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# AN ANDROID BASED HOME AUTOMATION SYSTEM WITH INERNET OF THINGS

**T. M. Adepoju[1,] *, O. K. Orimogunje[2], A. A. Akanni[3], and D. O. Oluwuyi[4]**

[1,2,3,4]Federal Polytechnic Ede, Nigeria

*corresponding author (Phone Number: +234-703-765-9707, Email: atemilola@gmail.com)

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**Abstract**
*Home automation is the introduction of technology within the environment to provide convenience, comfort, security and energy efficiency to its occupants. The management and control of our home appliances is germane to living and having a better quality of life, hence the need to design a system that automates the control of home appliances to ease the stress of having to manually control household appliances. An Android based home automation system with Internet of Things (IOT) was designed and implemented to control electrical appliances The hardware module consists of the power and control sections. The system draws power from the mains outlet and is converted to 5V by the AC-DC converter circuit. The software section comprises of the ESP8266 WiFi Microcontroller code, the Android application which controls the microcontroller wirelessly, the web server and WiFi connection. The designed home automation system was effective in remotely controlling electrical appliances. It also displays the weather information in the application in digital format. The system is portable and practicable due to its compact size. The system can be used to ensure efficient usage of electrical energy as well as maintain a good atmospheric condition.*

**Keywords:** Automation, Microcontroller, Android, Internet of Things (IoT), Sensors.

## 1.0 INTRODUCTION

Home automation can be described as the introduction of technology within the home environment to provide convenience, comfort, security and energy efficiency to its occupants. Adding intelligence to home environment can provide increased quality of life. Home automation performs an increasingly vital role in daily experience and global economy [1] . The concept of home automation has been around since the late 1970s. With the proliferation of technology and smart services, the expectations of the human race have grown a lot more over the years to perfectly turn their conventional homes and abodes into smart homes with minimal changes to the structure and architecture.

A home automation system means to grant the end users to manage and handle the electric appliances. Home automation systems over time have always tried to provide efficient, convenient, and safe ways for home inhabitants to access their homes. Regardless of the change in user's hope, growing technology, or change of time, the appearance of a home automation system has remained the same [1].

Internet of Things (IoT) is a system that consists of connected computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to send or receive data over a network without the need for human-to-human or human-to-computer interaction. Internet of Things in its definition has changed because of the coming together of various technologies, real-time analytics, machine learning, commodity sensors, and embedded systems. Internet of Things (IoT) is a concept which connects the devices and things to the internet. It imagines all objects around us as part of internet. IoT covers a very wide range of objects and includes variety of objects like smart phones, tablets, digital cameras and sensors. When all these devices are connected to one another, they enable more and more smart services and processes that support our everyday needs, environment and health [2].

The pursuance of a better quality of life and the need for ease by people in this age has led to the demand and use of more facilities and home appliances in our various environments. How to monitor, control and manage these facilities and appliances in a house without having to move around much are some of the attendant issues that come with having these facilities and appliances in our environment. Usually conventional wall switches are located in different corners of a house and with it comes the need for manual operations like pressing to turn the loads on or off. It becomes quite tasking for the elderly and the physically challenged to move around to operate them. Hence, the need to develop an IoT based home automation system to turn on and turn off home appliances in real time.

Home automation initially started with labor-saving devices. With the introduction of electric power distribution, self-contained electrical or gas-powered home appliances became viable in the 1900s and led to the introduction of washing machines (1904), water heaters (1889), refrigerators, sewing machines, dishwasher, and clothing dryers [3]. [4] stated that there are three generations of home automation namely, first generation, second generation and third generation. First generation is a remote innovation with intermediary server, for instance,. ZigBee robotization. Second generation is an artificial brainpower which controls electrical devices, for instance, Amazon Echo. Third generation is a robot buddy who associates with human, for instance. Robot Rovio, Roomba.

