Internet of things (IOTs) Based-Domotic Engineering

Karim Usman PhD
Department of Mathematics and Computer Science
Benue State University, Makurdi-Nigeria
kusman@bsum.edu.ng

Joseph I. Abe
Department of Mathematics and Computer Science
Benue State University, Makurdi-Nigeria
abejoseph41@gmail.com

Idris Oyibo Igagwu
FHI360 – Headquarter USA (oidris@fhi360.org)

Corresponding author: Joseph I. Abe (abejoseph41@gmail.com)

DOI: 10.56201/ijcsmt.v8.no2.2022.pg1.16

ABSTRACT

Context: *Technology has headed towards automation for a long time. The very basic principle of technology is to make lives easier by leaving fewer things to be explicitly done by humans. There is no doubt that automation is the future and it is happening the most significantly right in our homes. With this, life is getting simpler and easier in all aspects. Automated systems are preferred over manual systems the world over. The rising increase in the number of users of internet in recent decades, has made internet a part and parcel of life, and IoT is the latest and emerging internet technology. Internet of things has been a growing network of everyday object-from industrial machine to consumer goods that can share information and complete tasks while one is busy with other activities. Internet of things (IOTs) Based-Domotic Engineering is an IoT-based system that uses computers or mobile devices to control basic home functions and features automatically through internet from anywhere around the world.* ***Objective:*** *This project conducts an Internet of things (IOTs) Based-Domotic Engineering using arduino and wireless control via Bluetooth module.* ***Method:*** *This technique employs the integration of wireless communication using Bluetooth of an android smartphone to provide the user with remote control of various lights, fans, and appliances within their home.* ***Results:*** *The study successfully applied the Internet of things (IOTs) Based-Domotic Engineering to engineer a smart home using arduino and wireless control through a Bluetooth module and it was user friendly and cost effective. This system was designed so as to enhance cost effectiveness and expandable allowing a variety of devices to be controlled.* ***Conclusions:*** *Internet of things (IOTs) Based-Domotic Engineering can make home even more intelligent. This System can be used for building automation, industrial automation, hospital automation for patients and agricultural automation for farmers. Different sensor can interface with the system such as motion sensor, light sensor, flame sensor, temperature sensor etc. Automation toggling of device*

based on certain situation can also be implemented WiFi and Ethernet based home automation systems can be developed.

Keywords: *Internet of things, Domotic Engineering, Automation, Smart Home*

1. Introduction

In the present day, security systems play an important role in the protection of lives and investment. This is achieved by the incorporation of various subsystems into the security system with a single control unit such as surveillance, intruder control, access control, fire detection, etc. A smart home is one that is equipped with lighting, heating, and electronic devices that can be controlled remotely by Smartphone or via the internet. An internet-based home automation system focuses on controlling home electronic devices whether you are inside or outside your home (Nathan, Abafor, Aronu & Edoga, 2015). Home automation gives an individual the ability to remotely or automatically control things around the home. A home appliance is a device or instrument designed to perform a specific function, especially an electrical device, such as a refrigerator, for household use. The words appliance and devices are used interchangeably.

Automation is today's fact, where things are being controlled automatically usually the basic tasks of turning ON/OFF certain devices and beyond, either remotely or in close proximity. Automation lowers the human judgment to the lowest degree possible but does not completely eliminate it. The concept of remote management of household devices over the internet from anywhere, any time in the world today is a reality. Assume a system where from the office desk, the user could view the status of the devices and decides to take control by tuning his TV set to his favorite channel, turns on the cooling system, say the air conditioner, and switches on or off some of the lights. This, the user could walk back home and only find a very comfortable, pleasant home. The recent developments in technology which permit the use of Bluetooth and Wi-Fi have enabled different devices to have capabilities of connecting with each other. Using a WIFI shield to act as a Micro web server for the Arduino eliminates the need for wired connections between the Arduino board and computer which reduces cost and enables it to work as a standalone device. The Wi-Fi shield needs connection to the internet from a wireless router or wireless hotspot and this would act as the gateway for the Arduino to communicate with the internet.

In the present day, home automation is becoming essential for the purpose of improving life conditions. Home automation offers convenience and ease in the use of home appliances. This ranges from using a smart phone in turning on a TV to locking and unlocking doors. It also offers an efficient use of energy. However, to get or acquire such systems installed costs a lot of money and that is the major reason why home automation has not received much demand and attention in some parts of the world (including Nigeria). In addition, it is also complex to install and configure. There is therefore the need to develop a cost effective and easy to configure system so that a lot of people will be willing to acquire it in

their homes, offices and schools. It is against this backdrop that we undertake a design of a cost-effective home automation system using arduino board and smartphone. The aim was design and implement an automated arduino-based home automation using android application.

