# Controlling Living Space Remotely Using the ELV Home Automation System with Google IoT


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**Project Supervisor: Dr. Haider Zaman**

**Submitted By**

**[Talha Alam]**

**[Nafees Ullah]**

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**Electronic Engineering**

**University of Engineering and Technology Peshawar (Abbottabad Campus)**

# Abstract

This project presents a developed home automation solution designed to meet the up-to-date demand for smart, efficient living. Motivated by the desire to simplify complexities and enhance daily life, this project addresses the need for a cost-effective, time-saving, and userfriendly home automation system. The core problem addressed is the search for an adaptable solution that allows users to remotely control household appliances from anywhere globally using a smartphone. Engage Sinric Pro software on the software side and the ESP32 WROOM32 as the main controller on the hardware side, this approach perfectly integrates these components, showcasing a successful implementation. The system, operating on Extra Low Voltage (ELV), proves easily adaptable for both newly designed and existing structures. Results demonstrate the efficient remote control of various appliances, including refrigerators and air conditioners, validating the system's use and flexibility. In conclusion, this research contributes to a purposeful and innovative home automation project, offering a user-friendly, cost-effective, and time-saving solution that empowers individuals to manage their living spaces efficiently.


# Undertaking

I certify that the project “Controlling Living Space Remotely Using the ELV Home Automation System with Google IoT**”** is our own work. The work has not, in whole or in part, been presented elsewhere for assessment. Where material has been used from other sources it has been properly acknowledged/ referred.

| Talha | Nafees |
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# Acknowledgment

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We are also thankful to our friends and families whose silent support led us to complete our project.

# Chapter 1

## 1.1 Introduction

Today technology has this level that even people can do their daily routine work easily with the help of newly discovered technology, which took lots of time before, now just takes some seconds to be done using the power of the internet. Nowadays energy crises are the major problem in the growth of any country so from time-to-time new technologies are introduced and because of this, these problems are going to end in some countries but not in the world. So, on behalf of this, I design and implement a system that can help the user control their living space from anywhere in the world using phones. This is a power-saving system. This system required a maximum of DC 5V for its activation and working mode which added this in the ELV (Extra Low Voltage) system. Nowadays there are many home automation systems and also many companies offer them, but the thing that makes this project unique and more suitable is that I don't need to visit the field to implement this system as usually, the companies do. What I should need from the user is how many and which device the user wants to control or if they want to control. Also, the major difference between the company system and this local project is, that it is very cost-effective and easy to implement at any kind of building, there is no need for any distraction. In this system, I also designed a mini circuit to control fan speed which is a pretty good approach instead of doing it manually. Even to make it smarter there are two modes. In case of if there is an internet problem then it can be controlled manually as we all do in our daily routine.

## 1.2 Statement of the problem

Traditional home appliances cannot be controlled remotely, requiring manual operation. This can lead to:

- **Inefficiency:** Lights or appliances may be left on unintentionally, wasting energy.
- **Inconvenience:** Users may need to physically reach switches to adjust settings or turn devices on/off.
- **Limited Accessibility:** Individuals with mobility limitations might struggle to access controls manually.

This project addresses these shortcomings by offering a remote-controlled home automation system that prioritizes energy efficiency, user convenience, and worldwide accessibility.

## 1.3 Goals

This project seeks to create a remote-controlled home automation system that addresses the following:

- **Energy Efficiency:** The system should operate on low voltage (DC 5V), minimizing energy consumption.
- **Remote Control:** Users should be able to control devices from anywhere using a smartphone app.
- **User-friendliness:** The system interface should be intuitive and easy to navigate.
- **Cost-Effectiveness:** The system should be affordable and accessible to a wide range of users.
- **Easy Implementation:** The system should be readily installed and configured with minimal disruption to existing wiring.
- **Customization:** The system should allow users to control devices based on their specific needs and preferences.

## 1.4 Motivation

The ever-evolving technological landscape offers solutions to simplify daily routines. Tasks once requiring significant time can now be completed in seconds through the power of the internet and smart devices. However, the global energy crisis remains a pressing concern. This project aims to address both these issues by developing a home automation system that prioritizes energy efficiency and allows users to control their living spaces remotely using a smartphone application.

## 1.5 Assumption and Dependencies

This project assumes basic user familiarity with smartphone applications and internet connectivity. The system relies on a functional internet connection for remote control functionalities.

## 1.6 Methods

I got the idea for this project from the workshop by HDL company help on campus. This 2-day workshop encouraged me a lot to learn more about it and designed it simple, effective, user-friendly, easy to implement, and the most demanding factor cost-effective. So, I started designing it and successfully designed a very simple and more effective system. The results of this system were great and I implemented and used it in the field. Due to my success in this project, I got the opportunity to work on a research project with professors. The hardware integrates ESP32 wroom32 with electronic switches called relays and with a 5v power supply. The use of this is very simple, first, you need to install code in ESP32 wroom32 then connect Sinric Pro software with the Google Home app and that’s all. The user interface of Google Home is as simple as other daily routine apps like WhatsApp and Facebook but easier than that, the user just needs to click on the specific device that they want to control (Turn it on or off) or the user also gives a voice command to control devices.

## 1.7 Report Overview

This report details the design and implementation of a home automation system I built that lets you control your entire place from your phone, no matter where you are. Imagine turning on lights, adjusting the fan, or even checking if you left the iron on – all from your couch (or the beach!). But this system isn't just about convenience; it's also designed to be super energy-efficient, saving you money and helping the environment.

# Chapter 2

## System Design and Implementation

This chapter delves into the technical details of the home automation system, outlining the chosen hardware and software components, and explaining the design decisions made throughout the development process.

