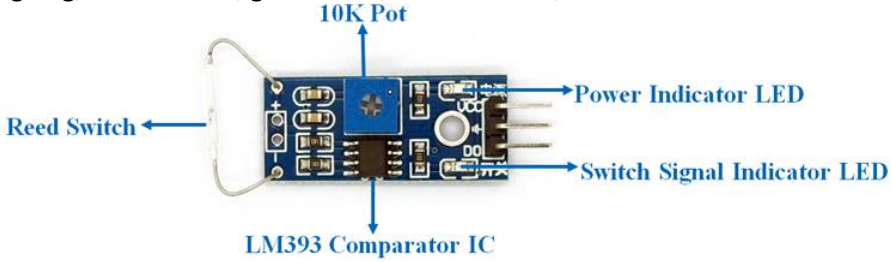
Table 8: Pin Description – Reed Switch

5.1.4.2 Technical Specifications

- Operating Voltage: 3.3V to 5V DC
- Output format: Digital switching output (0 and 1)
- LEDs indicating output and power
- PCB Size: 32mm x 14mm
- LM393 based design
- Easy to use with Microcontrollers or even with normal Digital/Analog IC
- Small, cheap and easily available

5.1.4.3 Module Functioning

The Reed Switch Sensor Module consists of a Reed Switch, resistors, capacitor, potentiometer, comparator LM393 IC, Power, and status LED in an integrated circuit. This sensor module can be used in photocopiers, washing machines, refrigerators, cameras, disinfection cabinets, doors, window magnetics, electromagnetic relays, electronic weighing, level meters, gas meters, water meters, etc.



5.1.4.4 Module Usage

Reed Switch Sensor Module consists of three pins i.e. VCC, GND, and DO. The digital out pin is connected to the output pin of the LM393 comparator IC. The internal Circuit diagram of the Reed Switch Sensor Module is given below.

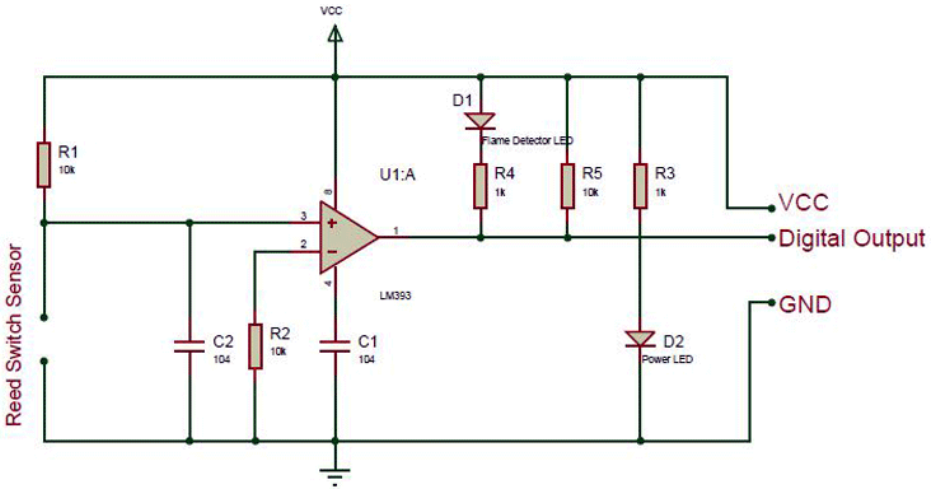


Figure 13: Reed Switch Working

Using the Reed Switch sensor module with a microcontroller is very easy. Connect the Digital Output pin of the module to the Digital pin of Microcontroller. Connect VCC and GND pins to 5V and GND pins of Microcontroller. When the Reed Switch sensor detects the magnetic field, it closes the circuit and the digital pin of the module that is connected to the LM393 IC goes high.
Alternate Sensor Modules: IR Sensor Module, LDR Sensor Module, TP4056A Li-ion Battery Charging/Discharging Module, DS3231 RTC Module, TMC2209 Stepper Motor Driver Module, DRV8825 Stepper Motor Driver Module, A4988 Stepper Motor Driver Module, NEO-6MV2 GPS Module, Joystick Module, EM18 - RFID Reader Module, Soil Moisture Sensor.

5.1.5 Rain drop Sensor Module

Raindrop Sensor is a tool used for sensing rain. It consists of two modules, a rain board that detects the rain and a control module, which compares the analog value, and converts it to a digital value. The raindrop sensors can be used in the automobile sector to control the windshield wipers automatically, in the agriculture sector to sense rain and it is also used in home automation systems.

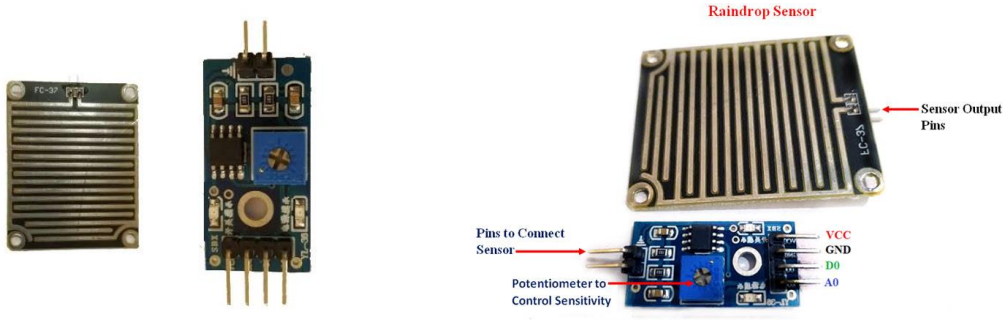


Figure 14: Rain Drop Sensor Pinout

5.1.5.1 Pin Description

S. No:	Name	Function
1	VCC	Connects supply voltage- 5V
2	GND	Connected to ground
3	D0	Digital pin to get digital output
4	A0	Analog pin to get analog output

Table 9: Pin Description – Rain Sensor

5.1.5.2 Technical Specifications

- Working voltage 5V
- Output format: Digital switching output (0 and 1), and analog voltage output AO
- Potentiometer adjust the sensitivity
- Uses a wide voltage LM393 comparator
- Comparator output signal clean waveform is good, driving ability, over 15mA
- Anti-oxidation, anti-conductivity, with long use time
- With bolt holes for easy installation
- Small board PCB size: 3.2cm x 1.4cm
- Note: The complete technical details can be found in the Rain Sensor datasheet given at the bottom of this page.

5.1.5.3 Sensor Usage

Interfacing the raindrop sensor with a microcontroller like 8051 or Arduino is simple. The rain board module is connected with the control module of the raindrop sensor as shown in the below diagram.

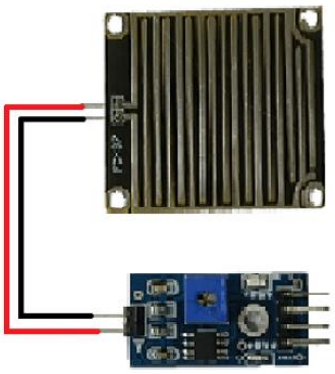
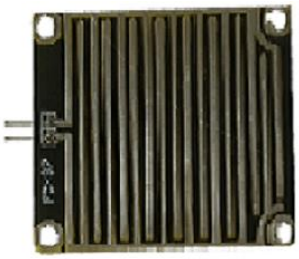


Figure 15: Raindrop Sensor functioning

The control module of the raindrop sensor has 4 outputs. VCC is connected to a 5V supply. The GND pin of the module is connected to the ground. The D0 pin is connected to the digital pin of the microcontroller for digital output or the analog pin can be used. To use the analog output, the A0 pin can be connected to the ADC pin of a microcontroller. In the case of Arduino, it has 6 ADC pins, so we can use any of the 6 pins directly without using an ADC converter. The sensor module consists of a potentiometer, LN393 comparator, LEDs, capacitors and resistors. The pinout image above shows the components of the control module. The rainboard module consists of copper tracks, which act as a variable resistor. Its resistance varies with respect to the wetness on the rainboard. The below fig shows the rain board module.



The circuit diagram of a raindrop sensor module is given below.