1.1 The Concept of Domotics

Domotics simply means building automation for a home referred to as smart home or smart house. A domotics otherwise known as intelligent home is a simulated intelligent home environment, populated with appliance agents (Ahmed 2015). Electronic agents interact and coordinate to perform home tasks efficiently by sharing resources. The house is a living laboratory for the home, with integrated ubiquitous sensor architecture. The vision of this project is therefore to develop a smart home, to study technology that motivates behaviour change in context. Home automation system control lighting, climate, entertainment systems and appliances. Domotics engineering may also include building home security systems such as access control and alarm system. When connected with the internet, home devices are an important constituent of the internet of things (IoTs). The Internet of Things is an interrelated computing device bet it mechanical or digital machines, objects, animals or people that are provided with unique identifiers (UiDs) and have the ability to transfer data over a network. The definition of the internet of things has evolved due to the convergence of multiple technologies, real-time analytics, machine learning, commodity sensors and embedded systems.

Different types of approaches have been made towards home automation. An SMS based method uses GSM technology available in phones to communicate with a microcontroller which acts as the main control for access to home appliances. A GSM module is also required to be attached to the microcontroller through a port to enable SMS capability (AlShu'eili, Gupta & Mukhopadhyay, 2011). The disadvantage of such a system is that it is not user friendly, as there is no graphical user interface, and access codes and command codes must be remembered to operate the system.

Another approach focuses on voice recognition to send commands through a wireless RF network. The voice command is captured using a microphone, digitalized, and sent to a computer to be processed by a program based on Visual Basic which employs Microsoft speech API. Upon recognition of the voice command, control signals are sent to the specified appliance addresses for action. The tested system however was not always accurate in recognising voice commands. Hand gestures were also proposed as control for home automation systems by. A small camera is worn as a necklace to observe the various gestures made by a user's hand in order to interpret and send command signals. The use of such technology, however, requires the use of a high-end PC for data processing, resulting in a higher setup cost.

1.2 Domotics Engineering in the Real World

In an ideal world, any device that can be connected to a remote network can be automated and controlled. In the real world, home automation most commonly, connects simple binary devices. This includes "on and off" devices such as lights, power outlets and electronic locks. Also, devices such as security sensors which have only two states, open and closed are automated as well. For a home to become truly smart, internet enabled devices must be attached to this network and controlled remotely. The home computer was the classic control unit for which most of the earlier home automation systems were built or designed. In recent times, most especially in the 21st century, home automation systems distribute programming and monitoring control between dedicated devices in the home like the control panel of a security system interdem with a user-friendly application interface that can be accessed via internet enabled-PC, smart phone, tablet, etc.

Manufacturers have produced a wide variety of "smart" devices, many of which are full of innovative features but few of which offer the kind of integration needed to be part of a complete home automation system. Much of the problem has been that each manufacturer has a different idea of how these devices should be connected and controlled. So, while one may have a "smart" TV, washing machine, refrigerator, thermostat, coffee maker or any of the other Internet-ready household devices on the market, the end result is usually a separate control scheme for each device (Ahmed 2015).

In the near future, home automation may be standardised to let users truly take advantage of all of these additional possibilities. For manufacturers in the present times, home security systems specialized in home automation is hinged on the most critical and useful part of a smart home. This means that doors, windows and environmental devices (thermostat, smoke detectors, temperature, humidity, fire and carbon dioxide sensors) at the basic level. For a real-time security, convenience and control, home automation systems from security providers also include options for video cameras.

1.3 Advantages of Home Automation Systems

The 21st century homes have become more and more self-controlled and automated due to the comfort automation provides, especially when employed in a private home. Home automation system serves as a means that allow users to control electric appliances of varying kind. Many existing and well-established home automation systems are based on wired communication. This does not pose a problem until the system is planned well in advance and installed during the physical construction of the building. Nonetheless, for already existing buildings, the implementation cost goes very high. In contrast, Wireless systems can be of great help for automated systems. With the advancement of wireless technologies such as Wi-Fi, cloud networks in the recent past, wireless systems are used every day and everywhere. This reduces the hitches associated with wired-network. Wireless systems like Wi-Fi have become more and more common in automated homes. Likewise, in home and building automation systems, the use of wireless technologies gives several advantages that could not be achieved using a wired network only.

