

IoT Enabled Smart House System using Wi-Fi Technology

Dr. Anazia Eluemunor Kizito , Dr. Wilfred Adigwe
Lecturer, Delta State University of Science and Technology, Ozoro

Abstract:- The developments of smart devices for effective information transmission and management have been increasingly acceptable among users in recent years but its design and availability has been a major problem because of the difficulty in programming the embedded systems, technical know-how and limited technicians in the field. Smart-homes are living spaces with home appliances (e.g. TV, Fridge, Lights, and DVD etc.) are managed with internet infrastructures and ICT related devices from the owner's comfort zone like the sitting couch via a WiFi technology. The proposed system reveals and implements the concept of home automation system using Arduinomicrocontroller Board, Relay, Sensors and an Android GSM Phone as the WiFi source. The system is designed using C, HTML, CSS, Bootstrap Frame work, JQuery, JavaScript and PHP and MYSQL Server as the backend design and implemented using Object Oriented Methodology.

Keywords:- Smart-Home, WiFi Technology, Internet of Things, Mobile Devices.

I. INTRODUCTION

Incorporating technology into our daily lives and activities has continue to detect or influence the way people live in recent times which of course is a great influencer of our daily lives like improved social communication, ease of transport, medicine, broadcasting, hospitality amongst others sectors of life. The creation of many devices such as mobile phones and computers have caused many people to rely on technology to communicate with their friends, store information such as pictures, movies, documents, and music[1]. The internet has created a common platform which enables many electronic gadgets to be deployed and managed for easy usage and an improved life style of users. Home Automation can be defined as the process of making a residential space to be intelligent and manageable through a remote point which helps to improve security and energy conservation. This is also known as internet of things (IoT) or smart Homes. IoT can be defined as a collection of interrelated devices (mechanical, electrical, computing or other objects) that has a unique identifier with the ability to transmit information and manage those devices via a network or the internet from a remote location with little or no human interactions.

IoT-based smart homes offers healthy, flexible, comfortable and secured environment to residents. At the inception of the development smart homes, systems were developed and managed remotely without being deployed over the internet but in recent times, these systems are deployed and managed over the Internet with the aid of various types of computers and other devices/gadgets. Most

systems would exchange data or would communicate with the help of Bluetooth, ZigBee (Zigbee is the wireless language that everyday devices use to connect to one another) and GSM [2].

Home Automation or Smart Homes can be defined as introduction of technology in the home space in order to enhance convenience, manageability, security and energy conservation to its residents. Adding intelligence to home environment can provide increased quality of life [3]. Despite home automation being around for the past 35 years, the rate at which users has embraced the technology has been very low. It has become very popular among residents and users in recent times.

II. STATEMENT OF PROBLEM

Despite the acceptability of Internet of Things (IoT) in recent times, its implementation and availability most especially as regards smart-homes is less than expectation. All of this these are as result of unavailability of hardware devices, programmability of the embedded peripherals, technical know-how, lack of platform for scheduling power regulation, security threats etc. The proposed system uses.

III. REVIEW OF RELATED LITERATURE

In the work [4], they were able to successfully implement the Bluetooth technology in networking domain that was able to control and manage home related appliances from a remote region. The use of speech-based interaction model remotely will have a better effectiveness to users most especially disable people within a locality [5] and [6] proposed an internet based wireless home automated and monitoring system for multi-purpose appliances that was able to reduce cost of implementation and maintenance. A home automation system using an internet based control approach where home appliances were able to be managed and secured from a remote base was implemented [7]. It was by [8] an SMS based home appliance automated system for monitoring and control of home related gargets with the user having full control of the device. Murthy, (2008) proposed a web based appliance automation in rural areas like IDP camp. The model was able to deploy SMS to user's cell phones within the camp alerting users of devices that is being tempered or any other security breach.

