IOT BASED HOME MANAGEMENT SYSTEM

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This project report submitted in partial fulfillment of the requirements for the award of the degree of Master of Engineering in Information and Communication Engineering.

Department of Information and Communication Engineering
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SUPERVISOR'S DECLARATION

We hereby declare that we have checked this project and our opinion, this project is adequate in terms of scope and quality for the award of the degree of Master of Engineering in Department of Information and Communication Engineering of Noakhali Science and Technology University.

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I hereby declare that the work in this project is my own except for quotations and summaries which have been duly acknowledged. This project report has not been accepted for any degree and is not concurrently submitted for award of other degree.

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ABSTRACT

Internet of Things (IoT) is the network of interconnected devices, digital machines, home appliances and other objects embedded with sensors, software, switches and connectivity which enable these things to connect to a network and collect and exchange data. The system creates the scope of connecting the non-internet-enabled physical devices and machines to be connected over the internet and remotely monitored and controlled. Home automation system uses the portable devices as a user interface. They can communicate with home automation network through an Internet gateway. This project intends to create architecture for home automation using near field and mobile communication along with a mobile application. The basic architecture or framework consists of connecting devices which will use protocol (WiFi or ZigBee) to connect Edge gateway and cloud stores the data information using backend storage system. Along with smart control of the appliances in our project we are focusing to reduce excess energy consumption by remotely controlling the devices and to maintain appliances for consumer's convenience.

Keywords: IOT, HAN, EMS, HEMS.

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LIST OF ABBREVIATIONS

IOT	Internet of Things
NFC	Near Field Communication
AMQP	Advance Messaging Queuing Protocol
MQTP	Message Queuing Telemetry Protocol
HEMS	Home Energy Management System
RFID	Radio Frequency Identification
WSN	Wireless Sensor Network
HAN	Home Area Network
EMS	Energy Management System
HTTP	Hypertext Transfer Protocol
AMI	Advance Metering Infrastructure
COAP	Constrained Application Protocol
RTP	Real Time Pricing

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Internet of Things (IoT) is the network of interconnected devices, mechanical and digital machines, vehicles, home appliances and other objects embedded with sensors, software, switches and connectivity which enable these things to connect to a network and collect and exchange data. The technology opens up the possibility of linking non-internet connected physical objects and computers to the internet and enabling them to be tracked and managed remotely. A human with a heart tracking implant, a car with an obstacle sensor, or home appliances linked to an application network are both examples of things in the Internet of Things. This also refers to industrial equipment such as an oil well drill or a plane's jet engine. These items are given an IP address and can send and receive data over the internet. Essentially, this is the idea of using the internet to connect any computers or machines that we can think of today. Previously, home-automated devices were considered simple and essential, with options ranging from light clocks to programmable indoor regulators. Currently, these systems are combining data from home exercises, neighborhood temperature frameworks, and other sources in order to acclimate to an optimum way of living and assist with improved home management. And better, they can communicate with one another and form a solid team that can work the whole building. This project aims to propose a home automation architecture focused on near field and mobile connectivity, as well as a mobile framework. The core architecture or platform consists of connecting devices using a protocol (MQTT or Zigbee) to link Edge gateways; and the cloud stores data using a backend storage mechanism. Along with smart appliance power, we'll concentrate on an energy usage management scheme that allows

users to reduce excessive energy consumption by remotely monitoring devices. This can save excessive use of any appliance energy, time and simultaneously abate extra wealth expenditure

1.2 INTERNET OF THINGS (IOT) BASIC CONCEPT

The Internet of Things refers to the interconnection of devices linked through the internet with embedded hardware systems utilizing wireless sensors and actuators that are centrally operated, monitored, and configured by the user for automation (IoT). Functional devices such as processors, cameras, sensors, and other related devices are referred to as "things" in this sense. By accessing a network, these physical machines are responsible for communicating, collecting information, and exchanging data. This knowledge sharing is made possible by the integrated technologies of these physical instruments. There are a variety of home automation features that can assist in making life at home more convenient and manageable, especially for busy, large families. Assume you will manage and monitor the devices you turn on and off on a daily basis as a result. You can handle equipment while you're out of the house with a home computerization framework, and if you're curious if you remembered to switch off the light or not, a smart machine would be there to address the issue.. The developing nearness of the Internet of Things in individual's lives has made development and advancement in the savvy home space, enabling clients to associate their gadgets through the web to their phones and tablets, and make better than ever benefits for family units. In addition, as house owner are adjusting their gadgets to one focal application, gadget or center, they further understand the worth these home automation items can bring to a family. It is the connectivity apart from the conventional devices using internet such as desktop, laptops, Smartphone, tablets etc. [1]. In figure 1.1 we can see the IoT operating technique sequence. Many types of IoT sensors can take data from environment, then can be send to the embedded hardware for further processing. At last processed data can be send to the user using internet.

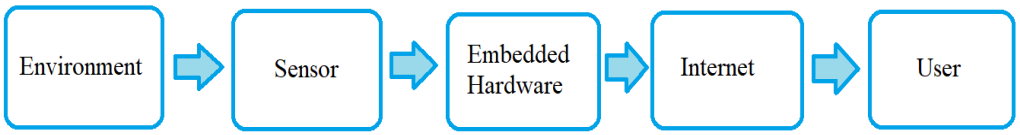

Figure 1.1: IoT Operating Technique.

1.3 IOT CHARACTERISTICS

IoT is one of the most popular terms in this modern era of the world. Internet of things (IoT) explains the network of different devices like home appliances or office works that contains software, electronics, sensor and connectivity to allow them to exchange data with connections. A number of sensors and actuators are used to connect the systems and provide input based on self-operations. IoT has persuaded the world of its global capabilities, and humans are fully reliant on it. In the not-too-distant future, the Internet of Things would have an unprecedented effect on human society, making it simpler, smarter, and stronger. It has also seized the exciting and vast digital fields of modernization that are quickly expanding. IoT User 3 for Cloud Stuff the synthesis of hardware and software using complex algorithms and computing techniques, whose knowledge authorizes them to behave and function in compliance with circumstances, is a feature of the Internet of Things. The connectivity of IoT devices enables the development of a network and a robust intelligence infrastructure by linking different artifacts. The complex design of IoT systems shows whether the device is on or off. In addition, an IoT system receives complex changes in data information from its surroundings. Since different platforms and networks are used, the core of IoT is variety and heterogeneity. Finally, IoT security issues are extremely relevant due to the sensitive details involved and the extensive measures taken to deter security issues. In the future, the magnitude of IoT components will grow to the point that dealing with or managing them will become extremely challenging.

1.4 IOT ARCHITECTURE

The IoT-based architecture provides high-level flexibility at the communication and information. It's a method that can be used in a variety of situations, including patient management, surveillance, traffic signal control, and device control. The Internet of Things (IoT) project seeks to highlight the different benefits of using IPv6 and other similar specifications to address the drawbacks of the Internet of Things [2]. The Internet of Things projects demonstrate a comprehensive and in-depth examination of all relevant functionalities, processes, and protocols that can be used to build IoT architectures; moreover, interconnections can occur between all types of IoT applications. The basic architecture of IoT in figure 1.2 consists of some stages including device, gateway connectivity, data processing and cloud or user interface. Firstly, physical devices such as sensors, appliances, devices and actuators assemble raw data from neighboring environment and convert it into useful data. Actuator and sensors work as a transducer which converts energy into one form to another form are used in IoT architecture. The computer, gateway networking, data processing, and cloud or user interface are all steps in the IoT architecture. To begin, physical instruments such as sensors, appliances, machines, and actuators collect and transform raw data from the surrounding world. In IoT architecture, actuators and sensors function as a transducer, converting energy from one type to another. Aside from sensors, which receive and respond to signals, actuators transform energy into motion. Meanwhile, there's the internet-gateway. To link Edge gateways, sensors use special protocols such as ZigBee, Bluetooth, near field communication (NFC), Wi-Fi, or a proprietary protocol. In addition to data aggregation, the edge gateway transfers raw data from analogue to digital using a data acquisition method. As an example, the internet gateway receives aggregated data and routes it to the cloud using systems such as network sockets, the event center, edge analytics, advance messaging queuing protocol (AMQP), Message queuing telemetry protocol (MQTT), Constrained application protocol (COAP), or fog computing. Furthermore, data analysis and distribution by onsite or offsite IT systems are comprehensive. Finally, data stored in the database or cloud. The cloud application handles the communication which transpires in all stages [3].

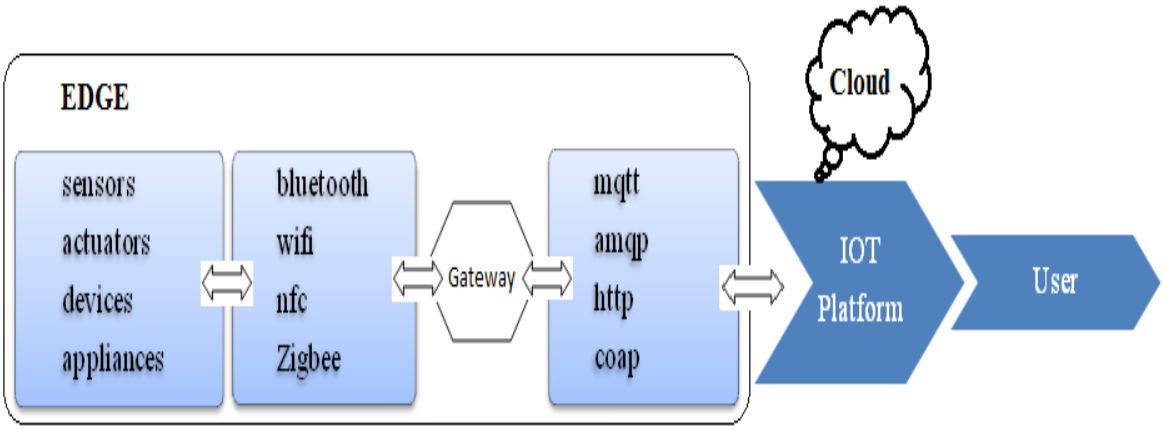

Figure 1.2: IoT Architecture

1.5 IOT APPLICATIONS

IoT application changes our life and made our life easy, comfortable and simple. The sector and area that IoT covers are huge. From figure 1.3 we can see IoT have extensive applications in different sectors for instance commercial, industrial, and medical and consumers. In all these cases IoT left its footprint and in future it surprises more. Smart house, smart city (parking, waste management), infrastructure (smart grid, smart metering), wearable devices, etc. are some of the real-world uses. Transportation and logistics (connected vehicles, vehicle management, and products tracking), industrial (process monitoring & regulation, production, and maintenance), agriculture (agriculture monitoring, atmosphere, and livestock tracking), telemedicine and nursing, elder care, and the forest (environment monitoring). Smart home is one of the most desired markets, with people seeking to become more modernized every day. We are working on smart home control solutions to handle additional energy use and tracking. A smart home is an interconnected home in which the owner can manage and monitor smart devices and other home appliances either automatically or manually. Lighting, ventilation, air conditioning, domestic robot, thermostat, wireless speaker, home protection and control, smoke alarm, water detector, washing machine, and refrigerator are all part of a smart home. The power usage of smart home electrical devices will inevitably shift market

demand response (DR) and find a good balance not just for power demand but also for supply. DR is in favor of seeking a perfect fit by balancing power against availability, enabling customers to save money on auxiliary expenditures. By engaging in and controlling their homes, customers play a key role in reducing extra power usage. At this time, humans are absorbing an increasing amount of energy from various sources, such as electrical and other industries. Humans' exponential development necessitates the use of these powers, which are a part of their lives. This limitless use of energies is in jeopardy, since these energies are themselves depleting. People are misusing electricity in different ways, such as clicking on the lamp in an empty space many times, and so on IoT is attempting to reduce this energy waste in order to improve performance. We can conveniently monitor the energy of a home from a remote location by using IoT gadgets. Our participation is not needed, but having access to the internet allows us to automate the process of reducing energy waste and consuming more efficient energy. We should not need to turn on the machines in our homes at all hours, much as we do not need to turn them on at all times during the official hour. We can operate it from our office using an IoT machine or laptop that is only connected to the internet or wirelessly. It would undoubtedly save oil. By doing optimal scheduling skilled user can save more energy and their extra expense of money at the same time. The Internet of Things (IoT) home energy management framework offers full satisfaction at the lowest possible expense. Using time interval optimization, the demand model of demand response provides higher satisfaction. Since scheduling isn't necessarily sufficient for all users, it's important to strike a balance. This form of advantage not only saves resources but also allows one to learn about more stuff in less time. As a result, we discover the idea of an IoT-based energy-saving home automation system, which is explored in this article, in a simple and cost-effective manner. Price reaction, time of use pricing (TOUP), real-time pricing (CPP), critical peak pricing (CPP), and demand side management are all priorities for us (DSM).

