

## PROJECT REPORT TEMPLATE

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1. Title page
2. Declaration
3. Certificate (date of submission should be mentioned)
4. Acknowledgement
5. Abstract
6. Table of Contents (including Chapters, tables & figures)
7. List of tables
8. List of figures
9. Introduction
10. Literature survey
11. Block Diagram/Schematic Diagram
12. Component Description
13. Code
14. Result
15. Conclusion
16. Future Scope
17. Bibliography

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# Smart Home Automation Using Blynk & ESP32 IoT Projects WiFi & Manual”

## MAJOR PROJECT REPORT

BY

| <i>Group Members</i> | <i>Roll Nos</i>   |
|----------------------|-------------------|
| <i>P. Shurthi</i>    | <i>2310040061</i> |
| <i>M. Raviteja</i>   | <i>2310040071</i> |
| <i>S. Vaishnavi</i>  | <i>2310040081</i> |
| <i>A. Gowthami</i>   | <i>2310040092</i> |

*in partial fulfillment for the award of the degree  
of  
Bachelor of Technology  
In  
Electronics & Communication Engineering*

**Under the Guidance of**

*Mrs.Madhavi Kosaraju*



Department of Electronics & Communication Engineering  
KLEF, Off Campus-Hyderabad

Aziznagar-500075, Rangareddy (Dist), Telangana, India

2024

## **DECLARATION**

we hereby declare that the project entitled “Smart Home Automation Using Blynk & ESP32 IoT Projects WiFi & Manual” which is being submitted as Major project of 4th semester in Electronics & Communication Engineering Aziznagar, Hyderabad in authentic record of genuine work done under the guidance of Assistant Professor Mrs. K.Madhavi department of Electronics & Communication Engineering Aziznagar, Hyderabad.

Date:

Place: Hyderabad

Shruthi - 2310040061

Raviteja– 2310040071

Vaishnavi– 2310040081

Gowthami -2310040092

## **CERTIFICATE**

This is certify that the Major project report entitled “Smart Home Automation Using Blynk & ESP32 IoT Projects WiFi & Manual” is being submitted by Shruthi, Raviteja, Vaishnavi, Gowthami has been a carried out under the guidance of Assistant Professor Mrs. K.Madhavi Electronics & Communication Engineering Aziznagar Hyderabad. The project report is approved for submission requirement for ESA project in 4th semester in Electronics & Communication Engineering Aziznagar Hyderabad.

Internal Examiner  
Date:

External Examiner

Head of the Department

**ECE**

## ACKNOWLEDGEMENT

We express our sincere indebtedness towards our guide **Assistant Professor Mrs. K.Madhavi, Electronics & Communication Engineering**, Aziznagar, Hyderabad for his invaluable guidance, suggestions and supervision throughout the work. Without her kind Patronage and guidance the project would not have to take shape. We would also like to express our gratitude and sincere regards for her kind approval of the project time to time counseling and advices.

We would also like to thanks to our **HOD Dr. M. Goutham Department of Electronics & Communication Engineering** Aziznagar, Hyderabad for his expert advice and counseling from time to time.

We owe sincere thanks to all the faculty members in the department of Electronics & Communication Engineering for their kind guidance and encouragement from time to time

**Date:**

**1.Shruthi  
2.Raviteja  
3.Vaishnavi  
4.Gowthami**

## ABSTRACT

Smart home automation using Blynk and ESP32 leverages IoT technology to provide efficient, remote, and real-time control of household appliances. The integration of Wi-Fi connectivity enables seamless communication between the ESP32 microcontroller and the Blynk mobile application, allowing users to monitor and manage devices from anywhere. This system enhances convenience, energy efficiency, and security by automating appliances based on predefined conditions and user commands. Additionally, the ability to send real-time notifications and collect data further improves the intelligence of the system.