A remote monitoring through mobile phones that are audio based was proposed by [9] which was specifically designed to work with spoken command. In the work of [10] had a system that is GSM based home automation model which provides unlimited access control and security for users. A wireless control of home appliance from within the

owner's convince using some listed components and specifications[11] while [12] had a work on soft screen based home automation system that works effectively using GSM and Zig-Bee technology. In the work of [13] they implemented the GSM technology in the management and automation of home appliances but its cost-effectiveness was a great drawback to their model. An Android based home appliances automation system that has a very low cost and management effectiveness compared to the previously developed models [14] while [15] did their work on the analysis of information regarding home automation and control system using Arduino technology. In the work of [16] they developed a home appliances automated system which central working mechanism is a motion sensor and PIR sensor that was able to cover considerable wide range which gives users the power to manage the appliances from distance. Despite the above works reviewed, they have been unable to design a web-based smart-home which depends on WIFI technology for the interaction among the connected devices but if fully implemented, the proposed system will be able to achieve the said aim.

In order to provide addition security layer in the implementation of Smart Home Applications, [17] designed a security of multi-factor authentication system which will check the security compromise by mitigating unauthorized users. Also [18] designed classified what is known as Liveness Detection Techniques into four major groups as follows; Motion-Analysis-Based, Texture-Analysis-Based, Image-Quality-Analysis-Based, and Hybrid-Analysis-Based System in a Smart Home Applications system. In trying to improve the security system in an IoT Based Home System, Hashing Technique was deployed for Protecting Passwords, Registration and Log-In activities[19].

An application that uses a Face Recognition Approach which is a well know Biometric Authentication method [20]. Biometric features provide reliable proof of user's identity which has kept biometric authentication method above other non-biometric methods. A Smart Home Security System that is MCU-ESP32-based system that has an Internet connectivity which supports remote device management of devices. The application transmits sensor data to the Firebase database which are controlled automatically by receiving commands from the server, allowing automatic control. Internet of Things based Integrated Smart Home Automation System [21]. Internet of Things (IoT) is described as next generation Internet revolution which will be an easy and flexible way of life with comforts to users by managing and interacting with their appliances remotely away from home [22]. A Home Automation System has various sensor devices which are used for sensing, communicating and collect data from various appliances a home to the user's server [23]. It was stated in the work of [24] that Internet of Things originated from the result of several novel technology; instead which has provided different complementary technical capabilities merge together to help close up the gap created between the virtual and physical locations.

In implementing smart home applications, home devices are automated, monitored and controlled from a remote location. In order to keep our eyes on our properties and dependent people like elderly parents, children, sick patients, or pets at home when we are away from homes, there is need to control and monitor activities inside from other position.

IV. WIRELESS IOT-BASED SMART HOME SYSTEM

The Internet of Things (IoT) as earlier defined is the process of connecting our daily appliance and devices like mobile phones, sensors and actuators via the Internet where the daily appliance and devices are smartly and intelligently connected to create and provide an established communication interface between the daily appliance/devices, user and other objects within the home and beyond and people, and between things themselves [25]. Designing and implementing IoT has grown beyond expectation in recent years significantly since the advent of the internet and improved mobile communication devices. Smart home systems are based on modern mobile communication devices and personal computers which are used to deploy and manage them and most cases these systems works automatically via the internet to other remote locations.

V. DEVICES NEEDED FOR SMART HOME SETUP

Upon deployment of this Smart-Home system using Wifi technology, it will be a low-cost system, easy deployment, easy installation, wider range of coverage, high scalable system, mobile-device integration and among others. The following devices are needed for the construction and installation of the proposed system.

A. Web Technology and its Application

The browser acts as an interface between the internet and the user and the browser window is the user's viewing page. We have several different browsers used but the most commonly used are the FireFox, Netscape Navigator and Microsoft Internet Explorer etc. These Web browsers work by linking through the Internet via modem or ISDN, via a server or ISP to remote gadgets, locating dedicated document (or page) and then editing the documents they receive for viewing on the personal computers.

B. Mobile Device

They are mostly Android GSM phone or other Tablets that are Wifi enabled. They contain SIM card through which communication is initiated or other means of making the cell phones/tablets have access to the internet. The entire model interact with the cell phone/tablet through the Wifi communication.

