A Major Project Report On

IOT Based Monitoring and Control of Appliances for Smart Home

Submitted in partial fulfilment for the
degree of Bachelor of Technology in
Information Technology

Submitted by
Arushi Barde 1413007
Hetal Patel 1413037

Under the guidance of
Prof. Sujata Kullur

Usha Mittal Institute of Technology
Juhu Tara road
Santacruz west
Mumbai - 400049

2017-18

CERTIFICATE

This is to certify that Ms Arushi Barde and Ms Hetal Patel has completed the Major Project report on the topic "IOT Based Monitoring and Control of Appliances for Smart Home" satisfactorily in partial fulfillment for the Bachelor's Degree in Information Technology under the guidance of Prof. Sujata Kullur during the year 2017-18 as prescribed by Usha Mittal Institute of Technology.

Guide

Prof. Sujata Kullur

Head Of Department

Dr. Sanjay Shitole

Principal
Dr. Sanjay Pawar

Examiner 1

Examiner 2

Abstract

Internet of Things (IoT) is an ecosystem of connected physical objects that are accessible through the internet. The thing in IoT could be objects that have been assigned an IP address and have the ability to collect and transfer data over a network without manual assistance or intervention. We are looking forward to implement smart home automation system using Internet of Things which would be more reliable, cheap and user friendly to lead more comfortable life. This purposed home automation technology provides smart monitoring and control of the home appliances. The control and monitoring the status (ON/OFF of the appliances) have been implemented using different ways such as The Internet and Graphical User Interface (GUI) . Wireless home automation system can be categorized in two ways, viz. Bluetooth and Wi-Fi. Bluetooth concept is suitable for control of devices within the limited range. Wifi module can be utilised for controlling appliances with comparatively longer range. Using this system, the consumer can reduce the wastage of electrical power by regular monitoring of home appliances or the proper ON/OFF scheduling of the devices. The project focuses on spreading the awareness of consumption of electricity. The user can monitor and manage the electricity consumption on daily basis as compared to monthly electricity bills.

Thus, we have successfully implemented the monitoring and controlling of Home Automation System by interfacing Arduino UNO with ESP 8266 WiFi module.

Keywords: *Arduino UNO, ESP 8266 WiFi module, AC712 Sensor, Smart Meter*

Contents

List of Figures

Nomenclature

IOT	Internet of Things
LED	Light Emiting Diode
IDE	Integrated Development Environment
ICSP	In Circuit Serial Programming
FTDI	Future Technology Devices International
ESP	Espressif Systems
TCP/IP	Transmission Control Protocol-Internet Protocol
AT	ATtention
UART	Universal Asynchronous Receiver/Transmitter
TTL	Transistor-Transistor Logic
COM	Communication port
LPT	Line Print Terminal
HTML	HyperText Markup Language
XML	Extensible Markup Language

Chapter 1

Introduction

IoT (Internet of Things) is an advanced automation and analytics system which exploits networking, sensing, big data, and artificial intelligence technology to deliver complete systems for a product or service. These systems allow greater transparency, control, and performance when applied to any industry or system. IoT systems have applications across industries through their unique flexibility and ability to be suitable in any environment. They enhance data collection, automation, operations, and much more through smart devices and powerful enabling technology.

Smart home automation forms a major IoT-based process, in which all the domestic appliances used in ones own house communicate with each other to perform functions and act in a way desirable to the occupants.[1] This system has two parts such as monitoring and control of the appliances and smart metering system. The appliances of the house can be monitored and controlled by constantly keeping a track on the electricity consumption. This automation system can send and receive data from the remote user via the internet. The user can monitor the status concerning ON/OFF and control the appliances of the home by online.

Electrical energy or power is an important factor for human being survival now a days. Apart from this efforts automation in the energy distribution is necessary for enhancing peoples needs. Now a days human meter reading is providing insufficient to cope up with future residential need. Real time information data monitoring of energy consumption is main objective of system.[1]

1.1 Problem Statement

In smart home automation, we can control all the devices and appliances in a house so that they perform functions like switch ON and OFF on our commands with a single tap or sound, track status of average electricity-consumption per month or year, give regular updates about each appliances current status. It provides convenience, comfort, security and saves energy. Automation makes not only an efficient but also an economical use of the electricity and reduces much of the wastage. With increasing adoption of internet technologies like Wi-Fi and 4G, it has become easier to connect two things with each other, be it humans or devices. Due to the same reason, even controlling simple appliances in ones home has become progressively efficient. And because of this, home automation has also gained popularity.

In this Project we are implementing Home Automation System using WiFi Module ESP8266. The components which are included for the implementation are Arduino Uno, WiFi Module ESP8266, Sensor Module ACS712, Relay Board, Bread Board, Electrical Wires and Jumper Wires, 240V Bulb and Resistors.

This home automation system is used to monitor and control basic home appliances like bulb or fan using IOT Devices. But the system is restricted to basic appliances only, that is it cannot be implemented on heavy home appliances such as Refrigerator, Washing Machine, Air Conditioner etc. The range of ESP8266 wifi module depends on environment it is used. If the system is used indoor then the range depends upon the number of walls, else outdoor, the maximum range will be 300 meters. The maximum range will be extended upto 479 meters if used with TPLink WR841N router or External antennas will give more range if they're oriented in the 'best' direction (usually parallel to each other).

The problem facing by common consumer is to pay continuously increasing bills for electricity without knowing the consumption again the problem of faulty meters and frequently cut off of energy. In such a situation, a question that arises constantly in the minds of consumers is that why the service provides are not providing any real time systems. This common consumers issue is solved in this system. He will get to know what is happening with his bill and meter readings.

1.1.1 Benefits

- Automation : The user can perform automated switch ON/OFF operation through Web Application over internet.
- Efficiency : The system ensures the efficient utilization of electricity.
- Scalability : The system can be easily scalable by adding more number of devices.
- Feasibility : Design of the system is simple and understandable by the user.

1.1.2 Limitations

- Restricted to basic home appliances : It cannot be utilized for heavy home appliances such as Refrigerator, Wash Machine, Air Conditioner, etc.
- Range : In presence of obstructions the range of the system is limited.

1.2 Real Time Applications

- **Lighting Control**

  Smart lighting allows you to control wall switches, blinds, and lamps, but how intuitive is a lighting control system. It turns out, quite; its capabilities are extensive. You are able to schedule the times lights should turn on and off, decide which specific rooms should be illuminated at certain times, select the level of light which should be emitted, and choose how particular lights react through motion sensitivity.[2]

- **Lawn Irrigation Systems**

  A lush and healthy lawn is a source of pride for most homeowners, but the weather doesnt always cooperate and provide the adequate elements for a flourishing landscape. For decades we have relied on sprinkler systems to keep our yards at peak presentation. The average American home spends approximately 30 percent of their daily water usage on lawn and garden

maintenance. Nearly half of that amount is wasted due to inefficiency. If you apply that statistic to the national average, up to 4.5 billion gallons of water is wasted per day through ineffective watering methods. If we reflect upon the monetary impact of this, it results in Americans spending over a thousand dollars a year in water, with a portion of that being waste. The global effects are even greater when you consider the growing concern over climate change and the dramatic decrease in agricultural natural resources. However, sprinkler control systems, like Skydrop, are providing water regulation through real-time communication with local weather data. If a rainstorm develops and deposits two inches of rainwater on your lawn, the automated sprinkler detects the saturation and disables its scheduled watering. Conversely, the system will be alerted to dry conditions and supply the necessary amount of nourishment, without over-watering.[2]

- **Smart Appliances**

  Smart refrigerators, such as LGs Smart ThinQ, allow you to scan grocery store receipts and keep an inventory of your items, and alerts you if an item is about to expire. More impressively, it suggests recipes based on your refrigerators contents and lets you know when you need to replace items. Smart ovens synch with your smartphone and automatically preheat to the correct temperature based on a recipe selected from your database. While these appliance options seem a bit superficial and convenience based, there is a conservation factor as well. By automating your kitchen appliance and making them accessible from your smart device, you are able to sever the electricity supplied to unused appliances and reduce your energy consumption and costs. Considering the number of appliances the average household owns; this could save a substantial amount of money over time.[2]

- **Security Systems**

  While efficiency and conservation are certainly IoT benefits, its potential to have improved control over home security is a primary focus. Smart locks, like Kwiksets Kevo, a Bluetooth enabled electronic deadbolt, and various connected home security systems, such as iSmartAlarm, offer a variety of

features including door and window sensors, motion detectors, video cameras and recording mechanisms. All of which are connected to a mobile device and accessible via the cloud, thus enabling you to access real-time information on the security status of your home. Naturally, there is a great deal of scrutiny regarding the level of trust in controlling your homes security system via a mobile device, but it begs earnest exploration when weighing the potential benefits and peace of mind it provides homeowners.[2]

1.3 Comparison of Traditional System with The Proposed System

SR NO.	PARAMETERS	TRADITIONAL SYSTEM	PROPOSED SYSTEM
1.	Cost of the System	Moderate	High
2.	Way of Control Method	Electrical Switch	GUI, Internet, Electrical Switch
3.	Circuit Complexity	High	Comparatively Less
4.	Integration of Appliances	Less	High
5.	User Comfort	Less	High

Figure 1.1: Comparison

1.4 Organisation of the Project

Chapter 1 Includes the Introduction of the proposed system followed by the Problem Statement, Benefits, Limitations and Applications.