Reduced installation costs: Installation costs are significantly reduced since no cabling is necessary. Wired solutions require cabling, where material as well as the professional laying of cables (e.g. into walls) is expensive.

System scalability and easy extension: The deploying of a wireless network is especially advantageous as extension of the network is necessary. In contrast to wired installations, with cabling extension is tedious and this makes wireless installations a seminal investment.

Aesthetical benefits: This attribute helps to full aesthetical requirements as well apart from covering longer areas. Examples include representative buildings with all-glass architecture and historical buildings where design or conservatory reasons do not allow laying of cables.

Integration of mobile devices: With wireless networks, associated mobile devices such as PDAs and Smartphones with automated systems become possible everywhere. Wireless technology is an attractive choice in renovation, refurbishment and for new installations.

2. Review of Related Works

Ahmed (2015) presented an implementation of cost-effective Home Automation System with a remote control. This framework was intended to help and give help to satisfy the needs of the elderly and the handicapped at houses. Additionally, Ahmed (2015) stated that the idea of home automation system will improve the normal living status at houses. The fundamental control system uses a wireless Bluetooth device gives a wireless access to smart phones. The system design does not remove the existing electrical switches and gives a safer control over the switches with low voltage usage technique. The switches status is synchronised everywhere each person interface demonstrates the current existing switch status. This system is designed to control electrical devices throughout the house with ease of installing it, ease of use and cost-effective design and implement. It was concluded that home automation system using arduino was a success. This system consists of an Arduino-Uno board, a Bluetooth Module, an Android phone, power sockets, home appliances and an android Application (ArduDroid). It is user friendly and it is cost effective.

Ilyas, Chiktay and Salahuddin (2016) presented a design and prototype implementation of new home automation system that uses WiFi technology as a network infrastructure connecting its parts. The proposed system consists of two main components; the first part was the server (web server), which presents system core that manages, controls, and monitors users' home. Users and system administrator can locally (LAN) or remotely (internet) manages and control system code. Second part was hardware interface module, which provided appropriate interface to sensors and actuator of home automation system. Unlike most of available home automation system in the market the proposed system is scalable that one server can manage many hardware interface modules as long as it exists on WiFi network coverage. System supported a wide range of home automation devices like power management components, and security components.

Rajneesh, Abhinav and Sh. Nishant (2015) while investigating internet of things based controlling of appliances using GSM/GPRS enabled embedded server for remote access

observed that the internet has initially started as the "Internet Of Computers", a global network enabling services that now include the World Wide Web (WWW), File Transfer Protocol and others allowing computers and hence users to communicate with each other and exchange information. There are several definitions for the Internet of Things (IoT) that explain what are the main functionalities of it and what we should expect from when connecting "Things" with each other and with the internet. Internet of Things (IoT) is an ideal emerging technology to influence the internet and communication technologies. Simply "Internet of Things" connects living and nonliving things through internet.

It can therefore be inferred from the above that the main aim of IoTs is to enable the users to control and monitor smart devices through internet. In this an interface between users and smart home by using GSM and internet technologies or simply creating GSM based wireless communication from the web server into the smart home.

Corroborating the above view in their paper titled "*Home Automation Using Internet of Things*", Vinay and Kusuma (2015) noted that with advancement in Automation technology, life is getting simpler and easier in all aspects. In today's world Automatic systems are being preferred over manual system. With the rapid increase in the number of users of internet, IoT is the latest and emerging internet technology. Internet of things is a growing network of everyday object-from industrial machine to consumer goods that can share information and complete tasks while you are busy with other activities. Wireless Home Automation system (WHAS) using IoT is a system that uses computers or mobile devices to control basic home functions and features automatically through internet from anywhere around the world, an automated home is sometimes called a smart home. It is meant to save the electric power and human energy. The home automation system differs from other system by allowing the user to operate the system from anywhere around the world through internet connection.

Sirsath, Dhole, Mohire, Naik and Ratnaparkhi (2013)'s work on "*Home Automation using Cloud Network and Mobile Devices*" proposed a Home Automation system that employs the integration of multi-touch mobile devices, cloud networking, wireless communication, and power-line communication to provide the user with remote control of various lights and appliances within their home. This system uses a consolidation of a mobile phone application and PC based program to provide a means of user interface to the consumer.