A Bluetooth based home automation system was proposed by [5]. The hardware architecture consists of the Arduino BT board and a cell phone, the communication between Arduino BT board and cell phone was connected wirelessly using Bluetooth technology. A home automation system was proposed and implemented by [6]. The hardware architecture consists of Arduino UNO and smartphone. The wireless communication between the smartphone and the Arduino UNO was done through Bluetooth technology. Android OS has a built-in voice recognizing feature which was used to develop a smartphone application which has ability to control the home appliances from user voice command. This application converts the user voice command into text, then it transmit that text message to Bluetooth module HC-05 which is connected with Arduino UNO.

[6] developed two protocols used for communication for home automation using cloud computing and cloud storage for data with hypertext markup language for the front end of Internet of Things (IoT) platform. **[7**] developed a smart home system using voice control with cloud data storage, the design was based on the "Alexa" voice platform in a cloud environment connected to Amazon echo. [8] implemented a system by using the Raspberry PI controller connected through a safe virtual private network (VPN) to display and control IoT devices such as temperature sensors, lighting systems and so on.

[9] proposed a system that uses IoT to control home appliances, an ATmega328 microcontroller was used to perform all the operations. The system was used to control house lights and fans, it also included an interface that allowed users to control the home appliances with ease through the internet. [10] designed a smart switch for home automation, the method used was based on a signal sent from an Android phone to WiFi module, the android application included graphical user interface (GUI) buttons for each home appliance, which made it easy for users to control their appliances over their mobile devices by just giving the commands on their phones. [11] made a proposal and implemented an architecture of a smart system for home control and monitoring using Arduino Uno controlled with a desktop application, the system provided a suggestion on how to control different home appliances and also provide security by using infra red (IR) sensors to detect human presence.

[12] developed a sytem that allowed users to wirelessly control home appliances such as light, fans, television sets, air conditioners and so on, the system was implemented using an Arduino Uno microcontroller board which was connected to a WiFi module which allowed the devices to be controlled from anywhere, an android application was developed to pass the signals to the Arduino board, the system could also be integrated into a single portable unit. [13] designed an advanced home automation system using the Pic16f877a microcontroller, the sytem was divided into two schemes; the first scheme was used to control electrical appliances through the internet via a website by using global system for mobile/general packet radio service (GSM/GPRS) while the second scheme used bluetooth technology for controlling electrical appliances when users are at home by voice control through an android application known as "ss control."

## 2.0 MATERIALS AND METHODS

The design was divided into two sections which are the hardware and software. The hardware section was made up different modules which were connected together through a wired and wireless medium respectively.

Figure 1. Shows how the components were initialized by supplying the required power of +5v through the power supply unit, this powers the relay as well. The ESP8266 WiFi Chip was connected to a WiFi network to establish internet connection. It received command from the Android application through the Internet Protocol and sends signal through the GPIO pins to turn on or off the relay connected to a particular home appliance (fan, bulbs, etc). The home automation system is controlled through the Android application. The DHT11 sensor detects the temperature and humidity of the home and sends the reading to the Android application. When the temperature reaches 32°C, the Automatic Temperature Regulation (ATR) socket turns on the Air Conditioner or fan automatically. The system checks every 10 seconds for temperature changes and and turns it off when the temperature is below 32°C. The circuit diagram of the android based home automation system is shown is Figure 2 which represent the internal connection and communication between integrated circuit (IC), relays, power supply and ground.

