Ha Noi University of Science and Technology

SCHOOL OF ELECTRONIC AND ELECTRICAL ENGINEERING

GRADUATION THESIS

PROJECT NAME:

DESIGN A SYSTEM TO CONTROL AND MANAGE SMART HOUSE THOUGH THE INTERNET

Ha Noi , 7-2022

ACKNOWLEDGEMENT

This master thesis in media and communication studies explores the concept of the smart home, which by various industries within communication, information and energy business alongside property developers is expected to be the model for future living, housing, and infrastructure development. Departing from a theoretical framework highlighting media and infrastructure as temporal and spatial phenomena, the analysis shows how the smart home arranges and manages both means of time and space due to its saturation of information technologies in the form of sensors, applications, and data visualizations.

The result of the study suggests that the smart home could be understood as a logistical medium, although the temporal bias present in the expectations on future living suggests that the purpose of the smart home is to sustain a flow of logistics and capital both over space and over time, the latter in terms of sustainability.

Before we get into thick of things, I would like to add few heartfelt words for the Professor Dinh Thi Lan Anh as well as my family who have been going with us side by side to help us this project perfectly

Ha Noi, 19 July 2022

Students

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STATEMENT OF ORIGINALITY

I'm Pham Ngoc Dat, student ID number 20181870, student of CTTT TDH-HTĐ class, class 63. My instructor is Dinh Thi Lan Anh. I hereby declare that all content presented in this project is the result of my research and research. The data stated in the project "DESIGN SYSTEM TO CONTROL AND MANAGE SMART HOUSE THOUGH THE INTERNET" is completely honest, reflecting the actual measurement results. All information cited is subject to intellectual property regulations; The references are listed. I take full responsibility for the content written in this project.

Hanoi, 31st July 2022

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CHAPTER 1. AN OVERVIEW OF SMART HOUSE

A smart house is one that uses internet-connected devices to enable remote monitoring and control of systems and appliances, such as lighting and heating. On their smartphone or other networked device, homeowners can use a smart home app to operate smart appliances, providing security, comfort, and energy savings. Home automation and domotics are other terms widely used to describe smart home technology (from the Latin "domus" meaning home). The internet of things' (IoT) smart home systems and gadgets commonly collaborate with one another, sharing information about consumer usage and automating tasks in accordance with user preferences.

Picture 1: General model of smart home[1]

1.1 The background concept of smart home

Smart home (also known as home automation, domotics, smart home or Intellihome) is a word that refers to homes that can automatically (or semi-automatically) do everyday tasks without

the need for human intervention. people such as automatically watering plants, automatically closing the curtains when it is dark, automatically turning on / off the electricity in the house...

Even though a smart home usually consists of many different components, there are usually 2 essential components, which include:

- Hardware: The physical devices in the smart home system such as smart led lights, smart surveillance cameras, smart switches, etc.
- Software: This is an application that helps you manage your Smart Home. These apps can help you work remotely without having to be at home. You will constantly be online, especially when using cloud-based programs. In a smart home, electronic devices will be interconnected over the internet and under the supervision of a separate server.

In a smart home, electronic devices will be linked together via the internet and monitored by a separate server. You just need to install, set the job for each device and it will automatically do it later. The process is completely automatic.

There are many smart homes equipped with their own "smart butler" that can learn the owner's habits and can communicate with the owner of the house like a real person. However, the cost for those home systems is very high and not everyone can afford it.

Currently, smart home systems do not have a common standard and are still quite fragmented. Smart home service providers use their systems and cannot communicate with external systems, which greatly hinders the scalability of the smart home system.

1.2 The meaning and some features of smart home

Smart home is a system of houses that are connected to each other by advanced electronic pages that bring the most conveniences to help users control and use anywhere through the security system at the heart of the smart home. home connected to the user's computer, or mobile phone.

Smart home devices all use internet connection to link, help users manage and monitor such as reducing light intensity, automatic door lock, home security with just a few basic commands. Smart home technology is also known to users as Home Automation, part of a network of

things connected via the Internet, sharing data with users to automate actions. of the homeowner.

Some feature of smart homes

- Lock and open the door automatically: When you leave the house, in and out of the Garage – the door system will help you open and close automatically. By technology integrated system Smart home - Smart Home, High-speed Camera. Be assured of the convenience and safety brought to you by a smart home.

- Control lights, air conditioners, electrical appliances from anywhere: Smart Home system will help you control and control lights, electrical appliances, air conditioners everywhere, with just a few simple steps on Smartphone, iPad, or laptop. Just connect to the Internet to control any devices you need to turn off.

- Save money from electricity bills: Because Smart home smart home helps us control electrical appliances, air conditioners from everywhere. We will turn off the air conditioner when we forget to turn it off, open the curtains automatically when it is morning and turn off the lights when not needed. All utilities help you get the most out of everything.

- Security monitoring control: Smart home smart home can integrate speed and high-definition camera system, door sensor system, motion sensor. Help alert breaking into your phone no matter where you are.

- Create a comfortable and clean-living environment: Smartphone, sensor, smart home smart home system will get information, calculate, and analyze information about temperature, humidity, light of the environment and give contexts for your home and family to have a conversation. most comfortable living.

- Teach and talk to the device: Smart home smart home combined with virtual assistants – helping you control everything in your home, virtual assistants will help you get information and advice when needed. In addition, smart home also learns according to your schedule and habits and gives you some context to help optimize our lives.

- Helps to keep the connection with the family: When we go to the office, go on a business trip abroad, or our children study abroad. With the smart home system - smart home, the accompanying utilities will help you contact and connect with your family anywhere on earth with an iPhone or iPad in hand.

- Enjoy life: Imagine, after so many years of working and trying. We go home and have the air conditioning system on, ceiling music playing the song you like, the garage door automatically opening will help us like and want to go home faster. Or our parents are elderly and have difficulty walking, it will be convenient to use smartphones and actively turn off the lights and open the curtains, when necessary, without anyone's help.

- Luxury and sophistication: Either way, after a long time of trying to build a house, we all want the house to be beautiful and convenient. Along with a reasonable price, a smart home - smart home will help the house become more attractive, more beautiful, more luxurious, and more convenient. Everyone loves a chance to experience your home.

1.3 Basic structure of a smart home

1.3.1 Architecture of smart home

With the structure indoor communication network in the family, we can observe that the power of all electric devices in our home can be controlled through the network interconnection. With only a smart home, cellphone, internet and other mean, the users can control all the home system structure and other service remotely.

Through sophisticated interactive interfaces, we also provide automatic water collection, information management, smoke detection, gas leak detection, anti-theft, emergency assistance, and other home security services, gas meters, and support and property management center cell master network, and achieve home security information authorized one-way transmission and other services.

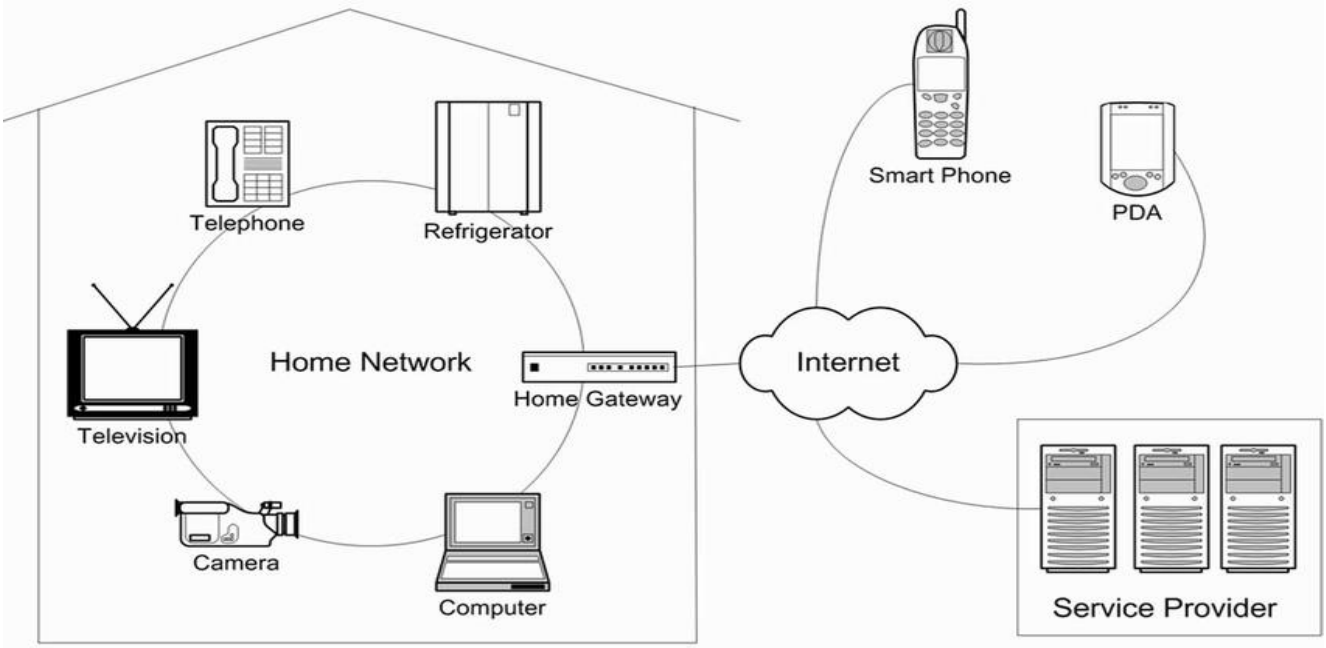


Figure 1: Typical structure of smart home[2].

1.3.2 Smart mechanisms

The mechanism of action can be divided into 3 types as follows.

- Recognition mechanism: The recognition mechanism allows the memory of pre-installed features in memory; If the identification does not match, the system will refuse to serve or give an alarm. For example, gates and garage doors open only to vehicles with number plates registered with the system, automatic fingerprint recognition doors only open to the right people; During the nighttime, if there is a stranger in the living room, the system will alarm…
- Programmable Mechanism: Some device systems are designed to operate on a certain schedule. For example, starting at 7pm garden lights, security lights automatically turn on and off at 5am, at 7am the TV in the kitchen area automatically turns on the correct program settings for breakfast people to watch, 8am light garden watering faucet works for 15 minutes; At 10:00 at night, the automatic safe door systems will close…
- Induction Mechanism: The induction mechanism is a flexible mechanism that operates on the state change that the sensing system recognizes to control itself accordingly. For example: At stairs, toilets, lights will automatically turn on when there are people and automatically turn off after a certain time when there are no people; The alarm system will notify when the door has more mechanical vibrations than usual (due to vandalism,

break-in), the glass roof will automatically close when it rains, the blinds - curtains automatically operate in the appropriate state. When sensitive to sunlight, the light automatically turns on when natural lighting is not enough…

1.3.3 Communication protocol in smart home

Communication between sensors, central processing unit is an integral part of smart home applications. Due to the variation in features, mode of operation; however, several communication protocols are more in use than others.

Some of common-use communication protocols include:

- WIFI
- Zigbee
- Z-Wave
- BLE

1.3.3.1 WIFI

WIFI gives user the easiest and probably the most reliable communication path for smart home solutions because of its ubiquitous use in other applications. Most houses would already have WIFI router which makes deployment of WIFI-based smart home devices easier and cheaper. Unlike other protocols, its IP-based architecture makes it relatively straightforward and easy to build IoT-based applications, and its high bandwidth makes it suitable for applications that require high data throughput.

1.3.3.2 Zigbee

Zigbee is the IEEE 802.15.4 personal network area standard, which has been around for more than a decade. It is seen as an alternative to Wi-Fi and Bluetooth for several applications including low-power devices that don't require a lot of bandwidth - like smart home sensor systems.

Zigbee doesn't focus too much on connection points. For instance, when exchanging data over Bluetooth across a close range between two high-power devices, the Zigbee network still performs well.

1.3.3.3 Z-Wave

Z-Wave is a wireless protocol that harnesses low-power radio waves to help smart devices or devices successfully communicate with each other.

Z-wave technology creates a wireless network, which is a collection of devices that link and communicate without wires. With Z-wave technology, devices "connect" to each other by sending signals over low-power radio waves on a dedicated frequency.

Z-Wave operates on the 800-900MHz radio frequency range. However, the actual frequency on which a Z-Wave device operates depends on the country in which it is being used.

1.3.3.4 BLE

Bluetooth Low Energy (BLE) is a low-power wireless communication technology that can be used over short distances to allow smart devices to communicate with each other. Some of the devices you interact with every day such as smartphones, smartwatches, fitness trackers, wireless headsets, and computers are using BLE to create a seamless experience.

BLE is a relatively new Bluetooth standard "designated" by SIG (Bluetooth Special Interest Group) with a focus on improving energy efficiency when transmitting data. BLE has many capabilities and is deployed in a wide range of areas such as health, fitness, security, home automation, home entertainment, smart industry, and IoT (Internet of Things). It also works with the smartphones and PCs you already own.

1.3.4 Comparison between BLE, WIFI, z-wave and ZigBee

1.3.4.1 Recommendation for Z-wave

If you prefer to keep things simple and live in the US or Canada, Z-Wave offers the most possibilities across practically all product categories. The brands that are offered include GE, Honeywell, Leviton, GoControl, Fibaro, Aeotec, and HomeSeer, among others.

If you live outside the US, your options will be somewhat more limited. Find businesses by doing a search for Aeotec, Fibaro, Qubino, and other names.

You will need a Z-Wave certified hub or software to control and monitor these devices, but there are several options available.

1.3.4.2 Recommendation for ZigBee

People choose to utilize ZigBee devices since they are often less expensive than their Z-Wave equivalents. Many hub producers, including SmartThings, Wink, IRIS, and IKEA, have created their own line of Zigbee-powered sensors.

You will need a hub or software that is Zigbee compliant to control and monitor these devices, but there are several options available. Amazon's Echo Plus is the only smart speaker with a built-in Zigbee radio.

1.3.4.3 Recommendation for WIFI

The simplest and most economical entry point into the realm of the smart home is WIFI. It is the only technology available that functions without a hub. You're all set to go after installing the necessary gear and software. Keep in mind that automations can only execute simple scheduled on/off tasks. It is simple to add a smart speaker to add voice control, and it is possible to install a multi-tech hub or software program to enable more advanced automation.

1.4 Context and demand for smart home

Homes, apartments, businesses, and other structures used for a variety of purposes typically contain several electrical systems and gadgets that need to be managed separately and function independently of one another. In most homes, we are unable to use the TV remote control or wall switches to unlock the door or change the radio station. This is because no system interacts with the others; instead, each runs alone.

A home that has a well-designed home automation system that integrates all the electrical components to control lighting, heating, air conditioning, ventilation, security (burglar) alarm systems, audio, and video systems, call devices, energy control equipment, presence, automation (door, windows, blids, gates), and technical alarms is referred to as a "smart house" (for example, in case of unintentional water spillage). In order to create a smart house, different home installation parts—such as lighting, heating, cooling, blinds, sensors, etc.—are combined into a unified system.

There is less need for human engagement with this kind of automation, which improves comfort and safety, creates new possibilities, and promotes energy economy. Since the

electrical system and the house itself were not programmed to be clever or smart, they cannot learn from their errors or rectify themselves (unless, of course, they are equipped with artificial intelligence systems)!. The terms "smart home system" and "smart house," however, are well-known and frequently used in marketing across all media. Second, we reduce our carbon footprint in accordance with current European and global policies by increasing energy efficiency, which entails using less electricity. One industry that has mostly avoided the pandemic unharmed is the global market for Internet of Things products, which Statista experts forecast will reach $1.1 trillion next year: "Homes are getting more attention now than they did before the Covid-19 outbreak.". Customers desire IoT technology more and more because it allows them to provide voice commands, digitally change their houses, and add more safety measures. This consumer behavior has shielded the Smart Home market from dramatically declining sales and the 2020 economic downturn.

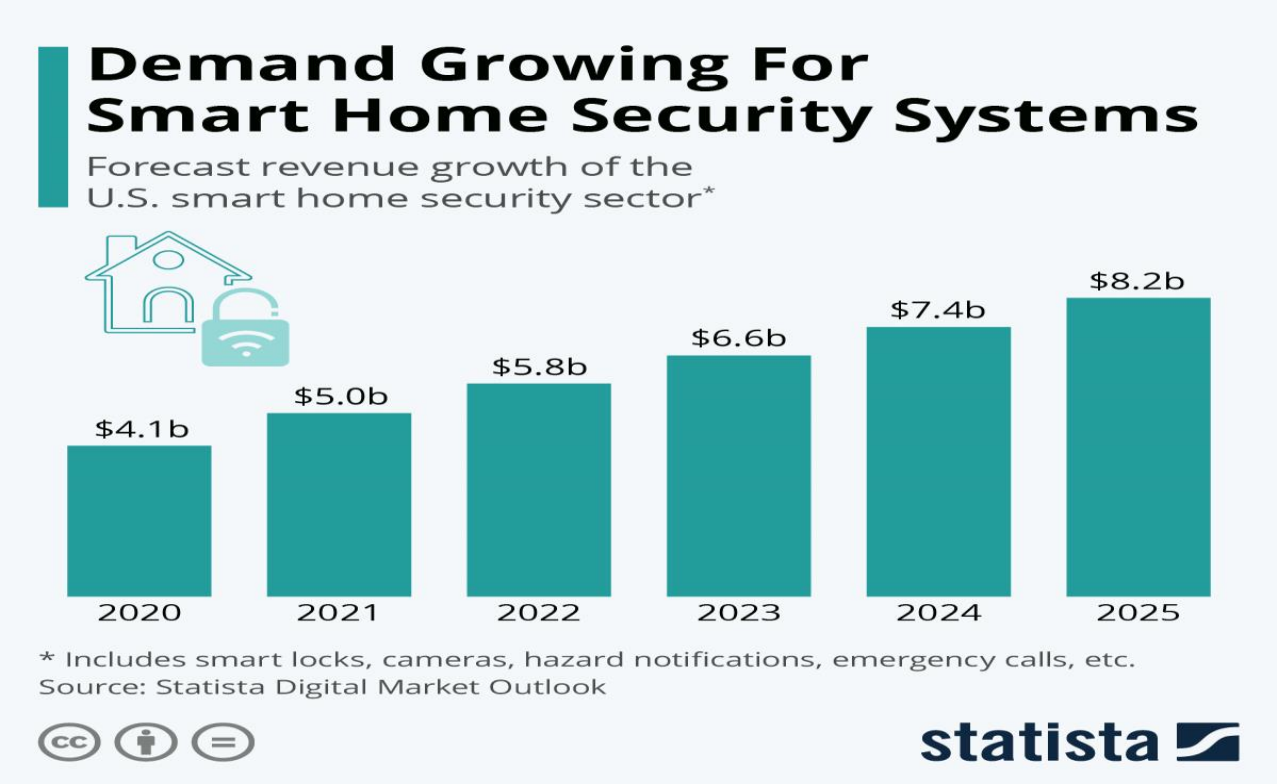


Figure 2: The increasing demand in smart home field

1.5 Some system models of smart home at present

1.5.1 Smart home solutions in the world

Referring to smart home brands from abroad, it is impossible not to mention. Schneider of France, Smartg4 of America, Gamma of Gamma JSC, Arteor of Legrand (France), My Home of Bticino (Italy), WattStopper (USA), Mhouse, Home access, Came with official agents are NTMC, Hager (France), Crestron (USA)... Smart electrical equipment products from abroad all have their own advantages. outstanding in design and functionality with advanced and modern solutions.

Here is an example of a smart home from several manufacturers in the US and Europe, with standards from basic to high-end for a family:

Figure 3: Smart home solution of COMPRO Technology

Figure 4: Smart home solution of Eco-Future-World

1.5.2 Smart home solutions in Viet Nam

In Vietnam, along with the strong growth trend of the market, smart home is gradually becoming an attractive field that no technology "giants" want to ignore, including Vietnamese technology enterprises. The smart home market in Vietnam is fiercely competitive with the presence of a series of foreign and domestic brands.

However, a huge obstacle for Vietnamese people to own a smart home from abroad is the cost. The estimated cost for a smart home from abroad is as low as 25000 USD ~ more than

500 million VND. In addition, there is a significant obstacle that these solutions are not suitable for the infrastructure and construction system in Vietnam.

Therefore, some Vietnamese businesses are now trying to build a smart home brand "Made in Vietnam" worthy of competing with brands from abroad, giving Vietnamese people the opportunity to experience and use the perfect smart home system in terms of quality as well as the most reasonable cost. Here we take a look at some popular smart home brands in Vietnam.

BKAV smart home is a product of BKAV technology group. Since its launch, Smart home BKAV has been focused on the high-end segment of the market, competing directly with smart home products from abroad with similar costs. This is also a big challenge for BKAV in bringing smart home closer to Vietnamese users.

Figure 5: Smart home solutions of BKAV

2.Project aim and scope

Smart home is a broad topic and has many problems. Depending on the intended use of the owner to design, an important part of the smart home system is the control and monitoring system.

In the past, smart homes were purely in the imagination as well as in the movies. Thanks to the continuous development of science and technology, smart home solutions are increasingly rich and convenient for users.

From the beginning, smart home only has remote control devices within the house to serve some human needs. Next is the automation of devices in the house with the ability to automatically adjust to the environment as well as the user.

Then, with the development and spread of the internet, people came up with a solution to connect and control home appliances through the internet and add conveniences such as safety systems, computing power, etc. energy usage, etc. helps the owner to control the device at a distance, not confined to the premises of the house anymore.

Security is also a top priority, because along with an internet connection, the possibility of being hacked into the system to gain control also increases. Owners can use their own passwords to log in to the system as well as the house through forms such as Passcode, fingerprint security, iris security... Accompanied by the ability to warn of intruders to help homeowners detectable anywhere with WIFI connection.

And recently, the trend of controlling devices by voice has also been added to the smart home building solution, making it easier for everyone in the house to use. In the future, thanks to new technological devices combined with artificial intelligence, the house can distinguish each member's voice and remember the habits of each family member.

Currently, in Vietnam, the solution to build smart homes with control and monitoring systems via the internet is still the most popular and developed because it is suitable with existing technological capabilities and economic conditions.

My group feels that this topic is suitable for automation major as well as high-tech flow, so in this topic, my group would like to choose to design a smart home according to the solution of using a control system. and monitor devices in the house via the internet, specifically the WIFI network on a smart home model with a small scale along with basic functions such as: automatic door opening/closing, monitoring and Fire alarm, gas leak warning, unauthorized intrusion warning, automatic curtains according to light, lights and fans turn on automatically according to the user and ambient temperature...

