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Home Automation System for Electrical Appliances Using Android Application

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Abstract: Every home appliances comes with a default way of switching in a traditional way to turn on and turn off by touching the switch. Sometimes, it is not comfortable for the elderly, or even the young and busy individuals especially when the frequent switching operation is required. Thus, an easier method of switching is needed to replace the manual switching method using an advanced switching method for electronic home appliance through the use of android application via our mobile devices. The research aimed to design and construct a prototype of a home automation system for electronic appliances, which gives the user complete control over all electrical appliances of the home using Wi-Fi (Wireless Fidelity). The system is a Wi-Fi based home automation system which has two main parts hardware and software. The system is developed using NodeMCU modules which receives, sends data and communicates with other components via Wi-Fi. The software development methodology used in the work can be described as a mix of incremental development model and the evolutionary prototyping approach. The Incremental model helps to divide the segment into small parts (e.g., functionality and features) each having objectives and constraint that was determined before the development. By using the evolutionary prototyping approach helps to improve the system by adding new features and functionalities. The programming language used for the system development is C++ to enable the NOdeMCU. The system is capable of switching on/off electrical appliances such as light bulb, fan, socket, AC-Air Conditioner automatically and can as well determine the time for power usage in the home through the mobile application thereby reducing cost and better safety for the equipment.

Keywords: Android application, Smart home, NodeMCU, Wi-Fi, Home appliances

I. INTRODUCTION

The use of technology has become a fundamental aspect of people's daily existence. It continues to influence human's daily activities, enhancing better communication and transportation mediums, the capability to dive into media and entertainment, and has helped in pharmaceutical research [1]. Numerous people now rely on technology for social interaction and storage of multimedia like photos, movies, and music as a result of the widespread use of devices like mobile phones and computers. The web has become a widely used platform that simplifies daily life for many people by enabling them to search for information and store their data in the cloud, while also providing better ways of managing information. Over the years, the use of mobile phones and the internet for communication purposes has dramatically increased, making them one of the major forms of communication. Advanced automation technology is already in use, including facial feature recognition for user identification, voice-activated commands, planning assistance, and chore advice. Residential automation is becoming increasingly popular. According to the Gartner Glossary (2018), 1.5 million home automation systems were installed in the US in 2012, and it is expected that shipments will exceed 8 million by 2017. The market will be worth $19 trillion by 2020, according to Cisco CEO John Chambers [3].

The majority of households utilize various electrical electronic devices, such as televisions, fans, air conditioners, light bulbs, video players, and radios. These appliances traditionally require manual switching to turn on or off, which can be an inconvenient method for physically disabled or elderly individuals, as well as for busy individuals who require frequent switching. To address this issue, a more convenient switching method has been developed using advanced technology known as WiFi IoT (Internet of Things) for electronic home appliances. This involves utilizing smartphones connected to WiFi to switch home appliances on/off.

By regulating the lighting and window treatments as well as tracking usage, smart homes enable residents to better control their energy use and save money. The increased portability and technology of smartphones have sparked interest in controlling appliances remotely through them. The automation of appliance control allows users to perform tasks before arriving home. The smart home control system provides assistive technology solutions, particularly for the disabled and elderly, through mobile remote-control apps [4], [5], [6]. According to a report, self-adjusting thermostats and remotely-lockable doors are the most important features of smart home devices. However, some categories of people, like the elderly and the disabled, find the system less user-friendly due to its complexity and expense. The best solution to solve this issue is to utilize a web server with an easy GUI interface. A single website can reach users across different types of mobile devices, whereas native apps require a separate version for each type of device [5].

This study introduced a smart home management system that integrates automatic home appliances based on sensor reading and user manual buttons in a built internet interface to enhance household operations while boosting overall safety. Using sensor data, the automatic function assures the control system to works well and effectively. The concept of IP networking applications and devices in the house enables home appliances to be controlled from anywhere using mobile devices (laptops, mobile phones, tablets) with internet access. The system developed offers a great deal of convenience to users with a particular focus on improving accessibility for those who are disabled or elderly. The flexibility and convenience of the system will make it appealing choice for those looking to simplify their lives and improve their home security.

II. LITERATURE REVIEW

A. Home automation Methodology

From a security standpoint, we go over several home automation strategies and techniques in this part. We go over each technology's advantages, disadvantages, and security flaws.

i. Mobile phone-based home automation system with Bluetooth

The input-output ports of the home appliances are connected to the Arduino UNO board through a relay in a Bluetooth-based home automation system. The Arduino UNO board's software is built using a Bluetooth connection and high-level interactive C language for microcontrollers. The availability of password protection allows for access to the equipment by only authorized users. The phone and Arduino UNO board establish a Bluetooth connection to enable wireless communication. The Python script is used in this system and can be installed on any Symbian OS environment, making it portable. One circuit is created and put into use to receive feedback from the phone, which shows the device's status [7].

ii. Using a cell phone-based Zigbee home automation system

The system design and implementation to monitor and manage home appliances uses Zigbee technology. Network coordinators make notes about the device performance and save them. This is done through the Wi-Fi network, which employs a contemporary router with four switch ports. Wi-Fi has already been configured with the network SSID and security settings. The virtual home algorithm first analyzes the message for security before re-encrypting it and forwarding it to the actual network device of the house [8]. The Zigbee controller communicated with the target via the Zigbee network. The digital domestic algorithm ensures the safety and security of all messages that are received. Zigbee communication is useful to lower system costs and the obtrusiveness of the system's installation, respectively [7].

