IoT BASED SMART HOME MANAGEMENT SYSTEM

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Project titled "IoT Based Smart Home Management System", submitted by A.F.M. Foysal Islam, ID No: 151-15-4808 And Nazmul Alam Shuvo, ID No: 151-15-5238 to the Department of Computer Science and Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 12 December 2018.

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Narayan Ranjan Chakraborty, Assistant Professor, and Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

With the advancement in technology, the number of electronic devices in our day-to-day life has increased to make life simpler. So there in necessity to construct a trustable remote system that will easily control all these devices from distance will not only reduce the complexity of handling the all of devices. And we also connect with our server therefore we can remote our home at anywhere. This research presents overall design of “IoT based Home Automation System”. After research, we make successful prototype. Using the Ethernet and microcontroller technology we design a Home Automation System where the entire electrical item will be controlled. Using the internet people can also monitor their Fan Light, Water pump and many other electrical devices through the user-friendly Android Application, web application and also have manual switches. Comparing to others this system is low cost, attractive, user friendly interface which is platform independent and it’s very easy to use after implementation of all the functions, the system is tested in different stages and it works successfully as a prototype.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The concept of Internet of Things (IoT) was introduced by the growth of the widely used global network known as the internet along with the deployment of ubiquities computing and mobiles is smart objects which bring new opportunities for the creation of innovation solutions to various aspects of life. The concept of Internet of Things (IoT) creates a network of objects that can communicate, interact and cooperate together to reach a common goal. IoT devices can enhance our single device and become part of an entire full connected system this provides us with resulting data to be analyzed for better decision-making tracking our business and monitoring our properties while we are far away from them [8].

As the paradigm of IoT is growing, it is stepping into every of our lives. This leads to an easier life through wider range of applications, such as electronic health care solutions and smart city concept. The concept of smart city aims of making a better use of resources, increasing services quality offered to the citizens, and reducing costs of the public administrations. Another application is home automation system which is the main focus of this research.

21st century is the era of science and technology. In keeping with the change of time with the technology of the home has been modernized a lot. Now maximum home automation is first introduced in water heater at 1889. After that, the uses of home automation increase day by day. Now-a-days home automation is more popular and quickly makes a better position in market and gives a greater field to work and research for the engineers. It is predicted that within 2020 the market value of home automation become more than 10 billion US $ [1].

Using the concept of IoT, it becomes very much flexible and user interactive. Different types of wireless network technology such as an internet, GSM, Wi-Fi makes the home automation system more effective. Using these technology home appliances are easy to control from far distance through the android based application

and web based application. To build a smart and intelligence home is now very possible by combining IoT and Home automation system [1].

Here we design home automation project based on IoT using Arduino mega to control electronics appliances and devices. The Arduino is connected to internet using Ethernet cable the mobile device and they can control and monitor their electrical home appliances. We design also some manual switch in our circuit board for any kind of limitation on electrical devices through the Android application and Web application.

1.2 Motivation

Indeed, home automation system will be a new addition to modern technology. When we study about embedded system we think that we can automate our home. On this semester we are developed normal remote-control fan light on off system. After that we decide to develop IoT based home automation system in our final year project. This system has the ability to easier our daily life. This will save our time and energy.

In fact, we are confident about the service of this research as this will be the most helpful system to the users. Users will like it for its superb features. Smartphone is pretty much available with every person. Everyone likes to have effective apps in their phone. We have also an android application to control this home automation system.

That's why we want to introduce this IoT based Home Automation System to you.

1.3 Objective

The main objective of this project is remote controlling of any household device from any place.

- User can remotely switch off or on the any appliance through an Android based application and web based application.
- User can control the any appliance through the manual switches.
- User can also control their home appliance using IR devices or IR remote.
- User also can see their electrical appliance present condition through an Android and Web application.

- Makes system interface is so much interactive so that it can help to control electronics devices of elder people.
- Makes the Android application is secure so that everyone cannot allow controlling devices.

1.4 Expected Outcome

In this automation system user can remotely control their home appliance using IR remote. There have some manual switches for off or on every appliance. We try to attached an LCD monitor for showing time, temperature, date and some weather information but at this time we cannot doing this for some of our technical problem. Obviously in future we are successfully fixed that problem. Wi-Fi modules connect to our home internet router and using our server for IoT. Our Android and Web application also connects with server. By this application user can see their home appliance present condition and they can control this at anywhere.

CHAPTER 2

BACKGROUND

2.1 Introduction

IoT aims in creating a network between user and devices. That can store data, analyze, communicate and exchange data together over the internet. This is lead to efficient smart home, manufacturing industry, energy management, Office and other corporate area [8].

As this research focused on Home Automation System through IoT. Smart home concept should be understood first. Smart home concept is, you can control your home appliance using IR remote, mobile and desktop application. User can control their appliance at anywhere [8].

This project designed for the IoT based home automation system when you connect with your devices with internet then you can able to control this system using our server dashboard and mobile application. In this era, so we many home automation systems they can remote fan light off/on but they have no PWM module for speed control circuit voltage. We have this feature user can control their fan speed and they can control any electrical devices just they need to install socket. Our web application represents a dashboard user can see their appliances present condition and they can off/on anything we have an also Android mobile application it's also work as a Web application.

Data stream network is the infrastructure and network that connects devices from anywhere in the world. Allowing developers to build real-time applications in a secure and reliable manner. Server is the data stream network that was used in this project as the subscribe communication design provide by it allowed bi-directional connection easily and reliably [8].

A software developed to be run on multiple and different platforms such as Android and Desktop is an open source SDK for developing application using HTML, CSS, Java, PHP, JavaScript and most of the component. It was using mobile and desktop application for controlling electrical appliances [8].

2.2 Related Work

Home automation is a very common topic around the world. Now a day's home automation and IoT integrated together. Lots of real-life project and research is developed or currently developing based on IoT based home automation system. The Internet of Things (IoT), also sometimes referred to as the Internet of Everything (IoE), consists of all the web-enabled devices that collect, A process called Machine-to-Machine (M2M) communication, and act on the information they get from one another. HomeSeer, Control4, Creston, Vera, Staples connect, Iris, Savant, SmartThings are the world best companies in field of home automation. The main advantages of IoT based home automation is user can remotely control on integrated with the electric appliance and devices at anywhere. Most of the home automation systems are relatively high cost comparing to Bangladesh. Most of the home automation is Android or IOS based. Not platform independent. So, the IoT based Home Automation System is a great field to develop and work. Still here is a great opportunity to enhancement quality of IoT based Home Automation [1].

2.3 Comparative Studies

At first, we need to know about microcontroller that's why we learn the basic and advance Arduino concept by books and some blogs. Then we need to know about ESP8266, IR-Receiver, Relay, AC-220v PWM modules then we learn briefly about this module and then we connect with Internet of things (IoT) also learned about all this hardware components and we can successfully complete our project.

2.4 Scope of the project

This research is completely controlling all home appliance remotely and manually. It can also work on office and large shopping mall. It's remotely accessible from intranet. It can accessible using internet from anywhere in the world. The research interface is very user friendly. It's an Android application which is help to control this system. That's why this application runs on any smart phone. We have also a web application that is runs on any web browser.

2.5 Challenges

We were developed our research using Arduino board, therefore when we connect this microcontroller server need to update data for showing present condition. It was worked but we need to make manual switches this is our special features and Arduino is not support to doing IoT and manual at the same time because of manual switch cannot pass data in server. Actually, Arduino UNO is not supported multitasking operation. Only Arduino can supply data this is the biggest challenges of our research. We are successfully transfer data in auto and manual system this is our big achievement on this research. Most of the Engineer develops the IoT based home automation system using raspberry pi and sonoff. Finally, we are able to doing this research using Arduino Uno.

CHAPTER 3

REQUIREMENT SPECIFICATION

3.1 Business Process Modeling

In business process management and systems engineering is the activity of representing processes of an enterprise, so that the current process may be analyzed, improved, and automated [3].