CHAPTER 2. DESIGN OF SMART HOME

2.1 Feature and design

2.1.1 Design of smart home

Our home was designed with features as listed below:

- 1 kitchen
- 1 garden
- 1 bathroom
- 1 bedroom

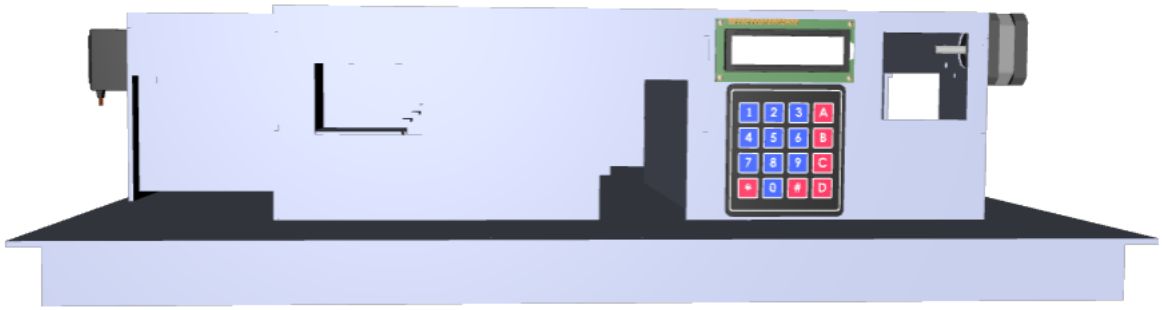


Figure 6: Smart home view from outside

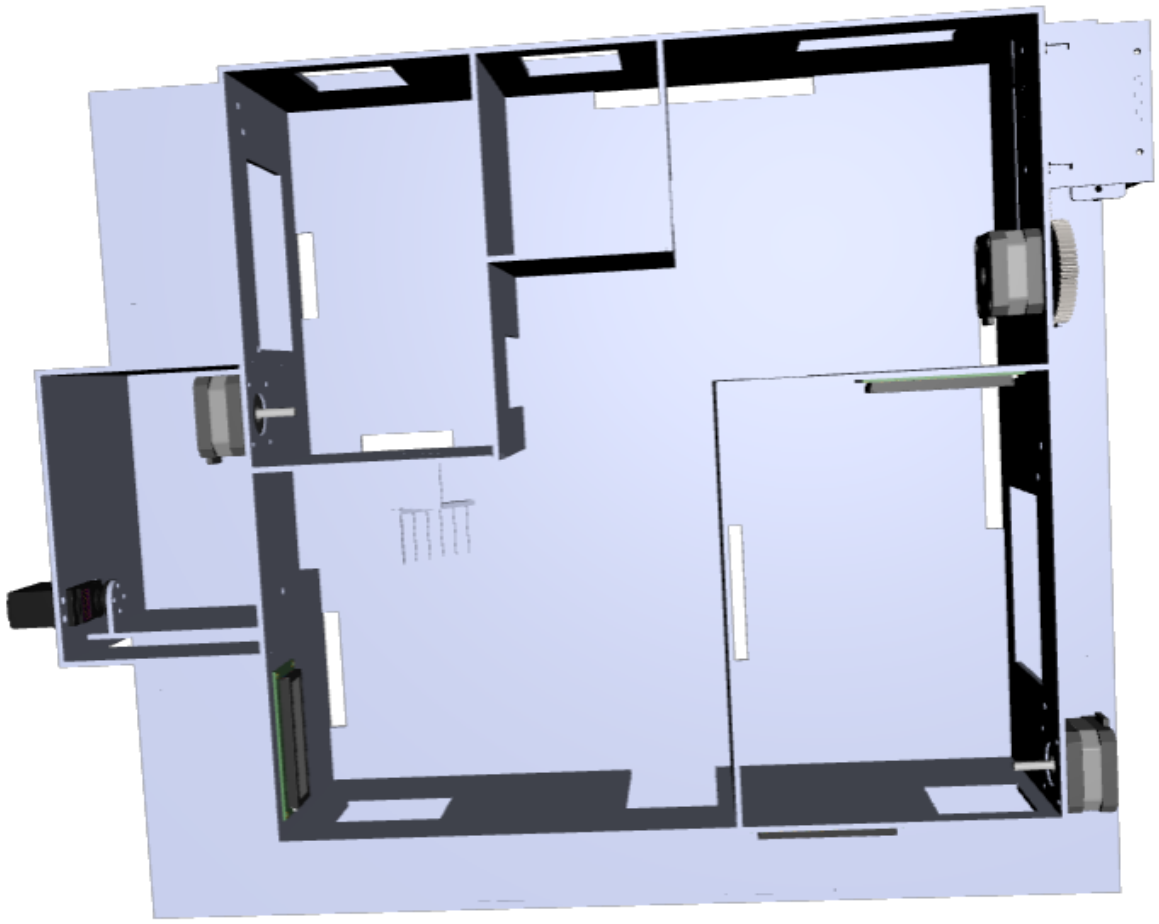


Figure 7: Smart home from top down

2.1.2 Requirement and features of smart home

2.1.2.1 Requirement for this project

In this project, our team want to design a prototype of a real smart home with a smaller scale. Our smart home, however, would have basic feature and facilities based on lower power devices for actuator, sensor, central processing unit compared to devices used in smart home in the real world. We also need to choose devices wisely such that, they can work properly together at a lowest cost as much as possible.

Our requirements for this project are listed below:

- User identification module allowing access right to the house by using fingerprint identification
- Design automatic fan and light control system for bathroom with ability to activate light and fan automatically when human is detected entering the bathroom

- In-house environment measurement system such as gas content, temperature, humidity allows user tracking the house from distance
- Automatic clothesline and window systems working based on environment conditions and user demands.

2.1.2.2 Feature

With the requirement as the aforementioned, our smart home will have such features as described below:

- Open door by fingerprint
- Automatic curtain system according to ambient light
- Temperature and humidity measurement system
- Automatic clothesline system adjusted to the weather
- Automatic fire alarm and gas leakage system
- Light and fan control system (with 2 modes on and off for light and speed adjustment for bedroom fan)
- Control each module by using app on mobile phone or by a website

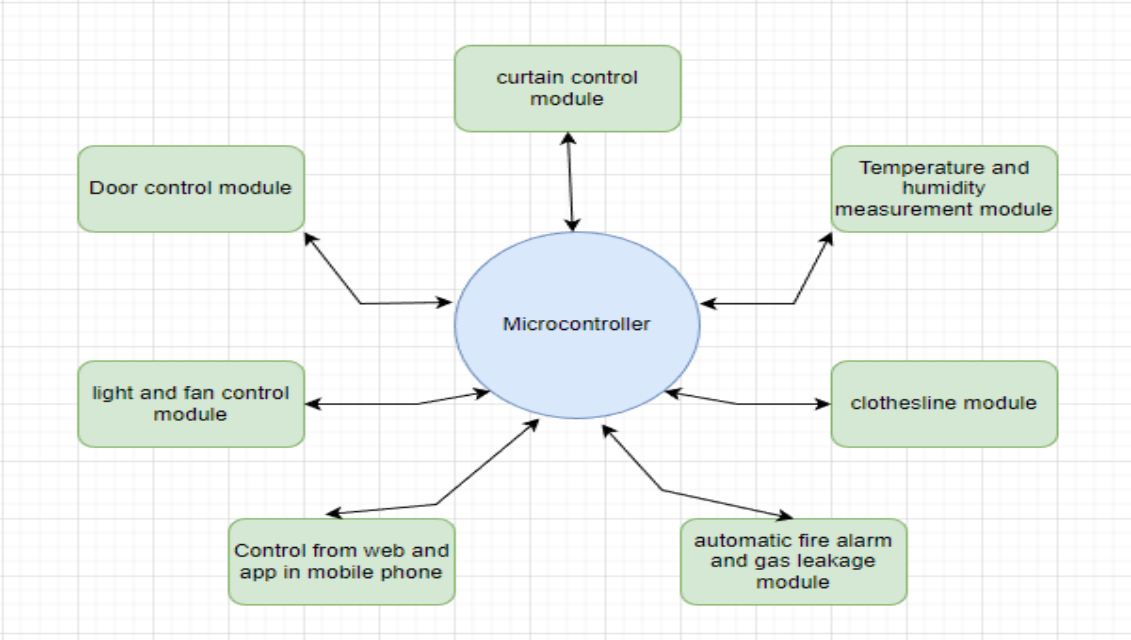


Figure 8: Feature of smart home

2.2 Analysis to choose solutions for the project

To meet our requirements and features of the smart home mentioned above. Sensor and actuator device selection is our first concern when to meet our requirements and features

of the house as discussed above (About device selection will be mentioned in details in the next chapter).

Protocol to communicate between the smart home and application on mobile or from the website on the internet is the following task we need to take into consideration. With a lot of communication protocol for smart home nowadays, choosing a perfectly fit communication protocol for each smart home is impossible because advantages will always come with disadvantages. Therefore, we would choose a communication protocol, which is the most ubiquitous communication protocol for smart house on the market, that we found out that a lot of MCU is integrated with Wi-Fi peripherals allowing MCU perform data transmission and reception much easier.

After we listed out several feasible options for devices of each module and protocol for data exchanging between user and MCU. MCU selection is our next crucial task when we need to choose a cheap, popular MCU satisfying our requirements and features such as the number of pins or the communication protocol compatible with sensors as well as sever it supports.

Choosing a popular MCU or development board brings a lot of advantages. We can have access to a lot of materials and look for help from forums, group on the internet. If we choose a less common-use MCU or board, it becomes much more difficult to solve the problems we encountered while developing our project. Based on the criteria above, we figured out that ESP32 development board fits our requirements.

Figure 9: ESP32 development board

Finally, development environment is of necessity because it will facilitate us during the development process. At this point, Arduino IDE (integrated development environment) is our choice. Although, this IDE is purposedly designed for Arduino board, we could utilize a lot of APIs to program our board in addition to several library designed exclusively for ESP32 development board.

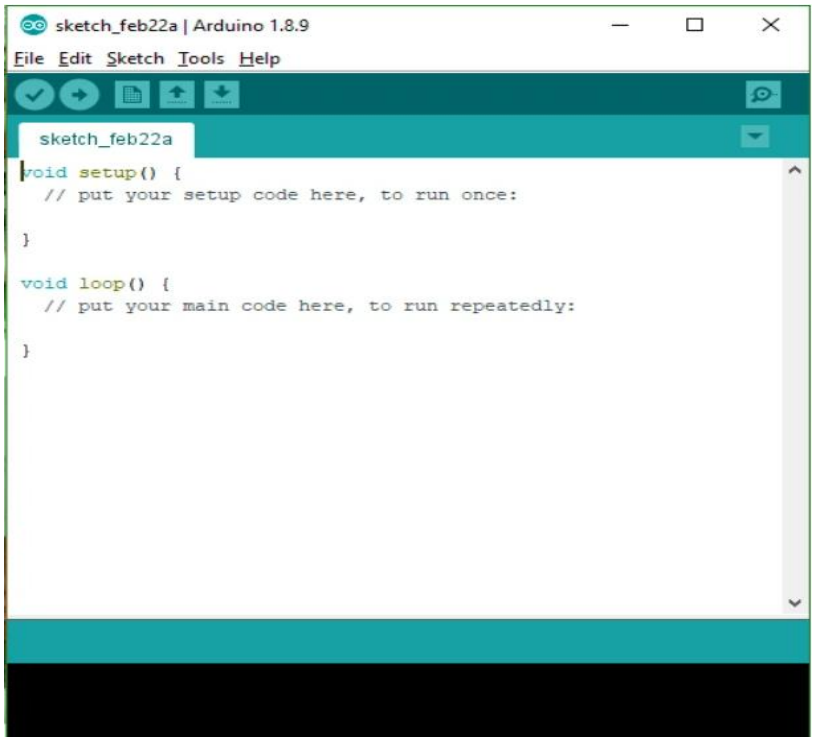


Figure 10: Arduino IDE interface

2.3 How to use Arduino IDE

2.3.1 File format

As a program written by the Arduino IDE called sketch, sketches are saved in .ino . format. This sketch is written in C/C++ programing language with a lot of features specified for MCU programming.

2.3.2 Button usage on Arduino Ide

	Name	Meaning
	Verify	Check errors and compile the code

	Upload	Compile and upload to board connected to computer
	New	Create new sketch
	Open	Open a sketch
	Save	Save sketch
	Serial monitor	Open serial monitor

2.3.3 Serial terminal

The Serial Monitor is a component of the Arduino IDE that enables the board and the computer to send and receive data to each other via the USB interface. To open the Serial, monitor screen, we choose Tool > Serial Monitor.

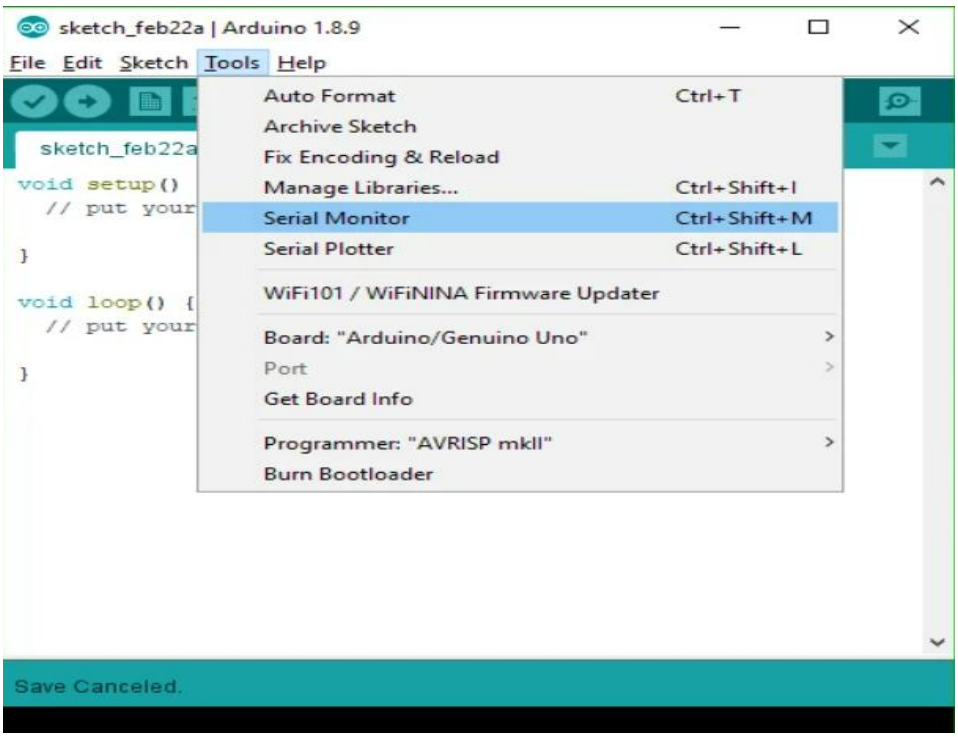


Figure 11: Debug our program to see the flow

After finishing your code, it is ready to load this sketch to our board connected to our computer by USB cable.

From the solutions we proposed above, the next section will discuss in details about the solutions that we choose and the devices, components we select to complete each feature for the smart home as well as meet the requirements.

2.4 Working principal diagram

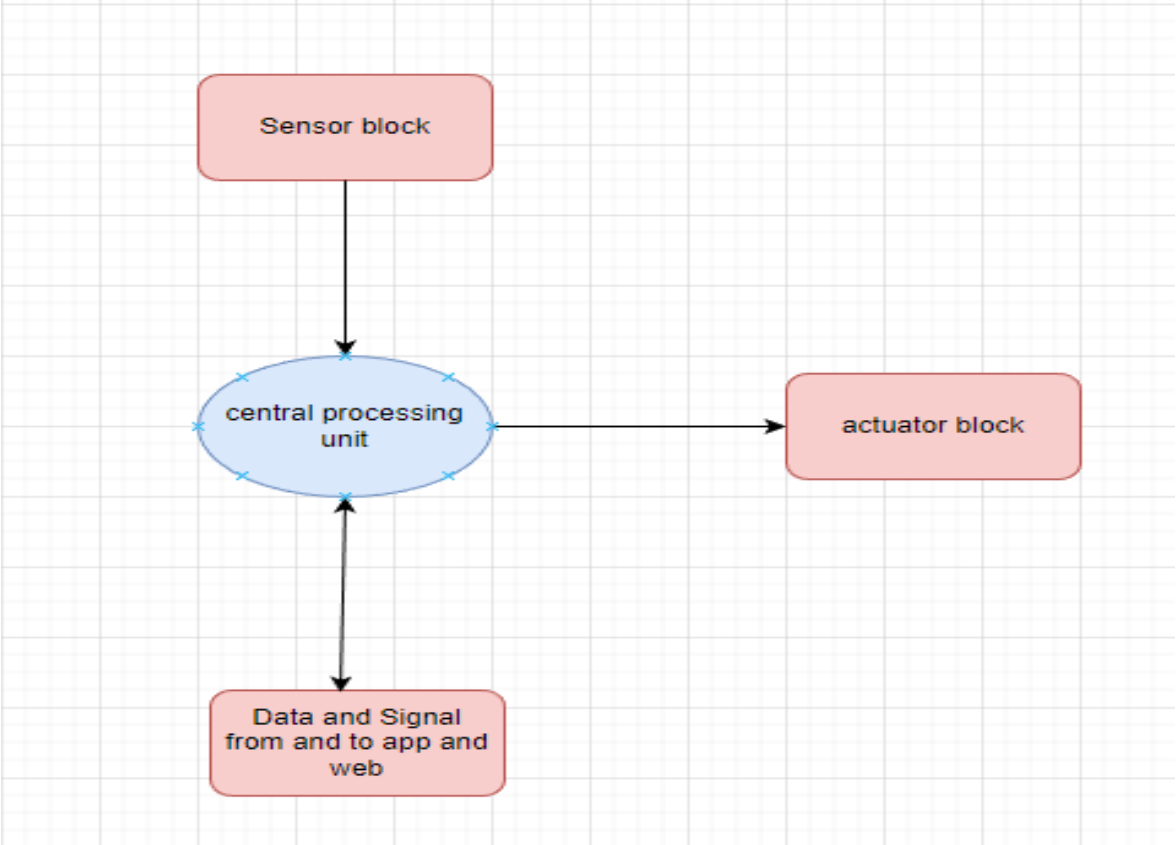


Figure 12: Working principal diagram

a, Sensor block:

- Temperature and humidity sensor with digital output
- Movement detected sensor with digital output
- Gas leakage sensor with analog output
- Infrared sensor with digital output
- Light detected sensor with digital output
- Rain detected sensor with digital output

b,Central processing unit

- NodeMCU ESP32 with ability of communicating through WIFI

c,Actuator block

- Step motor
- Servo motor
- DC motor
- LED
- LCD screen

d,App used to communicate with ESP32

- Blynk app on mobile phone
- Blynk web server on the internet

2.5 Schematic of smart home

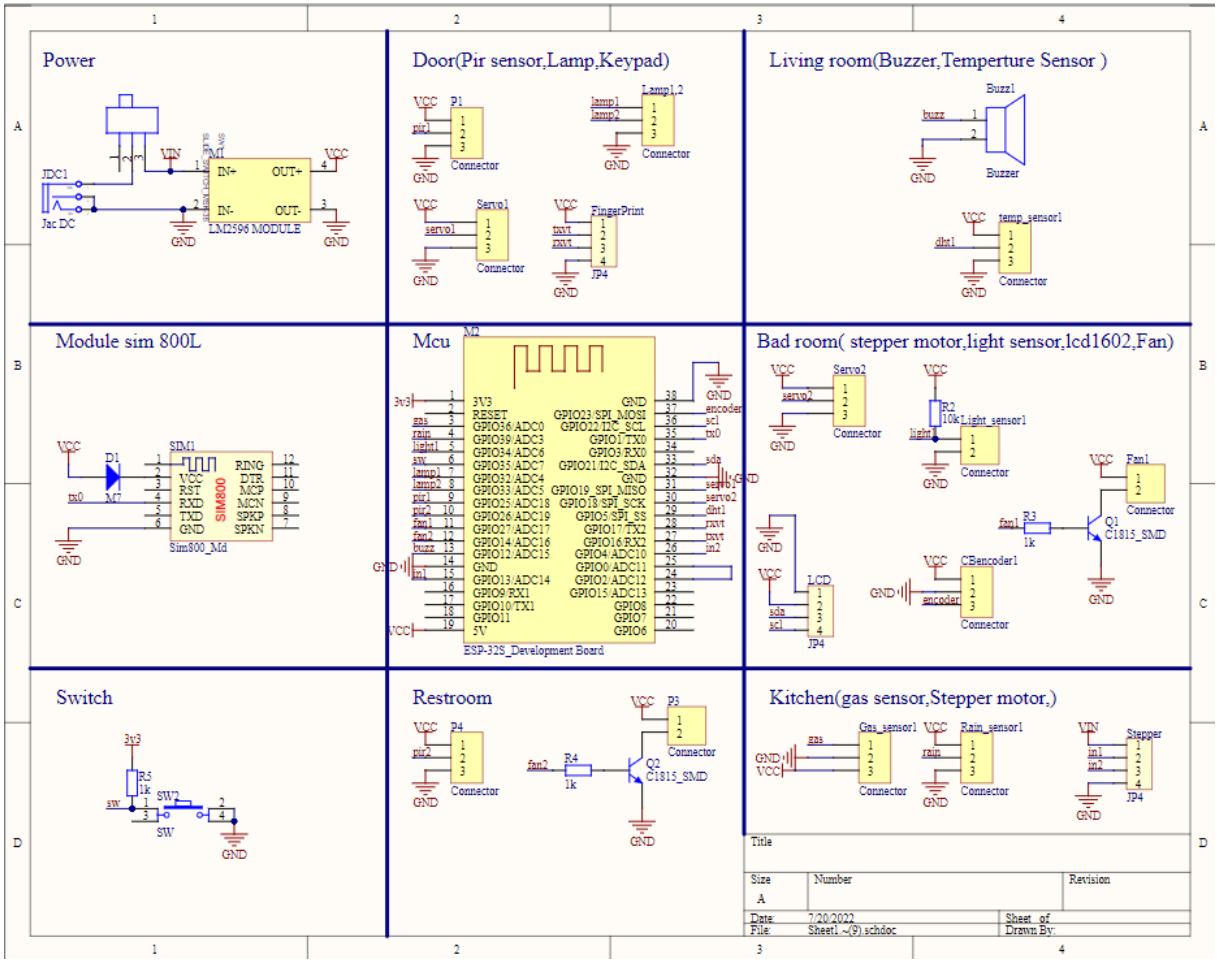


Figure 13: Schematic of smart home

2.6 Introduction to Node-MCU ESP32

2.6.1 Introduction

2.6.1.1 General about Arduino

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards can read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on wring), and the Arduino Software (IDE), based on processing.

