Home Automation using Internet of Things through Solar Panels

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IN
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CERTIFICATE

This is to certify that the project report entitled

"Home Automation using Internet of Things through Solar Panels"

is the Bonafide work done by

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in the Department of **Computer Science and Systems Engineering**, and submitted to Jawaharlal Nehru Technological University Anantapur, Ananthapuramu in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Computer Science and Systems Engineering during the academic year 2019-2020. This work has been carried out under my supervision. The results of this project work have not been submitted to any university for the award of any degree or diploma.

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

DECLARATION

We hereby declare that the project report titled **Home Automation using Internet of Things through Solar Panels** is the genuine work carried out by us, in **B.Tech (Computer Science and Systems Engineering)** degree course of **JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR** and has not been submitted to any other college or University for the award of any degree or diploma.

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea / data / fact / source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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ABSTRACT

As Internet of Things (IoT) is used in developing a wide range of applications in different industries, it can be used to completely automate a home system. The idea is that to build a home automation system that can be monitored and controlled with the help of smart devices like mobile phones that are connected to the internet. Lack of IoT technology usage, unfriendly user interface, limited wireless transmission range, and high costs are the limitations of existing home automation systems. Therefore, this study presents a cost-effective and hybrid (local and remote) IoT based home automation system with a user-friendly interface for smart phones and laptops. A prototype is developed with an algorithm that monitors and controls the home appliances. This system utilizes a node microcontroller unit (NodeMCU) as a Wi-Fi based gateway to connect different sensors and update their data to Adafruit IO cloud server. Data are collected from the sensors and can be accessed with the help of users' device. Solar panels are used to supply power to the kit. This is a low cost and reliable automation system that reduces energy consumption and can notably provide convenience, safety, and security for Smart Home residents.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

SH	Smart Home
IFTTT	If This Than That
MCU	Micro Controller Unit
GPOI	General Purpose Output Input
IDE	Integrated Development Environment
WiFi	Wireless Fidelity
IoT	Internet of Things
EDA	Electronic design automation

NOTATIONS

Vcc	Voltage supply
IN1/2/3/4	Input pins
D0/D1/D2/D3	General purpose input output pins
GND	Ground pin
NO	Normally Open
NC	Normally Close
COM	Common

CHAPTER 1

INTRODUCTION

1.1 Introduction to Home Automation

Home automation system has improved its communications technology. A home automation system is used to control the appliances in the real time over the internet. In today's world everything is connected with the internet as every device in the home are smart so, that they can communicate with the other smart devices like smart phone, smart television, smart sensors, smart washing machine. So, an automation system should be developed to manage the communication between smart devices within smart homes. Some automation systems are used for industries[9] also.

The home automation system is adopted to control the appliances either locally or remotely. With the invention of microcontrollers, the costs of electronic control have rapidly decreased at the end of the last century, and home automation has emerged. The controlling of home appliances has started by using mobile devices with short-range communication interfaces, such as Bluetooth[1][2] and wired[3] and by Wi-Fi[5] networks and GSM modules[4]. All these systems and technologies are useful for indoor control of home appliances and does not allow residents to monitor and control their homes from the outside. These Smart home systems can notify the things connected with the internet and some appliances can report fire stations in case of fire with the sensors. Internet of things can be utilized to improve the existing home automation systems by introducing a main control over the Internet and to monitor the appliances [6][7].

The main part of the home automation system based on IoT is the microcontroller. A node microcontroller unit (NodeMCU) Wi-Fi-based controller board[10] is an open source platform for IoT applications and is used as the main microcontroller in this project. NodeMCU is basically used to gather data obtained by sensors and uploads the data to the IoT server. In addition, this microcontroller receives commands given by users via smartphones/laptops to perform specific tasks.

The NodeMCU is same as the Arduino or Raspberry Pi which is a physical programmable circuit board. This NodeMCU can be programmed on Arduino software

which is an integrated development kit (IDE) to write the instruction codes and uploads them to the microcontroller. An important part of the home automation system is accessing the appliances or controlling the appliances by using the mobile application or through the web based application.

All the data obtained by the sensors and devices are used to display the patterns and detect the possible occurring problems and provides recommendations or alert the user. Home automation system utilizes several sensors to monitor various home-related parameters, such as temperature, humidity, gas leakage, motion, radio-frequency identification (RFID), and water level. Several actuators are used to control activities of home appliances. Thus home automation system to provide the comfort, safety and better quality of life. Renewable energy sources[8] are used in some works.

1.2 Statement of the Problem

While people are pursuing an ever-growing high quality of their lives today, this leads to more and more facilities and home appliances include in their buildings. How to control and manage these appliances in a house? Usually, conventional wall switches are located at different corners of a house and there is a need for manual operations like pressing turn on and off. It becomes very difficult for elderly people to operate them. So, our solution is to turn on and off all the appliances anywhere using the internet in a cost-effective manner and save the electricity using solar panels as the source of electricity supply for our problem.

1.3 Motivation

As in the current home automation systems there are few drawbacks like limited range and more power consumption by the IOT systems, it is better to develop a smart home system which can be controlled by the user with proper range of limits and it should also be eco friendly which can be achieved by using solar panels for the power supply. These drawbacks made up to this work to provide a home automation system with wide range of accessibility and an eco friendly one**.**

1.4 Objectives

1. To present a Cost-effective, local and remote IoT based home automation system with a user-friendly interface for smart phones and laptops.

2. To propose a IoT-based system for home automation that can easily and efficiently control appliances over the Internet and support home safety with autonomous operation.

3. To propose an automation system that reduces energy consumption and can notably provide convenience, safety, and security for Smart Home residents.

1.5 Existing System

Existing system of smart home automations consist of functionalities like indoor control, outdoor control, security, safety, and much more but they are not present in one existing system. Some features are present in some systems while other are present in other systems. All the existing systems are not eco friendly and consume much power when compared to proposed system. The existing systems are not much efficient as they do not have all features combined into one system which is overcome in the proposed system.

Demerits are as follows:

1. As connections are given using wires there might be problem of short circuiting.

2. This system is not eco friendly as it uses non renewable energy sources for power supply.

1.6 Proposed System

The proposed system is a hybrid indoor and outdoor controlled system which is operated with help of Wi-Fi from anywhere. The system need to be connected to a Wi-Fi and mobile phone should have internet facility then the system can be controlled with help of mobile phone through adafruit IO. The proposed system contains all functionalities like indoor, outdoor control, security, safety, monitoring, and other features.

Merits are as follows:

1. Solar panels for power supply are used so that the kit will get the energy source from them and carry its functionalities.

2. PCB is used instead of bread boards to avoid the short circuiting chances.

1.7 Applications

1. Lighting control can be done with automatic sensors or through mobile phone.
2. Smart Home appliances are controlled using Adafruit IO from mobile or from PC.
3. Improved home safety and security as monitoring of the appliances is available using Adafruit IO.
4. Smart switches are implemented as appliances can be turned on/off using mobile.

1.8 Limitations

1. Energy consumption is more, thus relay boards are used so that kit can work on low voltages as well.
2. Some Smart home systems are not eco friendly, thus solar panels are introduced as source of power supply.
3. There is a problem of short-circuiting, so PCBs are used for connecting the kit.

1.9 Significant contributors from investigations

The attributes used here are related to IoT which is used to build and automate the home system and making it into smart home system.

The proposed system will provide all the functionalities like safety, security, indoor control, outdoor control, and much more.

1.10 Organization of thesis

This document is organized into 5 chapters where each chapter will describe have their own importance. Chapter 1 will tells about the introduction part. Chapter 2 is based on literature review where various authors research is discussed here. Chapter 3 will tell about the methodology where complete analysis of smart home system is discussed here.

Chapter 4 will tells about the results and discussion and how much better the current work is than the existing works will be discussed here. Chapter 5 is on conclusion and future work to improve the future inventions.

Appendices section will have the code and all the work done here is mapped with our course outcomes.

CHAPTER 2

LITERATURE SURVEY

2.1 Techniques available for Smart Home automation

IoT: The Internet of things (**IoT**) is a system of interrelated computing devices, mechanical and digital machines provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

2.2 Nature of investigation (Rival Methods)

D.Anandhavalli [1] proposed Smart Home Automation Control Using Bluetooth And GSM as in last decade technology has advanced life more efficient and comfortable. The control of the home appliances from remote places has become crucial and everyonecan save lot of time and effort by this. It increases the need for doing in such a systematic manner that everyonehave implemented our system. The proposed system is an expanded method for home automating system. With the adoption of our system, the control over some important things that required continuous attention can be achieved.

The objective of this project is to develop a device that allows for a user to control multiple home appliances from both indoor and outdoor using an android mobile phone. This system can be served as a flexible and powerful tool that can provide the service at anytime and anywhere. The various possible appliances include the lights, climate control system and security systems but they are not limited to within these devices. Our proposed approach to design the system is to implement a microcontroller based control module that receives the instructions and command from the user through a mobile phone over the Bluetooth and GSM network. Then the microcontroller will carry out the given commands and then control the devices.

Due to the wireless technology, there are several of connections are introduced like Bluetooth, FPGA and ZIGBEE. Each of the connection has their unique specifications and applications. Among the four wireless connections, Bluetooth is chosen with its suitable ability to control appliances from indoor and GSM for outdoor. Also, most of the current

laptop or cell phones are come with built-in Bluetooth adapter. It will reduce the cost of this system. Through GSM, the user can effectively control and monitor the appliances from remote places by sending SMS. The concept behind this is to receiving the sent SMS and processing it further as required to perform several operations. This type of the operation to be performed depends on the nature of the SMS sent.

An SH automation control using Bluetooth and GSM module was proposed. The objective of this study is to help handicapped and elderly people to control home appliances from remote places. People used Bluetooth and GSM wireless communications to control the home. Bluetooth was also used to control the appliances indoor and GSM to control the appliances outdoor. Bluetooth can reduce system costs because most cellphones and laptops have this built-in application. Users can monitor and control the appliances from remote places by sending SMS through GSM. However, such a system has limitations in the two cases. Bluetooth has a limited range and data rate, and GSM is expensive because of SMS costs.

B.Davidovic [2] et.al proposed smart home system based on sensor technology that presents the model of smart home system based on Raspberry PI and Android device. The system is designed to be scalable and easy to setup and extend. It is based on powerful Raspberry PI microcomputer. It includes sensors for listening of the environment and appliances that are controlled via Android device. In the ever-changing technology trends a few components are being used in an attempt to make a more efficient, powerful and user-friendly smart home system. The components and technologies used for development of this smart home system are: 1. Raspberry PI. 2. Android. 3. Bluetooth. 4. Sensors.

The home automations system starts with sensors, devices that detect and respond to some type of input from the physical environment. They can sense things like window and door contact, the presence of person (for lighting control, heating, security), movement, humidity, temperature etc. Sensors used in our example include generic, light, motion, sound, humidity and temperature. It's possible to add more sensors, but even with just these the system is very universal, flexible and versatile. For example, temperature + humidity sensor can be used as a plant monitor to let the end user know when it needs water, as a leak detector in the bathroom or even be placed on clothesline to send an alert when the laundry is done drying. Then, couple the temperature sensing with light and the

results can be a light-based alarm that sends user a notification when the sun rises, or even a security system that will alert when a light comes on while there's nobody home. And a simple temperature and motion sensing can be used as a baby monitor, fridge or window alarm. There is a plethora of potential uses and it is perfectly customizable.

N.David et.al [3] proposed Design of a home automation system using arduino. An SH is the integration of technology that enables users to achieve a better quality of living. SH is a voice assistant for the remote control of all home appliances. SH can help to improve security, comfort, convenience, and energy management. SH aids elderly and disabled people by providing them a safe and secure environment. Basically, SHs can be categorized into two types, namely, wired and wireless systems. Wired systems use optical fibers, bus lines, and power lines. Wireless systems are a combination of a sender and a receiver. At present, many new applications use wireless technology, such as radio waves or infrared, to communicate with other devices. SHs can simultaneously work on wireless and wired systems. SH automation systems have gradually become all-purpose portable controllers that provide convenience to people in their daily routines.

An SH is an environment where heterogeneous and electronic devices are connected together to deliver smart services to individuals. IoT-based SHs are an important part of the proposed and developed smart cities worldwide. An SH is designed to improve the standard of living, safety, security, and reduce energy consumption and resources. In addition, SH plays an important role in community development. Thus, the key features of SHs include real-time monitoring, safety from hackers, remote control, and fire and gas alarms. As sensitive and personal data are managed between SHs, security and privacy solutions must be developed to protect users and corporate data from infringement while ensuring reliable services

E.Ganesh et.al [4] proposed Implementation of IOT Architecture for SMART HOME using GSM Technology that proposes a novel architecture of IoT enabled Smart home which is control and monitor smart devices through GSM and Internet Technologies. Normally the smart homes will be conscious about what happens inside a building, mainly impacting three aspects1.Resource usage (water conservation and Energy consumption etc.), 2. Security 3. Comfort The user can control or check the status of any resources or enable/disable security options of the smart home.

This paper introduces an IoT agent which is brain of this architecture and it controls web server and remote embedded system module. At very short period of time the IoT agent reads the user data from the web server, created a SMS command and it will be sent to remote embedded system module through GSM-SMS. This command will be received by GSM receiving module which is connected with embedded system placed in a remote home. The home appliances and other devices are directly connected and controlled by this embedded system module. The GSM module is inbuilt with IoT agent and embedded system module. After executing the commands, the acknowledgement will be sent to user.

