School of
Electronics and Communication Engineering

Minor-1 Project Report

on

Smart Home Automation

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SCHOOL OF ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

This is to certify that project entitled **" Smart Home Automation "** is a bonafide work carried out by the student team of **" Zeeshan Mirji (01FE21BEI019), Muzammil Kharadi (01FE21BEI021), Prajwal Shiggavi (01FE21BEI032), Abdul Razzak R Yergatti (01FE21BEI049) "**. The project report has been approved as it satisfies the requirements with respect to the minor-1 project work prescribed by the university curriculum for BE (VI Semester) in School of Electronics and Communication Engineering of KLE Technological University for the academic year 2023-2024.

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ABSTRACT

In recent years, smart home automation has become an attractive choice for improving homeowners' convenience, security, energy efficiency, and general quality of life. An overview of the main ideas, innovations, and advantages of smart home automation is given in this report. We represent in this project the design and implementation of a NodeMCU microcontroller-based comprehensive home automation system. In order to monitor and manage home factors including temperature, humidity, gas leak detection, flame detection, water tank levels, raindrop detection, home security, and electrical appliances, the system incorporates a number of sensors. A centralized Blynk app is used for monitoring and control. The sensors are positioned strategically around the house and are connected to NodeMCU microcontrollers. A camera module is also used for security surveillance, and video recordings are sent to the cloud for remote access. The system functions by continually collecting sensor data, analyzing it with the help of NodeMCU modules, and delivering control choices and real-time updates through the Blynk app interface. Consequently, homes will benefit from increased convenience, security, and comfort.

Contents

Chapter 1

Introduction

In the first chapter of the report, we have given an overview of the problem and the requirements. In addition, by researching the topics and reading a large number of reports and articles, we have completed a review of the literature and developed recommendations. Since the introduction of Internet of Things (IoT) technology, home automation systems have gained popularity as a means of improving home energy efficiency, safety, and convenience. The goal of our project is to create a complete home automation system that combines a number of sensors with control systems to keep an eye on and regulate different aspects of the house. NodeMCU microcontrollers are used in the system; they are low-cost, low-power, Wi-Fi-enabled platforms built around the ESP32 chipset[1]. We can develop a scalable and adaptable home automation system that is simple to modify to meet various needs by utilizing NodeMCU's features.

1.1 Motivation

1)Safety first: A safe living environment is guaranteed with instant alarms for gas leaks and cooking fires.
2)Always Alert: Peace of mind is provided by motion detection and video monitoring outside the entrance.
3)Resource-wise Living: Optimal resource use is achieved by real-time information on temperature, humidity, and water levels.
4)Easy Living: Using the Blynk app to operate appliances remotely enhances comfort and convenience.
5)Modern Living: Adopt the newest IoT innovations for a tech-aware way of living.

1.2 Objectives

1)Safety, Security, and Real-Time Monitoring: Use sensors and camera surveillance to improve security and safety while offering real-time rain, water level, gas, temperature, and humidity monitoring.
2)Remote Appliance Control and Alerting System: Use an alerting system to quickly inform users of anomalies or security breaches, and enable remote control of electrical equipment for ease and energy efficiency.
3)Integration with Mobile Apps and Scalability: Connect your system to a mobile app for convenient monitoring and management from any place, and make sure it can grow to accommodate future technological breakthroughs and new requirements.

1.3 Social Context

Real-time data from the cloud can be accessed from anywhere, and we can keep track at home. For example, when the homeowner is not present in the house, some sensors can sense if any thief or other thing is going on in his house; the sensed data is sent to the owner, who can monitor the data from anywhere on the earth and can alert the user about the activity. It is beneficial for the people and the government to make decisions. Moreover, it can prevent the upcoming disaster.

1.3.1 SDG connect

Several UN Sustainable Development Goals (SDGs) are in line with this project:

- SDG 7: Affordable and Clean Energy
- SDG 9: Industry, Innovation, and Infrastructure
- SDG 11: Sustainable Cities and Communitiess

1.4 Literature survey

To improve convenience, safety, and security throughout the house, a range of sensors and modules are strategically positioned and integrated by the home automation system. The installation of gas and flame sensors in the kitchen room guarantees quick identification of possible gas leaks or fire breakouts, reducing hazards and protecting people from injury[1]. Comparably, adding the motion sensor and camera module to the front door offers more sophisticated security capabilities that let homeowners keep an eye on things and take action, including monitoring suspicious activity or unlawful access. When combined with the processing capability of the central hub, these sensors give consumers instantaneous information about the state of their homes and allow prompt action when needed [2].

