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Review TEE

The Future of Domestic Convenience: An In-depth Review of IoT-enabled Smart Home Technologies

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Abstract

This study explores a design for a smartphone-controlled smart home automation circuit built around the ESP8266 microcontroller. The ESP8266, known for its Wi-Fi connectivity, is the heart of the circuit, enabling communication with a cloud platform and receiving user commands from a mobile application. Based on user commands received through the app, the ESP8266 triggers relays to control appliances like lights and fans. This design offers a cost-effective and customizable approach to home automation. Users can manage their connected devices remotely via smartphones through a cloud platform, promoting convenience and potential energy savings. IoT is a concept that facilitates the creation of a wireless network between numerous devices that are connected to the internet and use multiple IP protocols. Things in the Internet of Things (IoT) are devices like sensors, microcontrollers, and mobile phones that are connected to a wireless network. IoT creates an ecosystem among the devices, making them accessible remotely. This new, enhanced automation system provides users with a more efficient way to control their homes by utilizing advanced technology that enhances daily activities. Through the ESP8266 microcontroller, individuals can now remotely interact with their home appliances, thereby enhancing convenience and comfort. The IoT concept allows for seamless connectivity of smart devices, making it possible to remotely manage multiple devices with ease. Furthermore, the integration of cloud technology ensures secure access to one's personal network of smart devices, offering peace of mind and improved security for the entire home environment.

Keywords: ESP8266, smart home, Wi-Fi connectivity, smartphone App, relay control

INTRODUCTION

IoT is a concept that facilitates the creation of a wireless network between numerous devices that are connected to the internet and use multiple IP protocols. In essence, IoT makes devices remotely accessible by establishing an ecosystem among them. Things in the Internet of Things refer to wirelessly networked gadgets such as sensors, microcontrollers, and cell phones.

Technology has long encouraged the usage of Wi-Fi, also known as the Internet of Things (IoT), which eliminates the need for a cable connection and lowers costs. As a gateway that connects the appliances in the house to the Blynk server in this instance, the Wi-Fi module Node MCU (ESP8266) allows the appliances to be controlled remotely using the Blynk smartphone or tablet application. This example shows how combining the components with the mobile application may significantly increase the efficiency and accuracy of a home automation system. Through this ultimate

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system, we can hands-on monitor and control everything in the house such as the fan, light, etc. We certainly need to select the correct relay module that is entirely required. Here, we used a four-channel relay module to effectively control the devices with the Blynk Application.

LITERATURE SURVEY

The Internet of Things (IoT) has revolutionized home automation, and the ESP8266 microcontroller has emerged as a compelling development platform due to its affordability and Wi-Fi connectivity. This study reviews existing literature on ESP8266-based smart home systems, exploring their advantages, common applications, and security considerations. Research highlights the ESP8266's key strengths, cost-effectiveness compared to traditional solutions, seamless Wi-Fi integration enabling remote control and cloud connectivity, a supportive developer community fostering user-friendly development, and versatility in working with diverse sensors and actuators for comprehensive home automation.

The ESP8266 presents a powerful and cost-effective platform for developing user-controlled smart home Automation systems.

Some studies in this field showcase successful implementations in various domains, including remote lighting control with scheduling capabilities with real monitoring systems [1].

SMART HOME AUTOMATION

Smart home automation refers to the use of technology to automate and control various aspects of a home, often through the Internet of Things (IoT). This can include controlling lighting, thermostats, appliances, security systems, and more.

Smart Home

Smart home technology is also often referred to as “AN INTERNET BASED HOME AUTOMATION SYSTEM” or Domotis (from the Latin word “DOMOUS” meaning Home) [2].

It provides security, comfort, convenience, and energy efficiency by allowing them to control smart devices, often by a smart home app on their smartphone as few applications mentioned in the Figure 1.

Benefits

- Remote control of lights and appliance.
- Enhanced security features.
- Potential energy savings and improved accessibility.

Security Risks

The security risks associated with the specific devices are discussed in Table 1.

Table 1. The security risks associated with the specific devices.

