# ARTIFICIAL INTELLIGENCE HOME AUTOMATION SYSTEM WITH PATTERN ANALYSIS

**Uwizeye Samuel**
Lecturer, University of Kigali

**ISSN 2277-7733**
**Volume 13 Issue 3, December 2024**

**Abstract**

*Recent days, automation is playing significant role using computers (android phone) in human daily life, particularly, handicapped and senior citizens. Currently people to interact with home appliances need to be direct contact with them, which means that to take action on them such as switch on and off light (Bulb), switch on and off television, etc. This interaction requires enough time in one way or another, waste their money on unknown home appliances that is switched on and they need to be at home to carry out this kind of job. As we know, technology has come to easy many jobs for this current generation. Many things can be done without involving yourself manually. This has also spread to the home appliances control. Instead of operating home appliances using your hands, you can operate it remotely wherever you are. Appliances automation allows users to manage different appliances such as light (Bulb), PC, TV, charging electrical and electronics devices and so on. It can also give privilege to the home in charge to controls temperature variation and take action according to sensed temperature data. It has been observed that the internet services in all part of country especially in rural area are not as much better as required. Hence, GSM SIM900A based android application is developed named Home Appliances Automation system using Arduino. The developed system is decomposed into two separate entities: Hardware is designed and developed using Arduino UNO with other required electronics components that is programmed using embedded C language, and software that provides freedom to user to control and access the electronic appliances and the security system without internet. The overall objectives of this project is to design and implement Home Appliances Automation system with GSM from SMS sent by android application by using Arduino Uno to control automatically home appliances anytime, anywhere by using Smartphone. I recommend also all public institution and private institution to use Home Appliances Automation system instead of using manual system in case they are going to control home appliances for good, security, quick and smart control.*

**Keywords:** *Arduino Uno, Artificial Intelligence, SMS/GSM-SIM900A, Home Automation System, Microprocessor and Pattern Analysis*.

The phrase "*Internet of Things*" describes a collection of actual "things" that are outfitted with sensors, software, and other technologies and linked to a network of other hardware and systems via the internet. These gadgets include everything from standard domestic items to state-of-the-art industrial machinery.

One of the most important 21st-century technologies to recently emerge is the Internet of Things. Today, the capacity to connect everyday objects to the internet via embedded devices, such as home appliances, vehicles, thermostats, and baby monitors, enables seamless communication between people, processes, and things.

Low-cost computers, the cloud, big data, analytics, and mobile technologies enable sharing and collecting data by physical things with the least amount of human interaction. Digital systems can record, monitor, and modify every

interaction between connected things in today's highly connected environment. The physical and digital worlds connect and work together. A remote control is an electrical device that is used to wirelessly and remotely operate another device. It is also referred to as a clicker or remote. Consumer gadgets such as televisions, digital video/versatile players, and other appliances can all be controlled by a remote control.

Now that we have remote controls for all of our modern electronics, life is much easier. Have you considered installing a Home Appliances Automation system that would allow remote control operation of your electrical appliances and tube lights? Of course, yes! But are there more affordable options? We have found a solution if the response is "No." We have created a new system known as the Home Appliances Automation system using the Global System for Mobile (GSM). The user of this system will be able to control any electronic device without even having to pay for a remote control thanks to how cost-effective it is. With an integrated computer and additional features not typically found in phones, such as an operating system, web browsing, and the capacity to run software applications, this project makes it possible for users to control all of their electronic devices using a cellular phone (Smartphone). Having time is valuable. Everybody wants to save time, and it's not difficult to do. To assist people, save time, new technologies are being developed daily. We are happy to present the "*Home Appliances Automation system*," a brand-new system that makes use of the Global System for Mobile. The machinery and electrical appliances in your home can be managed using this technique and your mobile phone.

**Literature Review**

Projects associated: Home Automation system using Bluetooth: Bluetooth Based Home Automation Project using Android Phone was worth to notice on it while developing the project. This project was used to control and switch device on and off in a small diameter as Bluetooth don't have the range as Wi-Fi and GSM have technology which can control appliances in longer distance than Bluetooth technology Automation is also involved in building management system in which lights, temperature, security devices and other appliances are controlled through a high degree of computer involvement. In this report, all the devices, which are used in building management system, are control by a single controller using a wireless network. Client module and host controller are used to communicate with each other through a wireless device such as Bluetooth enabled the mobile phone. In this report, an android-based smart phone is used. This project was used in short range of distance and has numerous disadvantages: Bluetooth is used in this Home Appliances Automation system, which has a rage 10 to 20 meters so the control cannot be achieved from outside this range; Application is connected after disconnect of the Bluetooth; When the new users want to connect the first download application software then the code and configuration must be done. (Lab, 2016).