Moreover, the central hub of the system serves as the brains, coordinating the exchange of information among sensor nodes and enabling a smooth integration with the Blynk mobile application. By utilizing WiFi connectivity, the central hub gathers data streams from various sensor nodes, analyzes the data, and uses the Blynk interface to provide users with actionable insights[3]. Homeowners may remotely regulate electrical appliances for maximum comfort and energy efficiency, monitor temperature and humidity levels, and receive warnings for unusual events like gas leaks or rains using the user-friendly smartphone interface. By combining sensor data with user-centric control mechanisms, homeowners can now see and manage their living spaces like never before, improving convenience and safety at the same time[4].

The main method by which homeowners communicate with the system is via the Blynk smartphone app. Users may remotely monitor and operate connected equipment from the comfort of their smartphones or tablets. Regardless of where they are physically located, homeowners have unparalleled control over their living environment, whether it is by changing the temperature, monitoring the level in the water tank, or shutting off lights[5].

Through camera modules, our system incorporates security surveillance capabilities in addition to sensor-based monitoring and appliance management. These modules record video from important locations, including kitchens and entry doors, then broadcast it to the cloud for remote access and storage. In addition to improving home security, this gives homeowners piece of mind because they can keep an eye on their property in real-time and examine recorded footage as needed. Thanks to its scalability, versatility, and focus on comfort, security, and safety, our home automation system is a major step forward in modern home management [6].

1.5 Problem Statement

Design and implement an all-encompassing home automation system with ESP that provides homeowners with centralized control and monitoring capabilities for essential home parameters. In order to give consumers convenience, safety, and efficiency, the system should smoothly monitor temperature, humidity, gas leakage, water tank levels, home security, and electrical appliances.

1.6 Organization of the report

In this section we have covered Chapter 1: the introduction of our project the next sections/chapters will cover Chapter 2: block diagram and specifications, Chapter 3: algorithm and flowchart, Chapter 4: results and discussions, Chapter 5: Conclusions.

Chapter 2

System Design

2.1 Functional Block Daigram

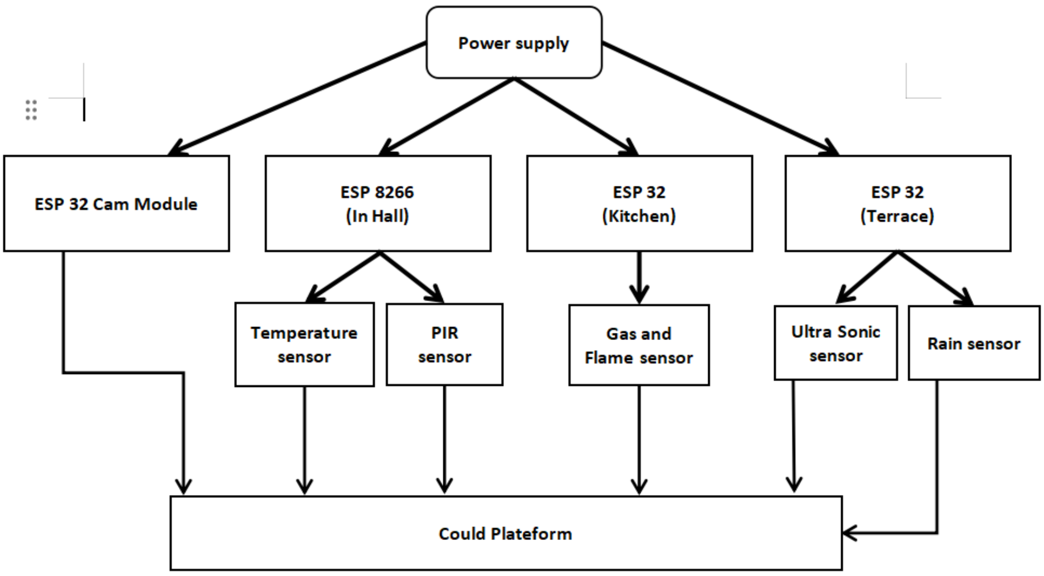

Figure 2.1: Block Diagram

The Figure 2.1 shows the functional block diagram:

1)Power Supply: Every part of the system is powered by the power supply.

2)Gathering Sensor Data: The sensors gather information from their surroundings
Temperature sensor: measures the Hall's temperature.
Hall motion is detected by the PIR sensor.
Flame and Gas Sensor: identifies any flames or gas leaks in the kitchen.
Using an ultrasonic sensor, you can measure the water level on the terrace.
Rain sensor: recognizes rainfall on the terrace

3) Transferring Data to the ESP32 Camera Module : The ESP 32 Cam Module gathers data from its surroundings and transmits it to the cloud.