A key feature of this automation setup is its dual control mechanism, which includes both Wi-Fi-based remote operation and manual switching. The manual mode ensures continued functionality even in the absence of an internet connection, thereby increasing the system's reliability. Various sensors, such as motion detectors, temperature sensors, and relays, can be integrated to enable smart decision-making and automation. The use of Blynk as a cloud-based platform simplifies the development process by providing a user-friendly interface for managing connected devices.

This project is built on established theoretical frameworks in IoT, embedded systems, and wireless communication. Prior research has demonstrated the effectiveness of ESP32 in smart applications due to its low power consumption, high processing capability, and built-in Wi-Fi support. By incorporating both automatic and manual control methods, the system ensures efficiency, accessibility, and ease of use. Overall, smart home automation with Blynk and ESP32 offers a cost-effective and scalable solution for modern home automation needs.

The ESP32, equipped with built-in WiFi and Bluetooth capabilities, acts as the central controller and communicates with the Blynk cloud server. A 4-channel relay module is used to switch appliances ON and OFF. Manual control is provided using tactile push buttons or switches directly interfaced with the ESP32, ensuring functionality even during internet outages.

The project demonstrates real-time status monitoring and feedback through the Blynk app, where users can view the state of each connected device. This dual-control approach ensures flexibility, ease of use, and reliability in daily life. The system can be easily scaled or customized for additional features such as scheduling, voice control, or integration with sensors.

This solution reflects a cost-effective and beginner-friendly approach to modern home automation using open-source technologies and cloud-based platforms.

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## Introduction

Smart home automation has revolutionized the way we interact with our living spaces, enhancing convenience, security, and energy efficiency. Leveraging the power of the Internet of Things (IoT), devices within a smart home can be interconnected, allowing users to remotely monitor and control various functions such as lighting, temperature, security systems, and more. One of the most popular and effective platforms for building IoT projects is Blynk, an intuitive mobile app that simplifies the process of controlling hardware devices via smartphones.

The ESP32, a versatile microcontroller with built-in WiFi and Bluetooth, is ideal for creating connected devices in a smart home setup. By combining Blynk and ESP32, users can design smart home automation systems that are both WiFi-enabled and manually operable. These systems can be controlled via the Blynk app or through physical interfaces like switches or buttons, offering flexibility and user-friendliness.

This approach provides a seamless way to integrate automation in homes without requiring complex wiring or installations. It also opens up the possibility for building scalable projects, where new devices can be easily added to the system as needs evolve. This combination of Blynk and ESP32 provides a powerful foundation for innovative and customizable smart home solutions.

The core of the system revolves around the **ESP32 microcontroller**, which communicates with the **Blynk IoT platform** to provide seamless remote access via smartphones, while also supporting physical switch inputs for local control.

The integration of **Blynk** allows for real-time monitoring and control of connected devices, giving users the ability to switch appliances on or off, receive status updates, and even set timers or automation rules from anywhere in the world. At the same time, the inclusion of **manual switches** ensures that the system remains functional in the absence of internet connectivity, thus enhancing the system's reliability and practicality in everyday use.

This dual-mode functionality not only improves **usability and accessibility** but also increases the **resilience** of the system, making it a perfect candidate for homes, offices, and even small industrial settings. Furthermore, the modular and scalable nature of the design means additional devices and sensors—such as motion detectors, temperature sensors, or voice assistants—can be added to expand the system's capabilities.

## **Literature Survey**

### **I. Literature Review / Application Survey on Smart Home Automation Using Blynk & ESP32**

Smart home automation, powered by the Internet of Things (IoT), has transformed residential spaces by offering greater control, convenience, energy efficiency, and security. The continuous evolution of IoT technologies has led to the widespread use of smart devices, and platforms like Blynk and microcontrollers such as ESP32 have made it easier than ever to develop and implement these systems. This literature review surveys existing studies and applications focused on smart home automation using Blynk and ESP32, showcasing their effectiveness in addressing various challenges in residential automation.

