



INTERNATIONAL JOURNAL FOR ENGINEERING APPLICATIONS AND TECHNOLOGY

SMART SWITCH – HOME AUTOMATION USING IOT

Abhijeet B. Raut¹, Ashish G. Umare², Raksha S. Pokale³, Mohini M. Naitam⁴

¹Final Year, Computer Science and Engineering Department, J.D.I.E.T., Yavatmal, MH, India, abhiraut041@gmail.com

²Final Year, Computer Science and Engineering Department, J.D.I.E.T., Yavatmal, MH, India, ashish.umare17@gmail.com

³Final Year, Computer Science and Engineering Department, J.D.I.E.T., Yavatmal, MH, India, rakshapokale6@gmail.com

⁴Final Year, Computer Science and Engineering Department, J.D.I.E.T., Yavatmal, MH, India, mohininaitam0609@gmail.com

Abstract

We live in an exciting time where more and more everyday items (things) are becoming smart! These things have sensors and can communicate to other things. The Internet of Things, i.e. IoT, has made huge development and people are rapidly inventing new gadgets that enhance our lives. This IoT based home automation project is done using low cost Arduino UNO, NodeMCU and Bluetooth module. It uses relays and a temperature sensor and few simple components. Many electrical devices can be controlled with smartphones and also parameters such as temperature and humidity can also be monitored locally or remotely using the system proposed in this project. With advancement of Automation technology, life is getting simpler and easier in all aspects. In today's world Automatic systems are being preferred over manual system. This home automation system differs from other system by allowing the user to operate from anywhere around the world through Internet connection. It also provides the facility to control the devices locally using Bluetooth technology in our smartphones without the need of Internet Connection. The Android Application which is used to interact with the user is well-designed and has some amazing features. This system uses the Google's Realtime Firebase Database as the database to store the user data and the system data. This project is not limited to a single Smart Switch device and user, it can handle thousands of devices as well as users and its capacity can be increased with the growing need.

Index Terms: *Arduino, NodeMCU, Automation, Internet of Things, Smart Home, Firebase Database.*

1. INTRODUCTION

Internet of Things(IoT) deals with billions of intelligent objects which would be connected to sense & collect the data and also communicate with surrounding people using mobile, wireless and sensor technologies. Main objective of IoT is to manage and control physical objects around us in a more intelligent and meaningful manner [2] and also improve quality of life by providing cost effective living including safety, security and entertainment. In this paper, we have come up with a system called Smart Switch – Home Automation using IoT and an Android Application. This system is super-cost effective and can give the user, the ability to control any electronic device connected to this system [1].

Time is a very valuable thing. Everybody wants to save time as much as they can. New technologies are being introduced to save our time. To save people's time, in this paper, we are introducing a unique Home Automation system. With the help of this system the user can control his/her home appliances from an Android Smartphone in multiple ways. The Smart Switch System has two modes of operation, which makes it quite different from other kinds of Home Automation systems. The Smart Switch System can operate in:

- Wi-Fi Mode (using Internet Connectivity).
- Bluetooth Mode (using Bluetooth for local use) [4].

The user is free to choose from any of these two modes or switch between these two modes as many times he/she likes.

1.1 Wi-Fi Mode

In Wi-Fi mode, the system connects to the network as specified by the user. For this system, we've used Google's Realtime Firebase Database, which will store all the necessary user data as well as system data required for the operation of the entire system. In Wi-Fi mode, the system will communicate with the Firebase database over the Internet. The user can control various home appliances connected to the Smart Switch Device by means of an Android Application. When the system is in Wi-Fi mode, the Android Application will communicate with the Google's Firebase database over the Internet and set various values for the devices to be turned on or off. On the other hand, the Smart Switch Device will continuously monitor the Firebase database looking for any changes in the values. As soon as changes are found, it will update the state of the household appliances as specified by the user from the Android Application. The Smart Switch device also monitors live temperature and humidity in the user's home. This data is then uploaded onto the Firebase database after every 10 second interval. The user is able to see this temperature and humidity data on his/her smart phone by means of the Smart Switch Android Application. The control

messages that are exchanged between the phone and the Firebase Server as well as the messages exchanged between the Smart Switch device and the Firebase Server are highly optimized to increase the overall speed of operation of the system.