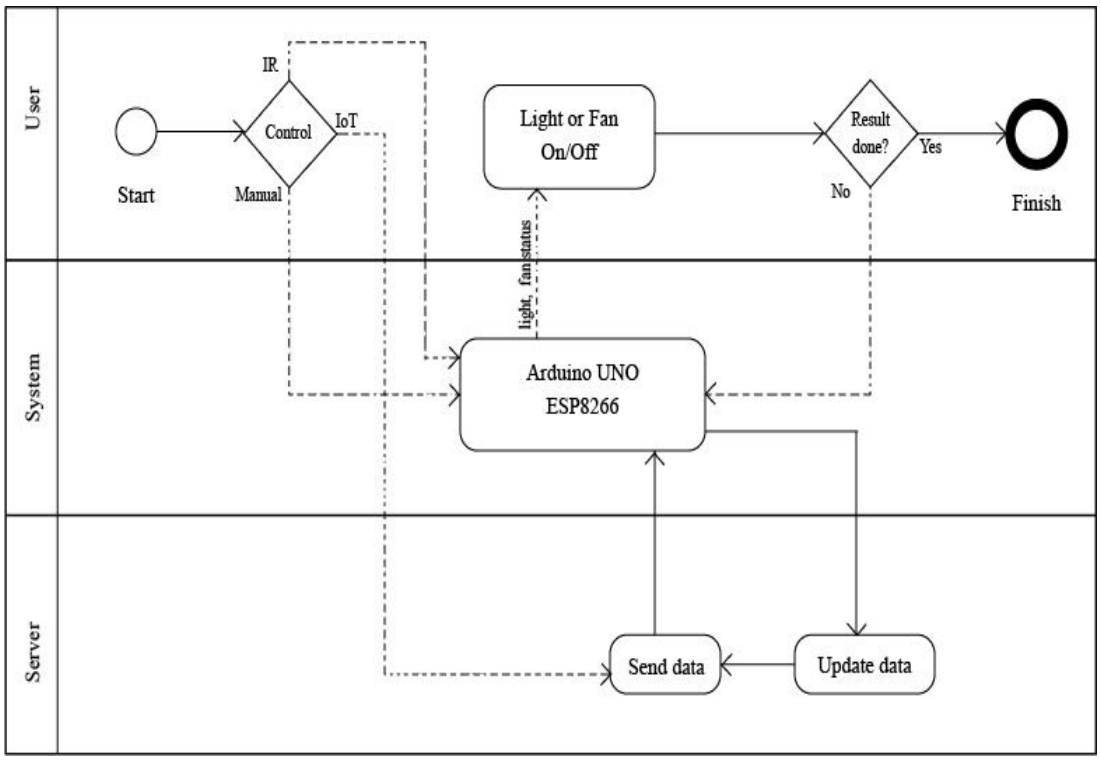

Figure 3.1.1: Business Process Model (BPM).

This model represents the main process model of our system. There have three stages such as user, system and server. User can control this system based on IR, Manual and IoT. First, if user send the command via IR or manual switches that time control panel send the command to Arduino UNO, system controller send to circuit device and finally user can see their result. On the other hand if user sends the command via IoT that time device connect with internet then send data to the server, system will update data and back to the database then server will show the result in front of user. This is the actual process model for the IoT based Home Automation System.

3.2 Requirement Collection and Analysis

Arduino Uno

The Arduino Uno is a board based on the ATmega328p. It has 14 digital, input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller, simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started [6].

The Uno differs from all preceding boards in that it does not use the FTDI USB to – serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter [6].

- Some technical specification of Arduino Uno are:
    1. Microcontroller – Atmega328p
    2. Operating Voltage – 5V
    3. Input Voltage(recommended) – 7-12V
    4. Input voltage(limits) – 6-20V
    5. Digital I/O Pins – 14
    6. Analog Input Pins – 6
    7. DC Current per I/O Pins – 40 mA
    8. DC Current for 3.3V Pin – 50mA
    9. Flash Memory – 32 KB of which 0.5 KB used by boot loader
    10. SRAP – 2 KB
    11. EEPROM – 1 KB
    12. Clock Speed – 16MHz

Pin Configuration

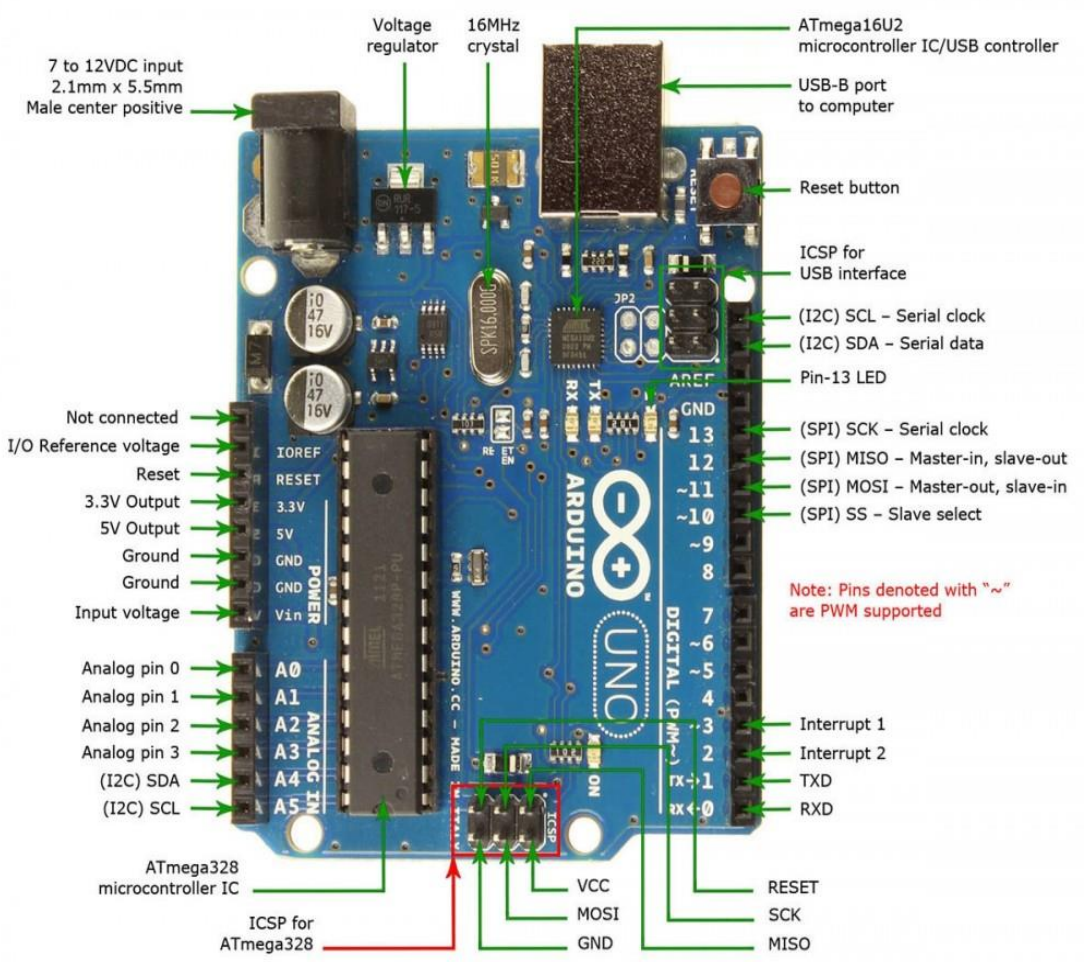

Figure 3.2.1: ATmega328p.

Bread Board

A breadboard is a construction base for prototyping of electronics. Originally it was literally a bread board, a polished piece of wood used for slicing bread. In the 1970s the solder less breadboard became available and nowadays the term "breadboard" is commonly used to refer to these.

Connecting Wire

A wire is a single, usually cylindrical, flexible strand or rod of metal. Wires are used to bear mechanical loads or electricity and telecommunications signals.

Relay module

Circuits that operate at high voltages or at high currents cannot be controlled directly by an Arduino. Instead, you use a low-voltage control signal from the Arduino to control a relay, which is capable of handling and switching high-voltage or high-power circuits. A relay consists of an electromagnet that, when energized, causes a switch to close or open. Relays provide complete electrical isolation between the control circuit and the circuit being controlled [7].

Figure 3.2.2: Relay module.

Bread Board

A breadboard is a construction base for prototyping of electronics. Originally it was literally a bread board, a polished piece of wood used for slicing bread. In the 1970s the solder less breadboard became available and nowadays the term "breadboard" is commonly used to refer to these.

Transformer

A transformer is a static electrical device that transfers electrical energy between two or more circuits. A varying current in one coil of the transformer produces a varying magnetic flux,

ESP8266 Wi-Fi

This module using for connect with Internet via Wi-Fi. It is based on ESP8266 chip and this module has some version such as NODE.MCU, ESP02, ESP01 etc. We using ESP01 version of ESP8266 it is very lower cost module. It has two digital I/O port GPIO-02, GPIO-0. Serial communication TX/RX and CH_PD, RESET Pin. Operating voltage 3.3V.