iii. Cellphone-based, GSM-based home automation system

Research is drawn to GSM-based home automation. For communication in GSM, the choices we principally evaluated were SMS-based home automation, GPRS-based home automation, and dual tone multi-frequency (DTMF)-based home automation. Below is a diagram illustrating the logic behind A. Alheraish's work. To convert machine operation into electrical impulses that are delivered to the microcontroller, the system uses a transducer. In order to send electrical impulses to the microcontroller, the system converts mechanical signals using a transducer. Sound, temperature, and humidity are physical properties that the system's sensors translate into another number, such voltage. The GSM module will select the most appropriate communication method from SMS, GPRS, and DTFC in accordance with the command it receives from the microcontroller after analyzing all signals and converting them into a command the GSM module can understand. [9].

iv. RF (Radio Frequency) module-based home automation

The creation of a home automation system using an RF-controlled remote is a key objective of the system. As technology advances right now, homes also become smarter. Modern homes purposefully migrate away from existing light switches and toward centralized control systems with RF-controlled switches [10]. Home automation can implement a simpler solution by combining an RF remote control with a microcontroller on the transmitter side that transmits ON/OFF signals to the receiver side. Traditional wall switches located in various parts of the home currently make it difficult for the end user to go near them to control and operate them, turning into more problematic for elderly people or physically challenged people to do so. Using wireless technology, the loads can be switched ON/OFF globally by turning the corresponding remote switch on the transmitter [9].

v. Android ADK (Accessory Development Kit) for home automation:

The ADK is connected to household appliances, and an association is established between the Android device and ADK. The Embedded System attached to the input ports of the board allows the ADK to be aware of

the status of the home appliances. The Arduino ADK microcontroller board is constructed around the ATmega2560. It connects to Android-based phones via a USB host connection. Android Open Accessory Protocol 2.0 (AOAP) has the following two key features:

The device's audio output can be used by the component as one or more Human Interface Devices (HIDs) for the Android device. The platforms used by this paper, Android and Arduino, are both FOSS (Free Open-Source Software). The addition of motion sensors to safety systems will automatically alert the user via a cell phone or the security system when it detects an unauthorized action [9].

vi. Cloud-based system for home automation

Home automation using a cloud-based system focuses on the design and implementation of a home gateway to gather information from home appliances, send it to the cloud-based data server, and then process it using Map-Reduce to implement a monitoring task for a remote user who is at home [11]. Automation System is steadily increasing its toughness by including the modern traits that satisfy the public's growing curiosity. This research provides an example of how to design and build a home automation system using cloud computing as a service. Three key components make up the current system: the cloud server, which manages and regulates client and user data as well as device status; the client; and the user. The hardware interface module is the second component that carries out the necessary connection to the actuators and sensing devices that provide the physical component called the Home Server, which creates the hardware component and offers the user interface [12]. In order to ensure data's security, storage, and accessibility, this paper focuses on developing web services using the cloud. of data. The current system provides a safe home automation system for the entire family while also being affordable, dependable, and comfy. The system consists of various client modules for various platforms, like as;

- Cloud server
- A hardware circuit microcontroller embedded program, and
- Any desktop or smartphone with an internet client.

vii. Smartphone-based wireless sensor network for Raspberry Pi home automation

Raspberry Pi has been used to create a home automation system by reading email subject lines and algorithms. The Raspberry Pi platform promises to be effective for the implementation of robust and affordable smart home automation [13]. Home automation utilizing a Raspberry Pi has numerous advantages over conventional home automation methods. As an example, a major disadvantage of DTMF (dual tone multi-frequency) for home automation is the connection charge. This approach does not require a web server's architecture or the required memory space because it just makes use of the previously established web server service offered by G-mail. This approach obviates the need for a web server's architecture and requisite memory space by just utilizing the existing established web server service offered by G-mail. [14LEDs were utilized to identify the switching action. This system offers flexibility, efficiency, and interaction.

Figure 1 and 2 shows how user can send commands to Raspberry Pi. The user's input commands are received by the script running on the server side of our laptop or a web server, which then sends them appropriately to the client (Raspberry Pi).

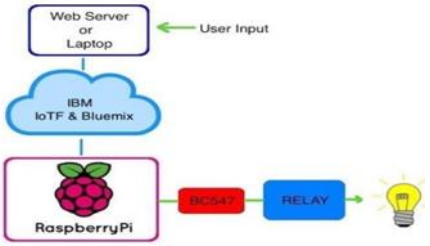

Figure 1: Sending Commands to Raspberry Pi (IOSR-JECE, 2018)

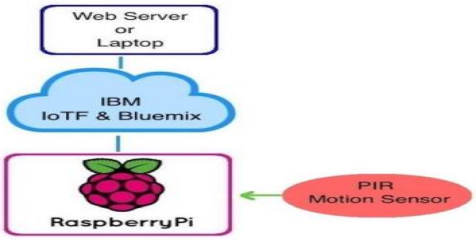

Figure 2: Receiving data from Raspberry pi (IOSR-JECE, 2018)

viii. Wireless Home Automation system using IoT (Internet of Things)