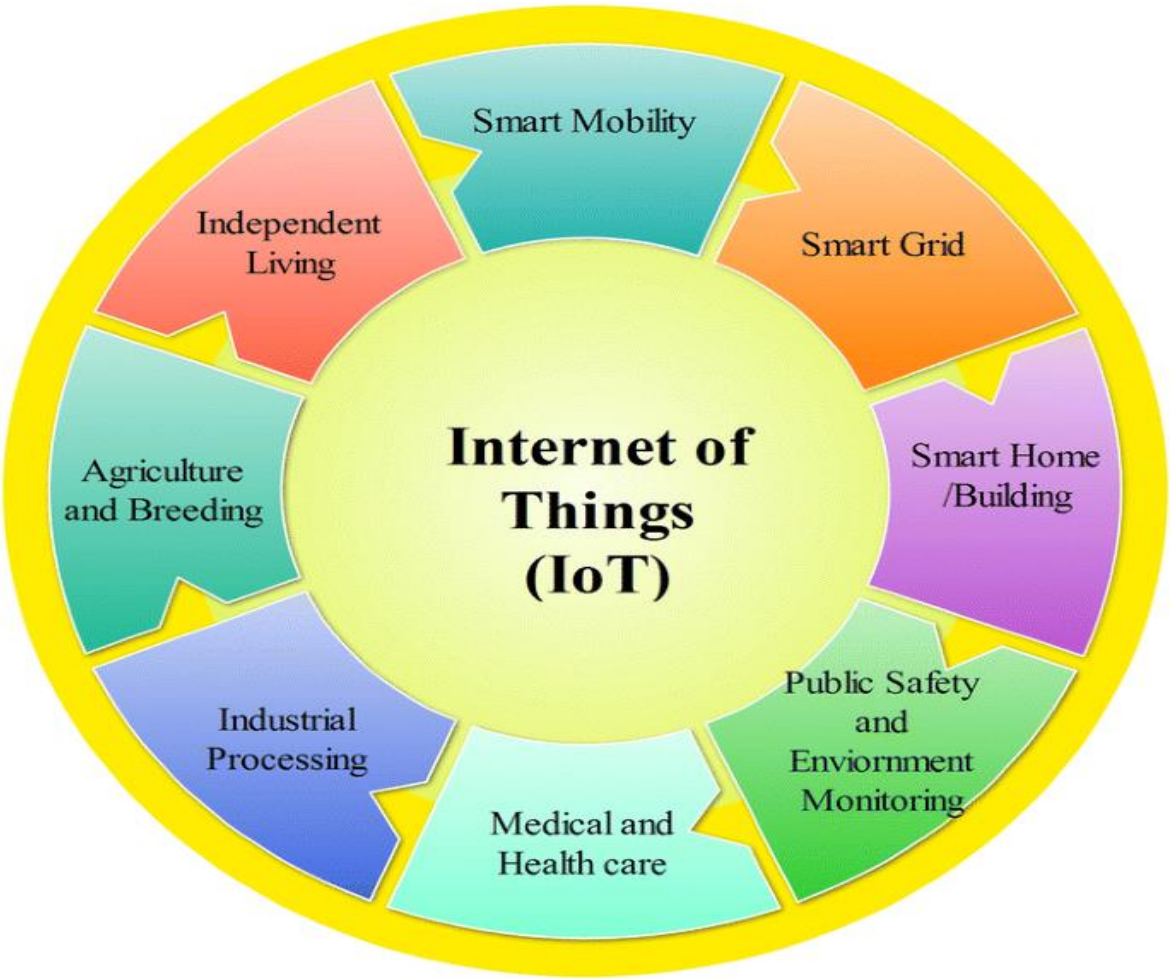

Figure 1.3: IoT Applications

1.6 HOME AUTOMATION

Home Automation is the process which all the household appliances can be controlled, monitored and maintained by the intelligence of device automatically or far from home regardless is typically called home automation which makes home smart. It will use the internet to link anything in the network. There used to be a lot of people who felt that a house should be fully automated. It is actually a reality. In view of the fact that they have more housing and support for the household, shrewd homes and penetrating home products are popular. The upgrade status of a computer can be checked at any time by the user. These

devices can transmit, monitor, and send data, as well as respond to user commands. We may use this technology to power home appliances such as lights, air conditioning, fans, washing machines, televisions, refrigerators, and surveillance systems. It can even self-control and track itself due to artificial intelligence. These frameworks additionally help increment home's vitality effectiveness, which can lessen vitality of bill.

1.7 WHY ARE HOME AUTOMATION NEEDED?

- **Savings**- For all of the connected electrical equipment, such as smart sprinklers, wirelessly activated lamps, monitoring power retailers, and water heating and cooling modules, energy and water consumption can be reduced.

- **Control**- Many of today's kitchen appliances, from broilers and refrigerators to deadbolts and cooling devices, can be operated naturally using projects on PCs, computers, and tablets. In certain cases, the power on any of these devices works even though you are out of the house and can change them, which means you might shut the door from the airport, check on the dog from anywhere in the country, or confirm that you switched off your stove from the supermarket or another shop.

- **Convenience-** Having the bulk of our lounge and room lightings updated when we enter our home remotely, the home theater and TV machine consequently betting our favorite tune, and the front entrance opening naturally as we enter it with hands full of purchases, are perhaps the end rich highlights of the astute and home. In any case, peace and happiness aren't just about leading a lavish and easy life; clever locks will also help you to permit access to a certain group of individuals at specific times and not in general, enabling you to avoid having to sit at home and hand over a key.so also, a sensor lets you know while your fridge vacant or out of stock encourages us to "arrangement" our entrance or leave entryway from wherever inside this world.

- **Security-** They are so straightforward, linked responses for the sharp home's welfare that they're logically calculated choices for each security-verified system. Using a video live, email, and prepared writings, remote activated cctv cameras, related construction sensors, and astute smoke alerts can be observed from within or outside a local.

- **Safety-** Sensors that have been tested to detect water spillage, process of stickiness, carbon dioxide, growth, warmth, and any other environmental problem that can be imagined help keep incidents from turning into disasters by allowing us to communicate with the owner legitimately at any time and from anywhere. Senior autonomy is essential. Automated sound notifications, as well as voice-activated ready frameworks, are only a few examples of local mechanization that allow seniors to live independently for longer periods of time. Moreover, cameras connected to the WiFi with - way report may furthermore help friends and family hold a watch on the senior inhabitants when they can't go and real beware of them.

1.8 PROBLEM STATEMENT

In these present days home automation is persuading the chance to be vital to improve our life conditions. Home automation is evolving because of the convenience and simplicity of using home computers. Home automation offers a cutting-edge lifestyle in which a person can monitor his entire house using a pushed wireless, from flipping on a TV to locking/opening sections; it also provides a proficient use of centrality. By and large, getting or verifying such a system displayed would cost a lot of money, which is the genuine explanation why home automation hasn't gotten much attention or thought, let alone the multifaceted idea of showing and designing it. As a result, it is critical to organize well and simply; once people are encouraged to do so, they can do so in their families, businesses, and classrooms. In certain ways, a framework change for home automation is expected in order to reduce the cost of implementing it in homes. Furthermore, home automation provides peace of mind and body to disabled or theoretically gradually settled individuals in their homes by requiring only a single tick to do what they need as of now.

1.9 OBJECTIVES

- To assembling a remote home automation structure constrained by gadget associated with the web.
- To arrangement and execute monetarily adroit home automation structure yet a capable one.
- To plan an easy to use and a guaranteed structure to control home machines particularly planned to support the more prepared individuals and weakened.
- To save energy proper management of electricity distribution.
- To show the effective way for power utilization and conservation.
- To control and monitor any operating system.
- To make power usage low and conservation more effective.
- To make smart and intelligent usage of energy and its conservation in home appliances.

1.10 PROPOSED SYSTEM FEATURE

As we enter the twenty-first century, the interaction between people and mobile phones is tearing down conventional boundaries and entering a new dimension within the massively innovation-driven culture of today. Cell phones have become an important part of our everyday lives. Mobile phones are more than just a way of contact. With the use of a mobile phone, we attempted to infer an agreement that would have more oversight on a nearby machine. The new system has a large number of computers in our homes that can be operated by switches. These devices can be switched on and off manually as they are needed. This contraption is much less effective and vulnerable to electric attacks. Similarly, the loss of fertility continues to be a focal point of the subject. The proposed activity is networks management, which involves linking our mobile phone to all devices through a smart trustworthiness circuit. The proposed system contains an astute realistic experience Circuit that is connected to home hardware. Any single home appliance's reputation can be improved with the help of a customer from afar using the individual's cell phone.

1.11 PROPOSED HOME AUTOMATION SYSTEM

The end individual can utilize their mobile phone or PC to sign into the machine. A fundamental test is accomplished for whether the equipment instrument is ON or not. Handiest on the off chance that the equipment is approved and ON, at that point the individual is verified. When the confirmation is done accurately, individual is then equipped for send the control alarms to the equipment machine. At the equipment device the single line intention power program will always follow for the change inside the distinction and will thusly transport the markers to the Circuit. While a client chooses an exchange inside the notoriety for any of the instrument, the records from the hand-held is sent to the web Server in a string design, wherein the web – site is the host. At the server the status is spared in the database of their non-open device field. At the equipment end, the circuit power program a web website page is utilized to rescue the notoriety of the contraptions in a reasonable example [for each 10sec]. Those changes come quite close to treats [which are transitory web files] from the web server and are spared at the PC inside the name of the net site on the web. Thusly every 10 sec on the grounds that the site page is revived and the new treat esteems are modernized.

1.12 PROPOSED HOME AUTOMATION SYSTEM FUNCTIONS

The foreseen home automation structure can control the going with activities in customers home and watch the going with alerts.

It can likewise control following machines:

- Lights on/off
- Fan on/off
- On/off various apparatus from anywhere
- Automatic fan speed control
- Fire/Gas leakage detection alarm
- Automatic light on/off

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Life has gotten smarter and more comfortable for us in the era of the internet. The internet has provided humans with previously unknown and extraordinary choices, such as the potential to create automatic smart systems. The idea of an automatic smart grid arose from the exponential spread of the internet, which can minimize the risk of either device as well as human participation. Worldwide study is underway to determine how to better consume the strength of an electrical machine or computer so that the pollution generated by human intervention can be minimized. The success of such an energy management system will bring us to the appropriate target of an integrated system that can be used constantly and efficiently without human interaction. For this globally promising electrical idea, we had a strategy in mind to work on something that might be useful in this field. The Internet of Things (IoT) framework encompasses a wide field for research and development. One of the most talked-about, promising, and internationally studied IoT markets is home automation. This home automation system has already created a significant impact in our technological area that is now looking for reducing the total power wastage reduction theory. The Home Energy Management System (HEMS) is currently in the spotlight as a way of reducing power outages, risky system faults, and human life loss. As a consequence, several research papers and projects from IEEE and other online publications share a large and significant concept of how we can conserve resources and reduce device risk. These ideas and their research prompted us to consider our research in a broader context. That is where the research paper's mission and objectives have been set. These articles and journals principles visualized the specifics of IoT, its uses, and a wide field of study, such as home automation, smart home appliances, home energy control systems, smart meters, scheduling for smart appliances, the disparity between

supplied and solar electricity, and our country's power usage. All of these ideas are useful in coming to a consensus and making a decision on the overall energy conservation project in this thesis article.

2.2 IOT AND HOME AUTOMATION

As the IoT has a vast chamber to discuss on mentioned earlier, it has been described briefly in a moderate way to show the concept of it in several research papers. A journal on “IoT-Home Automation” researched by S Bharat et al., published on International Journal at Computer Technology and Research (IJCTR) in 2016 showed a detail home automation appliance with short and clear view writing [4]. Lower maintenance costs, system stability, ease of extension, aesthetic advantages, and mobile device accessibility are all discussed here as benefits of home automation. Light and computers, as well as webcam tracking, magnetic doors, and other home control devices, must be present. Among the hardware and software-based technologies and modules discussed are Radio Frequency Identification (RFID), Wireless Sensor Networks (WSN), and addressing systems. In addition, this paper suggests a concept for using home automation equipment at peak and off-peak hours. Another paper on “Research and Applications on the Smart Home-Based Component Technologies and Internet of Things” written by Baoan Li and Jianjun Yu found in Sciverse Science Direct has elaborately discussed these RFID and WSN appliances [5]. The latest research on nanotechnology, sensor-based appliances, intelligence embedded technologies, RFID's potential appliances, and sea computing applications in the United States, Europe, China, Korea, and Japan is briefly discussed in this paper to give us an understanding of the wide application spectrum of RFID. The paper focused on the defense and intelligence systems of foreign countries' homes and workplaces, which have been evolving at a rapid pace. Family automatic appliances, medical appliances, Environmental automatic appliances are also mentioned here. Another paper on “The Internet of Things: How the Next Evaluation of Internet is Changing Everything”- authored by Dave Evans basically focused on the IoT aspects and its future. The author showed how the impact of IoT are is grabbing people and how the user of smart home appliances are increasing from 500 million to 50 Billion within just 15 years from 2005 to 2020. It also focused on the IoT covered fields, such as: - business, education, transport, energy, home, earth etc. In a word, there are hardly options that can’t be covered by IoT or may be invisible. From the very beginning of the machine and the spread of its equipment to the current large fields of IoT-based products and markets, the author ended

up with the emergence of IoT. Any publications and reputable internet outlets have also visualized the same idea with these information on IoT and home automation concepts. The fundamental idea of a wireless linked network from device to device and a human-friendly channel, referred to as the Internet of Things (IoT), has increasingly gained acceptance in society. It has had such an impact on our society that it has infiltrated every part of our daily lives. There will never be a cap to the number of IoT implementations that can be completely covered. IoT has an effect on agriculture, education, manufacturing, industry, home, defense, and many other areas. The explanation for this boom is smart and auto user-friendly devices that are helpful, time-consuming, and risk-free. The home automation concept, which is a major part of IoT, has thrived as a result of this consumption and user-friendly concept. It has removed our manual household tasks in order to save time, reduce risk, and simplify command. We no longer need to wait or linger in our homes to run anything because home automation systems now function effortlessly with a basic manual definition. Such benefits inspired this research paper to consider outside employment rather than domestic considerations. At this time, more power-consuming concepts are being researched, as IoT and home automation eliminate energy waste quickly, allowing people to get the most out of IoT and home automation. Thus, the broaden concepts of IoT and its home automation through these journals, papers and internet embedded our concept that can lead to work with such concepts [6].