### **II. Smart Home Automation: The Role of IoT**

The Internet of Things (IoT) has made significant strides in various sectors, including healthcare, agriculture, and transportation. In the context of smart homes, IoT has brought forth a new era of interconnectivity among household devices. IoT allows devices to exchange data and be remotely controlled over the internet, enhancing the convenience and intelligence of everyday tasks. The primary advantages of IoT in smart homes include energy management, enhanced security, remote monitoring, and automation.

According to a study by M. Alharbi et al. (2019), smart homes can significantly improve energy consumption efficiency through real-time monitoring and automatic adjustments based on data from connected devices. Energy-saving systems, such as automated lighting, heating, and cooling systems, have been developed using IoT devices, helping reduce carbon footprints and utility bills.

However, the development of cost-effective, user-friendly, and reliable systems has been a challenge. The integration of affordable hardware and intuitive software platforms has been essential in overcoming this hurdle. Here, the combination of Blynk and ESP32 stands out as an ideal solution for building user-centric smart home systems.

### **III. The ESP32 Microcontroller: A Versatile IoT Platform**

The ESP32 microcontroller has gained immense popularity in IoT applications due to its rich feature set, low cost, and ease of use. Developed by Espressif Systems, the ESP32 is a dual-core microcontroller with both Wi-Fi and Bluetooth capabilities. It also features low power consumption, making it suitable for battery-operated smart devices. The versatility of ESP32 allows it to handle tasks such as controlling sensors, actuators, and motors, while communicating wirelessly with other devices in a smart home network.

Studies like those of A. Karami et al. (2020) have highlighted the ESP32's role in creating flexible, low-cost smart home solutions. With its integrated Wi-Fi and Bluetooth, the ESP32 allows for seamless communication between devices, facilitating the creation of interconnected home systems. For instance, in smart lighting systems, the ESP32 can control lights, adjust brightness, and integrate motion sensors to turn the lights on or off automatically based on user presence. Additionally, the ESP32 can be programmed to manage environmental sensors for temperature, humidity, and air quality control.

In another study by S. Gupta et al. (2019), the ESP32 was used to develop a smart energy monitoring system, which can track the power consumption of various household devices. This system allows users to monitor their energy usage in real-time and receive alerts if consumption exceeds a set threshold. Such applications not only contribute to energy efficiency but also provide a foundation for smarter home energy management.

#### **IV. Blynk: Simplifying IoT Control**

Blynk is a mobile app platform designed to provide a simple and intuitive interface for controlling IoT devices. With Blynk, users can create custom dashboards that interact with hardware such as the ESP32, enabling remote monitoring and control of smart devices. One of the key advantages of Blynk is its user-friendly interface, which requires little or no coding knowledge. Developers can drag and drop widgets onto the app to design custom control panels, making it an attractive solution for both beginners and experienced developers.

According to a study by Shabina et al. (2021), Blynk's ability to support a wide range of IoT devices, including sensors, actuators, and microcontrollers like ESP32, has made it a popular choice in the development of smart home systems. The Blynk app connects to devices through the internet, allowing users to control appliances, lights, and security systems from anywhere in the world. This remote access enhances the convenience and flexibility of smart home systems.

Blynk also integrates seamlessly with other smart home platforms, such as Amazon Alexa and Google Assistant. This integration enables voice control, providing a more intuitive and hands-free way to interact with home automation systems. Blynk's integration with ESP32 has been used in projects ranging from simple lighting control systems to advanced security and health monitoring systems, showcasing its versatility and ease of use.

#### **V. Applications of Blynk & ESP32 in Smart Home Automation**

The combination of Blynk and ESP32 has been leveraged in numerous smart home applications, addressing various aspects of home automation, such as energy management, security, and convenience.

1. **Energy Management:** One of the most common applications of IoT in smart homes is energy management. Using ESP32 and Blynk, developers have created systems that allow users to monitor and control energy consumption in real time. For instance, a study by Gupta et al. (2019) demonstrated the use of ESP32-based energy meters that track the consumption of household appliances. These systems allow users to monitor energy usage through the Blynk app and adjust settings to optimize energy efficiency.