A smart home is one that uses mobile devices or computers to control basic home controls and may be automated to function automatically over the internet from anywhere in the globe. It aims to save both electrical and human energy. The proposed system consists of sensors, Wi-Fi modules for the server, and other parts and is a distributed home automation system. It is easy to set up the server to handle more hardware interface modules (sensors), and it handles and keeps track of the numerous sensors. The web server is the Arduino board, which has a Wi-Fi module integrated into it. Any local PC with a web browser can access the Automation System using the server IP, and any PC or mobile handheld device with an internet-connected web browser can do the same remotely [15]. The server real IP (Internet IP) is used to access the Automation System. Wi-Fi technology has been selected as the network architecture that connects the server and the sensors. Wi-Fi is used to boost system mobility and scalability while also enhancing system security by using a secure Wi-Fi connection.

B. Advantages of Home Automation System [16].

i. Home automation is a less expensive and also handled security
ii. This home security system doesn't use a smartphone application or any other kind of user interface; instead, it uses the phone's keypad's digits. The system is platform neutral, so it can be accessed from a variety of phones with various operating systems.
iii. The user does not need to have his phone's data connection enabled in order to utilize the home security system. The system functions properly when the launchpad is connected to wifi at home or at the workplace [17].
iv. The user may also want to control his household appliances without sensors being triggered, and the optional smart phone application takes care of that.
v. There is no need to be concerned about security leakage because the launchpad can only deliver voice calls to specific numbers that are listed in the web API. As a result, the system cannot be accessed by any other unauthenticated users. This thus improves the security system's fidelity.
vi. Unlike Bluetooth or IR remote controlled existing home automation solutions, which also lack any internet connectivity in the phone, the system can be operated from anywhere in the world thanks to the usage of a wifi equipped launchpad.
vii. The technology is straightforward and low-cost because the same set of motion sensors may be used for home automation and security systems.
viii. This method does not require the user to manually activate an alert, it gives the user the benefit of analyzing the scenario and remotely activating the security alarm from his phone.

C. Related works

In [18] presented research on energy management of electricity for smart home to know the consumption of unit for a customer. The internet of things was considered to manage the consumption of electrical appliance in the home such as fan, television set, light etc. This is being monitored from the mobile phone at any location of the user through use of microcontroller and wifi module to identify the theft of electricity from the mobile through sending of SMS. Users can use this solution to operate and control IoT devices equipped with Esp8266 wifi modules for home automation. Mobile phones are used in this automated procedure. The Internet of Things (IoT) is utilized in cloud-based processes to monitor data from solar and energy used.

In [19] Worked on the development of smart home automation system using Bluetooth technology. The Arduino board with other components is used to control up to 18 devices in the home. This system is not suitable for disabled and old people for special purpose but provide a flexible and user-friendly home automation system. An ultrasonic sensor, a soil moisture sensor, a Bluetooth module, an Arduino Uno, and a smartphone are used in the proposed home automation system's hardware implementation. The Arduino Uno's analog input pin AO is connected to the soil moisture sensor's pin (AO), while the Arduino Uno's RX and TX pins are connected to the Bluetooth module's TXD and RXD pins, respectively. The ultrasonic sensor's Echo and Trigger pins are connected to the Arduino Uno's pins 6 and 7, respectively, and their VCC pins are connected to a 5V DC supply. A Bluetooth wireless connection was made between a smartphone running the Bluetooth Terminal application and an Arduino Uno. Based on the technologies utilized, the system can only control the appliances within a small area.

In [20] The paper discussed on the development of home automation system by using raspberry pi. This research focuses on 3G mobile communication systems that can be used to manage smart home electrical products like lights and fans from a distance. The android application will display the connectivity status of each device connected via an internet gateway in this area. When the switch could be turned "ON" and "OFF"

utilizing android apps, the goal was achieved. Using a Wi-Fi dongle, it is successfully connected via wireless communication. The switch and electrical appliances can be operated by a smartphone.

[21] The design and development of smart homes using the Internet of Things (IoT) were the main topics of the study. An IoT-based hybrid (local and remote) home automation system with a user-friendly interface for smartphones and laptops is presented in this study. With the use of an algorithm, a prototype named IoT@HoMe has been created to allow for automated home appliance automation and remote monitoring of home conditions. A node microcontroller unit (NodeMCU) is used in this system as a Wi-Fi-based gateway to link various sensors and update their data on an Adafruit IO cloud server. To operate household equipment, such as turn on and off lights and fans, open and close doors and windows, and run motors and pumps, a variety of actuators are employed. The user receives alerts about any unusual conditions at home via the IFTTT server on their mobile phones for security and safety reasons. Home appliance control may be done quickly and effectively using the MQTT/Adafruit IO GUI or voice commands with Google Assistant. The study's findings have promise, and the system that was created can improve users' security, comfort, intelligence, and safety.