4) Remote Monitoring and Supervisors : A cloud platform or mobile app can be used to remotely monitor and control the system. Real-time seeing of the camera footage and sensor data is available to users. And, depending on sensor data, receive the alert signal

2.2 Technical Requirements

2.2.1 Hardware

- ESP32 and ESP8266 microcontrollers
- Sensors: DHT11, PIR , MQ-135, Flame, Ultrasonic, Rain level
- Camera module for security
- Relays for controlling electrical appliances

2.2.2 Software

- The Arduino IDE: is used to program the microcontrollers ESP32 and ESP8266.
- Home Automation Platform: To integrate and manage all IoT devices, such as Home Assistant.
- Mobile App: Possibly created bespoke or with platforms like Blynk, enabling real-time control and monitoring.

2.2.3 Bill of Materials

Table 2.1: Bill

Components Required	**Number of components**	**Price(Rs.)**
NodeMCU	03	1350
Flame sensor	01	40
DHT11 sensor	01	50
MQ 05 sensor	01	80
Ultrasonic sensor	01	50
Raindrop sensor	01	100
PIR sensor	01	70
2-channel Relay module	01	60
camera module	01	850
Connecting Wires	–	60
Fibreboard, Cardboard / Container	02	80

Table 1.1 provides a comprehensive list of the essential components required for the project along with their corresponding prices.

2.3 Algorithm:

Step 1: A power supply of 5V is supplied to the system.

Step 2: The sensor connections are made according to the circuit diagram.

Step 3: The power supply powers up the ESP8266 and ESP32.

Step 4: The code is implemented using Arduino IDE.

Step 5: The mobile application can handle the manual mode and automatic mode.

Step 6: The sensors are activated and send the data to the Blynk cloud.

Step 7: The channel is created in the Blynk cloud and data is recorded in it.

Step 8: The resulting data is shown in the Blynk cloud

2.4 Flow Chart:

ESP32 and ESP8266 are two ESP modules used in this home automation project to create a smart home environment. The system has various zones, including the area outside the main door, the hallway, the kitchen, and the terrace. Each zone is outfitted with particular sensors and modules that connect to a cloud platform for monitoring and control. A central power supply provides power to the entire system.

2.4.1 Top Level:

Power Supply to Every ESP Module

Power Supply to Every ESP Module : this is the initial stage, supplying all ESP modules placed throughout the house with the necessary power.

2.4.2 second and third level:

Outside Main Door (ESP32 Cam Module)

Streaming Video: Recording footage from outside the main entrance. Browser Updates: allows a web browser to receive the video feed in real-time for monitoring.

Owner Uses Phone to Monitor: enables the owner to use their phone to watch the video feed.

Owner Monitors through Phone: This feature enables the owner to watch the live video stream on their phone.

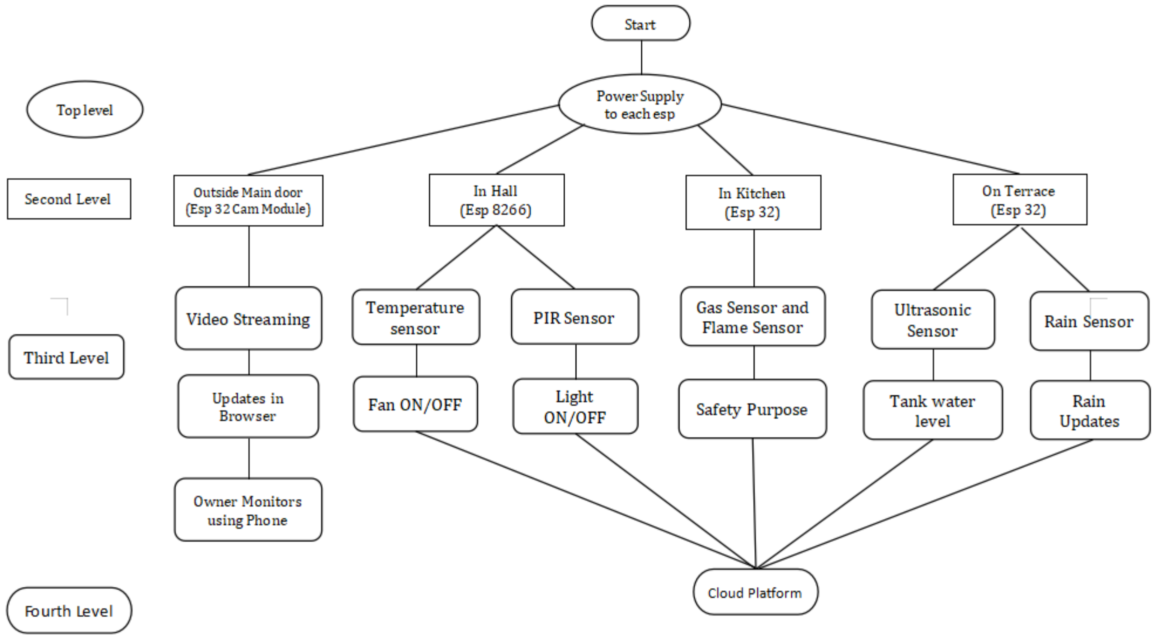

Figure 2.2: Flow Chart

The figure 2.2 shows the flow chart:

In Hall (ESP8266)

Temperature sensor: Determines the hall's temperature.
Fan ON/OFF: Utilizes temperature readings to control the fan.
PIR Sensor: Understands movement in the hallway.
Light ON/OFF: Uses motion detection to turn on and off the lights.

In Kitchen (ESP32)

Gas and flame sensors: monitor possible fire and gas leaks.
Safety Purpose: Guarantees safety by warning the owner in the event of a fire or gas leak.

On Terrace (ESP32)

Ultrasonic Sensor: The tank's water level is measured by an ultrasonic sensor.
Tank Water Level: Refreshes the status of the water level. Rain sensor: a rain detector.
Rain Updates provides real-time rain detection updates.

2.4.3 Fourth Level

Cloud Platform

The central location for integrating all of the devices and sensors.
This makes it easier to monitor and manage the home automation system remotely.
Provides notifications and alerts based on sensor readings and saves data for later analysis.

2.5 Specifications and System Architecture

1) ESP32 Cam Module:

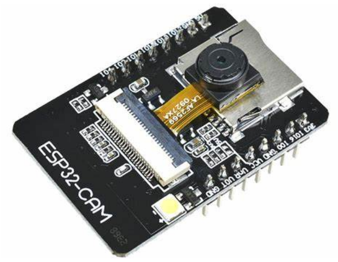

Figure 2.3: camera module

Fig 2.3 is the camera supports resolutions up to 1600x1200, and the ESP32 Cam Module combines Bluetooth and Wi-Fi for wireless connectivity. It runs on a 3.3V power supply, perfect for Internet of Things projects that use video streaming. The Cam Module is used in Live video streaming by placing the ESP32 Cam Module outside the main entrance. The homeowner can view this feed through a web browser and see real-time footage of the front door

2) DHT11 sensor:

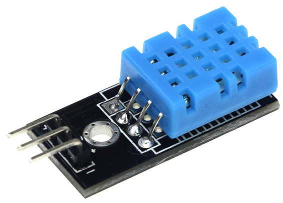

Figure 2.4: DHT11 sensor

Fig 2.4 is the DHT11 sensor operates between 3.5 and 5.5 volts and measures both temperature and humidity. Its temperature and humidity ranges are 0°C to 50°C (±2°C and 20 to 90 RH, respectively, with ±5 accuracy in each case. The sensor can be used for various environmental monitoring applications because it produces digital signals. The ambient temperature is continuously monitored by the temperature sensor. The system has the ability to regulate the fan's on/off speed to ensure a comfortable atmosphere based on established thresholds.

3) PIR Sensor HC SR-501:

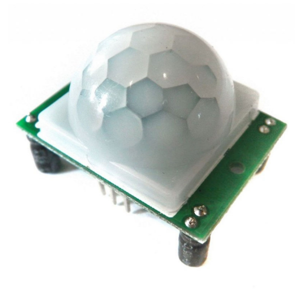

Figure 2.5: PIR Sensor

Fig 2.5 has a detection range of 3 to 7 meters With a 120-degree angle and an operating voltage range of 4.5V to 20V. Its current is still less than $50\mu A$. It works in temperatures ranging from -15°C to +70°C And used in The hall Here PIR (Passive Infrared) sensor picks up motion. The system can automatically turn on or off the lights when it detects movement, improving security and saving energy.

4) Gas Sensor (MQ-135):

Figure 2.6: Gas Sensor

Fig 2.6 is the MQ-135 gas sensor has a 10 to 1000 ppm detection range and runs at 5V. It can identify gases such as NH_3, NO_x, alcohol, benzene, smoke, and CO_2. It operates between -20°C and +50°C and outputs analog signals. It is used in our home automation project to monitor the air quality in the kitchen. It ensures safety by alerting the homeowner in the case of a gas leak or low air quality by detecting dangerous gases like CO_2, NH_3, and smoke.