Additionally, Blynk can integrate with temperature sensors and automated HVAC (Heating, Ventilation, and Air Conditioning) systems to regulate the indoor environment based on user preferences. Such systems can adjust the temperature based on occupancy and weather conditions, reducing energy waste while maintaining comfort.

2. **Security Systems:** ESP32 and Blynk have also been used to enhance the security of smart homes. Systems utilizing ESP32 can include features such as door lock control, surveillance camera monitoring, and motion detection. A study by Alharbi et al. (2019) showcased a smart home security system that integrates a camera module with ESP32, allowing users to monitor live video feeds through the Blynk app. Furthermore, the system could send real-time alerts if motion was detected in specific areas of the home, such as near doors or windows.
3. **Voice Control and Automation:** Integration with voice assistants, such as Amazon Alexa and Google Assistant, is another significant advantage of combining Blynk and ESP32. By adding voice control to existing systems, users can operate devices without the need for manual intervention. For example, users can ask a voice assistant to turn on the lights or adjust the thermostat, providing a hands-free experience. This integration simplifies automation further, making it easier for users to set schedules and routines.
4. **Health Monitoring:** Health monitoring applications have gained traction in smart homes, especially with the rise of wearable devices. Researchers have developed systems that integrate health-monitoring sensors with ESP32 and Blynk, allowing users to monitor vital signs such as heart rate, blood pressure, and body temperature. These systems can send alerts to users or caregivers if abnormal readings are detected, contributing to health and safety.
5. **Manual Control and Redundancy:** A key advantage of using ESP32 and Blynk in smart home systems is the ability to provide manual control in case of network failures. In a study by Karami et al. (2020), researchers demonstrated a smart lighting system that could be controlled both via the Blynk app and physical switches, ensuring that users still had access to control their devices even if Wi-Fi was unavailable.