Introduced a web-based IoT architecture using GSM to implement SH applications and presented a GSM-based design control system of SH. This work suggested a structure to enable users to monitor and control smart devices through the Internet, where the users give commands through the web, and the user input is converted to GSM–SMS commands. The proposed structure creates an interface between the SH and users through the Internet and GSM and provides a GSM-based wireless connection from the web server to the SH. These commands are sent to the integrated system module, which is placed anywhere in the world and can be directly connected to the devices the through GSM network.

In addition, the module is controlled through an IoT agent by the GSM network. The user commands are executed and analyzed using a microcontroller to control any electronic objects, such as lights and home appliances, and sends an acknowledgment. The prototype collects and transmits data through GSM– SMS. The initial test proves that the prototype is capable of monitoring and controlling devices in the published environment and has many advantages, such as zero data loss, rapid delivery, ease of use, flexibility, low cost, and energy efficiency.

S.Badabaji et.al [5] proposed An IoT Based Smart Home Service System that primarily focuses on the surveillance of home when the user is away from the place. In this article everyoneare going to give brief information on how to implement home safety when fire and gas get detected. The main purpose of this project is to monitor temperature, liquid petroleum gas (LPG) leakage and fire detection. When LPG concentration in the air increases to certain levels, the Gas sensor will detect the leakage and, promptly alert the

user by sending SMS to described mobile and alert the people at home by triggering the Buzzer alarm and display the message on the LCD. Similarly, when the fire is detected it will send the sms and automatically the sprinkler motor will be on.

Presented a system that managed home appliances through IoT, where the temperatures, fire, and gas were controlled by using different sensors, and their values were displayed on an LCD. This type of system is useful when the user is away because it monitors temperature, detects liquid petroleum gas leakage and fire, and provides brief information on household safety when fire and gas leakage are detected. In other words, the gas sensor detects the leakage and immediately alerts the user through an SMS to the mobile phone and the people at home by turning on the siren and displaying the message on an LCD screen. Similarly, an SMS is automatically sent, and the spray engine is turned on when fire is detected.

The proposed system determines a range of temperatures, fire, and gases because it uses different sensors. Thus, a message via GSM is received when the range of given values increases, where these values are stored on a server for future reference and displayed on an LCD screen. In addition, the data uploaded to the web server are updated and can be retrieved from anywhere in the world. In summary, IoT is used to enhance the safety standards, where the communication between sensors and transducers is wirelessly resolved by using one chip through Wi-Fi.

S.Kaur et.al [6] proposed Home Automation and Security System.Different techniques have been employed in order to implement home automation and security system efficiently. This research paper discusses Arduino, GSM, and Android based Home Automation and Security System with their implementation. Home Automation and Security System based on Arduino implies that whenever a person will enter the house then the count of number of the persons will get incremented, bulb will start glowing and alarm will start ringing. The count of the number of persons present in the room will be displayed on the LCD screen. Whenever the room gets empty i.e. the count of the person reduces to zero then the bulb will automatically stop glowing making the system power efficient.

Home Automation and Security System based on GSM and Android application implies that whenever a person tries to enter into the house then a SMS will be sent to

house owner's mobile phone indicating the presence of some person inside the house and the house owner can take some preventive measure in order to protect ones house from the burglar. Moreover, the person can control the home appliances using an android application present in the mobile phone which will reduce the human hard work. The list of various home appliances along with TURN ON and TURNOFF buttons will be provided in an android application. By clicking on that particular button the person will be able to TURN ON and TURN OFF the home appliances using an android application.

Provided information on home automation and security systems using different techniques, such as Arduino and GSM and Android applications to control home appliances. The number of people inside the house increases each time an individual enters the house; thus, home automation mode applications are turned on and security lights are also switched on with alarm. Moreover, the number of people that enters the house is displayed on an LCD screen. However, in "home automation" mode, the number of people becomes zero, and applications are turned off when the room is empty, making the system power efficient. In addition, anyone can control their home devices through an Android mobile app, which reduces human labor. At the same time, a text message is sent to the homeowner's mobile phone when someone enters under security mode, indicating that a person is inside the home. Thus, the alarm can be turned on through SMS or Android app.

P.Gupta [7] proposed IoT based Smart Home design using power and security management. In this model everyonehave proposed an Ethernet based system that let users monitor real time switching information of the electrical devices and controlling them through an android app as well as monitoring the security of their homes in case of unwanted entry or fire. Our model uses temperature sensor and smoke sensors to check for fire at the user home, PIR motion sensors to check for the unwanted presence at their homes and also monitor and control the real time tracking and switching of all their electrical devices through an android based mobile app. The system is connected to this android app using internet connectivity for better and fast communication. The model has an option of controlling devices by either sending voice commands or by simple tap-to-toggle system, making the overall system user friendly and easy to manage. So getting in detail about the model, everyonehave temperature sensor which works along with smoke sensor to check the presence of fire at home, PIR motion sensor to detect the human

movement in the house, and relay connected devices so that they can be easily toggled by the microcontroller.

The brain of our model is an Ethernet based Intel Galileo 2Generation Board which let our devices and sensors connected to the internet. The 2generation Intel Galileo board provides a single board which is based on the Intel Quark SoCX1000, a 32-bit Intel Pentium processor-class system on a chip (SoC). It is Arduino-certificated and designed to be hardware, software, and pin compatible with large range of Arduino Uno R3 shields. On the other side of our model, everyonehave an android based mobile app that has options to track the switching time of the devices, controlling the switching of devices either through touch mode or voice mode and also generates alerts in case of security breach or fire. The app is android based which is connected to the internet thorough either Wi-Fi or mobile data. It connects to the Intel Galileo based server over the internet and lets the users to monitor with the help of an internal mobile timer and toggles the switching by tap-to-touch or voice using Google API speech recognition tool. User can manually switch on or off the PIR sensor or the fire tracking system and even get alerts in case they do detect a change. The alert is sent real time to the user app and shown in the alert tab. Thus, an energy monitoring security system is being set up in the home with a user-friendly mobile app to make your home a smart and an intelligent home.

Implemented an SH intelligent system based on Ethernet to monitor power consumption in real time through tracking devices in the home using an Intel Galileo Gen 2 board, which can be used in homes and communities. The proposed system worked through voice control with real-time monitoring, which allowed the remote control and monitoring of electrical devices and keys with or without an Android-based application. In other words, this study presented a smart and intelligent system for energy management and security based on IoT with an independent and portable power control, where users can oversee the power management and security of their homes even when they are not around. The power consumption was reduced, and resource utilization was maximized through real-time tracking and monitoring of electrical appliances and home security. Different sensors were used to monitor the devices in real time and maintain home security.

The proposed system was remotely controlled and monitored using an Android app through an Internet or intranet connection. The results of this study provided multiple benefits, such as keeping the users in constant touch with their homes with the option to control switching devices through their voices or simple touches on their smartphones, delivering electricity bills at home, and monitoring resource usage to reduce electrical power consumption. The experimental results explained that the proposed system is suitable for energy management and security.

M.Daneshvar [8] proposed Transactive energy in future smart homes. In this work, to maximize the microgrids profit in presence of renewable energy resources (RERs), this paper employs the transactive energy (TE) technique for optimal scheduling of the distributed energy resources (DERs) throughout the system. Microgrids can exchange energy with the main grid not only to meet their demand but also to make a profit by active participation in energy and reserve provision process. In this regard, TE can be applied as an effective solution for energy supply management and dynamic balancing between the microgrids and the power grid. In this paper, the participation of five grid-connected commercial microgrids in day-ahead (DA) market is considered. The applicability and the satisfactory performance of the proposed approach are tested and validated on a 10-bus IEEE test system. Simulation results indicate that maximum profit can be achieved for the microgrids with optimal scheduling of the DERs based on the TE approach.

With the advent of new energy consumers with different energy consumption behaviors, demanded energy is dynamically changing. Because of the harmful effects of conventional energy generation units such as increasing greenhouse gas emissions, microgrids as a new renewablebased energy production structure are extensively employed to meet the most of the energy demand [1]. Renewable energy resources (RERs) such as solar and wind play a vital role in clean energy generation process [2]. To provide suitable conditions for energy exchanging in smart grids, energy markets have been created with comprehensive instructions over the past few decades and RER-based microgrids participation has been promoted accordingly in such markets. In these environments, microgrids support the grid operators through different energy management and control actions while seeking their own objectives. Moreover, this support can be effectively done by optimal scheduling of the distributed energy resources (DERs) in

microgrids as one of the effective and reliable ways for achieving beneficial goal.

R.Sinha [9] proposed A Survey of Static Formal Methods for Building Dependable Industrial Automation Systems. Industrial automation systems need to be highly dependable; they should not merely function as expected but also do so in a reliable, safe and secure manner. Formal methods are mathematical techniques that can greatly aid in developing dependable systems and can be used across all phases of the system development lifecycle, including requirements engineering, system design and implementation, verification and validation (testing), maintenance and even documentation. This state-ofthe-art survey reports existing formal approaches for creating more dependable industrial automation systems, focussing on static formal methods that are used before a system is completely implemented. Everyonecategorise surveyed works based on the phases of the system development life cycle, allowing us to identify research gaps and promising future directions for each phase.

Industrial Automation Systems (IAS) are highly distributed systems containing software to control mechatronic components interacting with physical processes. IAS find use in production, logistics, and energy generation and distribution. IAS need to provide a high level of dependability, which is defined as the trustworthiness of a computer system's ability to reliably provide the service it promises to deliver [1]. A dependable system must be functionally correct and do what it promises, but it must also meet non-functional requirements such as reliability, safety, and security. As system sizes and complexity grow, the lack of systematic methods can significantly limit our ability to build highly dependable systems. Formal methods include formalisms, algorithms and processes that have sound mathematical foundations and therefore provide more objective and unambiguous means to model and check the dependability of a given system. Due to factors like difficulty in their use, expert skills, significant manual effort required, and scalability concerns, only a few formal methods have found industrial use.

W.A.Jabbar [10] proposed Design and Implementation of IoT-Based Automation System for Smart Home.Home Automation System (HAS) gains popularity due to communication technology advancement. Smart home is one of the Internet of Things (IoT) applications that facilitates the control of home appliances over the Internet using automation system.

This paper proposes a low-cost Wi-Fi based automation system for Smart Home (SH) in order to monitor and control home appliances remotely using Androidbased application. An Arduino Mega microcontroller provided with Wi-Fi module is utilized to build the automation system. In addition, several sensors are used to monitor the temperature, humidity and motion in home. A relay board is exploited to connect the HAS with home under controlled appliances. The proposed automation system, can easily and efficiently control the electrical appliances via Wi-Fi and Virtuino mobile application.

Nowadays, the large diffusion of smart devices with embedded sensors and wireless interfaces have enabled the rapid advancement of Internet of Things (IoT). The IoT plays a remarkable role in improving the quality of life and growing the world's economy. It facilitates global connectivity over the world-wide physical objects (e.g., sensors, RFID, smartphones, vehicles, appliances) to serve people in a collaborative manner automatically and intelligently. The vision for the IoT states that various "things" are going to be connected and will be controlled across the Internet. Application domains of IoT cover smart home, smart healthcare, smart grid, smart transportation, smart city, industrial automation and surveillance. Among various IoT applications, the design of Smart Home (SH) has drawn great attentions from both academic and industrial because it is more related to people's lives

CHAPTER 3

METHODOLOGY

3.1 Experimental Setup

In this everyoneconnect the NodeMCU with the Wi-Fi and login to the adafruit IO to create the toggles and login to the IFTTT server to create the applets.

The preinstalled arduino packages are used to code the program and upload it to the NodeMCU. Embedded C programming is used to code the program to control the home automation.

3.2 Procedures Adopted

In this home automation to design the user interface, Adafruit Io is used and to control the home automation through voice commands IFTTT server is used. To code the program Arduino IDE is used and to connect the appliances, NodeMCU is used.

3.3 Hardware developed and implemented

In this SH system, IoT was used and to improve the power management of the system, solar panels were used so that it could be eco friendly. Circuit boards were replaced by PCBs.

3.4 Physical Model

The physical model describes the components used in the system for serving the purpose of home automation using IoT. Pin configuration is also mentioned in this section. The main components are connected as mentioned in the below points. Simple pin connections are shown in figure 3.1.

- Connect the NodeMCU to the 5v relay module using the wires in the given below connection pins and also connect the bulb ,fan and temperature sensors to the two pins(No , Com) of each relay module

IN1 ------- D0
IN2 ------- D1
IN3 ------- D2
IN4 ------- D3
VCC ------- VIN

Fig.3.1.Simple pin connections

- Now connect the nodemcu to the solar power panels for the power supply to the nodemcu and for relay module. Now, dump the code for controlling home appliances into nodemcu.
- Now connect to the wifi of nodemcu through the mobile wifi which has the application to control the home appliances.