Feature	Specific Devices	Benefits	Risks
Lightning Control	Smart bulbs, dimmers, switches	Remote control, scheduling	Hacking could lead to unauthorized control or Data breaches
Climate control	Smart thermostats, air conditioner, fans	Energy savings, Remote adjustments, automated comfort	Vulnerable to manipulation of temperature settings or data leaks
Security Systems	Smart lock security systems	Intrusion detection, remote monitoring	Risk of unauthorized access to Cameras or locks, potential privacy violations
Appliance management	Smart plugs, Refrigerator	Efficiency improvements, Remote Monitoring scheduling cycles	Device hijacking could disrupt appliance operation

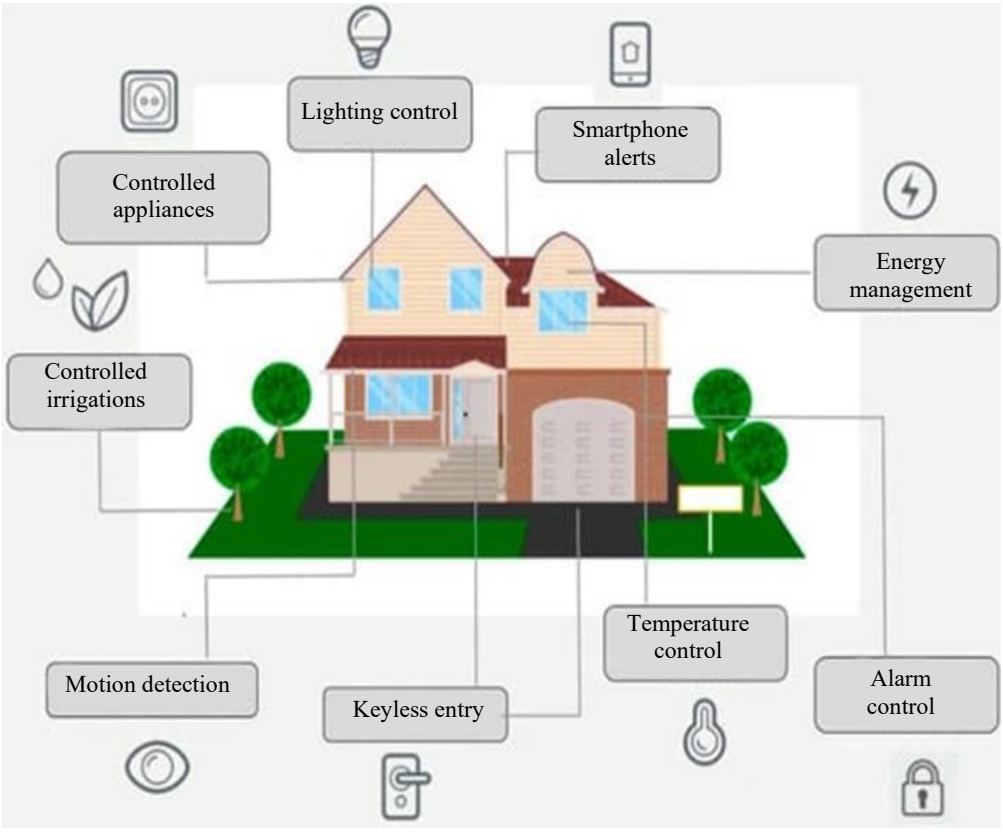

Figure 1. Smart home automation system in our home.

Advantages

- Convenience.
- Energy Efficiency.
- Security.
- Reduce power wastes.
- Accessibility.

Disadvantages

- Cost.
- Security Risks.
- Technical complexity.
- Compatibility issues.

POWER CONSUMPTION DUE TO SMART HOME AUTOMATION

Increased Consumption

- *Always-on devices:* Smart speakers, hubs, and certain sensors have a small but constant power draw even when not actively used, as discussed in Figure 2 [3–5].
- *Standby power:* Many smart appliances may use standby power when seemingly off.

Reduced Consumption

- *Optimized usage:* Smart thermostats, lighting, and irrigation systems can learn your habits and automate them to reduce unnecessary energy use.
- *Remote monitoring:* Ability to remotely turn off lights, adjust thermostats, or monitor appliance usage can prevent energy waste.

