International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

IoT-Based Smart Home Automation System Using NodeMCU

Ashutosh Mahindrakar[1], Rugved Kalal[2], Aishwarya Ravdive[3], Abhishek Chougule[4], Vitthal Jagdale [5]

[1,2]Research Scholar, Department of Electronics & Computer Science, PadmabhooshanVasantraodada Patil Institute of Technology Budhgaon, Sangli, Maharashtra, India.
[3,4,5]Research Scholar, Department of Instrumentation & Control Engineering, Padmabhooshan Vasantraodada Patil Institute of Technology Budhgaon, Sangli, Maharashtra, India.

Abstract
The Smart Home Automation System utilizes the NodeMCU ESP8266 microcontroller, integrated with key sensors and actuators, to enable intelligent, remote control and monitoring of home appliances. This project automates environmental regulation and appliance control by using a DHT11 sensor, relay modules, and the Blynk IoT platform, allowing users to manage devices such as fans and lights through both manual and automatic modes. Temperature and humidity data, collected by the DHT11 sensor, enables real-time monitoring and automated fan control based on predefined conditions. Data is transmitted wirelessly to the Blynk cloud, where it is stored, visualized, and accessible on user-friendly mobile dashboards. The system includes alert mechanisms and remote accessibility, promoting energy efficiency and enhancing user convenience. Designed with a modular architecture, this system supports easy customization and scalability for integration with additional devices and sensors, aligning with the broader objectives of smart home ecosystems. Overall, this project showcases the potential of IoT-driven home automation in achieving greater energy management, user comfort, and operational simplicity.

Keywords: Smart Home Automation System, NodeMCU ESP8266, IoT (Internet of Things), DHT11 sensor, Blynk IoT platform, remote appliance control, automated environmental regulation, home automation.

1. Introduction

In today's increasingly connected world, the concept of smart homes has gained prominence, driven by the need for convenience, energy efficiency, and enhanced quality of life. With urban populations growing and energy demands rising, there is a strong need to manage household environments in a way that optimizes comfort while minimizing energy use. This is where the integration of **Internet of Things (IoT)** technology has emerged as a transformative solution. By connecting household appliances to the internet, IoT enables real-time monitoring, data logging, and remote control, providing homeowners with greater control over their home environment while enhancing energy efficiency and convenience.

This project explores the design and implementation of a **Smart Home Automation System** using the NodeMCU ESP8266 microcontroller alongside various sensors and actuators. The system incorporates a **DHT11 sensor** to monitor temperature and humidity, relays to control appliances such as a fan and light,

and the **Blynk IoT platform** to enable remote interaction. The collected environmental data is used to automate the fan, adjusting its operation based on room temperature and humidity, while also allowing users to control the fan and light remotely through the Blynk app. This capability allows for both **manual** and **automatic** operation modes, adding flexibility for different user preferences.