## 2.1 Hardware Main Components

The hardware components of the system selected to achieve the project goals are:

### 2.1.1 ESP32 Wroom32 Microcontroller:

The ESP32 WROOM32 is a powerful microcontroller module developed by Espressif Systems. It's based on the ESP32 chip, which integrates a dual-core Xtensa LX6 microprocessor, Wi-Fi connectivity, Bluetooth, and various peripheral interfaces, making it suitable for a wide range of IoT (Internet of Things) applications

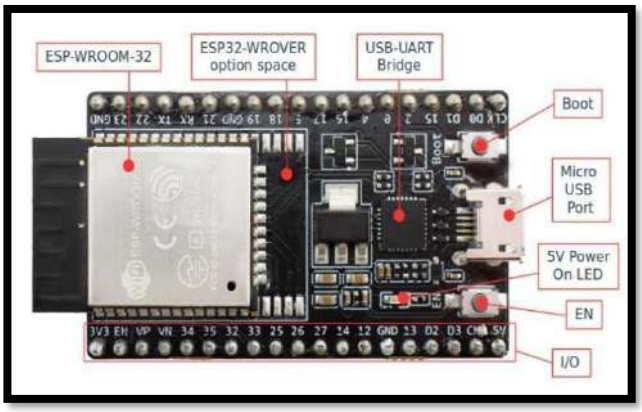


Figure 1: Esp32

### 2.1.2 Electronic Switches (Relays):

These relays act as electronic switches, enabling the system to turn devices on and off based on user commands or pre-programmed settings.

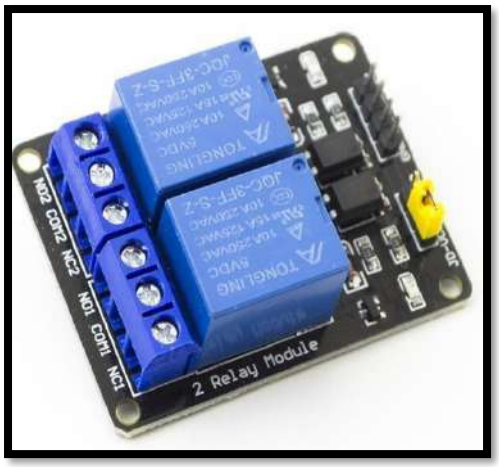


Figure 2: Electronic Switch

### 2.1.3 5V Power Supply:

A low-voltage power supply ensures the system operates efficiently, minimizing energy consumption and adhering to the ELV (Extra Low Voltage) classification.

## Hardware Setup

The hardware setup is very easy, the main device or board which is used in this project is ESP32 wroom32, which controls all the functionality and working of hardware also called the brain of this system. The detailed flow chart of hardware integration is given below:

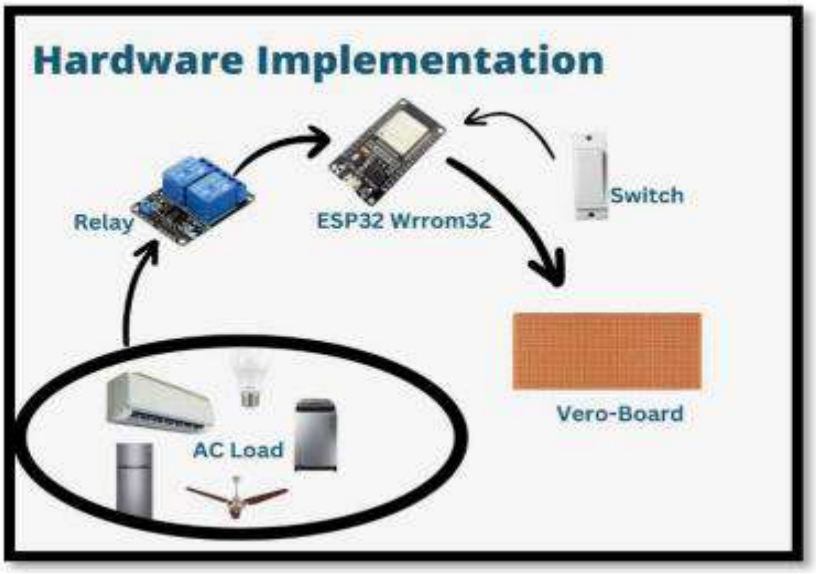


Figure 3: Hardware Architecture

## Hardware Blog Diagram

The detailed system hardware circuit blog diagram for a better understanding and system architecture with connected home load and detail schematic,