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments.

2.6.1.2 Why Arduino

Arduino has been used in countless projects and applications because of its easy-to-use interface. Beginners may use the Arduino program with ease, while skilled users can customize it to their own. Mac, Windows, and Linux are all supported. Teachers and students use it to create inexpensive scientific instruments, demonstrate chemistry and physics concepts, or begin learning robotics and programming. Interactive prototypes are created by designers and architects, and musicians and artists utilize them for installations and to test out new musical instruments. Of course, makers use it to construct many of the projects displayed, for instance, at the Maker Faire. A crucial tool for learning new things is Arduino. Anyone - children, hobbyists, artists, programmers

- can start tinkering just following the step-by-step instructions of a kit or sharing ideas online with other members of the Arduino community.

For physical computing, there are numerous additional microcontrollers and microcontroller platforms available. Similar capability is provided by MIT's Handyboard, Parallax Basic Stamp, Netmedia's BX-24, Phidgets, and many other products. All these tools take the complex microcontroller programming intricacies and put them in a convenient form. Additionally, Arduino makes working with microcontrollers easier, but it has several advantages over alternative platforms for educators, students, and curious amateurs:

- **Inexpensive** - Compared to other microcontroller systems, Arduino boards are reasonably priced. Even the pre-assembled Arduino modules cost less than $50, and even the cheapest version of the Arduino module can be put together by hand.
- **Cross-platform** - The Arduino Software (IDE) is simple for beginners to use and flexible enough for more experienced users as well. Being based on the Processing programming environment implies that students learning to program in that environment will be familiar with how the Arduino IDE works, which is helpful for teachers.
- Arduino boards are inexpensive when compared to other microcontroller platforms. including the pre-built modules for Arduino.
- **Simple, clear programming environment** - Beginners can use the Arduino Software (IDE) with ease, while advanced users can also benefit from its flexibility. It's built on the Processing programming environment, which is helpful for teachers because it means that students learning to program in that environment will be familiar with how the Arduino IDE operates.
- **Open source and extensible software** - Open-source tools for the Arduino software are made accessible for knowledgeable programmers to alter. Those interested in technical specifics can switch from Arduino to the AVR C programming language, on which it is based, and C++ libraries can be used to expand the language. Similar to that, you can directly add AVR-C code to your Arduino projects if you desire.
- **Open source and extensible hardware** - Due to the Creative Commons license that the Arduino board plans are released under, skilled circuit designers

are able to create their own version of the module, extending and improving upon it. The breadboard version of the module can be constructed by even quite inexperienced users to learn how it functions and save money.

2.6.2 General introduction to Node-MCU ESP32

Espressif-Systems' ESP32 is a dual-core MCU with built-in Wi-Fi and Bluetooth. If you have experience with the ESP8266, the ESP32 is a vast improvement with many additional functions. Complete beginners should read our Getting Started with ESP32 guide.

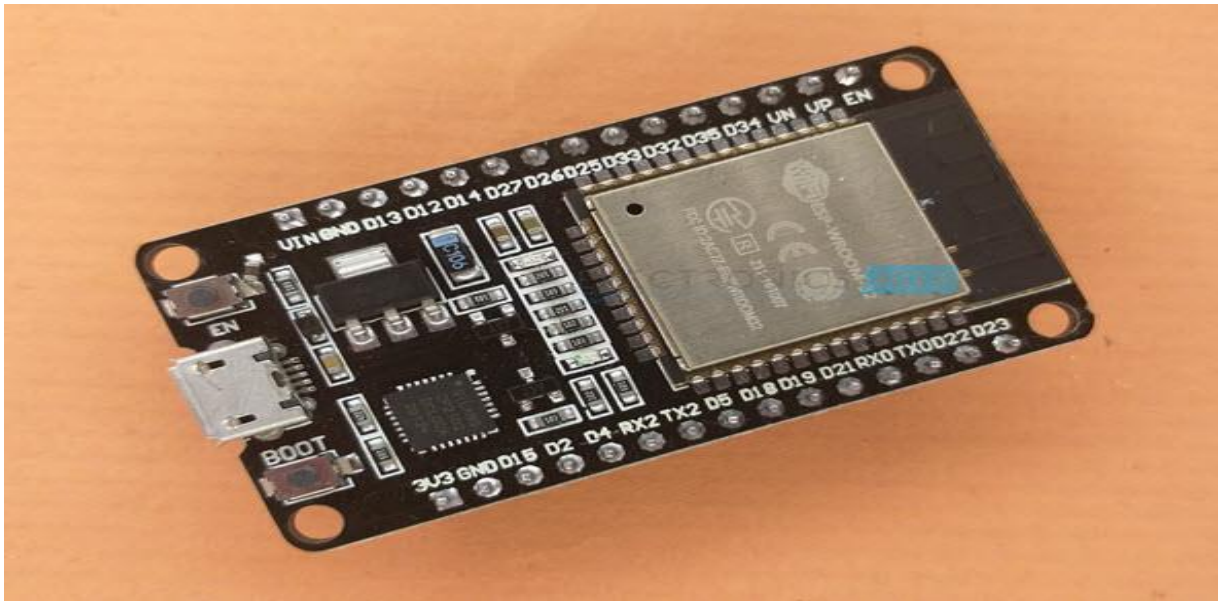


Figure 14: ESP 32 Module

Espressif Systems, the same company that created the well-known ESP8266 SoC, offers the inexpensive ESP32 System on Chip (SoC) Microcontroller. The 32-bit Xtensa LX6 Microprocessor by Tensilica is a replacement for the ESP8266 SoC and features built-in Wi-Fi and Bluetooth. It is available in single-core and dual-core versions.

The advantage of ESP32 is that it has inbuilt RF components such a power amplifier, a low-noise receiver amplifier, an antenna switch, filters, and an RF balun, similar to ESP8266. This makes it incredibly simple to construct hardware around ESP32 because there are so few external components needed.

The fact that ESP32 is produced utilizing TSMC's ultra-low-power 40 nm technology is another crucial information to be aware of. Therefore, employing ESP32 should make

it very simple to create battery-powered applications like as wearables, audio.

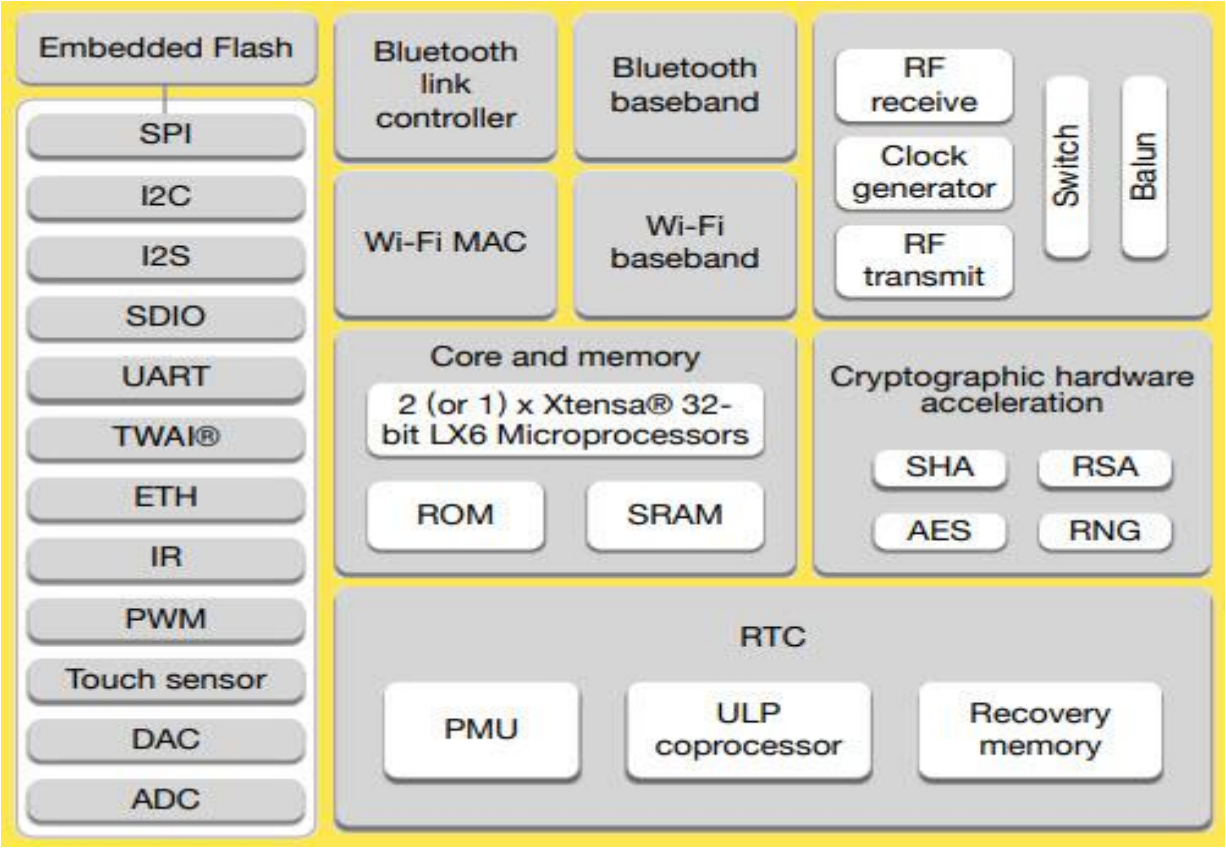


Figure 15: Block diagram of ESP32

2.6.3 Specification of ESP32

It is challenging to incorporate all the specifications in this Getting Started with ESP32 guide because ESP32 has many more functions than ESP8266. So, I've compiled a summary of some of the key ESP32 specifications here. But I strongly advise you to consult the Datasheet for the full set of specifications.

- Single or Dual-Core 32-bit LX6 Microprocessor with clock frequency up to 240 MHz
- 520 KB of SRAM, 448 KB of ROM and 16 KB of RTC SRAM.
- Supports 802.11 b/g/n Wi-Fi connectivity with speeds up to 150 Mbps.
- Support for both Classic Bluetooth v4.2 and BLE specifications.
- 34 Programmable GPIOs.
- Up to 18 channels of 12-bit SAR ADC and 2 channels of 8-bit DAC
- Serial Connectivity include 4 x SPI, 2 x I^2C, 2 x I^2S, 3 x UART.
- Ethernet MAC for physical LAN Communication (requires external PHY).
- 1 Host controller for SD/SDIO/MMC and 1 Slave controller for SDIO/SPI.

- Motor PWM and up to 16-channels of LED PWM.
- Secure Boot and Flash Encryption.
- Cryptographic Hardware Acceleration for AES, Hash (SHA-2), RSA, ECC and RNG.

2.6.4 ESP32 Devkit– The ESP32 development board

The ESP-WROOM-32 Module is one of numerous ESP32-based modules that Espressif Systems has produced. It is made up of an ESP32 SoC, a 4 MB Flash IC, a 40 MHz crystal oscillator, and a few passive parts.

The PCB of the ESP-WROOM-32 Module has edge castellations, which is advantageous. As a result, third-party manufacturers create a break-out board for the ESP-WROOM-32 Module.

The ESP32 Devkit Board is one such board. It includes the ESP-WROOM-32 as the primary module along with some extra hardware for quick ESP32 programming and GPIO Pin connectivity.

Figure 16: ESP-WROOM-32

2.6.5 Pinout of ESP32 board

By examining the design of the ESP32 Devkit Board, one of the well-known and reasonably priced ESP Boards on the market, we can understand what makes up a standard ESP32 Development Board.

The ESP-WROOM-32 Module is one of numerous ESP32-based modules that Espressif Systems has produced. It is made up of an ESP32 SoC, a 4 MB Flash IC, a 40 MHz crystal oscillator, and a few passive parts.

The PCB of the ESP-WROOM-32 Module has edge castellations, which is advantageous. As a result, third-party manufacturers create a break-out board for the ESP-WROOM-32 Module.

The ESP32 Devkit Board is one such board. It includes the ESP-WROOM-32 as the primary module along with some extra hardware for quick ESP32 programming and GPIO Pin connectivity.

I have a board with 30 pins (15 pins on each side). Some boards have 36 pins, while others have a few less. Check the pins again before connecting anything or even powering up the board.

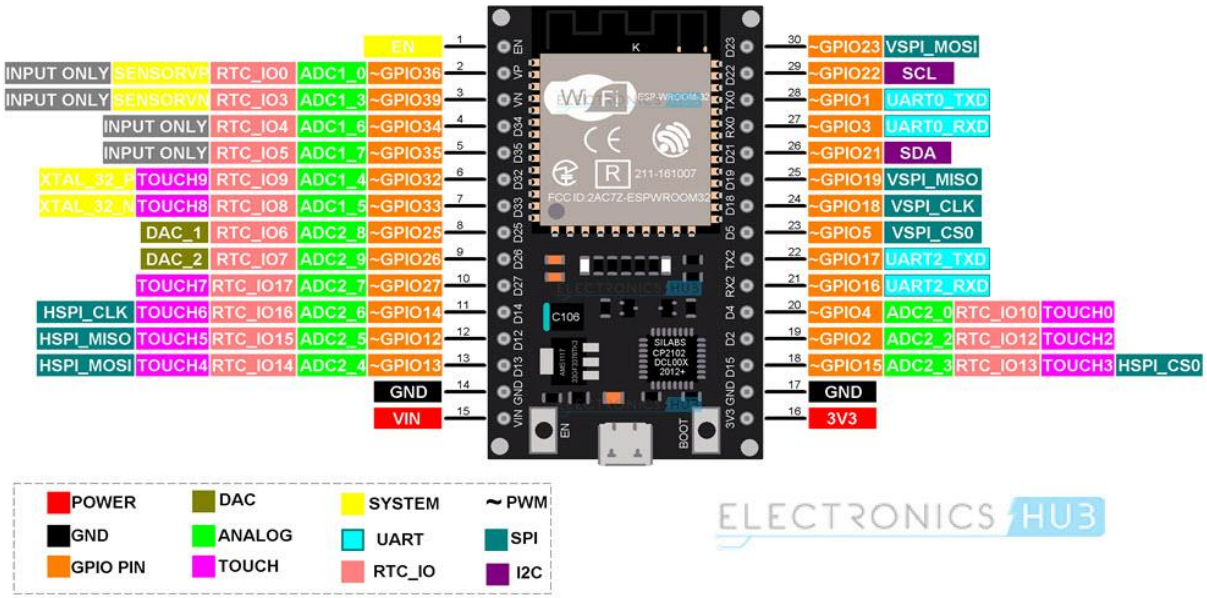


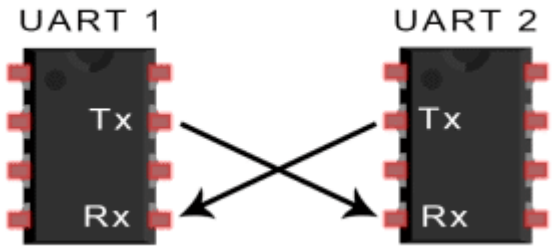
Figure 17: ESP32 Pinout

2.7 Communication protocol used in project

2.7.1 UART protocol

2.7.1.1 Overview

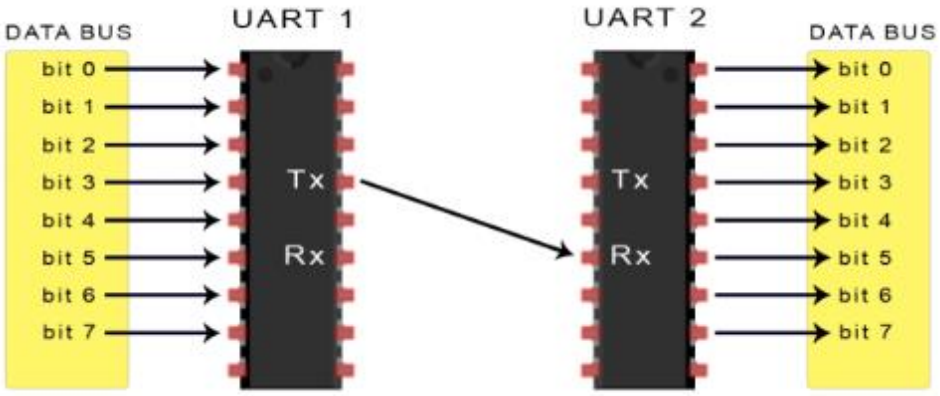
UART communication involves direct communication between two UARTs. The transmitting UART transfers parallel data in serial form from a controlling device, such as a CPU, to the receiving UART, which subsequently converts the serial data back into parallel form for the receiving device. Just two wires are needed to transmit data between two UARTs. The Tx pin of the transmitting UART transmits data to the Rx pin of the receiving UART.



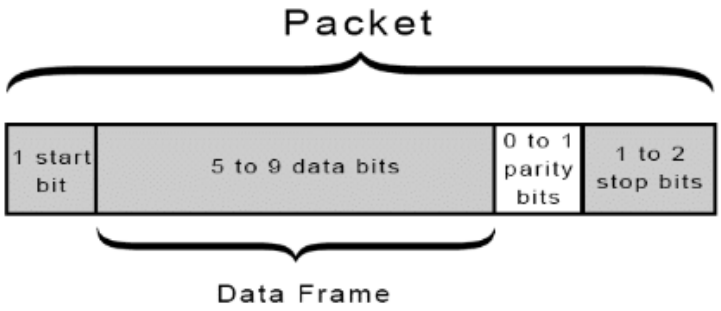
Because UARTs send data asynchronously, the sampling of bits by the receiving UART and the output of bits from the transmitting UART are not synchronized by a clock signal. The transmitting UART augments the data packet being sent with start and stop bits in place of a clock signal. For the receiving UART to know when to begin reading the bits, these bits specify the start and stop of the data packet.

The incoming bits are read at a specified frequency known as the baud rate after the receiving UART detects a start bit. Data transport speed is measured by the baud rate, which is represented in bits per second (bps). The baud rates of the two UARTs must be same. Only a 10% difference in baud rate can be made between the sending and receiving UARTs before the timing of the bits becomes too erroneous.

2.7.1.2 How UART works



A data bus provides the data to the UART that will send it. Data is sent to the UART by another device, such as a CPU, RAM, or microcontroller, using the data bus. Parallel data transfers occur from the data bus to the sending UART. The transmitting UART adds a start bit, a parity bit, and a stop bit to create the data packet after receiving the parallel data from the data bus. At the Tx pin, the data packet is then produced serially and bit by bit. At its Rx pin, the receiving UART receives the data stream bit by bit. After removing the start bit, parity bit, and stop bit, the receiving UART turns the data back into parallel form. Data sent through the UART is divided up into packets. Depending on the UART, each packet has a single start bit, five to nine data bits, an optional parity bit, and one or two stop bits.



2.7.1.3 Start bit

The UART data transmission line is frequently kept at a high voltage level even when no data is being sent. To begin data transfer, the transmitting UART pulls the transmission line from high to low for one clock cycle. As soon as the receiving UART

detects the high to low signal transition, it begins reading the bits in the data frame at the frequency of the baud rate.

2.7.1.4 Data frame

The data frame contains the actual data that is being transmitted. If a parity bit is used, its length might be anything between 5 and 8 bits. If there is no parity bit present, the data frame can have a length of nine bits. When transferring data, the least important bit is often delivered first. When the parity bit and the data match, the UART can determine that a transmission was error-free. However, if the parity bit is a 0, and the total is odd, or if the parity bit is a 1, and the total is even, the UART is aware that bits in the data frame have changed.

2.7.1.5 Stop bits

The transmitting UART drives the data transmission line from a low voltage to a high voltage for at least two-bit lengths to signify the end of the data packet.

2.7.1.6 Advantages of UART

- utilizes just two wires
- No clock signal is necessary
- has a parity bit to enable error checking
- Changes to the data packet's structure are possible if both parties are prepared.
- generally accepted and well-documented technique

2.7.1.7 Disadvantages of UART

- There is a maximum of 9 bits for the data frame size.
- Does not support multiple master or slave systems
- Each UART's baud rates must be within 10% of one another.

2.7.1.8 Application of UART in project

This kind of protocol is used for Tx and Rx line communication between MCU and module sim. When MCU meets certain criteria outlined in our project's requirements, MCU serves as the master initiating communication amongst them. In order to ensure that module sim receives data properly, MCU will then begin sending each byte of data at a certain speed preset for both MCU and module sim.

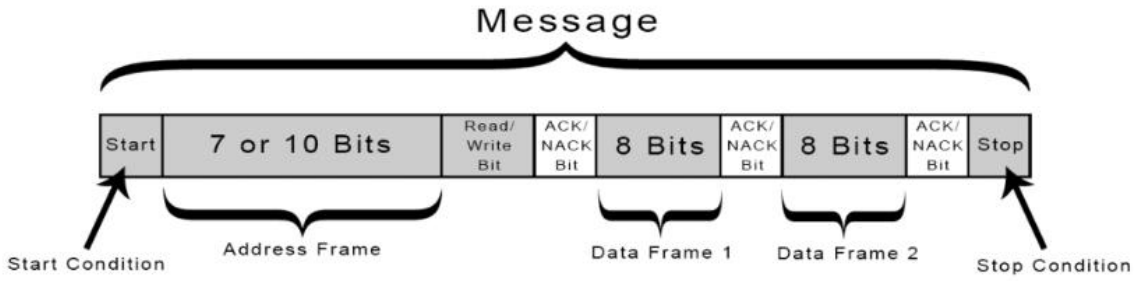
2.7.2 I2C protocol

2.7.2.1 Overview

The finest aspects of SPI and UARTs are combined in I2C. Like SPI, I2C enables the connection of several slaves to a single master and the control of one or more slaves by more than one master. When you wish to have many microcontrollers logging data to a single memory card or showing text on a single LCD, this is incredibly helpful. I2C employs only two wires, like UART, to transfer data between devices

2.7.2.2 How I2C works

I2C transports data using messages. To divide messages into sections, utilize data frames. Each message is made up of an address frame that has the binary address of the slave and one or more data frames that contain the data being transferred. The message also includes start and stop conditions, read/write bits, and ACK/NACK bits between each data frame



2.7.2.3 Start Condition

Before the SCL line changes from high to low, the SDA line goes from a high to a low voltage level.