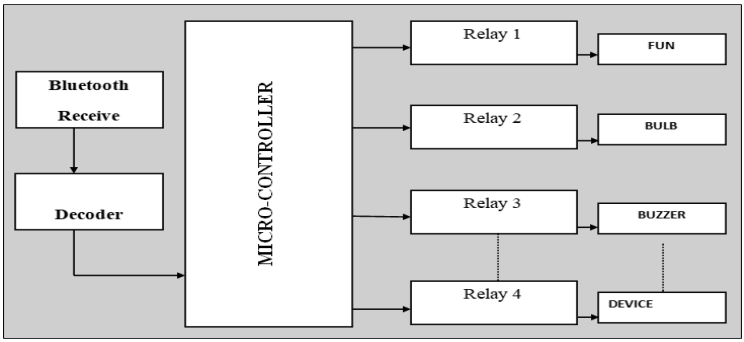


**Figure 1 - Block diagram of Bluetooth based Home Automation.**

Algorithm of Home Automation system using Bluetooth: STEP 1: Start; STEP 2: Connect Bluetooth; STEP 3: Send Request to The Micro Controller; If the request matched to the criteria from C++ script (arduino programmed instructions); Give command to the relay to turn OFF or ON the connected appliances; If the request isn't matched to the criteria from C++ script (arduino Programmed instructions); Back to step 3; STEP 4: Stop

GSM based home devices control system: GSM based home devices control system is another interested project we noticed on and we learned a lot about it while we were developing Home Appliances Automation system. The basic concepts of this project is to turn on or turn off home devices like fans, lights etc. through mobile phone. So SMS is used for this purpose. SMS communicates information between two devices. GSM module is kind of mobile phone. It has built in subscriber's identity module i.e. SIM. GSM module is connected with microcontroller. GSM module interfacing with microcontroller is not difficult task. Control devices are also connected with microcontroller. (Microcontrollers, 2015)

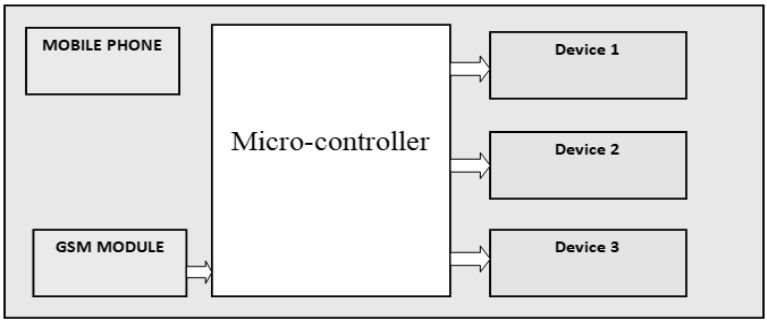


**Figure 2 - Block diagram of GSM based home devices control system**

Algorithm of GSM based home devices control system: STEP 1: Start; STEP 2: Open The Android App; STEP 3: Give The Request Via Android App Buttons;

STEP 4: Send Request To The Micro Controller; If the request matched to the criteria from C++ script (arduino programmed instructions); Turn OFF or ON the connected appliances; If the request isn't matched to the criteria from C++ script (Arduino Programmed instructions); back to step 3; STEP 5: Micro Controller Send Feedback to The User in The Form of SMS (GSM); STEP 6: Stop

Introduction to AT command: AT commands are instructions used to control a modem. AT is the abbreviation of Attention. Every command line starts with "AT" or "at". That's why modem commands are called AT commands. Many of the commands that are used to control wired dial-up modems, such as ATD (Dial), ATA (Answer), ATH (Hook control) and ATO (Return to online data state), are also supported by GSM/GPRS modems and mobile phones.

Besides this common AT command set, GSM/GPRS modems and mobile phones support an AT command set that is specific to the GSM technology, which includes SMS-related commands like AT+CMGS (Send SMS message), AT+CMSS (Send SMS message from storage), AT+CMGL (List SMS messages) and AT+CMGR (Read SMS messages).

Note that the starting "AT" is the prefix that informs the modem about the start of a command line. It is not part of the AT command name. For example, D is the actual AT command 8 name in ATD and +CMGS is the actual AT command name in AT+CMGS. However, some books and web sites use them interchangeably as the name of an AT command.