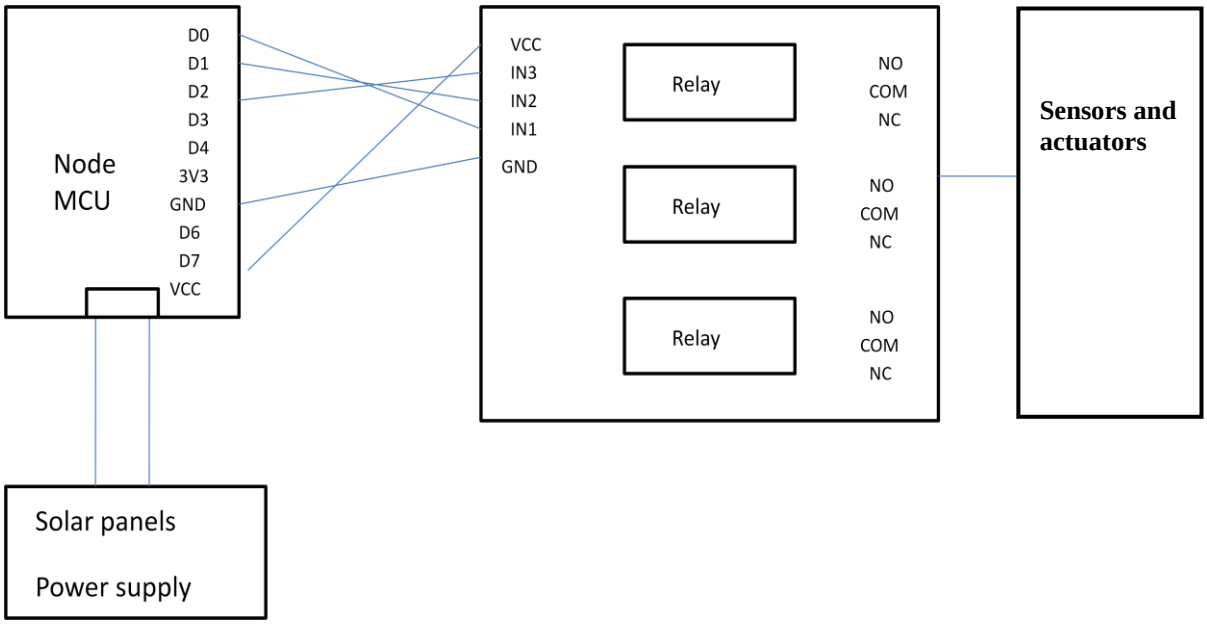

Fig.3.2.Physical model of the Home automation with 3 actuators.

As shown in the above figure 3.2 it is a simple physical overview of the modules, sensors, actuators connected to each other. The parts are as follows, NodeMCU, Solar panels, Relay placed on circuit board, Fan, Light, Temperature sensor. Each part of physical model is represented as follows:

1. NodeMCU:

NodeMCU is a low-cost open source IoT platform. It initially included firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which was based on the ESP-12 module. It is used to connect the entire actuators, sensors to it. It is a WiFi based circuit board which is used to connect to the WiFi so that it can be operated using mobile phones. It has a USB supported pin which can be used to upload the code into the nodeMCU. So, it is reusable that is the code can be updated whenever needed. It has few pins which can be used to form a connection between it and the relay board.

2. Solar panels:

As electricity is widely used by everyone in the world, it is better to make a project that consumes renewable resources as its power source. So, a set of solar panels are used to power the IoT kit. Solar panels gives the amount of energy required for the system to perform its functionalities.

3. Relay boards:

Relay boards are computer boards with an array of relays and switches. They have input and output terminals and are designed to control the voltage supply. Relay boards provide independently programmable, real-time control for each of several onboard relay channels. There might be problem of high voltages that are supplied through the home, which might cause a short circuit in the board of the system, to avoid this sort circuit problem these relays are used to keep the system safe.

4. Sensors and Actuators:

There are few sensors like temperature sensor and other sensors , few actuators like light , fan etc. These are operated using NodeMCU and circuit boards.

This describes physical model of the project that is used to control the home automation system.

The pin configuration is also mentioned in the section of physical model. Here is the NodeMCU Pinout of the Pins mapped with their corresponding values of GPIO no.

For example – D7 pin mapped to GPIO pin 13. so, in coding, we need to declare the D7 as pin 13.

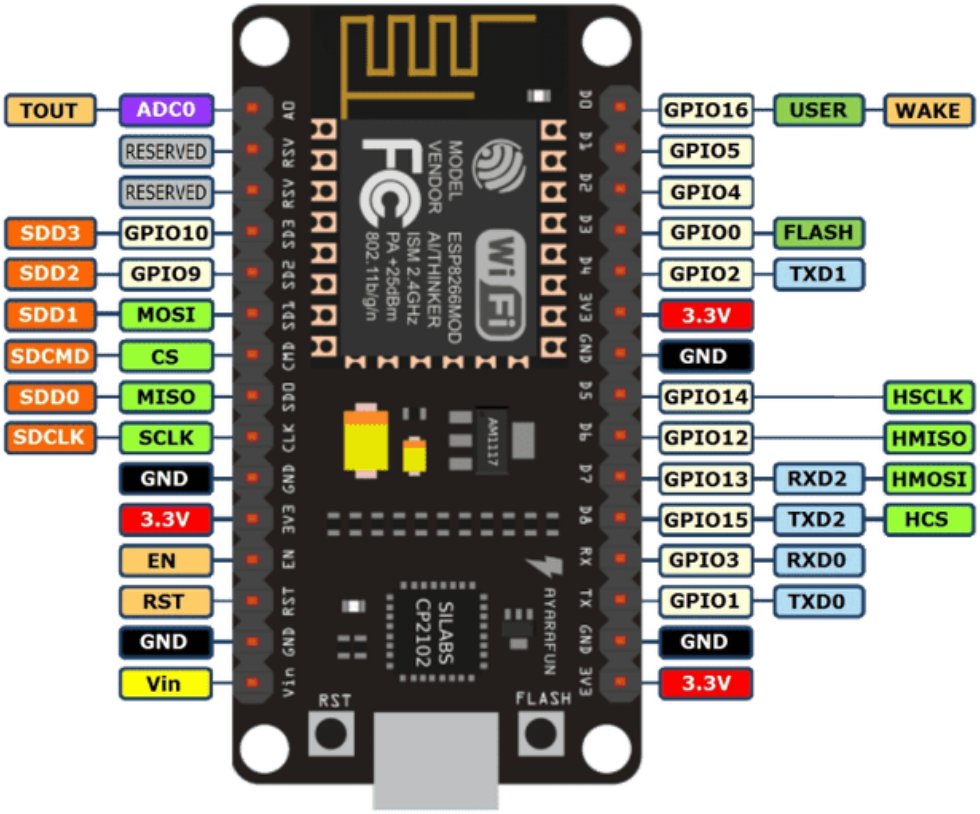

Fig.3.3.Pin configuration of NodeMCU esp8266.

NodeMCU ESP8266 based boards were first introduced with LUA scripting language for programming but since Arduino IDE is most popular among electronic hobbyist for programming the development boards, so this leads to the esp8266 package that needs to be added to Arduino IDE for programming ESP based boards. Since the NodeMCU ESP8266 boards were designed for a different architecture but later on implemented for Arduino IDE, as a result, we needed GPIO pin mapping of NodeMCU pinout that is marked on the board from D0-D8 but while in coding we use the mapped GPIO pin no. so that (note that in latest IDE we can directly write the pins as D0, D1 or so.The pins used in this work are listed and explained in the below table 3.1.

Table 3.1 Pin configuration of esp8266

Pin Number	Pin Name	Alternate Name	Normally used for	Alternate purpose
1	**Ground**	-	Connected to the ground of the circuit	-
2	**TX**	GPIO – 1	Connected to Rx pin of programmer/uC to upload program	Can act as a General purpose Input/output pin when not used as TX
3	**GPIO-2**	-	General purpose Input/output pin	-
4	**CH_EN**	-	Chip Enable – Active high	-
5	**GPIO - 0**	Flash	General purpose Input/output pin	Takes module into serial programming when held low during start up
6	**Reset**	-	Resets the module	-
7	**RX**	GPIO - 3	General purpose Input/output pin	Can act as a General purpose Input/output pin when not used as RX
8	**Vcc**	-	Connect to +3.3V only	

There are many other boards which are advanced versions of esp 8266 like esp-32 and esp-12. They also serve the purpose of esp 8266 and some features that are not available in esp 8266. As the purpose of home automation was served with the help of esp 8266 it was used as microcontroller for this project.

3.5 Simulation Model

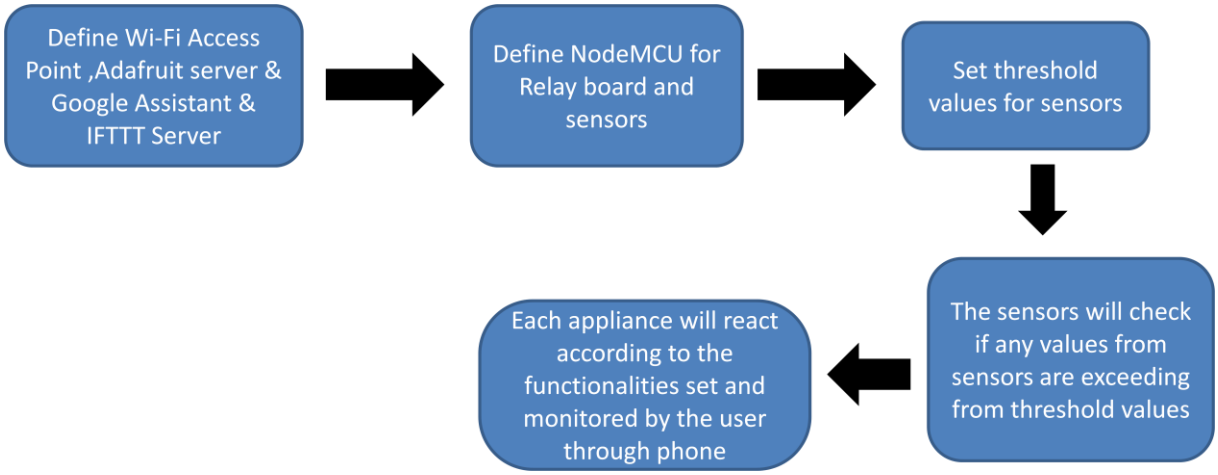

Fig.3.4.Simulation model of Home Automation

Simulation model shows the workflow of the system virtually. In the above figure 3.3, it is mentioned how the control flow goes to operate a home automation system. It is important to know the flow of the operation of the system for the user so one might get the idea, how to operate the system and to rectify any issues that may occur at any point of time.

As shown in the figure,

- First everyone need to create user interface using Adafruit IO, by creating buttons and their respective feeds.
- Defining of WiFi username, password and AIO key should be defined and upload the code to NodeMCU.
- Using IFTTT create applets and their respective triggers.
- If any sensor exceeds its threshold values, it will send an alert message to the mobile application.
- Control appliances using mobile and the sensors will react according to their functionalities.

The complete working and flow of control will be explained in the Testing and Implementation section in this document.

3.6 Analysis

3.6.1 Requirements specification:

Hardware Specifications:

- ESP8266 NodeMCU board
- Led bulb
- Small motor for fan
- LM35 Temp sensor
- Relay Module
- Connecting wires and a stripper
- Android phone for operating

Software Specifications:

- Arduino IDE software,
- Mobile application
- MIT Software for building applications
- Google Assistant

These are the required hardware and software facilities to make the work run and produce the results of home automation.

3.7 Design

Home automation is a method of controlling home appliances automatically for the convenience of users. This technology makes life easier for the user, and saves energy by utilizing devices according to strict requirements. Controls can be as basic as dimming lights with a remote or as complex as setting up a network of items in the home that can be programmed using a main controller or even via cell phone from anywhere in the world.

A home automation system can involve switching off electrical appliances like air-conditioners or refrigerators when a desired temperature has been reached, then switching on again when the temperature has crossed a certain value. A home automation system can also be used to secure a house from burglars by sending alerts to the nearest police station and the homeowner in case a trespasser is sensed.

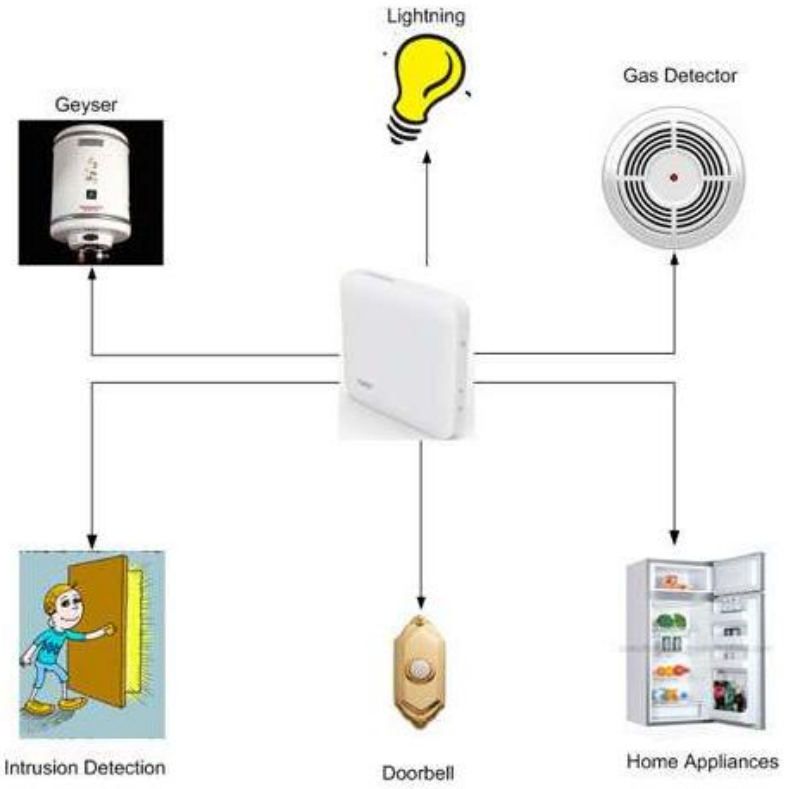

Fig.3.5.Basic home automation design

Apart from algorithmic automation, devices can be controlled by the user to suit personal requirements using direct buttons, cell phones, the internet, or infrared remotes. A network of appliances and sensors can interact with each other and make decisions for operation.