1.2 Bluetooth Mode

In Bluetooth Mode, the Smart Switch Device connects with the user's Android Smartphone via Bluetooth [4]. Then by using the same Smart Switch Android Application the user can control various home appliances connected to the Smart Switch Device locally i.e. within the range of Bluetooth communication. The temperature as well as humidity data is also shown in the Android Application, which is conveyed using Bluetooth to the user's smartphone.

1.3 Smart Switch Android Application

The User Interface of the Smart Switch Android Application is highly optimized and simplified to increase the ease of operation of the user. The Application offers a range of features which adds to the overall experience of using the Android Application by the user. The user can also rename the switches according to his/her needs. The user can also use his/her voice to turn on/off multiple switches [3]. The user can give a voice command to turn on/off multiple switches at the same time. Also, the Android Application is designed to use very less resources of the Smart-Phone. This Smart Switch mobile application will allow another Bluetooth device like Bluetooth enabled headphones to connect and operate on the user's smartphone, at the same time, when this application is using the Bluetooth to communicate with the Smart Switch device! All these feature makes Smart Switch Home Automation System more unique, efficient as well as user-friendly as compared to other such systems.

1.4 Smart Switch System

The Smart Switch Home Automation System is not limited to only one user and one Smart Switch Device. The Smart Switch System is designed to support the simultaneous operation of thousands of the Smart Switch Devices which can be operated using the Android Application. This capacity can be increased when the need arises. Each Smart Switch Device is identified using a Device-ID, which is unique for every system. The user can use the Smart Switch Device by registering with the Device-ID of the device. After which, the user can login to the Smart Switch app to control the appliances connected to the device via Internet.

This login and registration are required only when the Smart Switch device is to be operated in Wi-Fi mode. But when the device is to be operated in Bluetooth Mode, no such registration and login are required. The user can directly go to the Bluetooth Page and connect to the Smart Switch Device to control the appliances.

2. SYSTEM ANALYSIS

The entire Smart Switch system is a combination of hardware and software which works in synchronization to operate efficiently.

2.1 Hardware

The hardware of the Smart Switch Device includes:

1. Arduino UNO [1].
2. NodeMCU.
3. 8-Channel Relay.
4. Bluetooth Module (HC-05).
5. Indicator LED's.
6. Push Button.
7. Temperature and Humidity Sensor.

The Arduino UNO is connected to NodeMCU, and these two units communicate with one another. The Bluetooth Module is connected to NodeMCU. The 8-Channel Relay is connected to the Arduino UNO. The UNO is also connected to the temperature and humidity sensor. NodeMCU is also equipped with a push button and two LED indicator lights. The interconnection between the different hardware components is shown in the below diagram.

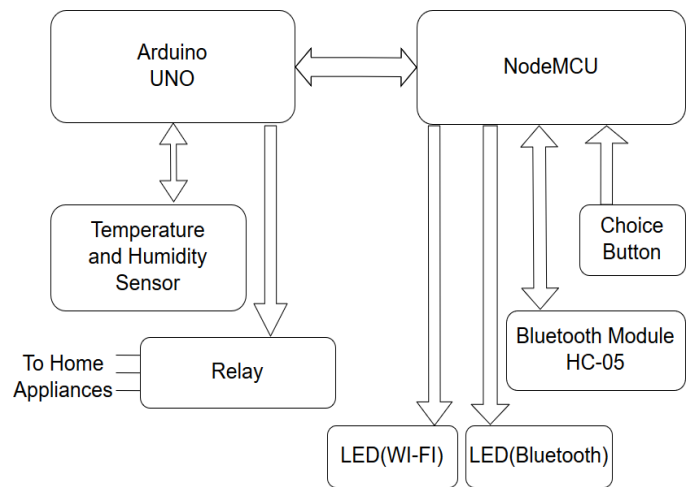


Fig. 2.1 Component Interconnection Diagram

2.2 Software

The software part of the entire Smart Switch system consists of three parts. The first and the most visible part of the software is the Smart Switch Android Application. The second part is the code that is written for the NodeMCU. And the third part is the code written for Arduino UNO. All the three parts of the software communicate with one another in a predefined way. The communication between various parts takes place by exchanging different control characters.

The Android Application is created using Android Studio and Arduino IDE is used to code NodeMCU and Arduino UNO. The database part of the whole project is handled by the Firebase database offered by Google.