2.7.2.4 Stop condition

After the SCL line changes from low to high voltage, the SDA line changes from a low voltage level to a high voltage level.

2.7.2.5 Address frame

A 7- or 10-bit sequence that is unique to each slave and identifies it when the master wishes to communicate with it.

In contrast to SPI, I2C lacks slave select lines, hence a separate technique is needed to let the slave know that data is being sent to it and not another slave. It achieves this via addressing. The first frame of a new message after the start bit is always the address frame.

The address of the slave that each linked slave wants to communicate with is sent to them by the master. The addresses of each slave are then compared to those provided by the master. If the addresses match, it sends a low voltage ACK bit back to the master. If the addresses do not match, the SDA line remains high, and the slave does nothing.

2.7.2.6 Read/write bit

A single bit at the end of the address frame indicates to the slave whether the master wishes to write data to it or receive data from it. The read/write bit is at a low voltage level if the master wishes to transfer data to the slave. The bit is at a high voltage level if the master is asking the slave for data.

2.7.2.7 Data frame

In contrast to SPI, I2C does not provide slave select lines, hence a separate technique is needed to inform the slave that data is being sent to it and not another slave. It uses addressing to do this. The first frame of a new message after the start bit is always the address frame.

The address of the slave the owner wants to communicate with is sent to every associated slave. The addresses of each slave are then compared to those provided by the master. If the addresses match, it sends a low voltage ACK bit back to the master. If the addresses do not match, the SDA line remains high, and the slave does nothing.

2.7.2.8 Advantages of I2C

- utilizes just two wires
- supports several masters and a few slaves
- ACK/NACK bit provides evidence that each frame is successfully sent.
- Hardware is simpler than it is with UARTs.
- generally accepted and utilized methodology

2.7.2.9 Disadvantages of I2C

- fewer rapid data transmission than SPI
- The data frame can only be 8 bits in size.

2.7.2.10 Application of I2C in project

To display some of the data from our smart home in this project, we utilized an LCD. We discovered that the LCD panel required 8 pins since it uses parallel communication. We utilized an I2C module attached to our LCD screen in order to reduce the number of pins used on our MCU. This made it much simpler for us to communicate with the LCD screen and reduced the number of pins required. Additionally, the library and API offered for this pairing of an LCD and an I2C module are readily available and simple to use. Given the justifications, using an LCD screen in conjunction with an I2C module is the best choice for us in this project.

2.7.3 1-wire protocol

2.7.3.1 Overview

As its name suggests, one wire protocol uses a single wire interface to transport data between devices. A master and slave configuration are used to interface the bus with a single master and one or more slaves. It is typically used for slow-speed, low-power communication. In a data exchange, the LSB (Least Significant Bit) is always transmitted first.

There is no clock signal used in this protocol. Instead, a signal from the master device is used to internally clock and synchronize the slave devices. The slave devices cannot start a data transfer on their own since the master device is completely in charge of the read and write activities of the slave devices. When the master resets, they can at least signal their presence over the bus. Each one-wire slave device's ROM stores a 64-bit address that uniquely identifies each master device.

2.7.3.2 How 1-write works

To start communicating via the data connection, the master resets the device. After pulling the data line LOW for 480 us, the standard pull-up resistor may pull the data line HIGH. In response to the reset signal, slave devices that are linked to the bus pull the

data line LOW for 60–240 us. If the line is dragged down by the slave(s), the master confirms their presence over the bus. After 60–240 us, the slave(s) release the data line, enabling the master to start writing.

The microcontroller, for instance, can transmit the function commands to begin the temperature conversion, read the temperature, etc. if a 1-wire temperature sensor is attached to the bus. 8 bits are used for the ROM and function commands.

The '0' and '1' bits are sent by adjusting the logical level of the data line for a particular time period as the 1-Wire standard does not employ a clock signal. The time window is typically 60 us long. Additionally, there is a 1us gap between each time slot, allowing the pull-up resistor to bring the data line HIGH once again. One bit is exchanged between the master and slave once every 60 us. The allocated time may be reduced by up to ten times if the bus is overdriven.

The slave device receives a ROM search or function command from the master, who then reads from it. The master device manages the read operation. While data is transmitted to the master in groups of 8 bits, the master reads from the slave bit by bit. Each bit is read during a 60-second period (or shorter if the bus is overdriven).

After 15 us, the master samples each bit. The line is pushed LOW during sampling if the bit supplied by the slave is "0." The line is pushed HIGH at the moment of sampling if the bit sent by the slave is "1."

2.7.3.3 Application of 1-wire protocol in project

This sort of protocol is used by our ESP32 MCU to connect with the temperature and humidity sensors. The MCU will initiate contact with the sensor whenever it needs data from it before updating the data on the LCD panel and the server.

CHAPTER 3. Design actuator block for smart home

3.1 Diagram for actuator block for smart home

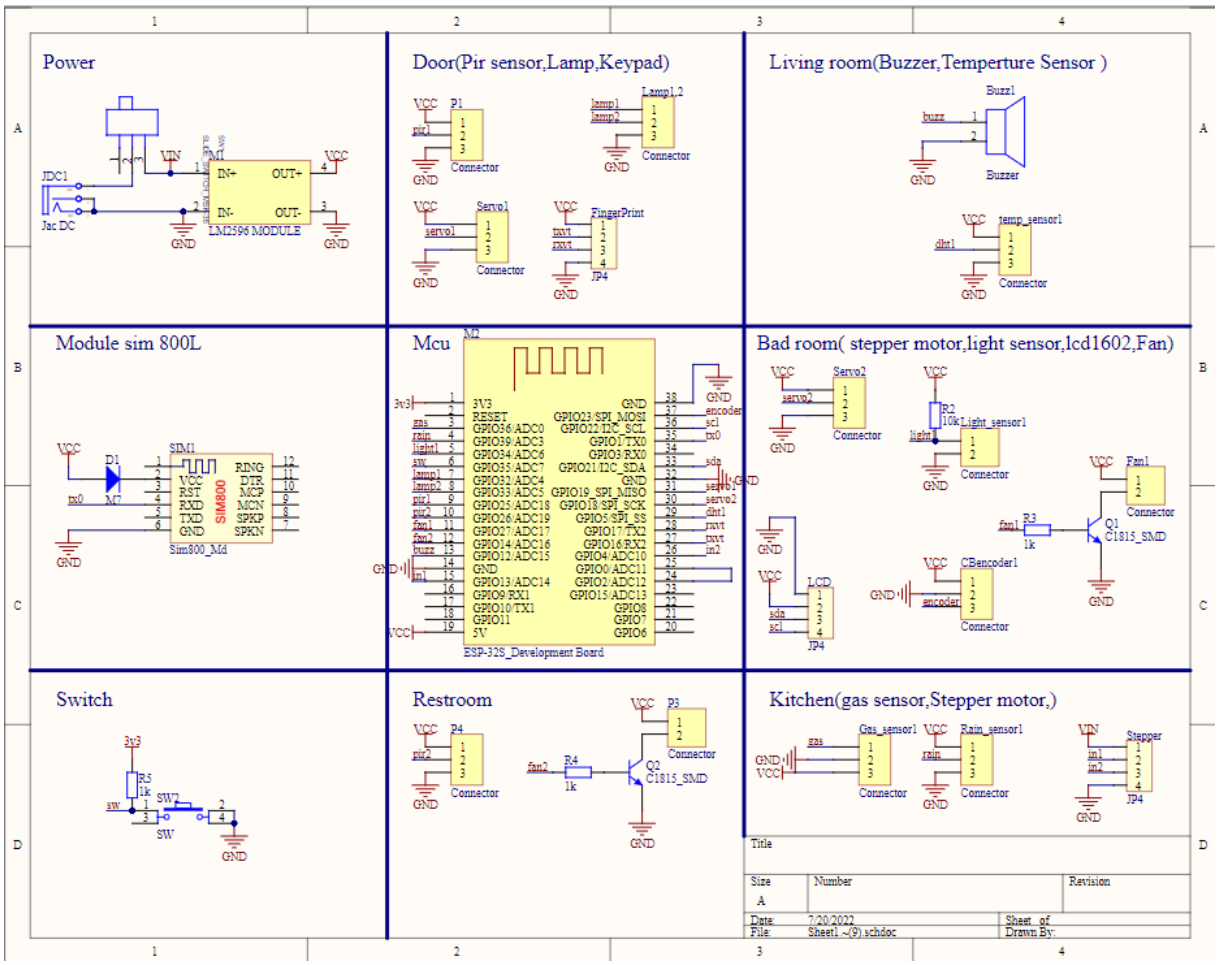


Figure 18: Diagram for actuator block

3.2 General about devices used in actuator block

3.2.1 Servo motor SG90

Figure 19: Servo motor SG90

Servo is a special type of electric motor. Unlike conventional motors, which are plugged in and rotated continuously, servos only rotate when controlled (by PPM pulses) with a rotation angle of any range from 0o - 180o. Each type of servo is different in size, and their weight and construction. Some type of servo has a weight of only 9g (mostly used on airplanes), some have a great torque (several tens of Newtons/m), or some are strong and sharp.

Servo motors are designed with closed loop feedback systems. The output signal of the motor is connected to a control circuit. When the motor rotates, the speed and position are fed back to this control circuit. If there is any reason preventing the rotation of the motor, the feedback mechanism will detect that the output signal has not reached the

desired position. The control circuit continues to correct the error for the motor to achieve the correct point.

a, Serve SG90 is a servo motor with 3 pins:

- Orange wire: pulse provided wire
- Red wire: positive voltage source
- Brown wire: ground wire

b, Main parameters:

- Torque: 1.8kg/cm
- Speed: 60 degrees in 0.1 ms
- Voltage source: 5V
- Working temperature: 0ºC -55ºC

c, Working principle

- When we provide a pulse with width from 1ms to 2ms, our desired degree would be reached

d, Application in project

- Open and close for main door when having appropriate access.

3.2.2 Step motor DC 5.6V/1.2A and control module A4988

3.2.2.1 module A4988

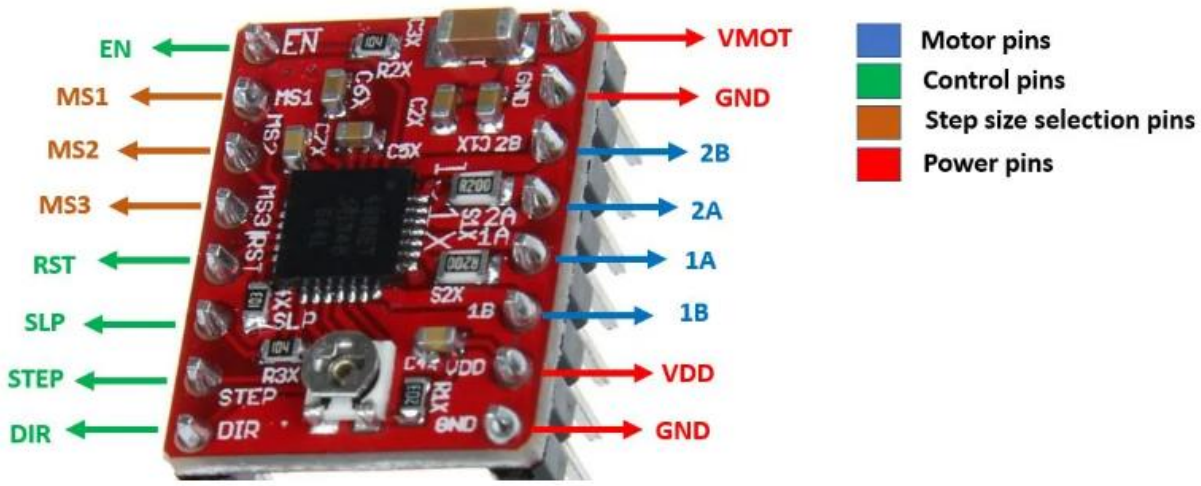


Figure 20: Electrical connection diagram for A4988 module

This module has 16 pins altogether, divided into 4 types. the motor would be connected to the blue output pins. The control pins are green, the power pins are red, and the step size selection pins are brown.

a, Motor pins

One of the four coils on the motor is connected by these pins. These pins are for the bipolar step motor.

b, Control pins

STEP: This is the pin which controls the rotation steps of the motor. It will relate to a GPIO pin of ESP32. When this pin receives a strong signal, the motor will advance one step. How rapidly the pin's signal increases in strength controls how quickly the motor rotates.

DIR: This is the pin controls the direction if the rotation of the motor. This will also be connected to GPIO pin of ESP32. When this pin receives a strong signal, the motor will advance one step. The motor's rotational speed is controlled by the pace at which the pin's signal climbs.

EN: this is enabled pin. It is used to enable the output of the module

RST: This is reset pin. It sets the internal translator to a predefined home state which is the position starts initially.

SLP: this is also an active low input pin which is used to reduce power consumption by setting the module to sleep mode when the motor is not in use.

c, Step size selection:

MS1	MS2	MS3	Microstep Resolution
LOW	LOW	LOW	Full Step
HIGH	LOW	LOW	1/2 Step
LOW	HIGH	LOW	1/4 Step
HIGH	HIGH	LOW	1/8 Step
HIGH	HIGH	HIGH	1/16 Step

Figure 21: Step size selection table

3.2.2.2 Step motor

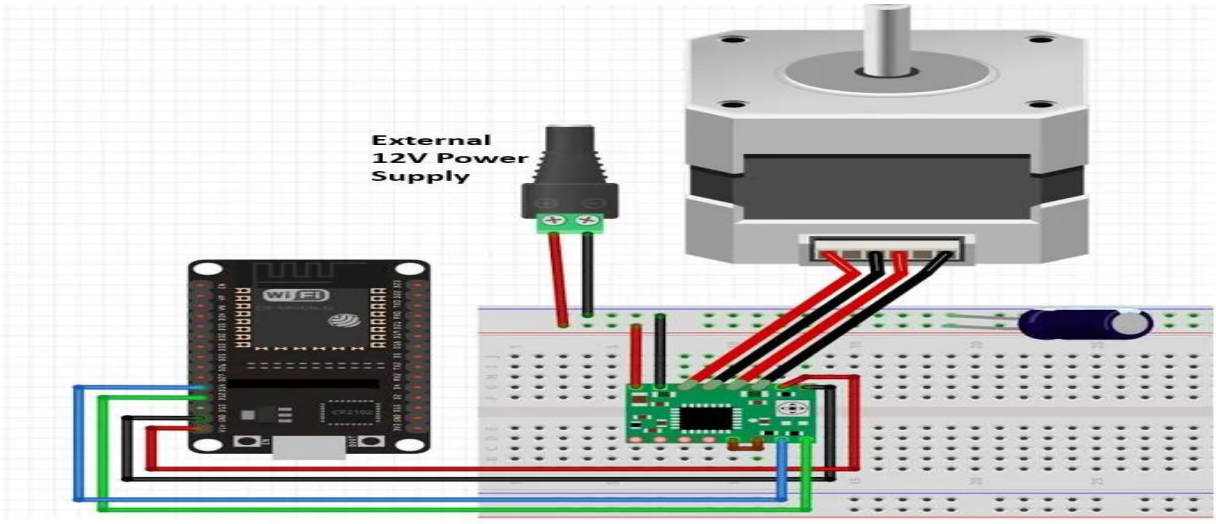


Figure 22: Electrical connection diagram for step motor

a, Working principle

The protocol for controlling the number of steps and the direction of rotation is very simple.

- 5 levels of step adjustment: 1; 1/2; 1/4; 1/8 and 1/16 steps.
- Adjust the rated current supplied to the motor by the potentiometer.

- Has short circuit protection, over temperature protection, voltage drop protection and anti-current function

reverse.

Turn the motor on and off via the ENABLE pin, the LOW level is on the module, the HIGH level is off

Motor rotation direction control via DIR. battery

Stepper control of motor via STEP pin, each pulse is corresponding to 1 step

(Or micro-step)

Select the operating mode by setting the logic level for pins MS1, MS2, MS3

b, Application in project

- Automatic curtain system
- Automatic clothesline system

3.2.3 Module sim

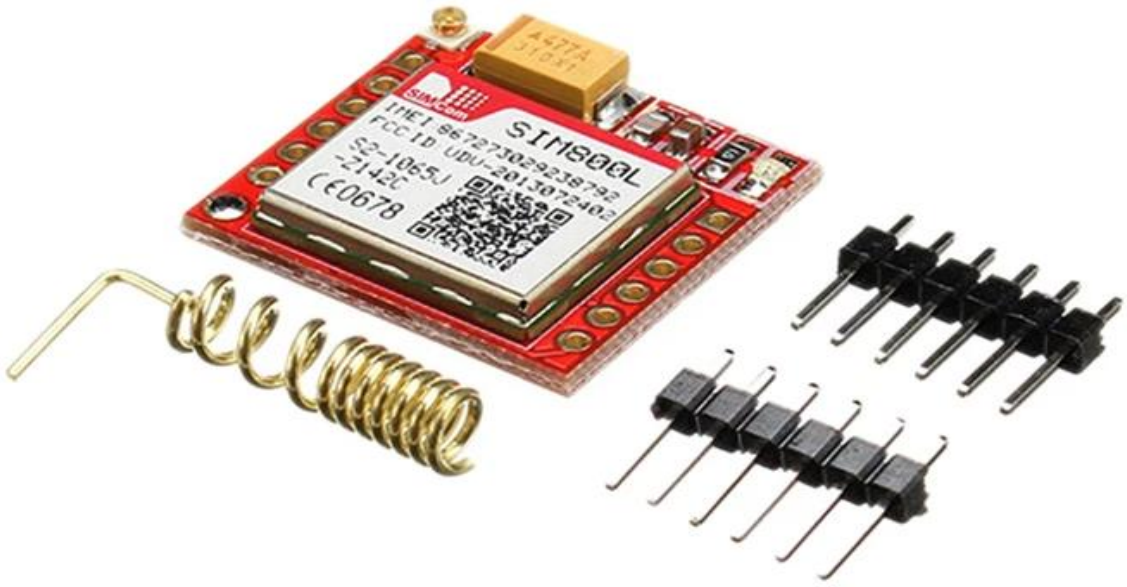


Figure 23: Module SIM 800L

At the heart of the module is a SIM800L GSM cellular chip from SimCom. The operating voltage of the chip is from 3.4V to 4.4V, which makes it an ideal candidate for

direct LiPo battery supply. This makes it a good choice for embedding into projects without a lot of space.

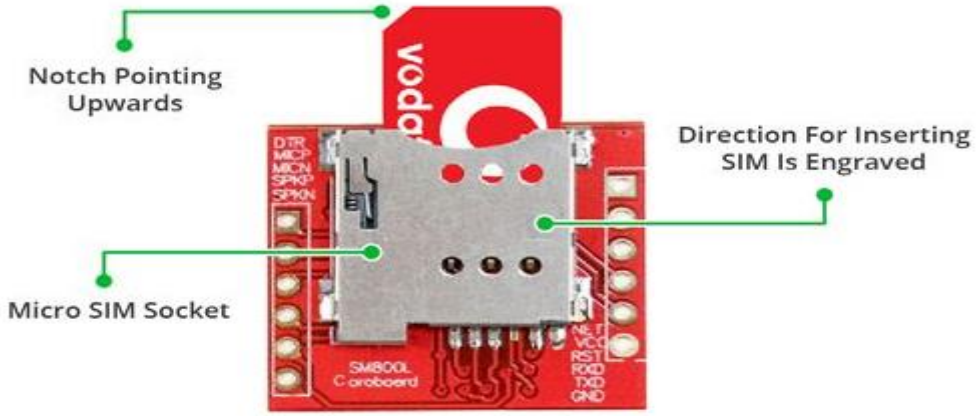


Figure 24: The back of module

There's a SIM socket on the back to insert our own sim card

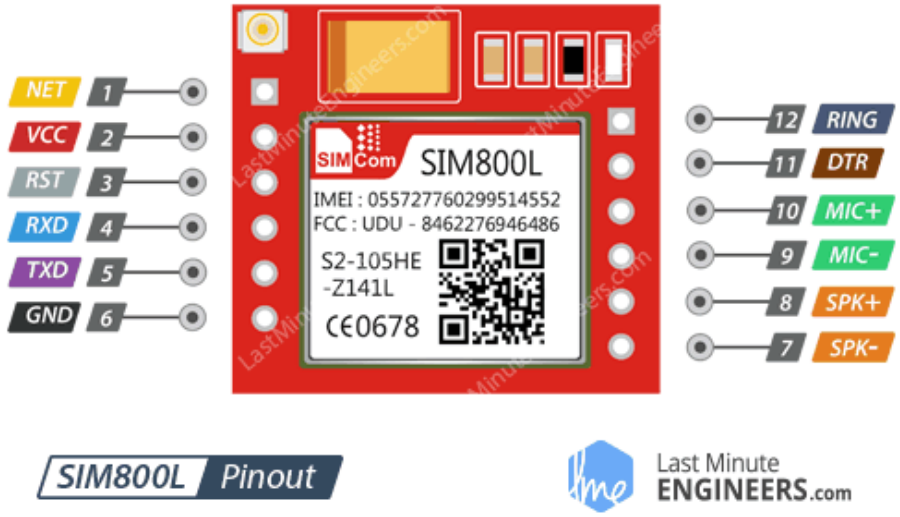


Figure 25: Module sim pinout

a, Pinout description

NET: is a pin to which the module's included helical antenna can be soldered.

VCC: delivers power to the module. Any voltage between 3.4 and 4.4 volts can be used for this. Remember that connecting it to the 5V pin will probably cause your module to fail! Not even 3.3 V can power it! An external power source could be a Li-Po battery or a 3.7V 2A DC-DC buck converter.

RST: is a hard reset pin. If you are positive that you placed the module in the incorrect location, pull this pin low for 100 milliseconds to perform a hard reset.

Rx and Tx: pin is used for serial communication.

GND: is the Ground Pin and needs to be connected to GND pin on the ESP32

RING: Pin serves as a Ring Indicator. It serves as the module's "interrupt" out pin, essentially. A call is automatically received as high and pulses low for 120 milliseconds. It can also be configured to pulse each time an SMS is received.

DTR: A pin activates or deactivates sleep mode. The module will enter sleep mode and lose serial communication if it is pulled HIGH. When it is pushed LOW, the module will come to life.