There are several design challenges and considerations involved while developing a home automation system, many of which are determined by user needs. Once those have been determined, the designer can choose the appropriate processor, sensors, and communication protocol for the system, keeping the following parameters in mind:

1. Type of Interface: The most basic and crucial requirement in a home automation system, the interface is the basic communication protocol and hardware combination used for sending and receiving messages between devices and the user. Designers have many

options for executing communication between devices, the user, and the overall system, depending upon the system, range, size of house, ease of use, etc. If a user wants to control the home appliances through the Internet, the designer needs to add an Ethernet/Wi-Fi interface to connect the system to the home network. If the user wants to control the system using Bluetooth from a cell phone, the designer needs to add a Bluetooth interface to communicate with the device.

The choice of communications interface also depends upon the topology used between the central control unit (CCU) and room control units (RCU). These units will be discussed in more detail later in this article.

2. Sensing Requirements: The designer needs to determine the sensing requirements of the user and decide upon the required sensor to perform the task. He or she also needs to assess the sensor specifications required for different needs and usability in different environments. The range of sensors that should be considered include:

- Thermistors can be used to control air conditioners, refrigerators, geysers, heating system, or in case of fire.
- Humidity sensors sense the moisture level in the environment.
- Gas sensors can be used to detect gas leaks.
- Light sensors can be used to detect the luminous intensity in the house.

The information provided by these sensors (after signal conditioning) is used by the processor to make several important decisions regarding the appliances and when to switch them ON or OFF.

3. Security level: Another major requirement while designing the home automation system is to make the entire system secure so that it can’t be easily altered to give control of the house to unauthorized users. It should be able to prevent most types of intrusion. Even if the system is broken into, it should be able to send signals to the user and the nearest police station. It also necessary to hide as many components as possible from direct access via the main control panel, preventing it from being turned into a black box. It should also be able to send and comprehend encoded data while communicating with other devices. This will prevent intruders from tapping into the system and using the same interface to hack devices.

4. Topology: Topology defines the way home automation control units interact with each other. A star type topology is the most commonly used as it makes use of a central control unit (CCU) interacting with all the available remote control units (RCUs) and taking over decision making responsibilities. The role of the RCUs is to send data fetched from the sensors back to the CCU. After it has assessed the input from the sensors and made any necessary decisions, the CCU sends the command back to the RCU to take a specific action.

Another topology to be considered is a mesh topology, which has no CCU and makes use of a constellation of control units of roughly equal intelligence and capability connected with each other. Each unit sends information on the network which is shared by all the units. Each Unit is independent and makes its own decisions based on the shared information.

The choice of system topology governs the selection of communication interfaces such as ZigBee, RF, Bluetooth, etc.

5. Depth of automation: System design is affected by the requirements ranging from simple control of lights in the house to controlling all appliances and the security system. Each requirement affects the overall design, and developers need to determine the most optimized way to perform all the tasks with the lowest cost and complexity. Despite the internal system complexity, the system should be easy to use and not pose barriers to its operation by a household user.

6. Cost: This is the most important aspect of system design as system complexity and depth of automation determine the cost. A highly complex – and thus costly – system can deter customers from purchasing and installing it in their house.

The cost of the system is directly linked with the number of components, interface used, and complexity of design of firmware and hardware. While there should be no compromise on the quality of hardware and software, the number of components in the system can be decreased to reduce the overall cost and system size as well. Rather than the traditional component-based approach, lower cost can be achieved using System-on-Chips (SoC) that integrate multiple peripherals and a processor into the same IC.

These are the design challenges to be taken care of while designing a smart ome automation.

Coming to the architecture of home automation, this module explains the basic architectural design of the home automation system. It shows how the flow of operation goes in a brief manner, so that everyone can understand and get a idea of how it works and provides us an automated home system. The system contains flow as - User, Smart device, Internet, Authentication, NodeMCU, Sensors, Actuators, Relay. The following is the picture of architecture of smart home automation.

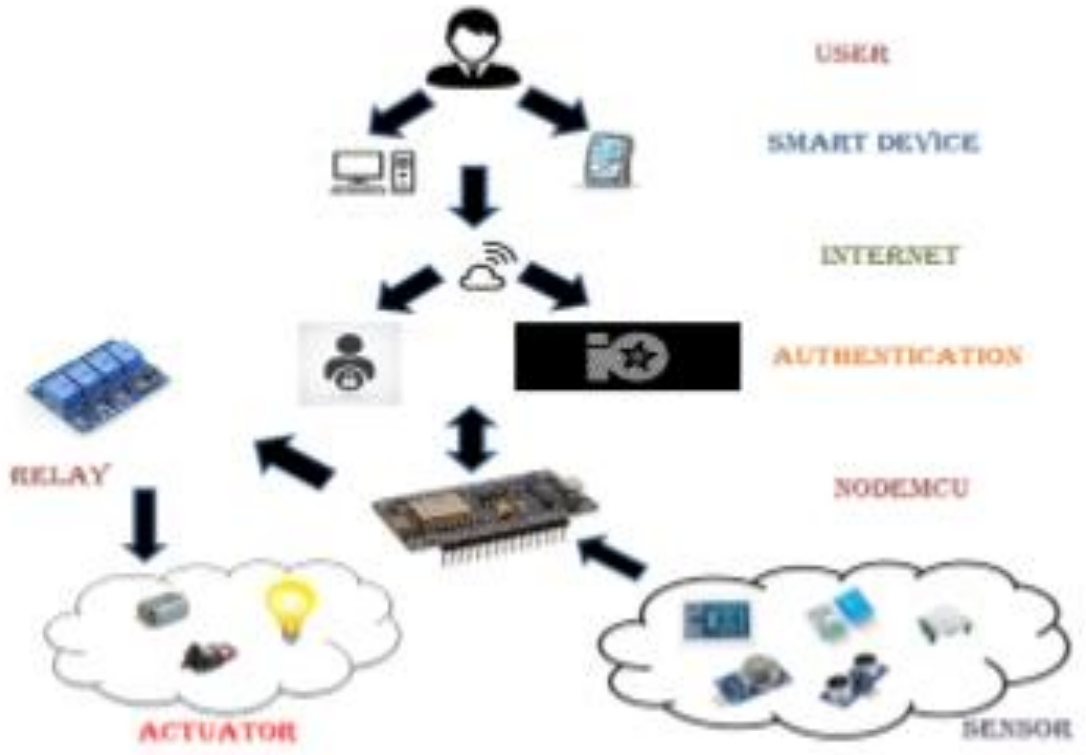

Fig.3.6.Architecture of Home Automation System

The overall system architecture of the developed automation system is illustrated in Figure 3.4 above. In this study, the NodeMCU sends the data collected by the sensor to the MQTT server (Adafruit.IO) and responds to the commands given by the user from the server to the system, such as ON/OFF switching of actuators similar to LEDs. The NodeMCU uses the embedded Wi-Fi module to connect to the Internet. Users can monitor the data on the server by logging in using any electronic device that can access the Internet

and control lights, fans, and motors. RFID is used to control the door relay by tapping the access card. Users receive notifications through IFTTT on their smartphones based on the sensor readings.For example the PIR motion sensor triggers the buzzer and sends a notification when a stranger enters the house. The gas and temperature sensors update the data to NodeMCU and trigger the ventilation and cooling fans. The ultrasonic sensor collects the data through the sensor and controls the water pump relay. All sensors are connected to the input GPIOs of NodeMCU, and actuators are their output. The system operates based on the developed coding in the microcontroller. Samples of sensors and actuators are used in the developed prototype. However, this system can be expanded by including many sensors and actuators in actual implementation.

3.8 Implementation:

A brief explanation of implementation is shown with help of the flow chart mentioned below figure 3.5.

Fig.3.7.Flow chart showing implementation of smart home system.

Implementation of this work uses the following technologies and techniques:

- Adafruit IO
- Google IFTTT
- EasyEDA
- Arduino IDE
- Google Assistant

With help of these a Printed circuit board can be designed and home automation can be

implemented.

Before explaining the implementation a brief description is given about each software as follows:

1. Adafruit IO:

Adafruit Io is a system that makes data useful. Its focus is on ease of use, and allowing simple data connections with little programming required. IO includes client libraries that wrap our REST and MQTT APIs. IO is built on Rails, and Node js. Here it is used to create a GUI to control the home automated appliances by creating buttons and monitoring meters.

2. Google IFTTT:

IFTTT is a freeware web-based service tat creates chains of simple conditional statements, called applets. An applet is triggered by changes that occur witin other web services such as Gmail, Facebook, Telegram, Instagram, etc. Here it is used to create an applet that handles the voice commands tat are used to control the home automation system.

3. EasyEDA:

EasyEDA is a web-based EDA tool suite that enables to design, simulate, and discuss schematics, simulations and printed circuit boards. EasyEDA offers a PCB fabrication service. Here a PCB is designed and fabricated for the home automation system.

4. Arduino IDE:

The Arduino Integrated Development Environment is a cross-platform application that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards. As NodeMCU is a Arduino compatible board so this software is used to write and upload code to the NodeMCU.

5. Google Assistant:

Google Assistant is an AI based voice assistant which is used to control few actions using voice. Here voice commands are used to control the home appliances.

These are used to setup a circuit board and code the program and make the home

automation work. The complete implementation of home automation system using few actuators(lights, fans) is as follows:

Step 1-Fabrication of circuit board:

As discussed EasyEDA software is used to design or simulate a printed circuit board. Everyoneneed to create a project and start designing the circuit board.

- This software has all tools needed to build the PCB.
- Everyoneneed to design the board to serve our purpose.
- Finally required circuit board should be selected, in this case NodeMCU is our required board, so everyoneselect NodeMCU board and finally check the layout of the board.
- If the board designed is fine everyonecan select the color, thickness and etc and place order of the board.

The View of EasyEDA software and outline of the printed circuit board looks as follows in the figure 3.6.

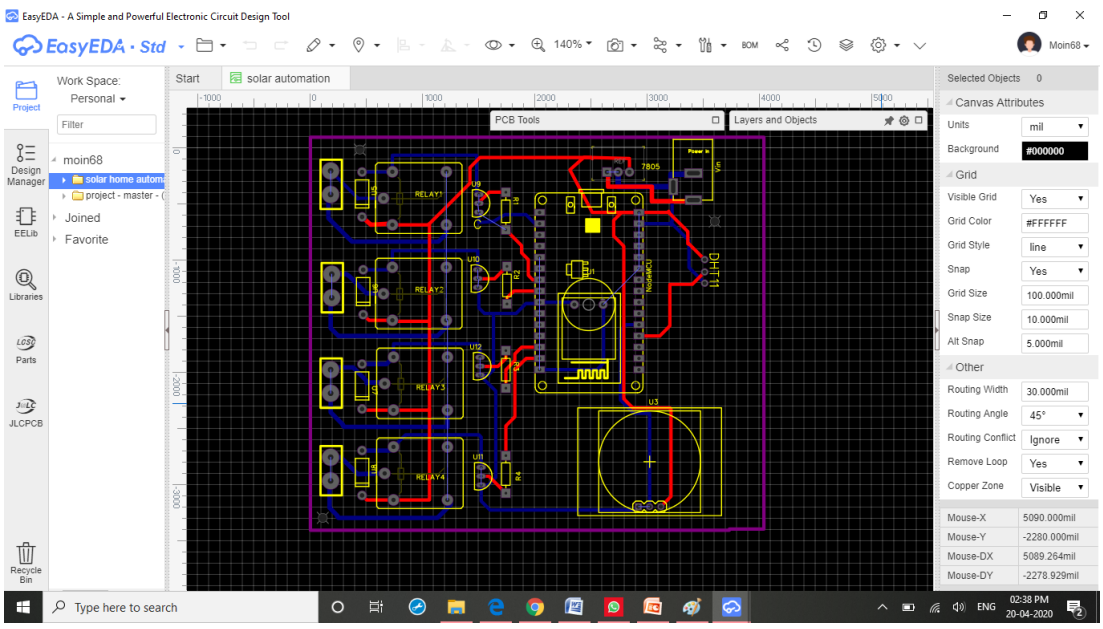

Fig.3.8.Outline of the circuit to operate lights of the home automation system.

Step 2-Creating User Interface for controlling appliances:

Everyoneare using Adafruit IO to create an User Interface which have some buttons to operate the appliances in smart home system. It is also used to monitor the appliances and their values.