## BLOCK DIAGRAM

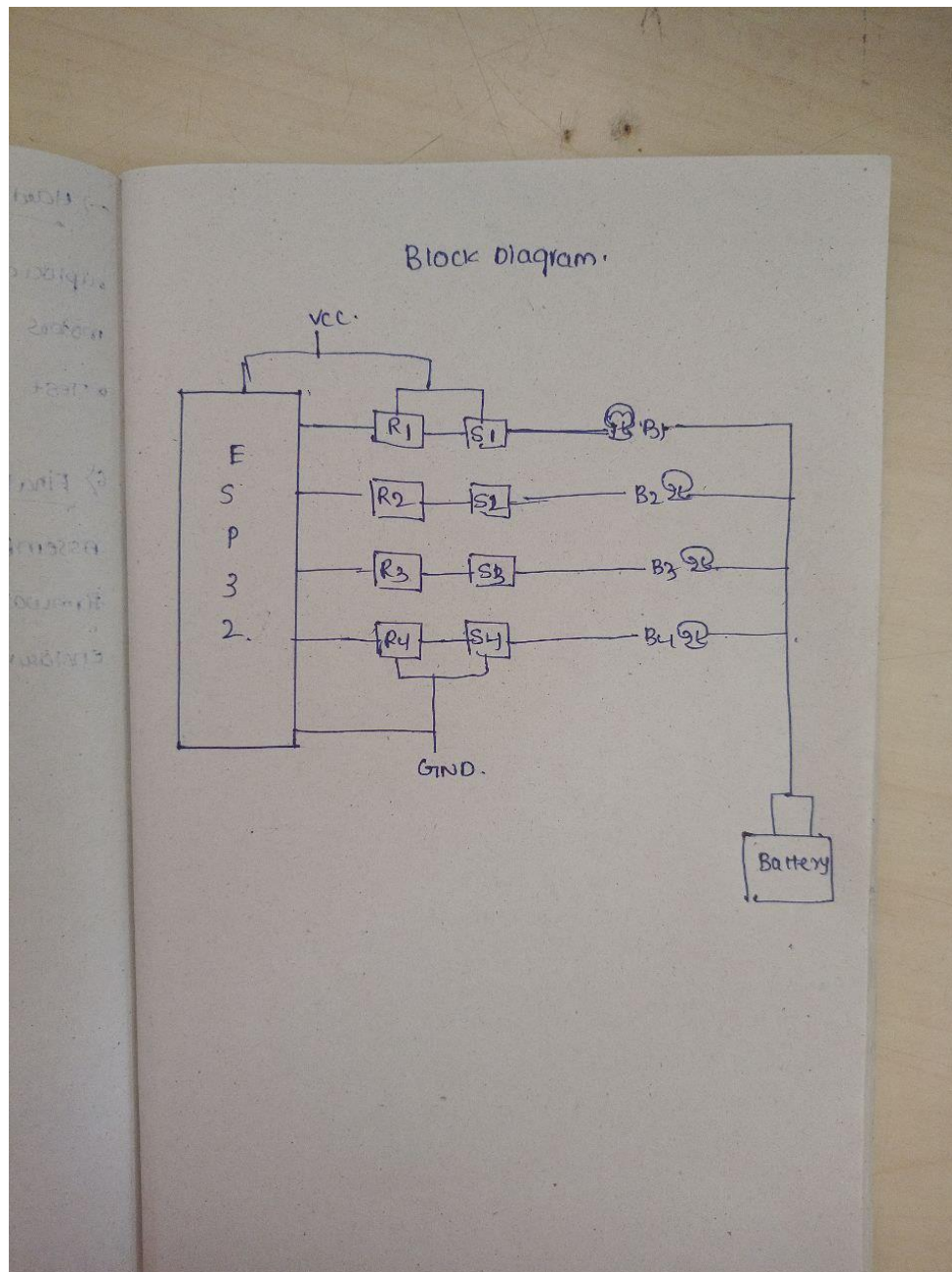


FIG 1.1

## COMPONENT DESCRIPTION:

### ESP32:

ESP32 is a powerful, low-cost, and energy-efficient microcontroller with built-in WiFi and Bluetooth capabilities. Developed by Espressif Systems, it is widely used in IoT, automation, and embedded systems due to its versatility and high performance.



FIG 1.2

### 4-channel 5V SPDT Relay Module:

A 4-Channel 5V SPDT (Single Pole Double Throw) Relay Module is an electronic switch used to control high-power electrical devices using a low-voltage microcontroller like ESP32, Arduino, or Raspberry Pi. It allows safe isolation between the control circuit and high-voltage loads.



FIG 1.3

### Pushbutton:

A push button is a switch that controls circuits by making or breaking connections when pressed. It has NO, NC, and COM terminals. A 2-pin button connects to GPIO and GND. Used in home automation, IoT, and embedded systems for manual control.



FIG 1.4

### **BULB:**

A 0.5V bulb is a miniature incandescent bulb that glows using a small tungsten filament enclosed in a glass envelope. It is specially designed for low-voltage applications, such as in small toys, science experiments, or custom electronic projects. Due to its low voltage rating, it produces a dim, soft glow and consumes very little power.