[22] suggested sensor-based SH automation that uses a remote control on an Android-based smartphone to automatically operate household appliances. Bluetooth was used as the communication mechanism by the writers, and Raspberry Pi served as the microcontroller. The Raspberry Pi controller and the smartphone were linked via Wi-Fi, which was also used to connect other smart appliances to the same network access point. By using a Raspberry Pi, every sensor updated its data on a nearby server. When the user is outside the Wi-Fi AP's coverage area, he is unable to connect to the server or directly use the smartphone to transmit orders to the Raspberry Pi controller.

In [23] introduced a web-based IoT architecture using GSM to implement SH applications and presented a GSM-based design control system of SH. This research proposed a framework that would allow users to monitor and manage smart devices over the Internet. Users would issue web-based commands, which would then be translated into GSM-SMS commands. The suggested configuration offers a wireless GSM connection from the web server to the SH as well as an interface between the SH and users across the Internet and GSM. The integrated system module, which may be located anywhere in the globe and is capable of connecting directly to devices through the GSM network, receives these commands. Additionally, the GSM network controls the module via an IoT agent. To control any electrical devices, such as lighting and home appliances, a microcontroller executes and analyzes user commands, transmits an acknowledgment, and then controls those objects. GSM-SMS is used by the prototype to collect and send data. The first test demonstrates that the prototype is capable of monitoring and managing devices in the published environment and offers numerous benefits, including zero data loss, quick delivery, simplicity, adaptability, cheap cost, and energy economy.

In [24] presented a system that managed home appliances through IoT, where the temperatures, fire, and gas were controlled by using different sensors, and their values were displayed on an LCD. It monitors temperature, looks for leaks and fires of liquid petroleum gas, and notifies the user when a fire or gas leak is found, this kind of device is helpful when the user is away. In other words, when the gas sensor detects a leak, it immediately sends an SMS to the user's phone, activates the siren, and displays a message on an LCD screen to the user and anyone else at home. Similar to that, when fire is discovered, an SMS is sent and the spray engine is activated. The suggested system uses many sensors to determine a variety of temperatures, fires, and gases. Thus, when the range of the provided values widens, a message through GSM is received, and the values are then saved on a server for later use and shown on an LCD panel. Additionally, the information submitted to the web server is updated and accessible from any location in the world. In conclusion, IoT is utilized to improve safety standards since it allows sensors and transducers to communicate wirelessly by using a single chip and Wi-Fi.

III. DESIGN METHODOLOGY FOR THE SYSTEM

A. Description of The Existing System

The wireless system used in the existing system determine the range and data rate requirements which dictate how much data can be transmitted over a given distance and how quickly are the two main design constraints. An SMS-based home automation system is created taking into account current technology to automate the home's appliances (such as lights, fans, air conditioners, and wall switches) by sending the proper text message to turn on each one. To receive a text message from a mobile phone, this system needs a GSM module connected to a micro-controller. However, this is quite expensive because sending an SMS requires payment to the network provider. Even worse, because of network failure, messages can be sent but not immediately delivered, making the situation even more problematic.

Taking into account other technologies already in use, a Radio Frequency-based home automation system is created to automate the use of conventional lighting mechanisms (wall switches) throughout the house using an RF-controlled remote. This system requires an RF remote that is interfaced with the microcontroller on

the transmitter side which sends ON/OFF signals to the receiver. Traditional wall switches situated in various parts of the home are examples of Home Automation using RF modules and sometimes make it laborious for the end user to go near them to control and operate them. It becomes more problematic for old persons or physically handicapped people to do so.

B. Proposed Methodology

The incremental development model and the evolutionary prototyping method were combined to create the software development methodology used in this research. The objectives and constraints for each section were developed once the job was broken into smaller parts (such as functionality and features). They were then created, put to the test, and improved. Finally, the following iteration was prepared. The system is continuously enhanced and expanded upon by employing an evolutionary prototyping strategy. The following paragraph provides a description of how the command-control functions were created as an illustration of the development methodology. On the Application, a basic command-control feature was developed.

The proposed system of hardware and software components, is a WIFI-based home automation system. A Smartphone, an Arduino board, and WIFI make up the three hardware parts. The Arduino Integrated Development Environment (IDE) and the WiFi application Smart Home make up the software part(s). The system connects to the smartphone via WiFi, and the smartphone then uses WiFi to send commands to an Android app to turn on or off home appliances.

The user commands are sent from the smartphone via a WIFI signal to the NodeMCU. Home appliances are given these commands, and in response, the commands either turn the appliances ON or OFF. The NodeMCU uses relays to switch appliances and searches for commands coming from the WiFi module.

The microcontroller itself includes the Arduino software, which was created using the IDE (Intgrated Development Enterprise) and C Programming language. The software for Arduino is effective at gathering instructions from connected controls, executing them on pre-programmed actuators, and then applying them. The proposed home automation system's software package is an android mobile-based application. It is capable of managing the entire setup and configuration of the home automation system and can be accessed remotely.