Steps to create a button:

- need to create an account using gmail and login using that gmail account as sown in figure 3.7

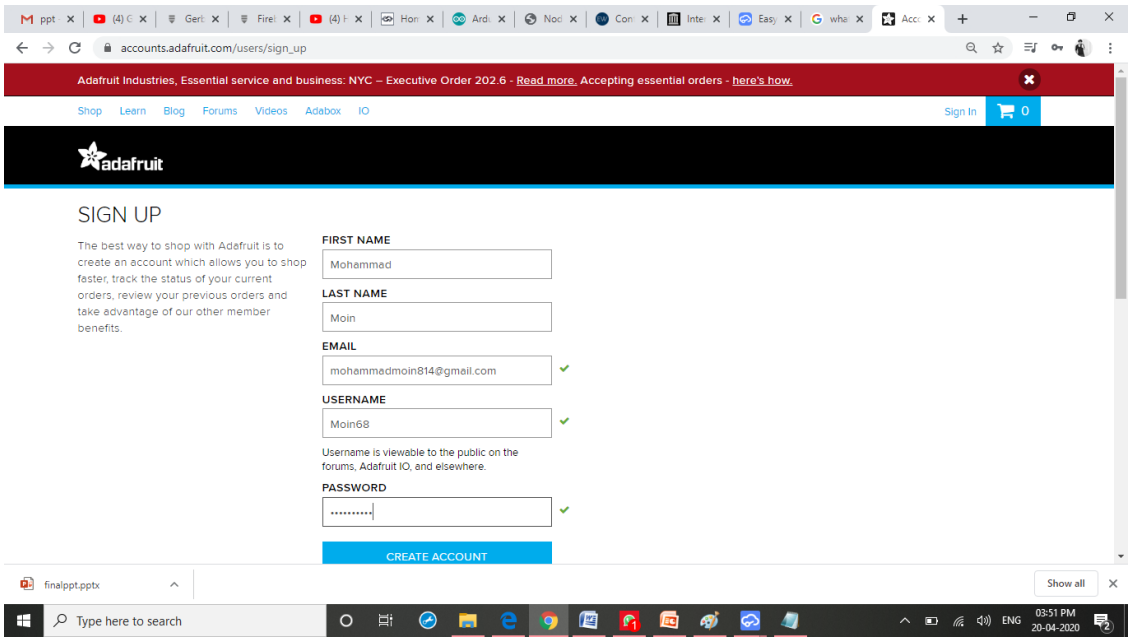

Fig.3.9.Creating an adafruit account

- In Adafruit Io, create a dashboard as shown in figure 3.8.

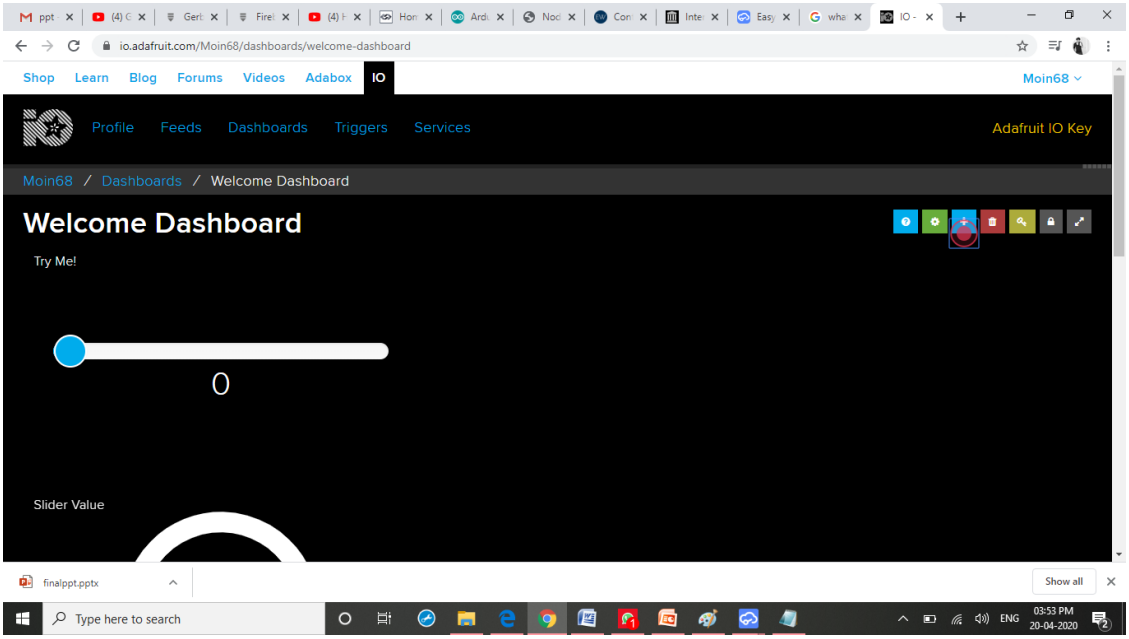

Fig.3.10.Creating a dashboard

- In dashboard, select add buttons and create feeds for that buttons. Edit each button feed value according to the functionalities as shown in figure 3.9 and figure 3.10.

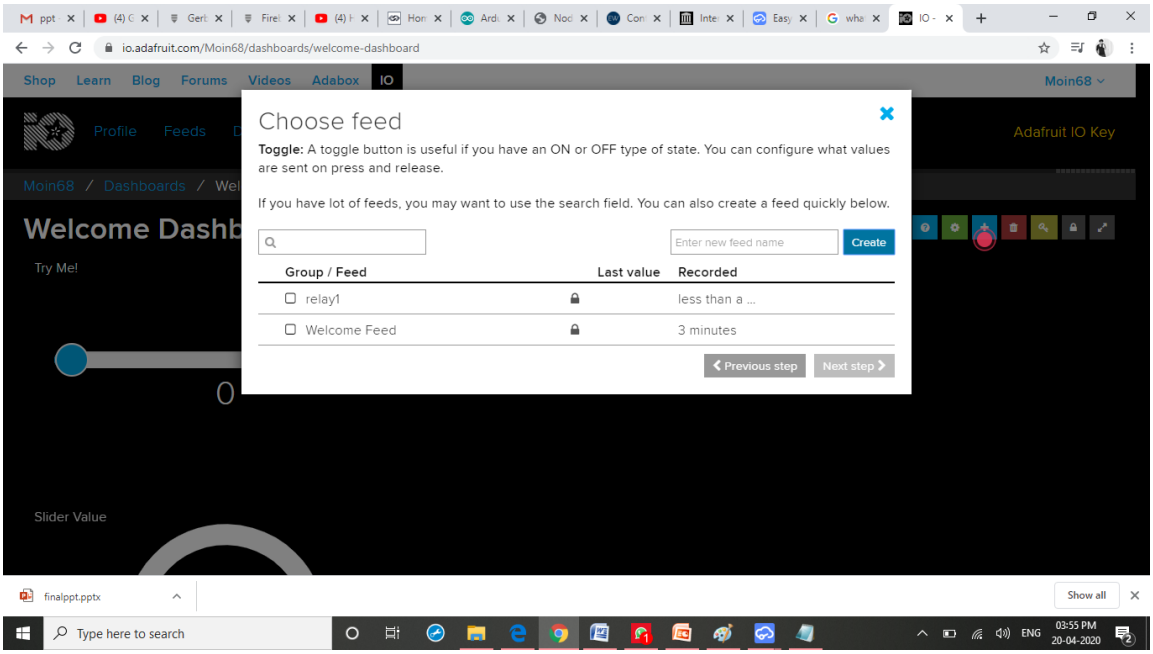

Fig.3.11.Creating feeds

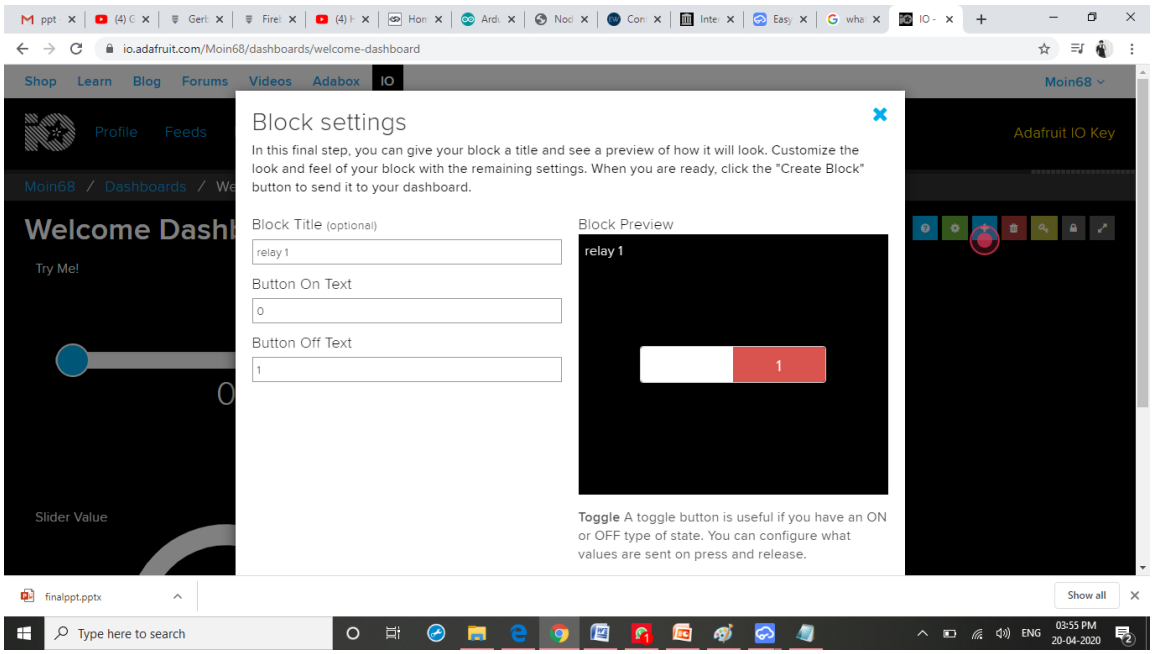

Fig.3.12.Setting feed values.

- can repeat step as many times aswant to match the number of buttons required to operate the home automation system.

The User interface to control the system is developed now coding part is to be done.

Step 3-Editing code and uploading to NodeMCU:

After creating the UI, editing of code and uploading of the code is done, for this Arduino IDE is used, the steps involved to get this done is as follows and IDE is as shown in figure 3.11.

- Import Arduino MQTT libraries into the IDE, next code the program.
- Edit the lines including username, AIO key.. AIO key will be available in Adafruit IO.
- Upload the code to the NodeMCU

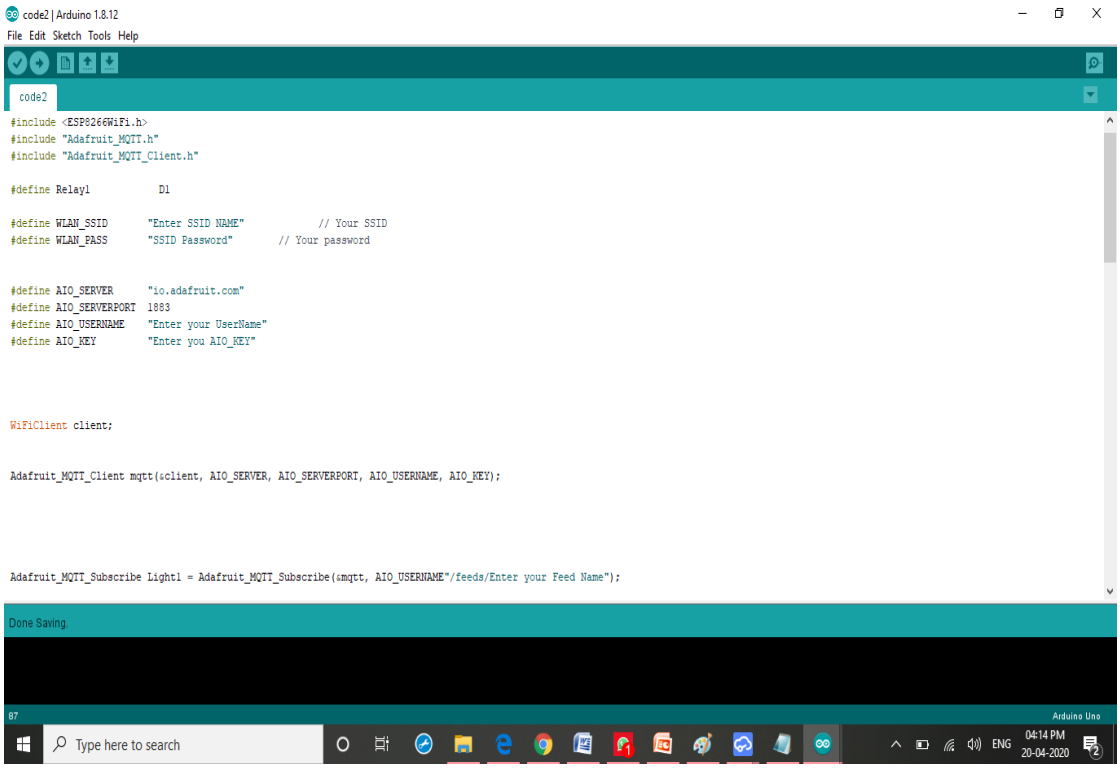

Fig.3.13.View of Arduino IDE

As shown in figure, “Enter your username” and “Enter your AIO_KEY” with your Adafruit username and AIO key present in the Adafruit IO website respectively.

After those editings upload the code to the NodeMCU.

Step 4-Creating Applets:

After creating the UI, coding the program and uploading it to the NodeMCU, First need to create applets to control the appliances using Google assistant. To make this happen users are using Google IFTTT. Creating an applet consists of following steps:

- Sign in to the IFTTT, then click on create applet as shown in figure 3.12.