Basil Hamed (2012) designed and implemented a control and monitor system for smart house. Smart house system consists of many systems that controlled by LabVIEW software as the main controlling system. Also, the smart house system was supported by remote control system as a sub controlling system. The system also is connected to the internet to monitor and control the house equipment's from anywhere in the world using LabVIEW.

Deepali, Mohd and Shreerang (2013) also conducted a study and investigated Home Automation and Security System Using Android ADK. The prime objective of this paper is to assist handicapped/old aged people. It gives basic idea of how to control various home appliances and provide a security using Android phone/tab. The design consists of Android

phone with home automation application, Arduino Mega ADK. User can interact with the android phone and send control signal to the Arduino ADK which in turn will control other embedded devices/sensors.

Basma, Sherine and Mahmoud (2013) proposed a new design for the smart home using the wireless sensor network and the biometric technologies. The proposed system employs the biometric in the authentication for home entrance which enhances home security as well as easiness of home entering process. The structure of the system is described and the incorporated communications are analyzed, also an estimation for the whole system cost is given which is something lacking in a lot of other smart home designs offers. WB-SH is designed to be capable of incorporating in a building automation system and it can be applied to offices, clinics, and other places. The authors argued that with an imagination for the future, the smart home will employ the biometric technology in a larger and more comprehensive form.

It is apparent from the literature review that the rapid growth of technology has drastically changed the living standards of modern society. Based on the increasing number of electronic devices being made in a household, automated home control system has become an increasing useful feature. Current systems, however, have problems with complexity, high costs, non-open sources and multiple incompatible standards; resulting in the limited venture of the home automation into the homes of the rich or hobbyists. This project intends to design an affordable and easy to use home automation system, which will be done by interfacing the Arduino microcontroller with wireless control via Bluetooth while creating a simple, easy-to-use system to control home appliances.

3. Materials and Methods

The technique used employs the integration of wireless communication using Bluetooth of an android smartphone to provide the user with remote control of various lights, fans, and appliances within their home. The material requirements for this project include the hardware and software components.

3.1 Hardware Components Required

Arduino UNO

Proto board

Android phone

Bluetooth module (HC-06)

Android application (to control the arduino via Bluetooth)

Some resistors

jumper wires

Relay modules

Light bulbs

Block connectors.

3.2 Software

Arduino 1.0.3 (Arduino Software)

Arduino Development Environment

Arduino Bluetooth Home Automation (Android app)

3.3 Programming the Arduino-Uno

In order for the Arduino-Uno board to be able to interact with the application used in this project certain program (code called sketch) needs to be uploaded to the Arduino-Uno. Arduino Company provides user friendly software which allows writing any code for any function wanted to be performed by the Arduino-Uno and upload it to the board.

3.3.1 Connecting the Arduino-Uno board to the Bluetooth module

A connection between the Arduino-Uno and the Bluetooth module is required in order to enable the android to control the Arduino-Uno. First, we need to connect the VCC pin of the Bluetooth module to the VCC port in the Arduino-Uno board. Second, we need to connect the GND pin of the Bluetooth module to the GND port in the Arduino-Uno board. Lastly, we need to connect the receiver of the Bluetooth module to the transmitter of the Arduino-Uno board and the transmitter of the Bluetooth module to the receiver of the Arduino-Uno board.

3.3.2 Android Phone + Android App

In this project, an android phone is used as the remote control for the user alongside with an App called Arduino Bluetooth Home Automation. Arduino Bluetooth Home Automation is a simple Android app that will make controlling the pins of Arduino-Uno from an Android phone wirelessly possible. Arduino Bluetooth Home Automation employs a simple Android user interface to control Arduino Uno's digital and PWM pins, send text commands to Arduino-Uno and receive data from Arduino over Bluetooth serial module. In this Project the Digital Pin Function is only required to make the system work, so the Arduino-Uno Board should be programmed to only support that feature.

3.3.3 Testing the Connection

After installing the app on the phone and connecting the Arduino-Uno board with the Bluetooth module, a test to make sure that the phone is interacting with arduino via the

Bluetooth module is needed.

- Open the app in the android device.
- Search for Bluetooth devices via the app.
- Connect to the Bluetooth module.
- If the light in the Bluetooth module stops blinking, then everything is working fine otherwise the wiring need to be checked.