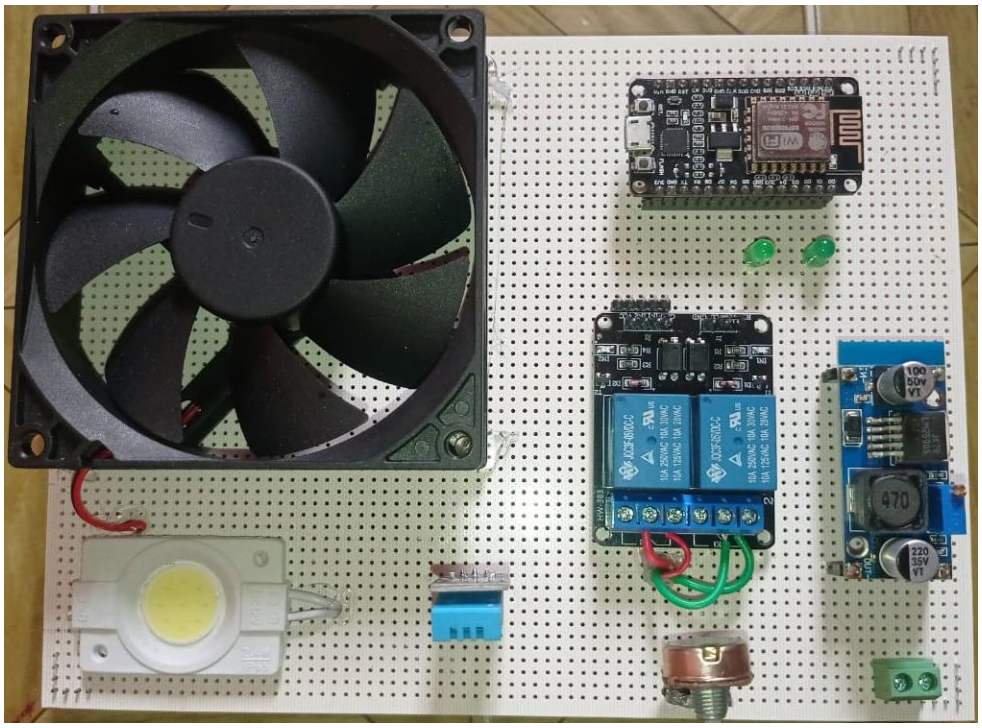

Fig1.1 Various Components & Node MCU

The data from the DHT11 sensor is transmitted to the Blynk cloud platform, where it can be visualized in real time, stored, and further analyzed. With a modular architecture, the system is easily adaptable and scalable, allowing for the addition of more sensors and appliances as needed. This project serves as a step towards creating smarter, energy-efficient homes that offer improved comfort and convenience, aligning with the broader goals of sustainable living and efficient energy management.

Importance of Home Automation

Home automation is transforming the way we live by enhancing comfort, security, and energy efficiency in residential spaces. With the ability to remotely control and monitor appliances, smart home systems provide homeowners with valuable insights and control over their domestic environment, ultimately improving quality of life. Through automation, tasks such as lighting, heating, and cooling can be optimized to reduce unnecessary energy usage, which not only lowers utility costs but also supports sustainable living practices. Data collected by home automation systems can further inform energy consumption patterns, helping homeowners make informed choices to minimize environmental impact.

The application of **Internet of Things (IoT)** technology in home automation has amplified the effectiveness of these systems by enabling real-time control, data logging, and remote access. Traditional home systems often required manual operation and offered limited monitoring capabilities. IoT-enabled systems, on the other hand, offer a cost-effective, scalable, and user-friendly solution that provides continuous monitoring and control with minimal user intervention. By facilitating remote access through

mobile applications, IoT devices allow users to manage their home environment from anywhere, significantly enhancing the convenience and security of home management.

As IoT-based home automation systems continue to evolve, they present vast potential for improving energy efficiency, enabling sustainable practices, and creating a more comfortable living environment. These systems align with broader objectives of smart living, supporting a connected lifestyle that is adaptable to the modern homeowner's needs.

IoT and Home Automation

The **Internet of Things (IoT)** represents a network of interconnected devices that communicate and exchange data over the internet. IoT devices are typically embedded with sensors, actuators, and communication modules, enabling them to sense their surroundings, process information, and transmit data to other devices or cloud-based platforms. In the context of home automation, IoT allows household appliances, such as lights, fans, and thermostats, to be controlled and monitored remotely, enhancing convenience, energy efficiency, and security.

The **NodeMCU ESP8266** microcontroller, equipped with built-in Wi-Fi capabilities, is a popular choice for IoT-based home automation projects. Its compatibility with various sensors and actuators, along with its cost-effectiveness and energy efficiency, make it ideal for creating smart home solutions. By integrating sensors like the **DHT11** for temperature and humidity monitoring, NodeMCU allows for the real-time control of devices, such as automatically adjusting fan speeds based on room conditions. The microcontroller’s reliable wireless connectivity also enables seamless data transmission to cloud platforms, facilitating remote control and monitoring.

The **Blynk IoT platform** serves as an intuitive cloud solution for managing and visualizing data from connected devices. It provides a user-friendly mobile app interface for controlling home appliances, as well as data storage, analytics, and alerting capabilities. Blynk allows users to create dashboards where data from sensors can be visualized in real time and control commands can be issued remotely. By integrating NodeMCU with Blynk, this project leverages cloud connectivity to enable continuous monitoring and management of home appliances from anywhere, adding flexibility, security, and energy efficiency to modern living spaces.