2.3 SUPPLIED POWER AND SOLAR POWER IN BANGLADESH

An important IEEE paper that worked mostly for this project and broaden work criteria is “An Optimized Stand Alone Green Hybrid Grid System for an Offshore Island, Saint Martin, Bangladesh” written by Khandakar Haque et al., as it is for an island of our country and matches with the system of our country [7]. As they worked on the solar electric grid of Saint Martin Island, the paper enriched the disparity between power supply and solar system energy storage efficiency. The gap quickly ensured an input on how the solar panel can be both powerful and cost effective, especially for a developing world like ours. As a result of the depth of that project report, this project integrating PV solar management, power usage, and cost was developed.

2.4 SUMMARY

After reading all of these and a few more articles and journals, the principle of IoT-based home automation, its energy management system, scheduling energy management system, and some alternative automation methods for efficiently consuming power are largely apparent. Establishing a small project and document for this project is sufficient to expand and correct our vision at work.

CHAPTER 3

METHODOLOGY & SYSTEM DESIGN

3.1 SYSTEM OVERVIEW

The purpose of this work is to develop an automatic system which is ductile, cost effective, energy saving remote control of home appliances. The web application governs the system for maintenance. Automatic controlling and remotely monitoring system compose our everyday life more satisfied and simultaneously save unnecessary dissipation of electrical energy. For economic growth of any country electricity plays very vital role. Progressive country like Bangladesh does not have enough sufficiency of electricity. Due to having lack of natural resources and pecuniary exigency the up-gradation and launch more new power plant paramount abridgement. The reason behind rising energy cost is negative usage of energy and unawareness of optimization of energy usages. The consequence results, the power plants do not provide the demand of power within the capacity of power station. Although Bangladesh government continuously trying to increase its capacity by installing new power plants and the overall settled electricity production retention tumid 20,000MW in energy sector. Especially the comprehensive power clients in Bangladesh are industries, residential sectors followed by commercial and agricultural sectors. Despite of having the limitation of power generation and increased demand the negligent use of heavy home appliances causes more impact on power grid. On our daily basis, we mostly repose the lights, fans and other electric household appliances on while it is no use or nobody is in the apartment. Indeed, sometimes we are in a hurry or sometime our inadvertency causes this wastage of energy. Whatever the condition is as a consequence the energy consumption requirement amplifies. To summaries, eliminate this entire residence problem this project shows a way out of this situation which save unnecessary energy consumption by the efficient use of home useable devices and appliances.

3.2 GENERAL BLOCK DIAGRAM

The block diagram of an IOT smart home automation system is seen in the figure 3.1. Several types of sensors are used inside the home, such as smoke detectors, gas detectors, temperature sensors, and ultrasonic sensors, all of which are attached directly to the microcontroller in this block diagram. The relay circuit links all of the equipment to the controller. Any specific loads are operated by green solar energy with a 12V DC battery, and when critical peak prices are high, suggested appliances can be used by this fuel. This prototype can be powered by either solar energy or the regular grid. The most critical feature of this test system is that it is internet-based, which ensures that the whole system can be regulated, tracked, and operated from anywhere in the world as it is connected to the internet.

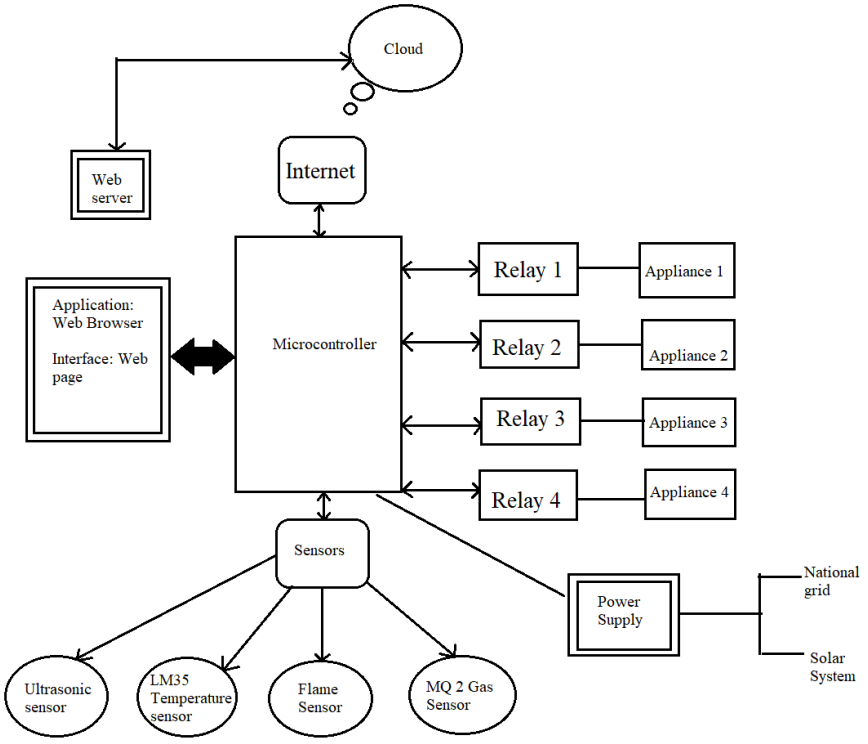

Figure 3.1: General block diagram

3.3 HARDWARE IMPLEMENTATION

3.3.1 Esp32

It is a less-cost, little power system on a chip microcontroller with included Wi-Fi and dual mode Bluetooth. The ESP32 is the project's brains. It's a microcontroller board that connects all of the sensors together. The board is coded with the source code to carry out the project's operations. On the ESP32, the source code is contained in the on-chip memory. This block acts as a conduit between the programmer and the end user. As a result, it is regarded as the project's nucleus. The operating voltage spectrum for the ESP32 is 2.2 to 3.6V. In regular operation, the ESP32 unit can supply 3.3V to the chip. The WiFi module on the ESP32 is built-in. This allows mobile users to submit instructions. The pin description of ESP32 is shown in figure 3.2.

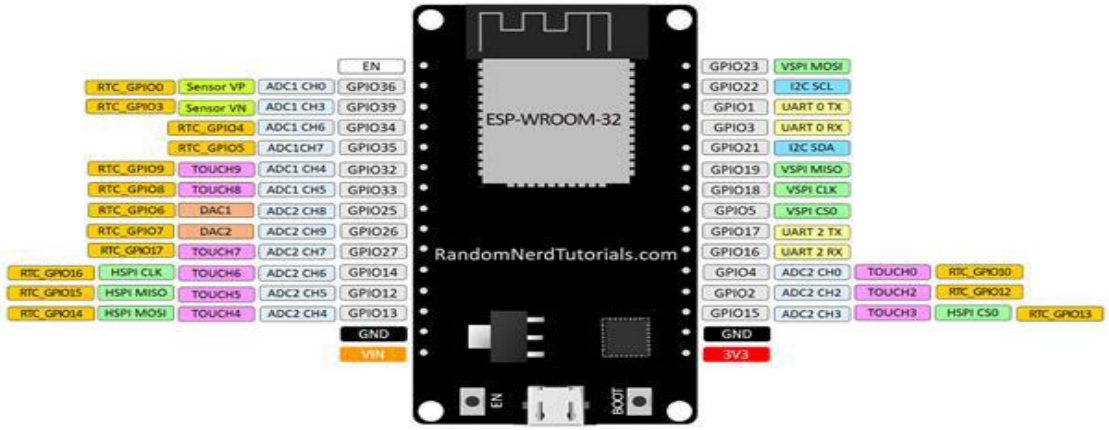

Figure 3.2: ESP32 Microcontroller

Features of the ESP32 include the following:

- Processors:
  - CPU: Xtensa dual-core (or single-core) 32-bit LX6 microprocessor, operating at 160 or 240 MHz and performing at up to 600 DIMPS
  - Ultra low power (ULP) co-processor
- Memory: 520 KiB SRAM
- Wireless connectivity:

- Wi-Fi: 802.11 b/g/n
- Bluetooth: v4.2 BR/EDR and BLE (shares the radio with Wi-Fi)

- Security:
  - IEEE 802.11 standard security features all supported, including WFA, WPA/WPA2 and WAPI
  - Secure boot
  - Flash encryption
  - 1024-bit OTP, up to 768-bit for customers
- Power management:
  - Internal low-dropout regulator
  - Individual power domain for RTC
  - 5 µA deep sleep current
  - Wake up from GPIO interrupt, timer, ADC measurements, capacitive touch sensor interrupt

3.3.2 Relay Module

In this project relay is an important component and which is employed to control high voltage home appliances. To power two appliances, we used a 5V two-channel relay. There are two governing inputs, VCC and GND, as well as four outputs. The relay's outputs are linked to two appliances, which are controlled by control inputs connected to two ESP32 digital output pins. Depending on our needs, we can use a 4 channel, 8 channel , or 16 channel relay module. A relay is an electromagnetic device that is used to electrically separate and attractively connect two circuits. They are useful devices that allow one circuit to switch to another while staying fully discrete. They are frequently used to interface an electronic circuit (working at a low voltage) to an electrical circuit which works at exceptionally high voltage. For instance, a relay can make a 5V DC battery circuit to switch a 220V AC mains circuit. In this manner a little sensor circuit can drive, say, a fan or an electric bulb.

The input and output parts of a relay switch can be isolated. When a small voltage from an electrical circuit is applied to the input part, it generates a magnetic field. Functional voltage is the name assigned to this voltage. Typical transfers come in a variety of operating voltage designs, including 6V, 9V, 12V, 24V, and so on. Contactors that interface or disconnect specifically make up the output portion. There are three contactors in a basic hand-off: normally

open (NO), normally close (NC), and normally open (NO) (COM). The COM is correlated with NC when there is no input state. At the point when the working voltage is connected the relay coil gets empowered and the COM changes contact to NO. Different relay arrangements are accessible like SPST, SPDT, DPDT and so forth, which have distinctive number of changeover contacts.

Figure 3.3: Two channel Relay Module.

3.3.3 Flame Sensor

A sensor which is most sensitive to a normal light is known as a flame sensor. This is why blaze detectors use this sensor module. This sensor senses flame if the light source emits a wavelength between 760 nm and 1100 nm. When exposed to high temperatures, this sensor is easily damaged. As a result, this sensor may be positioned a set distance away from the blaze. The flame detection can be achieved from a distance of 100cm with a detection angle of 600 degrees. This sensor's display is either an analog or a digital signal. These sensors are used as a blaze detector in firefighting robots. This sensor/detector can be made with an electronic circuit and an electromagnetic radiation receiver. The infrared flame flash system is

used in this sensor, which enables it to operate through a layer of oil, ashes, water vapor, or frost. This sensor's pin configuration is seen below. It comes with four sticks, including the following. When this module works with a microcontroller unit then the pins are

- Pin1 (AOUT): This is an analog output pin (MCU.IO)
- Pin2 (GND): This is a ground pin
- Pin3 (VCC pin): Voltage supply rages from 3.3V to 5.3V
- Pin4 (DOUT): This is a digital output pin (MCU.IO)

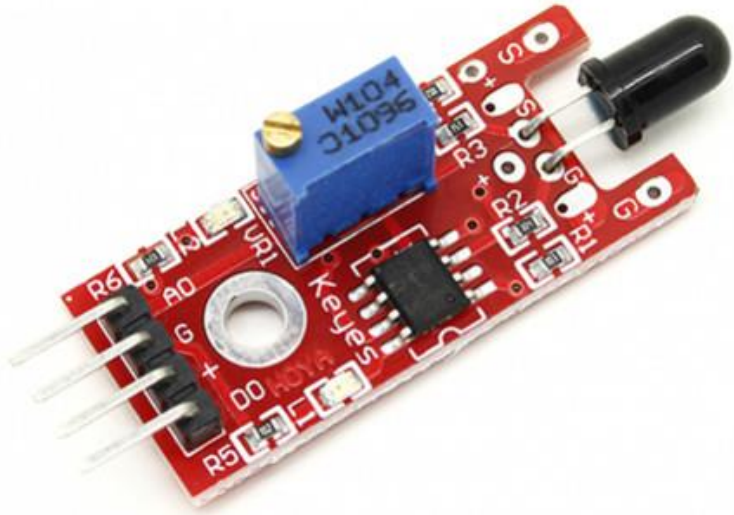

Figure 3.4: Flame Sensor.

3.3.4 MQ 2 Gas Sensor

For the gas leakage identification, this MQ2 gas sensor is used in home and industrial sides. Due to its high sensitivity and fast response, measurement can be done as soon as possible. Its sensitivity can be adjusted by potentiometer. Gases like Hydrogen, Carbon Mono-oxide, Hydro carbon, Fuel gases and smoke can be easily detected by this sensor. The wide detecting scope, higher sensitivity and long life time stability features make this sensor widely used in different professional and home sectors. In this project, this gas sensor is used to

identify the gas leakage in a room at home so that it can send alert via wireless connection to the user. A buzzer is connected to notify the alert to the user or home living people.

Figure 3.5: MQ 2 gas sensor.

3.3.5 Push Button

A push-button simply button is a simple switch mechanism to control some aspect of a machine or a process. Buttons are typically made out of hard material, usually plastic or metal. The surface is usually flat or shaped to accommodate the human finger or hand, so as to be easily depressed or pushed. Buttons are most often biased switches, although many un-biased buttons (due to their physical nature) still require a spring to return to their un-pushed state. Terms for the "pushing" of a button include pressing, depressing, mashing, slapping, hitting, and punching.

Figure 3.6: Push button.