5) Flame Sensor:

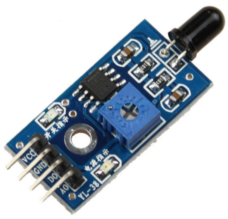

Figure 2.7: Flame Sensor

Fig 2.7 is flame sensor can detect wavelengths between 760 and 1100 nm and usually runs between 3.3 and 5 volts. It has digital and analog outputs, and its detection range is 0 to 1 meter. The sensor is appropriate for fire detection and safety systems because it is sensitive to flame and infrared light. It is used to o improve safety, a flame sensor has been installed in the kitchen. It alerts the homeowner in real time if it detects the presence of fire or flame. Early detection guarantees a timely response to disasters and helps prevent the risk of fire.

6) Ultrasonic Sensor:

Figure 2.8: Ultrasonic Sensor

Fig 2.8 is the HC-SR04 ultrasonic sensor uses about 15mA of power when operating on a 5V DC supply. It can precisely detect distances between 2 and 400 cm by emitting sound waves at a frequency of 40 kHz, which makes it a flexible option for proximity sensing applications. It used to measures the water level in the tank and notifies the owner, enabling them to control usage by being informed about the water levels.

7) Rain Level Sensor:

Figure 2.9: Rain Level Sensor

In Fig 2.9 , in order to measure the quantity of rainfall over a certain length of time, a rain gauge, also known as a rain level sensor, is necessary for hydrological research, agricultural planning, and meteorological observations. The principal parts consist of a rainwater collection collector and a type-variable measurement device. Common varieties include optical gauges, which use laser or infrared sensors to detect and measure raindrops; weighing gauges, which measure the weight of collected water to determine rainfall; and capacitance gauges, which measure changes in capacitance caused by water accumulation. Tipping bucket gauges use a pivoting bucket that tips when filled to a certain level, counting each tip as a measure of rainfall.

8) 2-channel Relay Module:

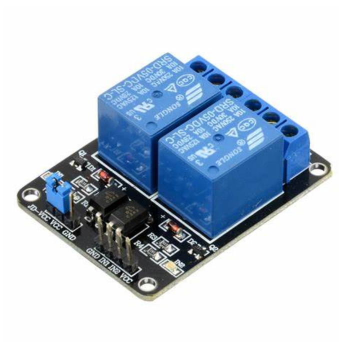

Figure 2.10: 2-channel Relay Module

In Fig 2.10 , addition to supporting a contact rating of 10A at 250V AC or 30V DC, the dual-channel relay module operates at 5V DC and has opto coupler isolation for secure microcontroller interfacing. For high-voltage device control in home automation projects, it is perfect. Lights and fans are controlled by it. It improves convenience and energy efficiency by enabling the system to remotely or automatically turn these devices on or off based on sensor inputs.

2.6 System Setup

1)Sensor Connection: Comprehensive guidance on attaching every sensor to the proper microcontroller module.

2)Programming Microcontrollers: You may upload code to the ESP32 and ESP8266 modules by using the Arduino IDE.

3)Integrating with Home Automation Platform: This section outlines the procedures for integrating the system for centralized control and monitoring with a home automation platform such as Home Assistant.

4)Mobile App Setup: Guidelines for configuring a mobile application for instantaneous supervision and management.

2.7 Challenges and Issues Faced

1)Hardware Limitations:
Limited Processing Power: ESP8266 has lower processing power compared to ESP32. This might limit complex functionalities or real-time processing needs. Consider using ESP32 if your project involves heavy sensor data processing or complex automation logic.
Limited Memory: Both ESP32 and ESP8266 have limited memory for code and data storage. This can restrict the size and complexity of your code. Optimize code to minimize memory usage and utilize libraries efficiently.

2)Software Development:
Coding Skills: Building a smart home system requires some programming knowledge. While Arduino IDE simplifies things, understanding core programming concepts is beneficial.
Library Dependence: You'll rely on libraries for various functionalities like sensor communication or cloud connectivity. Choosing the right library and keeping it updated is crucial.
Debugging Complexity: Debugging embedded systems like ESP boards can be more challenging compared to traditional PC development. Utilize serial monitors, code verification, and hardware checks as mentioned earlier.

3)Connectivity and Security:
Wi-Fi Reliance: These boards rely on a stable WiFi connection. Consider network congestion, signal strength, and potential outages.
Security Concerns: Connecting devices to the internet introduces security risks. Implement strong passwords, encryption (if applicable), and keep firmware updated.
Cloud Platform Dependence: If using a cloud platform for remote control, its reliability and stability become crucial factors. Explore local control options for backup functionality.

Chapter 3

Results and Discussion

3.1 Results

Tests were conducted on the ESP32 home automation system to assess its usability, performance, and dependability. A number of house factors, such as temperature, humidity, gas leak detection, flame detection, water tank levels, rain level, home security, and electrical appliances were all intended to be consolidated under the system's control and monitoring.