C. NodeMCU

It's an open-source hardware platform called NodeMCU has a variety of open-source libraries to connect its internal microcontroller to external devices like Bluetooth modules, GSM modules, motors, LEDs, LCDs, keypads, and other devices that can be connected to Arduino boards [25]. In essence, Arduino is manufactured from a microcontroller, but it also has all external ports for interacting with other devices and a built-in program for controlling Arduino from a computer. Consequently, Arduino is a fully functional board that is easy to program using a computer and comes with everything needed to connect to external peripherals. There are a lot of different Arduino boards available. The specification of the NodeMCU is listed in the figure 3 below:

Table 1: NodeMCU component features

Microcontroller	ESP-8266 32-bit	ESP-8266 32-bit	ESP-8266 32-bit
Pin Spacing	**0.9" (22.86mm)**	**0.9" (22.86mm)**	1.1" (27.94mm)
Clock Speed	80 MHz	80 MHz	80 MHz
USB to Serial	CP2102	**CP2102**	CH340G
USB Connector	Micro USB	Micro USB	Micro USB
Operating Voltage	3.3V	3.3V	3.3V
Input Voltage	4.5V-10V	4.5V-10V	4.5V-10V
Flash Memory/SRAM	4 MB / 64 KB	4 MB / 64 KB	4 MB / 64 KB
Digital I/O Pins	11	11	11
WiFi Built-In	802.11 b/g/n	802.11 b/g/n	802.11 b/g/n

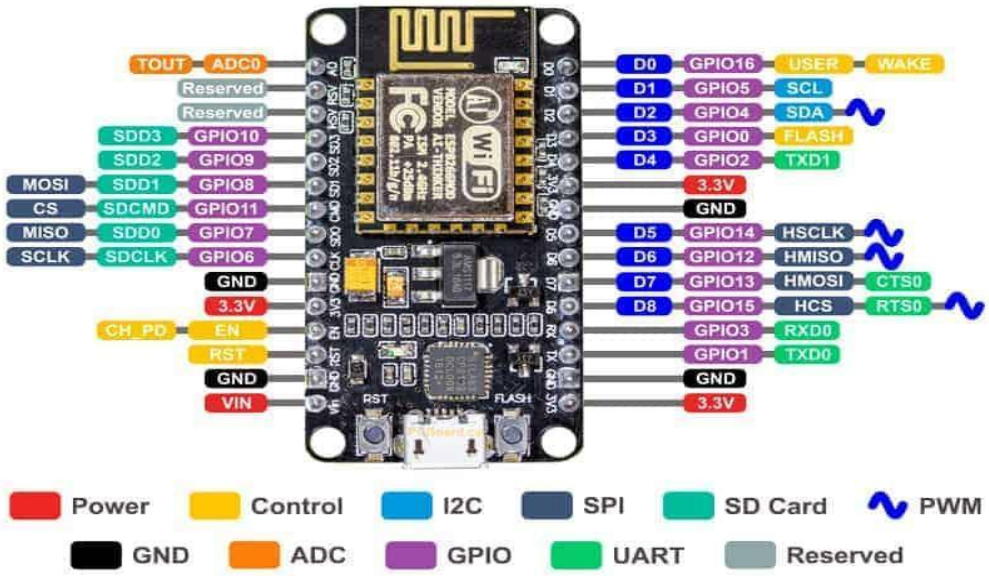

Figure 3: NodeMCU Components

D. Hardware Components

i. **Smartphone**: A smartphone is a compact, mobile device with built-in computing and capabilities. Their superior technology and robust mobile operating systems allow for more software, internet (including web browsing over mobile broadband), and multimedia features (including music, video, cameras, and games) than feature phones.

ii. **SMPS:** A switched-mode power supply is an electronic power source that efficiently converts electrical power using a switching regulator. Switched-mode power supplies can be substantially lighter and smaller than a linear supply since the transformer can be much smaller.

iii. **LED display:** A LED display shows the status of the devices connected to the system.

iv. **Light bulb:** A light bulb, also known as a lamp or a lightbulb, is a device that produces light from electrical energy.

v. **Relay module:** An electronic device known as a relay module is used to regulate the switching of electrical circuits using a low-power signal. It consists of a relay switch and related circuitry that enables high-power loads like lights, motors, and appliances to be controlled by a microcontroller or other low-power signal. A relay module is used to connect the NodeMCU to a number of different gadgets.

vi. **Four-Channel Relay:** Switching high voltage and high current loads with your Arduino or other microcontrollers is made simple by using this method. The board employs 4 digital outputs to individually operate 4 relays and is compatible with 3.3V and 5V logic. Each relay has a simple 5.0mm pitch screw terminal that is broken out to the common, generally open, and normally closed pins.

E. Software Tools

i. **Blynk Application:** The Blynk application is an all-inclusive software solution that provides a complete set of tools for designing, implementing, and managing internet-connected electronic devices, ranging from small-scale individual IoT projects to large-scale commercial products with millions of connections. With the Blynk application, multiple end users can control a specific device, as long as they have access to the Blynk application on their device and are granted permission to access the device. For our project, we will be utilizing the Blynk application specifically designed for Android-based devices.

ii. **C++ Programming Language:** The programming language C++ will be used to program the NodeMCU board.

iii. **Arduino Software (IDE):** The Arduino software (IDE) is open-source software, which is used to program the Arduino boards and is an integrated development environment, developed by Arduino.

