

A COST-EFFECTIVE AUTOMATED HOME SYSTEM WITH AUTHENTICATION

Sachin Sarkar¹, Rachit Garg², Sonam Sharma³

¹Sachin Sarkar, Student, SRM Institute of Technology, Modinagar, Uttar Pradesh, India

²Rachit Garg, Student, SRM Institute of Technology, Modinagar, Uttar Pradesh, India

³Sonam Sharma, Assistant Professor, Dept. of Computer Science and Engineering, SRM Institute of Technology, Modinagar, Uttar Pradesh, India

Abstract - This project is aimed at developing an all-around home wireless controlling and automation system that adds convenience to the life of the users who install it. With the help of this home automation project module, a user (admin) can give access to all family members so that everybody can easily control all their home appliances such as ordinary bulbs, fans, refrigerators, washing machines, and other electrical and electronic devices (which are connected to this system) with the help of an Android Application. This project will help the users reduce the cost of making their ordinary home devices smart, as in this implementation they just have to connect it with already existing appliances with the IoT system relays correctly. This way users can easily control the power to these non-smart appliances without any extra cost of buying pre-WiFi-enabled smart devices. When installed properly, this system can reduce the cost and time spent by the user to make their home devices remotely accessible. This project aims to deliver a cost-effective system that makes all the ordinary home appliances accessible and controllable just by a smartphone with proper authentication in mind.

Key Words: NodeMCU, ESP8266, IoT, 5V Relay, DHT11, Kodular, Google Firebase, Authentication, WiFi.

1. INTRODUCTION

The Internet has evolved quite a lot since its origin. From ordinary use of getting some basic information, the Internet is now being used to send texts, images, stream videos, play games, and much more. But there is one more aspect where the Internet has proven its great importance, and that is IoT. Through IoT, we can ask the Internet to perform a certain task, and it will try to do it for us. Nowadays, IoT has become more powerful than ever with the advent of biometric gadget uses in different fields. It is now being used to solve many worldly problems, in a way never imagined e.g., biometric use for withdrawal of cash from a Bank account, to mark attendance, etc. The quality of human life is improved by the work done with the help of IoT devices. IoT uses very few resources, which also helps to save the environment.

IoT is a technology that is best explained as, things or objects with sensors, software, and network access. It can be used to send and receive data over the network to perform various tasks without the need for much human interaction. IoT is vested with multifarious applications, one of which is Home Automation. Vide Home Automation setup, the ordinary home appliances sort of communicate with the Internet and do various tasks that they are programmed to do or asked for by the user. This not only improves the user experience but also saves energy, as it can automatically turn off the appliances when not in use.

Home automation is unique in the sense that it not only controls but works as a communication bridge between all the appliances of our house. The term Home Automation can be defined as a centralized communication system where-with all the appliances of the house, wired or wireless, are connected so that they can be controlled and automated as per the user's requirements/comfort. Installed centrally the microcontroller panel controls all the appliances and related functions such as lighting, heating, air-conditioning of the house. In other words, the electrical appliances and electronic devices are programmed to respond automatically to a centralized controlling gadget under diverse conditions. With the help of an Android phone, we can switch on or switch off any connected devices from a distance also.

Home automation alone cannot do much magic unless coupled with a remote server/database. This can be done with the use of Cloud Services. In our Home Automation System, we used Google Firebase as a remote server. Firebase is Backend-as-a-Service (Baas), which we are using as a Database server for our project. In this, the details of all the rooms and their appliances are present, which can be updated with the help of our application according to the user's needs. And if we want to turn On or Off the various appliances which are connected to the Home Automation, we can do so with the help of our application, from anywhere around the world. This kind of versatility is provided by our Home Automation model by the use of Firebase as our server.

Our home automation model requires various components with which we were able to connect the various appliances. These include Node Micro Controller Unit's-ESP8266 (NodeMCU), relays, DHT11 sensors, USB cables and chargers, and connecting wires.

The NodeMCU is the brain of this Automation. It does all the calculations to decide which appliance to turn off based on the command given. It consists of a WiFi module, which helps the automation model to connect to the internet and communicate with the Firebase. The relays are used to connect the appliances to the NodeMCU. The relays are connected to various pins in the NodeMCU, which are turned On/Off according to the user's needs.