Chapter 2 Includes the Review of Literature Survey.

Chapter 3 Includes the Analysis and Research Work which further includes various technologies, Hardware components and software applications.

Chapter 4 Includes Overall System Architecture which includes simplified block diagram which gives a brief idea of the proposed system followed by the procedure.

Chapter 5 Includes Conclusion.

Chapter 6 Includes References.

Chapter 2

Review of Literature Survey

2.1 Home Automation Using Internet of Things

With advancement of Automation technology, life is getting simpler and easier in all aspects. In todays world Automatic systems are being preferred over manual system. With the rapid increase in the number of users of internet over the past decade has made Internet a part and parcel of life, and IoT is the latest and emerging internet technology. Internet of things is a growing network of everyday object-from industrial machine to consumer goods that can share information and complete tasks while you are busy with other activities. Wireless Home Automation system(WHAS) using IoT is a system that uses computers or mobile devices to control basic home functions and features automatically through internet from anywhere around the world, an automated home is sometimes called a smart home. It is meant to save the electric power and human energy.

The home automation system differs from other system by allowing the user to operate the system from anywhere around the world through internet connection. In this paper we present a Home Automation system(HAS) using Intel Galileo that employs the integration of cloud networking, wireless communication, to provide the user with remote control of various lights, fans, and appliances within their home and storing the data in the cloud. The system will automatically change on the basis of sensors data. This system is designed to be low cost and expandable allowing a variety of devices to be controlled.[3]

2.2 An Intelligent Monitor System for Home Appliances Using IoT

Smart home is a house that uses Internet of Things (IoT) to monitor the environment, control the electric appliances and communicate with the outer world. Smart home is a complex technology, but a developing one. A smart home automation system has been developed primarily because in today's time and world, everybody's in a surge and wishes to screen and get to everything without being there physically. The main objective of this paper is to control the basic electrical appliance devices like fan, light and planning to implement advanced elements like ambient light sensor, motion sensor etc. The system also has an internet connection to monitor and control the house equipment from anywhere in the world.[4]

2.3 An IoT framework for smart power management system

In today's world the Internet of Things (IOT) pairing up with our daily life. The Internet of Things helps to peek into the virtual world of digitization where every smart device, every sensor is connected with the internet and therefore can be accessed the power management system all over the world. This paper propose a secured IoT framework with multiple sensor nodes that sends data to the web cloud server and allows users to access those data via a mobile application through a unique user id and password. The framework proposed is secured with end-to-end encryption. Among the numerous computer protocols present, TCP/IP protocol is used for data transfer in this framework. Due to the unique provision of adding multiple nodes the framework proposed seek its use in a number of fields such as commercial, meteorological, agriculture, medical etc. The cost effective design, long durability, minimal maintenance, ideal service makes the proposed framework a unique one. The home automation along with meteorological and agricultural automations has been successfully implemented with the help of the proposed framework providing much better efficiency.[5]

2.4 IoT Based Smart Home with Real Time E-Metering using E-controller

Technology stemming from web of things is home automation. Worlds main focus is to make a smart home to take advantage in providing comfort for human life. Web technology is a thing which is growing all the time. Embedded systems with Internet on Things (IoT) is becoming important and necessary part in the current IT industry and exhibiting potential market. Power consumption and efficiency with a users comfort level is most important issue during this stage while performing various operations. Controller is suitable for power consumption in system and efficiency experiments with size factor. E-controller is represented by combining embedded technology with IoT. Real time information data monitoring of energy consumption is main objective of system. The paper introduces smart home system based on IoT with the help of Web application.[6]

Chapter 3

Analysis

.

3.1 Research Work

Technology research aassociated with project includes

3.1.1 WiFi Technology

Boosting high bandwidth, Wi-Fi is already pretty much everywhere, so many manufacturers are enthusiastically making smart home devices to work with it. A multitude of homes in the U.S. already have wireless routers (which work on the Wi-Fi protocol), so obviously they have already got a central hub in place to which Wi-Fi compatible devices can be connected.

This does, however, come with one key drawback: interference and bandwidth issues. If your house is full of Wi-Fi-connected gadgets (TVs, game consoles, laptops, tablets, etc.) then your smart devices will have to compete for bandwidth and may be slower to respond. Wi-Fi is also hungry for power; consequently, battery-operated smart devices such as locks and sensors get drained much sooner than in other wireless environments. [7]

3.1.2 Arduino Technology

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. [8]

3.1.3 Database Technology

A database-management system (DBMS) is a computer-software application that interacts with end-users, other applications, and the database itself to capture and analyze data. A general-purpose DBMS allows the definition, creation, querying, update, and administration of databases.For the implementation of smart metering system, we have created database on XAMPP Server using MySQL Database Management System. XAMPP is a free and open source cross-platform web server solution stack package developed by Apache Friends consisting of the Apache HTTP Server, MariaDB database.[9]

We have created a database named 'abcd' which consist of two tables viz. 'sensor' and 'bill'. Sensor table includes real time current sensor readings (Amps readings) which will be extracted from the serial monitor of Arduino Uno. Bill table consist of user specified start date and end date will be used to fetch the values for calculating the total bill amount according to energy consumed.

3.2 Hardware Requirements:

3.2.1 Arduino Uno Board

The Arduino Uno is a microcontroller board based on the ATmega328. It has a 16 MHz ceramic resonator, 14 digital input/output pins (of which 6 can be used

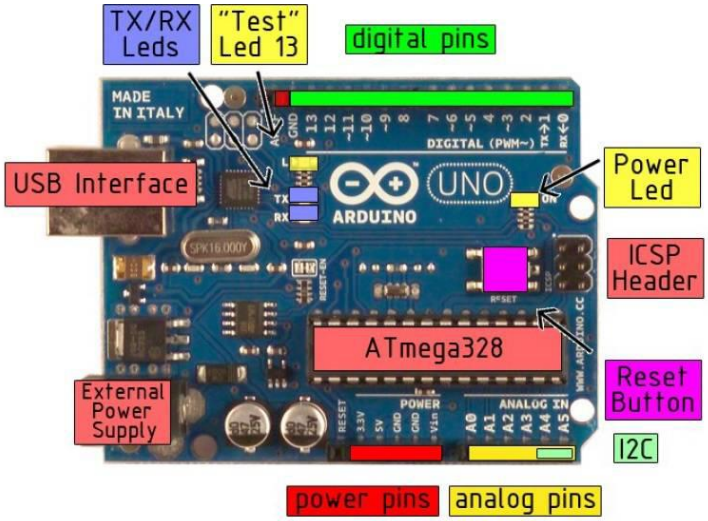

Figure 3.1: Arduino UNO Board

as PWM outputs), 6 analog inputs, a USB connection, a power jack, an ICSP header, and a reset button. This board is very simple and can be easily used, everything you need to support the microcontroller is in this board, just plug it in a computer via USB cable and power using an AC-to-DC adapter or battery to get started. The difference seen in the Arduino Uno is that it does not use the FTDI USB-to-serial driver chip but, it has the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB to serial converter. [8]

Steps to use Arduino Uno:

To get started with working of arduino uno the developer have to first install the Arduino Uno IDE which is a software used to make arduino function with user commands. The Arduino Software (IDE) allows you to write programs and upload them to your board.

Step 1. Install Arduino Software Download the Arduino Software (IDE)

Get the latest version from the download page. You can choose between the Installer (.exe) and the Zip packages. We suggest you use the first one that installs directly everything you need to use the Arduino Software (IDE), including the drivers. With the Zip package you need to install the drivers manually. The Zip file is also useful if you want to create a portable installation. When the download finishes, proceed with the installation and please allow the driver installation

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
Length	68.6 mm
Width	53.4 mm
Weight	25 g

Figure 3.2: Specification

process when you get a warning from the operating system.

Step 2. Open uno (.ino) file from the arduino folder downloaded

Step 3. Verify and compile the arduino code. If Done Compiling message appeared on screen proceed with upload.

Step 4. Upload the arduino code to the arduino board by connecting the board with USB and clicking on upload symbol. In successful uploading it will give Done Uploading message.

Step 5. Functioning of the circuit according to the code. [8]

3.2.2 ESP 8266 Module (WiFi module)

ESP-01 is the one of the most popular ESP8266 module available in the market. ESP8266 is a self contained SoC with integrated TCP/IP stack which helps any microcontroller having UART to access a wifi network. It can act as both WiFi access point as well as a WiFi client. It is pre-programmed with AT commands,

Figure 3.3: ESP8266 WiFi Module

so we can easily access and configure it using a microcontroller.