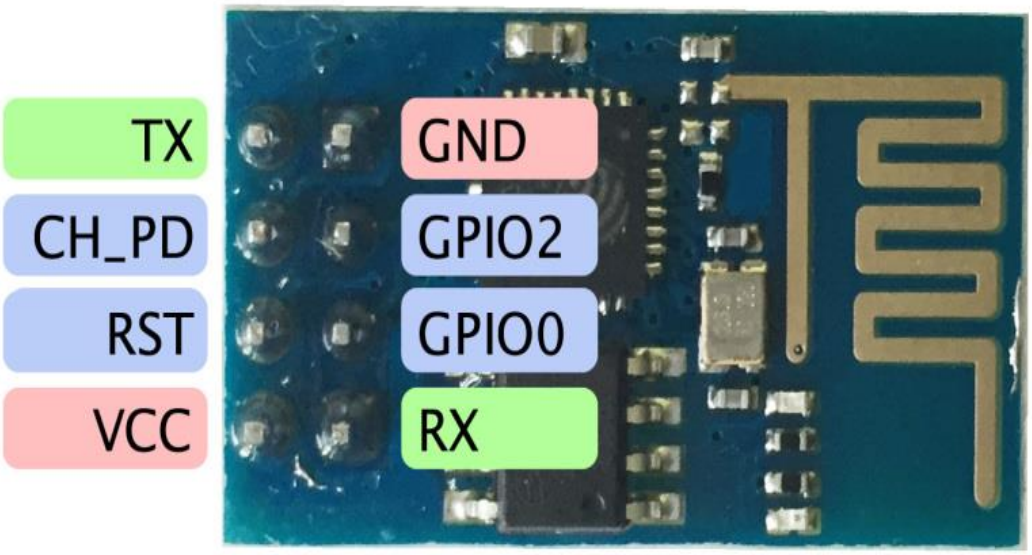

Figure 3.2.3: ESP8266 Wi-Fi.

AC PWM module

The process involved in inverting the DC voltage to the variable voltage variable frequency (VVVF) AC voltage in the inverter section of the VFD is called pulse width modulation or PWM.

This module can control AC appliance speed that means this module works for up/down voltage of any kind of appliance like fan, water pump, light dimmer etc.

IR-Receiver module

This module receives IR signal from remote and decoded to a workable value. It has one data out Pin and its operating voltage 5V.

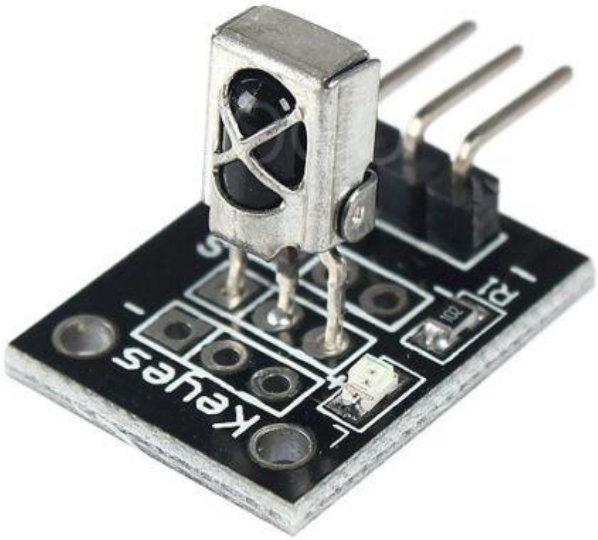

Figure 3.2.4: IR-Receiver module.

Push Button

This push button using for manually off/on switches.

Figure 3.2.5: Push Button.

3.3 Use Case Modeling and Analysis

In software and systems engineering, a use case is a list of actions or event steps typically defining the interactions between a role (known in the Unified Modeling Language as an actor) and a system to achieve a goal. The actor can be a human or other external system [4].

In this figure 3.3.1: we can see that is a use case model of our IoT based Home Automation System. User can remotely control our system using Android and Desktop platform user can access the registration page then they need to create account and login the control panel next they can see the index page there have control unit and they also can see about us. On the other hand device work with the control unit.

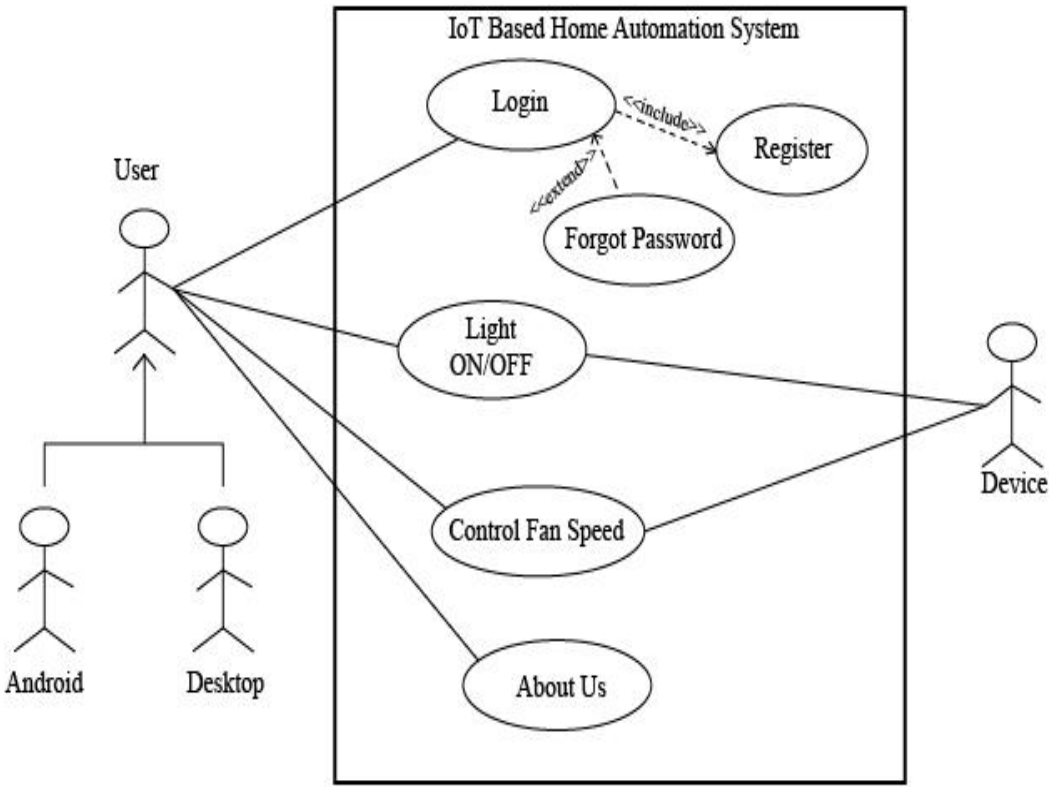

Figure 3.3.1: Use Case Model.

3.4 Logical Data Model

A logical data model or logical schema is a data model of a specific problem domain expressed independently of a particular database management product or storage technology (physical data model) but in terms of data structures such as relational tables and columns, object-oriented classes, or XML tags [5].

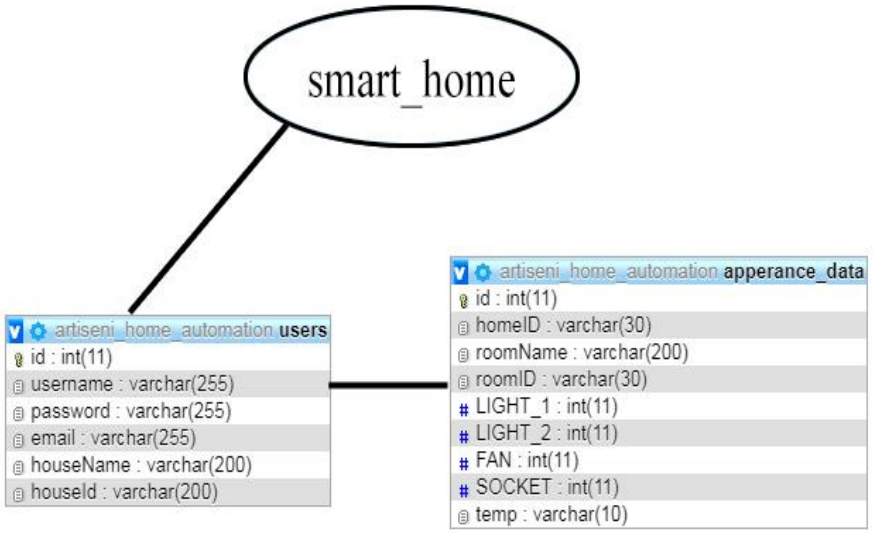

Figure 3.4.1: Database design.

Here we can see the database part of our project. There have two data table one is connect with another. First data table represent the user information and second table represent the system database.

3.5 Design Requirements

For Software design:

- Android studio.
- Arduino IED
- Notepad++
- HTML
- CSS

- PHP
- JavaScript
- Java
- MySQL
- XAMPP
- Illustrator
- Photoshop CS 2017

For Hardware design:

- Arduino UNO - Atmega328p
- ESP8266 Wi-Fi
- ESP8266 board library
- Relay module
- Push button
- AC 220V PWM
- IR-Receiver Module
- Connecting wire
- Board
- LED

CHAPTER 4

DESIGN SPECIFICATION

4.1 Front-end Design

Android splash window

Every android application take some seconds to launch home screen that time we want to show our title for few seconds.

Figure 4.1.1: Android splash screen.

Android user login

In android application user must need to login because of their identification. In this screen user put their username and password than tap to the login button than user will see their home control dashboard.