For the programming of the NodeMCU (ESP8266), we used Arduino IDE which is a tool, used by most of the IoT programmers to do all the Microprocessor programming. Embedded C is the Language for the programming of these microprocessors.

Our Home Automation also contains an Android application that was created with the help of Kodular. This tool is a great way to make an android app that is scalable and can be easily integrated with Firebase to do all the database operations. The key feature of our Home Automation system is the implementation of proper authentication methodology. No other kind of automation provides this kind of protection and security. We used the Mobile OTP/Email-PIN authentication system to Log-In in to the application. Vide Admin/Guest account a user can be logged in. An automation system has only one Admin but can have many guests. The functionality of adding guests is similar to that of adding a friend on Facebook. The admin can at any time revoke the permission of the Guest, this is useful if you want to give access to any guest who has come for few days and will eventually leave.

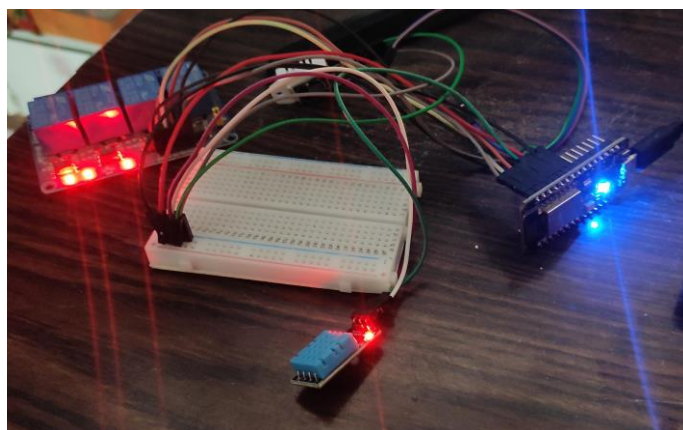


Fig -1: Working model of Project

2. IDENTIFICATION OF THE PROBLEM

We were inspired to work on this project considering the following:

2.1 Unnecessary electricity bill

It is quite tragic that we pay heavy electricity bills without even 50% use of it. Nearly every household leaves electrical appliances such as bulbs, fans unattended leading to inflated electricity bills. It crossed our minds as to how we can reduce hefty electricity bills.

2.2 Reduction of unnecessary wear and tear of home appliances

Unwanted excessive use causes wear and tear to the appliances we use at home. Minimizing unwanted use can give a better life to appliances that are used in households. Somewhere we had in mind appropriate use of electrical/electronic goods needed for daily routine life thereby saving on/avoiding early wear and tear of them. Our application will certainly be a tool for avoiding unwanted damage to appliances.

2.3 Security from unexpected/unforeseen hazards

We come across various news regarding electrical short circuits in households which cause unnecessary loss to property/appliances/human life while the family is away from home. To search for an application that can reduce such losses in the future as our prime motive. Our app will assist a lot in timely switching off the electricity when the appliances are not in use (even from remote places) by availing Internet facility.

2.4 Proper Authentication System to avoid foul play by unauthorized people

Security features by way of login facility didn't come to our notice to date through the apps available in the play store. Therefore, it was but a necessity for us to add a Log-In facility to our app. Vicious designs by rogues can be countered thereby saving the appliances/property from intentional damage by unwanted people.

2.5 The unwanted expense of extra wires for different rooms

Projects available in the market make synchronization compulsory through wires. Whereas our project proposal speaks of centralizing control of different rooms of a house through synchronization of NodeMCU's in the cloud reducing the expenses of the additional wires.

2.6 Addon DHT11

While away from home for a very short period we sometimes crave for a facility to regulate appliances under specific conditions of humidity and temperature. Our app includes this feature whereby under specific temperature and humidity the system will automatically control the Air-conditioner etc.

3. IMPLEMENTATION

3.1 Main Automation Controller - ESP8266 NODE MCU BOARD

NodeMCU is technically a development board specifically targeted at IoT applications and is based on an open-source Lua-based Firmware. It is a hardware-based ESP-12 module and includes firmware running on ESP8266 Wi-Fi SoC from Espressif Systems.