2.3 Bluetooth Operation

As defined earlier, the system can operate in two modes. When the system is in Bluetooth mode the communication takes place between the Android App and the Smart Switch Device using Bluetooth [4]. The user is prompted to select the Bluetooth device to connect when the App is in Bluetooth mode. When the user selects the corresponding Smart Switch device, then the App initiates the connection with the device. On establishing the connection, a

success message is shown to the user on the App. And after that the user can control various devices connected to the relay wirelessly by means of the Android Application.

When the user turns on/off a particular switch in the Android App, the App sends the control character corresponding to that button to the Smart Switch device, indicating to turn on/off that particular switch. This control character is first received by the HC-05 Bluetooth Module. The HC-05 module then transmits this character to the NodeMCU. The NodeMCU then identifies this character and finds out which switch is to be turned on/off. Now, as the relay is attached to UNO, so the NodeMCU sends the control signals to the Arduino UNO to turn on/off that particular switch. In this way the entire process of turning on/off any switch works. The following figure illustrates the components involved and the flow of control signals in the Bluetooth Control.

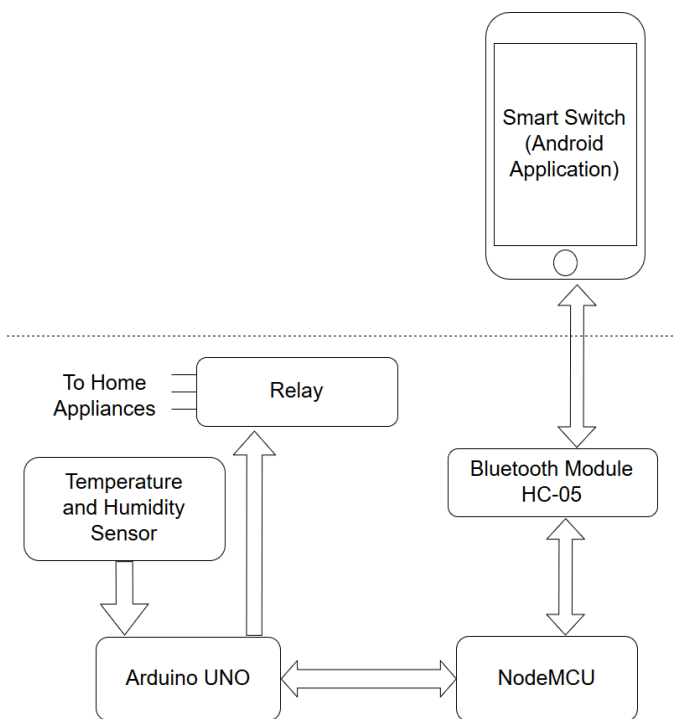


Fig 2.2 Bluetooth Control

Additionally, temperature and humidity data is also sent to the Android Application over Bluetooth. The App, after every 10 seconds send a special character to the HC-05 Module. This character is sent whenever the App wants to get the temperature and humidity. On receiving this character, the NodeMCU asks Arduino UNO for the temperature and humidity data by sending corresponding control signals. The Arduino UNO then collects the temperature data form the temperature sensor attached to it and sends it to NodeMCU which in turn passes it to the HC-05 module which sends it to the Android App, and then this temperature and humidity data is displayed on the smartphone screen. The various control characters that are used for communication between NodeMCU and Arduino UNO for turning on/off the switches are shown in the below table:

Table 2.1: Control Characters for communication between NodeMCU and Arduino UNO

Switch Name	Control Character (ON Command)	Control Character (OFF Command)
Switch 1	0	8
Switch 2	1	9
Switch 3	2	A
Switch 4	3	B
Switch 5	4	C
Switch 6	5	D
Switch 7	6	E
Switch 8	7	F

2.4 Wi-Fi Control

Now, for using the Smart Switch Device in the Wi-Fi mode, the user first has to register the device ID provided with the device in the Smart Switch Android App. On registering, the App creates a record for that device in the Firebase database with Device-ID as the primary key. It also adds certain variables corresponding to the 8 switches of the Smart Switch Device in the database. The value of these variables is changed when the user turns on/off any particular switch. Also, additional fields are created in the database for the temperature and humidity values, which will be uploaded to the database server by the Smart Switch Device. On completing of the registration process, the user will obtain a username and password, which should be used to login to the Smart Switch App and control various appliances connected to it. This username and password are required only when the system is to be operated in Wi-Fi Mode, for Bluetooth Mode it is not required.