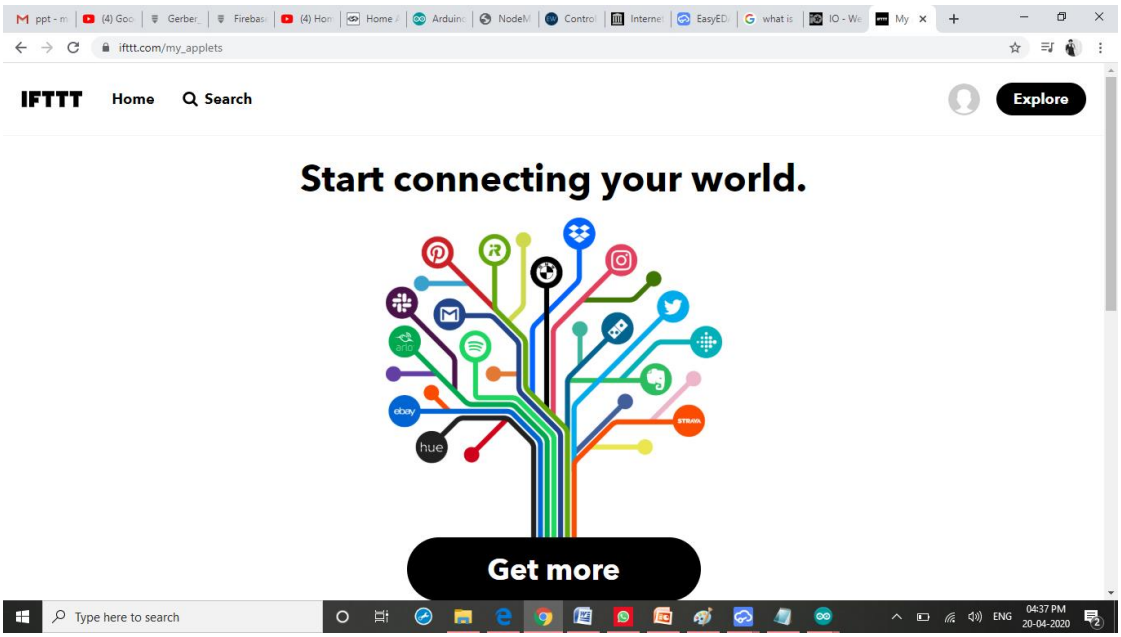

Fig.3.14.Home page of IFTTT

- Select Myapplets and click on “if+this” and search for google assistant and connect using gmail account as sown in figure 3.13.

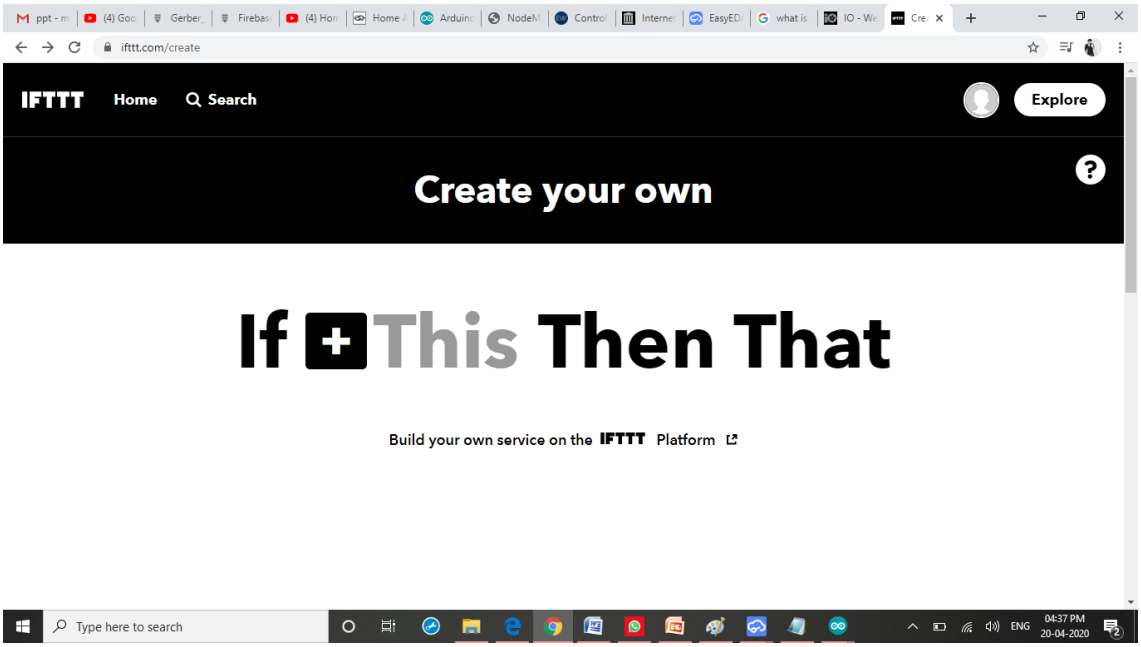

Fig.3.15.View of IF This Then That

- Next create an trigger and assign voice commands and their responses as shown in figure 3.14 and figure 3.15.

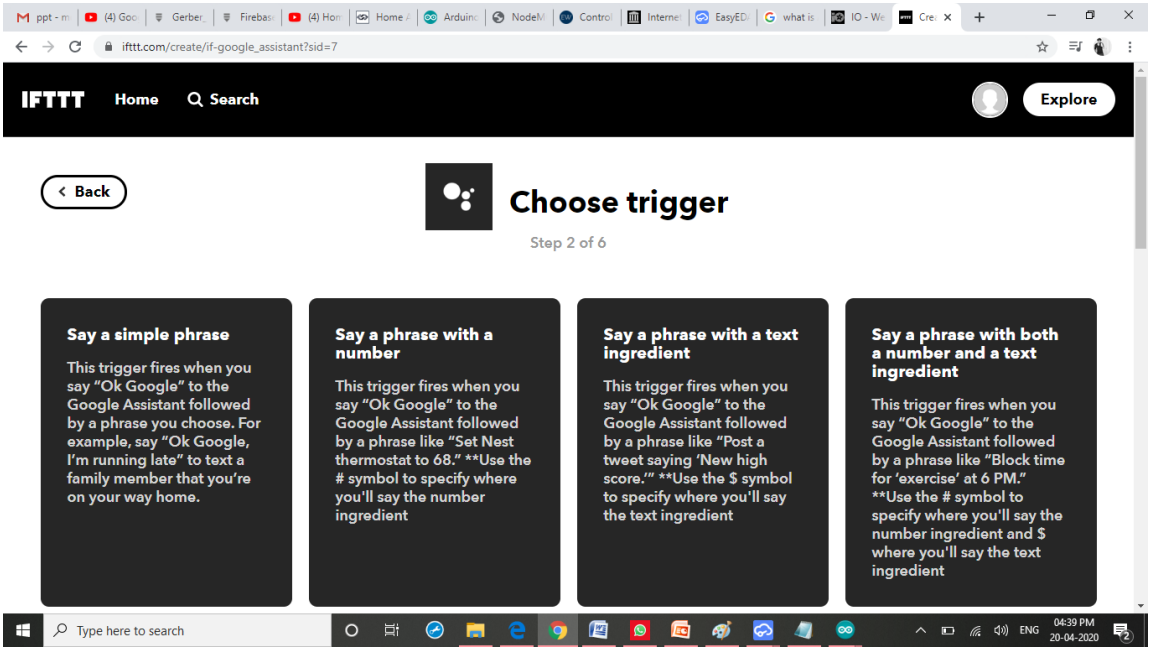

Fig.3.16.Selection of trigger

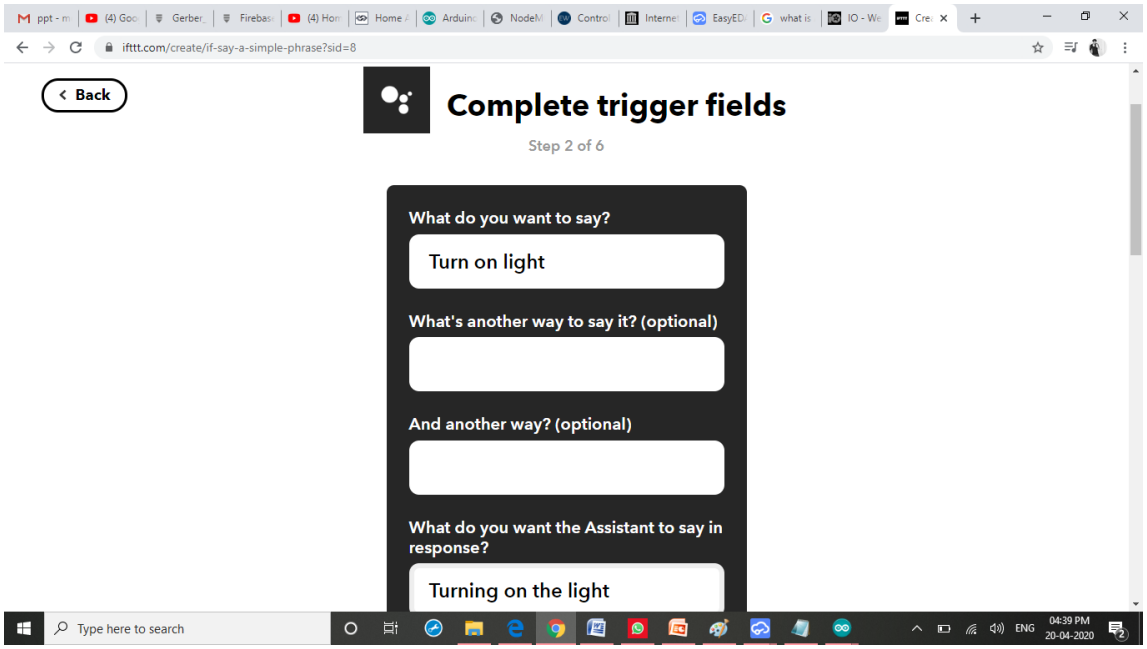

Fig.3.17.Creating trigger

- Select "that" and select adafruit then connect as shown in figure 3.16, later add feed names as placed in Adafruit IO and set data as shown in figure 3.17 and figure 3.18.