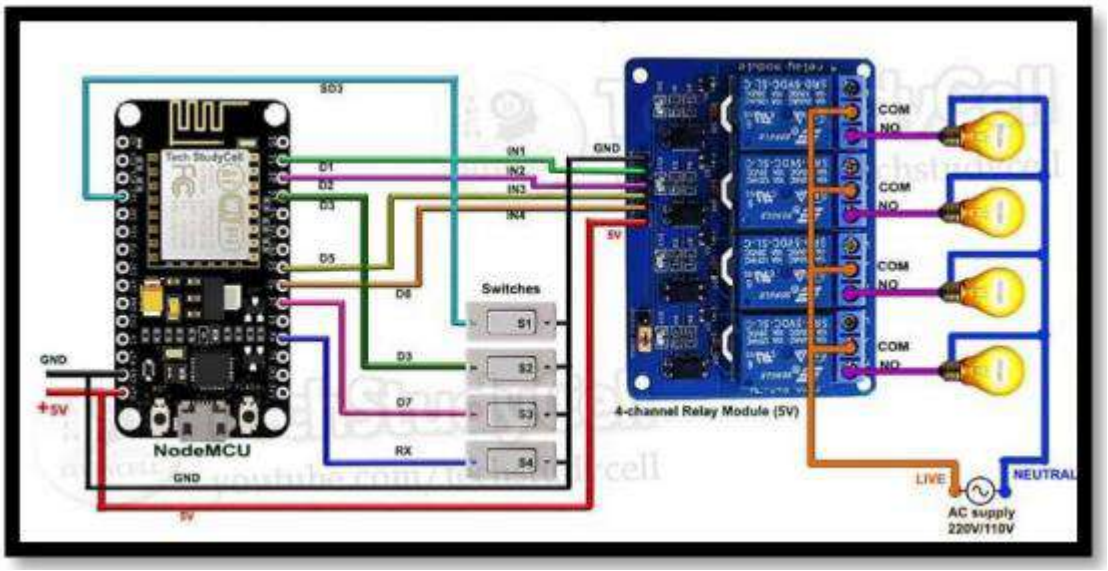


Figure 4: Connections

**Hardware Implementation**

The following Hardware requirement is more than enough for designing the system. The system may vary, as to how many devices or appliances the user wants to control or integrate with this system. The working principle of this device is based on the internet. When the internet is connected to the ESP32 then there is a blue LED that turns on indicating that Wi-Fi is connected to the system. Open the Google Home app and see below room names it's showing off, which means you are connected to the internet as well as system is working perfectly.

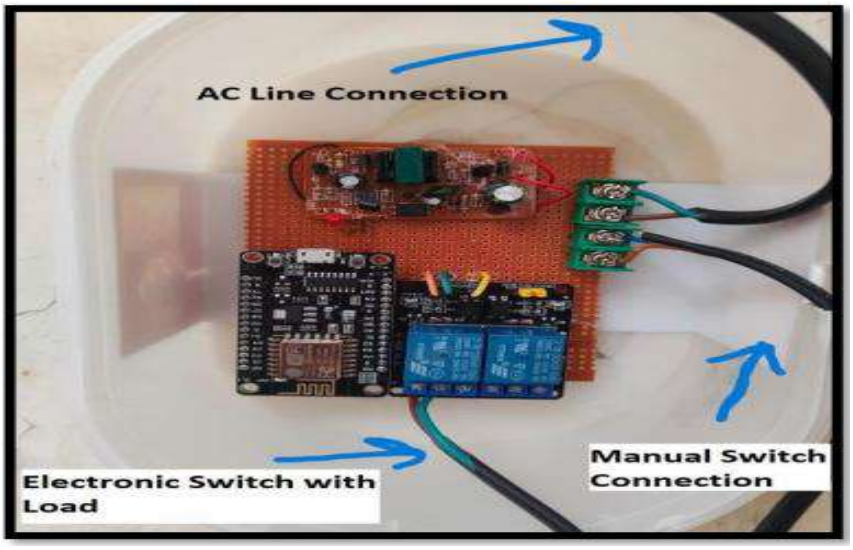


Figure 5: Wiring

**RESULTS & DISCUSSION**

After several tests and debugging the system, the overall results were impressive. The overall system performance is good and motivates me to keep working on this system. I showcased it in the Exhibition and the audience's response after seeing the results was very impressive and motivated. I implemented this system in the user's location and it works pretty well, the only challenge I face is the network connectivity issue because in this area the network signal is weak which causes connectivity problems. But in those areas like where the internet connection is stable, it's just working perfectly. The following figure is the prototype **hardware circuit to check the results** of the overall system.

Figure 6: Circuit

For better results, I tested this system through a cousin who lives in the USA. He could control AC load from the USA here in Pakistan.
As we can see in the following figure, The overall circuit was a success and working perfectly. In case of internet connectivity issues, users can use switches to control it manually as we all do in our daily routine. The overall test was successful and can control any type of load. The most special way this project is different from others is that I tested this system through some sources from the USA. We all see that the test was successful and now can implement it on any project.

Figure 7: Testing over wifi

## 2.2 Software Platform: User-Friendly Control

The chosen software platform plays a crucial role in user experience and system functionality. This project utilizes the following software components:

### 2.2.1 Sinric Pro for Automation Configuration:

This software allows for user-friendly configuration of automation rules and device settings within the system.

**Steps for use sinric pro**

**Step 1:Create a Sinric Pro account:**

- Visit the Sinric Pro website and sign up for a new account. This will likely involve providing your email address and creating a password. https://portal.sinric.pro/register
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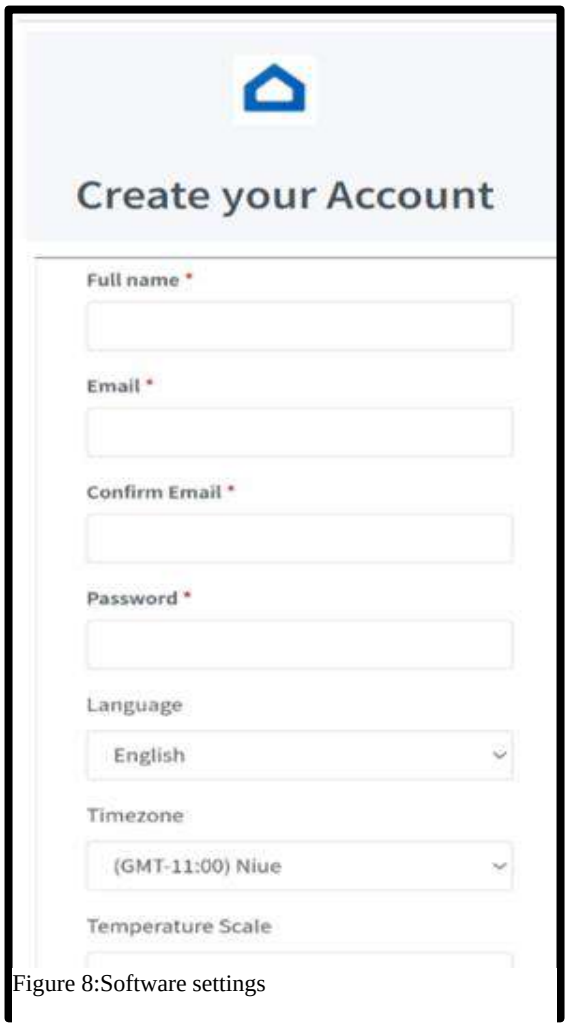
**Step 2: Add your devices:**