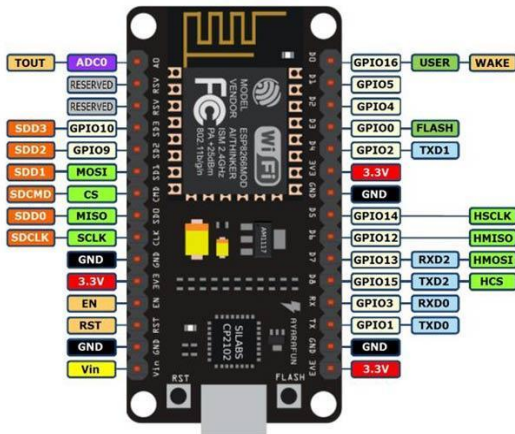


Fig -2: NodeMCU Pins

3.2 Interfaces

It is a medium with which interaction is established with a home automation setup. We come across various types of interfaces in our day-to-day life e.g., Smart Phones, Remotes, Touch Panels, and the Internet. Our project proposes an Android smartphone as the main device. The use of Android smartphones is widespread, and therefore we preferred it. Installation of a resource controller (application) on the smartphone is a prerequisite. Various reputable home appliances can be controlled within the mobile interface. Wouldn't it be convenient and a nice experience to switch on and switch off all appliances with a click on a smartphone either from the washroom, playground, before sleep, etc.

3.3 Control Methods

Three prime objects are under consideration viz: a controller, an interface (smartphone) to establish a communication platform for the controller, and sensors that

inform the prevailing activity on an appliance at home. WiFi is the medium through which entire communication is to be established. Wifi will facilitate communication and work as a medium to manage many components of our Home Automated System in various ways. Some interfaces which are considered to facilitate control through our Home Automation System are IP (Internet Protocol), Wi-Fi, Bluetooth, Zig-bee, IR, Serial Data, and Relays (automotive).

3.3.1 Wi-Fi technology

If ethernet wiring is not available at any place then wifi is a convenient option for the internet. As large data can be transmitted wirelessly, WiFi is a great option for interaction between large distances. Owing to comparatively larger expenses on the ethernet wiring WiFi is preferable.

Advantages of using WiFi technology:

- 3.3.1.1 Convenient for installation irrespective of location
- 3.3.1.2 Unnecessary hanging wires can be avoided
- 3.3.1.3 Additional Ethernet output is not required
- 3.3.1.4 Covers very large distances and is comparatively faster in data transfer

3.4 Google Firebase

Google Firebase is widely used and is a system-support software that is Google supported. This software is widely used by developers for the development of Android, iOS, and Web applications. To report and fix app crashes, to track statistics, to create marketing and product testing, the Google Firebase provides the necessary tools.

3.4.1 Authentication

To improve better login experiences for users and to build secure authentication systems the developers take support of Firebase Authentication. The services offered by Firebase include support for email and password accounts, complete ID solution, phone authentication, Google, Facebook, GitHub, Twitter login, etc.

3.4.2 Cloud Messaging

Firebase Cloud Messaging (FCM) is a tool for advanced messaging which enables companies to securely find and deliver messages to iOS, Android, and the web for free.

3.4.3 Realtime Database

The Firebase Realtime Database is a cloud-based NoSQL database that enables data to be stored and synchronized between users in real-time. Information is

synced to all clients in real-time and is still available when the app is offline.

need to be connected to relays which are controlled by NodeMCU.