3.3.4 Connecting the Appliances to the Arduino Board

After everything is set and ready (android phone is connected to the Arduino) connecting the Arduino to the home appliances is needed. Using wires and connector blocks connect the positive end of the home appliance (e.g. portable fan) to the normally open (in this project we want to make the output active high) port in the relay module and the negative end of the appliance to a power source. Then connect the IN-port of the same relay module to the wanted Arduino-Uno port. Apply the same for the other appliances only use different relays and different Arduino- Uno Ports. Connect the android phone with the Bluetooth module and now all the connected appliances can be controlled wirelessly using the android device.

3.3.5 Working of Arduino-Based Home Automation

Make the connection for Home Automation project as given in the circuit diagram. First of all, we connect the bulb with AC powered sources and with relays as given in the circuit diagram. Then the relays are given DC power from the Arduino Uno board. Data pins of the relays are connected at pins 8, 9, 10 and 11 to the Arduino which are the output pins of Arduino. Then connect the HC-06 module with the Arduino Board as shown in the diagram and power the Adruino Board. Upload the code given at the end of the project using Arduino IDE. Turn on the Bluetooth in your smartphone and connect the HC-06 module by entering the password. By default, the password is "0000" or "1234". After successfully connecting your smartphone with the HC-06, Open "Bluetooth terminal HC-06 app in your smartphone" and it will show your device connected to HC-06. Now send the data "Bulb1 turn on" or "Bulb2 to turn off" to turn on or off any bulb. This is how you can control other appliances in your home remotely.

4. RESULTS AND DISCUSSION

4.1 Results

Mobile App

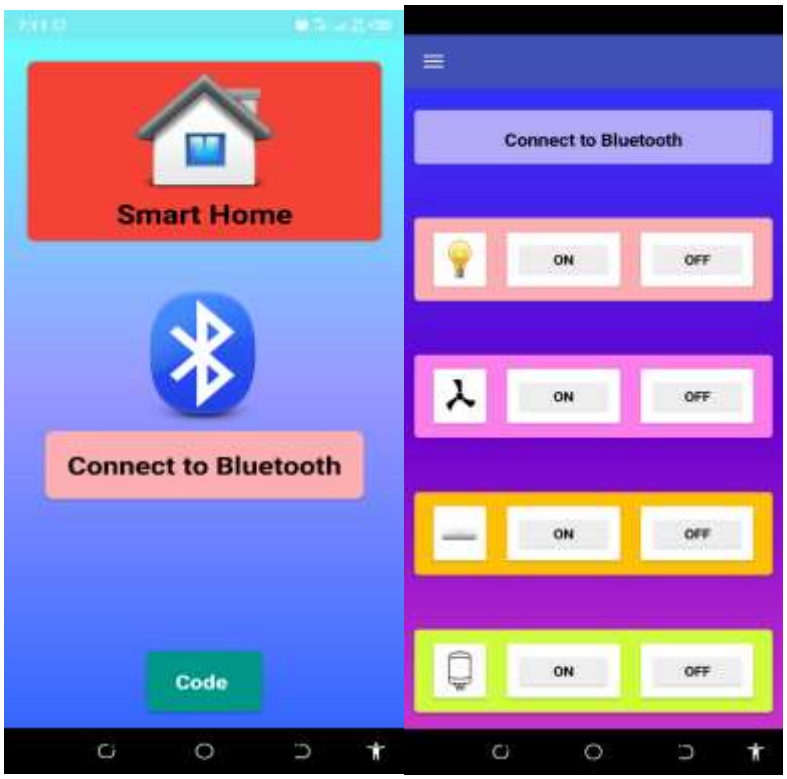

Figure 1: *Mobile App for controlling communication with Arduino via bluetooth module*

As seen in **Figure 1** above, the android app helps in establishing the connection between Bluetooth module. It also helps in controlling the appliance connected to the Arduino via Bluetooth module. Once the ON button is pressed on the screen, the first appliance, in this case, a light bulb will be switched on. Once it is pressed OFF, it will switch off.

4.2 Arduino, Bluetooth and Relay Module Control

The sketch as shown in chapter three was uploaded into the Arduino after connections (wiring) were done. The code was then uploaded into the Arduino and tested for communication. **Figure 2** below illustrates the connection and communication between Bluetooth module and Arduino. Thereafter, connection was also established between the Relay module, Arduino and home appliances and tested for automation.