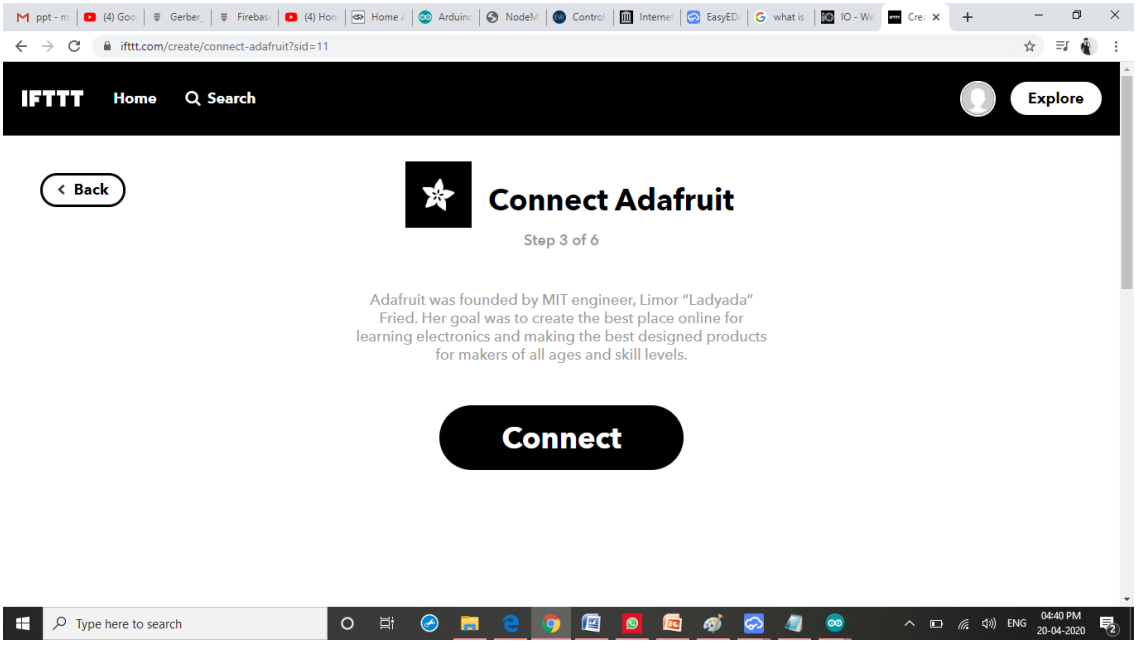

Fig.3.18.Creating "that" action by connecting Adafruit

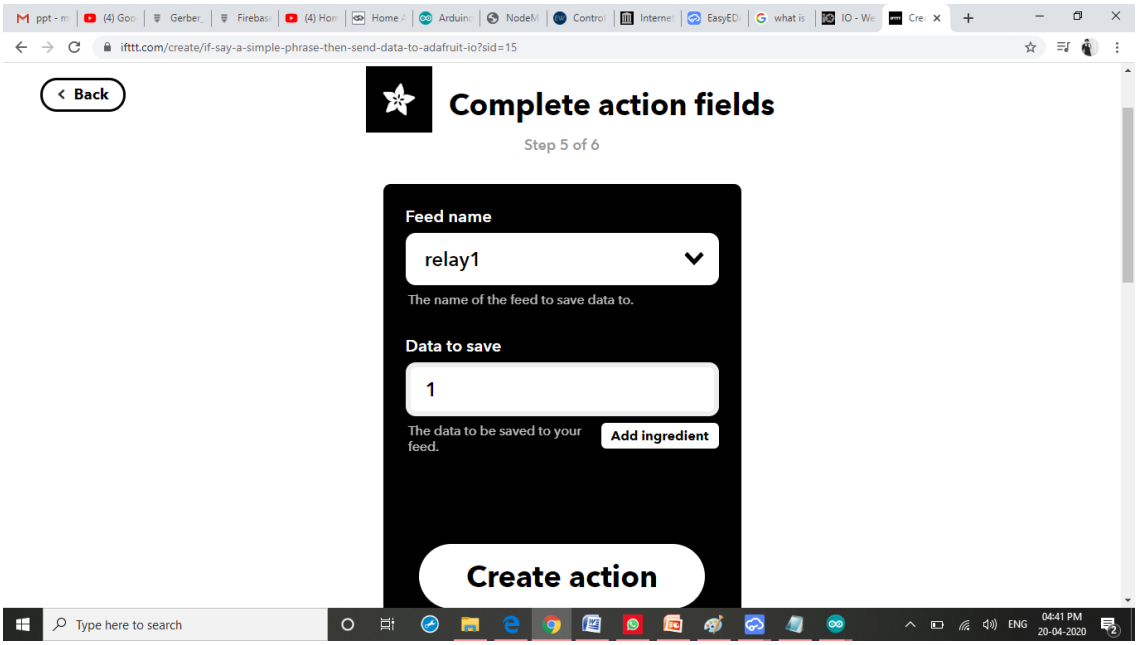

Fig.3.19.Completing action fields

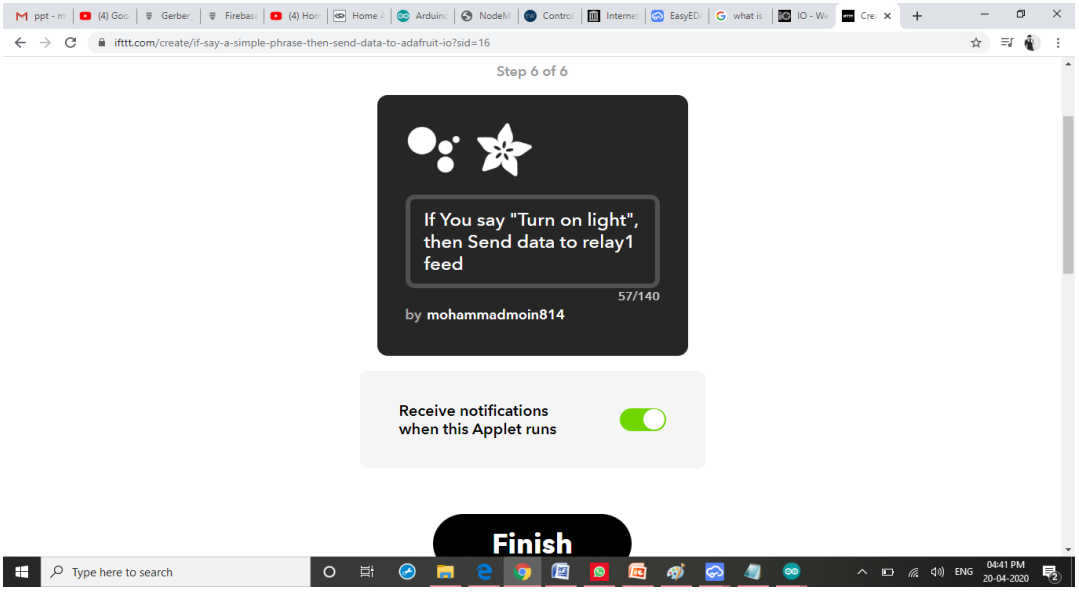

Fig3.20..Final Trigger

- Repeat above 4 steps in creating applets ,can get any number of triggers.

Hence by following above steps the implementation and controlling of the home automation wit Google voice assistant can be achieved. Make sure that toggle in the triggers are active otherwise it would not receive the notifications. It is mandatory to keep all the triggers active so that it receives voice commands and forwards it to NodeMCU which in turn performs commands on the home appliances.

3.9 Performance Evaluation

Performance Evaluation is an important feature to judge whether a system is giving good and expected results or not. Here the home automation system that works with help of solar panels saves current as the energy here is renewable. PCBs are also used so that there might be less chances of short circuiting. Performance of a work can be judged individually or by comparing with other works. In this case it is better to compare with other home automation systems because it will give an idea how much superior this work is when compared to other works related to home automation systems. First the comparison is done between a normal simple home automation in which Bluetooth and GSM were used to control the home appliances. The functionalities of this system are listed as follow:

Table.3.2.Comparison of two smart home systems

Functionalities	**Smart home with GSM/Bluetooth**	**Current work**
Indoor control	YES	YES
Outdoor control	YES	YES
Safety and security	NO	YES
Monitoring	NO	YES
Energy Management	NO	YES
Wireless Interface	Bluetooth/GSM	WiFi
Controller	PIC	NodeMCU
Real Implementation	YES	YES
Smartphone	YES	YES

As seen in above table, smart home with GSM/Bluetooth is the work done by **D. Anandhavalli, N. S. Mubina, and P. Bharathi** during the year 2015(Reference number [1]) and the other one is the current work done and explained in this document. In this comparison, can say that current work is better than the other smart home work. The comparison and superiority of current work is explained as follows:

1. Indoor and Outdoor control is compared as follows:

As operation of a smart home wirelessly is necessary for everyone, these both systems are having both Indoor and Outdoor control, but there is a problem in range of connectivity in outdoor control which will be explained in Wireless Interface.

2. Safety and Security is compared as follows:

In first smart home system there is no facility of Safety and Security which is present in our work; this is one of the reasons to say our work is superior to the other one.

3. Monitoring is compared as follows:

In our work, the monitoring of the home appliances is possible with the help of Adafruit IO which is not present in the other automation system.

4. Energy Management is compared as follows:

As our work is powered with solar panels it is able to save energy, whereas the other automation system uses batteries to power the kit, which in turn is a disadvantage in terms of Energy Management.

5. Wireless Interface is compared as follows:

In this functionality the operability of the home automation system in outdoor control can be constrained in the first automation system as Bluetooth/GSM are used and the range of Bluetooth is very less and GSM needs SMS charges to work. As this is a limitation, it has been overcome in this work as a WiFi is used to connect NodeMCU and home appliances with the mobile. The operability limit is not constrained in this case; just connection to WiFi is enough to operate this system.

6. Controllers are compared as follows:

In the first system PIC controller is used and NodeMCU is used in our work. NodeMCU is better when compared as it is compatible and it has option of editing the code or uploading a new code whenever necessary. This makes NodeMCU much more superior.

These are few reasons why Current work is better than other smart home automations. Thus ,can evaluate the performance of the home automation by comparing it with other systems. Thuscan say current work is having better performance as it has checked all the boxes of functionalities that a smart home should have and this is powered by solar panels which makes it eco friendly, which is a great feature that helps in Energy management.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Detailed Explanation

This provides the results to verify the functionalities of the implemented home automation system in the fabricated SH prototype. This work successfully controls home appliances (lights, fans, and others) and monitors various functionalities, such as temperature, gas, and motion using mobile phones/laptops through Adafruit IO, MQTT Dash, and Google Assistant. Users can monitor and control the SH prototype anytime and anywhere by connecting to the Internet.

One of the achievements of this study is the utilization of artificial intelligence in controlling home appliances by enabling Google Assistant voice commands to help people with disabilities. Users have multiple options by developing multi-dashboards and can utilize any device by connecting to the Internet regardless of time and location to monitor and control the home. NodeMCU is connected to the predefined Wi-Fi network to continuously connect the home automation system to the Internet. Users can use any mobile device, laptop or personal computer to log in to Adafruit IO, MQTT Dash, and Google Assistant applications to access the developed control system, which gets the sensor data from NodeMCU and sends the used commands to NodeMCU.

Thus, users can control all electrical appliances and monitor the appliances of the house. Users can obtain up-to-date information from the sensors through the Adafruit IO platform or MQTT Dash. In addition, users can switch ON/OFF the light bulbs using the buttons on the GUI. The values from sensors are not directly communicated to the nodeMCU, IFTTT serves as a gateway to transfer the commands to the nodeMCU and back to the mobile. For example, the bar color changes from yellow to blue when the gas sensor exceeds the value of 650, the data are sent through IFTT, and a notification is sent to the user’s smartphone. A DHT22 sensor can detect abnormal temperature that may be due to a fire at home, and Adafruit sends feeds to IFTTT to notify users on their smart phones when the temperature exceeds the threshold. Such functionality can increase the safety and security of SHs.

4.2 Evaluation of investigation carried out

The effectiveness of the developed system is validated by evaluating its functionalities on the fabricated SH prototype. All electrical appliances and sensors can be controlled and monitored using Adafruit IO, MQTT Dash, and Google Assistant. Maintaining rapid and accurate reading of the sensors is one of the issues encountered during the testing phase in this study. In the beginning, a 16-channel analog multiplexer was utilized to increase the number of analog ports due to the limited number of NodeMCU pins. The sensors connected to the multiplexer did not provide accurate readings during testing, and switching ON/OFF appliances was delayed. After several experiments, and added another NodeMCU controller. Subsequently, the system without analog multiplexer was tested, and all sensors were functioning well and provided accurate readings to the server. The switching delay of home appliances was reduced, and the response was fast..

The NodeMCU can be easily controlled by the computer and smartphone through the Internet. In addition, the NodeMCU facilitated editing and uploading the codes using Arduino IDE whenever necessary with the micro USB port. An Adafruit account was created to enable control and monitoring of the SH. This account can be logged in through the webserver where the application for the smartphone is not available. The Adafruit account did not fulfill this requirement due to the objective of the project, which was remote control of SH. To address this situation, an MQTT DASH smartphone application was used to connect and link with the Adafruit account. This application has a simple GUI design, where its color, title, and size can be selected by the user. Users can easily control and monitor their SHs within a few seconds through this application.

This project was implemented using Google Assistant to control the switch ON/OFF button. This implementation used IFTTT to trigger the Adafruit system. Users can easily control their homes by speaking to Google Assistant on their smartphones. Google Assistant triggers Adafruit with specific feeds and turns ON/OFF the light. This function helps elderly people to use mobile applications and improve their mobility. The UI of adafruit is shown in figure 4.1 and UI of google assistant is shown in figure 4.2

Fig.4.1.User Interface of adafruit website.

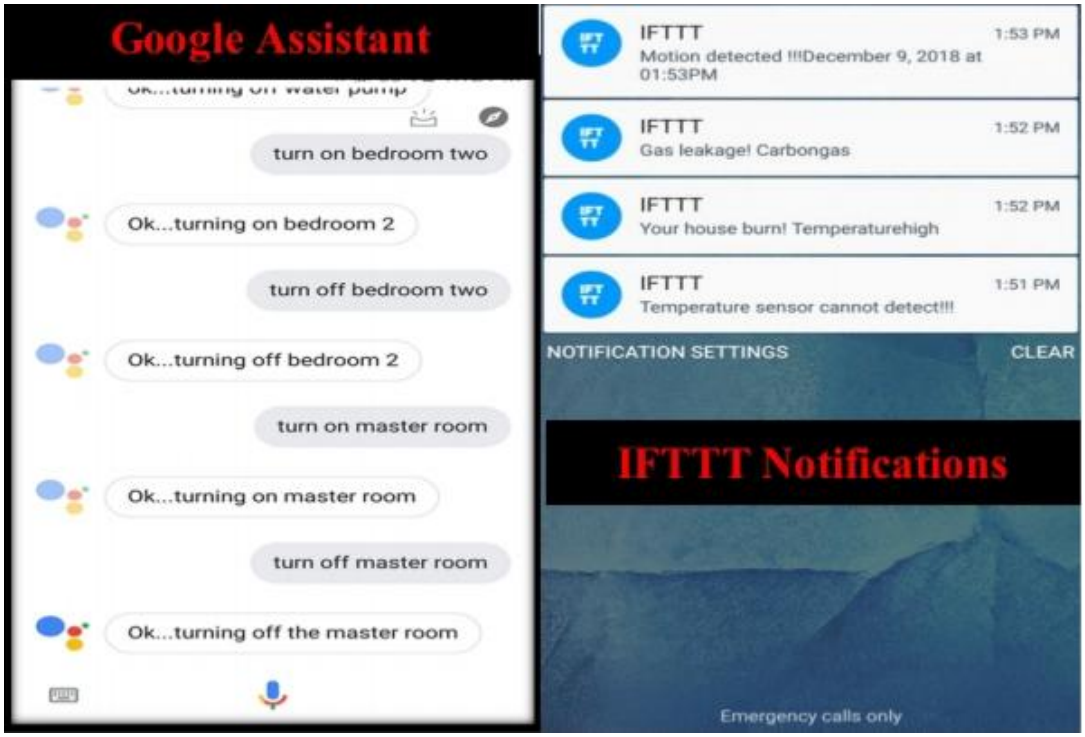

Fig.4.2.Google assistant and notifications received to mobile by IFTTT

CHAPTER 5

CONCLUSIONS AND FUTURE WORK

5.1 Conclusion:

This work helped to develop a smart home which is operated using IoT which was useful in controlling home appliances with help of smart phones or computers. This work included several sensors, actuators, microcontrollers and several hardware components, in which solar panels were used to supply the power necessary for the system to work. Other smart home systems used batteries to provide current supply which resulted in non eco friendly smart home systems, to overcome the non eco friendly concept and provide a fully functioning smart home system this work was successful in doing it. Using of solar panels made this work an eco friendly by consuming less power and provide better functionality.

5.2 Future Work:

This current work can be extended by using better protocol like CoAP instead of MQTT, which results in faster transmissions as UDP is used in CoAP whereas TCP is used in MQTT. Using of CoAP helps in using UDP but it also supports TCP for a safe side, if there is a doubt of loss of data packets TCP support in CoAP can be used to overcome this situation. This can be used as a future work of IoT based smart home.