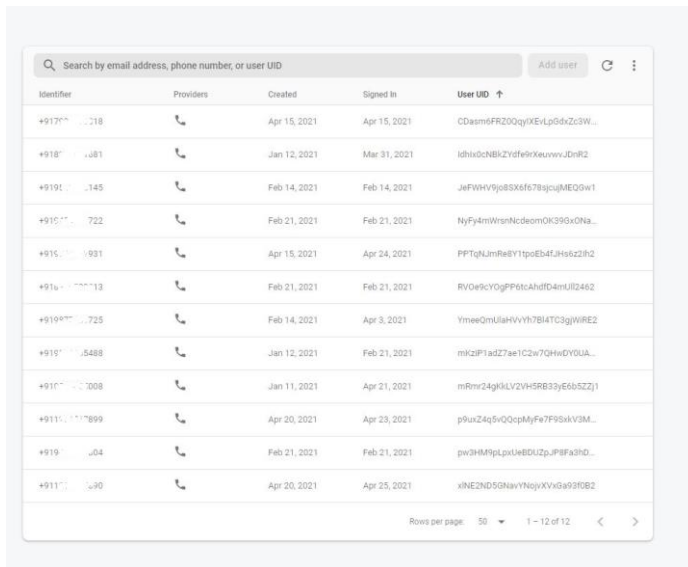


Fig -3: Firebase Authentication System

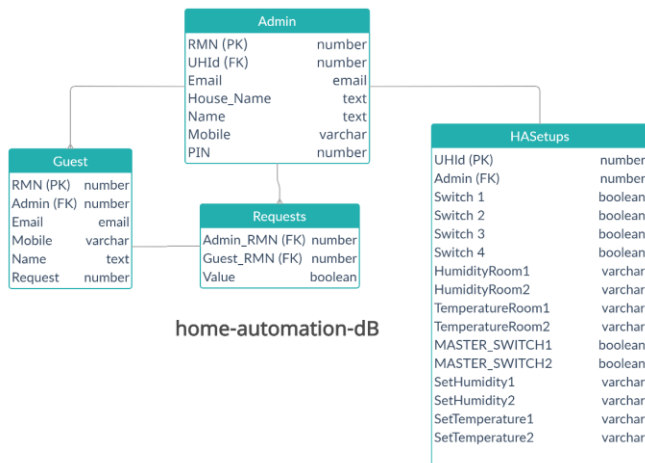


Fig -4: Firebase Database Design

3.5 Working

In this project, we built a home automation system that has two parts. One is the NodeMCU syncing with Firebase and updating the status of appliances like fan, bulb, cooler, motor, etc. where control is to be reinforced and the other is the android application to control and sync with Firebase.

Our system proposes the use of ESP8266 NodeMCU, DHT11 Sensor, Relays, and Kodular. The control of necessary appliances e.g., refrigerator, air conditioners, coolers, fans, lights, fans, etc. is facilitated by the above-said modules through the use of our application. All types of equipment

Access to WiFi networks is facilitated by NodeMCU since it is a self-contained SoC with TCP / IP stack integration. The dual job of a Wifi client and Wifi access point(AP) is served by it. For easy access and convenient configuring it is pre-programmed with AT instructions. Firstly, we have to connect ESP8266 with the power. It operates at 3.3V, it can be damaged if you connect it directly to 5V. Afterward, we connect NodeMCU with the relay pins and the DHT11 Sensor. Thereafter, electrical appliances are connected to the relay output to turn them ON/OFF.

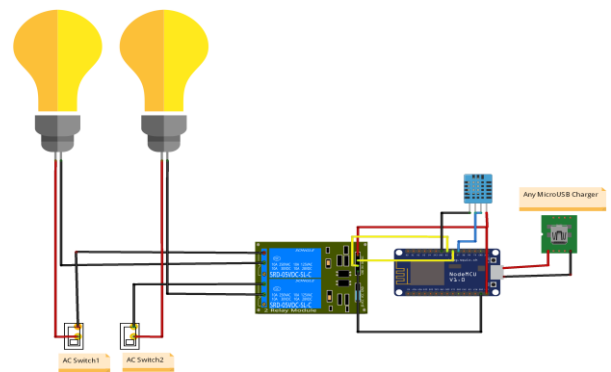


Fig -5: Hardware Model for a single room

For the implementation of our application, firstly we had developed an Android Application with Kodular to ensure the working of our model.

Authentication of a particular house to a particular user (Admin / Guest) is assigned through a login/signup page in our application. The Authentication system provided here is a mobile-number-based OTP system and email ID-PIN system. Also if a user is already signed in the application will auto fetch the account details for a hassle-free Log-In.

Under a given Unique House ID (UHID), only a single admin can exist who can approve other Guest users to have access to the house. The admin, at any time, can revoke access of the guests to that house. Once a person is Signed In as a guest of a house he has to delete his account to re-register as a guest in another house.