C. Arduino Microcontroller

Arduino was created by a group of Italian students in the year 2006 and it was an open-source single-board microcontroller. The idea behind the creation of this open-source single-board microcontroller called Arduino was to design an inexpensive and expandable gadget that will be quite different from other prototypes that are already available in the market space and also to bring the device

closer to the people [26]. Though the Arduino Microcontroller was originally designed for the automation of smart homes but due to its availability, flexibility and cost, users deployed it for the design of other microcontroller applications. Another advantage of using Arduino Microcontroller is that it supports easy execution of codes written on it, flexibility, easy-to-use hardware and programmable. The Arduino board is made extendable by the use of what is known as plethora add-on modules known as "shields." They are boards that can be plugged onto the Arduino PCB which provides extendable capabilities. The Arduino microcontroller is highly programmable by making sketches of the software programs using the Arduino Integrated Development Environment using object oriented languages like C and C++ languages.

D. WI-FI Module

The Wi-Fi section provides for the Arduino microcontroller the access to the internet via a network platform which is capable of either hosting an application or discharging all Wi-Fi networking capabilities from other application location [26]. Every of the WiFi module supports a preprogrammed AT command set firmware, which means, users can easily attach them the Arduino gadgets and have access enough Wi-Fi-ability as a Wi-Fi Shield offers. The WiFi module is highly affordable with a large demand base among users locally and internationally. This section has an effective on-board processing and high memory capacity that incorporates the use of sensors and other application gadgets. It uses its GPIOs that has a minimal development up-front and processing during runtime, the Wi-Fi module has a high degree of on-chip integration capability that supports low external circuitry within the front-end module. It is manufactured to occupy low PCB space. The module supports Bluetooth integration interfaces and a self-calibrated RF which provides it to work within several operating environment that does not need no external RF parts.

E. Relay

A Relay is defined as an electrical device that uses an electromagnet to mechanically operate a switch. They are used deployed mostly to control a low power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal [27].

The following are the various parts of a Relay;

- Electromagnet which becomes a magnet when it receives an electric signal.
- Armature that can be attracted by the electromagnet.
- Spring which pulls the armature when the electromagnet is demagnetized.
- Sets of electrical contacts.

F. Power Supply Unit

Electrical Circuits usually needs a DC power supply that can regulate a steady voltage while supplying the required current to carry a particular load [28]. In converting the AC line voltage into a usable (typically lower-level) DC voltage has to step down the AC voltage using a transformer. Thereafter, the transformed voltage is used via a rectifier

network to discard the negative swings. Once the negative swings are eliminated, a filter network is used to flatten out the rectified signal into a nearly flat (rippled) DC voltage pattern.

G. Transformer

The Transformer used in a smart home automation system is usually a four-terminal device that is designed to transform an AC input voltage into a greater or lower AC output voltage [29]. During the design of a smart home automation system, it is pertinent to choose a suitable transformer for power supply and the secondary voltage in the transformer should not be much greater than the output voltage of the regulator; else the energy will be dissipated as a result of the regulator being forced to dissipate heat. That notwithstanding, the secondary voltage must not go below the required minimum input voltage of the regulator (typically 2 to 3 V above its output voltage). It should be noted that in DC power supply regulation as the one employed in this system, transformer convert AC voltage (usually the public main supply) into a DC voltage produced should be lower than the value needed by the devices, and it should create a kind of isolation between the neutral line of the AC and the power supply's usual direction of flow of voltage.

H. Voltage Regulator

Modern electronic circuits generally employ an integrated circuit Voltage Regulator to provide the required power supply voltage stability [30]. Devices available are of varying degrees of complexity that are capable of satisfying all but the most stringent of specifications. The three terminal is the modest type of voltage regulator that is perfectly manufactured for the design appliances like smart home gadgets. This type of voltage regulators are designed in such a way that they automatically manage and adjust the quantity of current flowing through the system in order to avoid voltage fluctuation and maintain a constant output voltage with the amount that flows through the DC output which has a fixed or programmed internal reference voltage. Different types of voltage-regulator integrated circuit (IC) can be found in the market at present with variant performance and cost. Many of these gadgets are manufactured to produce output a fixed positive voltage and a fixed negative voltage, while are adjustable.

I. Resistors

Resistors are electrical devices that are designed to manage or bring down the flow of current and voltage levels in circuits [30]. The mathematical relationship between the voltage passed into a resistor and its equivalent current that passes through it is shown in the formula $V = IR$. There are several uses of Resistors in electrical designs. They are used to put up operating current and signal levels, give voltage reduction, set precise gain values in precision circuits, as shunts in ammeters and voltage meters, as damping agents in oscillators, as bus and line terminators in digital electrical circuits, and provide feedback system for amplifiers.