ESP8266 runs on 3.3V and its input pins are not 5V tolerant. So we need to reduce the 5V output of the Arduino Tx pin to 3.3V by using voltage dividing resistors to connect to Rx pin of ESP8266 module. Arduino TTL input pins will detect 3.3V as logic high, so we can directly connect 3.3V output of ESP8266 Tx to Arduino Rx pin.[10]

3.2.3 Sensor - ACS712

Figure 3.4: Sensor

A current sensor is a device that detects electric current in a wire, and generates a signal proportional to that current. The generated signal could be analog voltage or current or even a digital output. The generated signal can be then used to display the measured current in an ammeter, or can be stored for further analysis in a data acquisition system, or can be used for the purpose of control. Sensing and controlling current flow is a fundamental requirement in a wide variety of applications including, over-current protection circuits, battery chargers, switching mode power supplies, digital watt meters, programmable current sources, etc. This ACS721 current module is based on ACS712 sensor, which can accurately detect AC or DC current. The maximum AC or DC that can be detected can reach 5A, and the present current signal can be read via analog I / O port of Arduino.[11]

Features

1)Supply Voltage: 4.5V 5.5V DC

2)Measure Current Range: -5A 5A

3)Sensitivity: 180mV/A 190mV/A, Typical: 185mV/A

3.2.4 Relay Board

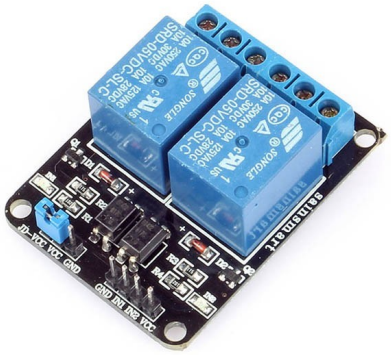

Figure 3.5: Relay Board

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.[12]

3.2.5 Wires and Jumpers

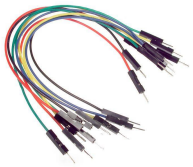

Figure 3.6: Wires and Jumpers

Jumpers are used to connect arduino ,relay modules , resistors and ESP8266 WiFi module.

3.2.6 Resistors

Figure 3.7: 221 OHM Resistor

Resistor are used to form a voltage divider network used to protect bluetooth module from high voltage.

3.3 Software Requirement

3.3.1 Arduino Software

The Arduino Uno is programmed using the Arduino Software (IDE), our Integrated Development Environment common to all our boards and running both online and offline.

1. Use your Arduino/Genuino Uno on the Arduino Desktop IDE

If you want to program your Arduino/Genuino Uno while offline you need to install the Arduino Desktop IDE The Uno is programmed using the Arduino Software (IDE), our Integrated Development Environment common to all our boards. Connect your Uno board with an AB USB cable; sometimes this cable is called a USB printer cable.

The USB connection with the PC is necessary to program the board and not just to power it up. The Uno automatically draw power from either the USB or an external power supply. Connect the board to your computer using the USB cable. The green power LED (labelled PWR) should go on.[8]

2. Install the board drivers

If you used the Installer, Windows - from XP up to 10 - will install drivers automatically as soon as you connect your board.

If you downloaded and expanded the Zip package or, for some reason, the board wasn't properly recognized, please follow the procedure below.

1. Click on the Start Menu, and open up the Control Panel.

2. While in the Control Panel, navigate to System and Security. Next, click on System. Once the System window is up, open the Device Manager.

3. Look under Ports (COM and LPT). You should see an open port named "Arduino UNO (COMxx)". If there is no COM and LPT section, look under "Other Devices" for "Unknown Device".

4. Right click on the "Arduino UNO (COmxx)" port and choose the "Update Driver Software" option.

5. Next, choose the "Browse my computer for Driver software" option.

6. Finally, navigate to and select the driver file named "arduino.inf", located in the "Drivers" folder of the Arduino Software download (not the "FTDI USB Drivers" sub-directory). If you are using an old version of the IDE (1.0.3 or older), choose the Uno driver file named "Arduino UNO.inf"

7. Windows will finish up the driver installation from there.[8]

3.3.2 Web Application

A web browser is a software program that allows a user to locate, access, and display web pages. Browsers are used primarily for displaying and accessing websites on the Internet, as well as other content created using Hypertext Markup Language (HTML) and Extensible Markup Language (XML), etc. Common browsers include Internet Explorer from Microsoft, Firefox from Mozilla, Google Chrome, Safari from Apple, and Opera.

3.3.3 MySQL

MySQL is the most popular Open Source Relational SQL Database Management System. MySQL is one of the best RDBMS being used for developing various web-based software applications. MySQL is developed, marketed and supported by MySQL AB, which is a Swedish company. MySQL is a fast, easy-to-use RDBMS being used for many small and big businesses. MySQL is developed, marketed and supported by MySQL AB, which is a Swedish company.

Features

1) MySQL is released under an open-source license. So you have nothing to pay to use it.

2) MySQL is a very powerful program in its own right. It handles a large subset of the functionality of the most expensive and powerful database packages.

3) MySQL uses a standard form of the well-known SQL data language.

4) MySQL works on many operating systems and with many languages including PHP, PERL, C, C++, JAVA, etc.

5) MySQL works very quickly and works well even with large data sets.

6) MySQL is very friendly to PHP, the most appreciated language for web development.

7) MySQL supports large databases, up to 50 million rows or more in a table. The default file size limit for a table is 4GB, but you can increase this (if your operating system can handle it) to a theoretical limit of 8 million terabytes (TB).

8) MySQL is customizable. The open-source GPL license allows programmers to modify the MySQL software to fit their own specific environments.[13]

Limitations

1) When using some storage engines other than the default of InnoDB, MySQL does not comply with the full SQL standard for some of the implemented functionality, including foreign key references and check constraints.

2) Up until MySQL 5.7, triggers are limited to one per action / timing, meaning that at most one trigger can be defined to be executed after an INSERT operation, and one before INSERT on the same table.No triggers can be defined on views.

3)MySQL database's inbuilt functions like UNIX_TIMESTAMP() will return 0 after 03:14:07 UTC on 19 January 2038. Recently, there had been an attempt to solve the problem which had been assigned to the internal queue.[13]

3.3.4 Netbeans IDE 7.3.1

NetBeans is an integrated development environment (IDE) for Java. NetBeans allows applications to be developed from a set of modular software components called modules. NetBeans runs on Microsoft Windows, macOS, Linux and Solaris. In addition to Java development, it has extensions for other languages like PHP, C, C++ and HTML5, Javadoc and Javascript. NetBeans IDE is an open-source integrated development environment. NetBeans IDE supports development of all Java application types (Java SE (including JavaFX), Java ME, web, EJB and

mobile applications) out of the box. Among other features are an Ant-based project system, Maven support, refactorings, version control (supporting CVS, Subversion, Git, Mercurial and Clearcase).

Modularity: All the functions of the IDE are provided by modules. Each module provides a well-defined function, such as support for the Java language, editing, or support for the CVS versioning system, and SVN. NetBeans contains all the modules needed for Java development in a single download, allowing the user to start working immediately. Modules also allow NetBeans to be extended. New features, such as support for other programming languages, can be added by installing additional modules. For instance, Sun Studio, Sun Java Studio Enterprise, and Sun Java Studio Creator from Sun Microsystems are all based on the NetBeans IDE.[14]

NetBeans Platform

The NetBeans Platform is a framework for simplifying the development of Java Swing desktop applications. The NetBeans IDE bundle for Java SE contains what is needed to start developing NetBeans plugins and NetBeans Platform based applications; no additional SDK is required. Applications can install modules dynamically. Any application can include the Update Center module to allow users of the application to download digitally signed upgrades and new features directly into the running application. Reinstalling an upgrade or a new release does not force users to download the entire application again.

The platform offers reusable services common to desktop applications, allowing developers to focus on the logic specific to their application. Among the features of the platform are:

1)User interface management (e.g. menus and toolbars)

2) User settings management

3) Storage management (saving and loading any kind of data)

4) Window management

5) Wizard framework (supports step-by-step dialogs)

6) NetBeans Visual Library

7) Integrated development tools[14]

3.3.5 Python

Python is a high-level, interpreted, interactive and object-oriented scripting language. Python is designed to be highly readable. It uses English keywords frequently where as other languages use punctuation, and it has fewer syntactical constructions than other languages.

1) Python is Interpreted Python is processed at runtime by the interpreter. You do not need to compile your program before executing it. This is similar to PERL and PHP.

2) Python is Interactive You can actually sit at a Python prompt and interact with the interpreter directly to write your programs.

3) Python is Object-Oriented Python supports Object-Oriented style or technique of programming that encapsulates code within objects.

4) Python is a Beginner's Language Python is a great language for the beginner-level programmers and supports the development of a wide range of applications from simple text processing to WWW browsers to games.[15]

Python Features

Python's features include

1)Easy-to-learn Python has few keywords, simple structure, and a clearly defined syntax. This allows the student to pick up the language quickly.