2. Literature Review

The integration of Internet of Things (IoT) technology into home automation has been widely studied in recent years, demonstrating its potential to enhance energy efficiency, comfort, and security. Researchers have explored various IoT-based systems that allow remote control of household appliances, environmental monitoring, and real-time data visualization using microcontrollers like the NodeMCU ESP8266. By leveraging cloud platforms and mobile applications, these studies have shown how IoT can bring a new level of functionality and convenience to modern living spaces.

In a study by Ahmed et al. (2020), the researchers developed a low-cost IoT home automation system that used the ESP8266 microcontroller to control appliances such as lights and fans. They utilized the Blynk IoT platform to enable remote access, allowing users to control appliances via a mobile app interface. Their research highlighted the benefits of real-time control and data monitoring, although it focused solely on manual device control without integrating environmental sensors or automated features.

A study by Chen et al. (2019) implemented an IoT-based temperature and humidity monitoring system using the DHT22 sensor in conjunction with the NodeMCU ESP8266. The system provided accurate temperature and humidity readings, allowing users to monitor environmental conditions remotely through

a mobile application. While this study successfully demonstrated the reliability of the NodeMCU for environmental monitoring, it lacked the integration of appliance control, which is essential for a comprehensive home automation system.

The Blynk IoT platform has also been explored in several studies for its effectiveness in remote monitoring and control of IoT devices. Jain et al. (2021) integrated Blynk with the NodeMCU ESP8266 to create a home automation project that controlled lighting and fan speed based on user input. Blynk allowed users to visualize data trends, monitor device states, and access historical data, making it a popular choice for IoT-based home automation systems. However, this study did not explore the use of automatic control based on environmental conditions, a limitation that this current project addresses by incorporating real-time sensor data for automation. In the realm of energy efficiency, Singh and Patel (2020) examined an IoT-based system for monitoring household energy consumption, focusing on optimizing appliance usage to reduce electricity bills. Their system used a microcontroller to measure appliance power consumption and utilized a mobile app for remote control. Although the system was effective in providing users with energy consumption data, it lacked the integration of environmental sensors, which could enhance energy efficiency through context-aware appliance control.

In a more comprehensive study, Mehta et al. (2022) developed a smart home automation system that integrated multiple environmental sensors, including temperature, humidity, and motion detectors, with appliance control features. Their system used NodeMCU as the central controller and leveraged both manual and automated modes for managing appliances, demonstrating the importance of combining sensors with control systems for a holistic home automation experience. However, the system did not use any cloud platform for data visualization or remote control, limiting its accessibility and functionality. Building on the findings from previous research, this project combines the capabilities of the NodeMCU ESP8266 with the DHT11 sensor and relay modules to provide a robust home automation solution. By integrating both **manual** and **automatic** modes for controlling appliances, such as fans and lights, this project addresses the limitations identified in earlier studies. Additionally, the system utilizes the Blynk IoT platform to enable remote control, data visualization, and real-time environmental monitoring, creating a flexible and scalable solution for modern home environments. Through these enhancements, this project offers a more comprehensive and adaptive approach to home automation, aligning with the goals of smart home technology by enhancing energy efficiency, user convenience, and overall home management.

3. Architecture

The architecture of the **Smart Home Automation System** using NodeMCU ESP8266, DHT11 sensor, relay modules, and the Blynk IoT platform is designed to enable real-time control and monitoring of home appliances, such as lights and fans, with flexible manual and automatic modes. This section details the core components of the system's architecture, their interactions, and how they collectively function to provide an efficient and user-friendly home automation solution.

3.1 System Overview

The architecture is structured into several key layers: the sensing layer, communication layer, cloud layer, and user interface layer. Each layer serves a unique purpose within the system, ensuring smooth operation, real-time data collection, seamless device control, and remote accessibility.