IMPLEMENTATION SETUP

Components

- NODE MCU (ESP8266).
- Solderless breadboard.
- 4-Channel 5 V Relay module.
- Push button.
- 220 V LED Bulb and holder.
- AC fan 220 V.
- Mini switches.

The appliances connection could be done in the manner as shown in circuit diagram of the Figure 3.

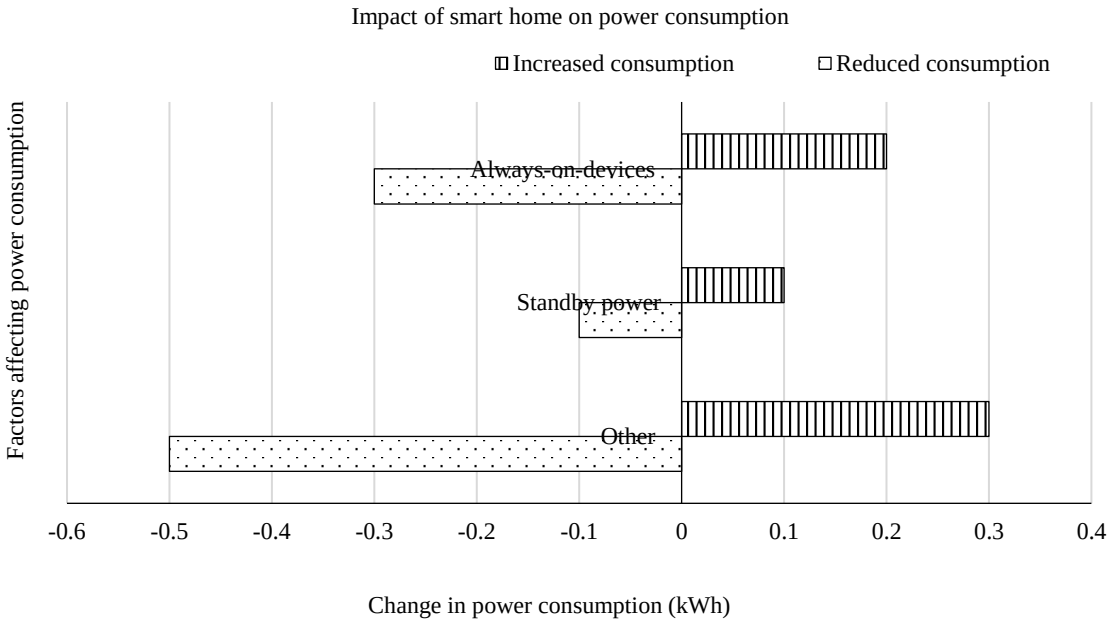

Figure 2. Graph represents power consumption.