2)Easy-to-read Python code is more clearly defined and visible to the eyes.

3)Easy-to-maintain Python's source code is fairly easy-to-maintain.

4)A broad standard library Python's bulk of the library is very portable and cross-platform compatible on UNIX, Windows, and Macintosh.

5)Interactive Mode Python has support for an interactive mode which allows interactive testing and debugging of snippets of code.

6)Portable Python can run on a wide variety of hardware platforms and has the same interface on all platforms.

7)Extendable You can add low-level modules to the Python interpreter. These modules enable programmers to add to or customize their tools to be more efficient.

8)Databases Python provides interfaces to all major commercial databases.

9)GUI Programming Python supports GUI applications that can be created and ported to many system calls, libraries and windows systems, such as Windows MFC, Macintosh, and the X Window system of Unix.

10)Scalable Python provides a better structure and support for large programs than shell scripting.[15]

Chapter 4

System Architecture

This IoT-based smart home system is a combination of different components. The components selected are on the basis of requirement of the goal. In this system, the Raspberry Pi2 model B and Arduino mega2560 are the main components.

This chapter includes the overall architecture of the system, the interfacing of various hardware components or devices and controlling of circuit through web application. To simplify the implementation procedure of the system we have created a block diagram which includes the brief plan about the system implemented.The block consist of the following steps- Consolidating Hardware Resources, Installation of the Software, Setting up the Hardware Connections, Installation of ESP Board Manager in Arduino IDE, Set the COM Port for Arduino UNO, Open the Arduino Code, Verify ,Compile and Upload the Code to the Arduino UNO, Test the Interfacing of ESP 8266 with Arduino UNO with the AT commands, Get the IP Address and set it in the HTML Front End Code, Switch ON/OFF operations will be Performed via HTML Buttons on GUI, Simultaneous Generation and Storing of Readings from Serial Monitor to Database via Python Code. Additional Feature of Smart Energy bill calculation is included in the system, it is done by using Java code and MYSQL Database. Output of the System will be total bill amount according to the user specified start and end date.

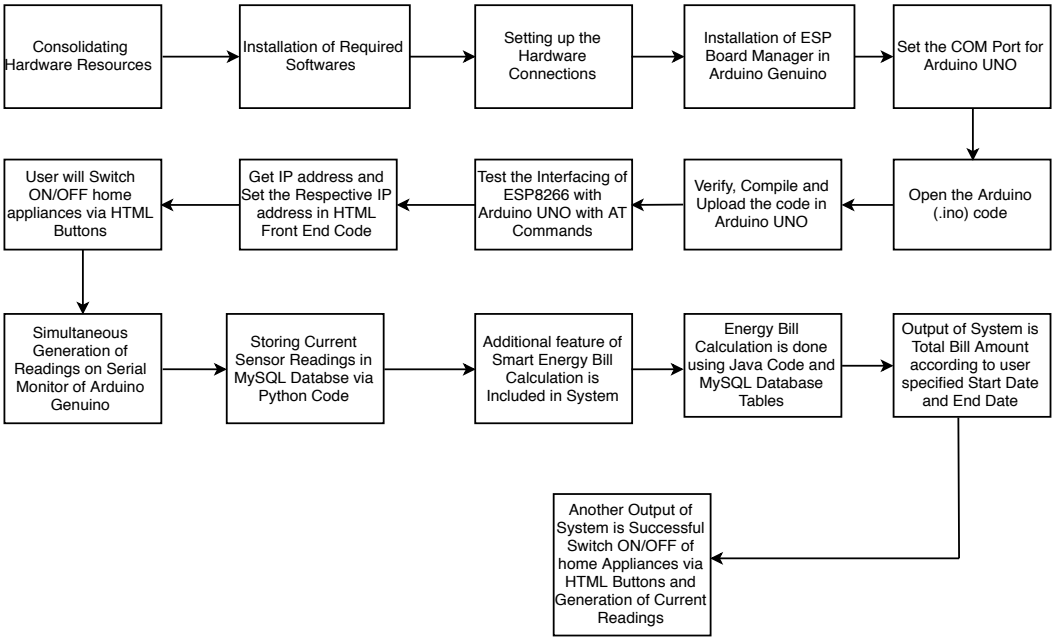

Figure 4.1: Block Diagram

4.1 Procedure

The Procedure to be followed to implement the proposed Home Automation System includes the following steps:

4.1.1 Setting up the circuit according to the Circuit diagram mentioned below:

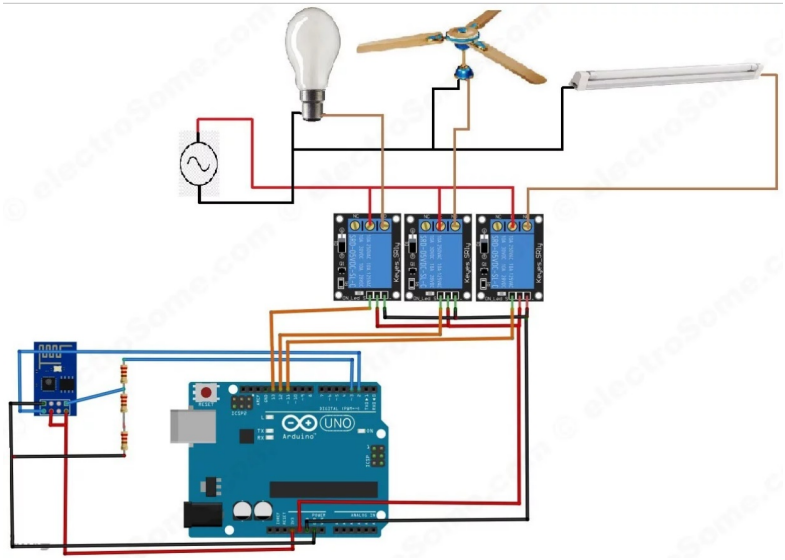

Figure 4.2: Circuit Diagram

First we can connect ESP8266 with the Arduino Uno. The ESP8266 runs on 3.3V, it may damage if you connect it directly to 5V from Arduino. Connect the VCC and CHPD of the ESP8266 to the 3.3V output pin of Arduino. CHPD is Chip Power Down pin, which is active low. So we will give 3.3V to it, which will enable the chip. Then connect the TXD pin of the ESP8266 with the digital pin 2 of the Arduino. Then make a voltage divider to make 3.3V for the RXD of the ESP8266 which is connected to the pin 3 of Arduino. Here we are using software UART through digital pins 2 and 3 of Arduino. Lastly, connect the ground of the ESP8266 with the ground of the Arduino.

Now we can connect relays to Arduino. Connect three relays to pins 11 of the Arduino. Also connect 5V and ground from the Arduino to power the relay. Note

that here I am using relay modules which having built in transistor driver. So dont forget to add driver when you are using bare relays. We can connect AC devices to the output terminals of those relays. First connect one wire (Phase) of the AC source with the common terminal (COM) of all relays and the second wire (Neutral) of AC source to one terminal of AC devices. Then connect the other terminal of AC devices to the NO (Normally Open) terminal of relays.[10]

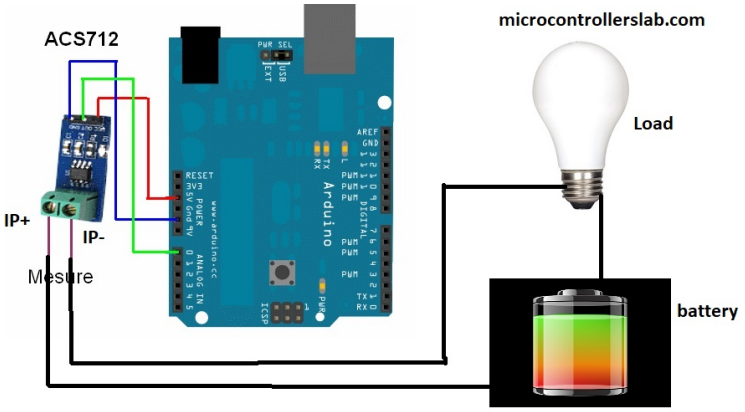

Figure 4.3: Sensor Diagram

Vcc pin of current sensor module is connected with 5V pin of Arduino and Ground pin is connected with Ground pin of Arduino and output pin of current sensor module is connected with Analog channel 0 of Arduino which built in analog to digital converter of Arduino. Load is connected in series with IP+ and IP- pin and dc battery.[16]

4.1.2 Uploading the Arduino code

Arduino code: $\sharp include < SoftwareSerial.h > //Includingthesoftwareseriallibrary$

$\sharp defineDEBUGtrue$

SoftwareSerial esp8266(2,3); // This will make the Arduino pin 2 as the RX pin and Arduino pin 3 as the TX. Software UART /* So you have to connect the TX of the esp8266 to the pin 2 of the Arduino and the TX of the esp8266 to the pin