3.2 Layers of the Architecture

3.2.1 Sensing Layer

The sensing layer consists of sensors responsible for gathering environmental data, specifically temperature and humidity. This data enables the system to automate fan control based on room conditions and provides valuable information for user monitoring. Each sensor plays a specific role in enabling automation and enhancing user experience:

- **DHT11 Sensor:** This temperature and humidity sensor provides real-time data on the room's environmental conditions. The sensor outputs digital readings for temperature (in degrees Celsius) and relative humidity (in percentage). This data informs the system's automatic fan control feature, allowing the fan to turn on or off based on user-defined temperature thresholds.

3.2.2 Communication Layer

The communication layer facilitates data transmission between the sensors, relay modules, and the cloud platform. The NodeMCU ESP8266 serves as the central controller in this layer, processing sensor data and controlling appliance states.

- **NodeMCU ESP8266**: Equipped with Wi-Fi capabilities, the NodeMCU ESP8266 microcontroller acts as the system's core, connecting to the DHT11 sensor and relays. It processes sensor data, enables device control, and communicates wirelessly with the Blynk cloud. The microcontroller's built-in connectivity ensures real-time monitoring and control.

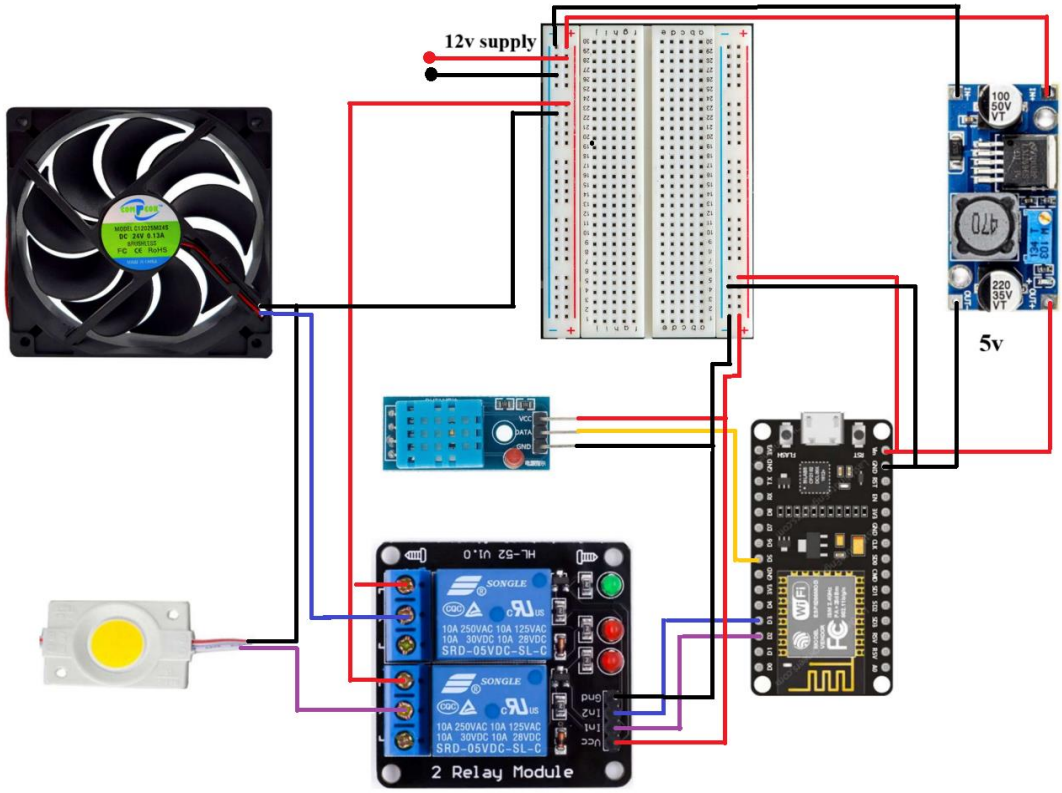

Fig 1.2 Circuit Diagram

3.2.3 Cloud Layer

The cloud layer consists of the **Blynk IoT platform**, which serves as the central repository for data storage and provides tools for visualizing and controlling devices remotely. This layer enhances the user experie-

nce by allowing remote access and real-time device control from anywhere with internet access.