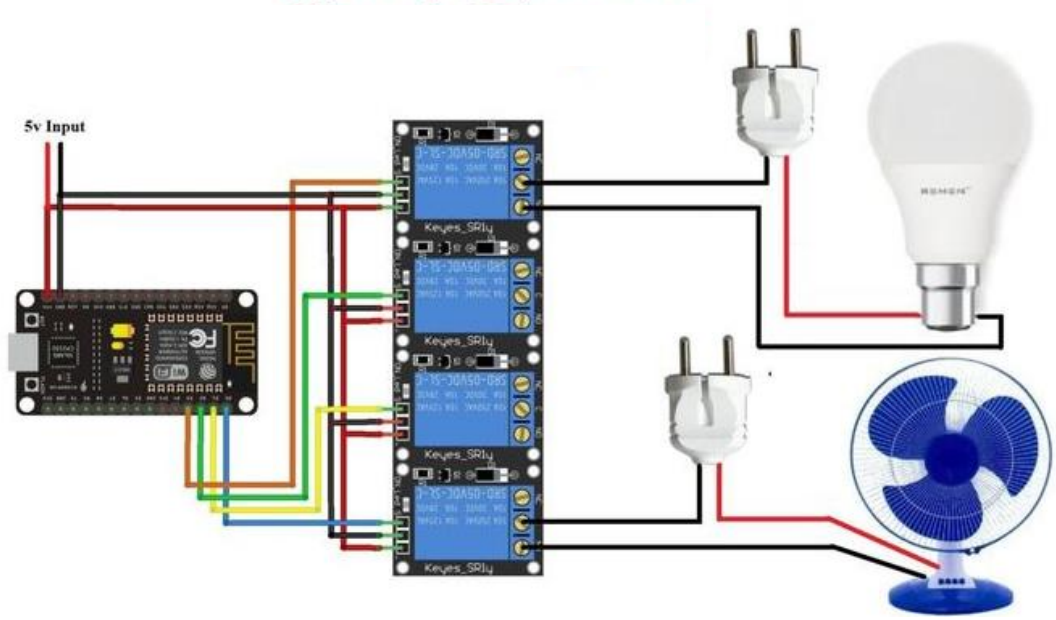

Figure 3. Circuit design of smart home automation.

IoT and manual switch control home appliances schematic diagram is shown in Figure 4.

PROPOSED SYSTEM

This study proposes a user-centric and budget-friendly smart home automation system built around the ESP8266 microcontroller [6]. This Wi-Fi chip serves as the central hub, connecting seamlessly to a cloud platform and receiving commands from a smartphone app.

Users can remotely control appliances like lights and fans directly from their smartphones, fostering convenience and potentially reducing energy use. This design empowers users to personalize and optimize their living environment through context-aware automation based on sensor data.

It allows the user to control everything from one place and sends notifications to the smartphone via the BLYNK app whether the devices were turned on or off [7]. This user-friendly system offers a cost-effective approach to smart home automation, putting control at your fingertips. It saves the energy and increases the power consumption.

WORKING

Upon receiving the power, the ESP8266 microcontroller boots up and initializes its internal components. The ESP8266 attempts to connect to the WIFI network using the pre-programmed credentials stored in its memory (Figure 5). The connection enables communication with the smartphone via the BLYNK app (cloud platform).

The 4-channel relay module consists of four individual relays, each with a control coil and set of contacts [8]. The ESP8266 controls the state (ON/OFF) of these relays by sending signals to their control signals. The cloud platform is used to communicate through the smartphone, it receives notifications or commands from the ESP8266. The ESP8266 receives commands from the app (via BLYNK APP).

These commands specify which devices (fan, light, etc.) the user wants to control. If the user turns ON a light from the app, the ESP8266 receives the command and activates the corresponding relay connected to the light power supply. This completes the circuit, allowing the electricity to flow and turn on the light [9–12]. The user can manage connected devices from anywhere with an internet connection with a cloud platform.