Note that mobile phone manufacturers usually do not implement all AT commands, command parameters and parameter values in their mobile phones. Also, the behavior of the implemented AT commands may be different from that defined in the standard.

In general, GSM/GPRS modems designed for wireless applications have better support of AT commands than ordinary mobile phones.

In addition, some AT commands require the support of mobile network operators. For example, SMS over GPRS can be enabled on some GPRS mobile phones and GPRS modems with the +CGSMS command (command name in text: Select Service for MO SMS Messages).

But if the mobile network operator does not support the transmission of SMS over GPRS, you cannot use this feature.

Basic Commands and Extended Commands: There are two types of AT commands: basic commands and extended commands.

Basic commands are AT commands that do not start with "+". For example, D (Dial), A (Answer), H (Hook control) and O (Return to online data state) are basic commands. Extended commands are AT commands that start with "+". All GSM AT commands are extended commands.

For example, +CMGS (Send SMS message), +CMSS (Send SMS message from storage), +CMGL (List SMS messages) and +CMGR (Read SMS messages) are extended commands. (SMS Tutorial: Introduction to AT Commands, Basic Commands and Extended Commands).

**Used languages and technologies**

Arduino Microcontroller: Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing. Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike. Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments.

**Why Arduino?**

Thanks to its simple and accessible user experience, Arduino has been used in thousands of different projects and applications. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. Teachers and students use it to build low cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics. Designers and architects build interactive prototypes, musicians and artists use it for installations and to experiment with new musical instruments. Makers, of course, use it to build many of the projects exhibited at the Maker Faire, for example. Arduino is a key tool to learn new things. Anyone, children, hobbyists, artists, programmers can start tinkering just following the step by step instructions of a kit, or sharing ideas online with other members of the Arduino community. There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handyboard, and many others offer similar functionality. All of these tools take the messy details of microcontroller programming and wrap it up in an easy-to-use package. Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems:

Inexpensive - Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than \$50.

Cross-platform - The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.

Simple, clear programming environment - The Arduino Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with how the Arduino IDE works.
Open source and extensible software - The Arduino software is published as open source tools, available for extension by experienced programmers.
The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, you can add AVR-C code directly into your Arduino programs if you want to.
Open source and extensible hardware - The plans of the Arduino boards are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money.

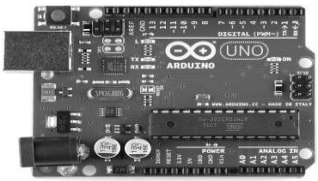


**Figure 3 - FArduino Uno microcontroller**

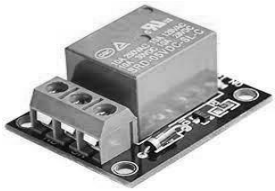

**Figure 4 - Relay**

*Relays* are the switches which aim at closing and opening the circuits electronically as well as electromechanically. It controls the opening and closing of the circuit contacts of an electronic circuit. When the relay contact is open (NO), the relay isn't energizing with the open contact. However, if it is closed (NC), the relay isn't energize given the closed contact. However, when energy (electricity or charge) is supplied, the states are prone to change.
Relays are normally used in the control panels, manufacturing and building automation to control the power along with switching the smaller current values in a control circuit. However, the supply of amplifying effect can help control the large amperes and voltages because if low voltage is applied to the relay coil, a large voltage can be switched by the contacts.
If preventive relays are being used, it can detect over current, overload, undercurrent, and reverse current to ensure the protection of electronic equipment. Last but not the least; it is used to heat the elements, switch on audible alarms, switch the starting coils, and pilots the lights.

**Global System for Mobile (GSM) module**

GSM is a mobile communication modem; it is stands for global system for mobile communication (GSM). The idea of GSM was developed at Bell

Laboratories in 1970. It is widely used mobile communication system in the world. GSM is an open and digital cellular technology used for transmitting mobile voice and data services operates at the 850MHz, 900MHz, 1800MHz and 1900MHz frequency bands. GSM system was developed as a digital system using time division multiple access (TDMA) technique for communication purpose. A GSM digitizes and reduces the data, then sends it down through a channel with two different streams of client data, each in its own particular time slot. The digital system has an ability to carry 64 kbps to 120 Mbps of data rates.

**GSM Architecture**

A Mobile Station: It is the mobile phone, which consists of the transceiver, the display and the processor and is controlled by a SIM card operating over the network.