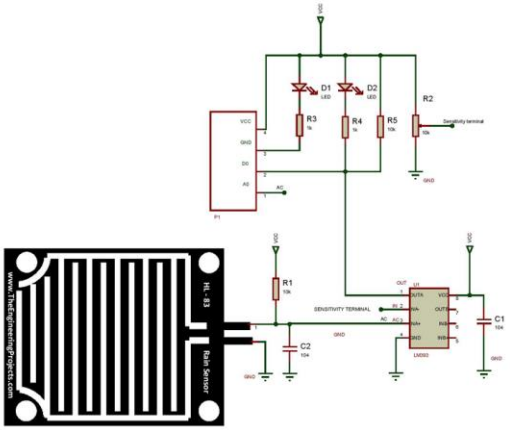


Figure 16: Rain Drop Sensor Circuit - 1

As shown in the above figure, the R1 resistor and the rain board module will act as a voltage divider. Capacitors C1 and C2 are used as a biasing element. The input for the Non-inverting terminal is taken from the connection point of the R1, and rain board module. Another point is taken from this connection and connected to the A0 terminal of the control module.
The input to the inverting terminal of the LM393 is taken from the potentiometer (R2). The R2 resistor acts as a voltage divider, and by varying R2 we can vary the input voltage to the inverting terminal, which in turn affects the sensitivity of the control module. The connections are shown in the above fig. The resistors R3 and R4 will act as current limiting resistors, while resistor R5 will act as a pull-up resistor to keep the bus in a high state when not in use.

5.1.5.4 Sensor functioning

Case1: When the input of the inverting terminal is higher than the input of the non-inverting terminal.

Case2: If the input of the inverting terminal is lower than the input of the non-inverting terminal.
The input to the inverting terminal is set to a certain value by varying the potentiometer and the sensitivity is set. When the rain board module's surface is exposed to rainwater, the surface of the rainboard module will be wet, and it offers minimum resistance to the supply voltage. Due to this, the minimum voltage will be appearing at the non-inverting terminal of LM393 Op-Amp. The comparator compares both inverting and non-inverting terminal voltages. If the condition falls under case (1), the output of the Op-Amp will be digital LOW. If the condition falls under case (2), the output of the Op-Amp will be digital HIGH. The below diagram shows the equivalent circuit of both the conditions.

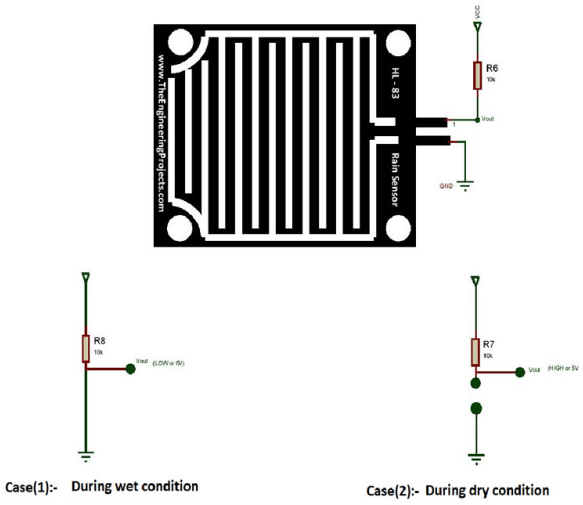


Figure 17: Rain Drop Sensor Circuit - 2

When the A0 pin is connected to the microcontroller, an additional analog to digital converter (ADC) circuit is used. In the case of Arduino, it consists of 6 ADC pins, which can be directly used for calculation purposes.

5.2 Circuit and Hardware Connectivity

Following figure shows the connectivity of various hardware components:

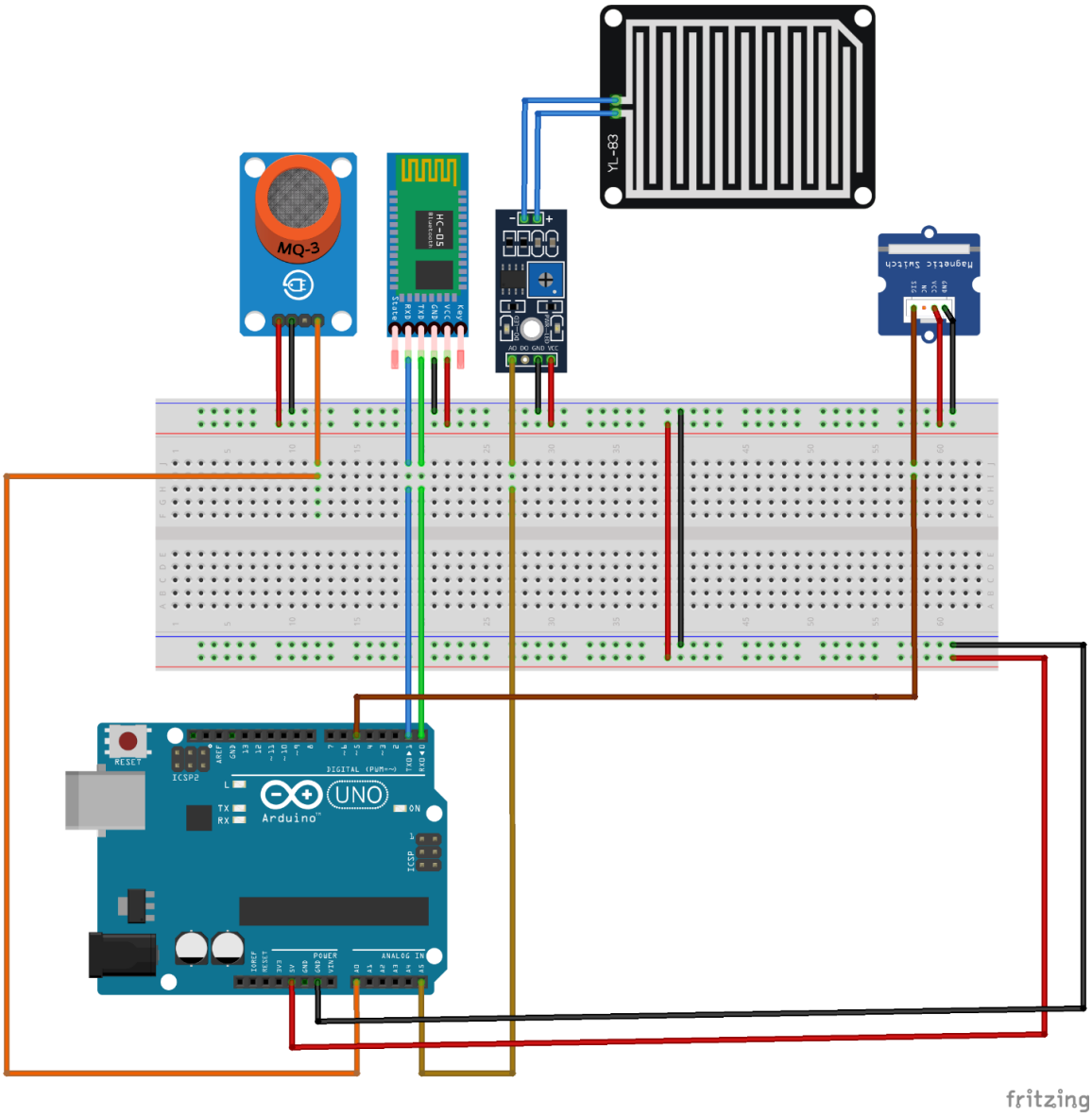


Figure 18: Hardware Connectivity – Bluetooth Implementation

5.3 Programming Arduino uno

Following Program is downloaded to the Arduino Uno module using a serial cable from the Laptop. The connectivity for downloading the program is as given below:

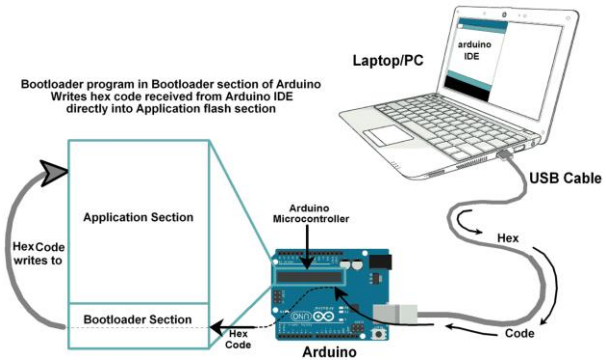


Figure 19: Downloading Program to Arduino

Arduino program for Bluetooth based implementation:

```
//This program read the input from multiple sensors and
send the input to mobile application over serial port over
Bluetooth//

int pinSwitch = 5;  //Pin Reed
int gaslvl;          // integer to store gas sensor values
bool StateSwitch;
int StateRain;       // integer to store rain sensor
values
String SwitchWrite;
String RainWrite;
#define gas (A0)    // Analog output of gas sensor is
connected to pin A5
#define rain (A5)   // Analog output of rain sensor is
connected to pin A0

const int sensorMin = 0; // rain sensor minimum
const int sensorMax = 1024; // rain sensor maximum

void setup()
{
Serial.begin(9600);
pinMode(pinSwitch, INPUT);
}
//void loop only runs the other functions sequentially

void loop()
{
  gaslevel();
  doorstatus();
  rainstatus();
```

```
  btprint();
  delay (3000);

}

// function to read the  gas sensor analog out put
void gaslevel()
{
  gaslvl = analogRead(gas);
}

// function to check the door status using reed magnetic
sensor

void doorstatus()

{

  StateSwitch = digitalRead(pinSwitch);

  if (StateSwitch==LOW)
      {
      SwitchWrite = "CLOSED";
      }
  else
      {
      SwitchWrite = "OPEN";
      }
}

// function to check the rain status based on the anlog
value from rain sensor and display appropriate strings

void rainstatus()

{

  StateRain = analogRead(rain);
  int range = map(StateRain, sensorMin, sensorMax, 0, 3);

//Checks the measured value with pre-stored condition and
displays the weather condition like RAINING, RAIN WARNING
& NOT RAINING.

  switch (range)
  {
    case 0: // Sensor getting completely wet
      RainWrite = "RAIN";
      break;

    case 1: // Sensor getting partially wet
      RainWrite = "WARNING";
```

```
      break;

    case 2: // Sensor dry
      RainWrite = "NO_RAIN";
      break;
  }

}

// this function concatenate all the different outputs and
send it as a single string on serial port for Bluetooth to
receive
// Outputs from different sensors are separated by special
character "|" so that the application can split the input
using the same

void btprint()

{
  Serial.print(RainWrite);
  Serial.print("|");
  Serial.print(SwitchWrite);
  Serial.print("|");
  Serial.println(gaslvl);
  delay(100);
}
```

5.4 Application Development using MIT Inventor App.

MIT Inventor Application development platform (from Google) is used to develop the application for Bluetooth. It offers the two-step approach to develop the application.

Step 1: Create the visual design of the app using the drag and drop menu options.

Step2: Write the code blocks and link the same to the design.

First the Bluetooth client and screen view are created to get the output data from the sensors connected to Arduino. Then we connect one android smartphone to the Arduino Bluetooth module. By pressing the App buttons, we will control the Arduino's outputs.

5.4.1 Application Development

To start with the application development with MIT App inventor, one need to login to the online platform using the mail ID.

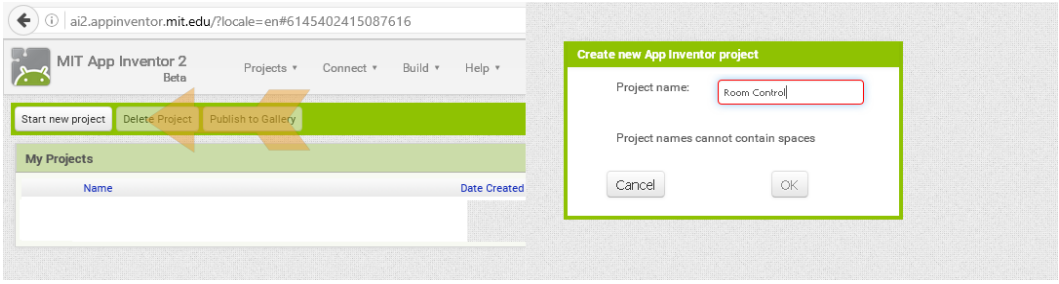


Figure 20: MIT App Inventor Setup

Start the new project to get the first screen where phone screen is designed by choosing the options provided.

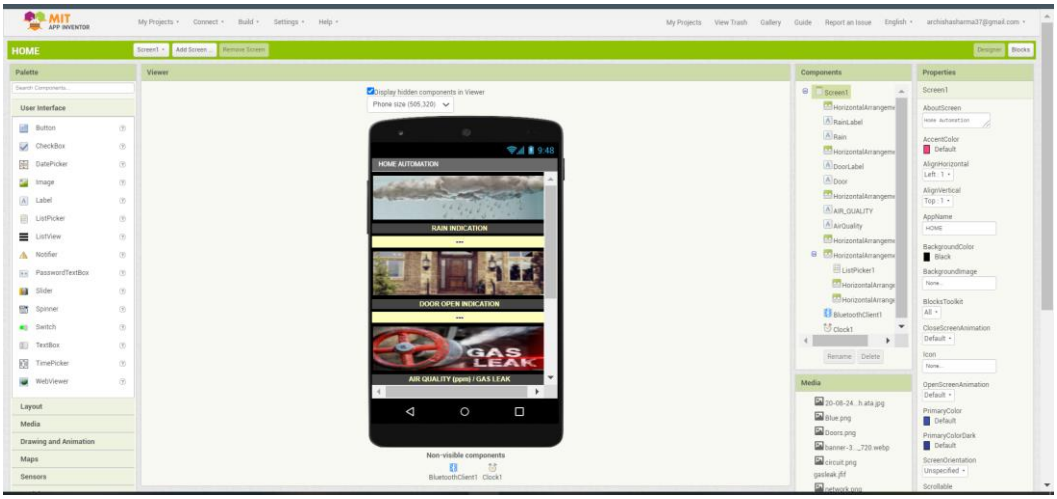


Figure 21: MIT App Inventor Designer

Once the design is ready then one need to go to the code block section and start writing the code blocks. Following different code blocks are written:

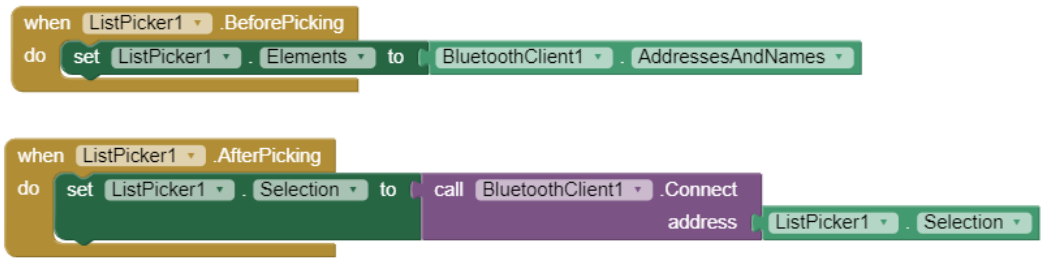


Figure 22: Bluetooth Blocks

Code to receive the sensor data from Bluetooth and display the same in the appropriate fields in the application design.

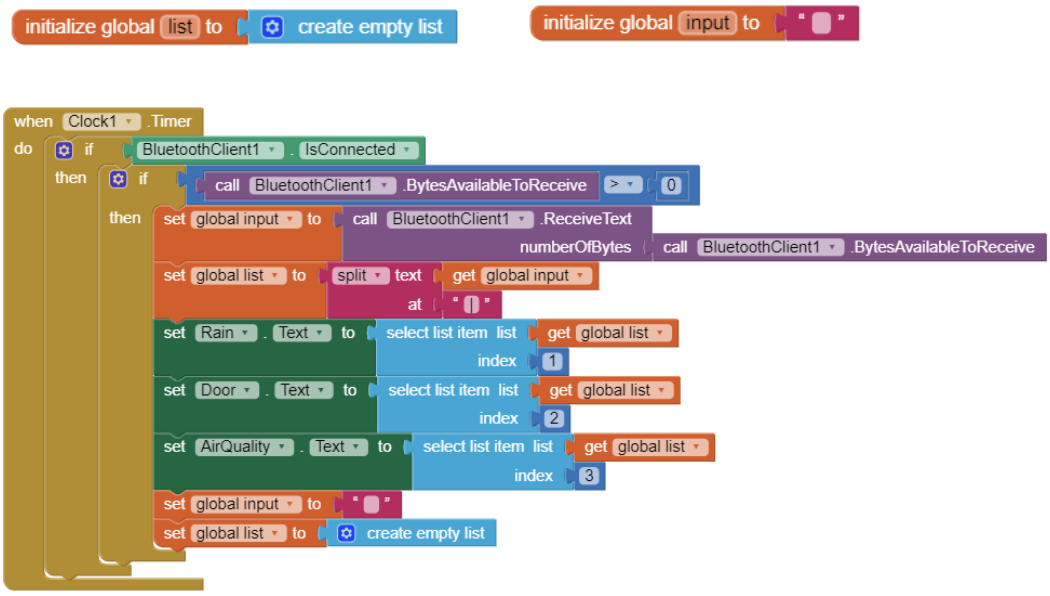


Figure 23: Data Processing Blocks

5.4.2 Building the application:

Once the code is written, one need to go to the top menu and click **build → build and save** the app to our PC.