J. Capacitors

A capacitor is an electrical component that which is made up of two conducting metal plates that are kept apart by an insulating material known as a dielectric [24]. The capacitor stores electric charge in this dielectric. The characteristic of a dielectric that describes its ability to store electric energy is called the dielectric constant. Some of the dielectric materials include Air, Teflon paper, Mica, Bakelite, or ceramic.

K. Diodes

In simple terms, a Diode can be described as an electrical device that manages and restricts the directional of flow of electrons within a circuit. Generally, diodes allows a one directional flow of electric current, but stops it from going through to the opposite direction. When electric current is needed to flow in one direction, more diodes are connected into the circuit designboard [30]. In recent times, many diodes are designed from semiconductor materials like silicon or germanium.

L. Light Emitting Diodes (LEDs)

These are devices that has two-lead semi-conductor light emitters that produces light if activated. If the required voltage is supplied into the leads, it produces light energies that are like photon through the combination of the electron holes within the device [24]. The older version of LEDs produced low-intensity infrared light. Circuit designer still use Infrared LEDs to transmit elements through a remote control circuits. These remote controls are used for a wide range of consumer's electronics devices. New technological developed LEDs are still found in ultraviolet form that has visible and high infrared wavelengths and intensity.

VI. METHODOLOGY

The methodology used in the design of the proposed system is Rapid Application Development which is popularly known as RAD methodology. Rapid Application Development is a software development approach that has a software developmental period of between 60 – 90 days in an incremental approach. In this methodology, the various parts of the system are developed in parallel with each other in the form of an independent mini components. The developments are time boxed, delivered and then coupled to become a single functional system. Rapid Application Development software engineering approach empowers users to have something to depend on the interim and provides a feedback system about the system delivery and requirements. This methodology was chosen because of the assembling and coupling of the several hardware components and the interfacing of the software that are involved in the proposed system.

VII. PROPOSED SOLUTION

Based on the above evaluation, the described components it is recommended that a web-app be integrated using the Arduino Programmable IDE with the capabilities of WI-FI Module creating remote access for consumers to manage and control the appliances within a smart home from a confined Wireless Network Region. The construction was carried out in stages since it is more efficient to assemble larger systems from smaller systems or independent modules with less error. The construction was embarked on after the circuit diagram was gotten from careful analytic designs and calculations made. The workability of all independent components was verified before they were used in the project. During the construction procedures, it began with the mounting of the different electrical parts on the on a project board (Breadboard) after its simulation with Proteus 8 professional and found to be working. They were connected to the 9volts output of the power supply and to the programmed Arduino programmer kit. Care was taken to ensure that the arrangement do not give rise to open circuits or short circuits.

The outputs for the loads were placed properly and several tests were done stage by stage to ensure workability. At the completion of the testing phase, all the electrical components were mounted on a platform known as Vero board. On the Vero Board, they were soldered permanently one after the other to checkimproper connections of the all various components parts and leads. at this point, Integrated circuit sockets were used for its proper protection from heat emission and to enhance quick of replacement during upgrade and maintenance. The power supply stage was soldered in place and tested. It was used to power the other stages. The next phase is testing phase to determine the workability of the system and thereafter the casement of the proposed system which is done by putting the entire circuit a red plastic casement placed on an extension casing housing the load sockets.

VIII. SYSTEM DESIGN PROCESS

System Design can be defined as the process of identifying the various stages and components like the architecture, devices, modules, interfaces, and data of a system to meet a specific requirements [6]. System Design Process is seen as the deployment of systems virtual conception to real life usable product development. It forms the technical kernel of the software development procedures which is applicable regardless of the developmental model that being used. Immediately the requirements of s software development are identified, analyzed and specified, the designflows which includes three technical phases – system design, code generation, and testing. All enumerated process are followed to have a complete and workable system design process.