3 of the Arduino. This means that you need to connect the TX line from the esp to the Arduino's pin 2 */

const int sensorIn = A0;

int mVperAmp = 185; // use 100 for 20A Module and 66 for 30A Module

double Voltage = 0;

double VRMS = 0;

double AmpsRMS = 0;

void setup()

Serial.begin(9600); // Setting the baudrate to 9600

esp8266.begin(9600); // Set it according to your esps baudrate. Different esps have different baud rates.

pinMode(11,OUTPUT); // Setting the pin 11 as the output pin.

digitalWrite(11,LOW); // Making it low.

pinMode(12,OUTPUT); // Setting the pin 12 as the output pin..

digitalWrite(12,LOW); // Making pin 12 low.

pinMode(13,OUTPUT); // Setting the pin 13 as the output pin.

digitalWrite(13,LOW); // Making pin 13 low.

sendData("AT+RST°",2000,DEBUG); //This command will reset module to default

sendData("AT+CWMODE=2°",1000,DEBUG); // This will configure the mode as access point

sendData("AT+CIFSR°",1000,DEBUG); // This will get ip address and will show it

sendData("AT+CIPMUX=1°",1000,DEBUG); // This will configure the ESP8266 for multiple connections

sendData("AT+CIPSERVER=1,80°",1000,DEBUG); // This will set the server on port 80

loop()

if(esp8266.available()) // Checking that whether the esp8266 is sending a message or not (Software UART Data)

if(esp8266.find("+IPD,"))

delay(1000); // Waiting for 1 sec

int connectionId = esp8266.read()-48; // Subtracting 48 from the character to get the number.

esp8266.find("pin="); // Advancing the cursor to the "pin="

int pinNumber = (esp8266.read()-48)*10; // Getting the first number which is pin 13

pinNumber += (esp8266.read()-48); // This will get the second number. For example, if the pin number is 13 then the 2nd number will be 3 and then add it to the first number digitalWrite(pinNumber, !digitalRead(pinNumber)); // This will toggle the pin // The following commands will close the connection

String closeCommand = "AT+CIPCLOSE=";

closeCommand+=connectionId;

closeCommand+="°";

sendData(closeCommand,1000,DEBUG); // Sending the data to the ESP8266 to close the command

Voltage = getVPP();

VRMS = (Voltage/2.0) *0.707; //root 2 is 0.707

AmpsRMS = (VRMS * 1000)/mVperAmp;

Serial.print(AmpsRMS);

Serial.println(" Amps RMS");

sendData(String command, const int timeout, boolean debug) // Function to send the data to the esp8266

String response = "";

esp8266.print(command); // Send the command to the ESP8266

long int time = millis();

while((time+timeout) ¿ millis()) // ESP8266 will wait for some time for the data to receive

while(esp8266.available()) // Checking whether ESP8266 has received the data or not

char c = esp8266.read(); // Read the next character.

response+=c; // Storing the response from the ESP8266

if(debug)

Serial.print(response); // Printing the response of the ESP8266 on the serial monitor.

return response;

getVPP()

result;

int readValue; //value read from the sensor

int maxValue = 0; // store max value here

int minValue = 1024; // store min value here

uint32$_t start_time = millis(); while((millis()-start_time) < 1000)//sample for 1 Sec$

readValue = analogRead(sensorIn); // see if you have a new maxValue

if (readValue ¿ maxValue)

/*record the maximum sensor value*/

maxValue = readValue;

if (readValue ¡ minValue)

/*record the minimum sensor value*/

minValue = readValue;

// Subtract min from max

result = ((maxValue - minValue) * 5.0)/1024.0;

return result;

Installing the ESP8266 Platform

First, the Arduino environment has to be setup to make it compatible with the ESP-01 module. It is required to have Arduino version 1.6.4 or higher in order to install the ESP8266s platform packages.

1. Open the preferences window from the Arduino IDE. Go to File >Preferences

2. Enter http://arduino.esp8266.com/stable/package_esp8266com_index.json into Additional (Refer Figure 4.4)

3. Open boards manager. Go to: Tools >Board >Boards Manager(Refer Figure 4.5)

4. Scroll down, select the ESP8266 board menu and install esp8266 platform.(Refer Figure 4.6)

5. Choose your ESP8266 board from Tools >Board >Generic ESP8266 Module

6. Setup the baud rate

7. Setup the COM Port (COM Port can be set up in the Control Panel >System >Device Manager)

item 8. Compile the Code, Verify the code and then Upload the code.

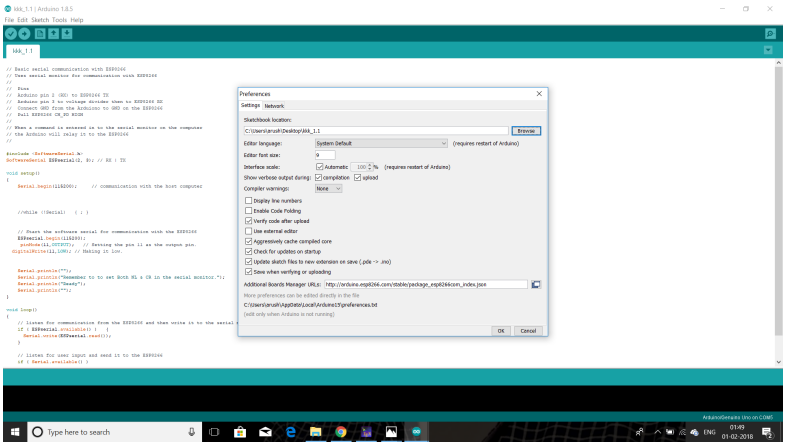

Figure 4.4: STEP 2: Go To: Files >Preferences

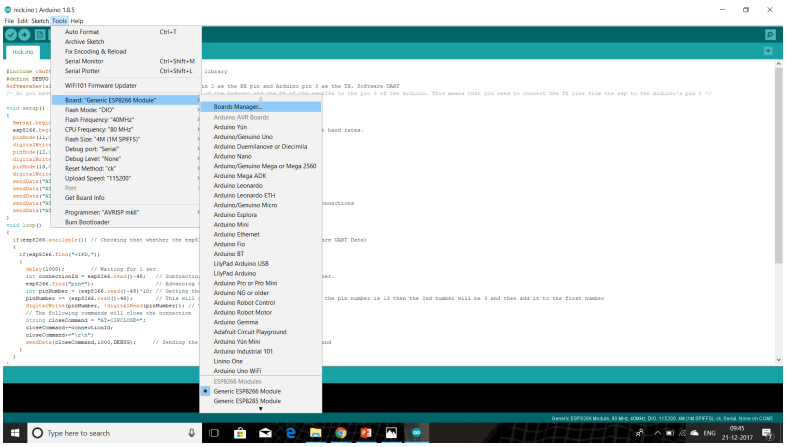

Figure 4.5: STEP 3- Go To: Tools >Boards >Boards Manager

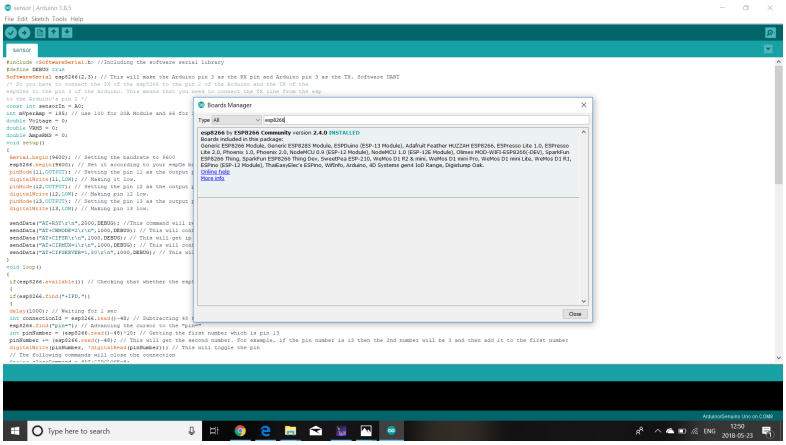

Figure 4.6: STEP 4: Installation of ESP8266

4.1.3 Test the Interfacing of Arduino UNO with the ESP8266

There are many AT commands that can be used to program the ESP8266 Wifi module. The following AT commands should be written in the Arduinos serial monitor (in order) to program the ESP8266:

- AT This will check if the module is connected properly and its functioning, the module will reply with an acknowledgment.
- AT+RST This will reset the wifi module. Its good practice to reset it before or after it has been programmed.

- AT+GMR This will mention the firmware version installed on the ESP8266. (Optional)
- AT+CWLAP This will detect the Access points and their signal strengths available in the area.
- AT+CWJAP=SSID,PASSWORD This connects the ESP8266 to the specified SSID in the AT command mentioned in the previous code.
- AT+CIFSR This will display the ESP8266s obtained IP address. If the user wants to disconnect from any access point then use the following AT command AT+CWJAP=,
- AT+CWMODE=1 This sets the Wifi mode. It should be always set to Mode 1 if the module is going to be used as a node (Like our mobiles connection to the access points) After this step is done, repeat step 2 to reset the Wifi Module. AT+RST [17]

Now you can connect your ESP8266 to the internet and get started with IoT.