F. System Construction

The mobile phone server and the Arduino microcontroller board, which is adaptable, affordable, and provides a range of digital and analog inputs, serial interface, and digital and PWM outputs. The two primary hardware elements of the suggested smart home automation system are wifi controller and Arduino IDE

(Integrated Development Environment). The construction of the mobile devices with the NodeMCU is displayed in figure 4.

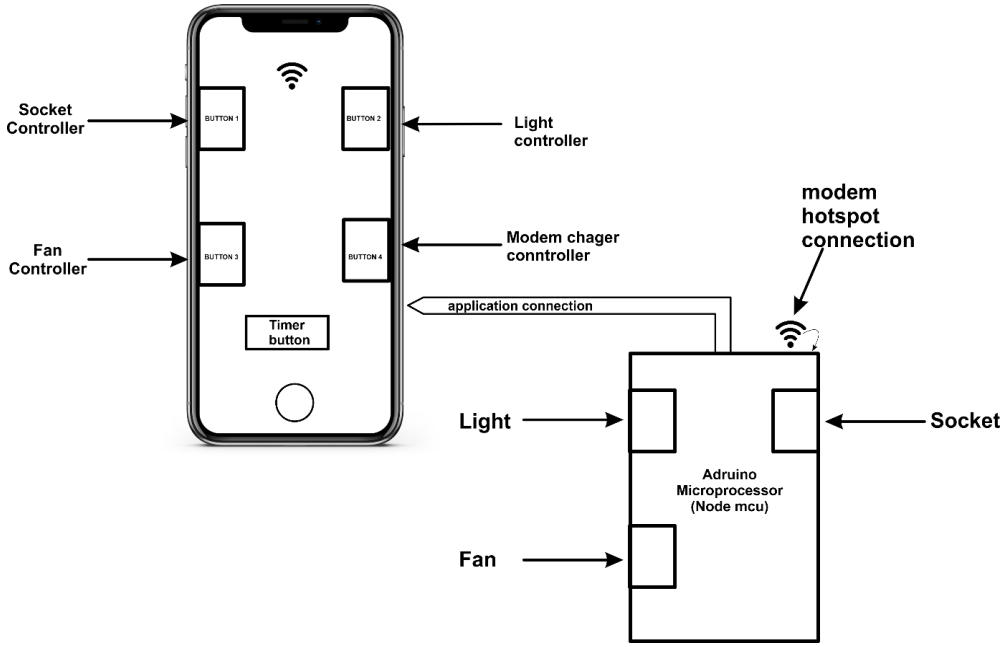

Figure 4: construction of the Mobile devices with the Arduino Microprocessor (NodeMCU)

G. Hardware coupling and Implementation

i. Hardware assembling

The SDLC's implementation phase, which is where the developer performs the most difficult tasks, is its most important phase. In this phase, the system is constructed and tested to make sure it follows the defined design and testing plan. Developers also need to be aware of how to install a new system once the project is complete in order to replace the old one. The development of backend tools, supporting materials, and system implementation are all included in this phase, as well as the system architecture and developers' supportive planning. The coupling of the hardware component is detailed in the figure 4.

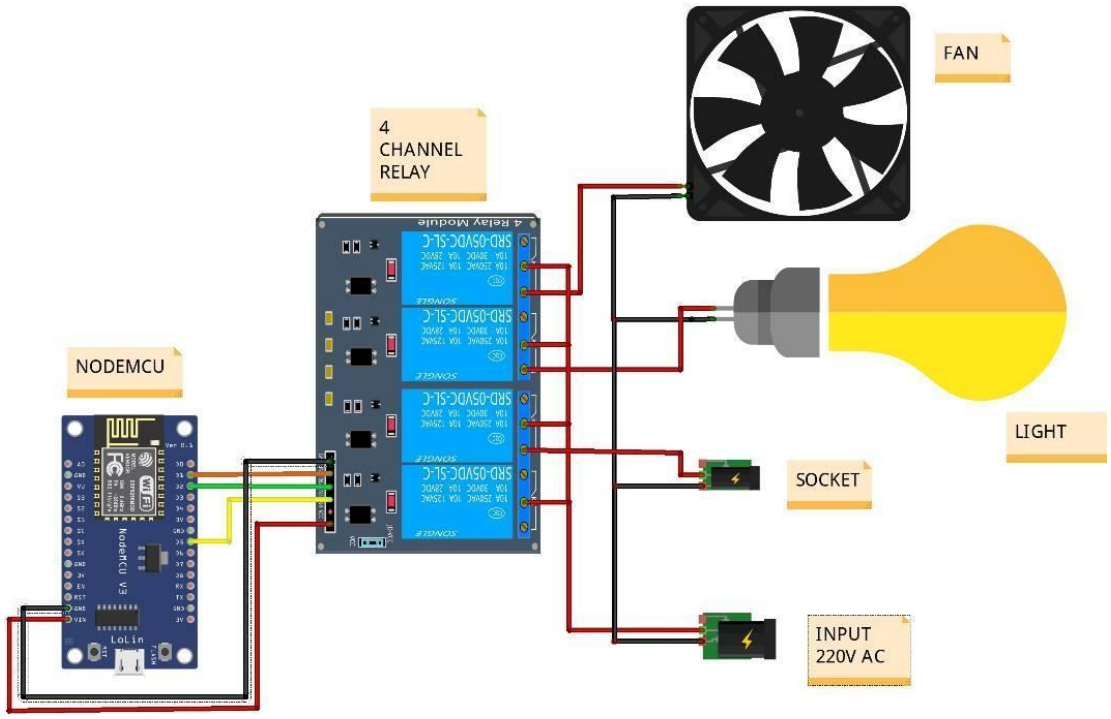

Figure 5: Component's connection with NodeMCU and the 4 channel Relay

As shown in figure 5, the hardware is connected starting from the left with the microcontroller NodeMCU, the 4-channel relay module, a handy board that can control high voltage, and a high current load. Also, we have the appliances included, the light, the fan, the socket, and the input.