SPK: is a differential speaker interface. You can connect a speaker's two pins directly to these two pins.

b, Connection with ESP32

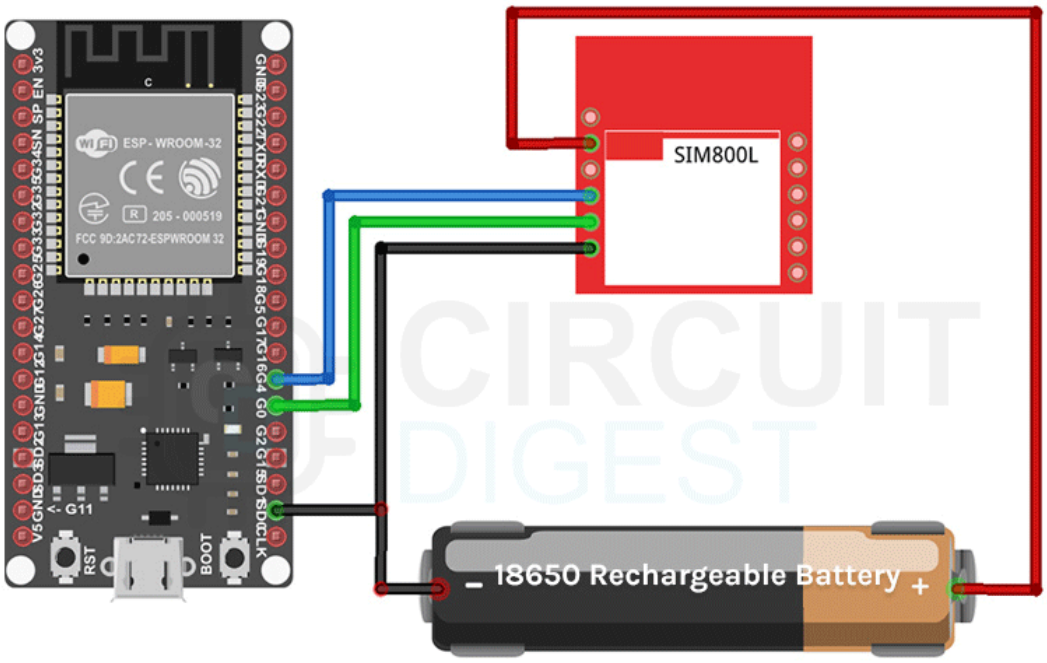


Figure 26: Electrical connection to ESP32

c, Application in project

- It is used to inform to homeowner that there is an illegal intrusion into the house or gas leakage in the kitchen.

3.2.4 DC motor

a, How DC motor works

The direction and speed of DC motor will be determined by how we power to it.

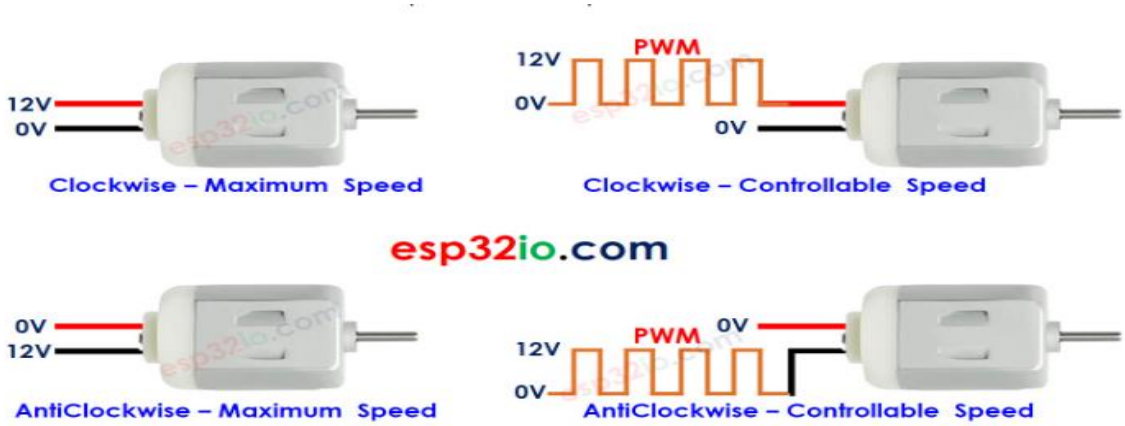


Figure 27: DC motor control

In case of using PWM, the bigger duty cycle PWM is, the bigger speed the motor spins.

b, Application in project

- Work a as fan in bedroom and ventilation fan in the bathroom.

3.3 General of sensor block

3.3.1 Gas sensor MQ2

a, General and pinout

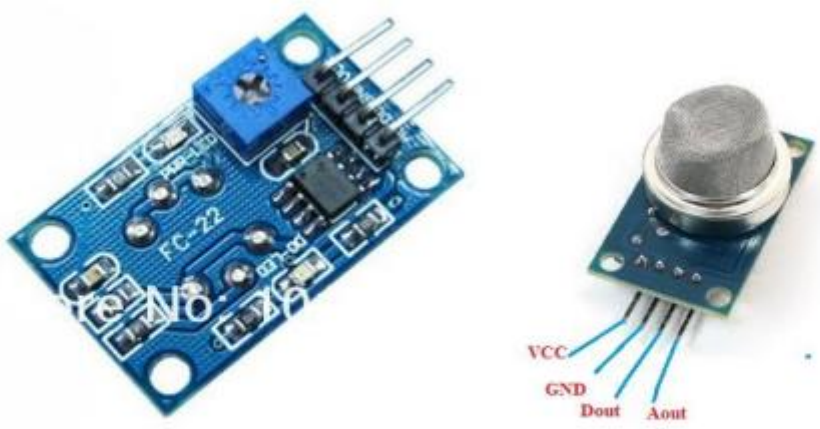


Figure 28: Gas sensor MQ2

Operating voltage 3-5 V.

- Connect 4 pins with 2 power supply pins (VCC and GND) and 2 output signal pins.

- Supports both analog and TTL outputs. Analog output 0 – 4.5V proportional to

gas concentration, TTL active low level.

MQ2 is a gas sensor, used to detect potentially flammable gases. It is structured

from the semiconductor SnO2. This substance has a low sensitivity to clean air. But when

In the presence of flammable substances, its conductivity changes immediately. It is because of the characteristics

To this, a simple circuit is added to convert from sensitivity to voltage.

When the environment is clean, the output voltage of the sensor is low, the lower the output voltage is

increases as the concentration of combustible gas around the MQ2 sensor is higher.

MQ2 sensor works very well in liquefied petroleum gas (LPG), H2, and other substances

other flammable gases. It is widely used in industry and civil due to the circuit

simple and low cost.

MQ2 works very well in liquefied petroleum gas (LPG), H2, and harmful gases

other fire. It is widely used in industry and civil due to its simple circuit

and low cost.

MQ2 is a gas sensor, used to detect potentially flammable gases. It is structured

from the semiconductor SnO2. This substance has a low sensitivity to clean air. But when

In the presence of flammable substances, its conductivity changes instantaneously. It is because of the characteristics

To this, a simple circuit is added to convert this sensitivity to voltage. When lips

clean field the output voltage of the sensor is low, the output voltage value increases as the concentration

The higher the concentration of flammable gas around MQ2, the higher.

When detecting a gas leak, the module will output a signal in two DOUT_digital formats

(digital) and analog_AOUT (analog). Users can depend on the purpose of use

used to select the appropriate signal.

b, Working principle

The MQ2 gas sensor is affordable and perfect for several uses. In addition to Methane and other combustible gases, it can be used to find LPG, Propane, and Hydrogen. The sensor is sensitive to flammable gases and smoke. 5 volts is used to power the smoke sensor. Smoke is detected by smoke sensors using the voltage they generate. A higher output results in more smoke. The sensitivity can be changed with a potentiometer. The used sensor, Sn02, has a low conductivity when the air is clean. On the other hand, the sensor generates an analog resistive output dependent on the smoke concentration when smoke is present. In the circuit, there is a heater. The heater receives power from the power supply's VCC and GND. The circuit has a variable resistor. The resistance across the pin is a function of the smoke concentration in the sensor's air. The resistance will be lessened if there is greater substance. The voltage between the sensor and the load resistor is also increased.

c, Calibrate MQ2

While calibrating the gas sensor, keep the gas sensor near any smoke or gas you wish to detect. Then, keep turning the potentiometer until the Red LED on the module starts to glow. The screw can be turned either clockwise or counterclockwise to increase or decrease sensitivity.

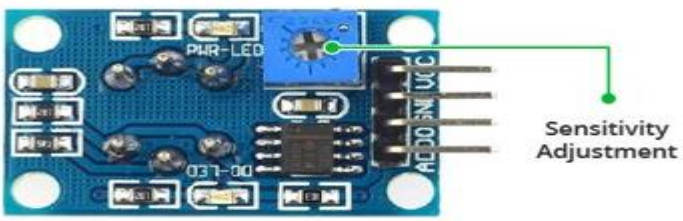


Figure 29: Calibrate MQ2

The comparator module's analog pin (A0) is continuously checked to see if the threshold value set by the potentiometer has been reached. When it hits the threshold, the digital pin (D0) will turn HIGH, and the signal LED will turn on. This setting is very useful when you need to initiate an action when a specific threshold is reached.

d, Application

Gas sensors have great applications in life:

- Detect gas leaks in the water.

- In industry used to detect flammable substances.

- Flammable gas detector.

3.3.2 Motion sensor HC-SR510

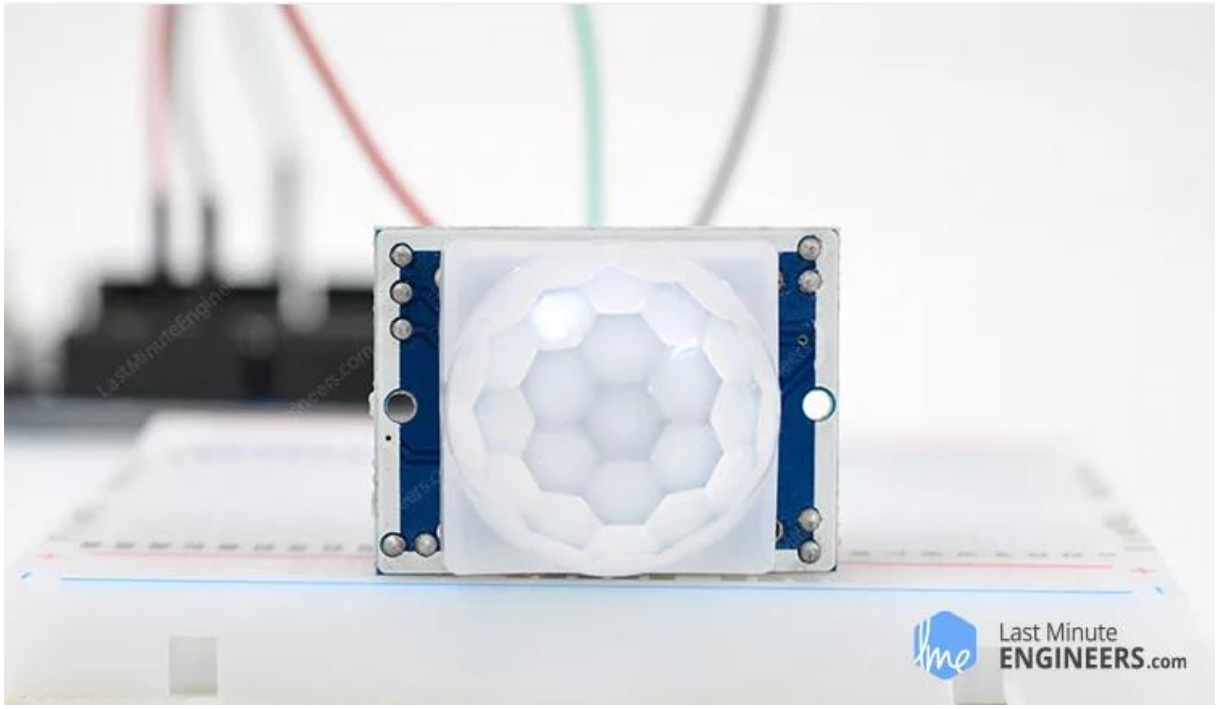


Figure 30: HC-SR510 Module

a, General and pinout

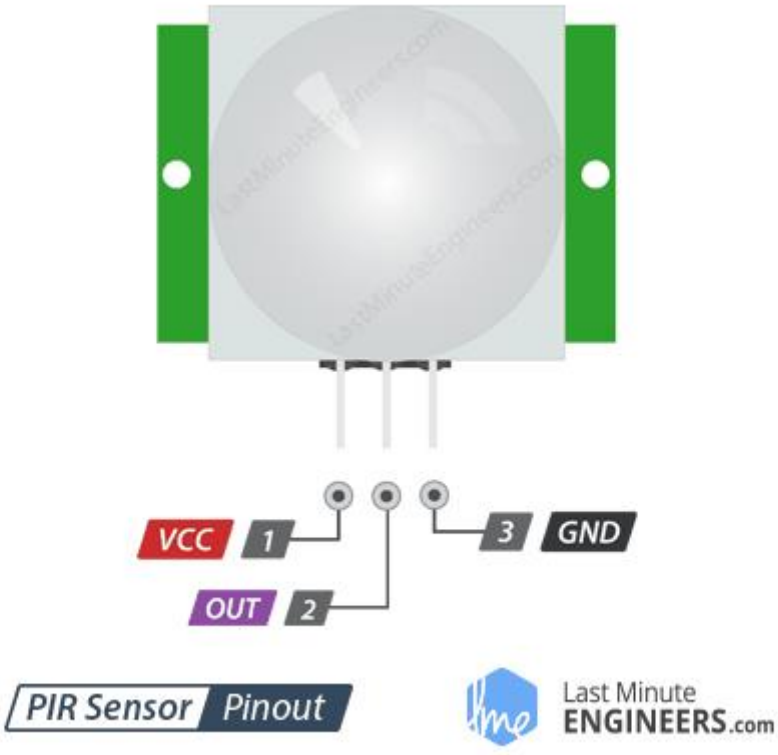


Figure 31: Pinout diagram of HC-SR510

VCC pin: active source of input sensor from 4.5V to 20V.

OUT pin: Output connected to the I/O pin of the microcontroller or relay. When giving a signal:

+ 3.3V with moving objects through.

+ 0V no passing object.

GND pin: ground pin to connect GND.

Mode H: Output voltage V-out automatically stays at 3.3V until there is no movement.

L mode: Output voltage V-out automatically turns to 0 when the time delay expires.

b, Working principle

PIR sensors are designed specifically to detect infrared light at this intensity. The two main parts are pyroelectric sensor and Fresnel lens, a special lens that concentrates infrared signals onto the pyroelectric sensor.

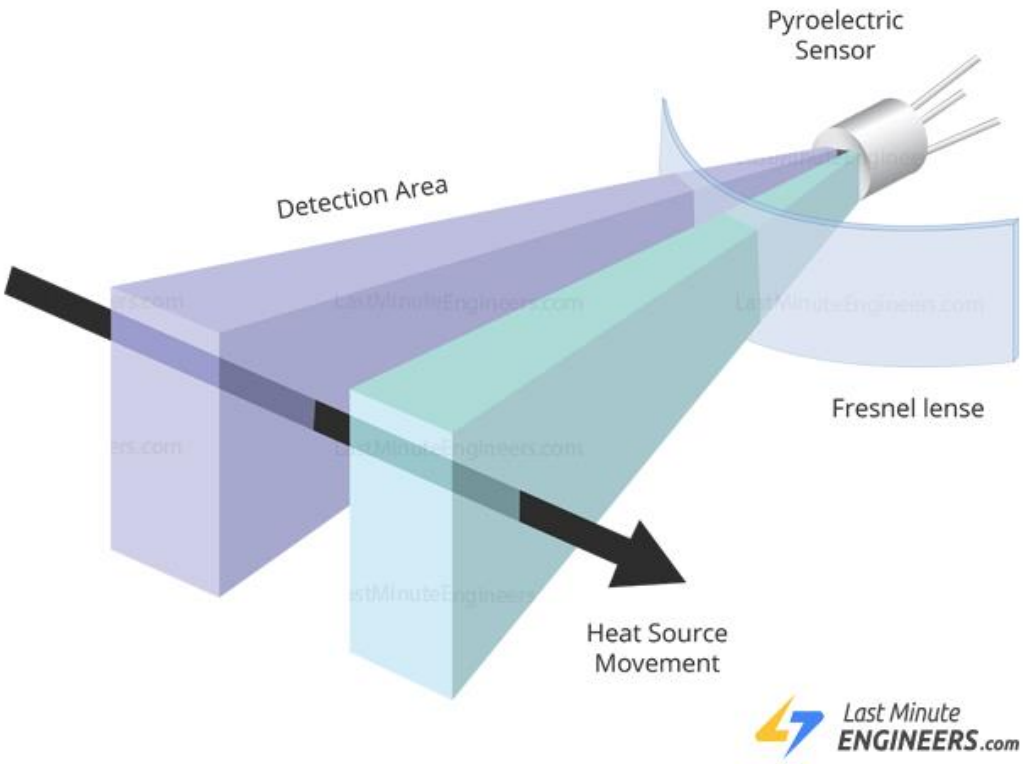


Figure 32: PIR sensor working principle

A warm body, such a person or animal, blocks one side of the PIR sensor first, which causes a positive differential change to occur between the two halves as the warm body goes by. On the other hand, when a heated body leaves the sensing region, the sensor produces a negative differential change. The appropriate pulse of signals causes the sensor to elevate its output pin.

c, Application

- Motion detected

3.3.3 Module DHT11- Temperature and humidity measuring sensor

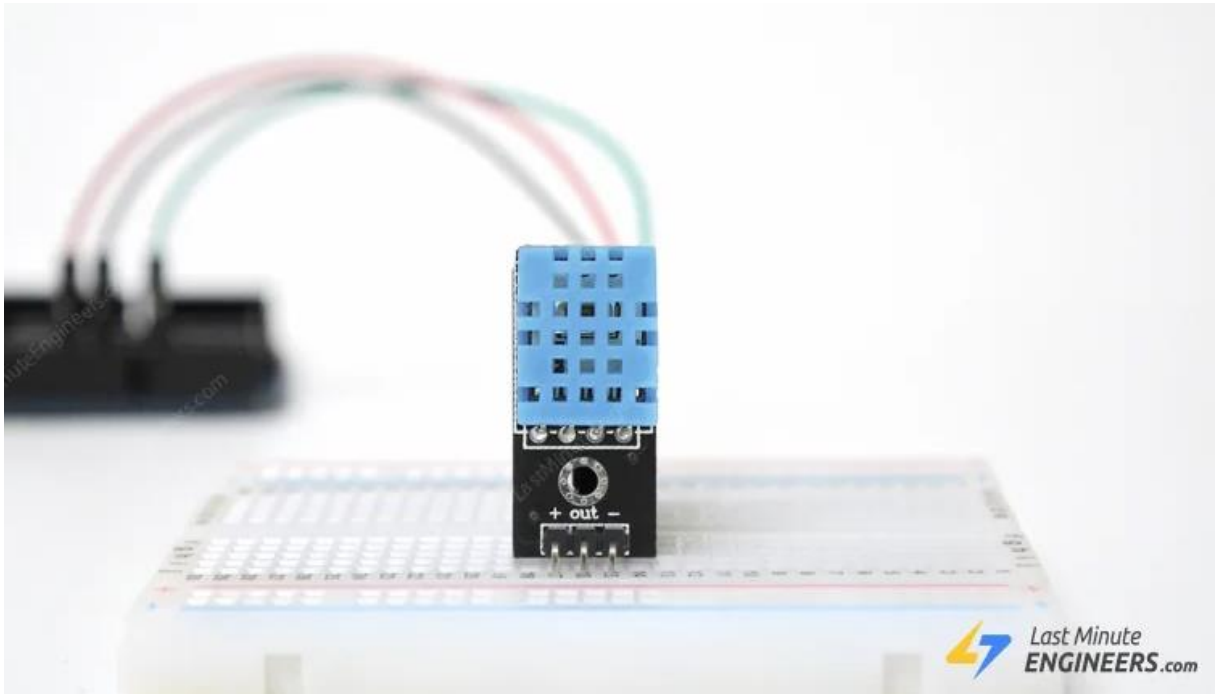


Figure 33: Module DHT11

a, General and pinout

DHT11 is a low-cost digital sensor for sensing temperature and humidity. This sensor can be easily interfaced with any micro-controller such as Arduino, Raspberry Pi etc… to measure humidity and temperature instantaneously.

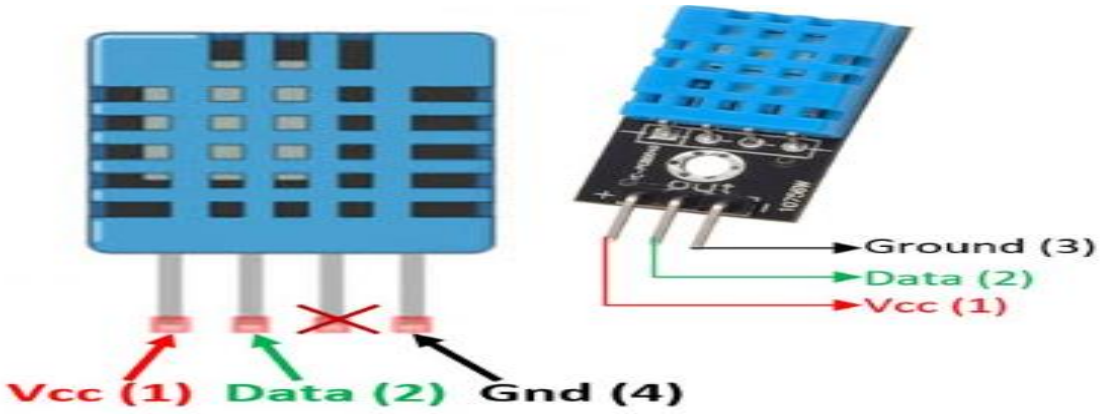


Figure 34: DHT11 Pinout

VCC: Connect to voltage source from 3.5V to 5V

Ground: Connect to ground of ESP32

Data: Where data is transmitted to ESP32

b, Working principle

The DHT11 sensor consists of a capacitive humidity sensor and a thermistor for detecting temperature. A substrate that can store moisture as a dielectric between two electrodes makes up the humidity-detecting capacitor.

The capacitance value changes as the humidity levels fluctuate. The changing resistance values are computed, decoded, and converted into digital form by the IC. This sensor measures temperature using a thermistor with a negative temperature coefficient, which causes the resistance value to decrease as temperature increases.

For this sensor to have higher resistance values even for the smallest temperature change, semiconductor ceramics or polymers are often used in its construction. With a 2-degree accuracy, the DHT11 offers a temperature range of 0 to 50 degrees Celsius. This sensor has a humidity range of 20% to 80% with a 5% accuracy. This sensor has a 1Hz sampling rate. Specifically, it provides one reading per second.

c, Application

- Offices, cars, museums, greenhouses, and industries use this sensor for measuring humidity values and as a safety measure.