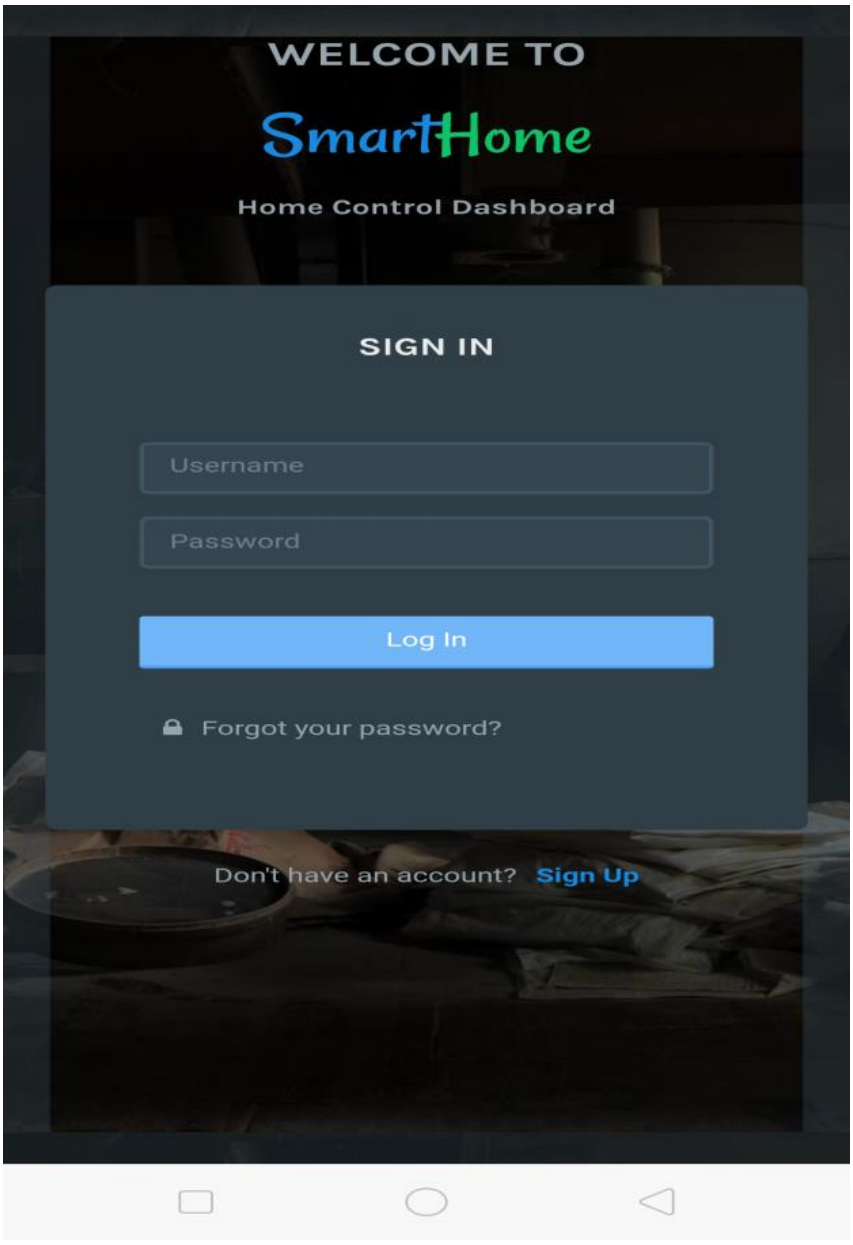

Figure 4.1.2: Android user login.

Desktop user login

This also the same as android application login page. The entire platform you must need to login to see your control panel dashboard.

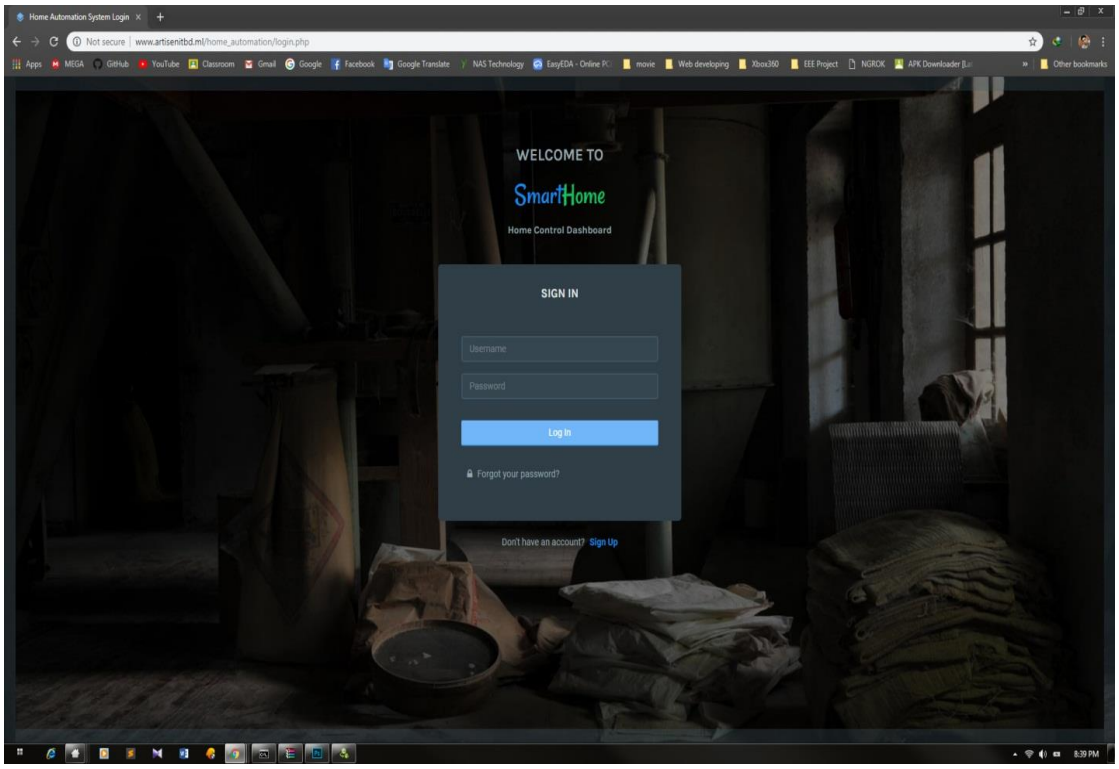

Figure 4.1.3: Web application user login

4.2 Back-end Design

In this figure 4.2.1 here is our back-end design we using Arduino to develop this project. We use some relay to control voltage and using Wi-Fi receiver module for receiving data from user and control all the home appliances. Here you can see two light bulbs one is using for light control example and other is fan control. Their also have some switches for manually control the automation system. We connect all the circuits using connecting wire. We using transformer for converting ac voltage. We also using IR receiver module for controlling this system by IR remote.

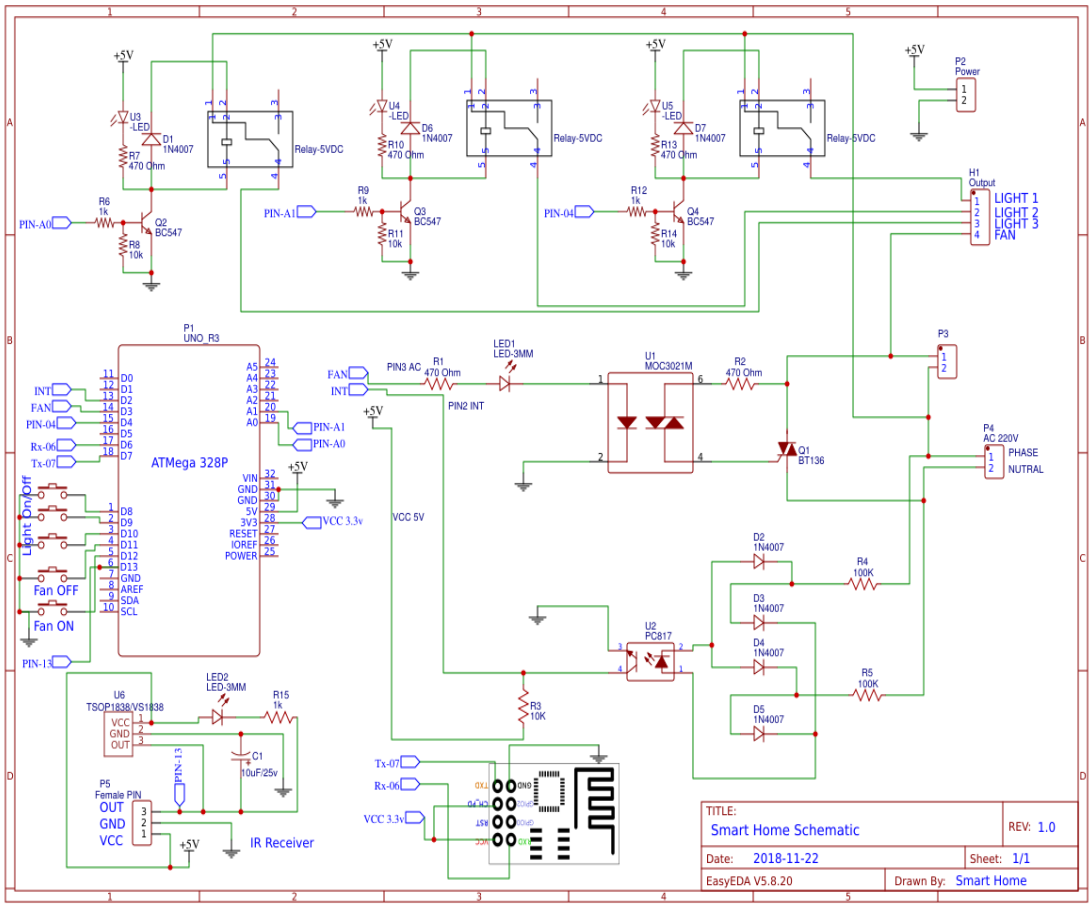

Figure 4.2.1: Back-end design.