3.2 Analysis

Figure 3.1: Hardware setup

Fig 3.1 is the hardware setup of our system , where the three ESP32 microcontrollers are used in our home automation setup for the camera module, kitchen, and terrace, while one ESP8266 is in control of the hall. Each of the microcontroller is customized to meet the demands of the specific region it is installed in, and it is equipped with sensors. For centralized control, they use WiFi to connect to a central server and to each other. This configuration allows the system to be scalable and adaptable while guaranteeing effective administration of various regions.The values can be seen in the serial monitor as well as the IoT platform that is Blynk.

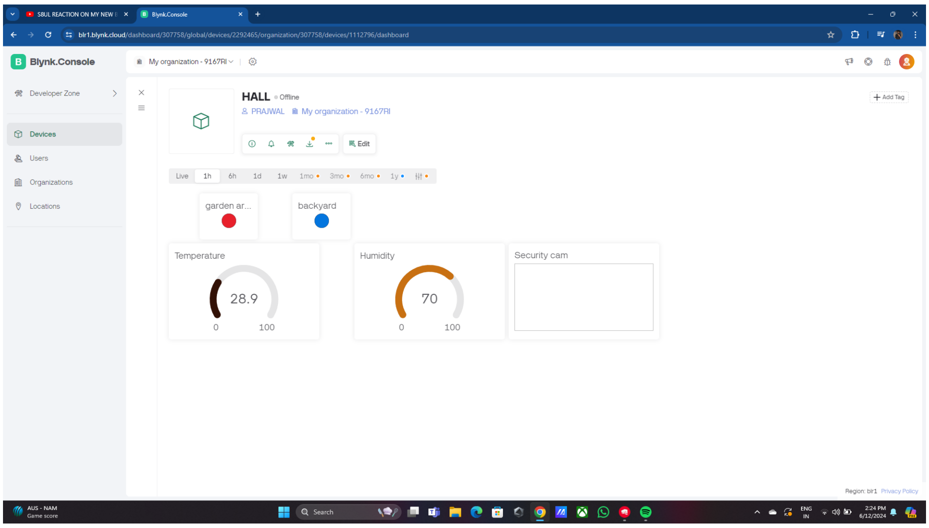

Figure 3.2: Blynk Cloud

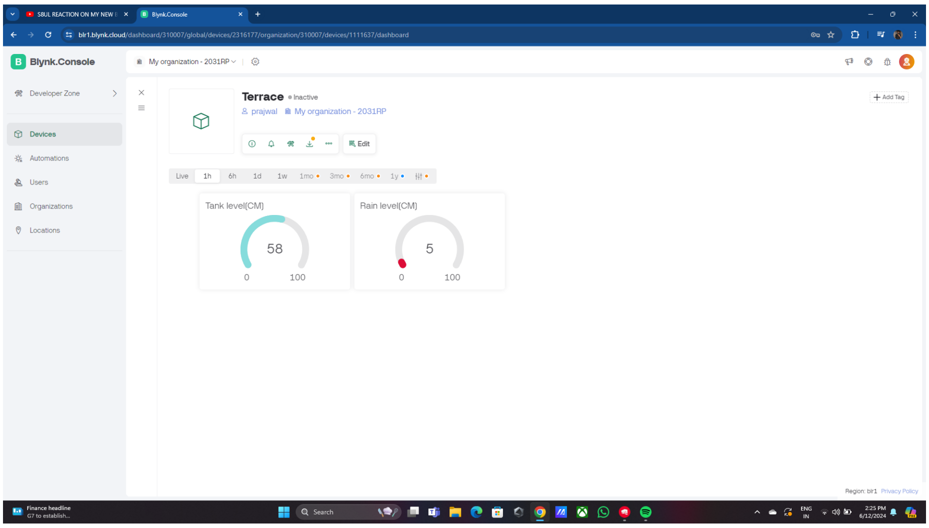

Figure 3.3: Blynk Cloud

In Fig 3.2, 3.3, 3.4 we are using the Blynk platform in our home automation system to smoothly integrate all sensor data and control commands. The Blynk cloud server receives the sensor readings from each ESP32 and ESP8266 microcontroller, which are configured to deliver data on temperature, humidity, gas levels, motion detection, and other topics.All incoming data from the microcontrollers is received and stored by the Blynk cloud server, which serves as a central hub. Users are then able to monitor their home characteristics in real-time from any location by using the Blynk smartphone app or web dashboard.