Next, the ".apk" file is copied to the Android based using a USB connection and install it on our android smartphone.

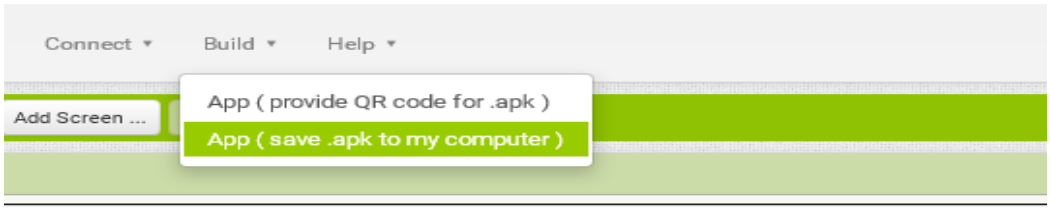


Figure 24: Building Application

5.4.3 Application Features:

The application when launched on the mobile phone, looks like as shown in the figure below with the explanation of the features.

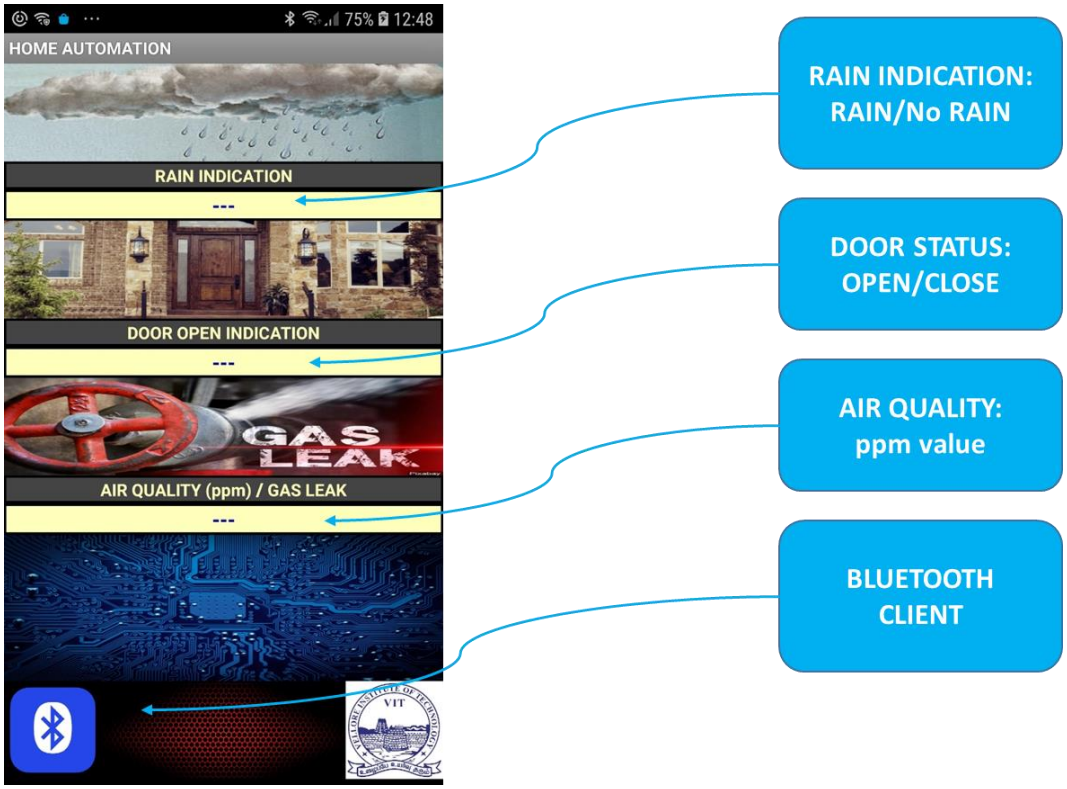


Figure 25: Application Features

5.5 Actual Project Image – Bluetooth based implementation

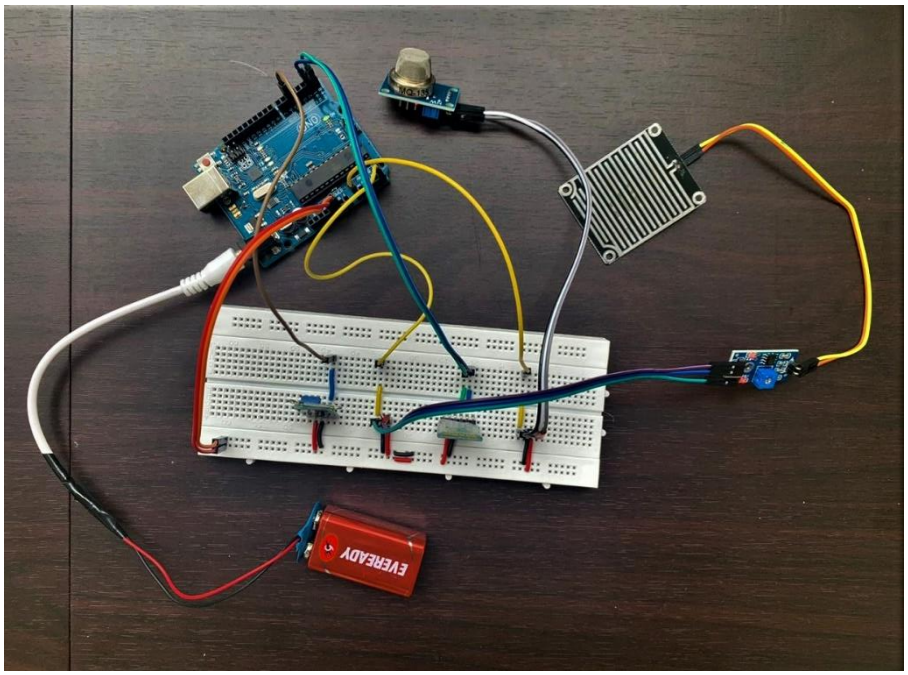


Figure 26: Project Image – Bluetooth based

6 CHAPTER 6 – SYSTEM DEVELOPMENT: WI-FI BASED

6.1 Hardware Components

6.1.1 Wi-Fi ESP8266 Development Board WEMOS D1

WEMOS D1 is a WI-FI development board based on ESP8266 12E. The functioning is similar to that of NODEMCU, except that the hardware is built resembling Arduino UNO.

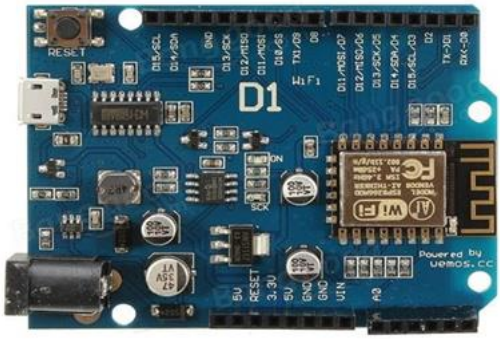


Figure 27: Wi-Fi ESP8266 Board

The D1 board can be configured to work on Arduino environment using BOARDS MANAGER.

So, it's not necessary to use a separate Arduino board, the D1 itself can be programmed on Arduino IDE. This is handy in using with IOT projects. Further many Arduino SHIELDs are compatible with the D1 board.

Different versions of D1 boards are available in the market R1, R2, MINI

As the name implies D1 Mini is a smaller version

R1, R2 boards look like Arduino UNO board, but version is not printed on board. On some boards WEMOS D1is printed, as the ESP12 chip is manufactured by WEMOS.

In some other boards it is printed just D, where the ESP12 chip is that of AI Thinker.

As the ESP12 chip has only one ANALOG pin, on board there is only A0 & other analog pins are dummy.