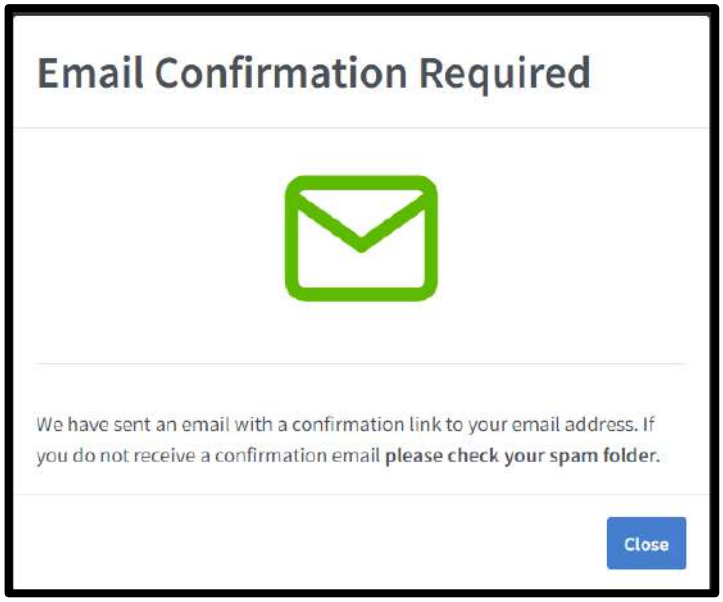
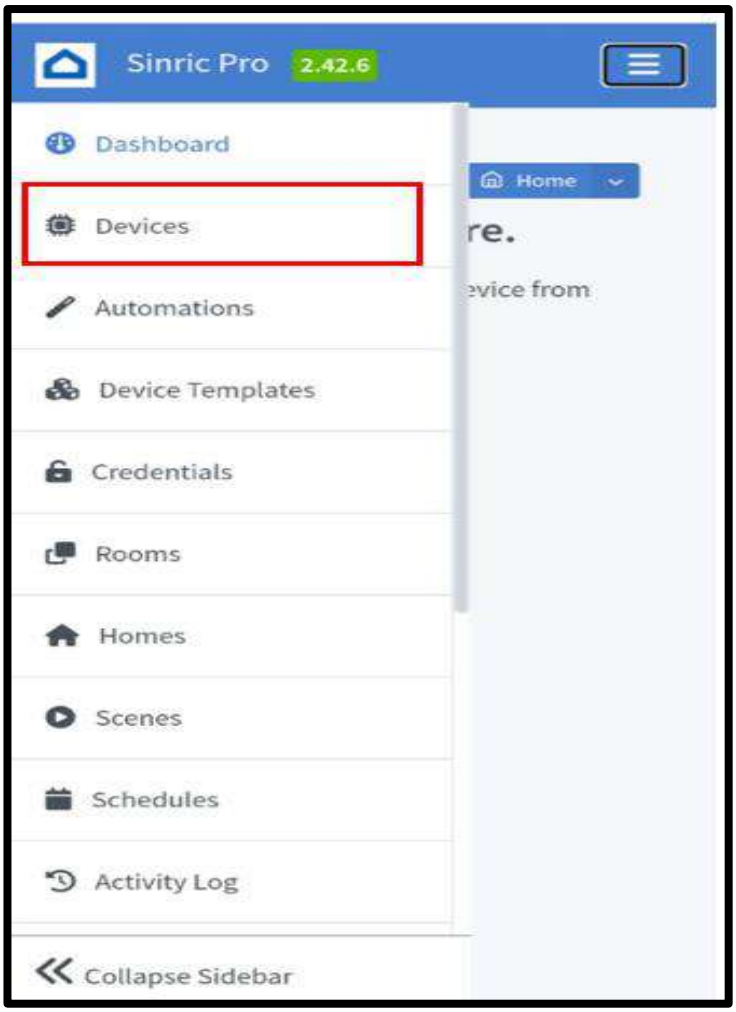
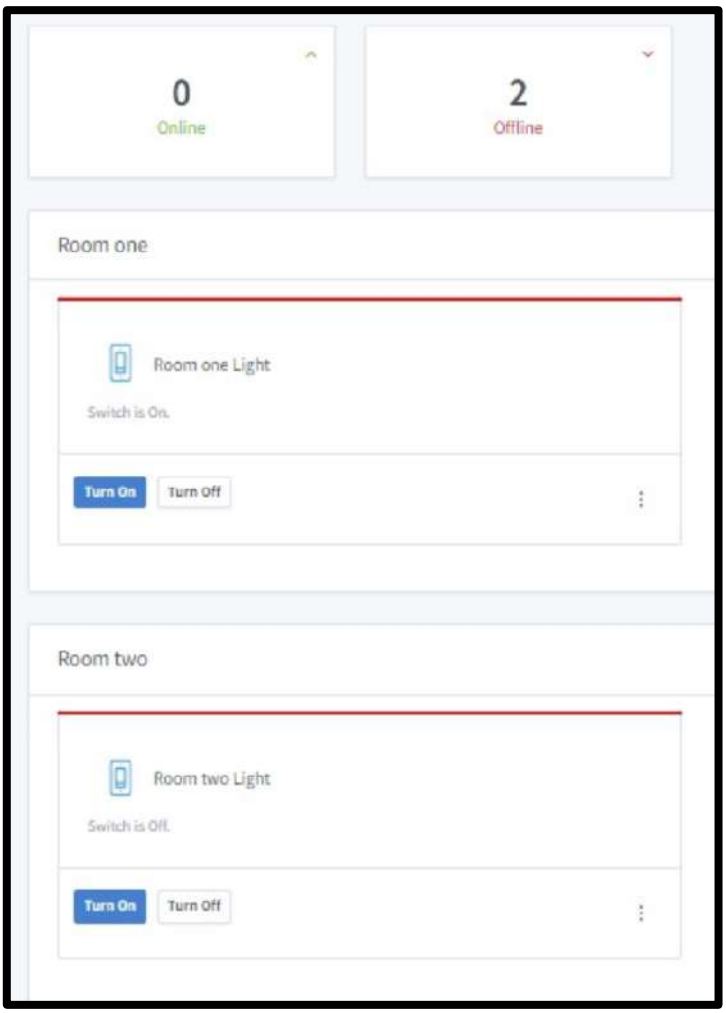