Base Station Subsystem: It acts as an interface between the mobile station and the network subsystem. It consists of the Base Transceiver Station that contains the radio transceivers and handles the protocols for communication with mobiles. It also consists of the Base Station Controller, which controls the Base Transceiver station and acts as an interface between the mobile station and mobile switching center.

Network Subsystem: It provides the basic network connection to the mobile stations.

The basic part of the Network Subsystem is the Mobile Service Switching Centre, which provides access to different networks like ISDN, PSTN etc. It also consists of the *Home Location Register* (HLR) and the *Visitor Location Register* (VLR), which provides the call routing, and roaming capabilities of GSM. It also contains the Equipment Identity Register that maintains an account of all the mobile equipment's wherein each mobile is identified by its own IMEI number. IMEI stands for International Mobile Equipment Identity.

Features of GSM Module: Improved spectrum efficiency; International roaming; Compatibility with integrated services digital network (ISDN); Support for new services; SIM phonebook management; Fixed dialing number (FDN); Real time clock with alarm management; High-quality speech; Uses encryption to make phone calls more secure Short message service (SMS)

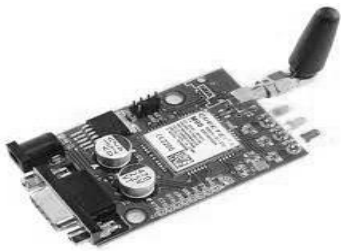

**Figure 5 - GSM module**

**Project Methodology**

The last technique I utilized to gather information for my thesis was observation. I looked through the electronic library for documents, used information search engines, and visited many electronics websites. With this method, you look at how things are currently done and, depending on the circumstance, develop a solution. Relays, a smartphone, a Global System for Mobile Communication (GSM) mobile communication modem, and an Arduino Uno microcontroller will all be used in this investigation.

**System Analysis and Design**

This project's main goal is to plan and implement A Home Appliances Automation system. A number of works have been finished in order to achieve this. The approach for the research attempt is shown in this portion of the project. It describes the research methods used to compile all the data, look at the problems with the current system, and evaluate the suggested replacement system.

A review of the present system: The system should concentrate on assisting the user in preventing unwanted access utilizing manually operated equipment, as well as monitoring all of the appliances placed throughout the house.

Issue with the present system: People today need to interact physically with household appliances in order to interact with them. This calls for them to take activities, such as turning on and off lights, televisions, or other electronic devices, on them. They invest their time and money on unidentified home equipment that are on and demand their presence at home in order to be manually completed.

Analysis of the new system: As is widely known, technology has made many things simpler for the modern day. You don't need to perform many tasks manually. This directly impacts how home appliance control functions. Without using your hands, you may operate home appliances remotely from anywhere.

System Requirements: The technique presented in offers three ways to operate the house: speech, the Internet, and the GSM network. Real-time monitoring is a crucial component of marketable Home Appliances Automation systems. The user may get a prompt alert when the devices' condition changes. Typically, user commands are sent from a PC to a server.

Before sending user commands to the appropriate units, the server processes them. This might facilitate controlling the machinery. GSM is utilized as a communication tool to aid in connection establishment in locations where suitable internet coverage might not be available. The server and GSM modem communicate using AT commands. The mobile interface was designed using J2ME. The system can be managed by SMS. The system uses a PIC16F887 microcontroller to manage home appliances. The appliances are controlled through GSM. In this method, SMS is utilized. GSM has gained popularity due to its superior availability, security, and coverage. SMS codes are the main method of controlling home appliances. The delivery of AT commands, which control the home appliances, is made possible through the GSM network. Additionally, the device sends and receives SMS messages from the user.

This technique may, however, result in additional SMS charges. The user cannot operate the device via a user interface (UI). This method's limitation is that it cannot program the devices.

Due to SMS's dependency on the networks, delivery delays are also possible. It is the user's responsibility to monitor the device's status because the system provides none. The AT (attention) directives and SMS were combined by this system.

Its primary control panel is a smartphone. The household appliances are controlled by a system based on the GSM network via SMS, as seen in the image below. An Arduino board serves as the appliance interface controller. Specific peripheral drivers and relays are used to implement this interface. Phones serve as the user interface. The system uses "App Inventor," a visual programming tool, to develop the user interface and other technologies to distribute the app.

The application generates SMS messages and sends them to the Arduino's GSM modem based on user commands. This enables the user to control the household appliances. Similar to SMS, the technology has price and dependability problems. Additionally, the interface is preprogrammed and cannot be adjusted to the devices.