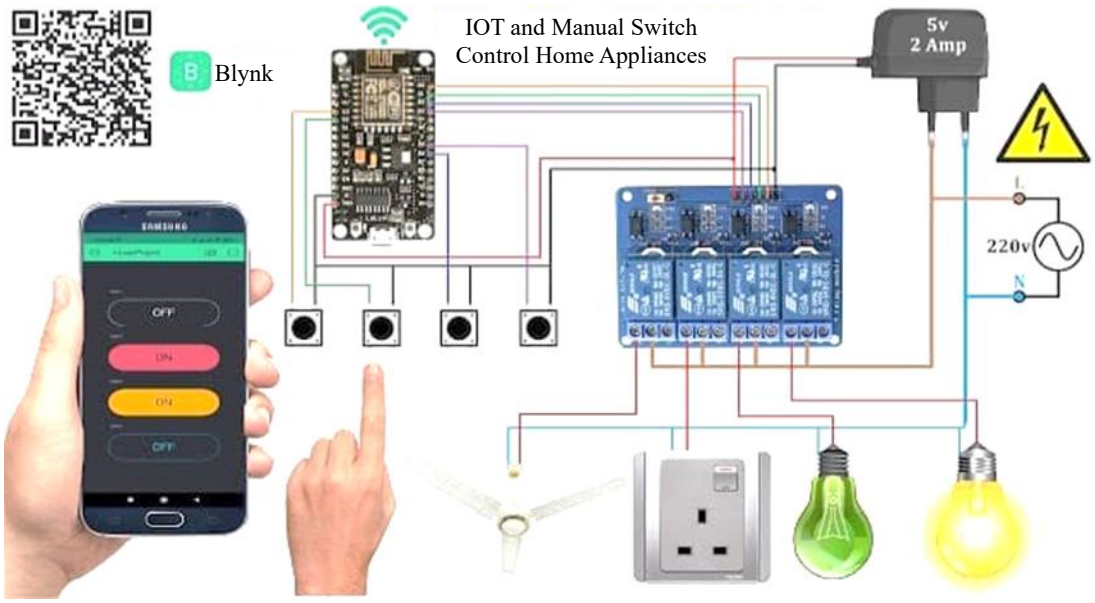

Figure 4. Schematic design of smart home automation.

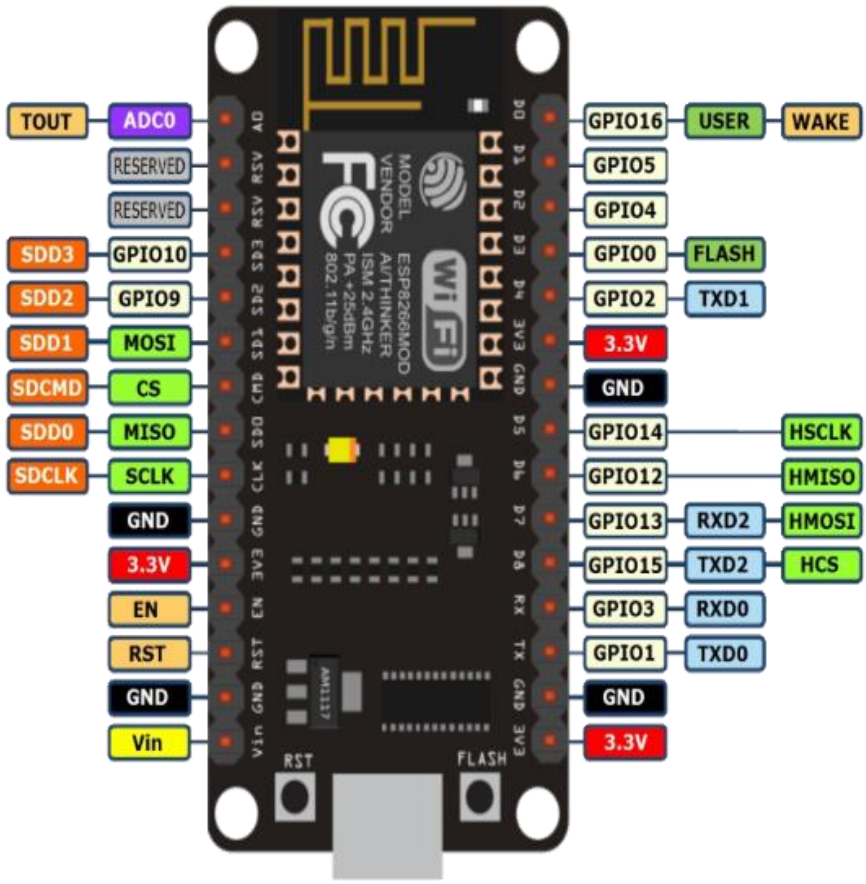

Figure 5. Node MCU (ESP8266).