3.3.6 Arduino Uno R3

The Arduino UNO R3 is a popular microcontroller board in the Arduino family. This is the third edition of an Arduino module, which was introduced in 2011. The biggest benefit of this board is that we can replace the microcontroller if we make an error. This board's key features include DIP (dual-inline-package) availability, detachability, and an ATmega328 microcontroller. This board's programming can be quickly loaded with an Arduino computer application. This board has a lot of help from the Arduino network, so it'll be a pretty easy way to get started with embedded electronics and a lot of other stuff. The Arduino Uno R3 is a microcontroller board based on the ATmega328P. It comes with everything you need to support the microcontroller; all you have to do is plug it into a PC via USB and power it up with an AC-DC adapter or a battery to get started. The pin diagram for the Arduino Uno R3 is shown below. It has 14 I/O pins with 14 digits. From these pins , 6-pins can be utilized like PWM outputs. This board includes 14 digital input/output pins, Analog inputs-6, a USB connection, quartz crystal-16 MHz, a power jack, a USB connection, resonator-16Mhz, a power jack, an ICSP header an RST button.

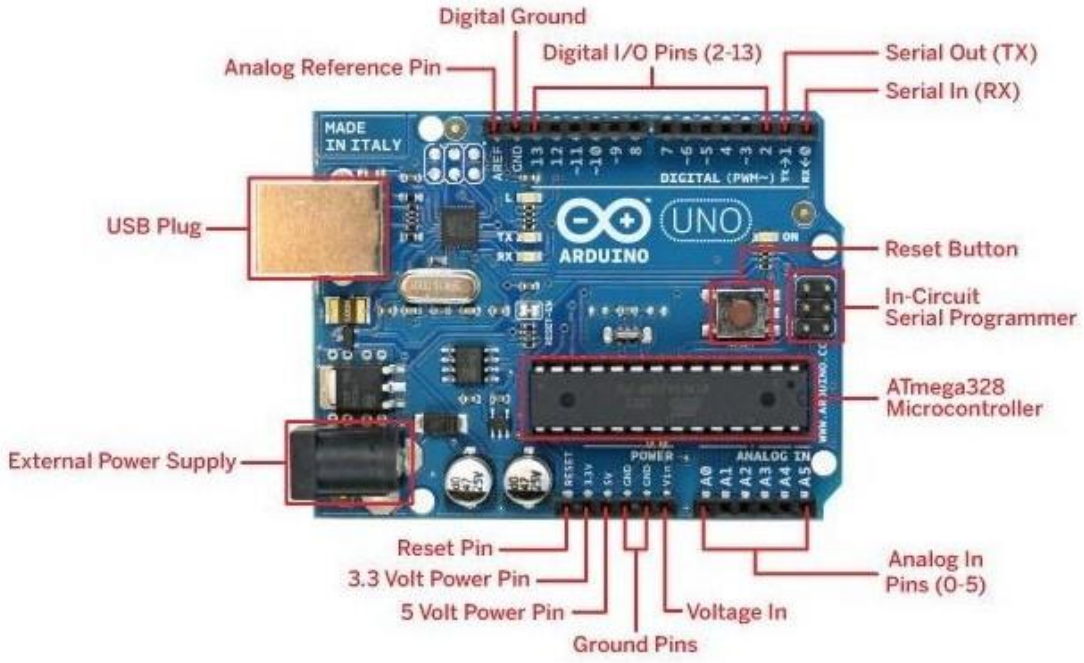

Figure 3.7: Arduino UNO R3 Microcontroller.

3.3.7 LM 35 Temperature Sensor

The LM35 is a temperature sensor that is linear and monolithic. The temperature operational range is sufficient for a home setting. VCC, OUTPUT, and GND are the three terminals on the LM 35. The output voltage of the sensor is 10 mV for a one degree increase in temperature. The sensor's sensitivity is linearly calibrated in degrees Celsius. The pins of LM35 as shown in figure 3.8.

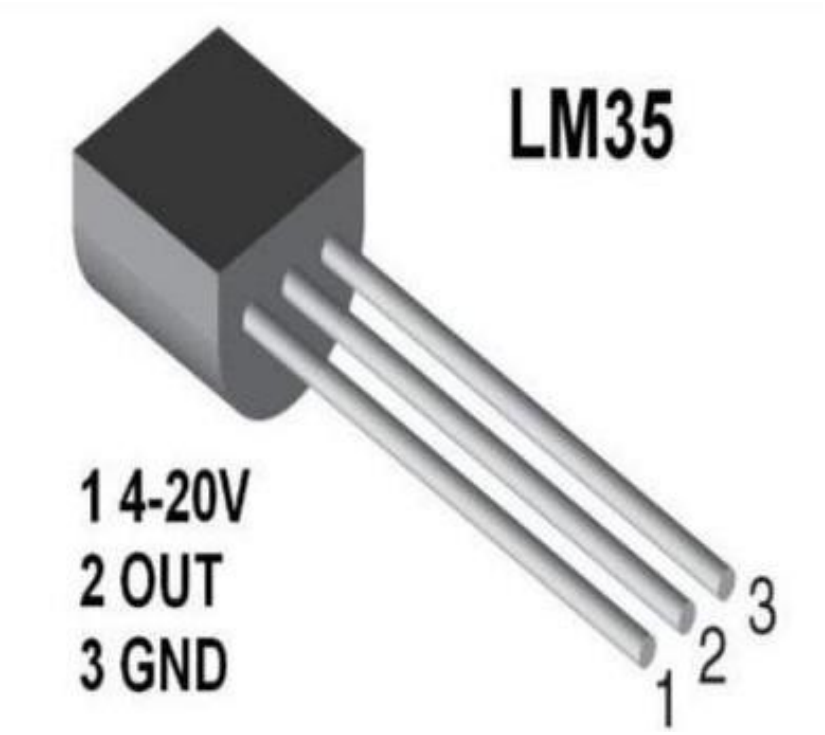

Figure 3.8: LM 35 Temperature sensor

3.3.8 16x2 LCD

In embedded device implementations, LCDs (Liquid Crystal Displays) are used to monitor different system parameters and status. The LCD 16x2 is a 16-pin unit that has two rows of 16 characters each. The LCD 16x2 will operate in either 4-bit or 8-bit mode. Custom characters can be developed as well. It has eight data lines and three control lines for control purposes.

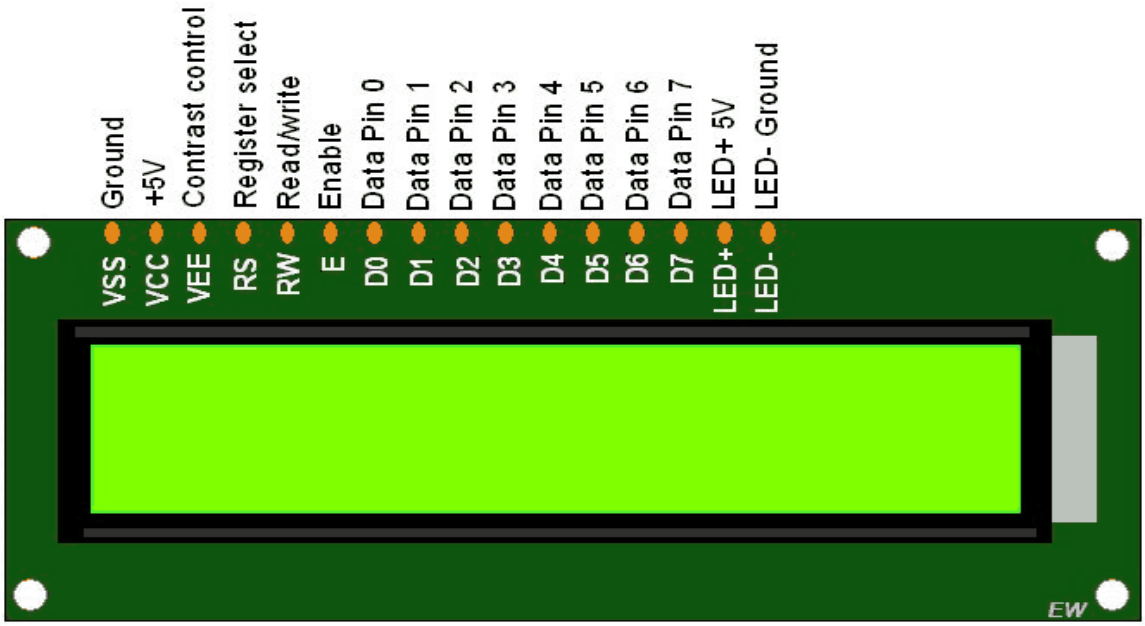

Figure 3.9: 16*2 LCD.

3.3.9 12V DC Fan

The direct current fans, or DC fans, are powered with a potential of fixed value such as the voltage of a battery. Typical voltage values for DC fans are, 5V, 12V, 24V and 48V. In contrast, the alternating current fans, or AC fans, are powered with a changing voltage of positive and of equal negative value.

Fig 3.10: 12V DC Fan.

3.3.10 1N4007 Diode

A 1N4007 is a widely used general purpose diode. It is normally build to use as rectifier in the power supplies section of electronic appliances for converting AC voltage to DC with other filter capacitors. The 1N4007 diode is built for working with high voltages and it can easily handle voltage below 1000V.

3.3.11 IRFZ44N Transistor:

The IRFZ44N is a N-channel MOSFET with a high drain current of 49A and low Rds value of 17.5 mΩ. It also has a low threshold voltage of 4V at which the MOSFET will start conducting. Hence it is commonly used with microcontrollers to drive with 5V.

3.3.12 Ultrasonic Sensor

We will use an ultrasonic sensor in our project. An ultrasonic sensor is a device that uses sound waves to calculate the distance between two objects. It determines distance by transmitting a sound wave at a certain frequency and tuning in for the sound wave to return. Understand that ultrasonic sensors would most likely miss a few things. In figure 3.11 we can see a ultrasonic sensor. It has four pins. They are Vcc, trigger, echo and GND pin.

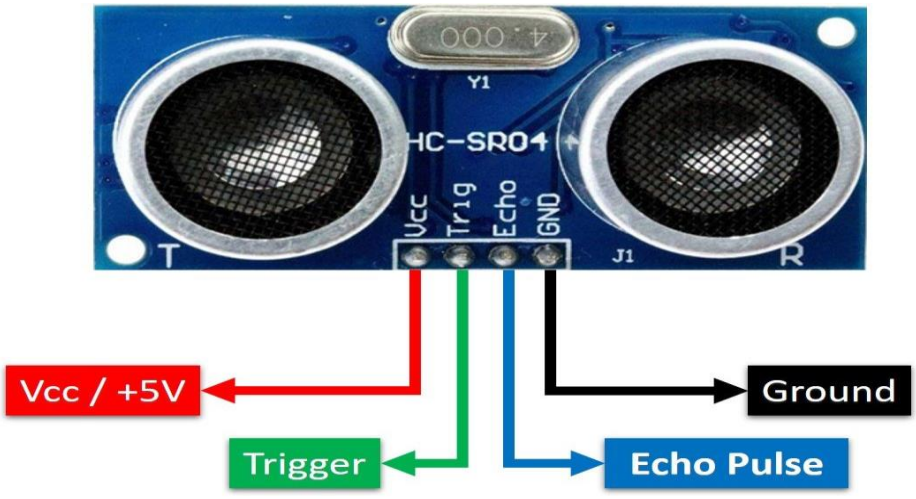

Figure 3.11: Ultrasonic Sensor.

Ultrasonic Sensor Pin Configuration

Pin Number	Pin Name	Description
1	Vcc	The Vcc pin powers the sensor, typically with +5V
2	Trigger	Trigger pin is an Input pin. This pin has to be kept high for 10us to initialize measurement by sending US wave.
3	Echo	Echo pin is an Output pin. This pin goes high for a period of time which will be equal to the time taken for the US wave to return back to the sensor.
4	Ground	This pin is connected to the Ground of the system.

3.4 SOFTWARE

3.4.1 Arduino IDE for Controller and ESP Programming

The Arduino Integrated Programming Environment (IDE), also known as the Arduino Program (IDE), includes a content manager for writing code, a message field, a content comfort, a toolbar with buttons for basic features, and a set of menus. It connects to Arduino and Genuine equipment to transfer and communicate programs. Projects composed utilizing Arduino Software (IDE) is called outlines. These representations are written in the word processor and are spared with the record augmentation. Cutting/gluing and looking/supplanting content are two areas that the editorial manager excels. The message territory criticizes when sparing and sending out messages, as well as showing errors. The convenience displays content created by the Arduino Program (IDE), such as total error messages and other data. The designed board and 35 sequential ports are visible in the bottom right-hand corner of the window. The toolbar catches enable you to confirm and transfer programs, make, open, and spare portrays, and open the sequential screen [8].

3.4.2 BLYNK application

Blynk is a modern framework that lets you easily develop interfaces to manage and track our hardware projects from our iOS or Android phone. We can create a project dashboard after downloading the blynk app and arranging buttons, sliders, graphs, and other widgets on the screen. We may use the widgets to switch pins on and off, as well as show data from sensors.

3.5 PROJECT FEATURES

3.5.1. Appliance Control from Remote Area

It is a method of controlling lights or home appliances with Blynk using WiFi using an ESP32 development board. Blynk is an iOS and Android application for managing Arduino, Raspberry Pi, and other Internet-connected computers. It's a digital dashboard where we can drag and drop widgets to create a visual interface for our project. It can connect to the Internet through Wi-Fi, Ethernet, or Bluetooth as well.For this Download blynk apps from Play Store or App Store.After download is done, open the apps and create an account. If you already create an account, we may log in. After you successful create an account, start by creating a new project. Build a project name, then pick the ESP32 Dev Board as the system and WiFi as the connection type. After pressing the "Build" button, a window named "Auth token was sent to..." may appear. We can verify our identification key by opening our account. Then, to open the widget box, press anywhere on the canvas. This is where we will find all of the available widgets. Select a tab now. To adjust the environment, tap on the widget. Set the LED pin to Digital- gp21 and switch the mode. Click the PLAY button when we are through with the settings. This will switch you from EDIT mode to PLAY mode where we can interact with the hardware. While in PLAY mode, we would not be able to drag or set up new widgets, press STOP and get back to EDIT mode.