FIG 1.5

## CODE:

```
// Template ID, Device Name and Auth Token are provided by the Blynk.Cloud
// See the Device Info tab, or Template settings
#define BLYNK_TEMPLATE_ID "TMPL3FTtLxxHr"
#define BLYNK_TEMPLATE_NAME "ESP32 Home Automation"
#define BLYNK_AUTH_TOKEN "q3WivHZtXHfX5lajRMr9hMhY2V6BEnWC"

// Comment this out to disable prints and save space
#define BLYNK_PRINT Serial

#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>

char auth[] = BLYNK_AUTH_TOKEN;

// Your WiFi credentials.
// Set password to "" for open networks.
char ssid[] = "Shruthi";
char pass[] = "chitti 20";

BlynkTimer timer;

#define button1_pin 14
#define button2_pin 12
#define button3_pin 13
#define button4_pin 4

#define relay1_pin 26
#define relay2_pin 27
#define relay3_pin 32
#define relay4_pin 33

int relay1_state = 0;
int relay2_state = 0;
14
```



```

int relay3_state = 0;
int relay4_state = 0;

//Change the virtual pins according the rooms
#define button1_vpin  V1
#define button2_vpin  V2
#define button3_vpin  V3
#define button4_vpin  V4

//-----
// This function is called every time the device is connected to the Blynk.Cloud
// Request the latest state from the server
BLYNK_CONNECTED() {
  Blynk.syncVirtual(button1_vpin);
  Blynk.syncVirtual(button2_vpin);
  Blynk.syncVirtual(button3_vpin);
  Blynk.syncVirtual(button4_vpin);
}

//-----
// This function is called every time the Virtual Pin state change
//i.e when web push switch from Blynk App or Web Dashboard
BLYNK_WRITE(button1_vpin) {
  relay1_state = param.asInt();
  digitalWrite(relay1_pin, relay1_state);
}

//-----
BLYNK_WRITE(button2_vpin) {
  relay2_state = param.asInt();
  digitalWrite(relay2_pin, relay2_state);
}

//-----
BLYNK_WRITE(button3_vpin) {
  relay3_state = param.asInt();
  digitalWrite(relay3_pin, relay3_state);
}

```

```

//-----
BLYNK_WRITE(button4_vpin) {
  relay4_state = param.asInt();
  digitalWrite(relay4_pin, relay4_state);
}
//-----

void setup()
{
  // Debug console
  Serial.begin(115200);
  //-----

  pinMode(button1_pin, INPUT_PULLUP);
  pinMode(button2_pin, INPUT_PULLUP);
  pinMode(button3_pin, INPUT_PULLUP);
  pinMode(button4_pin, INPUT_PULLUP);
  //-----

  pinMode(relay1_pin, OUTPUT);
  pinMode(relay2_pin, OUTPUT);
  pinMode(relay3_pin, OUTPUT);
  pinMode(relay4_pin, OUTPUT);
  //-----

  //During Starting all Relays should TURN OFF
  digitalWrite(relay1_pin, HIGH);
  digitalWrite(relay2_pin, HIGH);
  digitalWrite(relay3_pin, HIGH);
  digitalWrite(relay4_pin, HIGH);
  //-----

  Blynk.begin(auth, ssid, pass);
  // You can also specify server:
  //Blynk.begin(auth, ssid, pass, "blynk.cloud", 80);
  //Blynk.begin(auth, ssid, pass, IPAddress(192,168,1,100), 8080);
  //-----

  //Blynk.virtualWrite(button1_vpin, relay1_state);
  //Blynk.virtualWrite(button2_vpin, relay2_state);
  //Blynk.virtualWrite(button3_vpin, relay3_state);

```

```

//Blynk.virtualWrite(button4_vpin, relay4_state);
//-----
}

void loop()
{
  Blynk.run();
  timer.run();
  // You can inject your own code or combine it with other sketches.
  // Check other examples on how to communicate with Blynk. Remember
  // to avoid delay() function!

  listen_push_buttons();
}

void listen_push_buttons(){
  //-----
  if(digitalRead(button1_pin) == LOW){
    delay(200);
    control_relay(1);
    Blynk.virtualWrite(button1_vpin, relay1_state); //update button state
  }
  //-----
  else if (digitalRead(button2_pin) == LOW){
    delay(200);
    control_relay(2);
    Blynk.virtualWrite(button2_vpin, relay2_state); //update button state
  }
  //-----
  else if (digitalRead(button3_pin) == LOW){
    delay(200);
    control_relay(3);
    Blynk.virtualWrite(button3_vpin, relay3_state); //update button state
  }
  //-----
  else if (digitalRead(button4_pin) == LOW){
    delay(200);