For controlling the switches in Wi-Fi mode, first the user needs to login to the App. And then on the command screen the user can turn on/off any switch. When the user turns on/off any switch, the App sends the corresponding value to the firebase database and saves it in the variable associated with that device. The Smart Switch Device, which is in Wi-Fi Mode and connected to an Internet enabled network, constantly monitors the Firebase database for any changes. When any changes are found, then the Smart Switch system obtains the changed data which is received in NodeMCU. The NodeMCU is responsible for the Internet communication. When the data is received by NodeMCU it identifies it and find the actions that needs to be taken for the particular switch. The NodeMCU generates the necessary control signals and sends them to Arduino UNO which in turn turns on/off the corresponding switch. In this way the entire process of turning on/off any switch works. The below figure illustrates the components involved along with the interconnection paths between then for operation. Only the components involved in Wi-Fi control are shown in the below figure.

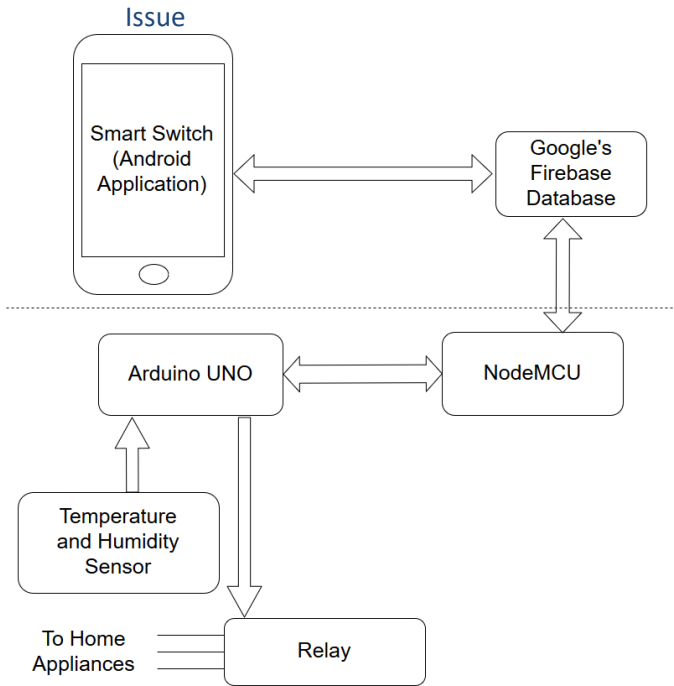


Fig 2.3 Wi-Fi Control

The temperature and humidity data is uploaded after every 10 seconds to the Firebase database by the Smart Switch system in the same way as was done in Bluetooth mode. The only difference is that, in Wi-Fi mode this data is sent to the server by NodeMCU instead of the smartphone. The Smart Switch Android Application periodically gets the temperature and humidity data from the server and display it over the App to the user.

2.5 Switching of Control Modes

The Smart Switch System is also capable of dynamically changing between the two modes as required by the user. This is achieved by means of the push button which is attached to NodeMCU. Also, the current mode of the system is indicated using the two LED's attached to NodeMCU. The LED corresponding to Bluetooth mode will turn on when the system is in Bluetooth mode and the LED corresponding to Wi-Fi mode will turn on when the system is in Wi-Fi mode. These LED's allow the user to easily check the mode in which the system is currently operating.

The user can change the mode in which the system is operating by pressing the push button. The modes will be changed alternately by the press of the push button by the user. Initially, when the system is powered on it will be in Bluetooth Mode by default. The user can change it to Wi-Fi mode by pressing the push button. When the system shifts to Wi-Fi mode the Smart Switch device tries to connect to the previously stored Wi-Fi connection. If the previously stored Wi-Fi connection is not available then the system waits for that Wi-Fi network to be active for 30 seconds, after which the device starts its own server with the name "esp8266". The user can then connect to this network for his/her smartphone. When the user connects to this network, a page is shown by the Smart Switch Device to the user in the smartphone. On this webpage the user can enter the SSID and the password of the Wi-Fi network which is available. After that the Smart Switch

Device connects to that specified Wi-Fi network and saves it for use for the next time.

When the device is started for the first time in Wi-Fi mode then the device starts the server directly and the user can enter the SSID and the password of his/her Wi-Fi network there. The Wi-Fi network that is used by the Smart Switch Device can be changed easily, from the server page of the Smart Switch Device. This is one of the unique features that this project offers apart from other Home Automation systems.