- **Connecting The Relay Module to The Appliance**

The relay module has three high voltage terminals on them (NO, C, and NC) which mean (Normally Open, Common, and Normally Closed). All the appliances are connected to the NO of each relay, and the C, where the supply is. So, when the appliances are turned on, the relay takes the supply from C to NO in which current flows to the appliance controlled and when it is turned off, it is restored to its previous state. The NO and C are not connected initially but when the appliance is turned on, then the NO and C are connected.

- **Connecting The Relay Module to NodeMCU**

The relay module also has three low-voltage pins (Ground, Vcc, and Signal) which connect to the microcontroller, i.e., NodeMCU. The ground connects to the ground pin on the NodeMCU. The Vcc connects the NodeMCU 5V pin and the Signal (IN1, IN2, IN3, and IN4) carries the trigger signal from the NodeMCU that activates the relay. Each relay is connected to D1, D2, D5, and D6 on the NodeMCU. Hence, when button 1 is on, it sends a signal to D1 to activate relay 1, the same occurs for other relays with their respective buttons.

ii. Implementation Procedure

We showed how to use our home automation system's internet of things (IoT) to control two devices during the implementation stage. It uses a NodeMCU ESP8266 microcontroller. One particular form of correspondence is involved: wireless correspondence. Using a smartphone application, a WiFi module and a NodeMCU board are connected via serial communication.

For the NodeMCU board to communicate with the application, a code modification is required NodeMCU provides a flexible platform that creates a code to enable any capability to be executed by the NodeMCU and transmitted to the board. The complete Synchronous Asynchronous Receiver Transmitter (USART) convention is used to interface the Atmega 328 with the Electrically Erasable Programmable Read Only Memory (EEPROM). The code is created using embedded C. The code is then organized and converted to HEX. The HEX code is then transferred to the Atmega 328 microcontroller a little while later. The setup of the hardware components and the NodeMCU is displayed in figure 6.

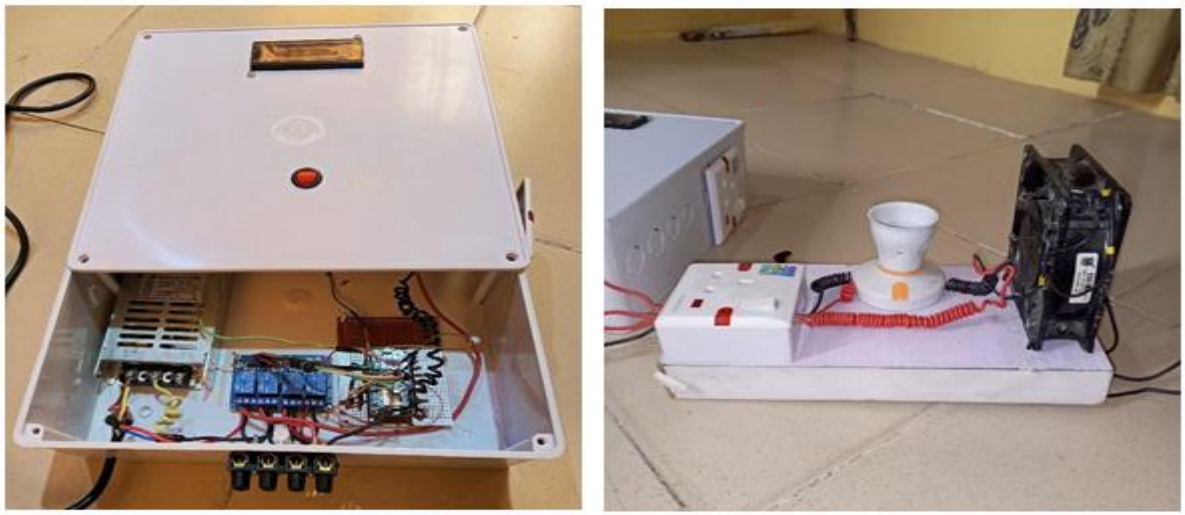

Figure 6: System setup of the components

iii. Power Supply to the Wifi

The solar panel was used as an alternate power source to run the wifi for connection to be established at any time. This power has three possible storage methods: thermally, in batteries, and as electricity. The quantity of solar energy that the earth receives in an hour and a half is enough to supply all of the planet's energy requirements for a whole year. Solar technologies can turn sunlight into electrical energy in two different ways: photovoltaic (PV) panels and solar radiation-concentrating mirrors. Light from the sun, also referred to as electromagnetic radiation, is called solar radiation. Solar technologies are able to capture this radiation and transform it into useful energy sources.