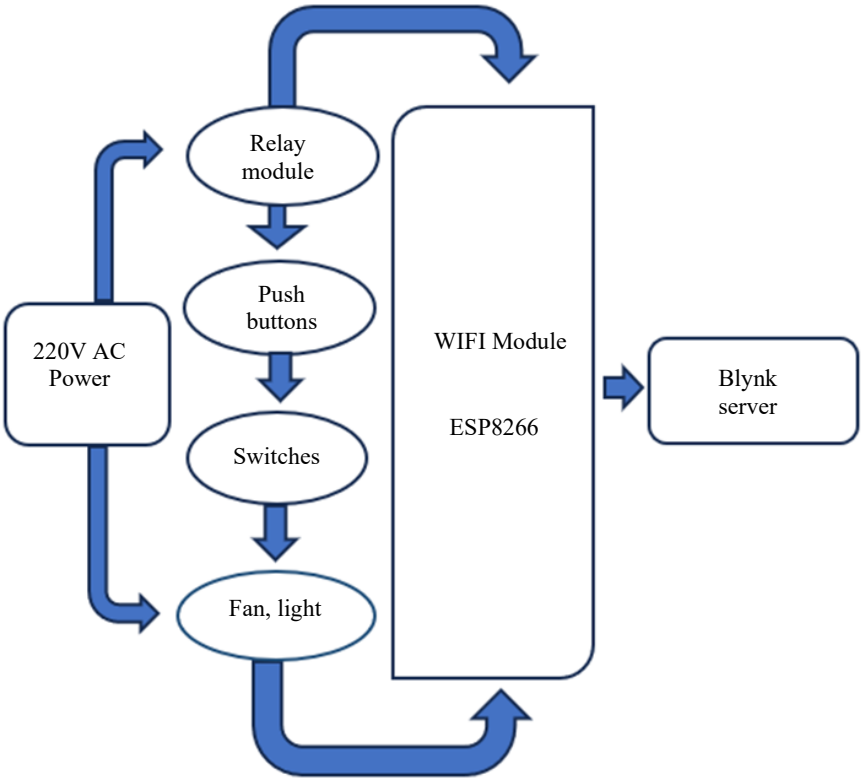

Figure 6. Block diagram of smart home automation.

Block diagram representation of the smart home automation system is shown in Figure 6.

METHODOLOGY

Circuit Setup

- *ESP8266 Microcontroller:* This is the heart of the circuit, responsible for processing data, Wi-Fi communication, and controlling relays.
- *Power Supply:* A regulated 5 V power supply is needed to power the ESP8266 and other components. A micro USB cable connected to a phone charger or a dedicated 5 V power adapter can be used.
- *Relays:* Relays act as electronic switches, allowing the ESP8266 to control connected appliances. (e.g., 4-channel relay for four appliances is shown in Figure 7).

Appliances: Fan, Light, etc.

Figure 7. 4-Channel relay.

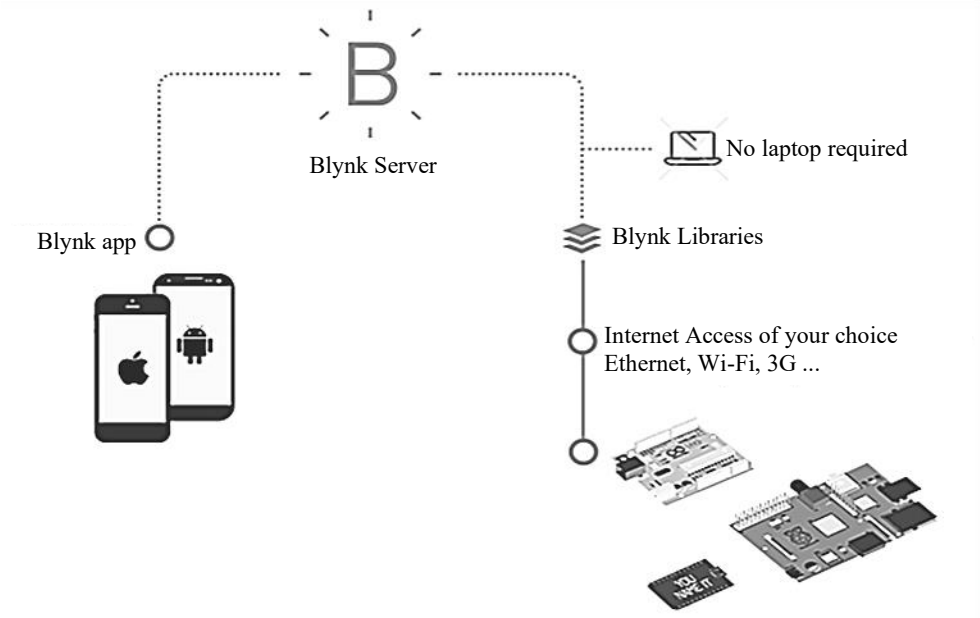

Figure 8. Blynk server.