IX. SYSTEM DESIGN PHASES

The design of an IoT enabled Smart House System Using Wi-Fi Technology is presented in the following stages with relevance to calculations for obtaining valuable components for all the stages involved. The design stages are as listed below; User Interface Design, Power supply, Wi-Fi and Arduino Module, Microcontroller stage, Power output and switching stage

X. USER INTERFACE DESIGN

User interface of an IoT enabled Smart House System Using Wi-Fi Technology design has to deal with how users input the needed information to the system. The interface also must be able to produce an output of the information accepted from the user via the. The home page which

happens to be the switch-board for controlling home appliances contains buttons for interaction with the system which is used to toggle on/off appliances from the switch-board.

XI. SYSTEM PROGRAM

Usually, computer programs that are hardware base are written in Assembly Language, so the codes for the design of an IoT enabled Smart House System Using Wi-Fi Technology follows same approach which also generated some flowcharts. The flowchart and the completed codes are presented in this section and the codes were developed using ASM assembler called MPLAB compiler. The program has a graphic user interface for developing codes which can compile the codes after debugging.

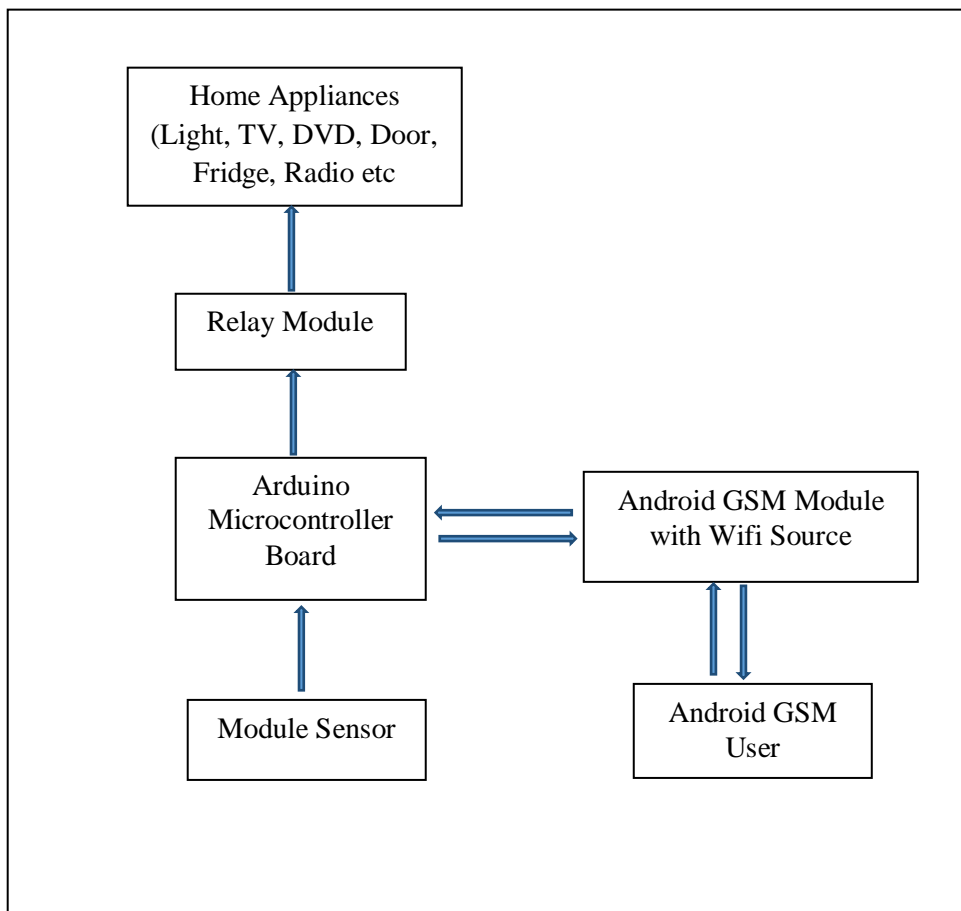


Fig. 1: A block diagram of An IoT enabled Smart House System Using Wi-Fi Technology

From the block diagram of the An IoT enabled Smart House System Using Wi-Fi Technology shown above, it is observed that when the model is switch-on, it initiates messages to the user indicating that it has started processing with the help of the embedded peripheral drivers which

sends communication signals between the drivers, Arduino microcontroller and the home gargets. The user manages the entire system and the home appliances with the cell phone or Tablet.