3.3.4 Rain sensor

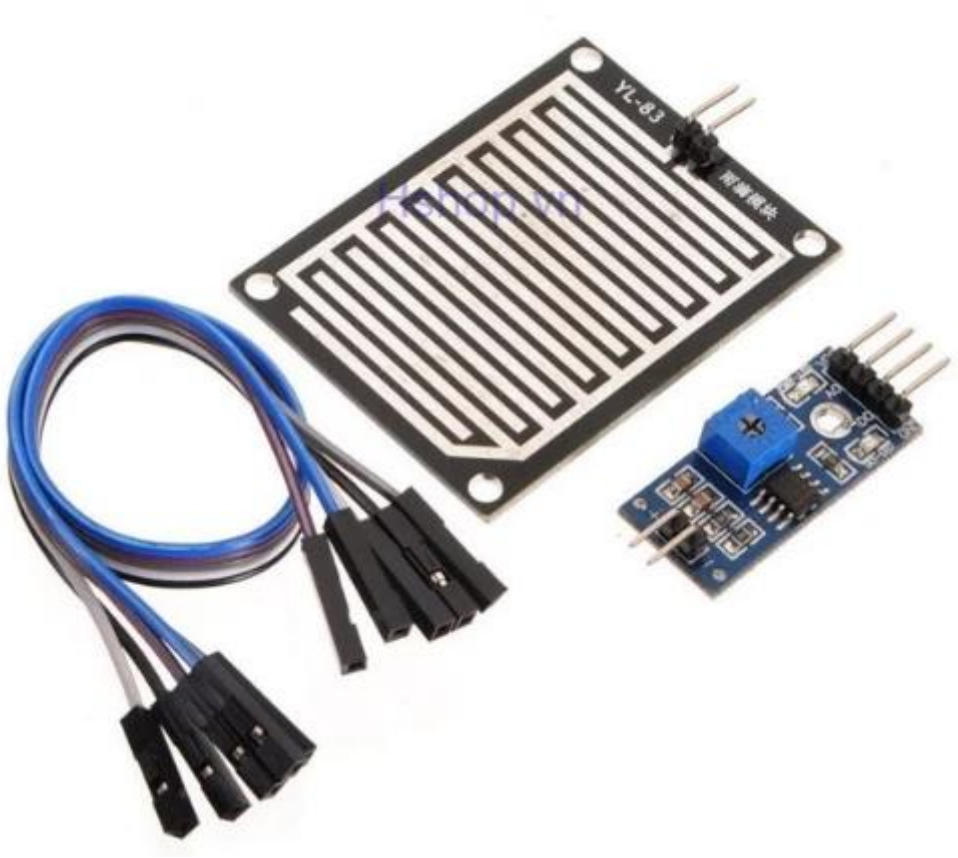


Figure 35: Rain sensor

a, General and pinout

Rain is detected using a sensor known as a raindrop. This gadget consists of a rain board that detects rain and a control module that compares the analog value and converts it to a digital value. Raindrop sensors are used outside of the automobile sector. They can also be utilized in home automation systems to automatically control the windshield wipers and in agriculture to detect rain.

b, Working principle

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

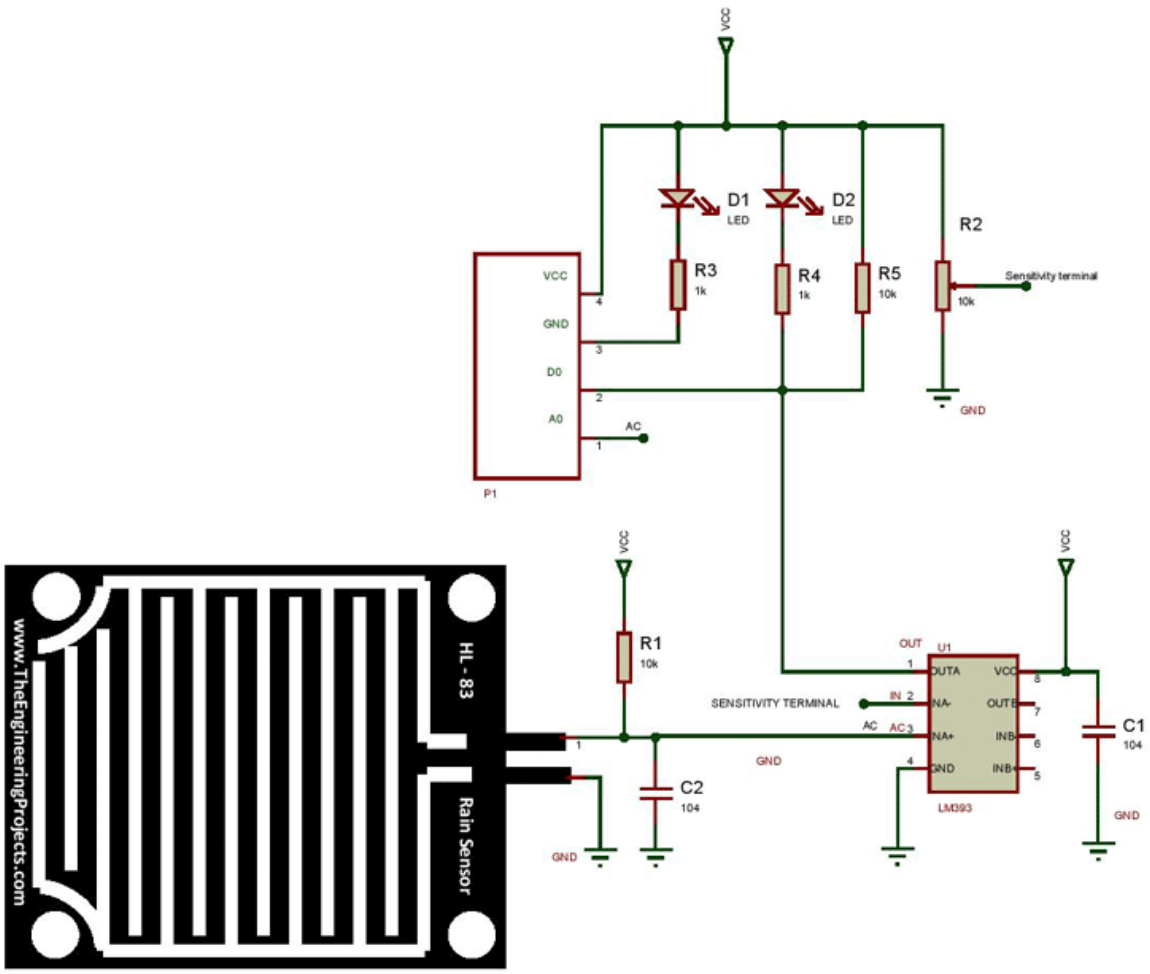


Figure 36: Working principal diagram

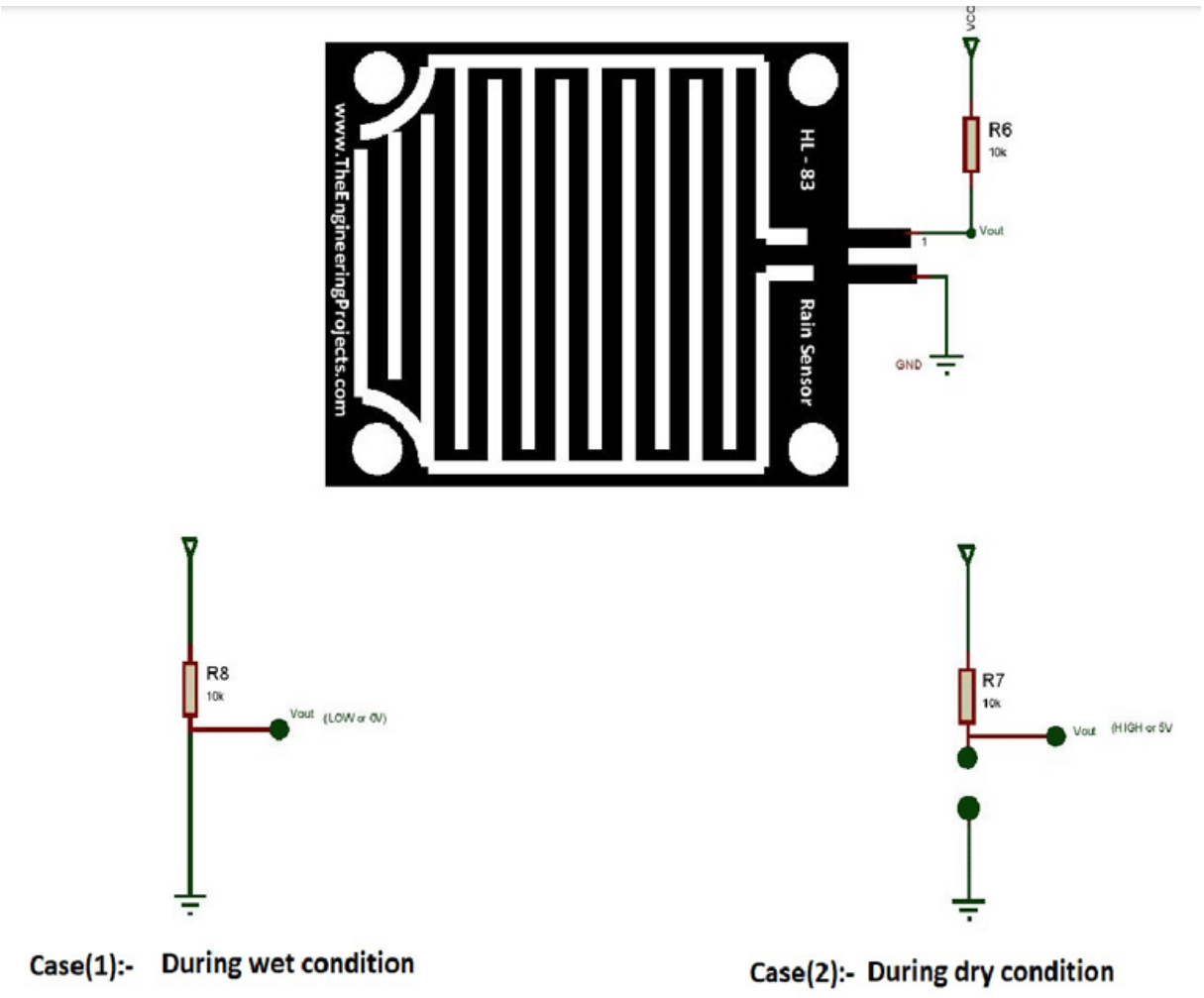
As shown in the diagram above, a voltage divider will be created by the R1 resistor and the rain board module. The capacitors C1 and C2 make form the biasing element. The input for the non-inverting terminal is the connection point between the R1 and rain board module. From this connection, a second point is taken out and connected to the A0 terminal of the control module.

The input to the LM393's inverting terminal is a potentiometer (R2). We can alter R2 to alter the input voltage to the inverting terminal, which in turn affects the control module's sensitivity. As a voltage divider, R2 is used. The connections are shown in the above figure. Resistors R3 and R4 are used. The connections are shown in the above figure. Resistors R3 and R4 function as current-limiting resistors, and resistor R5 acts as a pull-up resistor to keep the bus in a high state when not in use.

Case 1: When the input of the inverting terminal is higher than the input of the non-inverting terminal.

Case 2: When the input to the inverting terminal is lower than the input to the non-inverting terminal.

The input to the inverting terminal is adjusted to a certain value, and the sensitivity is calibrated, by setting the potentiometer. When exposed to rainwater, the surface of the rain board module becomes moist, offering the least amount of resistance to the supply voltage. As a result, the terminal of the LM393 Op-non-inverting Amp will show the minimum voltage. The comparator compares the terminal voltages of both inverting and non-inverting devices. If the situation falls under case, the Op-Amp will have a digital LOW output (1). If the situation falls under instance, the Op-Amp will generate a digital HIGH output (2). The schematic below shows the corresponding circuit for each of the two possibilities.



c, Application

- Automatic windshield wipers
- Smart Agriculture
- Home-Automation

3.3.5 Infrared sensor

a, General and pinout

Figure 37: Infrared sensor

A sensor is an electrical device that emits infrared light to detect specific elements of its surroundings. An IR sensor may detect movement in addition to tracking the heat of an item. Since they just measure infrared radiation instead of emitting it, these sorts of sensors are known as passive IR sensors. Typically, all objects emit some form of infrared thermal radiation.

Figure 38: Infrared sensor pinout

VCC: power supply of 5V

GND: Ground connected to our ESP32

OUT: could be digital or analog output

b, Working principle

Infrared transmitters come in a variety of designs based on the wavelengths, output power, and response time they have. The two components of an IR sensor, an IR LED, and an IR Photodiode, collectively known as a PhotoCoupler or OptoCoupler, are used.

IR Transmitter or IR LED

An infrared transmitter, often known as an IR LED, is a light-emitting diode (LED) that emits infrared radiation. An IR LED may appear to be a regular LED, but the radiation it emits is invisible to the human eye.

IR Receiver or Photodiode

Infrared radiation from an IR transmitter is picked up by infrared receivers or infrared sensors. Photodiodes and phototransistors are used as IR receivers. As opposed to regular photo diodes, infrared photodiodes only pick up on infrared radiation. In the figure below, a photodiode or an IR receiver is shown.

An IR photodiode serves as the emitter and an IR LED as the detector. An IR photodiode can pick up the IR light that an IR LED emits. The voltage and resistance of the photo-output diode vary proportionally to the amount of IR light received. This is the basic operation of the IR sensor.

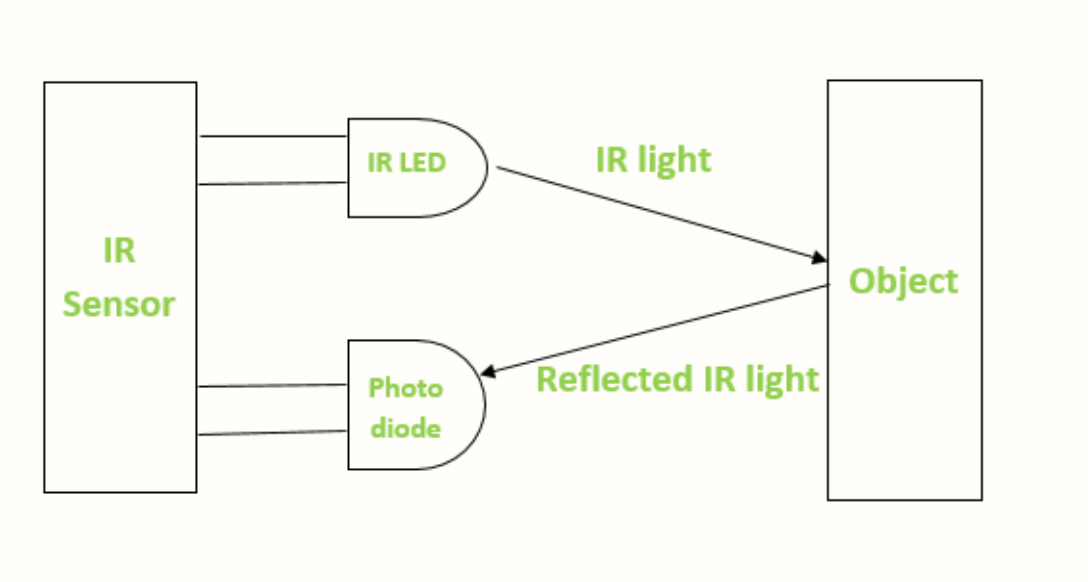


Figure 39: Working principle of IR receiver or Photodiode

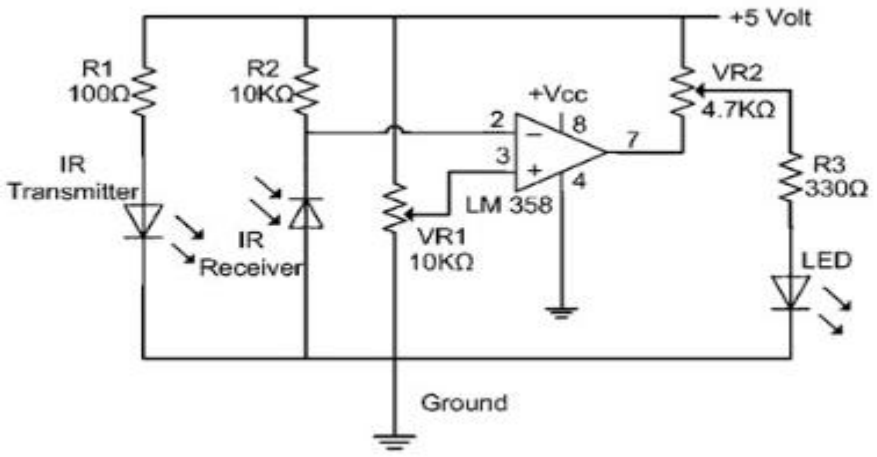


Figure 40: Infrared circuit diagram

When the IR receiver is not receiving a signal, the voltage at the comparator IC's inverting input is higher than the non-inverting input (LM339). As a result, while the LED is off, the comparator's output lowers. When the IR receiver module detects an IR signal, the voltage at the inverting input decreases. As a result, the output of the comparator (LM 339) rises and the LED starts to glow.

Resistors R1 (100), R2 (10k), and R3 (330) are used to make sure that at least 10 mA of current flows through the photodiode and ordinary LEDs, respectively, that are used in IR LED devices. With the help of resistor VR2 (preset=5k), the output terminals are changed. The circuit diagram's sensitivity is set using the resistor VR1 (preset=10k).

c, Application

- Night vision devices
- Radiation thermometers
- Infrared Tracking

3.4 Features of each room in the house

3.4.1 Bedroom

a Features

- Control a light in the room with a touch in a app on mobile phone as well as from a website

- Automatic curtain system with 2 modes which are automation and manual gives user flexible choices based on their prefer
- Control speed of a fan using app on mobile phone or website

b, Actuator and sensor devices

- Light sensor for purpose of using automatic mode of curtain system.
- DC motor working as a fan in the bedroom could be controller over the internet
- A small led could be controlled over the internet.
- A step motor used in curtain system to close or open the curtain of bedroom window

3.4.2 Livingroom and kitchen

a, Features

- Secure access with ability to control the door by utilizing finger print module
- Measure temperature and humidity of the house
- Detect motion to monitor the door properly
- Display gas content, temperature, and humidity on a screen

b, Actuator, and sensor devices

- Servo motor to open and close the door.
- A speaker to warn when gas leakage happens.
- Motion detected sensor
- Temperature and humidity sensor
- Gas sensor

3.4.3 Bathroom and Garden

a, Features

- Turn on light and ventilation fan automatically when infrared sensor detects person entering the bathroom
- Clothesline system pulls in and out clothesline based on weather detected by rain detection sensor

b, Actuator, and sensor devices

- A small light
- A DC fan
- A step motor
- Infrared sensor
- Rain detected sensor

CHAPTER 4. INTERNET OBSERVATION AND CONTROL SYMTEM OF SMART HOME THROUGHT INTERNET

4.1 Internet

The TCP/IP protocol stack is used by the Internet, a global network of linked computer networks, to interact with one another. Private, public, academic, business, and government networks with local to global reach are connected using a variety of electronic, wireless, and optical networking technologies. A few of the various information sources and services accessible on the Internet include the World Wide Web (WWW), which is composed of interconnected hypertext documents and applications, as well as electronic mail, phone service, and file sharing. In order to facilitate computer time-sharing, the US Department of Defense funded research in the 1960s. This research resulted in packet switching, which is where the Internet got its start. During the '70s, the ARPANET, the primary antecedent network served at first as a hub for tying together local academic and military networks. Numerous networks have combined, and new networking technologies have been developed with participation from all over the world as a result of the 1980s funding for the National Science Foundation Network as a new backbone and private sponsorship for additional commercial expansions. As successive generations of institutional, personal, and mobile computers were linked to the network in the early 1990s, this marked the start of the transition to the contemporary Internet. This expansion was sustained exponentially. Even though academia made extensive use of the Internet in the 1980s, commercialization integrated its products and services into almost every facet of contemporary life.

Internet-based services like email, Internet telephone, Internet television, online music, digital newspapers, and video streaming websites have replaced, redefined, or even completely replaced most traditional communication mediums like the telephone, radio, television, paper mail, and newspapers. Newspaper, book, and other print publication is transforming into blogging, web feeds, and online news aggregators, or is adapting to website technology. Through instant messaging, Internet forums, and social networking sites, the Internet has facilitated and accelerated the development of new types of

interpersonal connections. Since it allows companies to expand their "brick and mortar presence to serve a bigger market or even sell goods and services solely online, internet shopping has risen enormously for major retailers, small businesses, and entrepreneurs. Online financial services and business-to-business transactions supply chains across entire industries are impacted by online transactions.

The Internet is not governed by a single, central authority, and each of its constituent networks establishes its own rules for access and usage. A maintenance organization, the Internet Corporation for Assigned Names and Numbers (ICANN), is in charge of the expansive definitions of the two primary name spaces on the Internet: the Internet Protocol address (IP address) space and the Domain Name System (DNS) (ICANN). The Internet Engineering Task Force (IETF), a non-profit association of loosely associated international participants that anyone may associate with by providing technical skills, is responsible for the technical foundation and standardization of the fundamental protocols. The Internet was listed as one of the "New Seven Wonders" by USA Today in November of that year.

4.2 IP address

A device's IP address, which is a unique address, can be used to identify it on the internet or within a local network. The term "Internet Protocol," or IP, refers to the standards governing the structure of data supplied across a local or wide-area network.

In essence, the identifier that allows information to be transmitted between devices on a network is the IP address, which carries location information and makes devices reachable for communication. On the internet, there must be a way to identify computers, routers, and websites. IP addresses, which are vital to the operation of the internet, offer a way to accomplish this.

An IP address is composed of a string of integers, each separated by a period. IP addresses are represented by four numbers; 192.158.1.38 is an example of one such address. Each number in the set has a range from 0 to 255. The full IP addressing range is therefore from 0.0.0.0 to 255.255.255.255. IP addresses differ from one another. They are created and distributed mathematically by the Internet Assigned Numbers Authority (IANA), a division of the Internet Corporation for Assigned Names and Numbers (ICANN). To help preserve the internet's security and ensure that it is accessible to

everyone, ICANN was established in the United States in 1998. Everyone who registers a domain name on the internet does so through a domain name registrar, which pays ICANN a small registration fee.