4.1.4 Get IP Address in Response from ESP8266

After uploading the code to the Arduino, open the serial monitor from the Arduino IDE. It will show you the IP address as shown below.

4.1.5 Set the IP address in the HTML Code

First connect your system to the access point created by ESP8266 module (ESP_xxxxxx).

Update the IP address in the .html file.

Open the file using your web browser (Google Chrome or Mozilla Firefox).

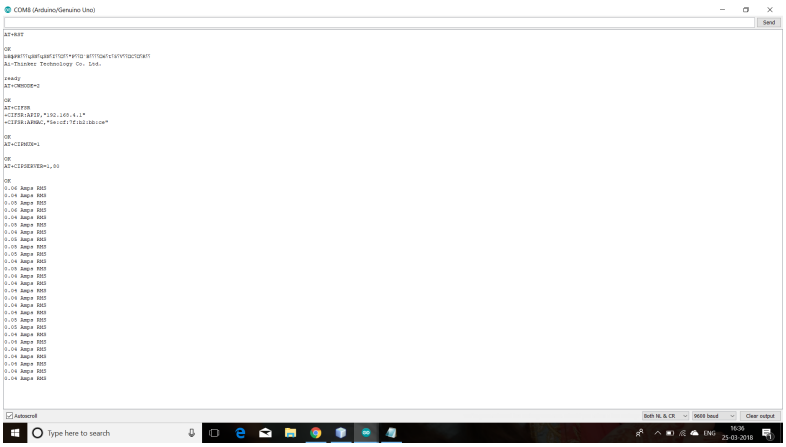

Figure 4.7: Generation of IP Address

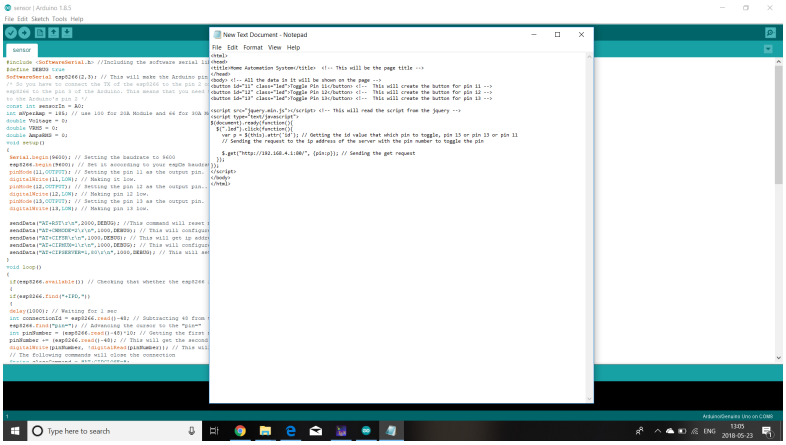

Figure 4.8: Set the IP Address in HTML code

4.1.6 User will perform Switch ON/OFF Operations

The Buttons will be created on the HTML page (depending upon the number of devices).

User will perform operations respectively and get desired results.

4.1.7 Generation of readings on Serial Monitor of Arduino UNO

Go to : Tools >Serial Monitor

Readings will be generated through Sensor ACS712 simultaneously while performing the operations and user can use this data for analysis.

Real time readings are extracted from here and stored into the database table named 'sensor' using python.

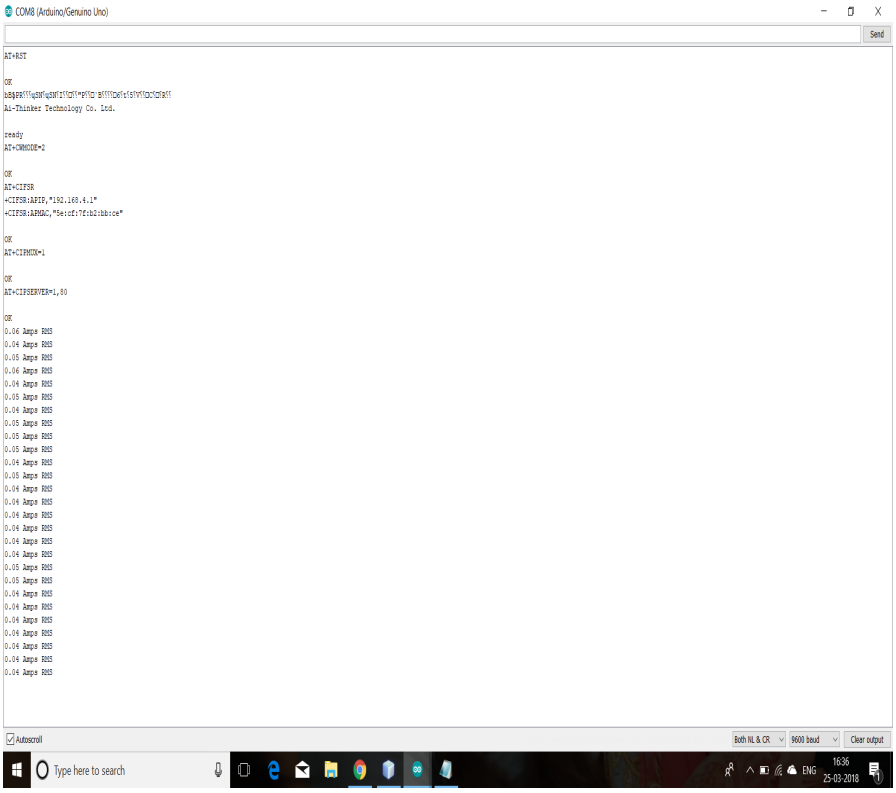

Figure 4.9: Generation of Current Sensor Readings (Amps)

4.1.8 Storing Current Sensor readings into MySQL database table via Python code

import MySQLdb as sql

import serial ♯*Serialimportedfor Serialcommunicationimporttime*♯*Requiredtousedelayfunctions*

ArduinoSerial = serial.Serial('com8',9600)

♯*CreateSerialportobjectcalledarduinoSerialDatatime.sleep*(2)
♯*waitfor*2*secoundsforthecommunicationtogetestablished*

♯*readtheserialdataandprintitasline*

while True:

reading = ArduinoSerial.readline('AmpsRMS*100')

print(reading)

(insert values)

db = sql.connect("localhost:9090/abcd","root","root")

cursor = db.cursor()

query = ("insert into sensor values(CURDATE(), CURTIME(), d ,240,(cur*volt));");"
reading

try:

♯*ExecutetheSQLcommandcursor.execute*(*query*)

result = cursor.fetchall()

♯*Commityourchangesinthedatabasedb.commit*()

except:

♯*Rollbackincasethereisanyerrordb.rollback*()

db.close()

$\sharp select for wattdb = sql.connect(\text{"}localhost : 9090/abcd\text{"}, \text{"}root\text{"}, \text{"}root\text{"})$

cursor = db.cursor()

query = "select date1,time1,current,volt,current*volt as watt from current;"

try:

$\sharp Execute the SQL command cursor.execute(query)$

result = cursor.fetchall()

$\sharp Commit your changes in the database db.commit()$

except:

$\sharp Rollback in case there is any error db.rollback()$

db.close()

4.1.9 Additional functionality of Smart Energy Bill Calculation

Smart Metering:

A Smart Metering is a software application that records the consumption of electric energy and communicates the real time information to the user for monitoring and billing.

Benefits of Smart Metering

- To reduce power consumption in the web applications
- To make energy metering easy by creating web application
- To make home automated and intelligent and provide comfort to every consumer
- The user can monitor and control the energy consumption and also get summarized bill anytime.
- Also the application is real time means the user can monitor real-time data and takes a particular action

We have created a graphical user interface through which user will select duration of bill and will get summarized total bill for that respective duration. Once user will input the provider and specify the start date and end date and click on the "Calculate Cost" button, backend database query will get executed to get required values. Further Java Code will be executed which involves logic and formula of Bill Calculation.

4.1.10 Generation of Final Result

Display of output table which involves Start Date, End Date and Total Bill columns. Successful Switch ON/OFF operations of Home Appliances via HTML buttons and generation of current sensor readings in Amps on serial monitor of Arduino Genuino UNO.