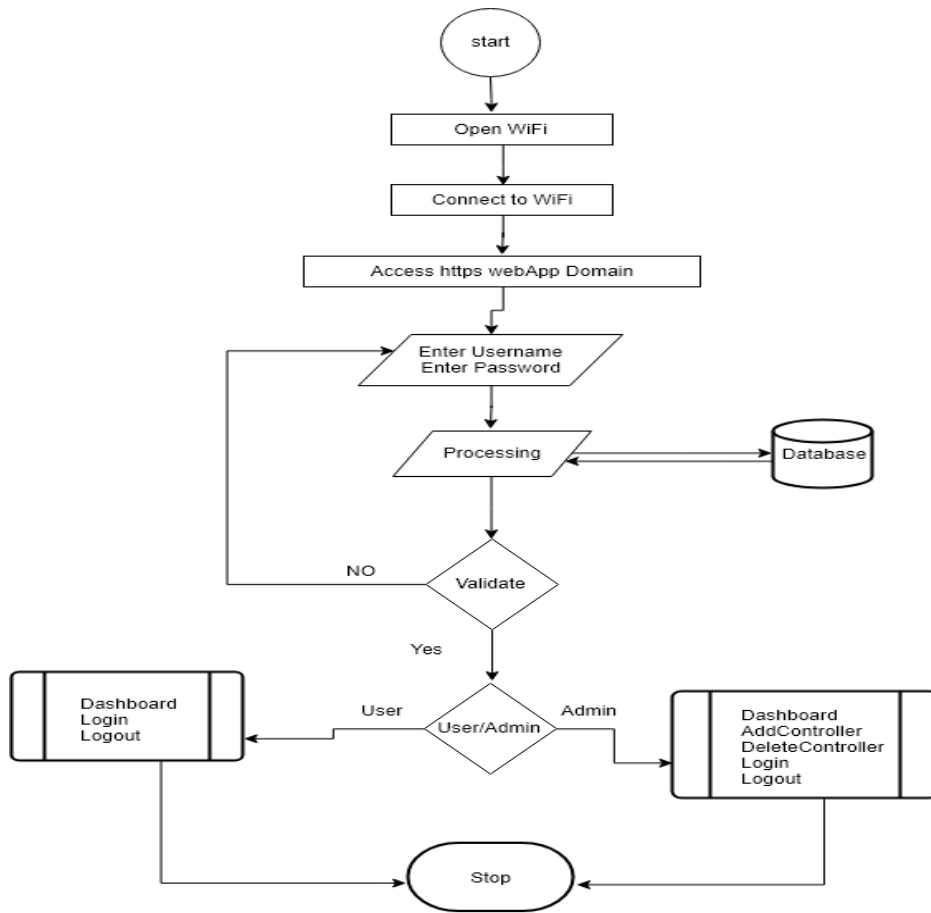


Fig. 2: A Flowchart showing the entire System

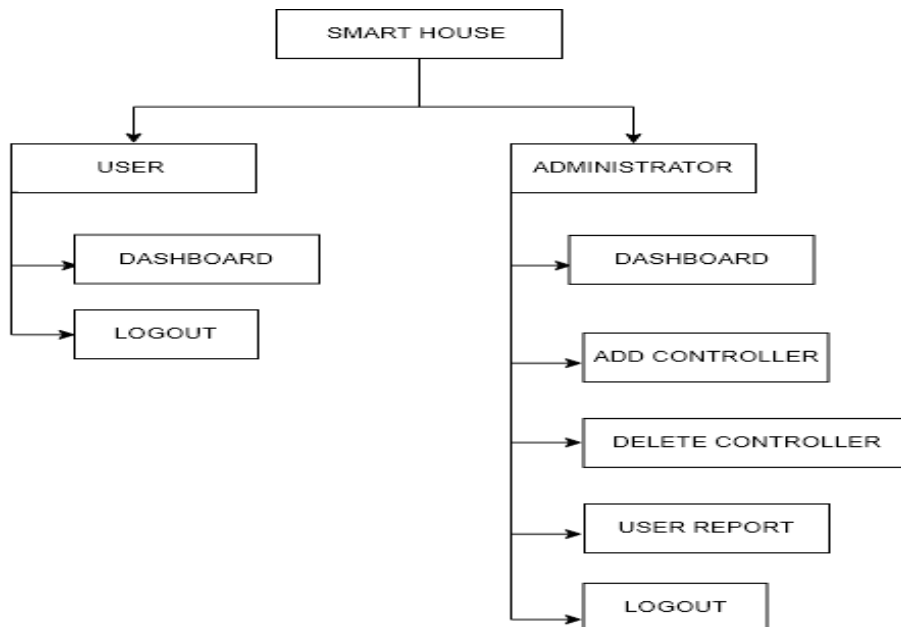


Fig. 3: Hierarchy Chart of Wi-Fi Home Automation System

The diagrams above, figure 1 and 2 are Flow Chart and Hierarchy diagrams of the proposed system showing a detailed graphic representation of the interconnection of the

various components of the system, program flow and the relationships between them from top to bottom.

XII. OVERVIEW OF SYSTEMS DESIGN IMPLEMENTATION

An IoT enabled Smart House System Using Wi-Fi Technology comprises of software or hardware components. The entire process has to deal encompasses of the gathering the hardware components and mounting them together on the board. Also writing of the software programs in order to manage the hardware resources. Also that vital phase of this design is the implementation phase. This has to deal with the system operating optimally within the specified environment, including analyzing requirements, installation, configuration, customization, running, testing, systems integrations, user training, delivery and making necessary changes. For any implementation process to be carried out successfully, different unit/department are involved in the entire process and several tasks are given to them. Organizations make sure to employ a reliable and known software implementation approaches and engage capable professional that will see them through the implementation phase. That uphill task encountered during system implementation is making sure that they are limited failures which is often resulted from the lack of accurate planning in the initial stages of the system design. This may be as a result of limited resources or exigencies. After the software has been successfully designed, it moves to the implementation stage where it is developed. The general System Implementation process entails the following tasks: software development, systems testing and conversion, users training and documents compilation [32].