4.3 Interaction Design

User can control their home appliance using android and web application. Applications connect with server this device also. Application send data to server for update and then server send data to Arduino for change the present condition. The other hand if internet was gone that time you need to control your appliance using manual switch. This is the main interaction between our devices with user. We think that is easier and reliable.

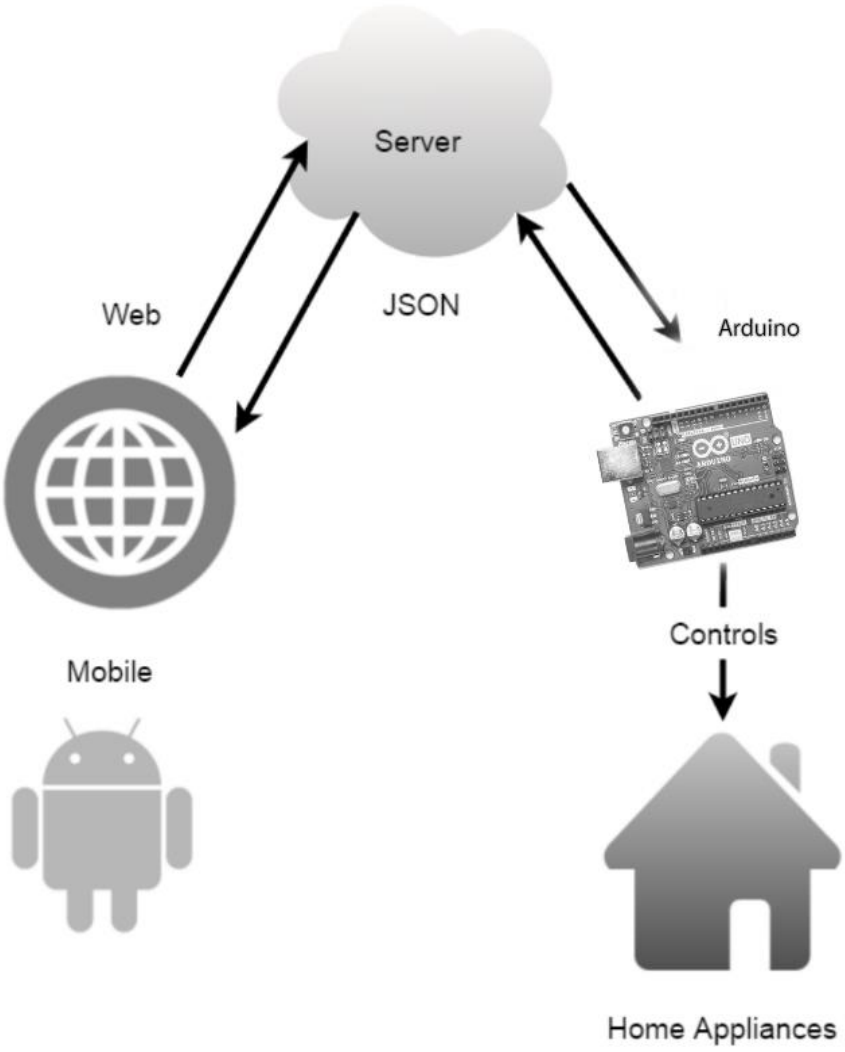

Figure 4.3.1: Interaction design.

4.4 Implementation Requirements

However we write down some minimum requirements for user implementation.

For Android application

- High speed internet.
- Lollipop 5.0
- RAM = 1GB.
- Internal space = 100MB.

For Desktop application

- High speed internet.
- Lite internet browser.
- RAM = 512MB.
- Processor = dual core.
- HDD = 128GB.
- Windows operating system.

For IR control

- IR remote.
- IR supported smartphone.

CHAPTER 5

IMPLEMENTATION AND TESTING

5.1 Implementation of Database

In this figure 5.1.1 we can see the picture of our database structure and there have a user database table and system control table. When user register their profile that time database will updated and other table is system control table in this table data based on the system present condition. This has some row for identify the user home and control the system. HomeID represent the home identification light_1 is representing the data for first light condition. Those all are represent different type of component and data. When user want to control the system database will updated properly.

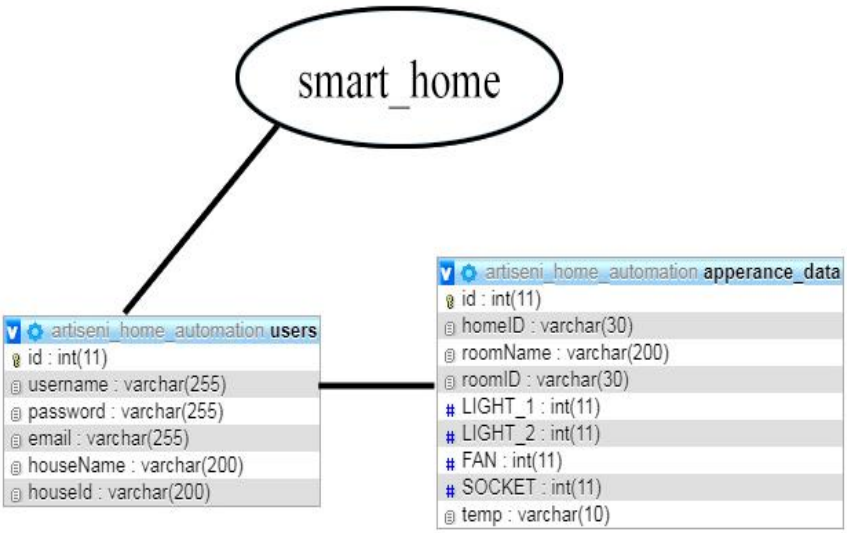

Figure 5.1.1: Database.

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5.2 Implementation of Front-end Design

Android user dashboard navigation

When android user login this system after login user can see the dashboard and every dashboard have some features or menu we design this menu as a navigation bar.

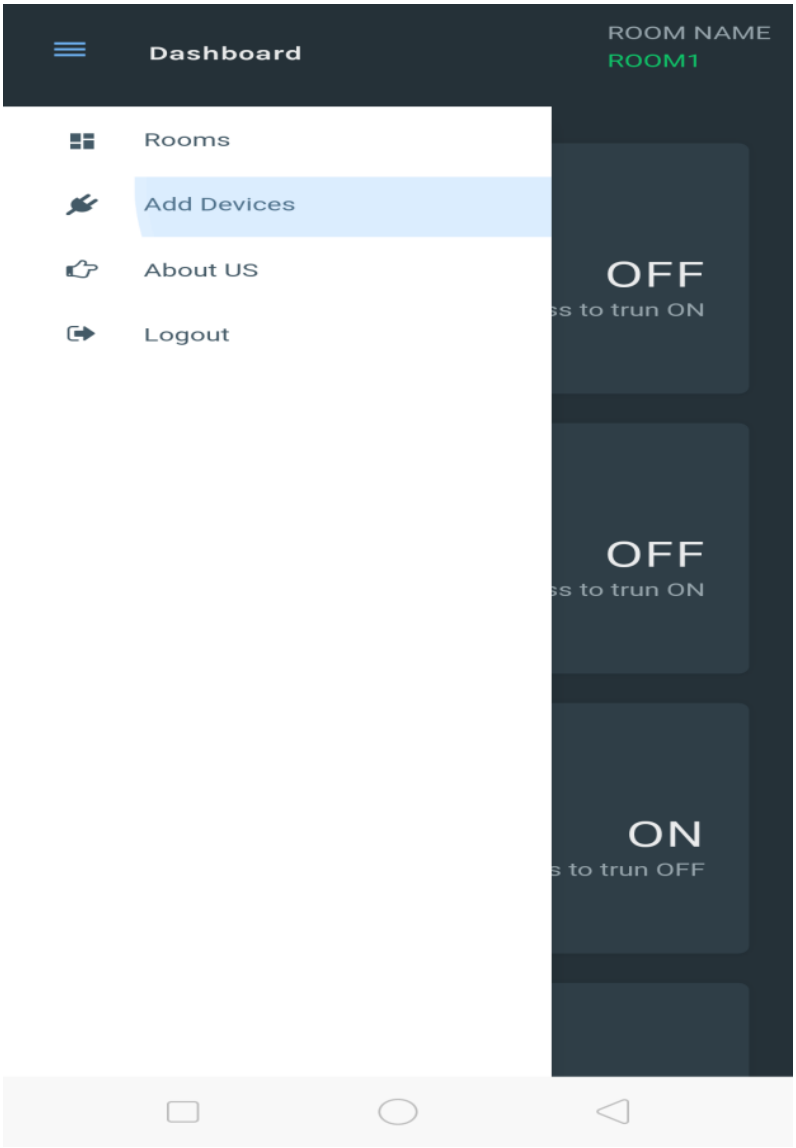

Figure 5.2.1: Android user dashboard.