3.5.2. Fire and Gas Detection Alarm

Method of detecting gas leakage becomes a problem after discovering the impacts of damaging gases on human welfare. A gas detector is a system that senses the presence of gases in the environment. Specifically, this equipment aids in the detection of flammable gas leaks and provides a warning to alert the consumer [9]. This gadget sends an alert to the owner over the internet using the blynk program, giving them the opportunity to quit or take action. The system by which sensors detect potentially dangerous gas leaks is known as gas leak detection. When a toxic gas is detected, these sensors typically emit an audible alert. A smoke detector is a smoke sensing device that is commonly used as a fire alarm. Protection systems transmit a signal to a fire alarm as part of a fire alarm scheme, while residential gas detectors, commonly known as smoke alarms, send a signal to a fire alarm. Responsive detectors can be used to track and discourage smoking in areas. The chance of dying in a house fire is cut in half in homes with functioning smoke detectors. Some homes do not have smoke detectors, so this method may assist in taking precautions. We used a gas detector or smoke detector alarm attached to an ESP32 to assess the presence of gas and smoke, and to provide a safety alert to the customer.

3.5.3 Automatic Fan Speed Control

In this arduino based project, we are going to build a temperature-controlled fan using Arduino**.** We would be able to alter the fan speed in our home or office based on the room temperature and view the temperature and fan speed adjustments on a 16x2 LCD display with this circuit. We'll use an Arduino UNO board, LCD, LM35 sensor module, and DC fan to accomplish this. This temperature-controlled fan circuit has very basic connections, and a liquid crystal display is used to display the temperature and fan speed status. In this circuit, we'll change the fan speed depending on the ambient temperature. If the temperature increases above a certain amount, the fan speed adjusts automatically; otherwise, the fan stays turned OFF below that point. This threshold temperature value can be set by adjusting the Variable resistor in the circuit, according to requirement.

3.5.4 Automatic Light Control

Automatic light of smart home is very simple, helpful and safe also important because of its energy efficiency and smartness. The automatic light is used to switch ON or OFF in response to the presence of a human. As anyone enters a room, the device immediately switches on the light, and when no one is present in a certain part of the room, the system turns off the light. The ultrasonic sensor acts as a detector, sending information to the control unit in response to an open or close command. The Arduino is the system's main control panel, or brain, which controls the system's opening and closing commands as well as keeping time by sensing human presence through the ultrasonic sensor. Automatic lighting reduces energy demand while still saving money [10]. Unnecessary energy usage in an empty space results in unnecessary costs, and lighting power consumption in a normal home is often a consideration that cannot be overlooked. Any situations arise in which the consumer forgets to switch OFF the lamps, and this intentional factor is one of the prime causes of excessive energy consumption. The automatic control mechanism requires the light to be turned ON or OFF depending on the presence of a human in the room. It's an energy-saving and security-enhancing automatic light control system. The controlling system composes our daily life easier, comfortable and save extra inessential waste of energy consumption. Therefore, we develop a system which optimize in such an affordable and efficient way to conserve energy. Because of having automation system technique of powering ON/OFF by detecting persons presence makes the home smarter and efficient. For this, the person does not need to have any switch or button to turn ON/OFF the lights. So, it helps the person to move easily without hesitation and does not have to keep in mind whether the room light is turned ON or OFF left behind. For this system design we used ultrasonic sensor through Arduino which detect the person and then allow which light should get to turn on/off. Ultrasonic sensor which detects the presence of person at a certain range and depending on the range it send information of its control unit to turn on the specific light within the range. Then the control unit known as Arduino collects the information from the sensor of specific range and command to turn ON the light in that specific range. If the person passes the range and enters into another range the control unit turn OFF the previous light and turn on new range light.

3.6 CIRCUIT DIAGRAMS

We have used thinkercad simulation software to draw the circuit diagrams and to implement simulation .Circuit diagrams of the systems are given below.

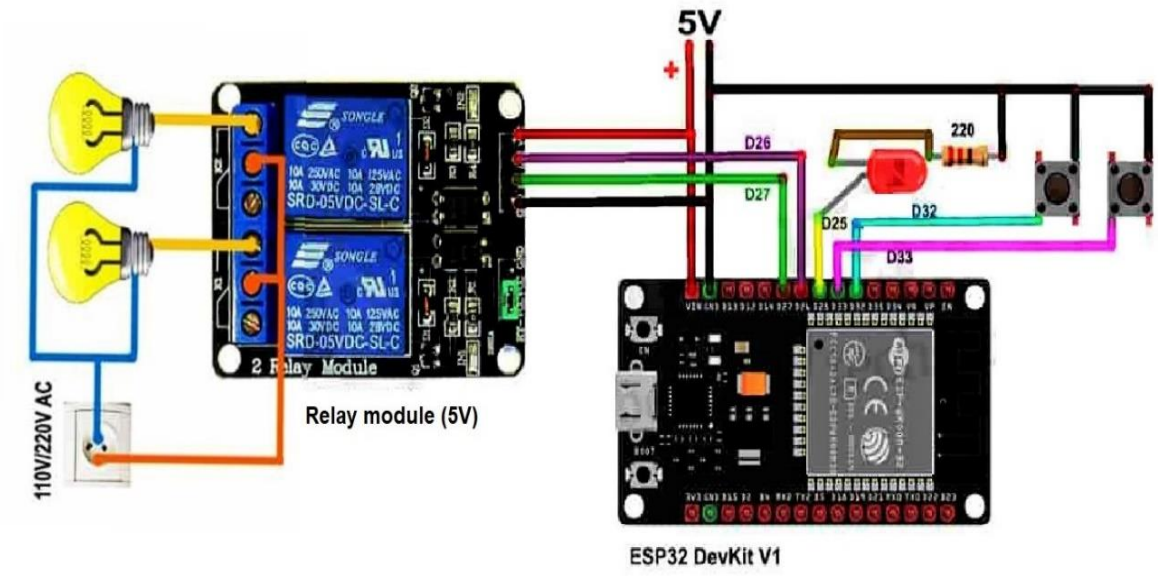

Figure 3.12: Circuit diagram of remote appliance control.

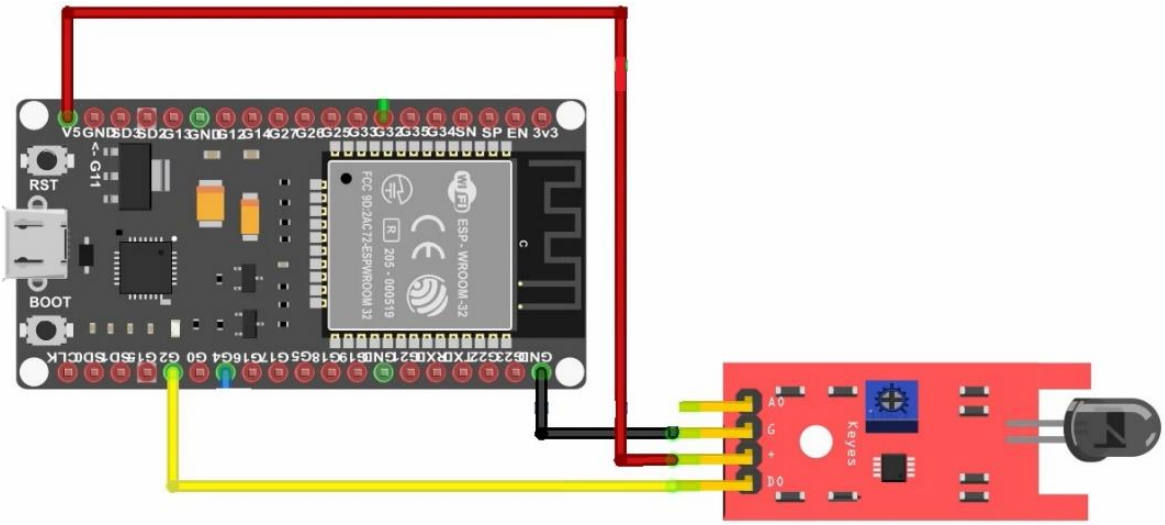

Figure 3.13: Circuit diagram of Fire detection alarm.

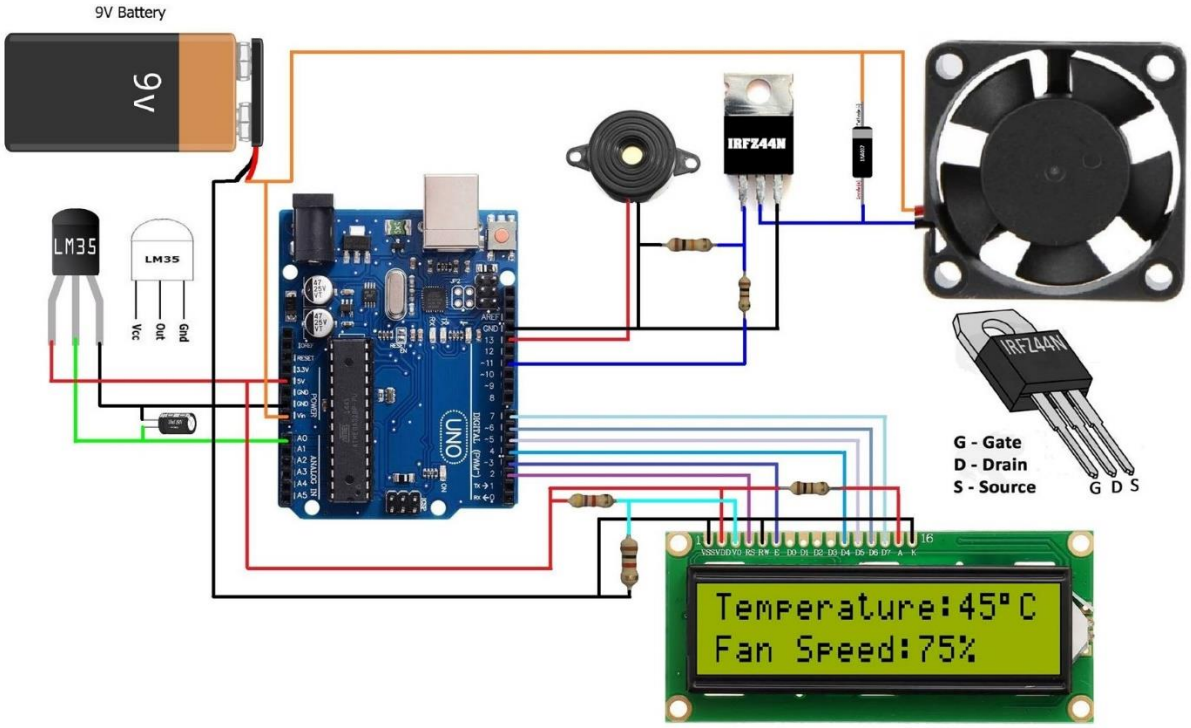

Figure 3.14: Circuit diagram of Automatic fan speed control.

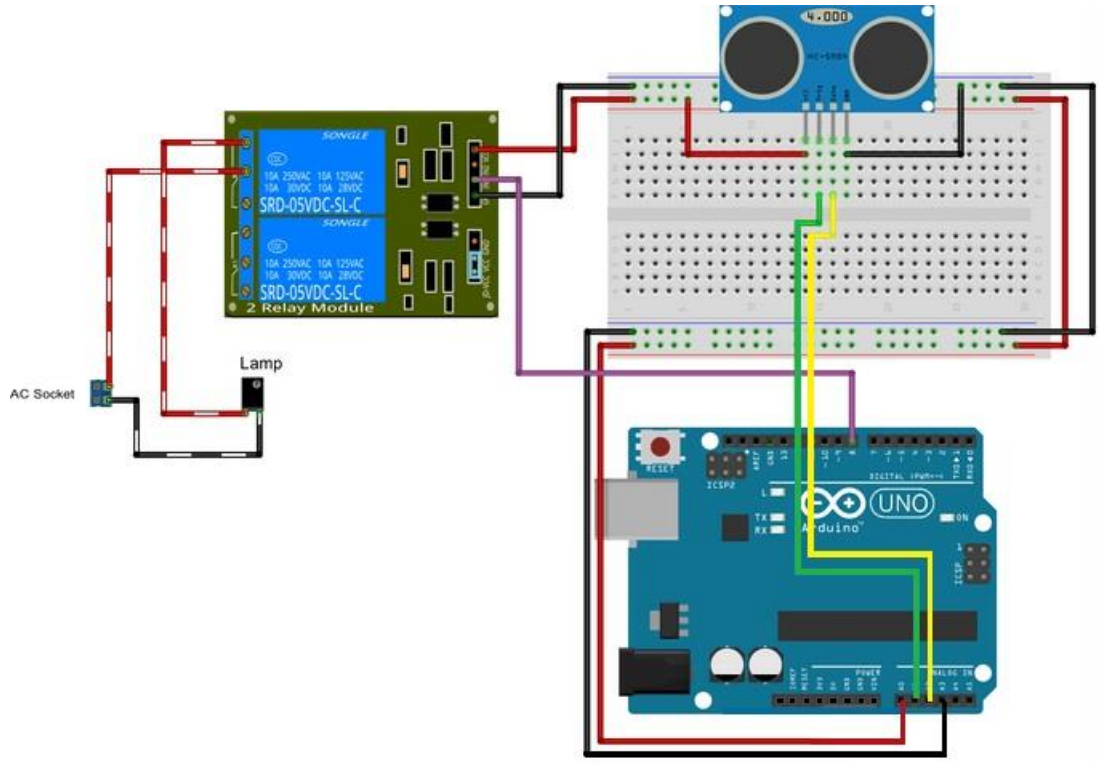

Figure 3.15: Circuit diagram of Automatic light control.