In the development of Home Based Automation System using WIFI Technology different loads were connected to the sockets and ON/OFF times were set and record taken for each load. However since only one socket was used while the others were represented by LEDs. Loads were turned ON at set time and turned OFF at set time.

XIII. PRECAUTIONS

In the course of the design the following precautions were observed:

- After calculations, values of few resistors could not be gotten, Hence we had to settle for the values closest to what is needed.
- All wiring was done neatly to prevent shorts-circuit and was done during power off.
- Component leads were kept as short as possible.

- Wires and jumpers were labeled appropriately to avoid wrong connections.
- The circuit diagram was followed carefully as not to make mistakes. Also using common ground for most components.

XIV. PROCEDURE FOR SOFTWARE INSTALLATION

To install the software and configure the website for use, do the following:

- Open XAMPP Control on your computer by doing the following:
- Start, XAMPP, Expand the computer name node, and then select the XAMPP Control Panel.
- Go to your web browser.
- Enter the name of the Project in the URL portion of the browser, in this case 'SmartHouse'
- Tap ENTER on the keyboard to launch the Web Application.

XV. USER TRAINING

In this case the user's guide is being prepared using several symbols, plain English, diagrams etc. to help the user of the system makes effective use of the system.

The basic tasks involved in operating the Smart Home System are clearly outlined in the simplified user's guide given below:

XVI. HOW TO LOGIN TO SMART-HOUSE

As a key objectives of this system is to build a secured platform where controllers of an automated house can dynamically control home appliances within a wireless configured region.

- **Step 1**
The user should power on a computer system or any mobile device with internet access.
- **Step 2**
The user should launch any web browser of his choice and enter the correct Uniform Resource Locator (URL) to redirect to the Home/Welcome page
- **Step 3**
From the home page click on the login tab on the menu bar or on the home page and login with an administrator given username and password.