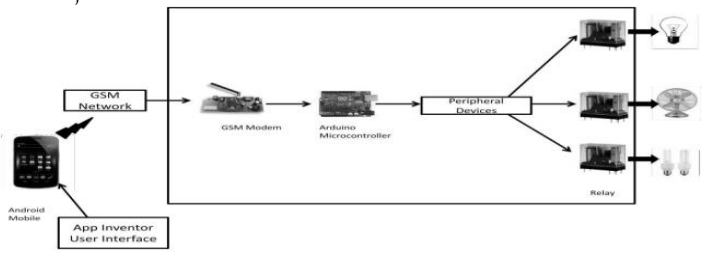


**Figure 6 - GSM based Home Appliances Automation system**

The projected voice control technology will enable the elderly and disabled to remotely control appliances. The main form of communication is GSM. Using a mobile device, the speech commands are recorded and converted to text. This is sent as an SMS message to another phone through the GSM network. This other phone uses Bluetooth to transmit the text commands to the Bluetooth module. A microcontroller from the PIC16F877A series is connected to this module.

This controller reads the commands and does the required actions. The load is kept apart from the control circuitry by using a separate mechanism to control electrical circuits. The system also offers feedback to let the user know how the command has worked.

Due of its voice command feature, everyone can use this system. However, because SMS is used, it is unreliable. The necessity of two phones one in the user's possession and another in the close proximity of the controller can incur significant expenditures. A system uses an AVR microprocessor and the GSM network. This approach also depends on SMS. User inputs are used to enter commands.

Data Collection Technique; Documentation Technique; I used search engines to locate documents and other electronic libraries in addition to browsing the actual contents in the electronic library for my research assignment.

**Observation Technique**

Observation was the final technique we used to collect data for our project proposal. These methods comprise evaluating how things are currently done and coming up with a remedy based on the circumstance.

Algorithm of the new system: STEP 1: Start; STEP 2: open the android app; STEP 3: Give the request via android app buttons; STEP 4: Send request to GSM; STEP 5: If Request received well by GSM; Send the action to Microcontroller (Arduino); STEP 6: If is not received well by GSM (Not interrupted); Back to STEP 4; STEP 7: GSM Send request to the micro controller; If the request matched to the criteria from C++ script (Arduino programmed instructions); Order relay to turn OFF or ON the connected appliances; Send feedback to the Mobile User; STEP 8: Stop

**Result and Discussions System Implementation**

Outcomes: I reached a lot of theoretical and practical conclusions after putting my study project into practice. Theoretical outcomes: My circuit is powered by an AC source. The entire component connected to the Arduino must get 5V of DC power; this power can come from the computer or the AC to DC converter on the Arduino. We also know that five volts, or 5V, are the difference between zero and five volts. 5V and above. A digital circuit recognizes the 5V as bits, and it has been determined that 5V equals 1024 bits.

Following analysis of the literature, each component used in our project conceptually defines its purpose and result, as shown in the table below:

**Table 1 - List of components, its application and its theoretical desired result**

| No | Components | Purpose of component | Result in project |
|---|---|---|---|
| 1 | Relay | To switch AC home appliances | Changing the status of appliances |
| 2 | Microcontroller | Heart of the project | To detect action, require and order component selected to perform that action |
| 3 | GSM | To send and receive SMS | GSM allows you to receive notifications on your phone. |
| 4 | Mobile phone | To send and receive SMS | To send command and to receive notification of performed action |

Practical Results: As we have discussed above the practical result that we obtain after implementing, we did many test to make sure that what we expect to do are done, by referring to the theoretical result we had, we have seen that in the following table:

**Table 2 - List of command used to control home appliances**

| No | Commands | Functions | Response from android mobile phone |
|---|---|---|---|
| 1 | INDOOR ON | Turn on living room lamp | LIVING ROOM LAMP IS TURNED ON |
| 2 | INDOOR OFF | Turn off living room lamp | LIVING ROOM LAMP IS TURNED OFF |
| 3 | OUTDOOR ON | Turn on outside lamp | OUTSIDE LAMP IS TURNED ON |
| 4 | OUTDOOR OFF | Turn off lamp | OUTSIDE LAMP IS TURNED OFF |
| 5 | TV ON | turn on television | TV IS TURNED ON |
| 6 | TV OFF | Turn on television | TV IS TURNED ON |
| 7 | PC ON | Turn on pc | PC IS TURNED ON |
| 8 | PC OFF | Turn off pc | PC IS TURNED OFF |