BLYNK APPLICATION

BLYNK is a brand-spanking-new platform that allows you to hastily build interfaces for controlling and monitoring your hardware projects from your Android devices and IOS.

After the BLYNK app is downloaded, you can create a project dashboard and arrange buttons, sliders, graphs, and other widgets on the screen.

Blynk was a developer of Internet of Things shown in Figure 8. It has numerous functions, including remote hardware management, data storing and visualization. BLYNK libraries are essential for all the widely used hardware platforms. They allow for crucial communication between the server and the handling of all the incoming and outgoing commands. However, sometimes the connection may be unstable, causing delays in command processing. Furthermore, compatibility issues with certain hardware platforms have also been reported.

CODE

```
/*
 https://arduino.esp8266.com/stable/package_esp8266com_index.json
 */

#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#include <EEPROM.h>

char AUTH[]="----------------"; //Auth code sent via Email
char WIFI_SSID[]="M.Ansar"; //Wifi name
char WIFI_PASS[]="78612345";  //Wifi Password

// define the GPIO connected with Relays and switches
#define Relay1 D0 //GPIO 16
#define Relay2 D1 //GPIO 5
#define Relay3 D2 //GPIO 4
#define Relay4 D3 //GPIO 0

#define Switch1 10 //SD3
#define Switch2 9 //SD2
#define Switch3 12 //D5
#define Switch4 14 //D6

#define wifiLed D4 //GPIO 2

int load1, load2, load3, load4;
int wifiFlag=1;

BlynkTimer timer;

void checkBlynkStatus() {// called every 3 seconds by SimpleTimer
  bool isconnected=Blynk.connected();
  if (isconnected==false) {wifiFlag = 1;
    digitalWrite(wifiLed, HIGH); //Turn off WiFi LED
  }
  if (isconnected==true) {
```



```
  if(wifiFlag==1){wifiFlag = 0;
  update_blynk();
  }
    digitalWrite(wifiLed, LOW); //Turn on WiFi LED
  }
}


void setup() {
Serial.begin(9600);

pinMode(Switch1, INPUT_PULLUP);
pinMode(Switch2, INPUT_PULLUP);
pinMode(Switch3, INPUT_PULLUP);
pinMode(Switch4, INPUT_PULLUP);

EEPROM.begin(512);
load1=EEPROM.read(1);
load2=EEPROM.read(2);
load3=EEPROM.read(3);
load4=EEPROM.read(4);

pinMode(Relay1, OUTPUT);
pinMode(Relay2, OUTPUT);
pinMode(Relay3, OUTPUT);
pinMode(Relay4, OUTPUT);

Relays();
pinMode(wifiLed, OUTPUT);
WiFi.begin(WIFI_SSID, WIFI_PASS);
timer.setInterval(3000L, checkBlynkStatus); // check if Blynk server is connected every 3 seconds
Blynk.config(AUTH);
delay(100);
}
void loop() {
if (WiFi.status() !=WL_CONNECTED){
   //Serial.println("WiFi Not Connected");
  }
  else{
    //Serial.println("WiFi Connected");
    Blynk.run();
  }
if(wifiFlag==0){with_internet();}
          else{without_internet();}
 timer.run(); // Initiates SimpleTimer
}
BLYNK_WRITE(V0){
load1=param.asInt();
Relays();
}
BLYNK_WRITE(V1){
load2=param.asInt();
```



```
Relays();
}
BLYNK_WRITE(V2){
load3=param.asInt();
Relays();
}
BLYNK_WRITE(V3){
load4=param.asInt();
Relays();
}
void with_internet(){
    if(digitalRead(Switch1)==LOW){
     load1=!load1;
     Relays();
     update_blynk();
     delay(300);
   }
else if(digitalRead(Switch2)==LOW){
     load2=!load2;
     Relays();
     update_blynk();
     delay(300);
   }
else if(digitalRead(Switch3)==LOW){
     load3=!load3;
     Relays();
     update_blynk();
     delay(300);
   }
else if(digitalRead(Switch4)==LOW){
     load4=!load4;
     Relays();
     update_blynk();
     delay(300);
  }
}
void without_internet(){
    if(digitalRead(Switch1)==LOW){
     load1=!load1;
     Relays();
     delay(300);
   }
else if(digitalRead(Switch2)==LOW){
     load2=!load2;
     Relays();
     delay(300);
   }
else if(digitalRead(Switch3)==LOW){
     load3 = !load3;
     Relays();
     delay(300);
   }
```



```
else if(digitalRead(Switch4)==LOW){
     load4=!load4;
     Relays();
     delay(300);
   }
}
void update_blynk(){
Blynk.virtualWrite(V0, load1);
Blynk.virtualWrite(V1, load2);
Blynk.virtualWrite(V2, load3);
Blynk.virtualWrite(V3, load4);
}
void Relays(){
digitalWrite(Relay1, load1);
digitalWrite(Relay2, load2);
digitalWrite(Relay3, load3);
digitalWrite(Relay4, load4);
write_eeprom();
}
void write_eeprom(){
EEPROM.write(1, load1);
EEPROM.write(2, load2);
EEPROM.write(3, load3);
EEPROM.write(4, load4);
EEPROM.commit();
}
```