XVII. OUTPUT SPECIFICATION

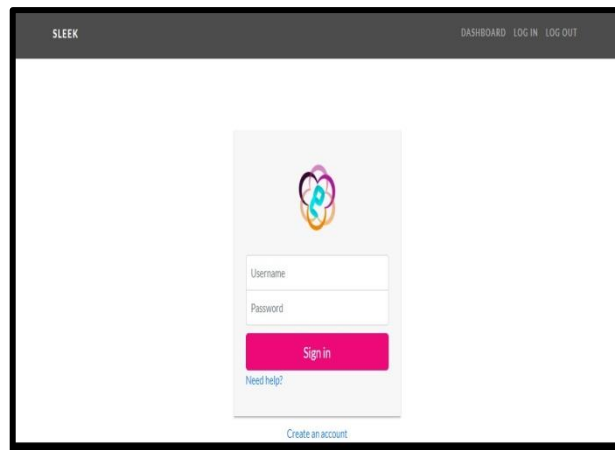


Fig. 4: The Sign-in Interface

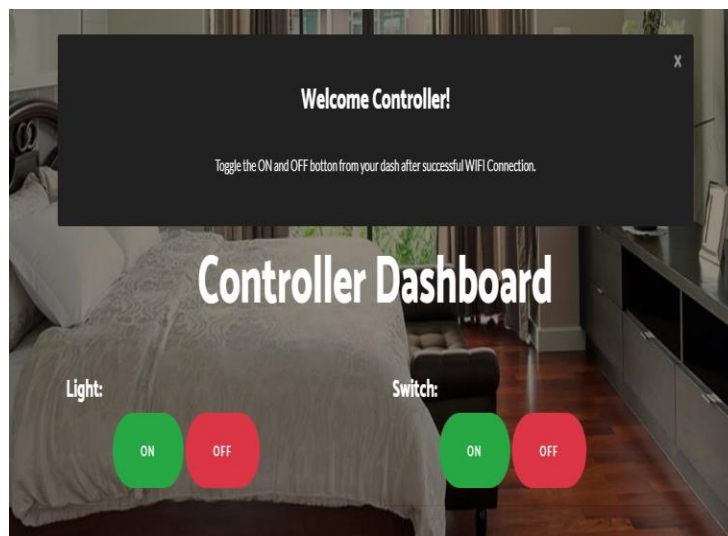


Fig. 5: The Controller Dashboard Interface

XVIII. DOCUMENTATION OF SYSTEM DESIGN

This is all about the documentation of the entire design procedure, they are used to guide, operation procedure and repair/upgrade procedures that are usually done by the software engineer future reference and use when the need arise. These documentation of system design can grouped into parts, internal documentation and external documentations. In Internal documents, these information are usually built codes during program writing in the form of comments and other non-executable statements and its likes. The external documentations describes the variables used in each module as well the operations performed by each module and other information in the form of manual added the system.

XIX. MAINTENANCE DETAILS

Keeping the System continuously useful and secured over a long period of time, there is need for regular maintenance. Maintenance has to do with providing support to software by fixing routine errors, adapting the systems to its new environment, enhancing its performance or improving its maintainability. This is necessary to ensure that it is useful over a long period of time. Once, the system is deployed, errors reported by users are corrected through maintenance process even as new features can be added to enhance the systems performance. The system is modular in nature and provides for easy maintenance. Maintenance may be performed for the following reasons:

- To adapt the system to a changed environment.
- To keep the system continuously useful over a long period of time.
- To enhance the performance of the system.
- To deal with unforeseen problems or errors that may occur during operation.
- To improve the software maintainability.

XX. RESULTS AND DISCUSSIONS

We found out that Internet of Things (IoT) is a rising technology that holds great potentials to controls off large range of devices ranging from homes appliances to industrial machines etc. Keying into this was the development of Home Based Automation System using WIFI Technology. On connection to the NodeMCUArduino Board WiFi Network controllers not only gain control of their appliances, but gain convenience and security in using the system.

The under listed are the achievements recorded in this research work;

- We were able to develop a system unify controllers onto a single WiFi Network.
- We were able to provide a system that will help controllers properly manage and control home appliances
- We were able to create a system that will help to monitor controllers in an automated wire-less home automation system

XXI. SUMMARY/RECOMMENDATIONS

In this research work to design anIOT Enabled Smart House System Using Wi-Fi Technology, we were able to design and implement the proposed system using the recommended equipment/devices, rules/regulations and precautions. The system has the following benefits being a low-cost system, easy deployment, easy installation, wider range of coverage, high scalable system, mobile-device integration and among others which are basically the drawbacks of the previous models as reviewed in the related literatures. For further research, it will be recommended that the model should be expended to a full-blown system and improve on the portability for commercial use.

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