Android room control

In room control menu user can easily control their room appliance which is connected with this system. They can off/on their light fan and socket. They can also control the fan speed. In the figure 5.2.2 right top side you can see the room name and left top their have menu bar for switch to other option.

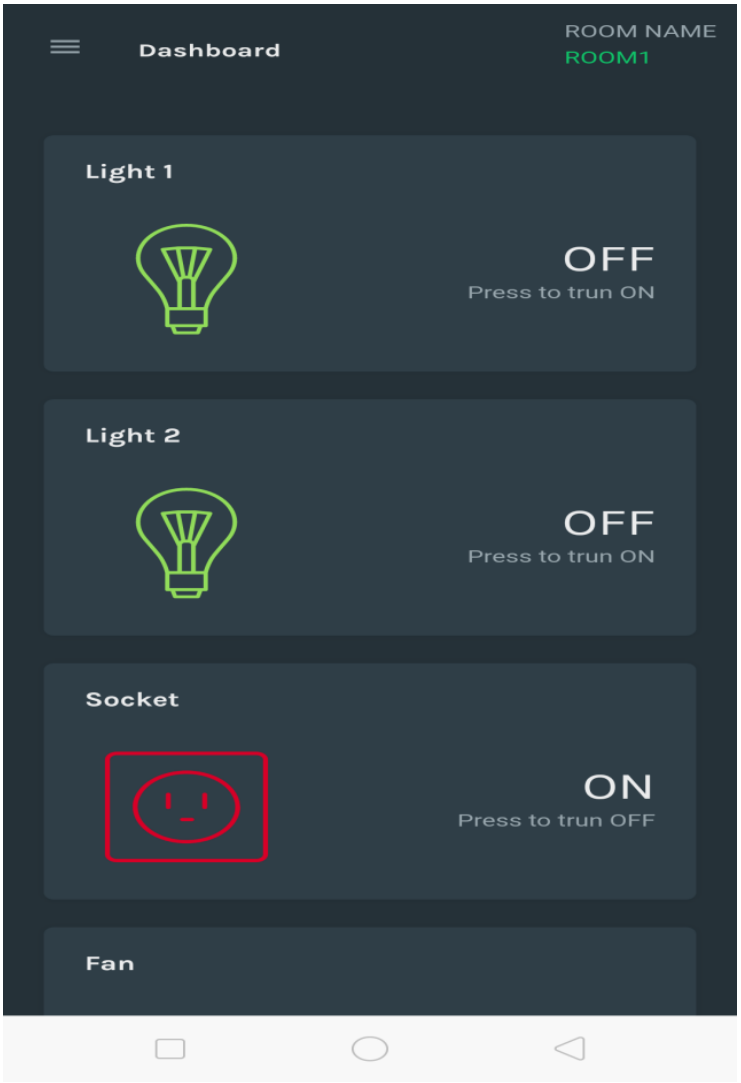

Figure 5.2.2: Android room control.

Desktop user Dashboard

This is the same as android application just the different platform. User can do everything using this dashboard. They can control their appliances, add another room, they can directly logout from this page.

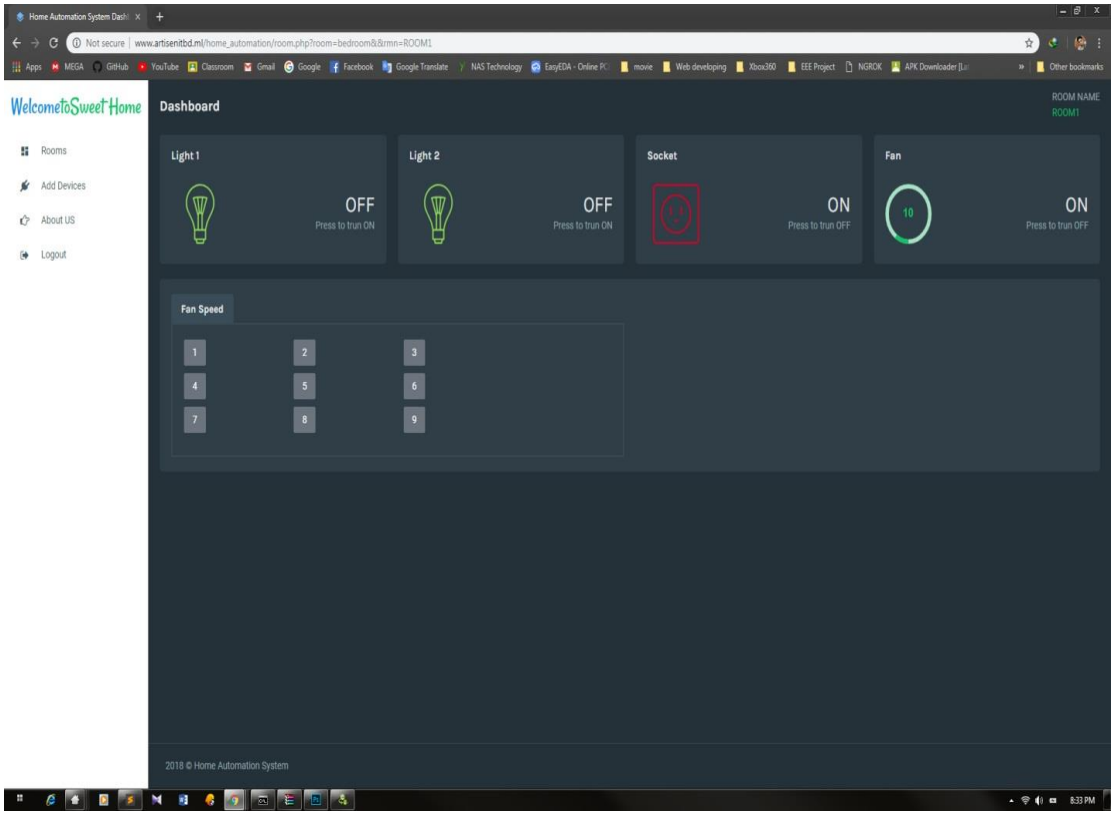

Figure 5.2.3: Web application user dashboard.

5.3 Implementation of interactions

Fan and Light ON

Now I want to see u the implementation of our interactions. In this figure 5.3.1 you can see the both light bulbs are on because of user on the light and fan.