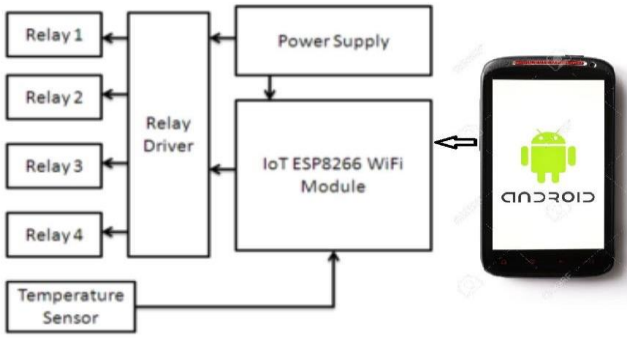


**Figure 1:** Component diagram of Android-based home automation system

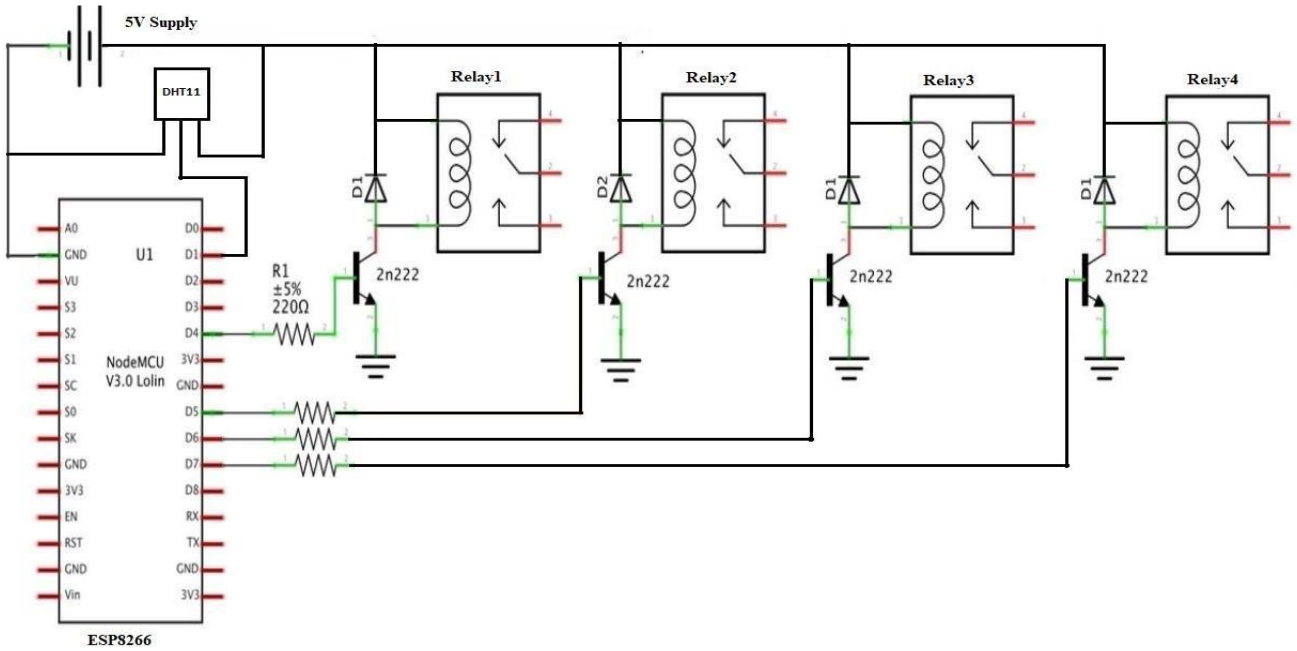


**Figure 2:** Circuit diagram of Android-based home automation system

The software section comprises of the web server, WiFi connection, the ESP 8266 WiFi microcontroller code and the Android application system deployed on mobile device to control the microcontroller wirelessly, the graphical user interface (GUI) of the android application was used as an interface to control the appliances and also to display the readings of the home as shown in Figure 6. It was also used for the log in and also to send commands through the internet protocol as shown in Figure 5, to turn on and off the relay to any of the home appliances. Figure 3 shows the prototype of the hardware connection of the home automation system before it was transferred to Vero board in as how in Figure 4 for permanently implementation.

## 3.0 RESULTS AND DISCUSSION

The Graphical User Interface of the Android application includes a splash screen, a login page for added security, an interface to control the appliances from anywhere in the world and an interface for

displaying the temperature and humidity of the homeas shown in Figure 7.