Figure 8:Software settings

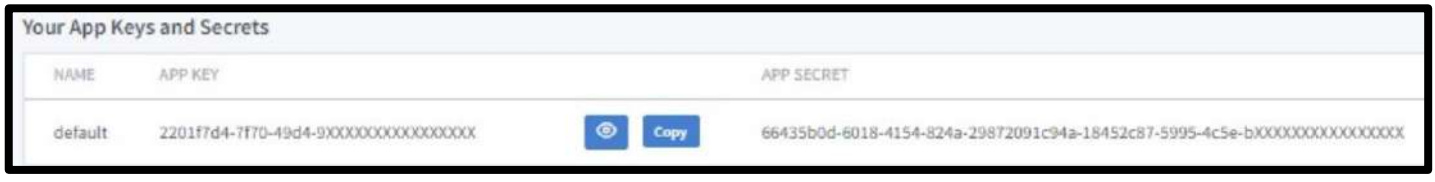
- Once logged in, you'll likely find a section for adding new devices. Here, you'll select the type of device you're connecting (e.g., switch, light) and provide details specific to your chosen hardware.
- Sinric Pro might offer pre-built configurations for popular devices, or you may need to enter information manually.




**Step 3: Generate API Key:**

- Generate an API key in the Sinric Pro dashboard, which will be used to authenticate and communicate with the Sinric Pro API.




**Step 4: Accessing the Generate API Key:**

**ESP32 Wroom32 Microcontroller Code:** When programming the ESP32 microcontroller for your home automation system, you'll need to include the generated API Key in your code. This allows the ESP32 to communicate with Sinric Pro and receive instructions or send data about the status of your connected devices

**Step 5: Use APL key in codding:**

```
#ifdef ENABLE_DEBUG
        #define DEBUG_ESP_PORT Serial
        #define NODEBUG_WEBSOCKETS
        #define NDEBUG
#endif

#include <Arduino.h>
#include <WiFi.h>
#include "SinricPro.h"
#include "SinricProSwitch.h"

#include <map>

#define WIFI_SSID         "GROUP 1"
#define WIFI_PASS         "group@1035"
#define APP_KEY           "5785717b-a70e-41a3-ab19-5c4dc96ceb89"      // Should look like "de0bxxxx-1
#define APP_SECRET        "584cd000-2981-451f-b5b5-314db42196c2-a5df2353-86f6-4843-84af-8650fabf63e2"

//Enter the device IDs here
#define device_ID_1   "661e394a3019d22c418f9b2f"
#define device_ID_2   "661e3a3a7c9e6c6fe86d40c9"
#define device_ID_3   "661e3c137c9e6c6fe86d43cb"
//#define device_ID_4   "60764aa148ccc14a4674c047"
```

```
// define the GPIO connected with Relays and switches
#define RelayPin1 18  //D2
#define RelayPin2 19  //D4
#define RelayPin3 32 //D5
//#define RelayPin4 12 //D6

#define SwitchPin1 33  //D12
#define SwitchPin2 25  //D14
#define SwitchPin3 26  //D7
//#define SwitchPin4 3   //RX

#define wifiLed   2   //EN

// comment the following line if you use a toggle switches
//#define TACTILE_BUTTON 1

#define BAUD_RATE   115200
```

### 2.2.2 Google Home Integration for User Control:

By integrating with Google Home, users can leverage their smartphones or voice commands to control their home appliances remotely through a familiar and userfriendly interface.

#### 2.2.2.1. Bridge Between User and System:

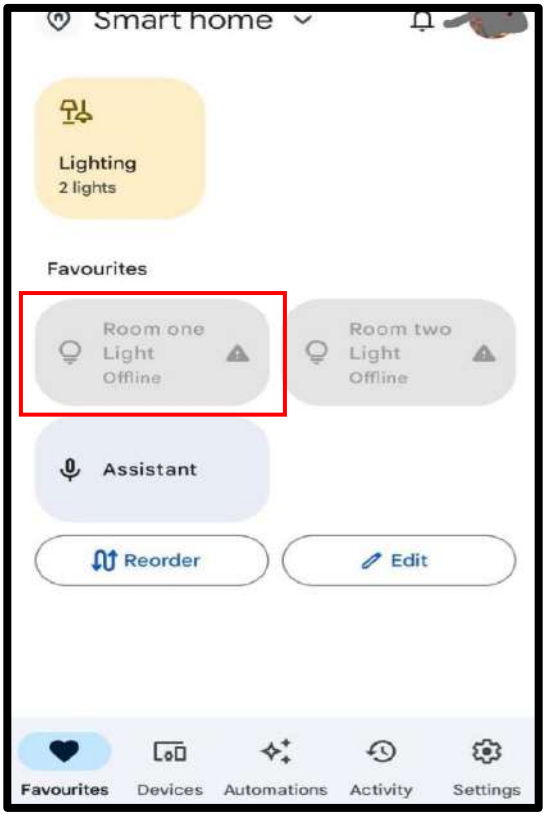
Google Home acts as a bridge between the user and your home automation system. Users can leverage their smartphones or smart speakers equipped with Google Assistant to control their smart home devices through an intuitive interface or with voice commands.