6.1.1.1 Technical Specifications

Here are the specifications of the board:

Microcontroller	ESP-8266EX
Operating Voltage	3.3V
Digital I/O Pins	11
Analog Input Pins	1

Clock Speed	80MHz/160MHz
Flash	4M bytes
Length	68.6mm
Width	53.4mm
Weight	25g

Table 10: Technical Specifications – ESP822

In summary, the board is controlled by the ESP8266 chip (a 32-Bit processor) and has a larger flash memory compared to an Arduino Uno. It consists of 11 digital I/O pins and 1 analogue (input) pin. the board can be connected using a Micro-B type USB cable. (Aka "Android Cable")

6.1.1.2 Pin Description

Pinouts are given below:

Pin	Function	ESP-8266 Pin
TX	TXD	TXD
RX	RXD	RXD
A0	Analog input, max 3.3V input	A0
D0	IO	GPIO16
D1	IO, SCL	GPIO5
D2	IO, SDA	GPIO4
D3	IO, 10k Pull-up	GPIO0
D4	IO, 10k Pull-up, BUILTIN_LED	GPIO2
D5	IO, SCK	GPIO14
D6	IO, MISO	GPIO12
D7	IO, MOSI	GPIO13
D8	IO, 10k Pull-down, SS	GPIO15
G	Ground	GND
5V	5V	–
3V3	3.3V	3.3V
RST	Reset	RST

Table 11: Pin Description – ESP8622

All the I/O pins Runs at 3.3V

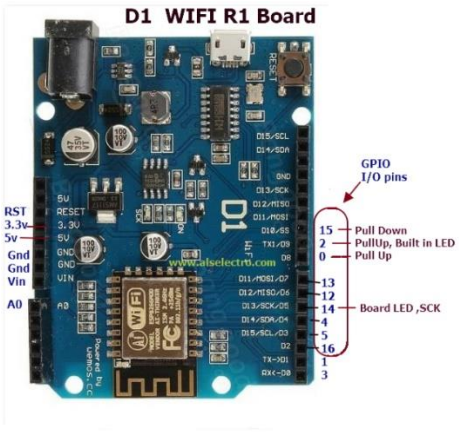


Figure 28: Wi-Fi ESP8266 Pinout

6.1.1.3 IDE

There are 2 IDE that can be used to program the ESP8266:

- The Arduino IDE
- The NodeMCU IDE

The Arduino IDE is used in the project to program the ESP8622 module.

6.1.2 DS18B20 Temperature Sensor

DS18B20 is 1-Wire digital temperature sensor from Maxim IC. Reports degrees in Celsius with 9 to 12-bit precision, from -55 to 125 (+/-0.5). Each sensor has a unique 64-Bit Serial number etched into it - allows for a huge number of sensors to be used on one data bus.

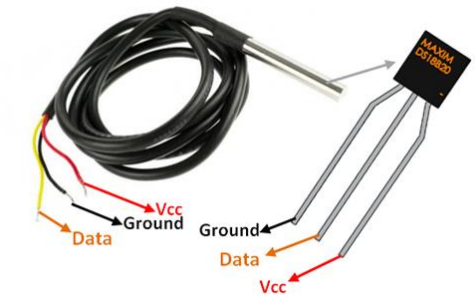


Figure 29: DS18B20 Pinout

6.1.2.1 Pin Description

No:	Pin Name	Description
1	Ground	Connect to the ground of the circuit
2	Vcc	Powers the Sensor, can be 3.3V or 5V
3	Data	This pin gives output the temperature value which can be read using 1-wire method

Table 12: Pin Description – DS18B20

6.1.2.2 Technical Specifications

- Programmable Digital Temperature Sensor
- Communicates using 1-Wire method
- Operating voltage: 3V to 5V
- Temperature Range: -55°C to +125°C
- Accuracy: ±0.5°C
- Output Resolution: 9-bit to 12-bit (programmable)
- Unique 64-bit address enables multiplexing
- Conversion time: 750ms at 12-bit
- Programmable alarm options
- Available as To-92, SOP and even as a waterproof sensor

Note: Read further to know why these parameters are important. Also, the DS18B20 datasheet can be found at the bottom of the page

6.1.2.3 Alternative Temperature Sensors

Thermocouple, TMP100, LM75, DHT11, SHT15, LM35DZ, TPA81, D6T

6.1.2.4 Where to use DS18B20 Sensor

The DS18B20 is a 1-wire programmable Temperature sensor from maxim integrated. It is widely used to measure temperature in hard environments like in chemical solutions, mines or soil etc. The constriction of the sensor is rugged and also can be purchased with a waterproof option making the mounting process easy. It can measure a wide range of temperature from -55°C to +125° with a decent accuracy of ±5°C. Each sensor has a unique address and requires only one pin of the MCU to transfer data so it a very good choice for measuring temperature at multiple points without compromising much of your digital pins on the microcontroller.

6.1.2.5 Sensor Usage

The sensor works with the method of 1-Wire communication. It requires only the data pin connected to the microcontroller with a pull up resistor and the other two pins are used for power as shown below.

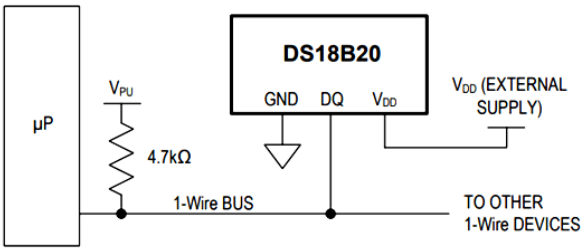


Figure 30: DS18B20 Connectivity

The pull-up resistor is used to keep the line in high state when the bus is not in use. The temperature value measured by the sensor will be stored in a 2-byte register inside the sensor. This data can be read by the using the 1- wire method by sending in a sequence of data. There are two types of commands that are to be sent to read the values, one is a ROM command and the other is function command. The address value of each ROM memory along with the sequence is given in the datasheet below. You have to read through it to understand how to communicate with the sensor.
If you are planning to interface it with Arduino, then you need not worry about all these. You can develop the readily available library and use the in-built functions to access the data.

6.1.3 Pulse Sensor

Pulse Sensor Amped is a plug-and-play heart-rate sensor for Arduino and Arduino compatibles. It can be used to get live heart-rate data. Pulse Sensor adds amplification and noise cancellation circuitry to the hardware. It's noticeably faster and easier to get reliable pulse readings. Pulse Sensor Amped works with either a 3V or 5V Arduino.

Figure 31: Pulse Sensor Pinout

6.1.3.1 Technical Specifications

Biometric Pulse Rate or Heart Rate detecting sensor

- Plug and Play type sensor

- Operating Voltage: +5V or +3.3V
- Current Consumption: 4mA
- Inbuilt Amplification and Noise cancellation circuit.
- Diameter: 0.625”
- Thickness: 0.125” Thick

6.1.3.2 Pin Description

Pin configuration of sensor is given below:

Pin Number	Pin Name	Wire Color	Description
1	Ground	Black	Connected to the ground of the system
2	Vcc	Red	Connect to +5V or +3.3V supply voltage
3	Signal	Purple	Pulsating output signal.

Table 13: Pin Description – Pulse Sensor

6.1.3.3 Sensor Functioning

The working of the Pulse/Heartbeat sensor is very simple. The sensor has two sides, on one side the LED is placed along with an ambient light sensor and on the other side we have some circuitry. This circuitry is responsible for the amplification and noise cancellation work. The LED on the front side of the sensor is placed over a vein in our human body. This can either be your Fingertip or you ear tips, but it should be placed directly on top of a vein.

Now the LED emits light which will fall on the vein directly. The veins will have blood flow inside them only when the heart is pumping, so if we monitor the flow of blood, we can monitor the heart beats as well. If the flow of blood is detected then the ambient light sensor will pick up more light since they will be reflect ted by the blood, this minor change in received light is analyzed over time to determine our heart beats.

6.1.3.4 Sensor Usage

Using the pulse sensor is straight forward but positioning it in the right way matters. Since all the electronics on the sensor are directly exposed it is also recommended to cover the sensor with hot glue, vinyl tape or other non-conductive materials. Also, it is not recommended to handle these sensors with wet hands. The flat side of the sensor should be placed on top of the vein and a slight presser should be applied on top of it, normally clips or Velcro tapes are used to attain this pressure.

To use the sensor simply power it using the Vcc and ground pins, the sensor can operate both at +5V or 3.3V system. Once powered connect the Signal pin to the ADC pin of the microcontroller to monitor the change in output voltage. If you are using a development board like Arduino, then you can use the readily available code which will make things a lot easier. Refer the datasheet at the bottom of the page for more information on how to interface the sensor with Arduino and how to mount it.

6.1.4 1 channel 5V Relay Module:

The Single Channel Relay Module is a convenient board which can be used to control high voltage, high current load such as motor, solenoid valves, lamps and AC load. It is designed to interface with microcontroller such as Arduino, PIC and etc. The relays terminal (COM, NO and NC) is being brought out with screw terminal. It also comes with a LED to indicate the status of relay.