SIMULATION AND RESULT

The resulted prototype for the connected appliances could be observed in Figure 9.

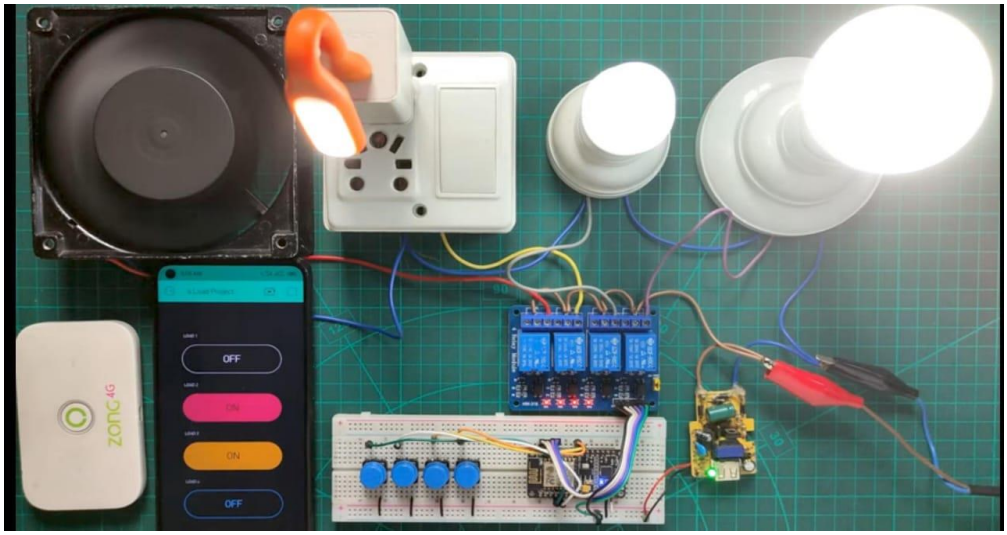

Figure 9. Complete circuit Prototype.

CONCLUSION

Smart home automation enhances convenience and efficiency through interconnected devices and systems. It increases comfort and provides peace of mind. With the ability to remotely monitor and control various aspects of the home, smart automation fosters a modern lifestyle that prioritizes convenience and sustainability. The proposed system integrates manual and smartphone control for

appliances. A microcontroller unit (MCU) like the Node MCU acts as the brain, interpreting user input from either push buttons or a smartphone app. This triggers the relay module, which functions as a switch, turning on or off the connected appliance. In essence, the circuit bridges the gap between traditional controls and modern smartphone interfaces, offering users flexibility in managing their home environment. By incorporating elements like Blynk for app communication, the circuit paves the way for a user-friendly and adaptable smart home experience. This design highlights the potential for creating simple yet effective home automation systems. With further customization through programming, users can personalize their living space for enhanced convenience and potentially improved energy efficiency.

Acknowledgement

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