3.7 PROTOCOLS

3.7.1 Transmission Control Protocol (TCP)

The Transmission Control Protocol (TCP) is a transport layer protocol for data segmentation and reassembly, multiplexing, access control, data flow, and data error control. Segments are the data units in this sheet. A port address and sequence number are allocated to the data unit to monitor the flow of segments.

3.7.2 Internet Protocol (IP)

The Internet Protocol (IP) is a set of rules and conventions that regulate the exchange of digital data between a large number of devices connecting to the internet by assigning IP addresses to each of them. This is the Network layer protocol, and packets are the data units at this layer. As a result, in order to exchange packets between the exact sender and recipient, each system requires a specific IP address, which is assigned by internet service providers (ISPs) and administered by the Internet Engineering Task Force (IETF). An IP address is created by 32-bit long binary number and written in four dotted decimal notations. For example, here 192. 168. 12.1 each decimal is represented by 8 bits [11].

3.7.3 MQTT

MQTT (Message Queue Telemetry Transport) is a publish-subscribe messaging protocol widely used in IoT applications. This protocol's goal is to transmit data between devices that have limited network bandwidth and authority. It is strongly recommended for microcontroller projects that transfer data over the internet.

MQTT Working Process

It's a binary-based protocol that interacts with a "broker" server to deliver messages to customers based on a particular "topic." Initially, the publisher sends the broker content, which is then read by the subscribers. A standard MQTT connection includes a host name, port, customer identity, username, and password.

MQTT Messages Type

• Connect: Waits to make a connection with the server and generates a connection between the nodes.

• Disconnect: Prepares for the MQTT client to complete any job they need to do and to disconnect the TCP / IP session.

• Publish: Arrives to the application thread promptly after the request is transferred to the MQTT customer.

MQTT is the best for IoT because with M2 M communication, neither HTTP nor Web socket have been intended specifically.

CHAPTER 4

TESTING & MAINTENANCE

4.1 INTRODUCTION

Systems are error-prone. Big systems have lots of errors. The Internet-of-Things poses us one of the biggest and widespread systems, where errors directly impact people's lives. Testing and maintenance is how one deals with errors; but testing and maintaining a planetary-scale, heterogeneous, and ever growing ecosystem has its own challenges and idiosyncrasies. As of today, the solutions available for testing these systems are insufficient and fragmentary.

4.2 CODING MAINTENANCE OF DIALECT USED

When composing code we are continually making changes, including usefulness that we require or fair expelling the one we don't require any longer. Learning a programming dialect and knowing how the calculations work can be troublesome but composing clean code is frequently indeed more complicated. Clean code is a collection of concepts that aim to render code:

- Readable Reading
- Maintainable Inside
- Extendable

We need to understand the features offered by the correct language in order to write pythonic code, features that enable us to easily understand and improve readability as well. Some of the features we can use to accomplish this are Decorators, Managers of context, Dunder approaches.

- **Decorators**: Decorators can offer assistance us to maintain a strategic distance from duplication and partitioned rationale in little reusable pieces.
- **Managers of Context**: Context managers help us work with those tasks that include conditions before and after a task is done, such as reading or writing files, opening them before they are processed, and closing them until they are no longer required.
- **Dunder approaches**: Dunder Strategies or Enchantment Strategies offer assistance us to compose way better our code, improving the classes so that the code remains basic and justifiable but with higher usefulness.

4.3 CODING STANDARDS OF USED LANGUAGE

Coding Standards used in the whole project are given below

- Begin with a set of comments clearly describing the purpose and assumptions of the code.
- Import any required library headers.
- Define constants.
- Define global variables.
- Define setup() and loop().
- Braces are used even when the body is empty or contains a single statement.
- Two space indentation.
- Column limit can be 80 or 100 characters.
- C-style array declarations. .
- Function name should start with lowercase letter.
- Define subroutines (functions).
- Use the loop() function as an event-loop, i.e., allow it to exit and be iterated, rather than capturing control within it.
- Invoke all one-time activity from setup(), possibly by calling subroutines.
- Keep functions short.
- Avoid preprocessor directives wherever possible.
- Constants should generally be all uppercase.

- Names should generally be longer than a single character.
- Specify units in the comments wherever relevant (e.g. microseconds, Volts).
- Local non-static variables are preferred to global variables wherever possible.

4.4 TEST PLAN

A project plan is a text that outlines the scope, strategy, tools, and timetable of the project activities to be conducted. It lists test items, features to be checked, testing assignments, who will execute each task, and any risks that necessitate contingency planning. In project testing, a test plan gives detailed testing information regarding an upcoming testing effort, including:

- Scope of testing
- Schedule
- Test Deliverables
- Release Criteria

That's often referred to as a summary of how the testing will take place, who will administer it, what will be measured, how long the test will take, and to what standard degree the test will be done. The method of identifying a project in order to evaluate and manage it properly. The test preparation process results in a high-level test plan document that describes the program products to be evaluated, the degree of tester freedom, the test setting, the test case configuration and test measurement methods to be used, and the reasoning behind their use.

4.5 TESTING LEVELS AND METHODS

Testing approaches can be in one or more levels, depending on the scope of the test and objective. So, different test levels are defined, as follows [12]:

- **Unit Testing:** Testing of individual hardware or software units or groups of related units [13]. It consists on isolating each part of the system and show that individual parts fit its requirements and functionalities.
- **Integration Testing:** Software and/or hardware components are combined and tested to check the interaction between them and how they perform together [13].
- **System Testing:** Testing a complete, integrated system to check the system's compliance and behavior within the specified requirements [13].
- **Acceptance Testing:** Formal testing conducted to determine whether or not a system satisfies its acceptance criteria and to enable a customer, a user, or other authorized entity to determine whether or not to accept the system [13]. Different methods can be used to test the system under test (SUT), namely, white-box testing [14], gray-box testing and black-box testing [15] [16]. These methods are hereby described:
- **White-box Testing:** The internals of the SUT are all visible and known, and, as such, this information can be used to create test scenarios. Additionally, white-box testing is not restricted to failure detection, but is also able to detect errors.
- **Black-box Testing:** The SUT internal content is hidden, and only knowledge about the system's or module's inputs and outputs is known, being closer to real-world use situations.
- **Gray-box Testing:** A mix of the two previous techniques is used. Information about the internals of the SUT is used, but, however, tests are conducted under realistic conditions, where only failures are detected.

4.6 TESTING THE INTERNET-OF-THINGS

IoT systems are complex by nature, depending on different software and hardware components, modules and architectures, produced by many manufacturers and with different working properties. As such, diverse needs of testing appear in result of the different variables that need to be tested. One can identify various challenges, as, for example, the high-heterogeneity, large-scale, dynamic environment, realtime needs, security and privacy implications and the difficult on test automation. Hence, different testing needs appear from the different IoT layers.

- **Edge Testing**: Concerns about testing the more low-level parts of IoT system's, like micro-controllers (e.g. Arduino) and programmable logic controllers (PLC). Testing approaches like embedded system testing can be typically used to perform tests on the edge layer, asserting the edge devices against their specification .

- **Fog Testing**: Tests regarding the middle-point layer on IoT system's, normally composed of gateways. Software testing approaches can be seamlessly applied since the devices that belong to this layer have, typically, a comfortable amount of computing power and memory, running full operating systems. Additionally, since this is the connectivity-enabler layer, connecting the restraint devices and the Internet per se, it should cover network testing and security testing [17][18].

- **Cloud Testing**: Cloud testing addresses the need of test the unique quality concerns of the cloud infrastructure such as massive scalability and dynamic configuration. This field have open-challenges and issues of its own, and they are extensively analyzed in the literature [19].

4.7 INTERNET OF THINGS TESTING SOLUTIONS

As of today there are already some solutions available for testing IoT-based systems. These solutions focus different IoT layers and enabling technologies. The tools have been selected after a curated search on scholar database (Scopus) and Google search engine, and are shortly described in the following paragraphs.

PlatformIO: It is a cross platform code builder and library manager, supporting nearly 200 development boards and most major embedded software development platforms. It has a unit testing feature.

IoTIFY: It is an application development environment for IoT without hardware dependencies. By resorting to device virtualization, it provides a virtual lab for building embedded prototypes and a network simulation for system scaling and data generation.

FIT IoT-LAB: It is a scientific test bed for testing small wireless sensor devices and heterogeneous communicating objects built on a very large scale infrastructure, deployed around six sites in France with over 2000 sensor nodes.

ArduinoUnit: It is an unit testing framework for Arduino libraries. Being a lightweight library, developers can easily test their systems in an Arduino board, despite their low amount of resources.

MAMMotH: It is a large-scale IoT emulator, being able to emulate ten thousand devices per Virtual Machine, whose architecture presumes three distinct scenarios, namely: mobile devices connected via GPRS to a base station forming a star topology, a stand-alone wireless sensor network (WSN) connected to a base station via GPRS and constrained devices (e.g. sensors) connect to proxies, which in turn connect to the backend a large-scale IoT emulator [20].

SimIoT: It is a toolkit to achieve experimentation on dynamic and real-time multi-user submissions within an IoT scenario. The toolkit is based on the SimIC, a system that allows modelers to configure a diversity of clouds in terms of datacenter hosts and software policies wherein the desired number of users could send single or multiple requests for computational power, software resources and duration of VM virtualization [21].

Cooja Simulator: The Cooja Simulator is a emulation/simulation platform developed for the Contiki OS. It is an extensible Javabased simulator able to simulate the network, operating system and instruction set.

TOSSIM: It is a wireless sensor network simulator that was built with the specific goal to simulate TinyOS devices. Since TinyOS is event-based, it is easily translated into a simulator engine with discrete events, thus simplifying it and making it more effective [22].

iFogSim: It is a Fog Computing Simulator able to simulate edge devices, cloud data centers, and network links, and perform metrics evaluation on them. With these features, it allows investigation and comparison of resource management techniques based on QoS (Quality-of-Service) criteria.

MobIoTSim: It is a mobile IoT device simulator, developed in Android, designed to help researchers learn IoT device handling without buying real sensors, and to test and demonstrate IoT applications utilizing multiple devices.

IOTSim: It is a Cloud simulator built on top of the CloudSim system and designed to support the testing of IoT big data processing, resorting to a MapReduce approach. By inherently supporting big data systems, it facilitates the understanding and analysis of the impact and performance of IoT-based applications by researchers and commercial organizations.

DPWSim: It is a simulation toolkit to support the prototyping and development of service-oriented and event-driven IoT applications. It aims to support the OASIS standard Devices Profile for Web Services (DPWS), which, although it enables the use of web services on smart

and resource-constrained devices, reduces the scope of such a system to IoT devices that implement the referred device profile.

SimpleIoTSimulator: It is an IoT device simulator that can create test environments comprised of thousands of sen sors on a single computer. It supports many common IoT protocols and is able to learn from data of recorded packet exchanges from real servers and sensors and model the behavior of its simulated devices from such data.

MBTAAS: The Model-Based Testing as a Service allows the systematically test the IoT and data platforms. The approach resorts to a combination of model-based testing (MBT) techniques ans service oriented solutions. The solution has been tested on top of the FIWARE IoT-enabling platform [23].

4.8 TESTING SCHEDULE

This section will explain the timetable for testing.

- Specify test signals.
- Stipulate proceedings transmitted entirely by article.
- Obligatory approximation time for each research mission.
- Plan activities and test signs absolutely for testing.
- Stipulate its retro usage for each test supply.

4.9 TESTING ENVIRONMENT

Testing environment is an arrangement of software and hardware for the testing teams to perform test cases. In other words, it checks the implementation of hardware, software and network configurations. The main component to be set up for the test environment consists of:

- Framework and software
- Research results
- Front end running setting
- Client method of service
- Browser
- Hardware requires the operating system server
- Network

- Needed documentation such as reference documents/configuration guides/installation User manuals/guidebooks

4.10 MAINTENANCE PLAN

Corrective maintenance, adaptive maintenance, perfective maintenance and preventive maintenance can be enforced by the Schedule Management System.

- **Corrective Maintenance:** We will get the copy of the application from the server in the event of errors occurring in the application and hold it to correct the errors occurring. Then we'll replace the application on the server with the corrected application. As soon as we get informed, the errors will be corrected.
- **Adaptive Maintenance:** When the system has to adjust to the changing demand and environment, adaptive maintenance will be performed. This would be done to meet the user's evolving requirements.
- **Perfective Maintenance:** When the user asks any functionality to be installed, perfect maintenance will be maintained in the situation. This will be done to strengthen services in the system.
- **Preventive Maintenance:** Preventive maintenance will be introduced so that the device and its data will not be accessible by hackers or unauthorized users.

4.11 SUMMARY

The key features that differentiate IoT testing needs from the traditional systems are the heterogeneous and large-scale objects and networks. These factors lead to an increase on the complexity and difficulty of testing IoT-based solutions. As such, this project report addresses the actual state-of-threat techniques and methodology largely widespread on the software development community and the need of bringing such techniques and methodology to the IoT development scope. Then, the gaps on the current available testing solutions are aggregated by an inspection on the commercial and open source tools for testing such systems. Within this, we consider that there is a set of old-known challenges that is now influencing directly the IoT systems and that further work must be pursued on the development of testing solutions, automation procedures for testing and continuous integration features.

CHAPTER 5

RESULTS

Using the BLYNK program, we will be able to monitor appliances from anywhere using a remote appliance control device. Using the BLYNK program, we will get notifications from our fire warning alarm system for some kind of fire that occurs in our home. The speed of the fan can be adjusted based on the room temperature using a temperature-dependent fan control system. Based on the location of an individual in a certain distance location, the automatic light control mechanism will turn on/off the lights.