```

```

control_relay(4);
    Blynk.virtualWrite(button4_vpin, relay4_state); //update button state
}
//-----
}
void control_relay(int relay){
//-----
if(relay == 1){
    relay1_state = !relay1_state;
    digitalWrite(relay1_pin, relay1_state);
    Serial.print("Relay1 State = ");
    Serial.println(relay1_state);
    delay(50);
}
//-----
else if(relay == 2){
    relay2_state = !relay2_state;
    digitalWrite(relay2_pin, relay2_state);
    delay(50);
}
//-----
else if(relay == 3){
    relay3_state = !relay3_state;
    digitalWrite(relay3_pin, relay3_state);
    delay(50);
}
//-----
else if(relay == 4){
    relay4_state = !relay4_state;
    digitalWrite(relay4_pin, relay4_state);
    delay(50);
}
//-----
}

```

## RESULT:

In this project, a Smart Home Automation system was successfully designed and implemented using the ESP32 microcontroller and the Blynk IoT platform. The system enables users to control electrical appliances such as lights and fans via WiFi using a smartphone app as well as through manual physical switches.

The ESP32 board connects to the internet and communicates with the Blynk cloud. The Blynk mobile app was configured with virtual buttons, each linked to a digital output pin of the ESP32 that controls a 4-channel relay module. Appliances were connected to the relay outputs. Additionally, manual switches were connected to the ESP32 to provide local control.

The system was tested by turning ON and OFF the connected appliances both through the app and the manual switches. The app accurately reflected the current status of each device in real time, even when toggled manually. The project demonstrated dual control functionality, remote monitoring, and real-time feedback, making it a reliable smart home solution.

The result shows that the system is effective, scalable, and user-friendly, combining IoT-based automation with manual operation for flexibility and reliability. It is suitable for modern homes aiming for convenience, energy saving, and control from anywhere.

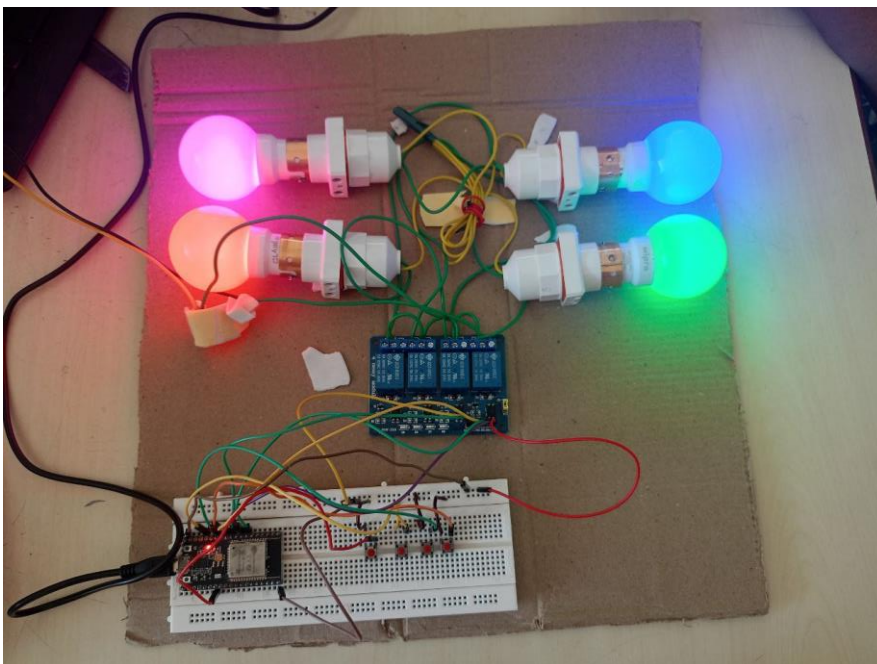


FIGURE1.6

## CONCLUSION:

The development and successful implementation of the Smart Home Automation system using Blynk and ESP32 marks a significant step toward making homes smarter, safer, and more energy-efficient. The project effectively demonstrated how modern Internet of Things (IoT) technology, when integrated with traditional manual systems, can create a hybrid model of control that offers convenience, flexibility, and reliability.