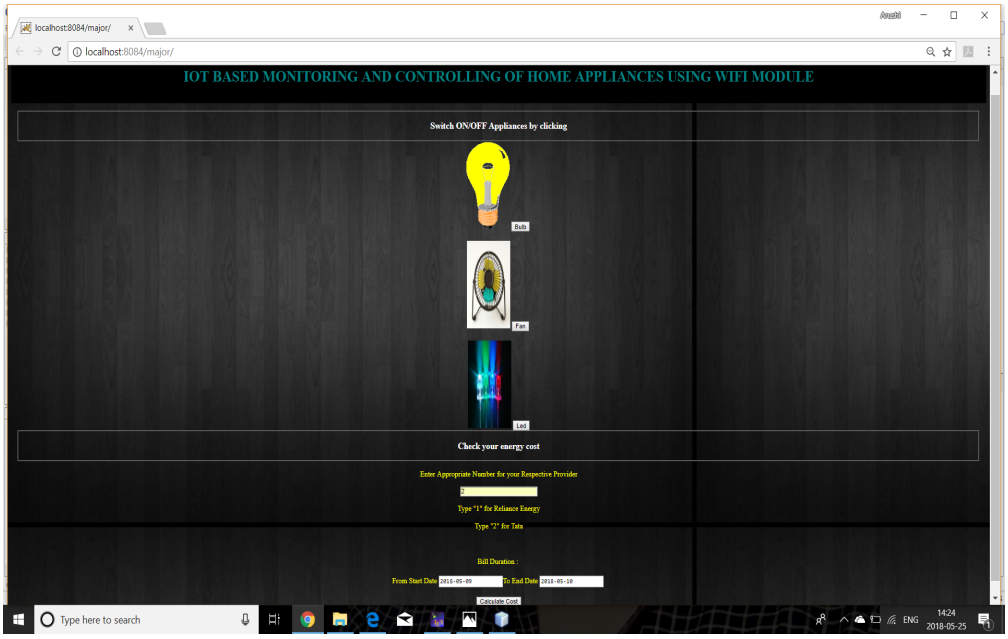

Figure 4.10: User Interface

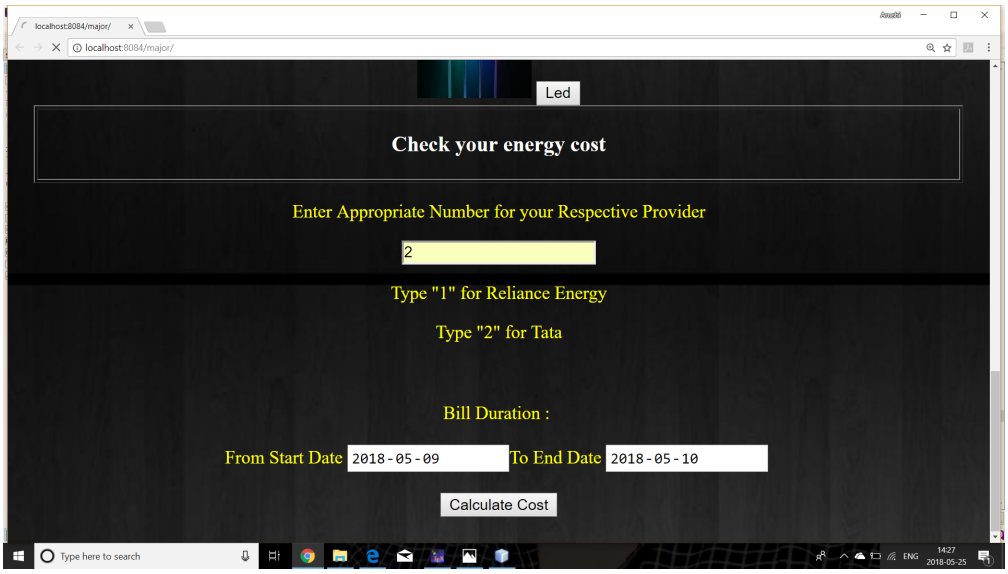

Figure 4.11: User Interface with Smart Metering

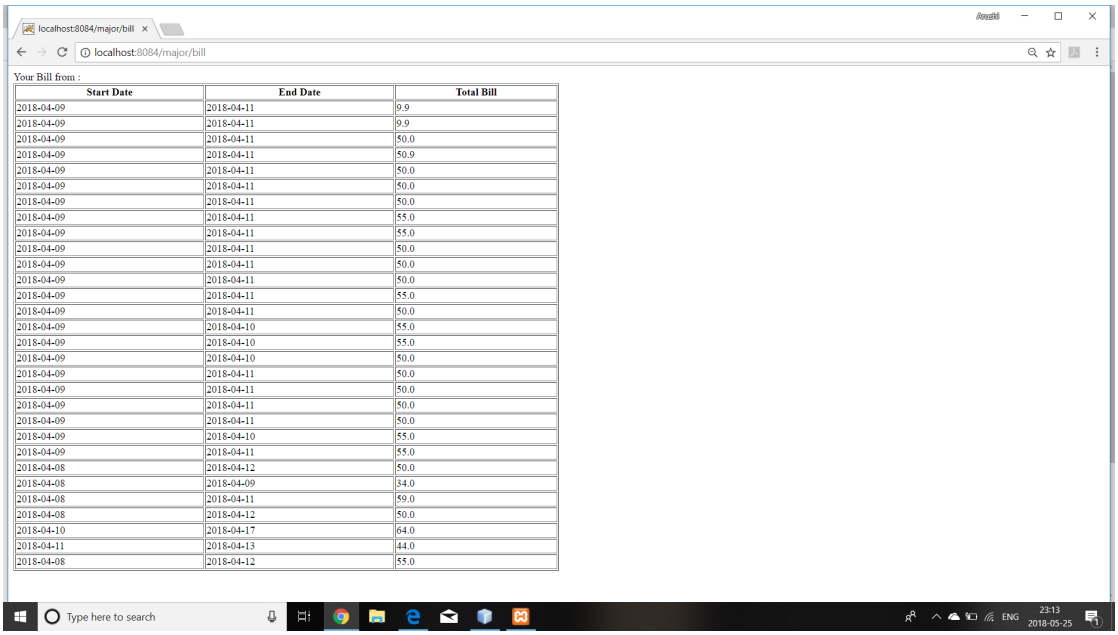

Figure 4.12: Total Bill Calculation

Chapter 5

Progressive Report of System Implementation

The main motto of this chapter is to elaborate the system implementation from the initial phase to the final system.

Our team has successfully implemented the home automation system. The implementation of the system has been completed through the following stages.

5.1 Initial Implementation

We started the initial Implementation by thorough research of the topic i.e. "IOT Based Monitoring and Control of Smart Home". We researched about the various components that are mentioned in the paper. Considering the important factors like estimation and compatibility of the components we identified the alternative hardware components for the proposed sytem.The main component that we have used in our project is Arduino UNO,Since our project included integration of hardware components rather than more instructions processing wherein the Rasberry pi acts as mini computer and majorly focuses on processing instructions. Due to similar functionality of both the components we have selected Arduino Uno which is more affordable as compared to Raspberry pi.

For the better understanding of the System Implementation we begin with Interfacing of Arduino Uno with Bluetooth Technology. We Implemented this basic

architecture on small scale by connecting the Bluetooth HC-05 with Arduino UNO and contolling this system through Android Application. Since we successfully implemented this basic architecture, we than proceeded to next stage.

5.2 Interfacing of Arduino UNO with WiFi Module

In this stage we interfaced Arduino Uno with ESP8266 WiFi module. We first connected both the hardware components and checked whether the communication link is established between ESP8266 and Arduino UNO. We tested the interfacing by sending the AT Commands via Serial Monitor of Arduino IDE (Arduino Software) and receiving the response. The communication is established only when we get "OK" reponse, if we receive "ERROR" in response the communicatio is not established. In this way we successfully implemented the interfacing of Arduino UNO with the WiFi Module ESP8266.

5.3 Final System Implementation

After successfully implementing all the basic modules we moved further towards the final implementation of the Home Automation System.

In this Stage, we added additional hardware components viz., ACS712 Current Sensor, Relay Board and basic home appliances. We have also created a User Interface wherein we have implemented Smart Metering system. In this system the user can monitor and control the energy consumption. The user can easily monitor the electricity bill as per dates according to his requirements irrespective of monthly electricity bills.