5.1 USER INTERFACE

We have downloaded the Blynk app from Google play store or App store. Then we have created a new project in the Blynk app. We have entered the project name and chosen the device. In this IoT project, we have used ESP32, so we have selected ESP32 Dev Board. After that Blynk have sent an Auth Token to the registered email id. The Auth Token is required while programming the ESP32. BLYNK User interface for remote appliance control can have switches for controlling appliances. In figure 5.1 there are two switches for controlling light-1 and light-2. We have created switches in the Blynk app to control the relay module. For this, we opened the project in the Blynk App, then clicked on the "+" icon on the top. Selected the Button Clicked on that button and selected the output pin V1 & Mode –> Switch. In similar way we created switch with V2 pin to control the second relay.

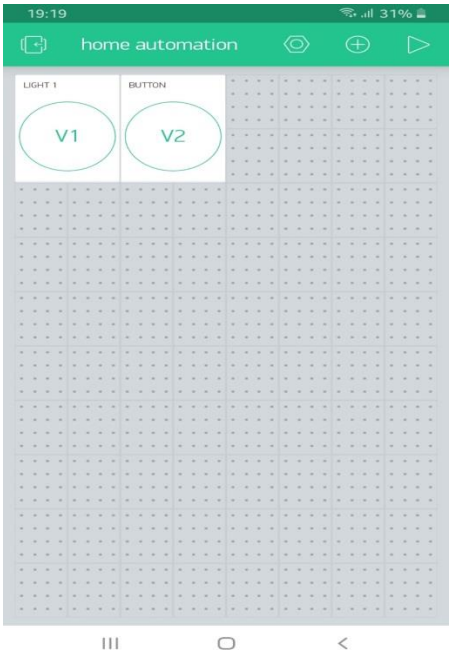

Figure 5.1: BLYNK User interface of remote appliance control

BLYNK User interface for Fire detector alarm can have a notification bar. In figure 5.2 we can see the notification bar of BLYNK user interface. If there is any fire or smoke in the house the system will notify us through this notification bar.

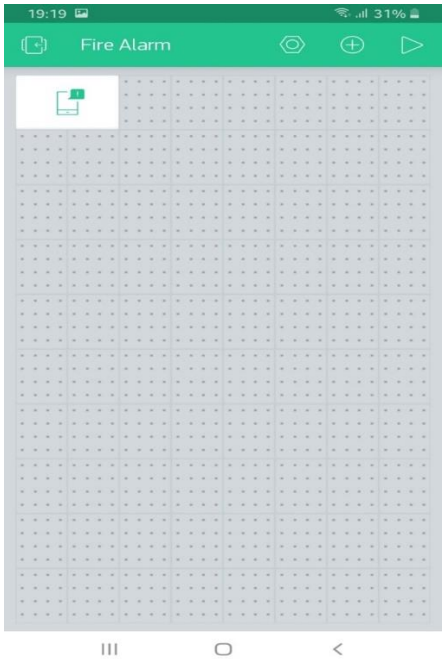

Figure 5.2: BLYNK User interface of Fire detector alarm

5.2 OUTLOOKS AND RESULTS OF THE SYSTEMS

Following are the Outlooks and results of the working systems which we developed.

5.2.1 Remote Appliance Control System

We have used an ESP32 board for remote appliance control system in home automation project using the Blynk App with real-time feedback. If there is no internet, still we can control the relay module manually. We can easily make this smart home device using the ESP32 and relay module. For this smart home project, we have installed the Blynk library before programming the ESP32 board. Then we connected the home appliances with the relay module as per the circuit diagram shown in figure 3.12. We have taken proper safety precaution while working with high voltage. When WiFi is connected then we can control the home appliances both from push buttons and the Blynk App. And we can also monitor the real time feedback of the switch on the Blynk App. When there is no internet, the ESP32 move to the "No WiFi" mode, and the Red LED will turn off.In this mode we can control the appliances from the push buttons only.When the internet comes back the ESP32 will move to "with WiFi" mode automatically, and the Red LED will turn on.

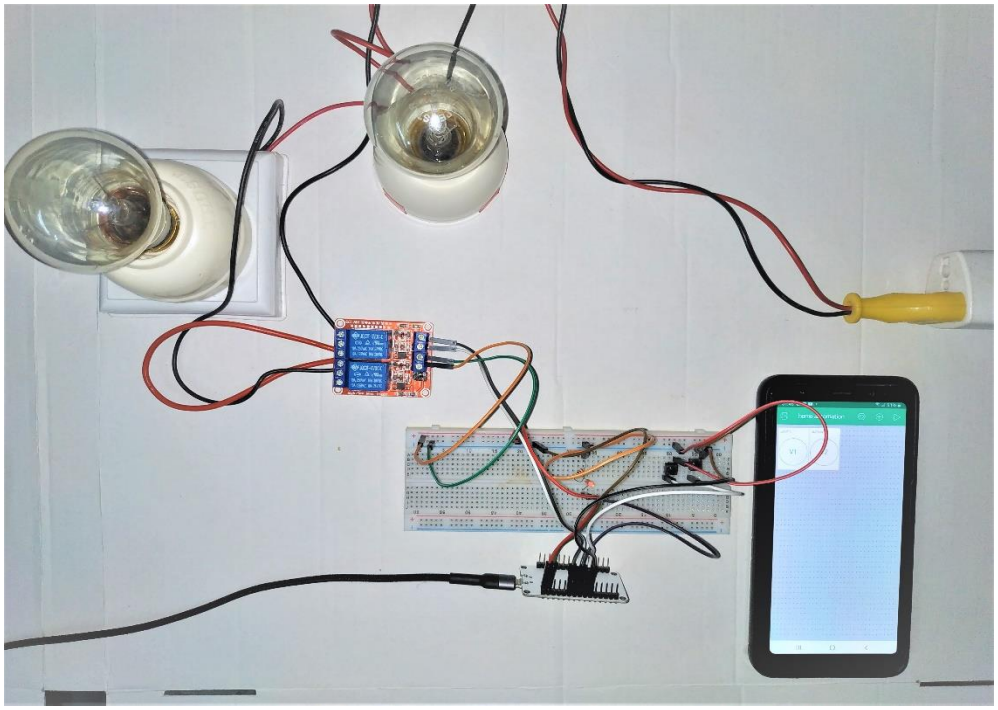

Figure 5.3: outlook of remote appliance control system.

5.2.2 Fire Detector Alarm System

This is quite obvious that we all are updated with the usage and importance of Fire alarm that how significant role it plays in every office or banks or home or in special places. This is regarding the IoT project for Fire Alarm Notification System using NodeMCU ESP32 with Blynk App. The NodeMCU ESP32 collect the information from the fire sensor and send it to Blynk App every second. NodeMCU is best known for IoT open-source platforms which added firmware that easily runs on the low cost as well. Moreover, this NodeMCU ESP32 has even included the hardware based on the ERP-12 module. This IoT based Fire Alarm System has an infrared flame sensor. We have followed these simple steps to connect the circuit like figure 3.13. First step to connect the GND pin of NodeMCU to G pin of Flame Sensor. Second step is connect the Vin pin of NodeMCU to VCC (+) pin of Flame Sensor. Last & the important step is connect D0 pin of Flame Sensor to 27 pin of NodeMCU. Then we set up the Blynk App .First of all, we downloaded the app from our smartphone. To setup the blynk application we followed some steps. We opened the app & logged with our mail ID. Created a New Project .Gave a proper project name. Then chosen Device (ESP8266 & NodeMCU). Then copied the AUTH Token which will be sent to our registered mail. We have included a "Push Notification" Widget in the app. When we press "Play" (The triangle at right up corner), the Blynk app will show NodeMCU is offline. Then we uploaded the full code at our Arduino IDE.

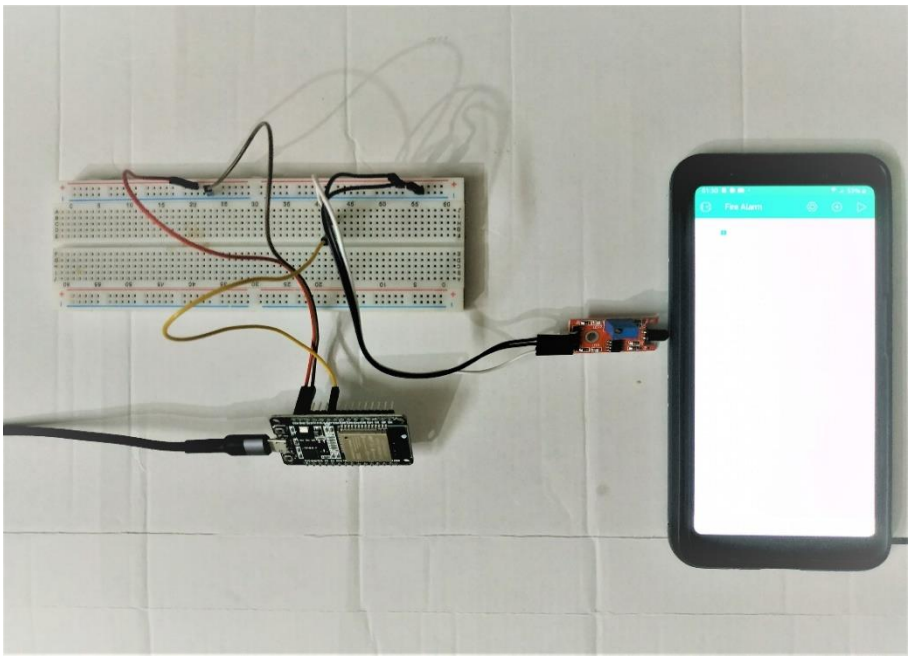

Figure 5.4: outlook of Fire detector alarm system.

5.2.3 Automatic Fan Speed Control System

We used an LCD shield to display the current temperature and speed of the fan, but we can use the circuit without the LCD display. We also need selected the transistor by the type of fan that we used. In my case I used the well-known BD139 transistor and a 9V battery to provide power to the fan and transistor. The LM35 temperature sensor and red led are powered with 5V from the Arduino board. The microcontroller controls the speed of an electric fan according to the requirement & allows dynamic and faster control and the LCD makes the system user-friendly. Sensed temperature in Celsius Scale and fan speed in percentage are simultaneously displayed on the LCD panel. Circuit diagram of the Temperature Based Fan Speed Control & Monitoring with Arduino & LM35 is shown above in fig 3.14. Arduino is at the heart of the circuit as it controls all functions. LM35 is a precision integrated-circuit whose output voltage is linearly proportional to Celsius (Centigrade) temperature. It is rated to operate over a -55°C to 150°C temperature range. It has +10.0mV/Celsius linear-scale factor. The IRFZ44N Mosfet acts as a switch and controls the fan speed depending upon temperature. 1N4007 diode controls the fan from being damaged. The LED glows whenever the temperature exceeds 60°C.Temperature sensor LM35 senses the temperature and converts it into an electrical (analog) signal, which is applied to the microcontroller of the Arduino UNO Board. The analog value is converted into a digital value. Thus the sensed values of the temperature and speed of the fan are displayed on the LCD. When the temperature exceeds 30°C the fan starts rotating. A low-frequency pulse-width modulation signal, whose duty cycle is varied to adjust the fan's speed is used.

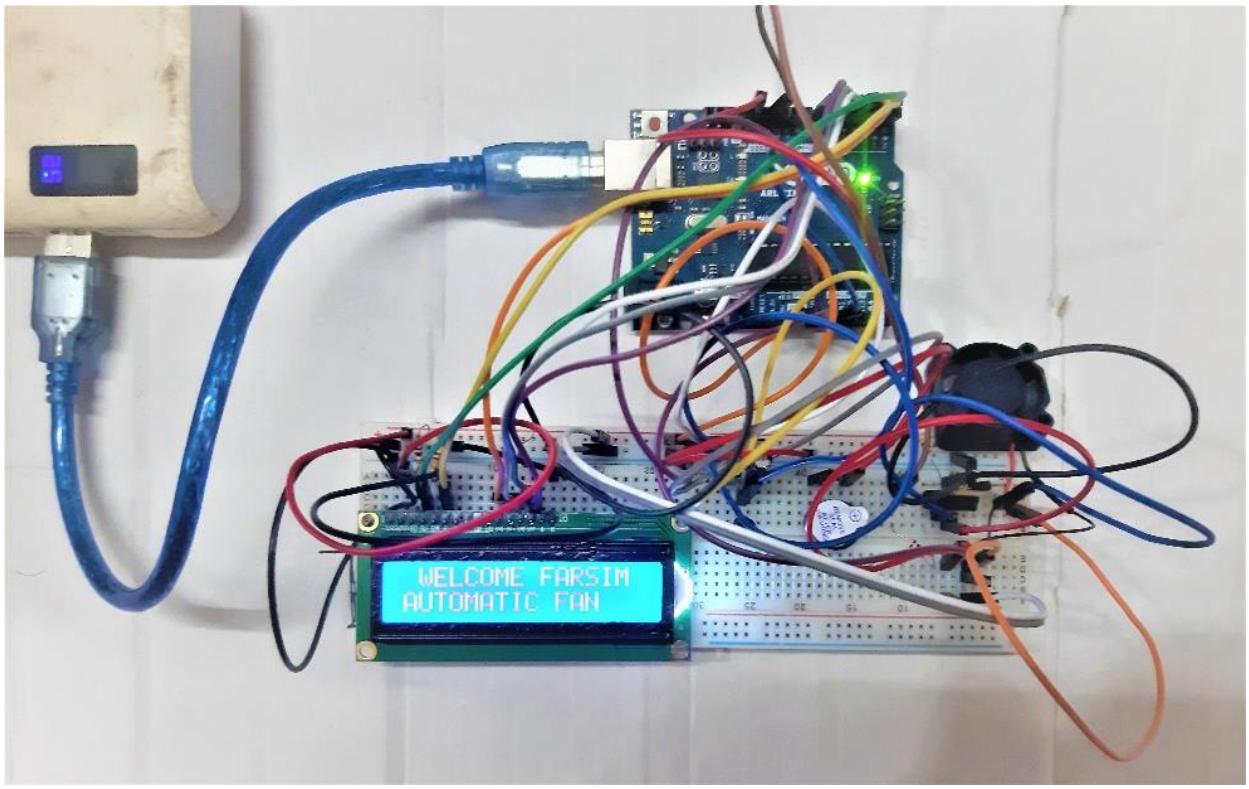

Figure 5.5: outlook of automatic fan speed control system.