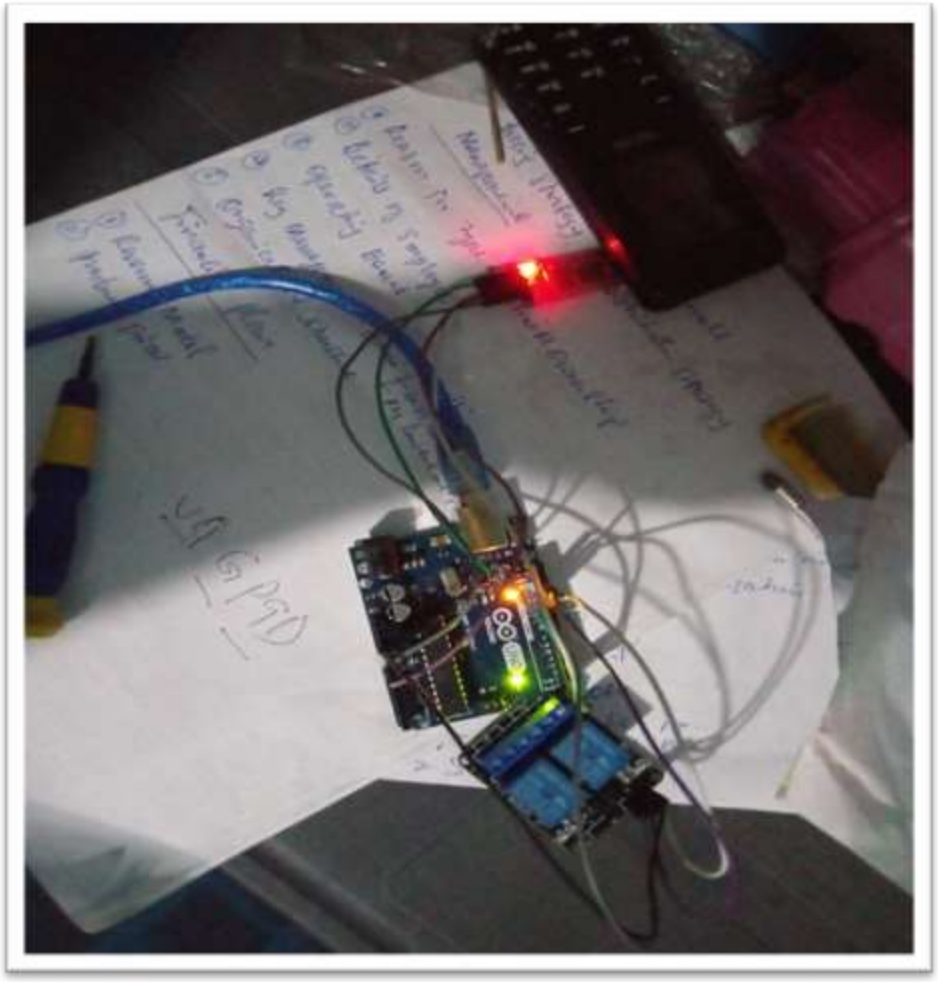

Figure 2: Arduino, Bluetooth and Relay Module Control

4.3 System Integration and Testing

The whole system was packaged using adapter box. The Arduino was powered with an adapter of AC 12v 500mA 6VA. The reading represents respectively: alternating current, maximum output load and power, expressed in VA (that can always be obtained by means of the P=V*I formula). In some cases, in the place of the AC abbreviation, the symbol "~" may be found, and it still means "alternating current". This reason for packing is because when we want to use an Arduino board in stand-alone mode, the first problem to face is the one of how to power it, once it is disconnected from the computer's USB port. Unfortunately, a faulty knowledge of the theme of powering sometimes leads people to make unforgivable mistakes, since the first result is often that of seeing the board go up in smoke and almost always irremediably, since from that moment it will not work anymore. **Figure 3** below shows the fully packaged system.