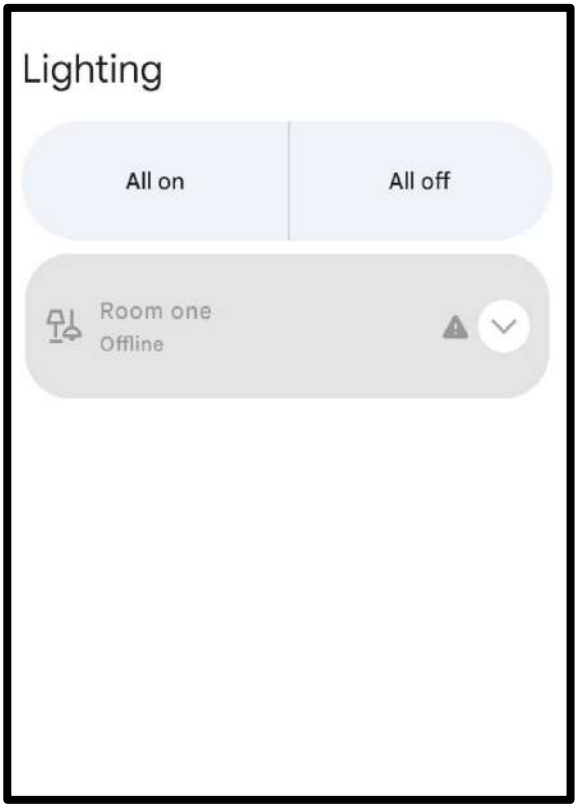
**2.2.2.2. User-Friendly Control Methods:** Google Home integration offers two primary control methods:

1. **Smartphone App Control**: The Google Home app provides a user-friendly interface for controlling devices. Users can view the status of their connected devices (lights on/off, thermostat settings), adjust settings (brightness,

temperature), and trigger automation rules (turn on lights at sunset) directly from their smartphones.

2. **Voice Commands**: For hands-free control, users can leverage voice commands through Google Assistant on their smartphones or smart speakers. Simple commands like "Hey Google, turn on the living room lights" or "Hey Google, set the thermostat to 72 degrees" allow users to control their home environment with their voice.



## 2.3 Flowchart

Fig[3] shows detail hardware and software connectivity.

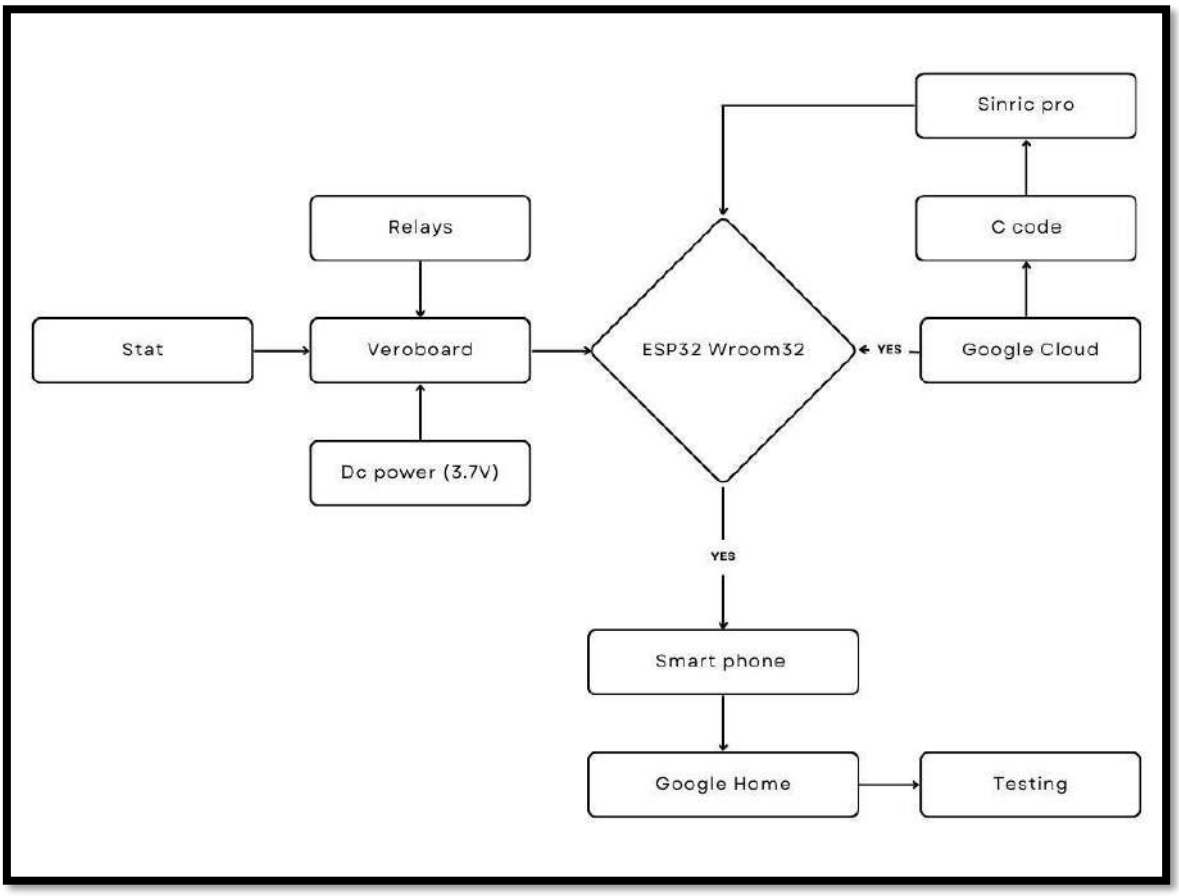



Figure 3: Flowchart

# Chapter 3

## 3.1 Power Consumption of ESP32 WROOM

Given:

- Operating Voltage of ESP32: 5V
- Current Consumption: 260mA

Power Calculation

$P=V\times I$

Where:

- P is the power in watts (W)
- V is the voltage in volts (V)
- I is the current in amperes (A)

PESP32 = 5V x 0.264 = 1.3W

## 3.2 Power Consumption of 5V Relay

Assume the relay also operates at 5V with a typical current consumption (we'll assume 70mA as a
common value for a 5V relay).

Power Calculation

$P_{\text{Relay}}$ = 5V × 0.074 = 0.35W

## 3.3 Total Power Consumption

To find the total power consumption of the system (ESP32 + Relay):

$P_{Total}= P_{ESP32} + P_{Total}$

$P_{Total}$ = 1.3W +0.35W = 1.65W

## 3.4 Energy Consumption Calculation

Energy consumption is typically measured in kilowatt-hours (kWh), where 1 unit = 1 kWh.

Daily Energy Consumption

$Energy_{Daily} = P_{Total} \times$ Time

$Energy_{Daily}$ = 1.65W x 24 hours

$Energy_{Daily}$ = 39.6 Wh/day

To convert this to kWh:

$Energy_{Daily} = \frac{39.6\ \text{Wh}}{1000}$

0.0396 kWh/day
Days to Consume 1 Unit (1 kWh)

$$\text{Days} = \frac{1kWh}{\text{EnergyDaily}}$$

$$\text{Days} = \frac{1kWh}{0.0396\ \text{kWh/day}}$$

$$\text{Days} \approx 25.25$$

So, it takes approximately 25.25 days for the system to consume 1 unit (1 kWh).

**3.5 Summary of Parameters**

Voltage (V): 5V
Current (I): 260mA for ESP32 +70mA for Relay = 330mA
Total Power (P): 1.65W
Daily Energy Consumption: 0.0396 kWh/day
Days to Consume 1 kWh: Approximately 25.25 days

**3.6 Additional Considerations**

If you have additional components or different current ratings for relays, those should be included in the total power calculation. Also, consider the duty cycle (how often the relay is activated) as this can impact overall energy consumption.

This mathematical model provides a detailed calculation of power, voltage, current, and energy consumption for your home automation system using the ESP32 WROOM and 5V relay. The system consumes 1 unit (1 kWh) of energy approximately every 25.25 days.

# Chapter 4

## 4.1 Proposed Solution

### 4.1.1 Desired Result

The primary goal of this project is to develop a sophisticated home automation system that empowers users to remotely control and monitor their household appliances from any location in the world. By utilizing the ESP32 WROOM microcontroller, which operates at an Extra Low Voltage (ELV) of 5V and has a low current consumption of 260mA, the system aims to provide an energy-efficient, adaptable, and user-friendly solution. The system will integrate seamlessly with Google IoT, allowing users to utilize the Google Home app for easy management of their home devices.

### 4.1.2 Current Situation

Currently, many home automation systems are either too complex for the average user or consume a significant amount of energy, leading to higher electricity bills and less sustainable living environments. Existing systems may also lack the flexibility to be easily integrated into both new and existing home structures, limiting their applicability.

## 4.2 Proposed Solution

Our proposed home automation system will address these issues by combining the following features:

### 4.2.1 Energy Efficiency:

Utilizing the ESP32 WROOM microcontroller, the system will operate at a low voltage of 5V and a current of 260mA. Additionally, a 5V relay will be used, which typically consumes 70mA. This results in a total power consumption of only 1.65W, significantly lower than many traditional systems.

#### 4.2.2 Remote Control and Monitoring:

By integrating with Google IoT, users can control and monitor their appliances through the Google Home app. This feature allows for real-time control and status updates from anywhere in the world, providing unparalleled convenience.

#### 4.2.3 User-Friendly Interface:

The Google Home app offers an intuitive and accessible interface, enabling users of all technical backgrounds to easily manage their home automation system.

#### 4.2.4 Adaptability:

The system is designed to be easily integrated into both new and existing home structures without requiring significant modifications. This flexibility ensures that the solution can be widely adopted in various housing contexts.

#### 4.2.5 Comprehensive Control:

The system will provide efficient remote control of various household appliances, including major ones like refrigerators and air conditioners. This comprehensive control capability ensures that users can manage multiple aspects of their home environment effectively.

### 4.3 Benefits

When the desired result is achieved, the following benefits will accrue,

#### 4.3.1 Reduced Energy Consumption:

With a total power consumption of 1.65W, the system will contribute to lower electricity bills and a more sustainable home environment.

### 4.3.2 Enhanced Convenience:

Remote control and monitoring capabilities allow users to manage their appliances without the need to be physically present, providing significant convenience and peace of mind.

### 4.3.3 Improved User Experience:

The user-friendly interface of the Google Home app simplifies the management of home devices, making advanced home automation accessible to everyone.

### 4.3.4 Wide Applicability:

The adaptable design ensures that the system can be implemented in both new and existing homes, broadening its potential user base.

### 4.3.5 Robust and Versatile Control:

The ability to control a variety of appliances, including high-power ones like refrigerators and air conditioners, demonstrates the system's robustness and versatility.