Figure 32: Relay Module

6.1.4.1 Technical Specifications

- Digital output controllable
- Compatible with any 5V microcontroller such as Arduino.
- Rated through-current: 10A (NO) 5A (NC)
- Control signal: TTL level
- Max. switching voltage 250VAC/30VDC
- Max. switching current 10A
- Size: 43mm x 17mm x 17mm

6.1.4.2 Pin Description

Pin Number	Pin Name	Wire Color	Description
1	In	Relay Control	Control Relay – Active Low
2	Gnd	Ground	Connect to ground
3	Vcc	+5V	Connect to +5V
4	NO	Normally Open	Stay open circuit until trigger LOW voltage
5	NC	Normally Open	Stay close circuit until trigger LOW voltage

Table 14: Pin Description – Relay Module

Figure 33: Relay Module Pinout

6.1.4.3 Module Usage

Arduino is a microcontroller based prototyping board that runs on small DC power. A Relay is a device that helps microcontrollers (or microcontroller-based boards) like Arduino to switch on or off different household appliances like motors, lights, water heaters, television and fans etc.
The advantage of using a 5V relay in this project is that the power supply for the relay can be directly given from the Arduino UNO board itself. Let us now see some basics of a relay. A relay is a type of a switch that acts as an interface between microcontrollers and AC or DC Loads.

6.1.5 Active Passive Buzzer

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke.

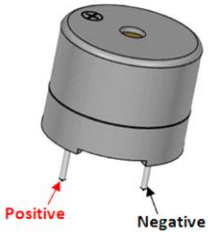


Figure 34: Buzzer

6.1.5.1 Buzzer Pin Configuration

Pin Number	Pin Name	Description
1	Positive	Identified by (+) symbol or longer terminal lead. Can be powered by 6V DC

2	Negative	Identified by short terminal lead. Typically connected to the ground of the circuit

Table 15: Pin Description - Buzzer

6.1.5.2 Technical Specifications

- Rated Voltage: 6V DC
- Operating Voltage: 4-8V DC
- Rated current: <30mA
- Sound Type: Continuous Beep
- Resonant Frequency: ~2300 Hz
- Small and neat sealed package
- Breadboard and Perf board friendly

6.1.5.3 Equivalents for Buzzer

Piezo Electric buzzer, Speaker, Active Passive Buzzer with Module

6.1.5.4 Buzzer Usage

A buzzer is a small yet efficient component to add sound features to our project/system. It is very small and compact 2-pin structure hence can be easily used on breadboard, Perf Board and even on PCBs which makes this a widely used component in most electronic applications.

There are two types are buzzers that are commonly available. The one shown here is a simple buzzer which when powered will make a Continuous Beeeeeeppp.... sound, the other type is called a readymade buzzer which will look bulkier than this and will produce a Beep. Beep. Beep. Sound due to the internal oscillating circuit present inside it. But the one shown here is most widely used because it can be customized with help of other circuits to fit easily in our application.

This buzzer can be used by simply powering it using a DC power supply ranging from 4V to 9V. A simple 9V battery can also be used, but it is recommended to use a regulated +5V or +6V DC supply. The buzzer is normally associated with a switching circuit to turn ON or turn OFF the buzzer at required time and require interval.

6.2 Circuit and Hardware Connectivity

Following figure shows the connectivity of various hardware components:

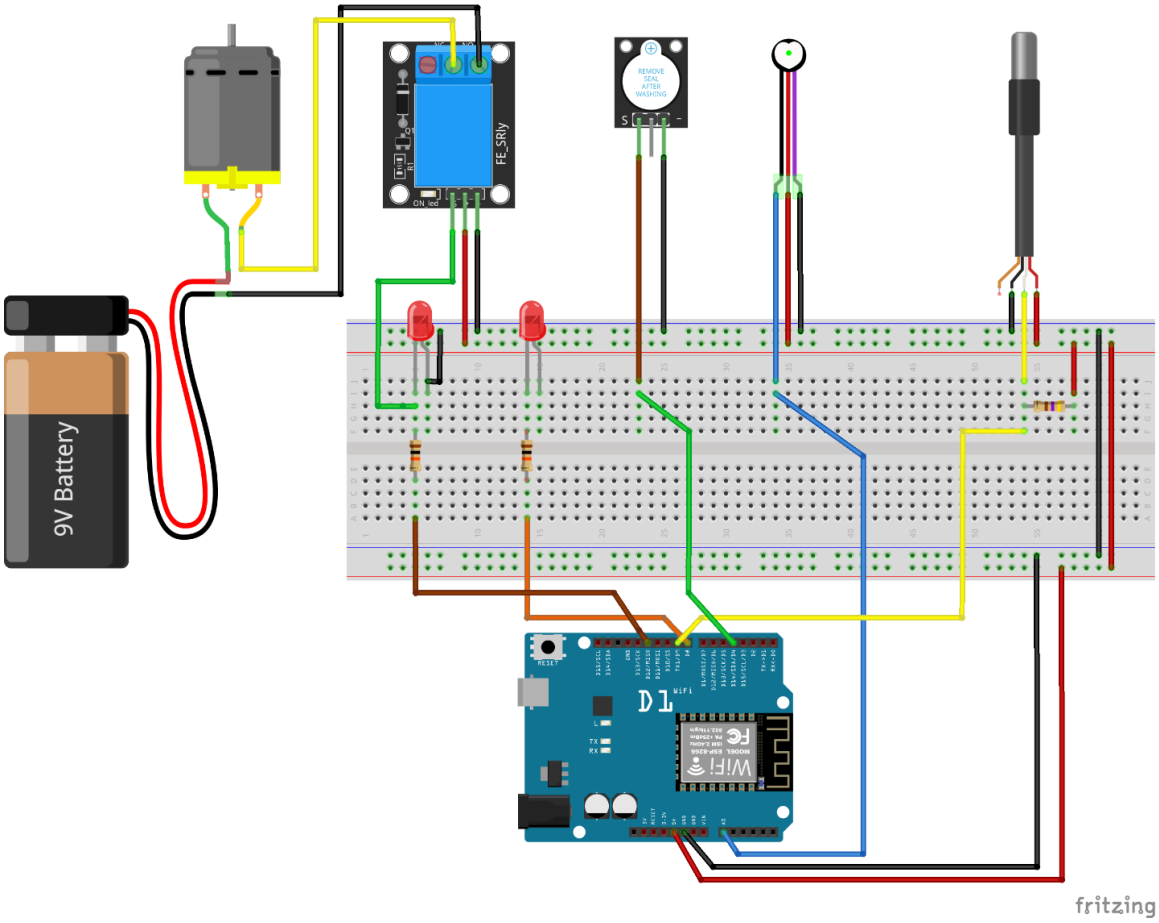


Figure 35: Hardware Connectivity – Wi-Fi Implementation

6.3 Software

Arduino IDE (Integrated Development Environment) is used to program the ESP8266 board as well by configuring IDE as follows:

1. Open the Arduino IDE & select this COM port.
2. Click on "File -> Preferences".
3. In “Additional Boards Manager URLs" add this line and click on "OK": "http://arduino.esp8266.com/stable/package_esp8266com_index.json"
4. Go to "Tools -> Board -> Boards Manager", type "ESP8266" and install it.
5. Go again to "Tools -> Board" and select "Generic ESP8266 Module".

Now ESP8266 module is ready to be used as a stand-alone module.