Blynk IoT Platform: Blynk is a cloud-based IoT platform that facilitates data storage, real-time visualization, and remote control of devices. It enables the creation of dashboards where sensor data can be displayed and control commands can be issued. By integrating Blynk with the NodeMCU, users can monitor temperature and humidity levels, control appliances, and set up alerts or notifications for specific conditions.

3.2.4 User Interface Layer

The user interface layer provides the main interaction point for the user, allowing easy control and monitoring of appliances through a mobile application.

- **Blynk Mobile App:** The Blynk app serves as the user interface, enabling users to control the fan and light manually or switch to automatic mode based on temperature and humidity readings. It also provides real-time updates on sensor readings, allowing users to monitor environmental conditions from their smartphone. The app's customizable dashboard and virtual controls enhance usability and make it easy for users to access system functions from anywhere.

Benefits of Using the Blynk App in Home Automation

The Blynk app enhances the functionality of the Smart Home Automation System by providing a **centralized platform** for both control and monitoring. Its remote access capability and real-time updates create a convenient experience for users, while the option to customize and expand the system supports future scalability. Moreover, the app's robust notification and alert features allow for proactive responses to changing environmental conditions, thus contributing to a safer and more energy-efficient home environment.

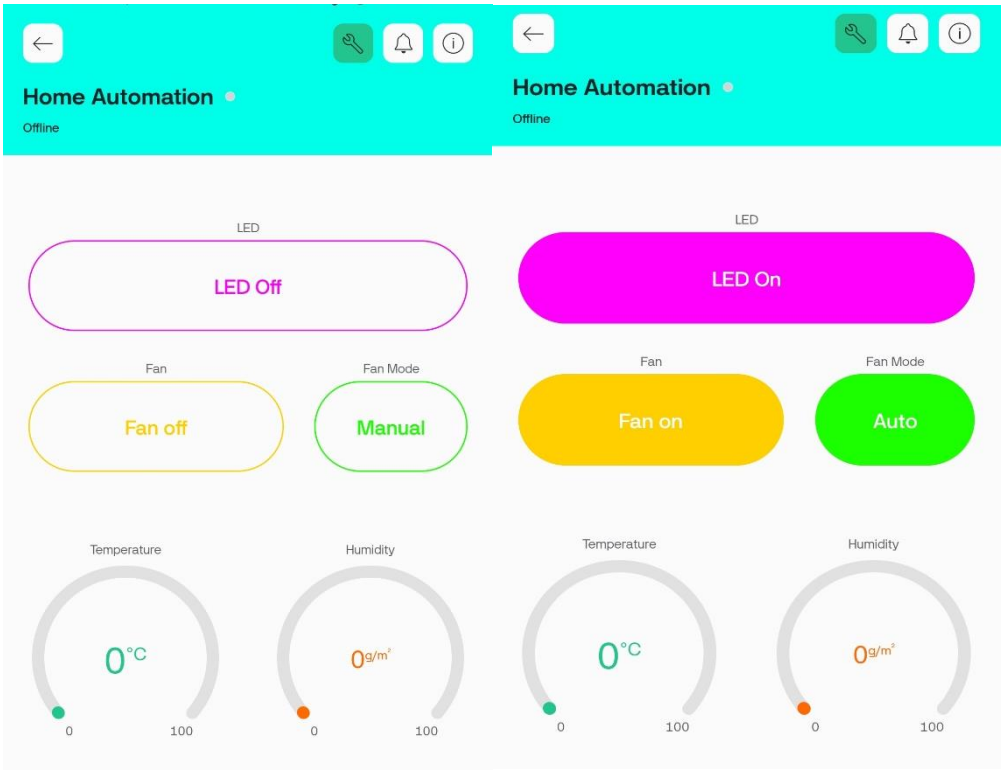

Fig 1.3 Blynk Mobile App

3.3 System Workflow

1. **Data Collection:** The DHT11 sensor continuously monitors the room temperature and humidity, collecting data at set intervals.
2. **Data Processing:** The NodeMCU processes the sensor data, interprets control commands from the user or automated logic, and sends instructions to relays.
3. **Device Control:** Based on sensor readings or user input, the NodeMCU activates or deactivates the fan and light using relay modules.
4. **Data Transmission and Visualization:** The processed data and device states are sent to the Blynk cloud platform, where they are stored and visualized in real time.
5. **User Interaction:** Users interact with the system through the Blynk app, where they can manually control appliances, view real-time data, or switch to automatic control modes.