2.6 Smart Switch App Additional Features

The Android Application that is used by Smart Switch has voice recognition built into it [3]. So, the user can simply give voice commands to the phone to control the switches, which makes this app even more user friendly. Also, multiple switches can be controlled through voice control. The Android App is built in such a way that it can easily identify the voice of the user and efficiently follow the given orders. The voice recognition operates in both the modes.

The Smart Switch Android Application also gives the user the flexibility to rename the switches as per his/her needs. And then the user can use these switch names in giving voice commands also. Also, when the user uses the system in Wi-Fi mode, he/she needs to perform the login process by entering the username and the password. This is a tedious thing and diminishes the entire experience of using the Android App.

To solve this issue, there is a checkbox named Auto-Login on the login page. If this checkbox is checked by the user at the time of login, then the App saves the username and the password. And when the user opens the App in Wi-Fi mode again, then he/she does not have to enter the credentials again, the system enters them automatically and performs the login, thus saving user time and effort. The Android App also gives the user, the option to change the password by using security mechanisms such as security question and security answer which were entered by the user at the time of registration.

The App is designed in such a way that it uses very less resources of the user's smartphone. When the Smart Switch Android Application operates in Bluetooth Mode, it does not interrupt the other connected device. The user can listen to music on Bluetooth enabled headsets at the same time when he/she uses the Smart Switch App in Bluetooth Mode. This feature distinguishes this App from any other Home Automation Apps. The user can also contact the developers about certain errors in the App by means of the Contact Us screen.

2.7 Advantages and Disadvantages

There are many advantages of the Smart Switch System, some of them are:

- This system can operate in Bluetooth and Wi-Fi mode and the mode can be changed dynamically by the user.
- The Smart Switch Android Application is highly responsive and user-friendly.
- The system offers eight switches that can be controlled by the system.

Issue

- Many Smart Switch devices can be support by the entire system.
- This system can be easily integrated with the existing electrical connections in the user's home.

The Smart Switch system has many more advantages.

Some of the disadvantages of this system are:

- When this system is in Wi-Fi mode it requires constant Internet Connection for proper operation.
- The Internet speed needs to be high for the system to be efficient in Wi-Fi mode.
- The user needs Android App to control the switches connected to the Smart Switch Device

These are only few disadvantages of the system as compared to its numerous benefits.

3. CONCLUSION AND FUTURE SCOPE

The entire Smart Switch System has certain parts where it can be improved in the future. The Arduino UNO which is used in this project to control the relay has certain pins which are not used. In future, more sensors can be added to this Arduino UNO to add more functionality to the entire system. The sensors such as Light Sensor which can be used to turn on/off the lights based on light intensity, gas sensor which can monitor the gas level in the house and alert the user when the gas rises above a threshold level, etc. can be added.

In this paper, we have proposed a system called as Smart Switch which can be used for controlling the household appliances via an Android Application. The main advantage of this system is that it can operate in both Wi-Fi and Bluetooth mode. In Wi-Fi mode it uses an Internet connection, and hence the user can control the appliances from anywhere in the world where an Internet connection is available. The Android Application which is used to control the switches can be highly optimized to be user-friendly and reliable.

ACKNOWLEDGEMENT

We are indebted to all the faculties of Computer Science and Engineering Department because without their valuable guidance this work would not have a success. Their

ISSN:-.....

constructive, useful, timely suggestions and encouragement in every stem immensely helped us to carry out our paper work. Their invaluable presence was a great boost for us in achieving our goal.

REFERENCES

- [1]. H. El-Kamchouchi and A. El-Shafee, "Design and prototype implementation of SMS based home automation system", in Proc. 2012 IEEE International Conference on Electronics Design, Systems and Applications (ICEDSA), Kuala Lumpur, pp. 162-167.
- [2]. K. Mandula, R. Parupalli, C. A. S. Murty, E. Magesh, R. Lunagariya, "Mobile based home automation using Internet of Things(IoT)", 2015 International Conference on Control Instrumentation Communication and Computational Technologies (ICCICCT), pp. 340-343, 2015.
- [3]. Eleonora Nan and Una Radosavac and Istvan Papp and Marija Antić "Architecture of voice control module for smart home automation cloud", 2017 IEEE 7th International Conference on Consumer Electronics - Berlin (ICCE-Berlin).
- [4]. Muhammad Asadullah and Khalil Ullah, "Smart home automation system using Bluetooth technology", 2017 International Conference on Innovations in Electrical Engineering and Computational Technologies (ICIEECT).