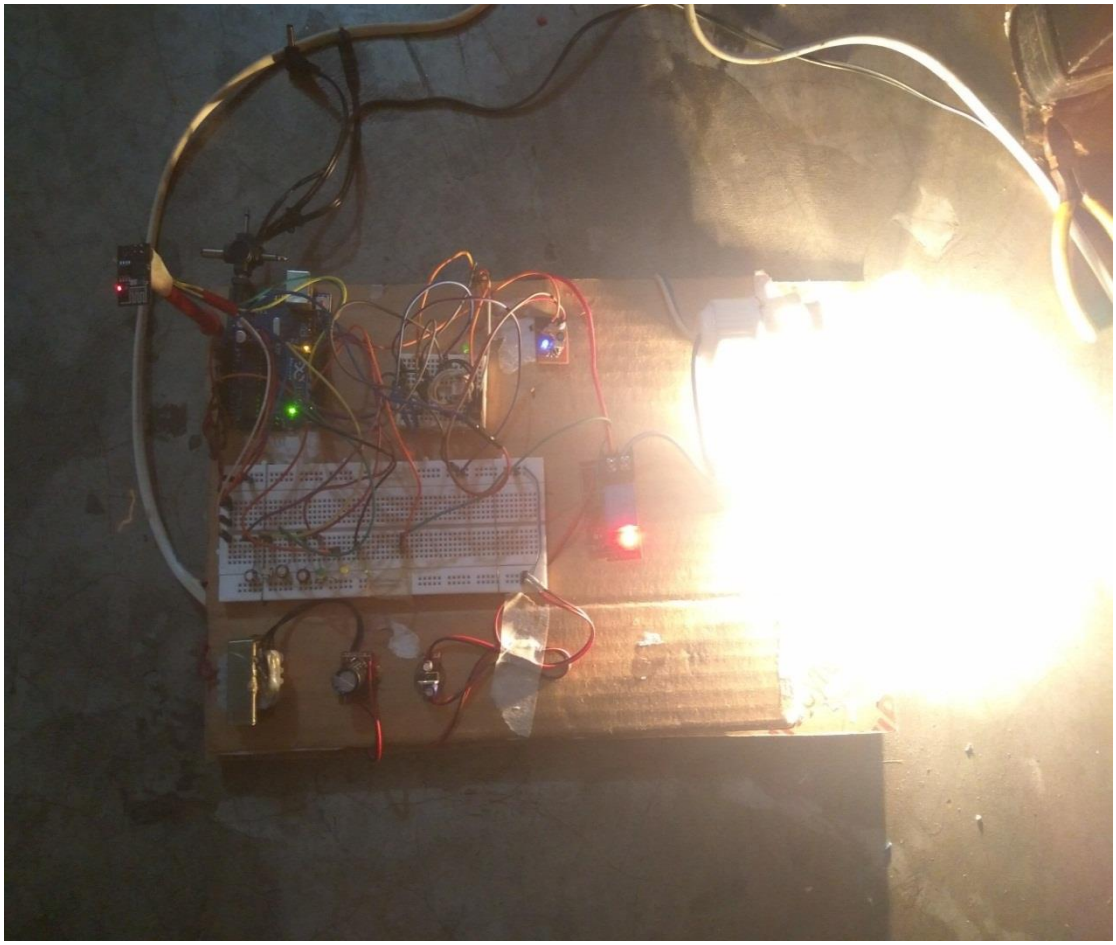

Figure 5.3.1: Light and fan switch on.

Light ON and Fan speed Medium

In figure 5.3.2 here is the implementation of our project. Here user on the light and they control the fan speed this stage light fully on and fan speed is 50%.

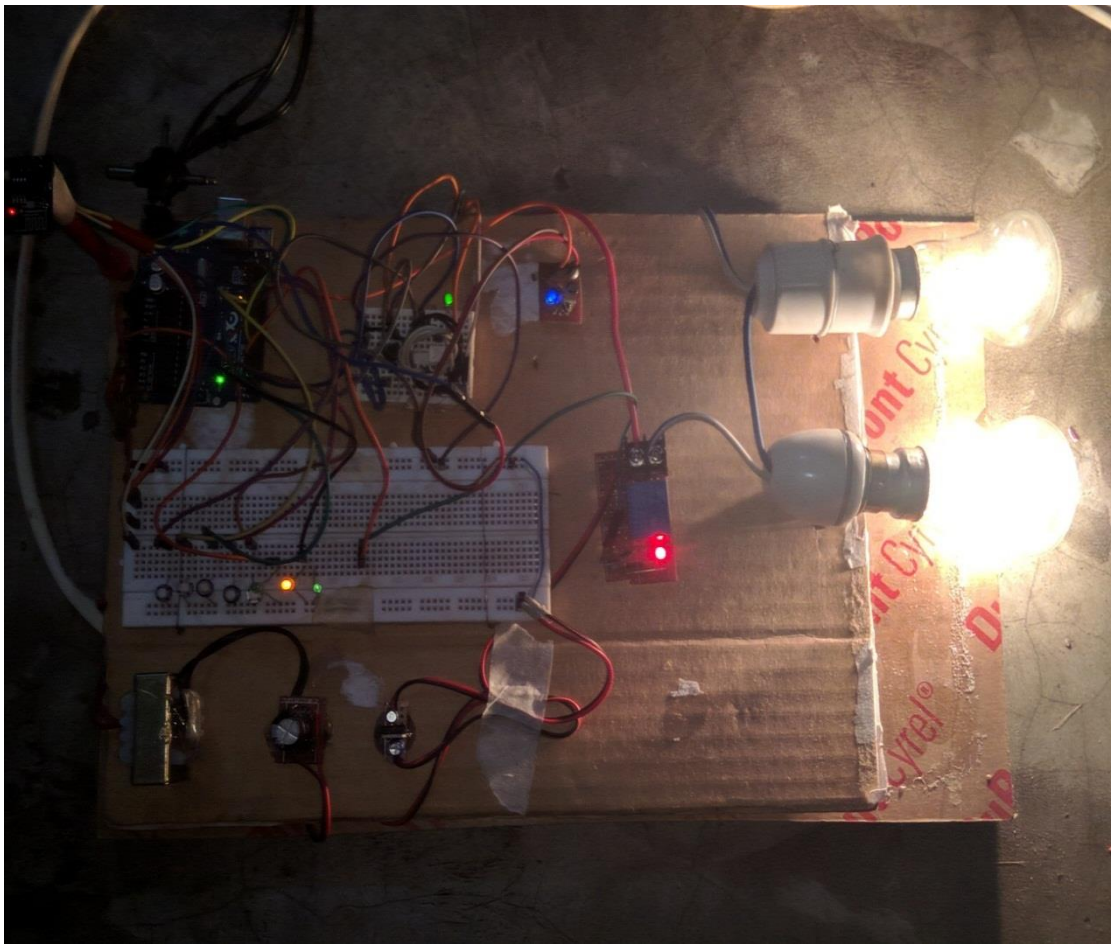

Figure 5.3.2: Light on and fan speed medium.

Light OFF and Fan speed Low

In this figure 5.3.3 we try to show the voltage control system. In this stage light bulb is fully off and the fan is on. In that stage fan speed is 25% this is the lowest fan speed. We converting fan speed in percentage because the better understand for users.

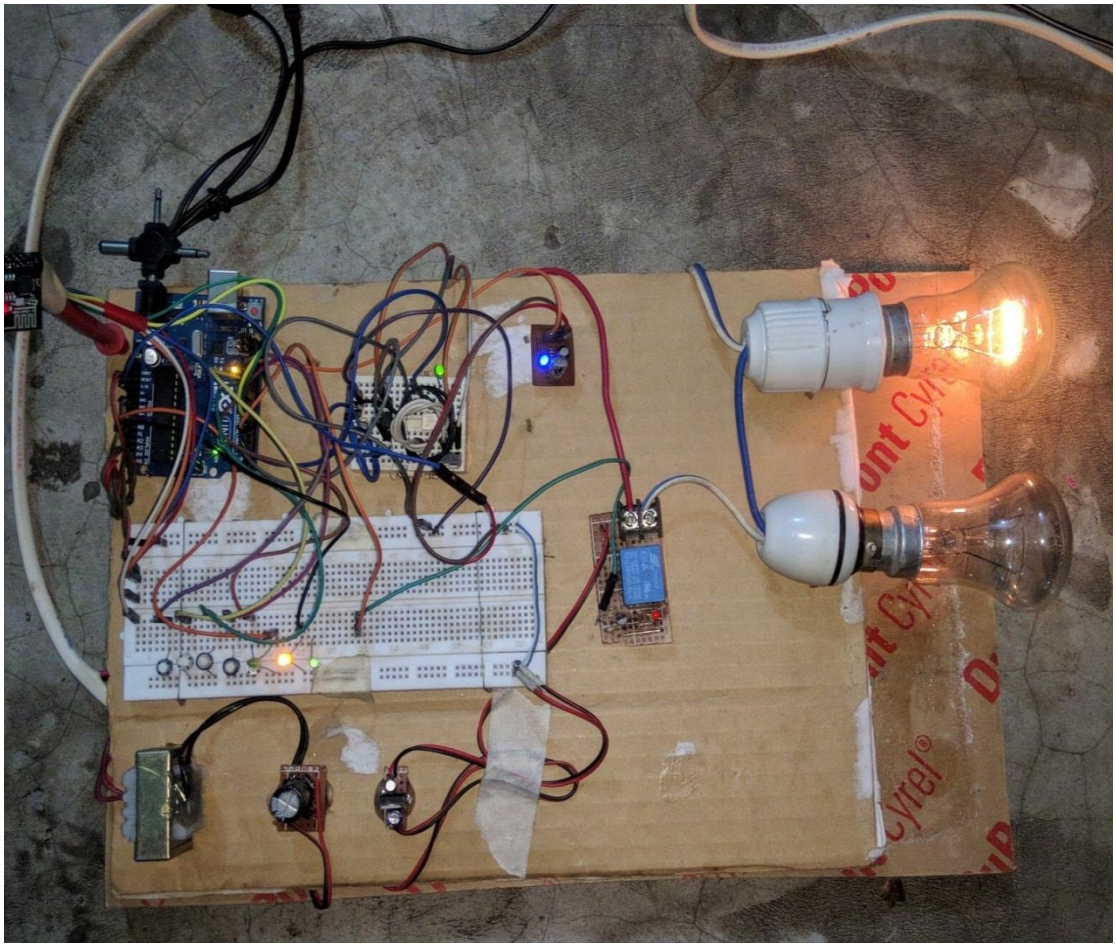

Figure 5.3.3: Light off and fan speed low.