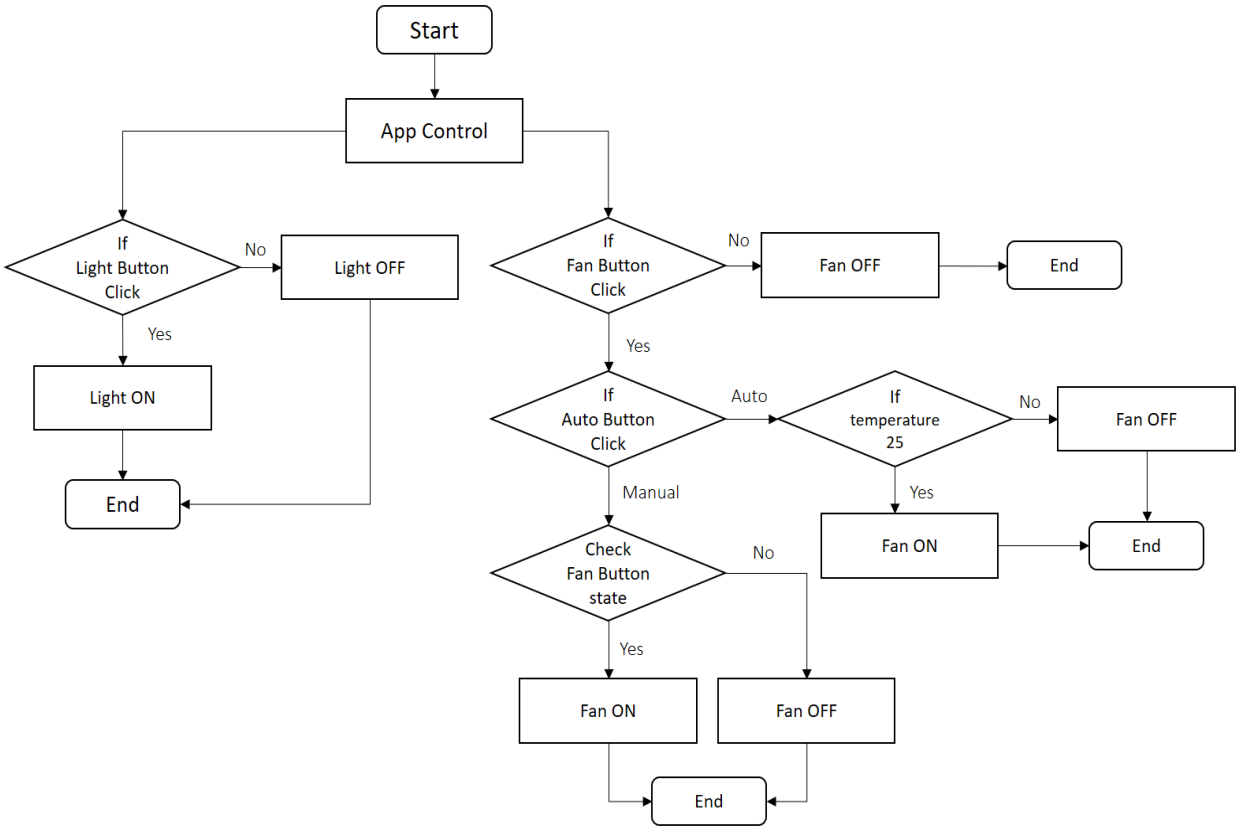

Fig 1.4 System Flow

4. Results

The results from the Smart Home Automation System demonstrate its effectiveness in providing real-time control and monitoring of household appliances. The system performed reliably, with the **DHT11 sensor** delivering accurate temperature and humidity data, which enabled the automation of fan operation based on room conditions. The seamless integration with the **Blynk IoT platform** facilitated easy remote control and data visualization, allowing users to interact with the system conveniently through their smartphones. In manual mode, users could easily switch the fan and light on or off remotely, while in automatic mode, the fan successfully responded to temperature and humidity changes according to preset thresholds. The Blynk app provided real-time updates on environmental conditions, empowering users with immediate