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CHAPTER 6

APPENDICES

6.1 Code for receiving notification to mobile phone

```
#include <ESP8266HTTPClient.h>
#include <ESP8266WiFi.h>
#define REED_SWITCH 5 //D1

const char* ssid = "WifiRouter";
const char* password = "WifiPassword";
int doorClosed = 1;

void setup() {
  pinMode(REED_SWITCH, INPUT_PULLUP);

  Serial.begin(115200);

  setupWifi();


}

void setupWifi()
{
    // Connect to WPA/WPA2 network.
   WiFi.mode(WIFI_STA);
   status = WiFi.begin(ssid, password);

   Serial.print("Attempting to connect to SSID: ");
   Serial.println(ssid);
```

```
  // Wait for connection
  while (WiFi.status() != WL_CONNECTED) {
   delay(1000);
   Serial.print(".");
  }
  Serial.println("Connected to wifi");
}

void loop() {
  if (WiFi.status() != WL_CONNECTED)
  {
    setupWifi();
  }

 // this is main code, it runs repeatedly:
   if ((digitalRead(REED_SWITCH) == HIGH) && (doorClosed == 1))
   {
     Serial.println("DOOR OPEN!!");
     while (get_http(String("DOOR_OPEN_")) != 0);
     doorClosed = 0;
   }
   else if ((digitalRead(REED_SWITCH) == LOW) && (doorClosed == 0))
   {
     Serial.println("DOOR CLOSED!!");
     while (get_http(String("DOOR_CLOSED_")) != 0);
     doorClosed = 1;
   }
   delay(10);



}

int get_http(String state)
```

```
{
  HTTPClient http;
  int ret = 0;
  Serial.print("[HTTP] begin...\n");

  // configure ifttt server
   http.begin("http://maker.ifttt.com/trigger/door/with/key/your_key_from_Iftt"); //HTTP

   Serial.print("[HTTP] GET...\n");

   // start connection and send HTTP header
   int httpCode = http.GET();

   // httpCode will be negative on error
   if(httpCode > 0) {

   // HTTP header has been send and Server response header has been handled
   Serial.printf("[HTTP] GET code: %d\n", httpCode);

     if(httpCode == HTTP_CODE_OK) {
       String payload = http.getString();
       Serial.println(payload);
     }
   } else {
       ret = -1;
       Serial.printf("[HTTP] GET failed, error: %s\n",
http.errorToString(httpCode).c_str());
       delay(500); // wait for half sec before retry again
   }

   http.end();
   return ret;
}
```

6.2 Code to control actuators using app and Google firebase

```
#include <ESP8266WiFi.h>
#include<FirebaseArduino.h>
#define FIREBASE_HOST "test-fcb91.firebaseio.com"
#define FIREBASE_AUTH "yoezZbKI1mZmcIlAAsMRC2Mdf4tinEQ5k02uQl"
//Your Firebase Database goes here
#define WIFI_SSID "wifiName"                                    //your WiFi SSID for which
yout NodeMCU connects
#define WIFI_PASSWORD "wifiPassword"                            //Password of your
wifi network

#define Relay1 12 //D6
int val1;

#define Relay2 14 //D2
int val2;

#define Relay3 4  //D1
int val3;

#define Relay4 5 //D5
int val4;

void setup()
{
  Serial.begin(115200);
  pinMode(Relay1,OUTPUT);
  pinMode(Relay2,OUTPUT);
  pinMode(Relay3,OUTPUT);
  pinMode(Relay4,OUTPUT);

  digitalWrite(Relay1,HIGH);
  digitalWrite(Relay2,HIGH);
```

```
 digitalWrite(Relay3,HIGH);
 digitalWrite(Relay4,HIGH);
 WiFi.begin(WIFI_SSID,WIFI_PASSWORD);
 Serial.print("connecting");
 while (WiFi.status()!=WL_CONNECTED){
  Serial.print(".");
  delay(500);
 }
 Serial.println();
 Serial.print("connected:");
 Serial.println(WiFi.localIP());

 Firebase.begin(FIREBASE_HOST,FIREBASE_AUTH);
 Firebase.setInt("S1",0);
 Firebase.setInt("S2",0);
 Firebase.setInt("S3",0);
 Firebase.setInt("S4",0);

}
void firebasereconnect()
{
 Serial.println("Trying to reconnect");
   Firebase.begin(FIREBASE_HOST, FIREBASE_AUTH);
 }

void loop()
{
 if (Firebase.failed())
     {
     Serial.print("setting number failed:");
     Serial.println(Firebase.error());
     firebasereconnect();
     return;
```

```
    }
    //Reading the value of the varialble Status from the firebase

 val1=Firebase.getString("S1").toInt();
 if(val1==1)                                    // If, the Status is 1, turn on the Relay1
   {
    digitalWrite(Relay1,LOW);
    Serial.println("light 1 ON");
   }
  else if(val1==0)                                 // If, the Status is 0, turn Off the
Relay1
   {
    digitalWrite(Relay1,HIGH);
    Serial.println("light 1 OFF");
   }

 val2=Firebase.getString("S2").toInt();                  //Reading the value of the
varialble Status from the firebase

 if(val2==1)                                    // If, the Status is 1, turn on the Relay2
   {
    digitalWrite(Relay2,LOW);
    Serial.println("light 2 ON");
   }
  else if(val2==0)                                 // If, the Status is 0, turn Off the
Relay2
   {
    digitalWrite(Relay2,HIGH);
    Serial.println("light 2 OFF");
   }

  val3=Firebase.getString("S3").toInt();                  //Reading the value of the
varialble Status from the firebase
```

```
 if(val3==1)                                  // If, the Status is 1, turn on the Relay3
   {
    digitalWrite(Relay3,LOW);
    Serial.println("light 3 ON");
   }
  else if(val3==0)                                  // If, the Status is 0, turn Off the
Relay3
  {
    digitalWrite(Relay3,HIGH);
    Serial.println("light 3 OFF");
  }

  val4=Firebase.getString("S4").toInt();                  //Reading the value of the
varialble Status from the firebase

 if(val4==1)                                  // If, the Status is 1, turn on the Relay4
   {
    digitalWrite(Relay4,LOW);
    Serial.println("light 4 ON");
   }
  else if(val4==0)                                  // If, the Status is 0, turn Off the
Relay4
  {
    digitalWrite(Relay4,HIGH);
    Serial.println("light 4 OFF");
  }
}
```

6.3 Code for controlling home appliances using google assistant

```
#include <ESP8266WiFi.h>
#include "Adafruit_MQTT.h"
#include "Adafruit_MQTT_Client.h"
#define Relay1            D1
#define WLAN_SSID       "Enter SSID NAME"             // Your SSID
#define WLAN_PASS       "SSID Password"        // Your password
#define AIO_SERVER      "io.adafruit.com"
#define AIO_SERVERPORT  1883
#define AIO_USERNAME    "Enter your UserName"
#define AIO_KEY         "Enter you AIO_KEY"

WiFiClient client;
Adafruit_MQTT_Client mqtt(&client, AIO_SERVER, AIO_SERVERPORT,
AIO_USERNAME, AIO_KEY);




Adafruit_MQTT_Subscribe Light1 = Adafruit_MQTT_Subscribe(&mqtt,
AIO_USERNAME"/feeds/Enter your Feed Name");

void MQTT_connect();

void setup() {
  Serial.begin(115200);

  pinMode(Relay1, OUTPUT);
  Serial.println(); Serial.println();
  Serial.print("Connecting to ");
```

```
  Serial.println(WLAN_SSID);

  WiFi.begin(WLAN_SSID, WLAN_PASS);
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
  Serial.println();

  Serial.println("WiFi connected");
  Serial.println("IP address: ");
  Serial.println(WiFi.localIP());
   mqtt.subscribe(&Light1);
}



void loop() {

  MQTT_connect();

  Adafruit_MQTT_Subscribe *subscription;
  while ((subscription = mqtt.readSubscription(5000))) {
    if (subscription == &Light1) {
      Serial.print(F("Got: "));
      Serial.println((char *)Light1.lastread);
      int Light1_State = atoi((char *)Light1.lastread);
      digitalWrite(Relay1, !(Light1_State));

void MQTT_connect() {
  int8_t ret;

  if (mqtt.connected()) {
```

```
  return;
}

Serial.print("Connecting to MQTT... ");

uint8_t retries = 3;

while ((ret = mqtt.connect()) != 0) {
  Serial.println(mqtt.connectErrorString(ret));
  Serial.println("Retrying MQTT connection in 5 seconds...");
  mqtt.disconnect();
  delay(5000);  // wait 5 seconds
  retries--;
  if (retries == 0) {
    // basically die and wait for WDT to reset me
    while (1);
  }
}
Serial.println("MQTT                                                    Connected!")
```

SREE VIDYANIKETHAN ENGINEERING COLLEGE (AUTONOMOUS)

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To be one of the Nation's premier Engineering Colleges by achieving the highest order of excellence in Teaching and Research.

MISSION

- To foster intellectual curiosity, pursuit and dissemination of knowledge.
- To explore students' potential through academic freedom and integrity.
- To promote technical mastery and nurture skilled professionals to face competition in ever increasing complex world.

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Sree Sainath Nagar, Tirupati-517102

DEPARTMENT VISION AND MISSION

Department of Computer Science and Systems Engineering

VISION:

- To become a Centre of excellence in Computer Sciences and Systems Engineering through teaching, training, research and innovation to produce high quality engineering professionals who can solve the growing complex problems of the society and Industry.

MISSION:

- Established with the cause of development of technical education in advanced computer sciences and engineering with applications to systems there by serving the society and nation.
- Transfer of Knowledge through contemporary curriculum and fostering faculty and student development.
- Create keen interest for research and innovation among students and faculty by understanding the needs of the society and industry.
- Skill development among diversity of students in technical domains and profession for development of systems and processes to meet the demands of the industry and research.
- Imbibing values and ethics in students for prospective and promising engineering profession and develop a sense of respect for all.

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Department of Computer Science and Systems Engineering

PROGRAM OUTCOMES

After the completion of the program, a successful student will be able to:

1. Acquire knowledge of mathematics, sciences and concepts of Computer Sciences and Engineering.
2. Ability to perform analysis of electronic systems, computer systems and software systems to meet the requirements.
3. Design and develop computer, software, mobile, embedded systems and high performance computing systems.
4. Skills to solve problems in hardware and software systems.
5. Use of computer science principles and modern tools to computing systems engineering practice.
6. Create solutions of social context the impact of Computer Science and Systems Engineering.
7. Practice computer sciences and engineering in compliance with environmental standards.
8. Follow ethical code of conduct in professional activities.
9. Achieve personal excellence and ability to work in groups.
10. Develop effective communication in professional transactions.
11. Life skills for effective project management.
12. Appreciate the significance and applications of computer science and engineering and to engage in lifelong learning for knowledge and skill upgradation.

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Department of Computer Science and Systems Engineering

PROGRAM SPECIFIC OUTCOMES

On successful completion of the Program, the graduates will be able to

1. Acquire knowledge of mathematics, Computer Science and Systems Engineering to solve complex engineering problems.

2. Identify, Analyze, Design among alternatives and Develop software for applications and systems in the domain of Computers and its based Systems to meet the societal needs.

3. Use the research-based knowledge and methods to solve realworld problems in the fields of Computer Science and Systems Engineering.

4. Apply appropriate techniques, use modern programing languages, and packages to simulate and develop software by thoroughly understanding the requirements of the system and its constraints in Computer Science and Engineering.

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Department of Computer Science and Systems Engineering

PROGRAM EDUCATIONAL OBJECTIVES

After few years of graduation:

1. Graduate will pursue advanced studies in Computer Science domain and Management.
2. Graduates will be employed in reputed Software Industries and develop Quality Software Systems.
3. Graduates will have career progression through professional skill development, continuing education with ethical attitude.

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Department of Computer Science and Systems Engineering

COURSE OUTCOMES

Completion of the project work enables a successful student to demonstrate:

CO1. Knowledge on the project topic.

CO2. Analytical ability exercised in the project work.

CO3. Design skills applied on the project topic.

CO4. Ability to investigate and solve complex engineering problems faced during the project work.

CO5. Ability to apply tools and techniques to complex engineering activities with an understanding of limitations in the project work.

CO6. Ability to provide solutions as per societal needs with consideration to health, safety, legal and cultural issues considered in the project work.

CO7. Understanding of the impact of the professional engineering solutions in environmental context and need for sustainable development experienced during the project work.

CO8. Ability to apply ethics and norms of the engineering practice as applied in the project work.

CO9. Ability to function effectively as an individual as experienced during the project work.

CO10. Ability to present views cogently and precisely on the project work.

CO11. Project management skills as applied in the project work.

CO12. Ability to engage in life-long leaning as experience during the project work

MAPPING OF COURSE OUTCOMES WITH PROJECT

CO mapping with project

CO4, CO8	Algorithmic approach	√
CO3, CO8	Simulation Model/Experiments Design	√
CO2	Identification of metrics related to the work	√
CO2, CO5	Comparison of results with rival methods	√
CO6	Society related Problem	√
CO9	Self Dependency in Performing Tasks/team work	√
CO12	Is the abstract appropriate to the project?	√
CO1	Introduction and literature Review	√
CO3, CO8	Modeling and Implementation	√
CO7	Results for sustainable development	√
CO11	Feasibility study, Cost Model	
CO10, CO12	Conclusions and Future work	√

CO mapping with PO and PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03	PS04
CO1	√												√			
CO2		√												√		
CO3			√												√	
CO4				√												√
CO5					√											
CO6						√										
CO7							√									
CO8								√								
CO9									√							
CO10										√						
CO11											√					
CO12												√				