5.2.4 Automatic Light Control System

In figure 5.6 we can see the outlook of automatic light control system. At first we have connected the ultrasonic sensor's Vcc pin to arduino's A0 pin and ultrasonic sensor's GND pin to arduino's A3 pin. Then we have connected. Then we have connected ultrasonic sensor's trigger pin to arduino's A1 pin and echo pin to A2 pin. Then we have connected relay module's IN1 pin to arduino's pin 7. We have joined a light source using relay modules NO and COM pin. The other end of the light source is connected to the DC current source. Then have programmed the arduino. After that we have connected the arduino to a 5V power source. Then we can see that if we put any object in front of ultrasonic sensor within 15cm, the light is in power ON mode. We can change the sensitivity range of ultrasonic sensor using program code. When there is no object in the sensitive area for 10 seconds, the light is in power OFF mode. The sensitivity time also can be changed using programming code.

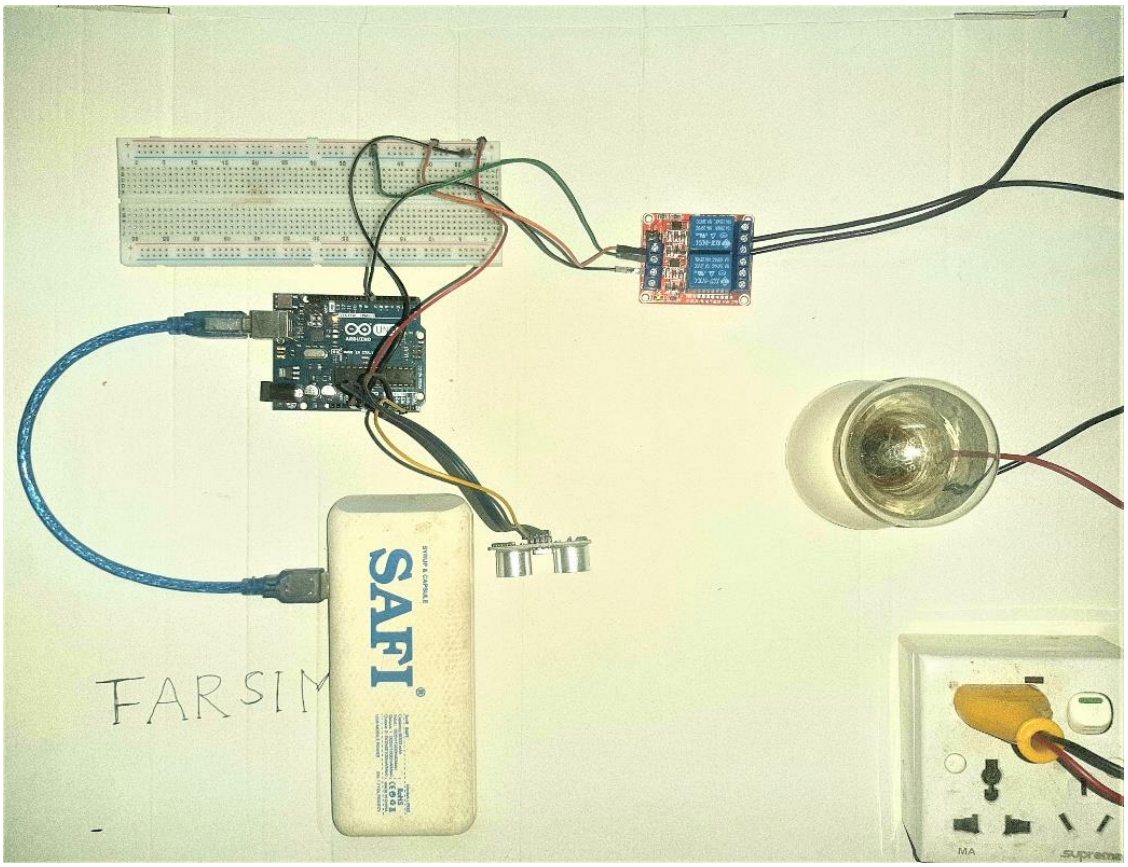

Figure 5.6: outlook of Automatic light control system.

CHAPTER 6

CONCLUSION & FUTURE SCOPE

6.1 CONCLUSION

This project depicts the home appliance management by using systematic usages of home appliances in a smart home. It is a novel concept that we applied at a low cost framework to evaluate an authentic smart home by using intelligent home appliance management. The home mechanization framework is made up of several various processes and technologies. Home customization technology helps to mitigate our fears by ensuring that our home is safe and though we are gone. It's also designed to reduce the amount of effort you put into running our family on a daily basis, allowing us to focus more on ourselves and the group as a whole. Consider how much money, time, and effort we could save if our home could automatically save our money, time, and effort. These goals are feasible with a substantial number of these well-established and evolving structures. The project's key aim is to use home electricity effectively by reducing energy waste, saving money, and enhancing user-friendly home appliance maintenance. In this project, the cost control system's performance is inadequate as compared to any other automated tool present on the market. In this circuit, we also use a variety of various types of appliances. It will assist in the smooth operation of the household. They need a solid structure that functions as a single entity, issuing astute and effective directions for the home owner's way of life without them having to say so. These tasks are carried out in light of the client, whether by one-time programming or by finding out how to analyze movement and follow up on its own. Keen home structures will only continue to evolve and become more mature. Many technologies and architectures are built to fit in with their environments or to stand out as a statement object. So, while smart home frameworks may take some time to comprehend and master, they can, and already are, simplifying life.

6.2 FUTURE SCOPE

The scope of capabilities can only broaden as the creativity for smart homes progresses. At the moment, home customization is also in its infancy. Ordinary assets have been turned into computerized machines in the future, enabling you to gather data about our own consumption habits and respond to them. Given the pace at which these advancements are formed and integrated into our daily day-to-day existences, homes of the future will just contain shrewd home highlights. However, certain people will need to set up and maintain home automation devices on their own.

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APPENDICES

Code for remote appliance control:

```
#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>

BlynkTimer timer;

int toggleState_1 = 1;
int pushButton1State = HIGH;

int toggleState_2 = 1;
int pushButton2State = HIGH;

int wifiFlag = 0;

#define AUTH "dUei08M3Vv-OIh5g9Lf_Z-Unc0ay9t-x"
#define WIFI_SSID "Farsim"
#define WIFI_PASS "far17079"

#define RELAY_PIN_1      26
#define RELAY_PIN_2      27
#define WIFI_LED         25

#define PUSH_BUTTON_1    32
#define PUSH_BUTTON_2    33

#define VPIN_BUTTON_1    V1
#define VPIN_BUTTON_2    V2

void relayOnOff(int relay){
```

```
   switch(relay){
     case 1:
           if(toggleState_1 == 0){
            digitalWrite(RELAY_PIN_1, HIGH);
            toggleState_1 = 1;
            }
           else{
            digitalWrite(RELAY_PIN_1, LOW);
            toggleState_1 = 0;
            }
           delay(200);
     break;
     case 2:
           if(toggleState_2 == 0){
            digitalWrite(RELAY_PIN_2, HIGH);
            toggleState_2 = 1;
            }
           else{
            digitalWrite(RELAY_PIN_2, LOW);
            toggleState_2 = 0;
            }
           delay(200);
     break;
     default : break;
     }
}

BLYNK_CONNECTED() {

  Blynk.syncVirtual(VPIN_BUTTON_1);
  Blynk.syncVirtual(VPIN_BUTTON_2);
}
```

```
BLYNK_WRITE(VPIN_BUTTON_1) {
  toggleState_1 = param.asInt();
  digitalWrite(RELAY_PIN_1, toggleState_1);
}

BLYNK_WRITE(VPIN_BUTTON_2) {
  toggleState_2 = param.asInt();
  digitalWrite(RELAY_PIN_2, toggleState_2);
}

void with_internet(){
  if (digitalRead(PUSH_BUTTON_1) == LOW) {
      relayOnOff(1);

      Blynk.virtualWrite(VPIN_BUTTON_1, toggleState_1);
    }
  if (digitalRead(PUSH_BUTTON_2) == LOW) {
      relayOnOff(2);

      Blynk.virtualWrite(VPIN_BUTTON_2, toggleState_2);
    }
}
void without_internet(){
  if (digitalRead(PUSH_BUTTON_1) == LOW) {
      relayOnOff(1);
    }
  if (digitalRead(PUSH_BUTTON_2) == LOW) {
      relayOnOff(2);
    }
}

void checkBlynkStatus() {

  bool isconnected = Blynk.connected();
```

```
  if (isconnected == false) {
    wifiFlag = 1;
    digitalWrite(WIFI_LED, LOW);
  }
  if (isconnected == true) {
    wifiFlag = 0;
    digitalWrite(WIFI_LED, HIGH);
  }
}

void setup()
{
  Serial.begin(9600);

  pinMode(RELAY_PIN_1, OUTPUT);
  pinMode(PUSH_BUTTON_1, INPUT_PULLUP);
  digitalWrite(RELAY_PIN_1, toggleState_1);

  pinMode(RELAY_PIN_2, OUTPUT);
  pinMode(PUSH_BUTTON_2, INPUT_PULLUP);
  digitalWrite(RELAY_PIN_2, toggleState_2);

  pinMode(WIFI_LED, OUTPUT);

  WiFi.begin(WIFI_SSID, WIFI_PASS);
  timer.setInterval(3000L, checkBlynkStatus);
  Blynk.config(AUTH);
}

void loop()
{
  if (WiFi.status() != WL_CONNECTED)
  {
    Serial.println("Not Connected");
```

```
  }
  else
  {
    Serial.println(" Connected");
    Blynk.run();
  }

  timer.run();
  if (wifiFlag == 0)
    with_internet();
  else
    without_internet();
}
```

Code for fire detection alarm:

```
#define BLYNK_PRINT Serial
 #include <WiFi.h>
 #include <WiFiClient.h>
 #include <BlynkSimpleEsp32.h>
 BlynkTimer timer;
 char auth[] = "N3w8oTPGrvdHdkghRwPz6shVrmeh4xDq";
 char ssid[] = "Farsim"; char pass[] = "far17079";
 int flag=0;
 void notifyOnFire()
 {
   int isButtonPressed = digitalRead(27);
   if (isButtonPressed==1 && flag==0) {
     Serial.println("Farsim Fire in the House");
     Blynk.notify("Alert : Farsim Fire in the House");
     flag=1;
   }
   else if (isButtonPressed==0)
   {
     flag=0;
   }}
 void setup()
 {
 Serial.begin(9600);
 Blynk.begin(auth, ssid, pass);
 pinMode(27,INPUT_PULLUP);
 timer.setInterval(1000L,notifyOnFire);
 }
 void loop()
 {
   Blynk.run();
   timer.run();
 }
```

Code for temperature dependent fan :

```
LiquidCrystal lcd(2,3,4,5,6,7);
int tempPin = A0;
int fan = 11;
int led = 8;
int temp;
int tempMin = 30;
int tempMax = 60;
int fanSpeed;
int fanLCD;

void setup() {
pinMode(fan, OUTPUT);
pinMode(led, OUTPUT);
pinMode(tempPin, INPUT);
lcd.begin(16,2);
Serial.begin(9600);
}
 void loop()
{
temp = readTemp();
Serial.print( temp );
if(temp < tempMin) {
fanSpeed = 0;
analogWrite(fan, fanSpeed);
fanLCD=0;
digitalWrite(fan, LOW);
}
if((temp >= tempMin) && (temp <= tempMax))
{
fanSpeed = temp;
fanSpeed=1.5*fanSpeed;
fanLCD = map(temp, tempMin, tempMax, 0, 100);
```

```
analogWrite(fan, fanSpeed);
}

if(temp > tempMax) {
digitalWrite(led, HIGH);
}
else
{
digitalWrite(led, LOW);
}

lcd.print("TEMP: ");
lcd.print(temp);
lcd.print("C ");
lcd.setCursor(0,1);
lcd.print("FANS: ");
lcd.print(fanLCD);
lcd.print("%");
delay(200);
lcd.clear();
}

int readTemp() {
temp = analogRead(tempPin);
return temp * 0.48828125;
}
```

Code for automatic light control system

```
const int trigger = A1;
const int echo = A2;
int vcc = A0;
int gnd = A3;
int OP = 7;
long Time;
float distanceCM;
float distance = 15;
float resultCM;
void setup()
{
pinMode(OP,OUTPUT);
pinMode(trigger,OUTPUT);
pinMode(echo,INPUT);
pinMode(vcc,OUTPUT);
pinMode(gnd,OUTPUT);
}
void loop()
{
digitalWrite(vcc,HIGH);
digitalWrite(gnd,LOW);
digitalWrite(trigger,LOW);
delay(1);
digitalWrite(trigger,HIGH);
delayMicroseconds(10);
digitalWrite(trigger,LOW);
Time=pulseIn(echo,HIGH);
distanceCM=Time*0.034;
resultCM=distanceCM/2;
if(resultCM<=distance)
{
digitalWrite(OP,HIGH);
```

```
delay(4000);
}
if(resultCM>=distance)
{
digitalWrite(OP,LOW);
}
delay(10);
}
```