**Description of the project**

**Figure 7 - Main**


**Figure 8 - App info**


**Figure 9 - History**

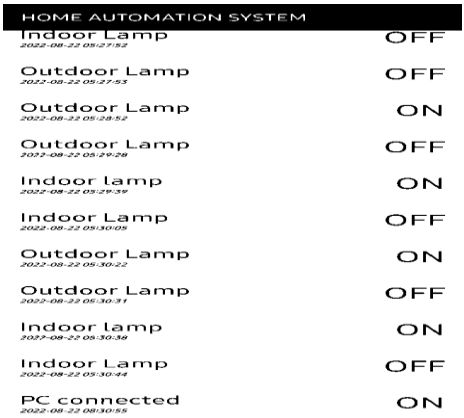


**Figure 10 - Feedback**

**Discussion**

This section, where I explain how the work's theoretical and practical findings came to be, is the most important part of my work.

After looking at them, I realized that my product is offering a solution to the problem I wanted to address. By sending a command to the SIM installed in the GSM module using an Android mobile phone, a homeowner can remotely control appliances in my circuit system.

The microcontroller is then automatically interrupted and given instructions to tell the relay to change the status of the appliances, turning them ON or OFF, based on the feedback received from the home appliance.

A GSM SIM card will be given to the registered Android phone as of the time of this writing.

**Conclusion**

Design and implementation of the Home Appliances Automation system has been implemented successfully. The purpose of the project is to use mobile phone inbuilt SMS facility and GSM Modem for automation of Home Appliances. Home Appliances Automation system application program is tested on various Android mobile phones that are quite satisfactory and responses received from the community in general are encouraging. I can also conclude that the objectives of this research project have been successfully met and they are as follows: Constructed Home Appliances Automation system controlled by an android mobile phone application, To remote and control home appliances anywhere anytime, To allow the people to switch ON/OFF home appliances from single device without movements especially disabled and elderly people, To help project user to save energy, improve safety and effective usage of electrical equipment and appliances, To provide smart life for project user by

giving peace of mind and avoiding the stress where he/she forgot to turn ON/OFF home appliances

**References**

*Why should you do mini/ final year projects on IoT*?. Retrieved May 6, 2022, from Skyfilabs https://www.skyfilabs.com/blog/why-should-you-do-mini-final-year-projects-on-iot

L. Atzori, A. Iera, G. Morabito, The Internet of Things: A survey, Computer Networks 54 (15) (2010) 2787–2805.

*Android Introduction - Tutlane. (n.d.). Retrieved May 12, 2022, from tutlane:* https://www.tutlane.com/tutorial/android/android-introduction

*arduino-introduction. (n.d.). Retrieved May 12, 2022, from arduino:* https://www.arduino.cc/en/guide/introduction

*What is GSM Architecture and Working of GSM Module with Circuit. Retrieved June 17, 2022, from elprocus:* https://www.elprocus.com/gsmarchitecture-featuresworking/

*Elshafee, A. M. (2012, August). Design and Implementation of a WiFi Based Home Appliances Automation system. Retrieved June 23, 2022, from researchgate:* https://www.researchgate.net/publication/230883124_Design_and_Implementation_o f_a_WiFi_Based_Home_Automation_System

*Gupta, L. (n.d.). What is Java programming language? - HowToDoInJava. Retrieved July 10, 2022, from howtodoinjava:*
https://howtodoinjava.com/java/basics/what-is-javaprogramming-language/

*How Relays Work | Relay diagrams,relaydefinitions and relay types. (n.d.). Retrieved July 19, 2022, from Galco:* https://www.galco.com/comp/prod/relay

*Bluetooth based Home Appliances Automation system using android phone. Retrieved July 20, 2022, from microcontrollers website:*
https://microcontrollerslab.com/bluetooth-home-automation-system-android/

*What is smartphone? - Definition from Whatls.com. Retrieved August 7,2022, from techtarget :* https://searchmobilecomputing.techtarget.com/definition/smartphone

*Microcontrollers, L. (2015, November 2). home devices control using GSM and microcontoller. Retrieved August 1, 2022, from Microcontrollers Lab website:*
https://microcontrollerslab.com/gsm-based-home-devices-control-system/

*SMS Tutorial: Introduction to AT Commands, Basic Commands and Extended Commands. (n.d.). Retrieved August 10, 2022, from developershome:* https://www.developershome.com/sms/atCommandsIntro.asp

*What is C Programming language? Basics, Introduction and History. (n.d.). Retrieved August 20, 2022, from guru99:* https://www.guru99.com/c-programming-language.html.