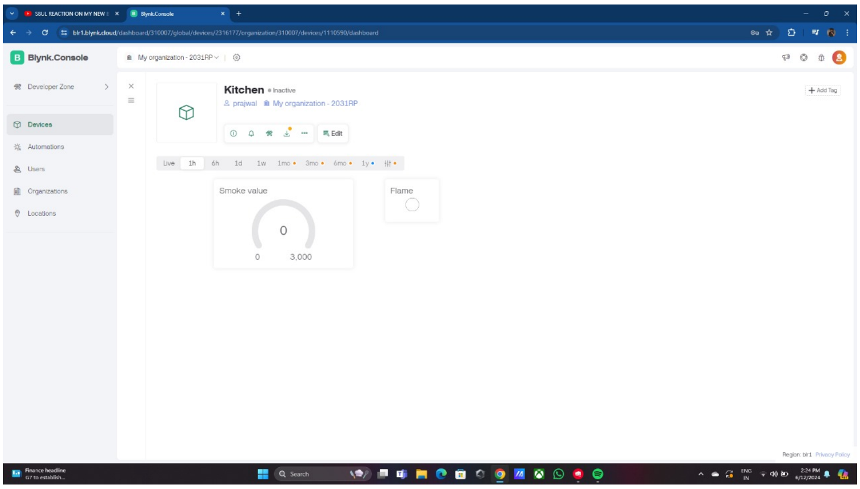

Figure 3.4: Blynk Cloud

Furthermore, users may remotely control lighting, appliances, and other linked devices by sending control commands to the microcontrollers via the Blynk app or dashboard. All things considered, our home automation system gives consumers an easy and centralized way to monitor and control their home environment from any location with an internet connection through the use of the Blynk cloud platform.

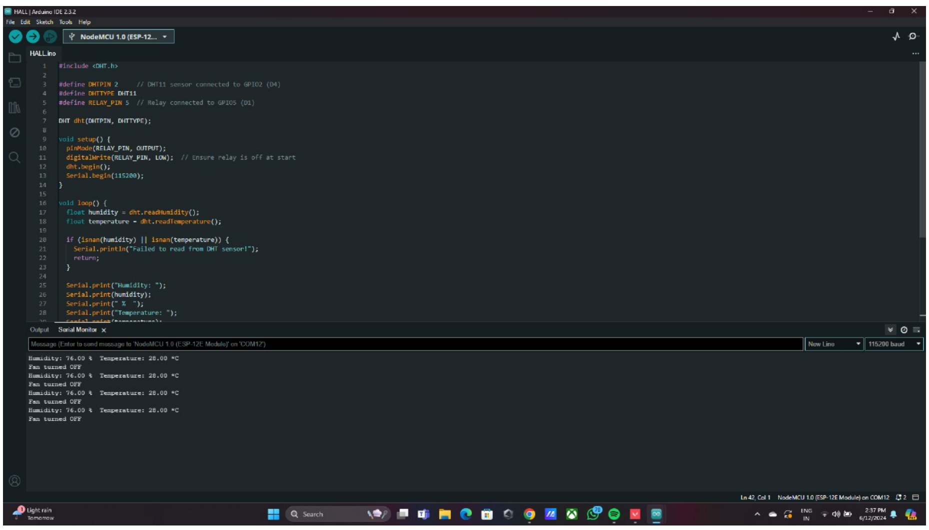

Figure 3.5: Serial Monitor

In Fig 3.5 , the serial monitor displays the values or data that are sent to it.

Chapter 4

Sustainability Development Goal Connect

4.1 Social Context/ SDG

Smart home automation systems are emerging as powerful tools for individuals and communities to contribute to a more sustainable future. These systems leverage technology to optimize resource use and promote responsible living, directly impacting three key Sustainable Development Goals (SDGs). Here's how it contributes to SDGs:

• SDG 7: Affordable and Clean Energy

Reduced Energy Consumption: Smart home systems can optimize energy use by automatically adjusting lighting, heating, and cooling based on occupancy and preferences. This can lead to significant energy savings, lowering reliance on power grids and promoting renewable energy sources. Smart Appliances: Integration with smart appliances allows for more efficient operation. For example, smart thermostats can learn your habits and adjust temperature settings automatically, reducing energy waste.

• SDG 9: Industry, Innovation, and Infrastructure

Innovation in Automation Technology: The development and implementation of smart home systems drive innovation in sensor technology, data analytics, and automation algorithms, contributing to advancements in various industries. Smart Grid Integration: Smart homes can participate in smart grid initiatives, allowing for two-way communication between homes and the power grid. This enables utilities to optimize energy distribution and integrate renewable energy sources more effectively.

• SDG 11: Sustainable Cities and Communities

Reduced Energy Demand in Buildings: As mentioned in SDG 7, smart homes can significantly reduce energy consumption in residential buildings, helping cities achieve sustainability goals. Improved Resource Management: Smart systems can monitor water usage and detect leaks, promoting responsible water management within homes.