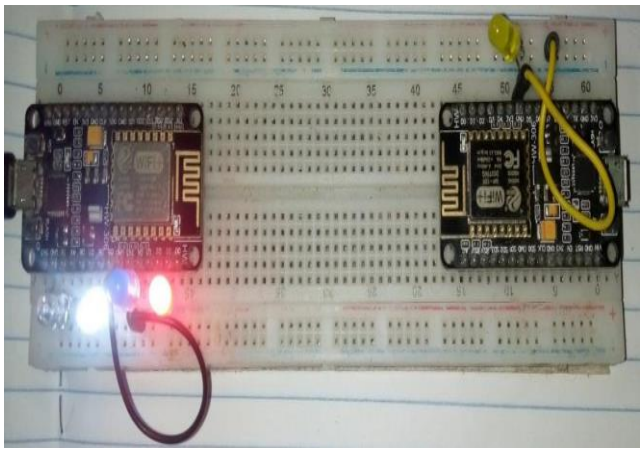

**Figure 3:** Breadboard prototype of the Home Automation System

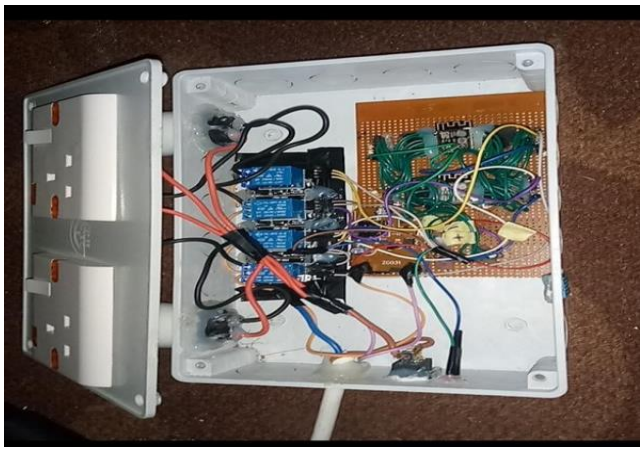

**Figure 4:** Components connection before closure

The test data used includes the voltages on the circuit, the WiFi connection signals between the ESP8266 modules, signals received by the Android application, and ESP8266 modules read/write to the database. These test data were used to check the overall performance of the home automation system. The unit was tested before and after casing as shown in Figure 4 and Figure 5 respectively. The unit was initially tested on a breadboard for prototyping as shown in Figure 3. Afterwards, it was moved to the Vero board as shown in Figure 4, for the final design. Before casing, components on the Vero board were tested to ensure that adequate voltage was passed to each module. During the process of testing, the software interface design, was also tested to ensure that each button performs the designated function. The database was checked to make sure that it was read and written from properly.

The functionality of the system depends on the correctness of the signal(s) being produced by the ESP8266 modules, the database and the Android application. The unit was tested before and after casing it. The unit was initially tested on a breadboard for prototyping. Afterwards, it was moved to the Vero board for the final design. Before casing, components on the Vero board were tested to ensure that adequate voltage was passed to each module. Table 1 shows the voltages discovered during the test.

**Figure 5:** Complete design in the casing


**Figure 6:** Log in Page


**Figure 7:** Graphical User Interface for controlling the appliances

**Table 1:** Voltage Readings

| Voltage in the components | Value |
|---|---|
| ESP8266 modules | 3.2V |
| Relay module (DC side) | 5.0V DC |
| Relay module (AC side) | 216V AC |
| Temperature sensor | 5V DC |

Table 1 shows the results of the voltage readings of the components. The continuity was also tested and no short circuit was discovered. The temperature sensor connected to the socket was also tested and was found to be working properly, with accurate temperature readings. After casing, operational test was carried out. The power cable was plugged to the mains terminal and the power switch was turned on.