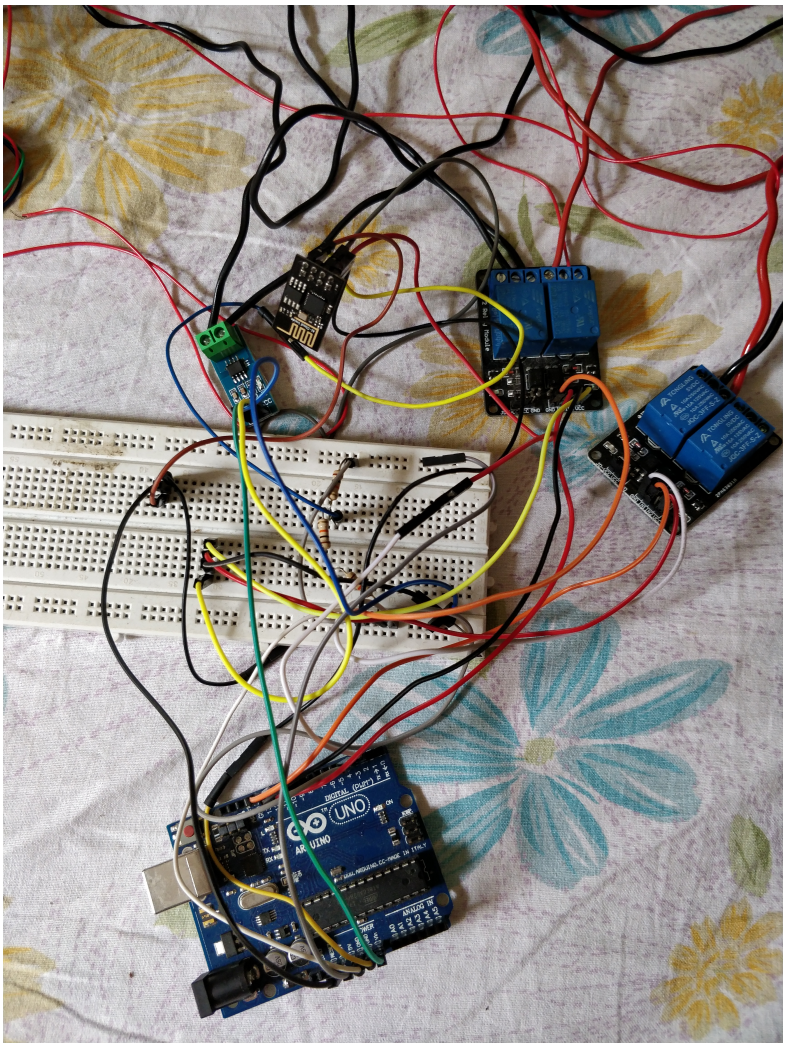

Figure 5.1: Connection of Hardware Components

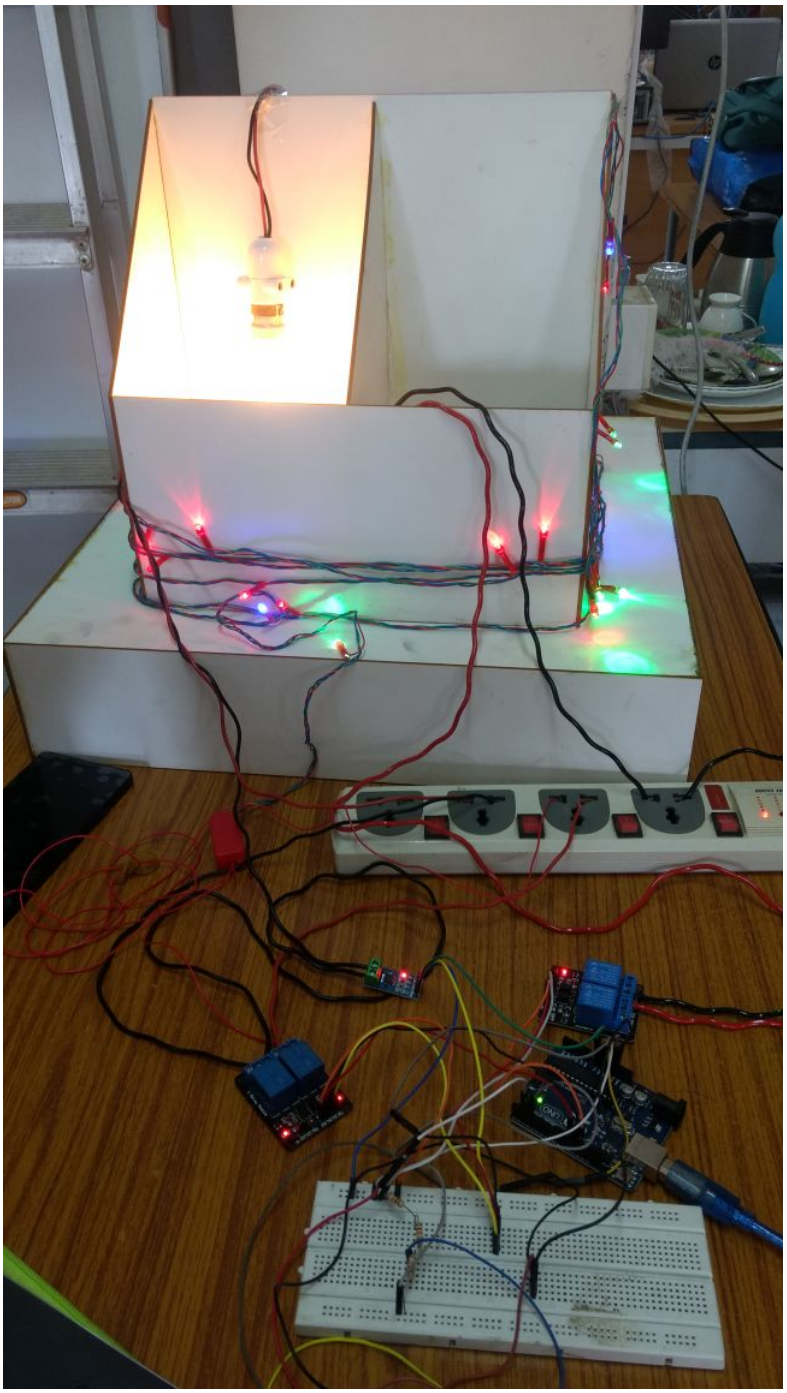

Figure 5.2: Connection with Basic Home Appliances

Figure 5.3: Exhibition Phase

Chapter 6

Project Estimation

SR NO.	COMPONENTS	QUANTITY	COST (RUPEES)
1.	Arduino UNO	1	350
2.	ACS712 Current Sensor	1	200
3.	Relay Board	2	200
4.	ESP 8266 WiFi Module	1	250
5.	Jumper Wires (Both Male to Male and Female to Male)	40	60
6.	BreadBoard	1	60
7.	Resistors	3	15
8.	Bulb	1	10
9.	LED Lighting	1	120
10.	Fan	1	120
		TOTAL COST:	**RS. 1,385**

Chapter 7

Conclusion

Low-end mainstream and Home Automation consumers desire the cheapest and easiest ways to connect to devices they want to use in their homes. They want to connect using controllers they already have, and they want them to be able to retrofit easily into their existing home environments. They also want all these devises to work together, and for them to be able to control them from a single software interface. Wi-Fi will be successful. Wi-Fi is ubiquitous in these market segments, and as the backbone to the internet, it is the easiest and cleanest choice for controlling the home. Since almost every home is already Wi-Fi equipped, the easiest and cheapest way for consumers to add functionality to the home is to add Wi-Fi endpoints. Whether lights, security systems, or locks, they all can be connected via Wi-Fi. To take full advantage of its future potential in the home, Wi-Fi must continue to drive the cost and power curves lower.

Chapter 8

References

[1] https://ieeexplore.ieee.org/document/7808011/

[2] https://www.link-labs.com/blog/applications-of-home-automation

[3] https://www.irjet.net/archives/V2/i3/Irjet-v2i3317.pdf

[4] https://ieeexplore.ieee.org/document/8067586/

[5] http://ieeexplore.ieee.org/document/8117195/

[6] https://ieeexplore.ieee.org/document/7443823/

[7] https://www.electronichouse.com/smart-home/home-automation-protocols-what-technology-is-right-for-you/

[8] https://www.arduino.cc/en/Guide/Introduction

[9] https://en.wikipedia.org/wiki/Database

[10] https://electrosome.com/home-automation-arduino-esp8266/

[11] https://www.elecrow.com/wiki/index.php?title=File:ACS712_Current_Sensor-_5A.jpg

[12] https://en.wikipedia.org/wiki/Relay

[13] https://www.tutorialspoint.com/mysql/mysql-installation.htm

[14] https://en.m.wikipedia.org/wiki/NetBeans

[15] https://www.tutorialspoint.com/python/python_overview.htm

[16] http://microcontrollerslab.com/acs712-current-sensor-interfacing-arduino/

[17] http://microcontrollerslab.com/at-commands-tutorial/

Acknowledgement

We are glad to present this project report on **"IOT BASED MONITORING AND CONTROL FOR SMART HOME"**. Many people have contributed directly or indirectly in successful completion of this project. So we would like to express our Gratitude towards them.

We are very much obliged to our project Guide **Prof. Sujata Kullur** (Associate Professor in Information Technology Department) for her constant Support, Suggestion and Guiding us throughout the project. Due to her Valuable Contributions and constant Motivation we could accomplish timely completion of our project.

We would equally like to thank our Head of Department **Dr. Sanjay Shitole** and our Honourable Principal **Dr. Sanjay Pawar** for their valuable co-operation. We are also greatful to our Project Co-ordinator **Prof. Anita Morey** and appreciate all her efforts contributed towards the students.

Finally, We would like to thank all our **Teaching and Non-Teaching Staff members** and our friends who directly or indirectly contributed to the same.

Date: 29th May 2018

Name of Candidates

Ms Arushi Barde

Ms Hetal Patel