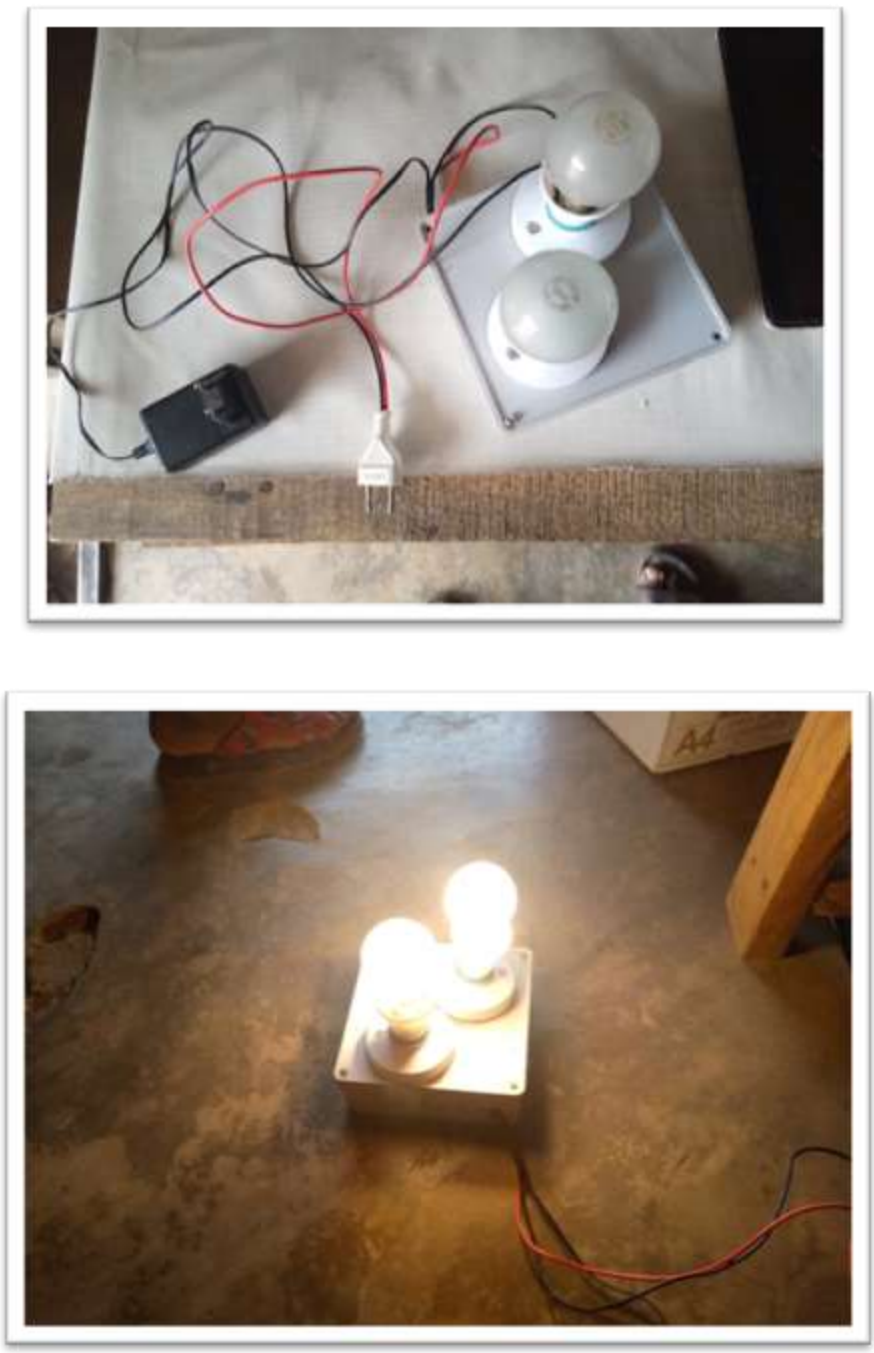

Figure 3: Packaged Home Automation System Prototype Using Adapter Box

5. Discussion

We have successfully applied the Internet of things (IOTs) Based-Domotic Engineering to engineer a smart home using arduino and wireless control through a Bluetooth module and it was user friendly and cost effective. User-friendly as in anyone can use just a click of a button on an android screen and everything works. And it is cost effective as in it will cost exactly as the project requires (optimum price). Home automation market is very auspicious sector which is developing rapidly. It requires extensive range of developments that can be made in the idea of smart homes. Modeling and execution of home automation system using

Bluetooth Module and GSM through android application has been discussed in this research. The proposed system is practical, economical and simple. While using Bluetooth the motive of the system is to use mobile phone integral feature for automating the Home. The key advantage of system is if control circuit fails then manual switching option of traditional method is available.

5.1 Implication for Big Data Involvement

It is deduced from the study that IoT has become so vital in daily life and it is creating a big impact for the future. For example, solutions can be provided instantly for traffic flows, reminders about vehicle maintenance, reduce energy consumption, etc. Monitoring sensors will diagnose pending maintenance issues, and even prioritise maintenance crew schedules for repair equipment. Data analysis systems will help metropolitan and cosmopolitan cities to function easily in terms of traffic management, waste management, pollution control, law enforcement and other major functions efficiently.