**Table 2:** Result of the Appliance (Fan) when connected to the temperature regulation socket

| S/N | Temperature (°C) | Humidity (%) | Observed State | Expected State |
|---|---|---|---|---|
| 1 | 32.80 | 64.00 | On | On |
| 2 | 32.70 | 63.00 | On | On |
| 3 | 32.60 | 64.00 | On | On |
| 4 | 32.40 | 71.00 | Off | Off |
| 5 | 32.60 | 75.00 | On | On |
| 6 | 32.70 | 64.00 | On | On |
| 7 | 32.50 | 74.00 | On | On |
| 8 | 32.30 | 64.00 | Off | Off |
| 9 | 32.20 | 64.00 | Off | Off |
| 1 | 32.20 | 63.00 | Off | Off |
| 11 | 32.00 | 61.00 | Off | Off |
| 12 | 32.20 | 63.00 | Off | Off |
| 13 | 31.90 | 71.00 | Off | Off |
| 14 | 31.60 | 67.00 | Off | Off |
| 15 | 31.30 | 66.00 | Off | Off |
| 16 | 31.10 | 66.00 | Off | Off |
| 17 | 31.00 | 66.00 | Off | Off |
| 18 | 31.00 | 68.00 | Off | Off |
| 19 | 30.90 | 69.00 | Off | Off |
| 20 | 30.80 | 67.00 | Off | Off |

Table 2 shows the extracted results of the appliance (fan) connected to the Automatic Temperature Regulation Socket when the trigger temperature was set to 32.5°C.

**Table 3:** Results of Mobile phone charger and Television connected to sockets1 and 2

| S/N | Signal from the Application | Observed State | Expected State |
|---|---|---|---|
| 1 | Turn on socket 1 | On | On |
| 2 | Turn off socket 1 | Off | Off |
| 3 | Turn on socket 2 | On | On |
| 4 | Turn on socket 1 | On | On |
| 5 | Turn off socket 2 | Off | Off |
| 6 | Turn off socket 2 | Off | Off |
| 7 | Turn off socket 1 | Off | Off |
| 8 | Turn on socket 1 | On | On |
| 9 | Turn on socket 2 | On | On |
| 10 | Turn off socket 1 | Off | Off |
| 11 | Turn off socket 2 | Off | Off |
| 12 | Turn off socket 1 | Off | Off |
| 13 | Turn on socket 1 | On | On |
| 14 | Turn on socket 2 | On | On |
| 15 | Turn off socket 1 | Off | Off |
| 16 | Turn off socket 2 | Off | Off |
| 17 | Turn on socket 2 | On | On |
| 18 | Turn on socket 2 | On | On |
| 19 | Turn on socket 1 | On | On |
| 20 | Turn off socket 2 | Off | Off |

Table 3 shows the result of the Mobile phone charger and Television when connected to socket 1 and socket 2 and also the expected and observed results.

**Table 4:** Results of Light bulbs

| S/N | Signal the Application | Observed State | Expected State |
|---|---|---|---|
| 1 | Turn on bulb 1 | On | On |
| 2 | Turn off bulb 1 | Off | Off |
| 3 | Turn on bulb 2 | On | On |
| 4 | Turn on bulb 1 | On | On |
| 5 | Turn off bulb 2 | Off | Off |
| 6 | Turn off bulb 2 | Off | Off |
| 7 | Turn off bulb 1 | Off | Off |
| 8 | Turn on bulb 1 | On | On |
| 9 | Turn on bulb 2 | On | On |
| 10 | Turn off bulb 1 | Off | Off |
| 11 | Turn off bulb 2 | Off | Off |
| 12 | Turn off bulb 1 | Off | Off |
| 13 | Turn on bulb 1 | On | On |
| 14 | Turn on bulb 2 | On | On |
| 15 | Turn off bulb 1 | Off | Off |
| 16 | Turn off bulb 2 | Off | Off |
| 17 | Turn on bulb 2 | On | On |
| 18 | Turn on bulb 2 | On | On |
| 19 | Turn on bulb 1 | On | On |
| 20 | Turn off bulb 2 | Off | Off |

Table 4 shows the result extracted when the Light bulbs were connected and it also shows the expected and observed results.