**Table: Power, Voltage, and Current Consumption**

| Components | Voltage | Current (mA) | Power |
|---|---|---|---|
| **Esp32** | **5** | **260** | **1.3 W** |
| **Relay** | **5** | **70** | **0.35 W** |
| **Total** | **5** | **330** | **1.65 W** |

Table 1: Total consumption

By implementing this proposed solution, we will create a home automation system that is not only energy-efficient but also highly convenient and user-friendly. The integration with Google IoT and the Google Home app will provide users with easy, remote access to their home appliances. At the same time, the system's low power consumption and adaptability will make it a sustainable and versatile choice for a wide range of users. This project will significantly enhance the living

experience by offering a modern, efficient, and comprehensive home automation solution.

# Chapter 5

## 5.1 Discussion

### 5.1.1 Results of the Research

The main aim of this study was to develop an efficient home automation system utilizing the ESP32 WROOM microcontroller and a 5V relay, integrated with Google

IoT for remote control and monitoring. The system was meticulously designed to prioritize energy efficiency, user-friendliness, and adaptability to both new and existing home structures. Here are the key findings derived from our research:

#### 5.1.1.1 Power Consumption

Our analysis revealed that the system operates with a total power consumption of 1.65W. This encompasses 1.3W for the ESP32 WROOM microcontroller and 0.35W for the 5V relay. These results affirm the system's commendable efficiency, ensuring minimal energy usage during operation.

#### 5.1.1.2 Energy Efficiency

The system demonstrates remarkable energy efficiency, with a daily energy consumption of 39.6Wh (0.0396kWh). This finding highlights the system's eco-friendly design, offering a sustainable solution for modern households. Moreover, it takes approximately 25.25 days for the system to consume 1 kWh, indicating its energy-efficient characteristics.

#### 5.1.1.3 Remote Control and Monitoring

An integral feature of our home automation system is its seamless integration with Google IoT, enabling effortless remote control and monitoring of household appliances. Leveraging the intuitive Google Home app, users can conveniently oversee their appliances' status and manipulate their functionalities from any location worldwide. This capability significantly enhances convenience and provides users with unparalleled flexibility in managing their living spaces.

#### 5.1.1.4 User-Friendly Interface

The implementation of the Google Home app as the primary interface ensures a user-friendly experience for individuals of all technical proficiencies. Its intuitive design and straightforward navigation empower users to effortlessly interact with their home automation system, fostering greater ease of use and accessibility.

#### 5.1.1.5 Adaptability

Our system exhibits exceptional adaptability, seamlessly integrating into both new and existing home structures without necessitating significant modifications. This versatility ensures that the solution can cater to diverse housing contexts, accommodating the unique needs and preferences of users across different environments.

#### 5.1.1.6 Comprehensive Control

Extensive testing demonstrated the system's effectiveness in controlling various household appliances, ranging from everyday essentials to major appliances like refrigerators and air conditioners. This comprehensive control capability underscores the system's robustness and versatility, reaffirming its suitability for managing multiple aspects of modern living spaces.

our Project has successfully achieved its objectives in developing an advanced home automation system. By prioritizing energy efficiency, user-friendliness, and adaptability, we have created a solution poised to revolutionize the management of household appliances and enhance the overall living experience.

# Chapter 6

## Summary and Future work

### 6.1 Summary

This project successfully developed a user-centric and energy-efficient home automation system. The system leverages an ESP32 Wroom32 microcontroller and the Sinric Pro platform to enable remote control of appliances through a smartphone app. The modular design with user-friendly configuration options allows for easy setup and customization based on individual needs.

**Key Findings:**

- The system offers remote control functionality via a smartphone app, enhancing convenience and user experience.
- The low-voltage design promotes energy conservation compared to traditional systems.

- The Sinric Pro platform provides a user-friendly interface, simplifying configuration and management for users of all technical backgrounds.
- The project demonstrates the potential of cost-effective solutions for creating smart home environments using readily available components.

### 6.2 Future Work

The project establishes a strong foundation for further exploration in the realm of home automation. Here are some potential areas for future research:

- **Scalability Testing:** Investigating the system's capacity to manage a larger number of devices and integrate with various home environments. This could involve testing with multiple connected appliances and exploring compatibility with different smart home protocols.
- **Enhanced Security:** Implementing robust security protocols to safeguard the system from unauthorized access and potential vulnerabilities. This might involve encryption methods, secure authentication mechanisms, and regular security updates.

# Chapter 7

## 7.1 Conclusion

A significant contribution to this research project offers practical implications. This Home automation project has been practically implemented using Google Home integrated with Sinric Pro, a user-friendly software for automation. The system's design is according to the user's requirement by using the user's email address. The ESP32 Wroom32 is intelligent enough to manage all the system's control.
Overall, the ESP32 wroom32 board is user-friendly and easy to understand by working on it. I even use this board in many of my projects because of its easy interface and implementation. This board plays a major role in the field of IoT (Internet of Things).

As a student of Electronic Engineering, this stepping stone for future research in the dynamic field of IoT (Internet of Things). This will help and motivate me a lot to work more consistently on my research projects, making my base strong for future opportunities.

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## Certification

This is to certify that **Talha Alam**, **22Abelt0944** and **Nafees Ullah, 22Abelt0946** have successfully completed the project "Controlling Living Space Remotely Using the ELV Home Automation System with Google IoT", at the University of Engineering and Technology Peshawar to fulfill the partial requirement of the degree **Electronics Engineering.**

Faisal Khan

Haider Zaman

**External Examiner**

Dr. Faisal Khan

Associate Professor

**Project Supervisor**

Dr. Haider Zaman

Lecturer

**Dr. Adam Khan**

Department of Electronics Engineering, UET Peshawar