Linked devices can help people personally get an alert from the refrigerator reminding them to shop some vegetables when the vegetable tray is empty, the home security systems enables people to open the door for some guest with help of connected devices (IoT). Since there is a massive growth in number of devices day by day, the amount of data generated would also be enormous. Here is where Big Data and IoT go hand in hand.

Big Data manages the enormous amount of data generated using its technologies. The Internet of Things (IoT) and big data are two vital subjects in commercial, industrial, and many other applications. The name IoT refers to the world of machines or devices connected to the Internet, by which a large amount of big data is collected, stored and managed. Big data additionally refers to the analysis of this generated data to produce useful results. The main motivating power behind the IoT and big data has been the collection and analysis of data related to consumer activities in order to find out why and what customers buy. It was not too long ago that visualised houses of the future where things would be done on their own- lights coming on by themselves, coffee being brewed just the way an individual like, as waking up and taking a shower knowing the weather outside and adjusting the water temperature accordingly. The world is at a point where technology to achieve all that has been around for a while and has now become affordable. Hence, it is not a particularly big surprise that the world is witnessing some amazing things happening in the world of automation.

5.2 Future works

There are some recommendations for Future works. Some of them are: (1) The home automation system was limited to control Lights on/off, Fan on/off, On/off different appliance which makes use of Bluetooth wireless control. Future work should make use of cloud networking connection and also include temperature and humidity, motion detection, fire and smoke detection and light level control and data stored in a cloud server. This will enable users to control their homes remotely from anywhere using internet service and

smartphones; and (2) there is the need to design a smart home which employs the biometric technology in a larger and more comprehensive form.

6. Conclusion

It can be concluded that Internet of things (IOTs) Based-Domotic Engineering using arduino and wireless control through a Bluetooth module was a success. This system consists of an Arduino-Uno board, a Bluetooth Module, an Android phone, power sockets, light bulbs and an android Application (ArduDroid). It is user friendly and it is cost effective. Also, it can be concluded that the objectives of this project has been successfully met and they are as follows: (i) constructed a wireless home automation system controlled by a smartphone specifically an android device, (ii) designed and implement cost effective home automation system yet an efficient one and (iii) designed a user friendly and a safe system to control home appliances especially aimed to aid the elders and handicapped. The motive of making the project cost efficient and user friendly is taken into account and achieved. The project is comprised of components such as a Bluetooth module, an Arduino board, an Android mobile device, optocouplers, and an Android application.

Internet of things (IOTs) Based-Domotic Engineering can make home even more intelligent. This System can be used for building automation, industrial automation, hospital automation for patients and agricultural automation for farmers. Different sensor can interface with the system such as motion sensor, light sensor, flame sensor, temperature sensor etc. Automation toggling of device based on certain situation can also be implemented WIfi and Ethernet based home automation systems can be developed.

Using this system as framework, the system can be expanded to a distributed home automation system that consists of server, sensors. Server controls and monitors the various sensors, and can be easily configured to handle more hardware interface module (sensors) with various other options which could include home security features like capturing the photo of a person moving around the house and storing it onto the cloud. This will reduce the data storage than using the CCTV camera which will record all the time and stores it. The system can be expanded for energy monitoring, or weather stations. This kind of a system with respective changes can be implemented in the hospitals for disabled persons or in industries where human invasion is impossible or dangerous, and it can also be implemented for environmental monitoring.

Acknowledgements

We are grateful to Dr Adekunle Adeyelu whose contribution was very essential to the success of research work. We are deeply grateful for his support. I also appreciate the scholarly efforts of all the lecturers in the Department of Mathematics and Computer Science, Benue State University, Makurdi particularly for their advice and co-operation, Dr. Innocent Otache Ogwuche, Prof. Michael T. Imande, late Prof. Moses Abanyam Chiawa, Dr Musa Egahi, Mr Tivlumun Ge, Dr. Patrick Obilikwu, Dr Aamo Iorliam, Dr Stephen S. Akuma, Dr Mrs Samera Bright Otor, Mr Agber Selumun, Mrs Beatrice Akumba, Mr Adom

Isaac, Dr Harold Kpojime and many others too numerous to be mentioned herein.

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