Light OFF and Fan speed high

In this figure 5.3.4 we want to show the voltage control part this stage we turn off our light bulb and turn on the fan. In this voltage stage fan will running with full speed that means 100% speed. User can also see this speed meter in their web and android control dashboard monitor.

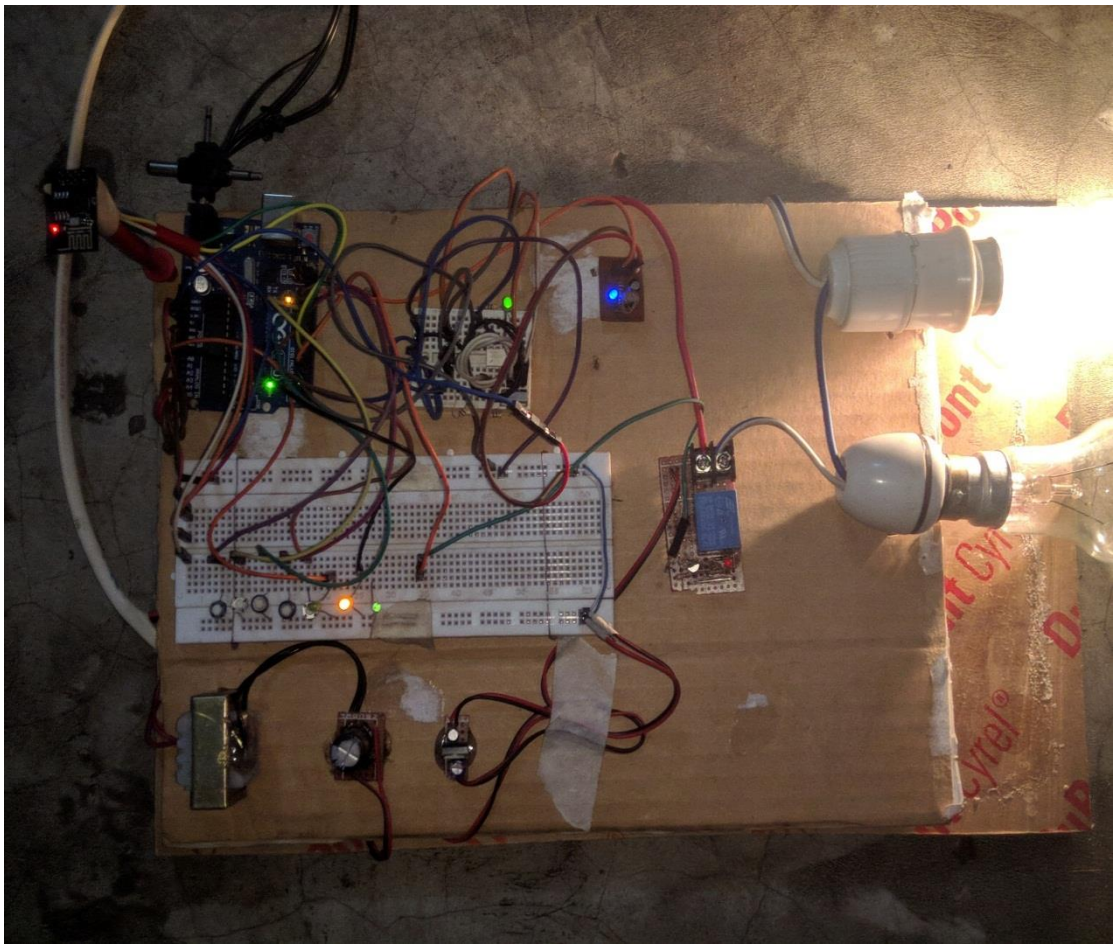

Figure 5.3.4: Light off and fan speed high.

Fan OFF and Light ON

In this figure 5.3.5 we want to show individual work for system in this stage our voltage control unit is totally off and the other hand light bulb is on. We were testing it different way and different home for our satisfaction. This system work for all testing stage.

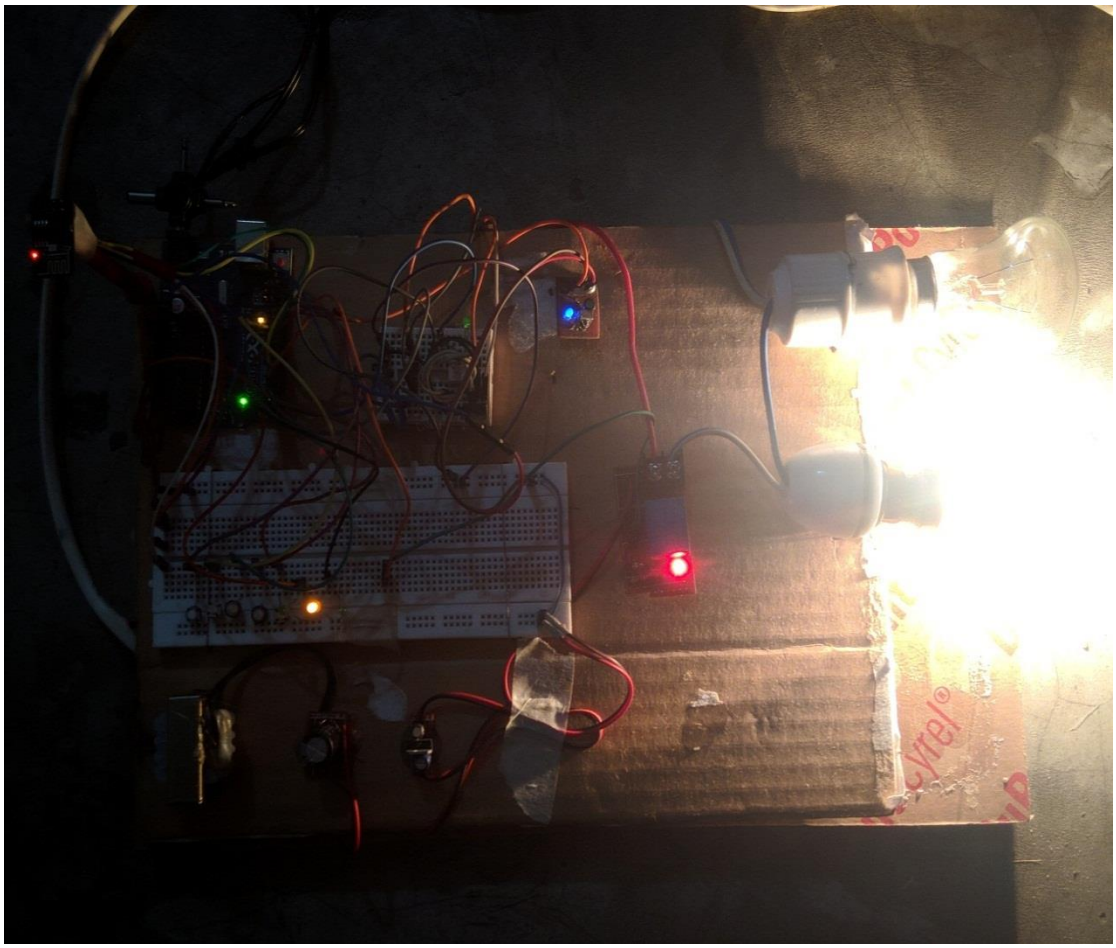

Figure 5.3.5: Light on and fan off.

5.4 Testing Implementation

After completing the project we completing some test. We complete unit testing, component testing and integrated testing. To do unit test we check our all source code that was work correctly. After completing unit test we are not found any bugs in our system. In component test we are testing part by part like as light, fan, fan speed, socket every home electrical appliance. All are work correctly as we want. We check our user interface that was work properly. Finally I can tell we are successfully complete our project “IoT based Home Automation System”.

5.5 Test Results and Reports

The system testing result show as a table below:

Table 5.5.1: Testing Result.

No. of Test	Test Case	Expected Result	Observed Result	Test Result
1	User can successfully login the system	Successfully login	Successfully login	Pass
2	User can easily access the home appliance	Accessible any menu	Easily accessible	Pass
3	User can control the electrical appliance using Android and Desktop application	Easily controllable	User controlled	Pass
4	User can control the electrical appliance using IR remote	Easily controllable	User controlled	Pass
5	User can control the electrical appliance using manual switches	Easily controllable	User controlled	Pass

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

6.1 Conclusion

This IoT based Home automation System is made from low-cost available components and can be used to control more than hundred home appliances. This system is easily adjustable at any home or office space. The automation system was tested a number of times and successfully control different home appliances (this is as long as the maximum power and current rating of the appliance does not exceed that of the used relay) in anywhere. If your home internet connectivity lost that time user can control their appliances using manual switches. Finally, this home automation system can be also implemented over Infrared connectivity without much change to the design and yet still be able to control a variety of home appliances. Hence, this system is scalable and flexible. In future we will make it more attractive and more efficient [1].

6.2 Scope for Further Developments

In future we will make it more attractive and more efficient. Next we want to add the LCD monitor for showing room temperature, time, and system output display. We will make more attractive and add more features in our Android application.

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