4.2.1 How do IP addresses work

Internet Protocol communicates by adhering to established standards to transmit information, just like any other language. All connected devices communicate with one another using this protocol to find, send, and share information. By using the same language, every computer, no matter where it is, may communicate with any other computer.

The use of IP addresses typically happens behind the scenes. The process works like this:

- Your device first connects to a network that is connected to the internet, giving it access to the internet, and then it connects to the relevant network.
- When you are at home, that network probably acts as your Internet service provider (ISP). Where you work will have a company network.
- Your ISP gives your device a special IP address.
- Your internet activity passes through the ISP and is then sent back to you by the ISP using your IP address. Since they are giving you access to the internet, it is their job to provide your device an IP address.
- But it's possible for your IP address to change. It can be changed, for example, by turning on or off your modem or router. Alternately, you could contact your ISP, who can make the change for you.
- When you travel or use your device in other public settings, your home IP address is not followed. This is because you will be using a separate network to access the internet (such as Wi-Fi at a hotel, airport, coffee shop, etc.), and a different (temporary) IP address that was assigned to you by the ISP of the hotel, airport, or coffee shop.

4.2.2 Some kinds of IP addresses

- Consumer IP address: Every individual or business with an internet service plan will have two types of IP addresses: their private IP addresses and their public IP address. The terms public and private relate to the network location —

that is, a private IP address is used inside a network, while a public one is used outside a network.

- Private IP address: Every device that connects to your internet network has a private IP address. This includes computers, smartphones, and tablets but also any Bluetooth-enabled devices like speakers, printers, or smart TVs. With the growing internet of things, the number of private IP addresses you have at home is probably growing. Your router needs a way to identify these items separately, and many items need a way to recognize each other. Therefore, your router generates private IP addresses that are unique identifiers for each device that differentiate them on the network.
- Public IP address: A public IP address is the primary address associated with your whole network. While each connected device has its own IP address, they are also included within the main IP address for your network. As described above, your public IP address is provided to your router by your ISP. Typically, ISPs have a large pool of IP addresses that they distribute to their customers. Your public IP address is the address that all the devices outside your internet network will use to recognize your network.
- Dynamic IP address: Dynamic IP addresses change automatically and regularly. ISPs buy a large pool of IP addresses and assign them automatically to their customers. Periodically, they re-assign them and put the older IP addresses back into the pool to be used for other customers. The rationale for this approach is to generate cost savings for the ISP. Automating the regular movement of IP addresses means they don’t have to carry out specific actions to re-establish a customer's IP address if they move home, for example. There are security benefits, too, because a changing IP address makes it harder for criminals to hack into your network interface.
- Static IP address: In contrast to dynamic IP addresses, static addresses remain consistent. Once the network assigns an IP address, it remains the same. Most individuals and businesses do not need a static IP address, but for businesses that plan to host their own server, it is crucial to have one. This is because a static IP address ensures that websites and email addresses tied to it will have a consistent IP address — vital if you want other devices to be able to find them consistently on the web.

- Share IP address: Websites that rely on shared hosting plans from web hosting providers will typically be one of many websites hosted on the same server. This tends to be the case for individual websites or SME websites, where traffic volumes are manageable, and the sites themselves are limited in terms of the number of pages, etc. Websites hosted in this way will have shared IP addresses.
- Dedicated IP address: Some web hosting plans have the option to purchase a dedicated IP address (or addresses). This can make obtaining an SSL certificate easier and allows you to run your own File Transfer Protocol (FTP) server. This makes it easier to share and transfer files with multiple people within an organization and allow anonymous FTP sharing options. A dedicated IP address also allows you to access your website using the IP address alone rather than the domain name — useful if you want to build and test it before registering your domain.

4.3 Design pattern for observation system

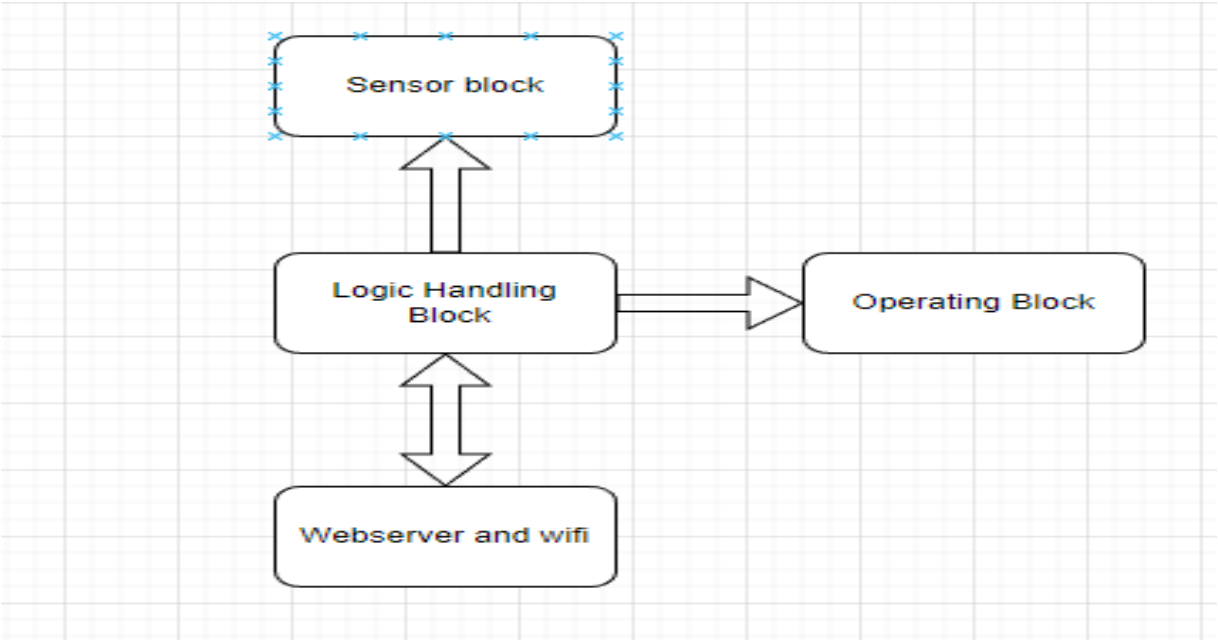


Figure 41 Block diagram of observation and control system

4.4 Properties of observation and control system

a) Properties

- Security, monitoring temperature, humidity, gas leaking warning system
- Control and showing all the status of front door, temperature, humidity and gas level inside the house…as well as with other operating systems.

b) Requirement for observation system

- Showing security status, temperature, humidity inside the house
- Control all the system through internet

Observation and control system consist of 3 main parts:

- Sensor block: collect the data from all the sensor and then transfer the data to handling logic block
- Handling logic block: the responsibility of this block is processing all the data in before sending them to the webserver as well as through WIFI to control all the devices
- Operating system: consist of light system, temperature system, front door. This block receives from the handling logic block to make an appropriate decision.

Sensor's system was used to collect data from environment. After that it makes the right decision and send it to be handling logic block and finally forward it to webserver and through WIFI. In this project, we are using an open source to build web to decide

4.5 Data transmissions principle

4.5.1 WLAN Protocols

Wireless Local Area Network is what it means. A local area network using wireless communication is known as a WLAN. High frequency radio waves are used for wireless communication and are sent through an access point. A hardware component known as an access point serves as a hub for wireless signal transmission. Imagine a huge fountain with a lone spout (access point). You will always be soaked if you remain within a predetermined distance of the spout's center (called the coverage distance) (maintain signal connection). The wireless access point is the same way. The access point enables

continuous network connectivity for all connected devices within a defined coverage region.

Wireless data transmissions are governed, like all other network operations, by a set of protocols that define the nature and purpose of the network. The 802.11 standard protocol created by the IEEE (Institute of Electrical and Electronic Engineers) Standards Committee is where WLAN protocols got their start. From this standard, subsequent protocols were developed.

In a Wireless LAN, a wireless network interface controller is included on each station. There are two categories for stations:

- **Wireless Access Point (WAP)** − Wireless routers, also known as WAPs or access points (AP), serve as the base stations or access points. Through the distribution system, copper or fiber wires are used to connect the APs.
- **Client** − Clients include workstations, laptops, printers, smartphones, and other electronic devices. They are within an AP's detection range by a few tens of meters.

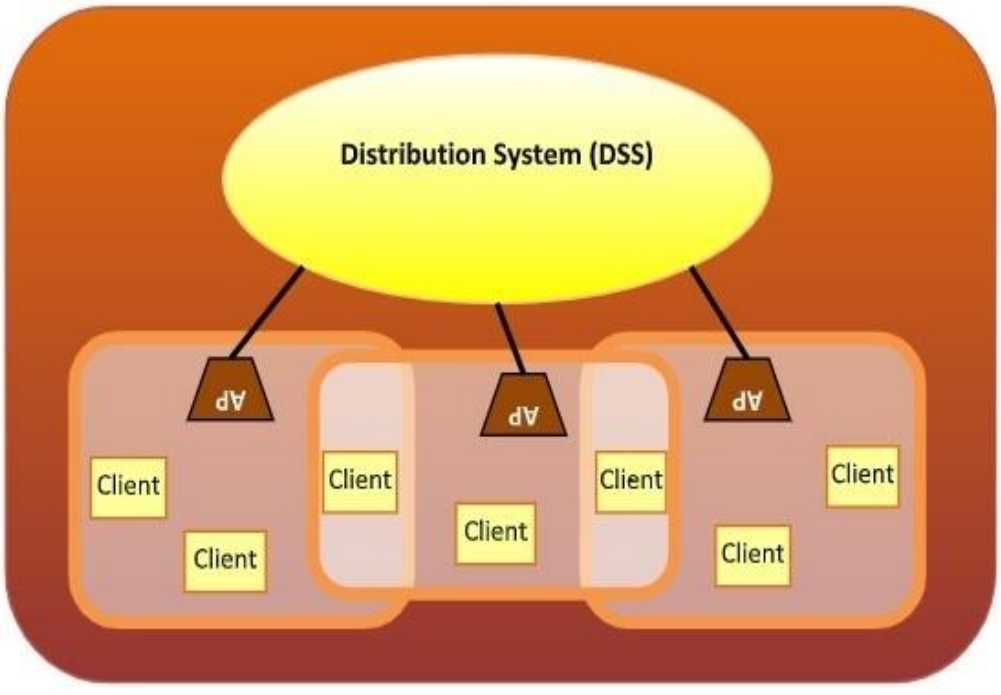


Figure 42: Wireless LAN protocols

The Frame Control is the first two octets that a station transmits. In all varieties of 802.11 frames, the first three subfields of the frame control and the last field (FCS) are always

present. These three subfields are made up of a four-bit Subtype subfield, a two bit Type subfield, and a two bit Protocol Version subfield.

Figure 43: 802.11 frame

4.5.2 Types of WLAN Protocols

IEEE 802.11 or WIFI has several variations, the main among which are −

- **802.11a Protocol**− This protocol supports 54Mbps, which is a very high transmission speed. Its high frequency (5GHz range) makes it difficult for signals to pass through walls and other barriers. Orthogonal frequency division multiplexing is used (OFDM).
- **802.11b Protocol** − This protocol supports 11Mbps speed and runs in the 2.4GHz frequency band. It makes path sharing easier and is more resistant to obstacles. It makes use of the Ethernet protocol and carrier sense multiple access with collision avoidance (CSMA/CA).
- **802.11g Protocol** − This protocol combines the advantages of the 802.11a and 802.11b technologies. As per the 802.11a specification, both the 2.4GHz and 5GHz frequency bands are supported (as in 802.11b standard). Due to its dual properties, 802.11g is backwards compatible with 802.11b equipment. 802.11g has many advantages, including fast speeds, variable signal range, and obstacle resistance. The price of implementation is higher, though.
- **802.11n Protocol** − This is Wireless N, which is an upgraded version of 802.11g. It delivers very high bandwidth and signal coverage (up to 600Mbps). For Several Input/Multiple Output (MIMO), which is employed at both the transmitter end and the reception end, multiple antennas are needed. Whenever there are signal obstructions, alternate routes are selected. The expense of implementation is, however, quite high.

4.5.3 Operating principle

TCP/IP employs the client-server model of communication, where a user or machine (a client) requests a service from another computer (a server) over the network, such as sending a webpage.

The TCP/IP suite of protocols is categorized as stateless, which means that since each client request is independent of earlier ones, it is regarded as new. Being stateless liberates network paths, allowing for continuous use.

However, the transport layer itself is stateful. It sends a single message, and the connection is maintained until the destination receives and reassembles all of the message's packets.

The seven-layer Open Systems Interconnection (OSI) networking model was modeled after the TCP/IP model, but there are some minor differences. Applications' network communication capabilities are outlined in the OSI reference model.

4.5.4 Channel Bandwidths

The channels used by early 802.11 products are roughly 20 MHz wide. The 2.4 GHz ISM frequency range has eleven 20 MHz channels (three of which are non-overlapping: 1, 6, and 11) that are used by 802.11b/g radios in the US. The channel bandwidth for 802.11's OFDM PHY was 20 MHz at first, with support for 5 and 10 MHz bandwidths later added. 12 non-overlapping 20 MHz channels in the 5 GHz Unlicensed National Information Infrastructure (UNII) spectrum are used by 802.11a radios. In the ISM or UNII band, 802.11n equipment can employ 20 or 40 MHz wide channels.

Support for both an 80 MHz and a 160 MHz bandwidth are available in 802.11ac. The reception and transmission of channels with a bandwidth of 20, 40, and 80 MHz must be supported by the 802.11ac device. Two separate 40 MHz channels that are not contiguous to one another will make up the 80 MHz channel. Two 80 MHz channels, which may or may not be nearby (contiguous), will combine to generate the 160 MHz channels. They can increase throughput by using a wider bandwidth thanks to the more recent standards. It's crucial to understand, though, that the 2.4 and 5 GHz frequency bands did not expand. Products must utilize the same bandwidth across all 802.11 specifications. The greater bandwidths can only be used if there is spectrum available.

As a result, a lot of 802.11n WLANs could limit their use to 40 MHz channels in the 5 GHz range.

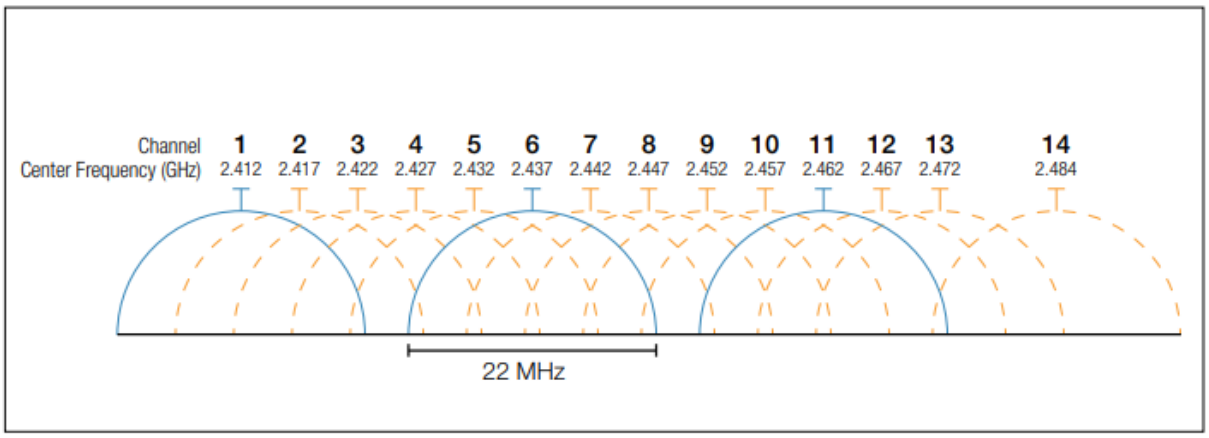


Figure 43:The 2.4 GHz band is divided into 14 overlapping channels

4.6 Algorithm flowchart

In this part we will introduce about the algorithm flowchart of all smart home system

4.6.1 Humidity and Temperature measurement module

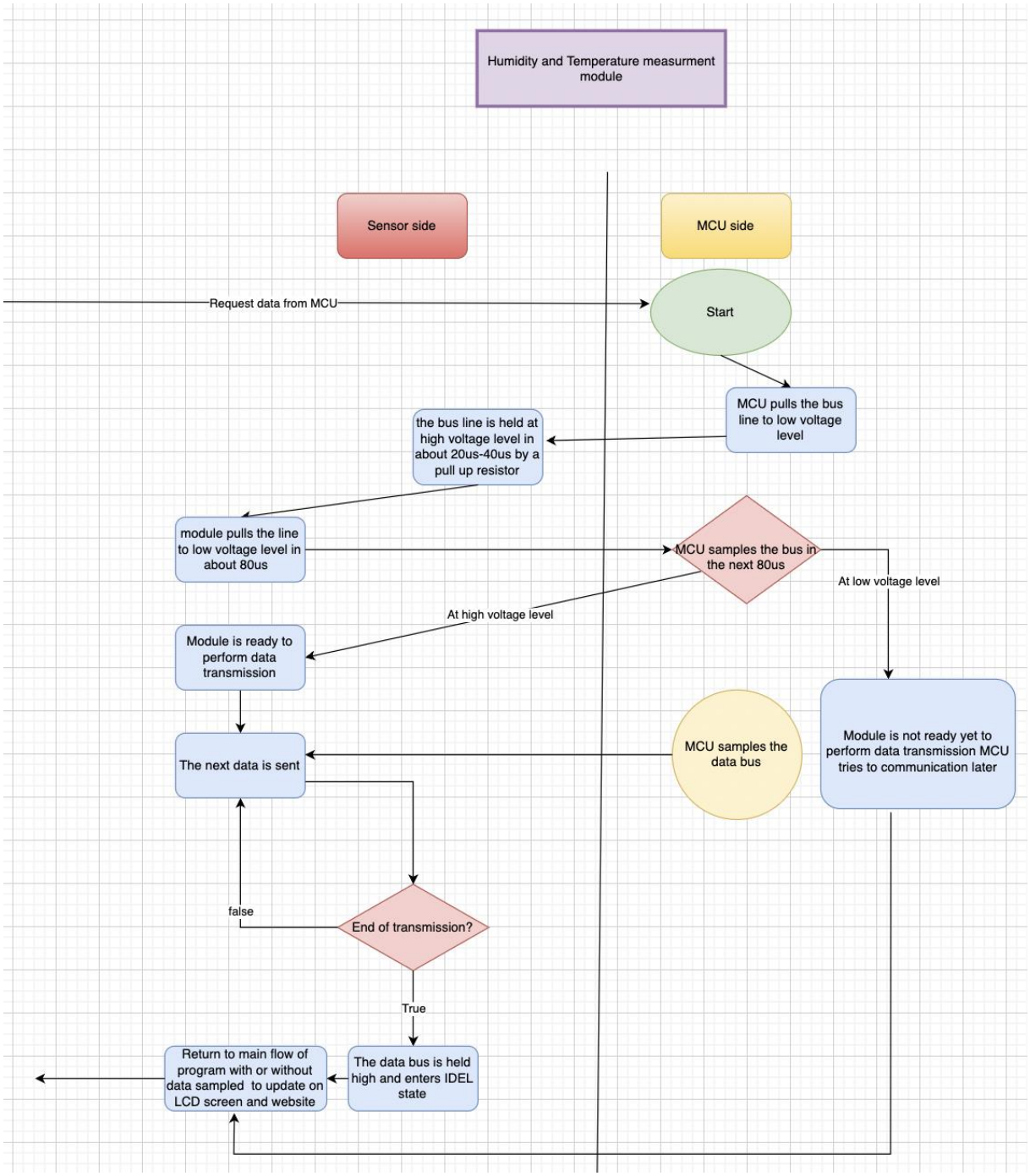


Figure 44: Humidity and temperature measurement module

When the MCU sends a request, this module receives data. First, the MCU will set one pin to a high level, which is then maintained for 20–40us by a pull resistor. Second, it will take the module roughly 80us to pull that pin to low voltage. The MCU will sample the bus in the following 80us after that. If the pin is still at a low voltage level, the temperature and humidity are not suitable for carrying out data transmission. In contrast, if the pin is high level, data will be delivered until it reaches the end of transmission, at

which point the data bus is retained at high level and enters the IDEL state. Returning to the main flow program without data sampled to update screen and website.

4.6.2 Gas module workflow

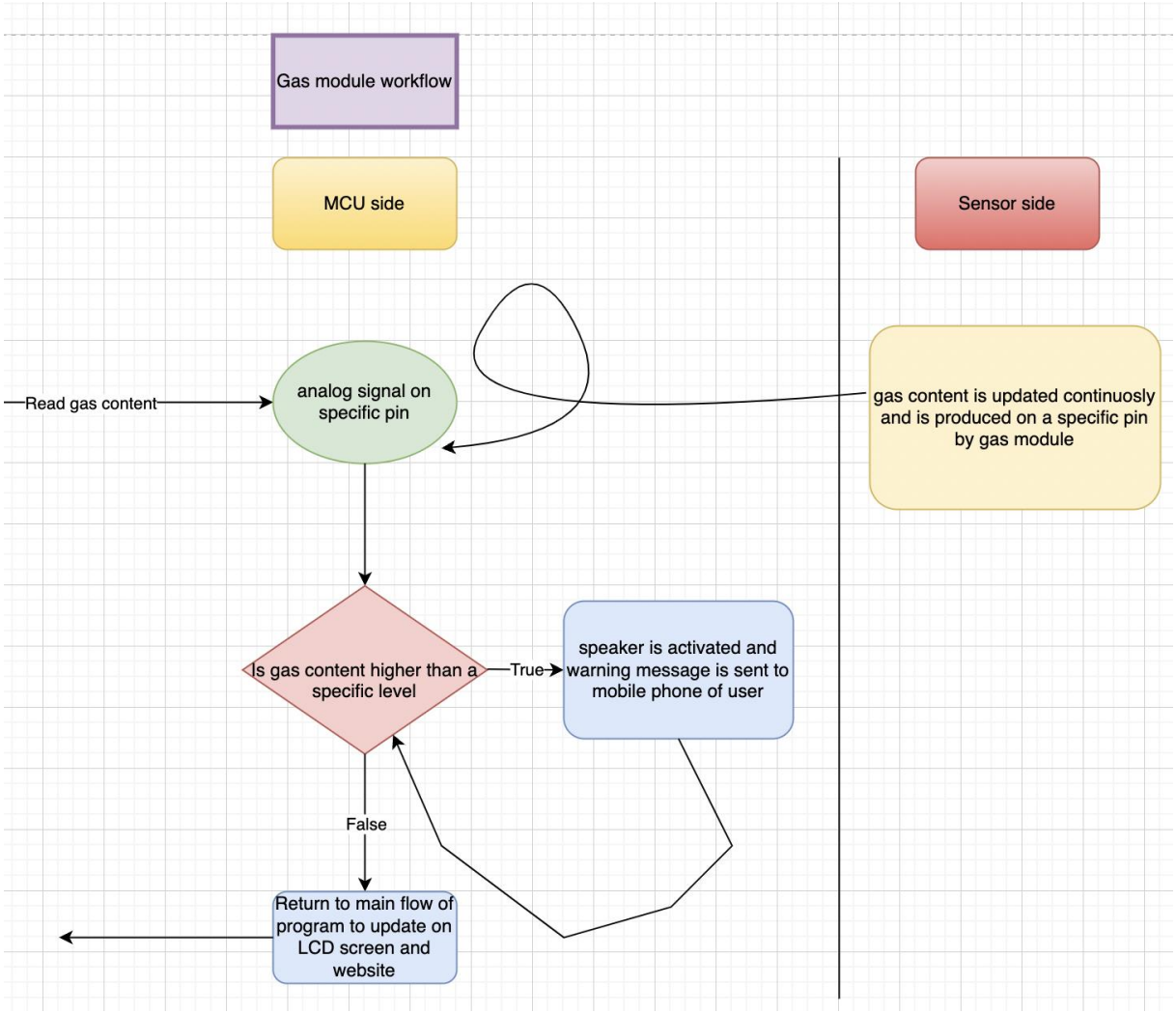


Figure 45: Gas module workflow

when the MCU sends a request to this module. On a given pin, the MCU will deliver an analog signal (Gas data is updated continuously and is produced on a pin that connected to gas sensor). The MCU will compare the data received from the gas sensor to a preference level that we had established in our code. The speaker is engaged, and a warning message is sent to the user's mobile phone if the gas level is higher than the recommended limit. The module completes its task by sending data back to the main flow of the software for updating on the LCD screen and website.