The ESP32 microcontroller, with its inbuilt WiFi capabilities, served as a powerful and cost-effective platform for interfacing with both the Blynk IoT cloud and the connected electrical appliances. Through the use of a 4-channel relay module, multiple household appliances such as lights, fans, and possibly door locks were controlled in real time. The Blynk app played a crucial role in the remote interface design, allowing users to switch devices ON/OFF, view real-time status updates, and monitor the system from anywhere with internet access.

What made this project more practical and user-centric was the inclusion of manual switches. These switches ensured that appliances could still be operated during internet outages or in situations where users preferred local control. The system architecture allowed both Blynk commands and manual inputs to be processed without conflict, showcasing the reliability and safety of the design. This dual-mode control system significantly improves the usability of home automation for all types of users, including those not comfortable with smartphone applications.

During testing, the system functioned as expected, with quick response times, accurate device status feedback, and seamless switching between manual and app control. The appliances responded reliably to commands, and the Blynk app updated the status in real-time, reflecting the changes made either remotely or locally. The system proved to be stable and robust for continuous operation over WiFi.

Moreover, this project is highly scalable and customizable. More relay channels can be added to control additional appliances, and sensors (like temperature, motion, or humidity sensors) can be integrated to create an intelligent environment that responds automatically to real-world conditions. Advanced features like voice control using Google Assistant or Alexa, automatic scheduling, and energy consumption monitoring can also be incorporated to enhance the system further.

In conclusion, this smart home automation project provides a realistic, affordable, and expandable solution for modern-day homes. It bridges the gap between traditional home control and IoT-based systems, making automation accessible to a wider audience. The project not only enhances the comfort and convenience of managing home appliances but also promotes energy efficiency and security. With continued development, this system has the potential to evolve into a fully automated smart home ecosystem, demonstrating the practical application of IoT in everyday life.

## **FUTURE SCOPE:**

The Smart Home Automation system using Blynk and ESP32 presents an excellent foundation for building intelligent and connected living environments. While the current implementation successfully demonstrates control over home appliances using WiFi and manual switches, the future scope of this project is vast and can be expanded in several directions, incorporating advancements in IoT, artificial intelligence, and sensor technology.

### **1. Integration with Voice Assistants**

A natural extension of this project would be to integrate it with voice-controlled AI assistants such as Amazon Alexa, Google Assistant, or Apple Siri. By connecting Blynk with platforms like IFTTT (If This Then That) or using direct APIs, users could control their appliances using voice commands, further increasing accessibility and convenience, especially for elderly or differently-abled individuals.

### **2. Automation Based on Sensors**

Currently, the system relies on user input via app or manual switches. In the future, the system can be made smarter by incorporating sensors like:

- PIR motion sensors to automatically turn on lights when someone enters a room.
- Temperature and humidity sensors to control fans or air conditioners.
- Light sensors (LDRs) for automatic lighting based on ambient conditions.
- Gas and smoke sensors for fire and gas leak alerts.

These additions would turn the system from user-controlled to context-aware automation, increasing safety and energy efficiency.

### **3. Energy Monitoring and Efficiency**

Adding current and voltage sensors (like ACS712) can help monitor the power consumption of connected devices. The system can then generate real-time energy usage reports and notify users if certain appliances consume excessive energy. This feature would promote energy-saving habits and allow users to optimize their electricity usage, helping reduce utility bills.

### **4. Mobile Notification and Alert System**

Another future enhancement is to implement a real-time alert and notification system via push notifications, SMS, or email. For instance:

- Notifications when someone manually toggles a switch.
- Security alerts if a door is opened at an unusual time.
- Reminders for scheduled device operations or maintenance tasks.

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