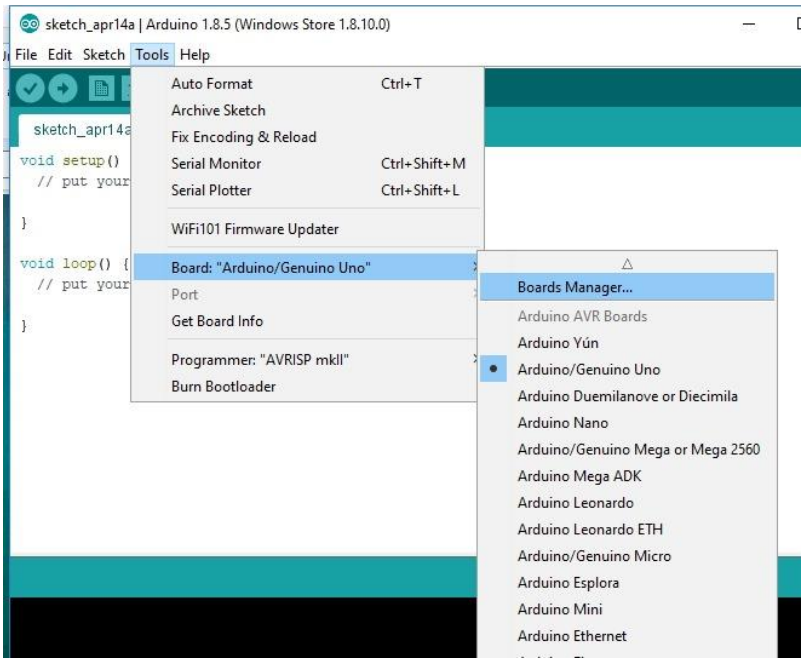


Figure 36: ESP8266 Programming

Arduino program for Wi-Fi based implementation:

```
//Tested well with App on iPhone 8//
//Use Pin D9 to connect the teamperature sensor//
//Tested with Dummy Analog input//
// Light Pin  D6 (Blync) D12 on board
// Fan Pin  D3 (Blync) D8 on board
// Emergency Pin  D2 (Blync) D4 on board

#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#include <SimpleTimer.h>
#include <OneWire.h>
#include <DallasTemperature.h>
#define BLYNK_PRINT Serial    // Comment this out to
disable prints and save space
WidgetLCD lcd(V5);

char auth[] = "NHOeQnFdeDK-1ZquIuo5i5cXWaSxwLud";

/* WiFi credentials */
char ssid[] = "Air101";
char pass[] = "9600122660";

SimpleTimer timer;
```

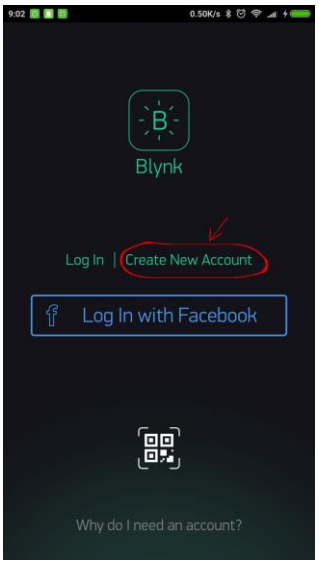
```
#define analogpin A0
#define ONE_WIRE_BUS 2 // DS18B20 on arduino pin2
corresponds to D4 on physical board "D4 pin on the ndoemcu
Module"
OneWire oneWire(ONE_WIRE_BUS);
DallasTemperature DS18B20(&oneWire);
float temp;
float Fahrenheit=0;
float bpm;
void setup()
{
  Serial.begin(115200);
  pinMode(A0, INPUT);
  Blynk.begin(auth, ssid, pass);
  DS18B20.begin();
  timer.setInterval(1000L, getSendData);
}

void loop()
{
  timer.run(); // Initiates SimpleTimer
  Blynk.run();
}

/**************************************************
 * Send Sensor data to Blynk
 **************************************************/
void getSendData()
{

  DS18B20.requestTemperatures();
  temp = DS18B20.getTempCByIndex(0); // Celcius
  Fahrenheit = DS18B20.toFahrenheit(temp); // Fahrenheit
  bpm = analogRead(analogpin);
    lcd.clear();
    lcd.print(0,0,"VIT Project");
  Serial.println(temp);
  Serial.println(Fahrenheit);
  Serial.println(bpm);
  Blynk.virtualWrite(V3, temp); //virtual pin V3
  Blynk.virtualWrite(V4, Fahrenheit); //virtual pin V4
  Blynk.virtualWrite(V5, bpm); //virtual pin V5 for Analog
Sensor

}
```

6.4 Application Development

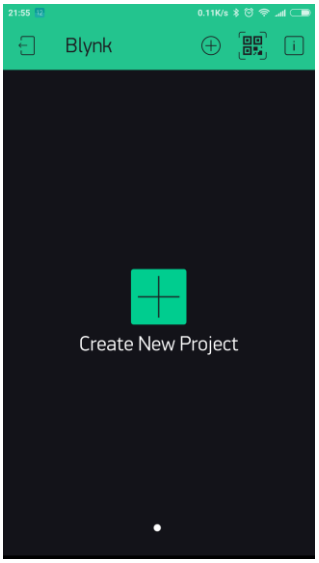
As explained in the sections above Blynk application is used due to its perceived benefits. Following is the step by step process to start the application development.

Getting Started with The Blynk App:

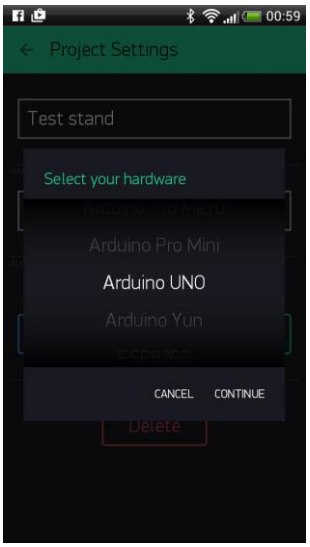
1. Create a Blynk Account
After you download the Blynk App, you'll need to create a New Blynk account. This account is separate from the accounts used for the Blynk Forums; in case you already have one.
It is recommended to use real email address because it will simplify things later.



Why an account is needed?
An account is needed to save the projects and have access to them from multiple devices from anywhere. It's also a security measure.

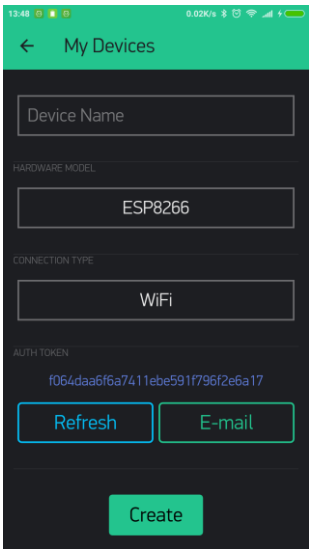


2. Create a New Project
After you've successfully logged into your account, start by creating a new project.



3. Choose Your Hardware

Select the hardware model you will use. Check out the list of supported hardware!



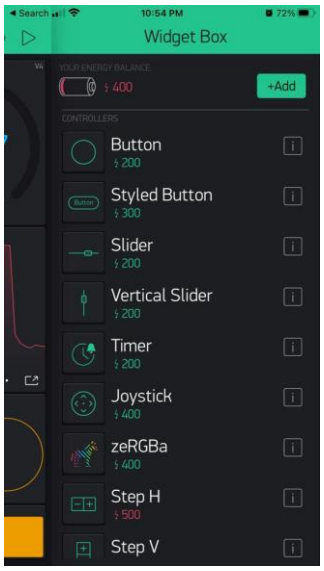
4. Auth Token

Auth Token is a unique identifier which is needed to connect your hardware to your smartphone. Every new project you create will have its own Auth Token. You'll get Auth Token automatically on your email after project creation. You can also copy it manually. Click on devices section and selected required device and you'll see token.

NOTE: Don't share your Auth Token with anyone, unless you want someone to have access to your hardware.

It's very convenient to send it over e-mail. Press the e-mail button and the token will be sent to the e-mail address you used for registration. You can also tap on the Token line and it will be copied to the clipboard.

Now press the "Create" button.



5. Add a Widget

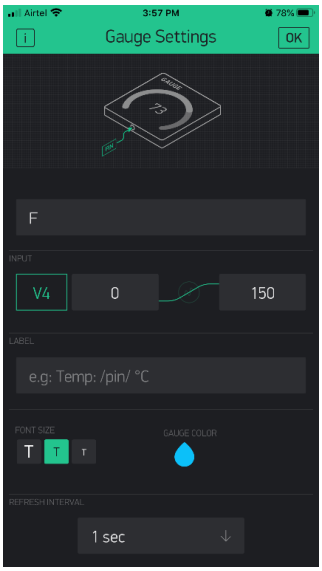
Your project canvas is empty, let's add a button to control our LED.

Tap anywhere on the canvas to open the widget box. All the available widgets are located here. Now pick a button.

Widget Box

Drag-n-Drop - Tap and hold the Widget to drag it to the new position.

Widget Settings - Each Widget has its own settings. Tap on the widget to get to them.



6. Configure the Pin

The most important parameter to set is PIN. The list of pins reflects physical pins defined by your hardware. If your LED is connected to Digital Pin 8 - then select D8 (D - stands for Digital).

8. Run the Project

When you are done with the Settings - press the PLAY button. This will switch you from EDIT mode to PLAY mode where you can interact with the hardware. While in PLAY mode, you won't be able to drag or set up new widgets, press STOP and get back to EDIT mode.