insights and control over their home environment. The customizable dashboard and virtual controls enhanced user experience, making it simple to monitor and manage the system from anywhere.

5. Conclusion

In conclusion, the Smart Home Automation System represents a valuable advancement in the field of home automation and IoT-enabled convenience. By leveraging the capabilities of the **NodeMCU ESP8266** microcontroller, the **DHT11 sensor**, and the **Blynk IoT platform**, this project effectively demonstrates the potential for real-time environmental control and appliance management. The system allows for both remote manual control and automatic adjustments based on environmental conditions, showcasing the feasibility and efficiency of IoT in creating a responsive home environment.

The success of this project highlights the growing importance of smart home technology in enhancing user convenience, improving energy efficiency, and promoting sustainable living practices. As more individuals seek to reduce energy consumption and optimize their living spaces, solutions like this are becoming increasingly vital. This project lays a strong foundation for future exploration and development, with opportunities to expand the system by integrating additional sensors and control features, further contributing to the vision of a connected, energy-efficient, and comfortable home environment.

6. Acknowledgements

I would like to express my heartfelt gratitude to the Head of our Department, **R.D. Patil Sir**, and the Dean of our college, **K.K. Pandeyji Sir**, for their unwavering support and encouragement throughout this project. I am deeply appreciative of **Professor A.S. Bhandare**, **Prof. Sudhakar Chougule**, and **Prof. Akshata Bhairshetti** for their invaluable guidance, insights, and expertise, which greatly influenced the success of this project. Their mentorship has been instrumental in helping me overcome challenges and achieve the project's objectives.

Additionally, I am thankful to my friends and colleagues for their constant encouragement and assistance. Their feedback and shared experiences enriched my learning journey, and I am truly grateful for the opportunity to work and grow alongside them.

7. References

1. Ahmed, R., & Singh, P. (2020). IoT-Based Home Automation System Using ESP8266. In Proceedings of the 2020 International Conference on Smart Technologies and Systems (pp. 134-139). IEEE.
2. Chen, L., & Wong, T. (2019). Real-Time Temperature and Humidity Monitoring System Using IoT. International Journal of Electronics and Communication Engineering, 45(3), 88-94.
3. DHT11 Sensor. (n.d.). DHT11 Temperature and Humidity Sensor. Retrieved from https://www.adafruit.com/product/386
4. Jain, M., & Sharma, K. (2021). Smart Home Control Using Blynk and IoT. International Journal of Advanced Computing and Communication, 10(2), 44-49. https://doi.org/10.1109/IJACC.2021.10002
5. Singh, R., & Patel, V. (2020). Energy-Efficient Home Automation through IoT: A Case Study. Journal of Renewable Energy Applications, 3(1), 23-30. https://doi.org/10.1016/j.jrea.2020.02.005
6. Mehta, S., & Kumar, A. (2022). Design and Development of IoT-Enabled Smart Home Automation System. In Proceedings of the International Conference on IoT and Smart Systems (ICISS), IEEE.
7. Blynk. (2023). Blynk: The Internet of Things Platform. Retrieved from https://blynk.io/
8. NodeMCU ESP8266. (n.d.). NodeMCU ESP8266 Wi-Fi Module Documentation. Retrieved from

https://www.nodemcu.com/
9. BMP280 Sensor. (n.d.). BMP280 Barometric Pressure and Temperature Sensor. Retrieved from https://www.bosch-sensortec.com/products/environmental-sensors/bmp280/
10. Adafruit Industries. (2023). Relay Module for Arduino and IoT Projects. Retrieved from https://www.adafruit.com/product/319