4.2 System Level Description

Smart homes play a significant role in achieving Sustainable Development Goals (SDGs).The SDG 7 by promoting energy efficiency. Sensors monitor environmental conditions like temperature and light, allowing the system to automatically adjust lighting, heating, and cooling based on occupancy and preferences. This data-driven approach significantly reduces energy waste, particularly when combined with smart appliances. For example, smart thermostats learn your habits and adjust settings automatically, minimizing energy used for unnecessary heating or cooling.

The development and implementation of smart home systems contribute to SDG 9 by fostering innovation in various sectors. The core technology relies on advancements in sensor technology, data analytics, and automation algorithms. This continuous development cycle drives innovation not just within smart homes, but has broader applications across industries. Additionally, smart homes can participate in smart grid initiatives, a key driver of SDG 9. Two-way communication between homes and the power grid allows utilities to optimize energy distribution and integrate renewable energy sources more effectively.

Smart home automation directly addresses challenges faced by cities striving for sustainability, aligning with SDG 11. By significantly reducing energy consumption in residential buildings, smart homes contribute to lowering overall energy demand within cities. Furthermore, smart systems can monitor water usage and detect leaks, promoting responsible water management within homes, a crucial resource in urban environments. The potential doesn't stop there. Smart home systems with integrated sensors can be programmed to detect smoke, gas leaks, or flooding, potentially alerting homeowners and emergency services faster, increasing overall safety and security in smart communities.

In conclusion, smart home automation systems offer a compelling approach to creating a more sustainable future. By promoting energy efficiency, fostering innovation, and encouraging responsible resource management, smart homes directly contribute to achieving SDGs 7, 9, and 11, paving the way for a greener and more sustainable future for all.

4.3 Causal Loop Diagram

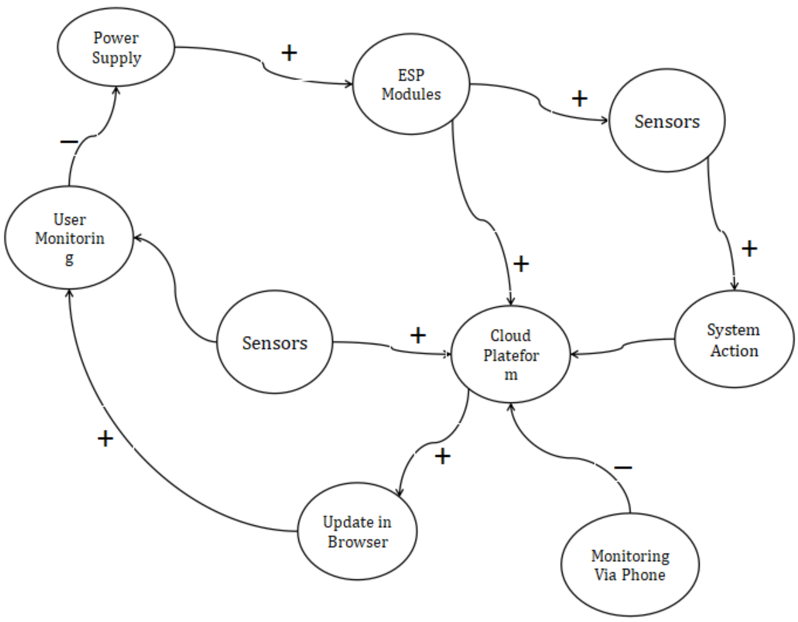

Figure 4.1: Casual Loop Diagram

Chapter 5

Conclusion and Future scope

5.1 Conclusion

To sum up, this home automation project uses ESP32 and ESP8266 modules and various sensors to produce a responsive and intelligent home. The main door's video streaming, the hallway's temperature and motion sensors, the kitchen's gas and flame detection, and the terrace's rain and water level sensors are some of the essential features. Through cloud platform integration, web browsers or smartphones can access real-time control, monitoring, and alerts. The project improves convenience, security, and energy efficiency by automating basic tasks like lighting, fan control, and safety monitoring. This gives homeowners an advanced option for modern-day living.

5.2 Future scope

An ESP microcontroller-based home automation system has a lot of potential in the future. By anticipating user behavior and identifying abnormalities, sophisticated AI and machine learning may be integrated into the system to increase its intelligence. Improved connectivity will lead to better real-time monitoring and control, including the usage of 5G technology and interoperability with other smart home appliances. Functionality will be improved by adding more advanced air quality sensors and intelligent actuators for dynamic changes. Ultimately, adding strong security elements to the system, such as biometric authentication, will guarantee increased safety and user trust.

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