Here is the format of sample Arduino program that runs on the Wi-Fi Module.

```
#define BLYNK_PRINT Serial
#include <SPI.h>
#include <Ethernet.h>
#include <BlynkSimpleEthernet.h>

char auth[] = "YourAuthToken";

void setup()
{
  Serial.begin(9600); // See the connection status in Serial Monitor
  Blynk.begin(auth);  // Here your Arduino connects to the Blynk Cloud.
}

void loop()
{
  Blynk.run(); // All the Blynk Magic happens here...
}
```

Figure 37: Program sample for using Blynk

6.4.1 Building the Application

There is no need to build the application, it has to be run after configuring the same as explained in step 6 above.

6.4.2 Application Features

Following is the final layout and features of the Applications:

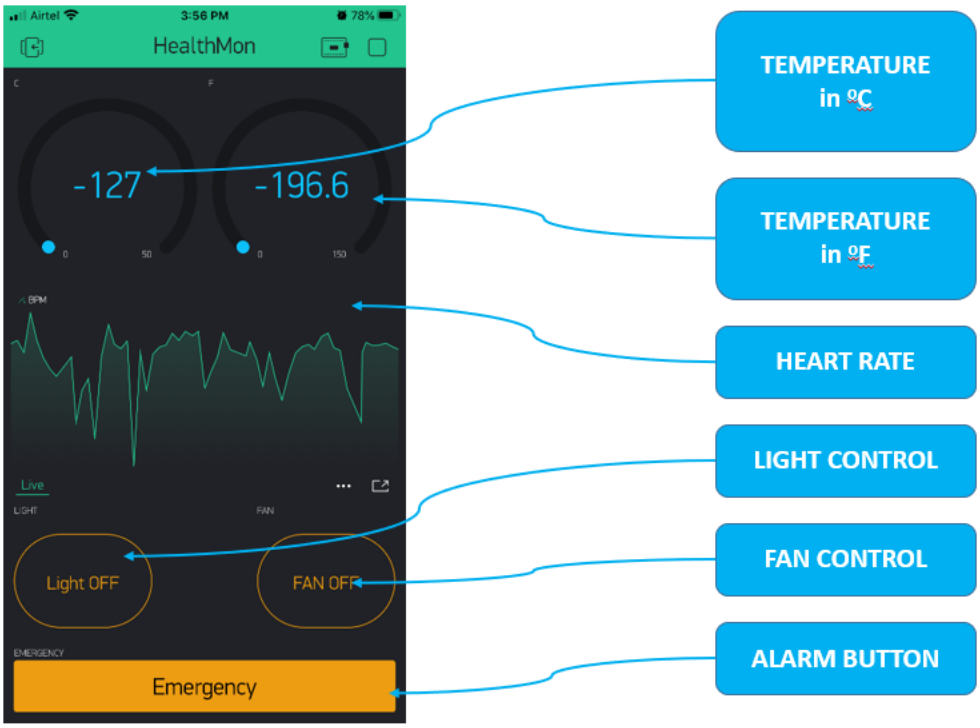


Figure 38: Blynk Application and Features

Application when buttons are operated:

Figure 39: Blynk Application Screen

6.5 Actual Project Image – Wi-Fi based implementation

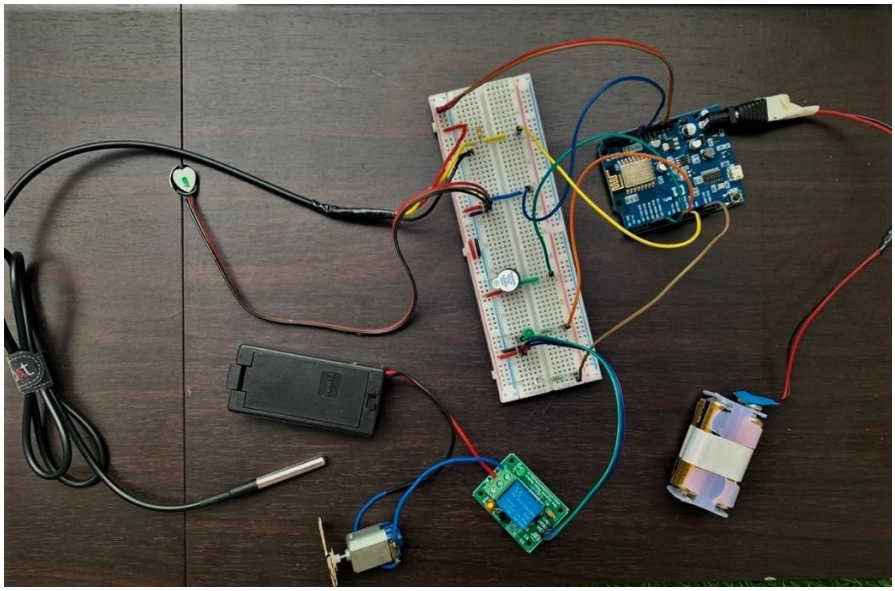


Figure 40: Project Image – Wi-Fi Based

7 CHAPTER 7 – TESTING THE USECASES

Once both the implementations are ready, it is important that functional testing is done to ascertain that the implementation is serving the desired purpose. The test methodology used is black box testing in which the system under test is subjected to various inputs and corresponding outputs are checked for the correctness.

Figure 41: Blackbox Testing

Following functional tests are conducted to verify the functionality.

7.1 Bluetooth based implementation

S. No.	Functionality Checked	Results
1.	Powering on the Arduino board with all the connections	Success
2.	Opening the application on Mobile Phone	Success
3.	Connecting Bluetooth with Arduino module	Success
4.	Checking functionality of Reed Sensor by bringing the magnet near the sensor and moving away and noting that the digital output of the sensor changes when magnet comes near the sensor.	Success
5.	Checking the Gas Sensor functionality by generating smoke in the jar and moving sensor near to the smoke. The analog output of ppm shows the increase.	Success
6.	Checking the Rain sensor functionality by pouring water over the sensor and checking that analog output varies significantly.	Success
7.	Bluetooth range testing by moving away from the boards and accessing the board from all corners of the home.	Success

Table 16: Testcases – Bluetooth based implementation

7.2 Wi-Fi based implementation

S. No.	Functionality Checked	Results
1.	Powering on the ESP8266 board with all the connections	Success
2.	Checking the connectivity of Wi-Fi module to the hotspot.	Success
3.	Opening the application on Mobile Phone	Success
4.	Connecting Application with ESP8266 module	Success
5.	Checking change in the temperature by putting the Temperature sensor in the hot water glass.	Success
6.	Checking BPM display on the graphical display.	Success
7.	Checking the light control function by switching ON and OFF the light and checking that the LED turns ON and OFF respectively.	Success
8.	Checking the Fan Control function by switching ON and OFF the fan and checking that the LED turns ON and OFF respectively and relay also triggers making the motor run.	Success
9.	Checking the Alarm functionality by pushing the Alarm button and noting the buzzer sound for the duration the button is pressed.	Success
10.	Checking the functionality from a remote location (few KMs. Away) to check the system still works.	Success

Table 17: Testcases – Wi-fi based implementation

8 CHAPTER 8 – CONCLUSIONS

8.1 Conclusions

The project was successfully designed, developed and tested and it served the intended purpose. We are able to demonstrate the use of IoT for the elderly with respect to the different use cases. This project has given us the opportunity to learn about the various types of controllers, sensors, application development platform and technologies. We faced many challenges while developing the project but were able to solve these challenges one by one by referring to the references. The objective of the project is successfully met.

8.2 Future Scope

Power of IoT combined with cloud-based web services can do wonders. With the cost of hardware further going down and the accuracy of sensors further increasing, will pave way for new era of home automation. This has potential to take away pain out of the life of elderly and improve their quality of life by providing convenient and safe living environment. Such an IoT ecosystem not only help them physically but also them psychological support to them, by increasing the accessibility to various services at their fingertips.

This project has a scope to add new capabilities and sensor to further improve the experience. Some of the possible addition to the existing project are:

1. Access card-based entry and exit from the main door
2. Main Door operation by Face recognition
3. Light operation by using proximity sensor
4. Bulgar alarm by using proximity and ultrasonic sensors
5. Walking assistance by alerting about the obstructions by using distance sensor
6. Automatic door or window operation based on the environmental conditions.
7. Mobile applications can be more intuitive and smarter
8. Notifications feature in mobile applications can also help to check the sensor state change, so that appropriate actions can be taken.
9. Email alerts can also be configured for the specified people to note any adverse condition like gas leak.
10. And many more…

Commercialization of this project is going to be very viable, due to the intended benefits and the associated costs. This project offers good RoI for the customers.

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