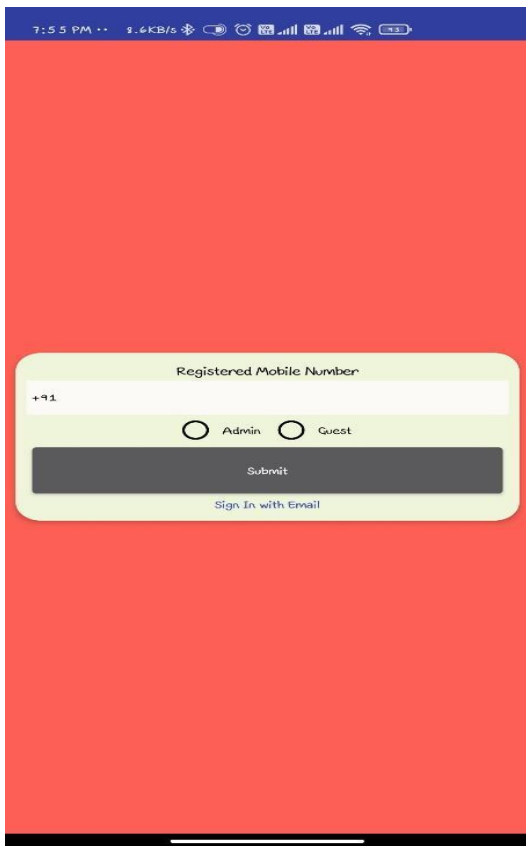


Fig -6: Login Screen



Fig -7: Home Screen

Once we are logged into the application we can control the appliances that are connected with the relays. The DHT11 sensor plays a crucial role in the application home page. Using the DHT11 sensor we are providing the current approximate temperature and humidity of each room within the house. Also for each room, we can automate the fans and coolers to turn on and off at a given temperature and humidity combination which ensures electricity conservation with a master switch of that room. The Admin Panel has a few extra options such as revoking and providing access to other guest users of that house.

Link for our application on Google PlayStore: <https://bit.ly/2R5jtUL>

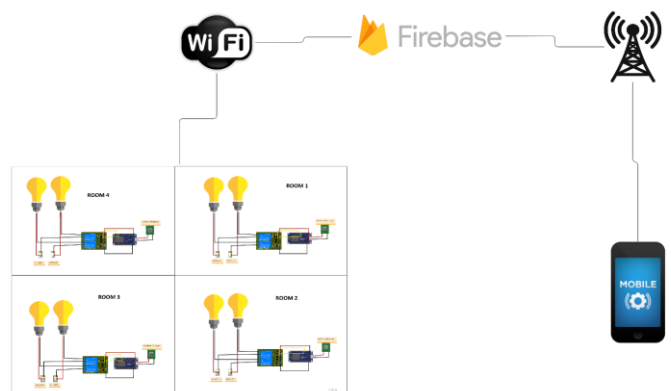


Fig -8: Flowchart of Working

4. CONCLUSIONS

The primary aim of this project is to ensure cost-effective measures with the perspective of ease, security of the android application embarking the IoT. This project takes this responsibility seriously and tries to deliver the output in consonance with the objective. The possibility of elimination of risks is also explored to ensure that only the authorized person is allowed to ask for these tasks. This project focuses on authentication, as much as it focuses on its automation functionality. The authentication part of this project is handled by Google Firebase Authentication where the user can Log-In using a mobile number through the OTP process or by their registered EmailID-PIN combination. With proper use of the application, we can reduce unnecessary expenses on electricity and avoid hazardous incidents by timely switching ON/OFF electrical/electronic equipment. This will not only ensure a convenient lifestyle but also work as a time-saving measure and will help to avoid human/property loss.

5. FUTURE SCOPE

This project is a basic structure of how we can improve "IoT for home automation" and this is subject to further improvement/addition. The access mechanism can be extended to direct web access for laptops instead of using

Android Emulators. The scope of this project can be extended to include other security features for example automated door lock, security camera, etc.

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BIOGRAPHIES



I am an aspiring Kodular Developer. I prefer using JAVA language rooted in MySQL/Firebase for the database. I have a keen interest in different research-based IoT projects.



A Tech Enthusiast and highly motivated Computer Science Student, currently pursuing my B.Tech from SRM IST (4th Year). My fondness for Computer Technology compels me to dive deep into all the technologies one of which being IoT.



Assistant Professor at SRM Institute of Technology. Currently pursuing my PhD with Software Defined Networking.