H. Users Guide and Installation

The user's guide is to give direction on how to activate the software and to establish connection with the devices available on the network. The hotspot network will connect the NOdeMCU with that application developed.

i. Steps to activate the application to connect to the device

Step 1: Open the Blynk IoT application "figure 4.6"
Step 2: Click on "log in"
Step 3: Log in with this detail's username or Email **'yctsmarthomeproject@gmail.com'** password **'yctsmarthome1'**
Step 4: Click on the button name and control the appliances.

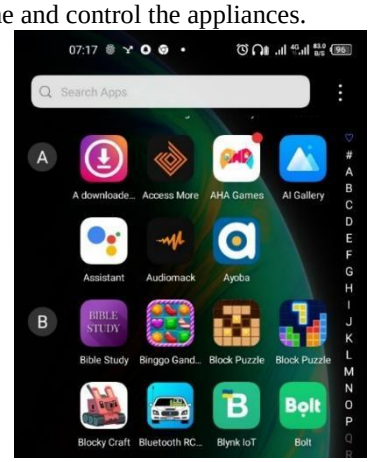

Figure 7: Blynk ioT Controller Application

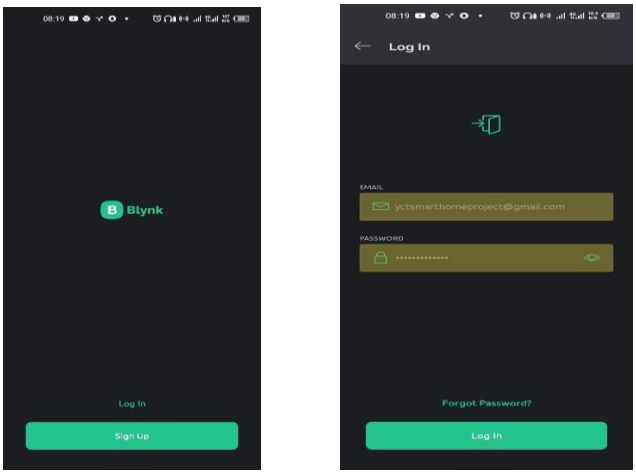

Figure 8: Log-in Interface

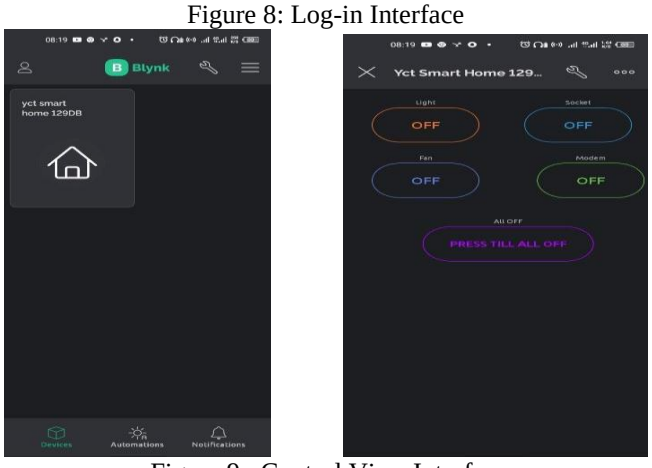

Figure 9: Control View Interface

ii. Steps to configure the devices to a new hotspot on the application

Step 1: log in successfully on the application with the details that are provided earlier.
Step 2: Click the three dots in the right top corner of the controller interface.
Step 3: information about the module will be displayed, click the three dots again.
Step 4: Click on configure
Step 5: Click on yes, proceed, and continue, this procedure will request to on the mobile phone wifi.
Step 6: The next page will search for available (NodeMCU) Arduino board that is nearby so click on the NodeMCU name for the project.
Step 7: the next page will search and list all the nearby hotspot devices, so click on the hotspot you want to connect to the device, then the next page will request the information of the hotspot that will be connected to the device, the information is the hotspot name and password, input the information where necessary click on done and wait for some seconds for it to connect.

iv. Steps to use automation mode

Step 1: Click on automation in the control interface.
Step 2: Activate the automation bar and click on it.
Step 3: set up your notification message, set up your start time, and activate the button you want to put ON.
Step 4: click the plus icon below the bar, then select the action you need.
Step 5: Repeat step 3 set up again but this time the opposite action to put OFF, click on done.

IV. CONCLUSION

The research work showcased a smart home control system for electrical appliances, that could be controlled from the mobile devices. It presents existing literature on the home automation system were discussed with its advantages and related works. The work proposed using incremental and evolutionary prototyping model to developed the system and the C++ programming language was considered. The system components used are both hardware and software, which consist of Wi-Fi, Arduino, NodeMCU, Microcontroller, Mobile devices etc. These was assembled together to work with our mobile devices and be able to control the application from any location through our phones. NodeMCU-based home automation system with an Android app was developed and deployed for use. The using of the application is user-friendly, quick, widely accessible, and dependable in communications between the remote user and devices. Home automation system's design made use of a cross-platform off-the-shelf application and WIFI technology. The construction of the system will help to reduce the hazards caused in the home, assist disabled or aged person to have control at any location and to make better the security.

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