4.6.3 Fan and light control in bathroom module

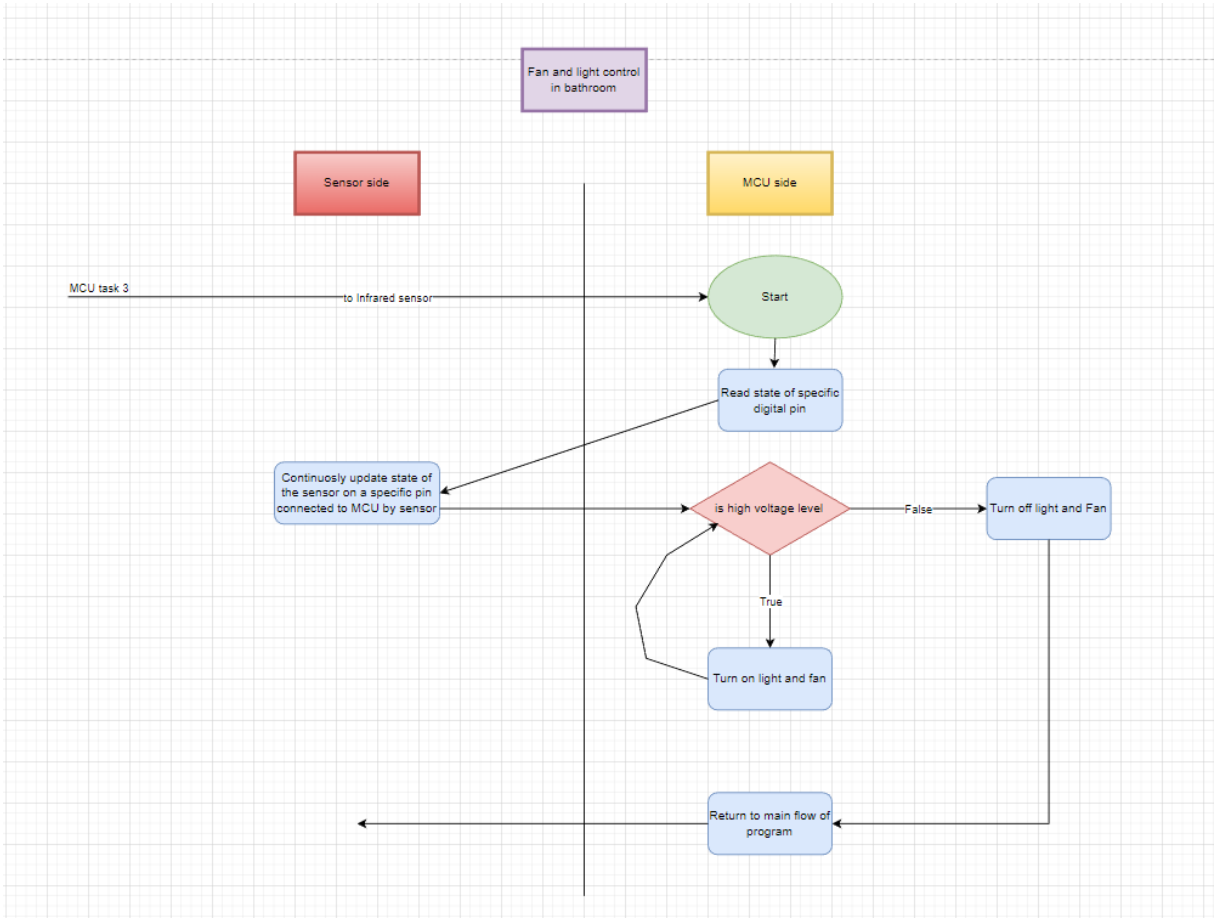


Figure 46: Fan and light control in bathroom module

When the MCU sends a command to the infrared sensor in this section. The status of a particular digital pin will be read, and that pin will then be set to a high-level voltage (State of sensor on a that pin connected to MCU by infrared sensor will be updated continuously). Light and a fan will turn on if that pin has high voltage. They will be turned off if not. The module completes its task by delivering data to the main flow of the software for updating on the LCD screen and website.

4.6.4 Door control module workflow

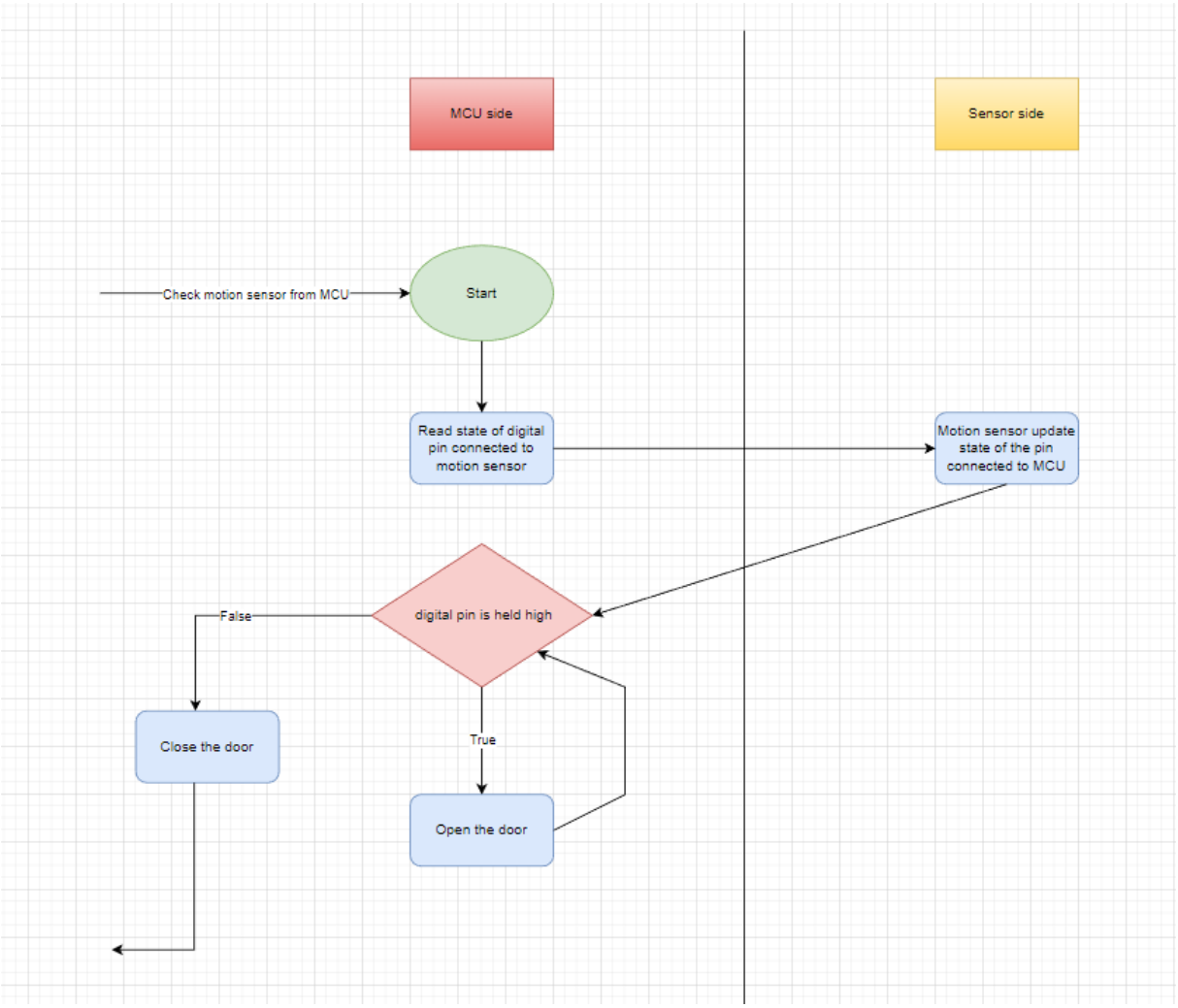


Figure 47: Door control module workflow

In this part, the MCU will read state of digital pin connected to motion sensor. From the signal received from that pin we have two flowing conditions as flowing by. If the digital pin is at high level voltage, the door will open. If the pin is at low level the system will close the door

CHAPTER 5. CONCLUSION

5.1 Achievement success

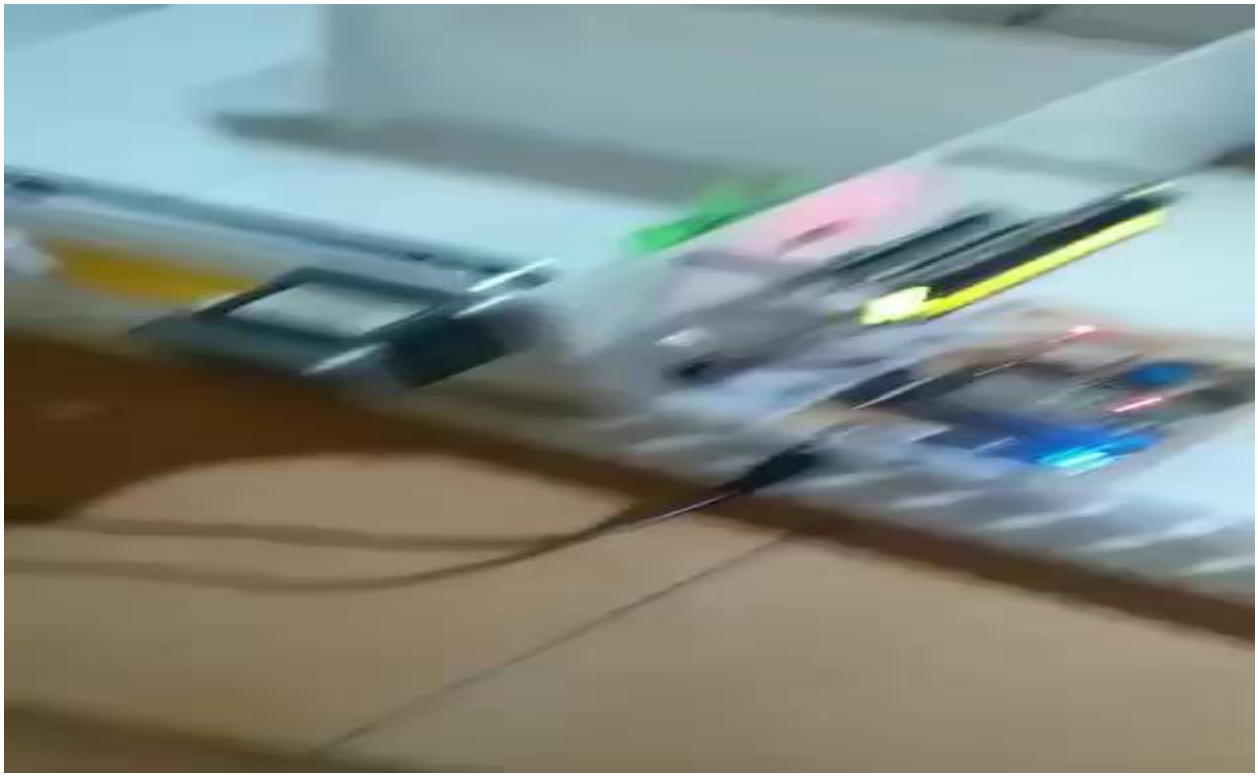
The need for smart homes has a risen because of technological advancements like internet of things (IoT) and its numerous applications. Because automatic processes are utilized to substitute manual efforts to carry out some essential duties in the home, the simplicity with which home equipment can be remotely monitored and controlled raises the standard of living. People's hectic lifestyles have increased the urgent demand for intelligent homes. Even though they were not physically present at home, household owners frequently pay extra for electricity usage because their devices were purposefully or unintentionally left on when not in use. Simple actions like manually turning on and off lights, fans, TV sets, and other household appliances can be difficult for elderly persons and people with physical disabilities. In this work, a smart home that can autonomously operate without human intervention and remotely automate the operation of home equipment is proposed.

Information and communication technologies must modify their designs with smart devices and strategies because of the Internet of Things and workflow integration. I've had some trouble conducting my study because this is a novel subject. But along with my efforts to investigate and the teacher's enthusiasm and passion, the desire to learn new things has enabled me to succeed in the following ways: Overview of the monitoring and control system via the internet, and the smart home. At the same time, I also know the usage situation and development trends of Vietnam and other countries in the world.

- Successfully designed a smart home model.
- Learn the basis and meaning of controlling devices over the internet.
- Understand the working principle of the modules in the system and how to connect them.
- Run the experiment and evaluate the results.

Besides the obtained results, the model still has many technical limitations such as the ability to expand the number of monitoring and control variables, interference occurrence, long web interface response time.

Two video below is to demonstrate all our smart home features



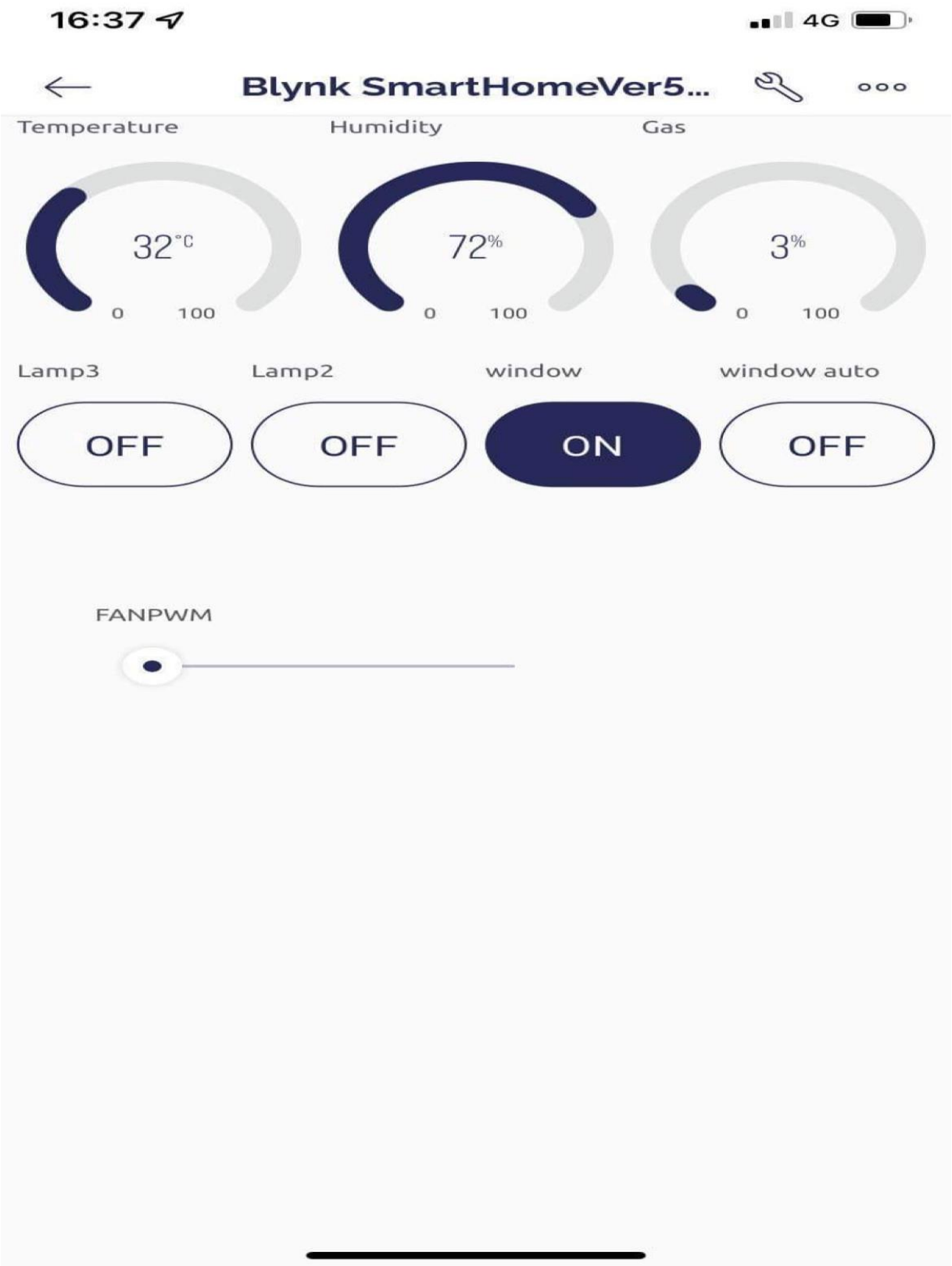


Figure 48: UI on mobile phone

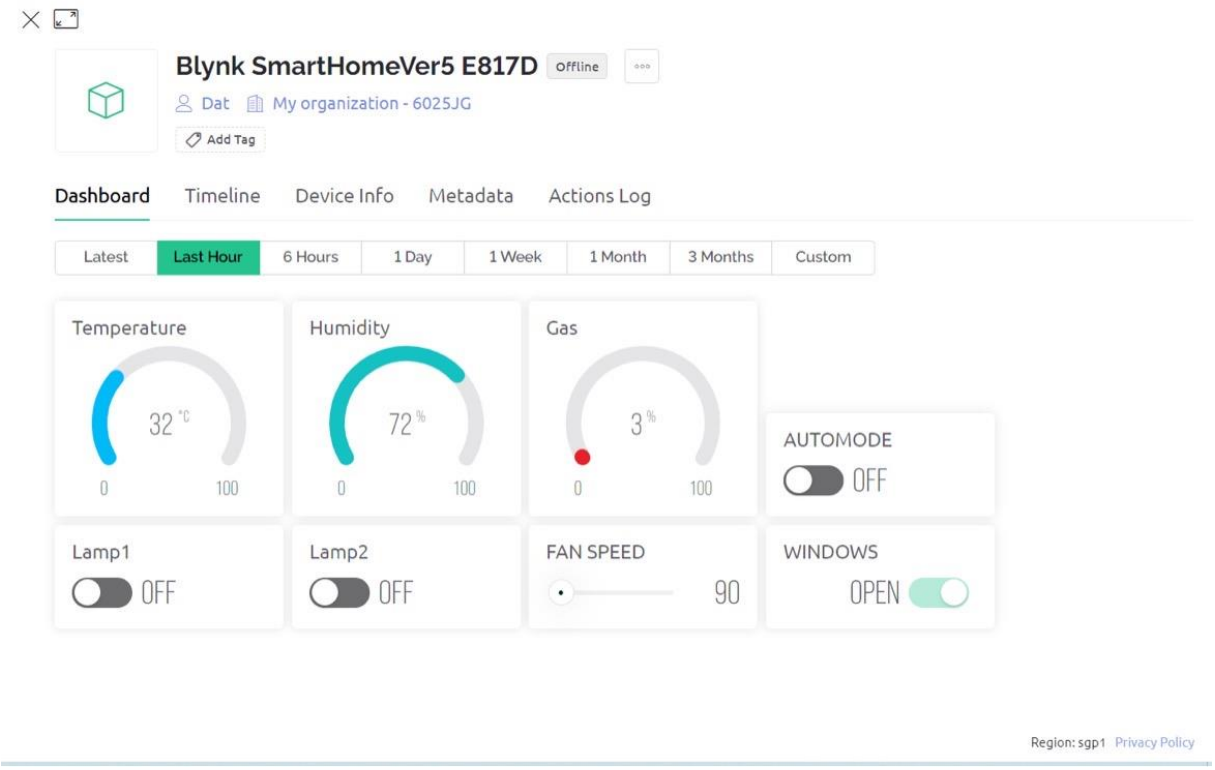


Figure 46: UI on website

5.2 Development for the project

The emergence of smart home will set off a new wave in the field of residential interior design. Let designers begin to try to look at the living environment from another perspective, so that smart home can not only bring convenience to residents, but also satisfy residents' pursuit of beauty. The development trend of smart home in the future must be coordinated development from economic support, social affirmation, government support and residents' needs.

In particular, the advantages of smart home fully combine people's personalized needs with science and technology, enhance residents' subjective initiative, and conform to the lifestyle and aesthetic trend of the current era. In addition, energy reuse and resource sharing in smart home are consistent with the concept of green energy conservation upheld by today's social environment. Therefore, all levels will increase the proportion of investment in the future of smart home, and more innovation and exploration are also needed. It is also thanks to these intelligent devices that the high-tech family life dreams in science fiction have entered our lives.

Through this project we propose some development this project

- Install camera integrated with light sensor temperature sensor as well as humidity sensor for observation system. Therefore, we can monitor anything in the house and the status of their smart home.
- Develop management software in mobile to increase the convince with customer.
- Develop a reuse energy source. For example, solar energy integrated with electric energy.

PREFERNCE

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