## 4.0 CONCLUSION

The home automation system worked perfectly in all observed tests under the conditions of a stable and steady power supply. However when the power supply

becomes unstable, the system behavior can change by being unpredictable. The designed home automation system was effective in remotely controlling electrical appliances with an android application as well as display of the states of the appliances. It also displayed the weather information in the application in digital format. The system is portable and practicable due to its compact size. The system can be used to ensure efficient usage of electrical energy as well as maintain a good atmospheric condition.

Further improvements can be made to the system to provide timely notifications on the states of the appliances in the home as well as the weather conditions either by email or other instant messaging applications. The android application can also be made customizable so as to add more devices for a more efficient automated control and also measure and notify on the amount of energy used by each appliances.

**REFERENCES**


[1] Somayya, M. R., and Ramaswamy, S. T. "Internet of Things (IoT): A Literature Review", *Journal of Computer and Communic-ations*, 2015, Vol. 3, Issue 164, Pp. 17.

[2] Rye, D. "My life at X10". AV and Automation industry eMagazine, 1999.

[3] Hill, J. "The smart home: A glossary guide for the perplexed", 2015.

[4] Li, R., Li, H. and Mak, C. "Sustainable Smart Home and Home Automation", Big Data Analytics Approach. IJSH, 2016, Vol. 10; Pp. 177-198

[5] Piyare, R. and Tazil, M. "Bluetooth Based Home Automation System Using Cell Phone", *2011 IEEE 15th International Symposium on Consumer Electronics.* Singapore, 2011, June 14-17, Pp. 192-195.

[6] Vinay, S. and Kusuma, S. "Home Automation using Internet of Things", *International Journal of Engineering and Technology*, 2015, Volume 2, Issue 3, Pp. 1965-1970.

[7] Guaman, S., Calvopina, A., Orta, P., Tapia, F. and Yoo, S. G. "Device Control System for a Smart Home Using Voice Commands," *Proceedings of the 10th International Conference on Information Management and Engineering*, 2018, Pp 86-89.

[8] Venkatraman, S., Overmars, A. and Thong, M. "Smart Home Automation: Use Cases of a Secure and Integrated Voice Control System". *Journal of MDPI*, 2021, Vol. 9. Issue 4, Pp 77.

[9] Pimpalkar, V. M., Bhoyar, C., Gattewar, D., Aglawe, P. and Khobragade, P. "IoT Based Home Automation Control using AT-MEGA328 Microcontroller". *International Journal of Engineering, Applied Sciences and Technology*. 2020, Vol. 4, Issue 10. Pp 242-246.

[10] Shejal, A., Pethkar, A., Zende, A., Awate, P. and Mane, G. S. "Designing of Smart Switch For Home Automation". *International Research Journal of Engineering and Technology*. 2019, Vol. 6, Issue 5. Pp 1755-1758

[11] Kousalya, S., Reddi, G., Vasanthi, P. and Venkatesh, B. "IoT Based Smart Security and Smart Home Automation". *International Journal of Engineering Research amd Technology*, 2018, Vol. 7, Issue 4. Pp 43-46.

[12] Doshi, A., Vakharia, D. and Rai, Y. "IoT Based Home Automation". *International Journal for Research in Applied Sciences and Engineering Technology*. 2021, Vol. 9, Issue 8. Pp117-125

[13] Nadguandi, S. K., Hiremath, G. R., Sakpal. A. and Chaudhari, P. "IoT Based Adavnced Home Automation". *International Research Journal of Engineering and Technology.* 2020, Vol. 7, Issue 3. Pp 4450-4454.