

DIFFERENT IOT PLATFORMS FOR INTELLIGENT AUTOMATION

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Abstract

Automation systems have evolved from isolated local controls to intelligent, globally accessible solutions due to the Internet of Things' (IoT) rapid growth. This paper presents the development of a comparative multi-platform IoT automation system using three different technologies: Bluetooth with Arduino UNO and HC-05, a standalone web server using ESP8266, and cloud-based control with ESP32 via the Blynk IoT platform. For demonstration purposes, a total of six relays connected to light bulbs are managed by each configuration, which controls two relays. The system assesses the three platforms' cost-effectiveness, scalability, range, and usability. A detailed comparative analysis highlights the scenarios where each platform excels, offering insights into practical implementations for residential or small industrial smart automation.

Keywords: IoT, Arduino UNO, HC-05, ESP8266, ESP32, Blynk IoT, Home Automation, Relay Control

1. INTRODUCTION

1.1 Background

The development of IoT has brought about a revolutionary change in home automation. Traditional systems, which are often limited by range and manual interfaces, are currently being replaced by microcontroller-based wireless solutions. Cloud-based platforms like Blynk, Wi-Fi-enabled local servers, and Bluetooth-controlled devices are some of the most accessible. Each offers unique advantages in terms of range, connectivity, cost, and control flexibility [2].

In this paper, three well-known IoT control platforms for smart relay operation were combined and contrasted [4]. The goal was to assess how well they performed in automating six relays that were connected to lightbulbs in real time, simulating the control of household appliances [8]. This study is pertinent in both academic and practical domains due to the increasing demand for wireless, reasonably priced, and user-friendly smart home solutions [9].

1.2 Objectives

- To manage two relays each, develop and implement three different IoT platforms.
- Assess each platform's range, responsiveness, and control dependability.
- Provide an observable, portable system that can be controlled both locally and remotely.
- To help with selection based on particular use cases, compare their performance.

1.3 Scope

Small-scale smart automation in residential, institutional, or experimental settings is the system's intended use. It prioritizes ease of use, provides modular control, and is not solely dependent on internet connectivity (offline capability)[14].

Scalability and low cost. Its practical implementation and real-time testing aid in bridging the gap between theoretical ideas and practical applications [12].

2. LITERATURE REVIEW

In recent years, ESP8266 and ESP32 microcontrollers have been used in a large number of home automation systems [2]. For proximity-based automation, Bluetooth control is still a common entry-level method. In the meantime, Blynk IoT has become a reliable cloud-based remote control platform with real-time monitoring and an easy-to-use interface [5]. Few studies, however, have combined and contrasted the three platforms—cloud IoT, local server, and Bluetooth—in a single system.

The limitations of traditional automation systems, such as their high cost, lack of flexibility, and reliance on particular brands or technologies, are also highlighted by research [8]. These restrictions are addressed by new open-source platforms like Blynk, the Arduino IDE, and NodeMCU-based modules, which increase automation's accessibility for students, hobbyists, and small-scale developers [13].

By providing a unified, comparative automation setup and analysis, this paper closes that gap.

3. METHODOLOGY

3.1 System Overview

Three separate modules make up the system:

- **Module 1:** Arduino UNO featuring a 2-channel relay and an HC-05 Bluetooth module
- **Module 2:** Relay-controlled ESP8266 NodeMCU serving as a web server
- **Module 3:** Blynk IoT cloud and mobile app interface with ESP32

Two relays that are connected to AC bulbs are independently controlled by each module [18]. The modules were selected due to their ease of integration, affordability, and dependability.

3.2 Working Principle

- **Bluetooth Module:** The Bluetooth terminal app allows the user to send ON/OFF commands. After decoding, Arduino switches the relays appropriately. Perfect for proximity control at the room level without requiring the internet.
- **The ESP8266 module creates a Wi-Fi hotspot.** In order to control relays through a straightforward HTML page, the user connects and uses a browser to access 192.168.4.1. Because of this, web-based control is possible even in offline settings.
- **ESP32 Blynk Module:** Users can monitor real-time status, extend functionality through dashboards, and remotely control relays using an internet connection and the Blynk app. Appropriate for smart city and remote applications.

3.3 Components Used

Component	Quantity
Arduino UNO	1
HC-05 Bluetooth Module	1

ESP8266 NodeMCU	1
ESP32 Dev Kit	1
2-Channel Relay Module	3
Light Bulbs	6
Breadboard, Wires	-
Smartphone	1

SYSTEM ARCHITECTURE

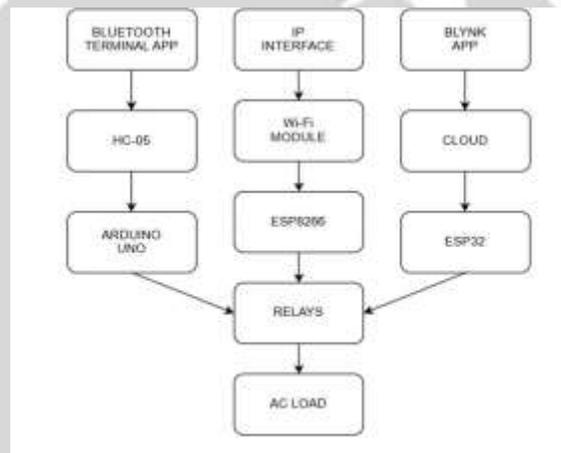


Figure 1: Block Diagram of the Entire System

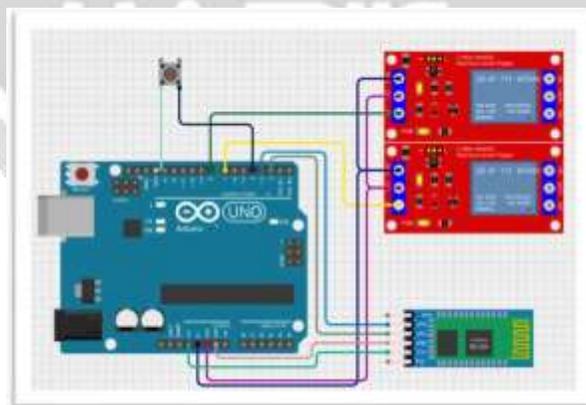


Figure 2: Circuit Diagram Arduino UNO + HC-05

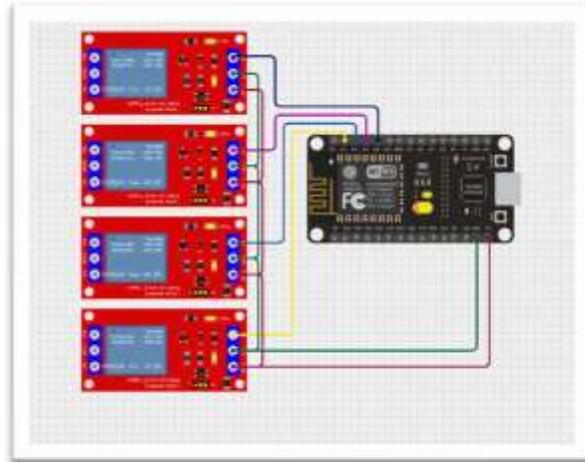


Figure 3: Circuit Diagram ESP8266 Web Server

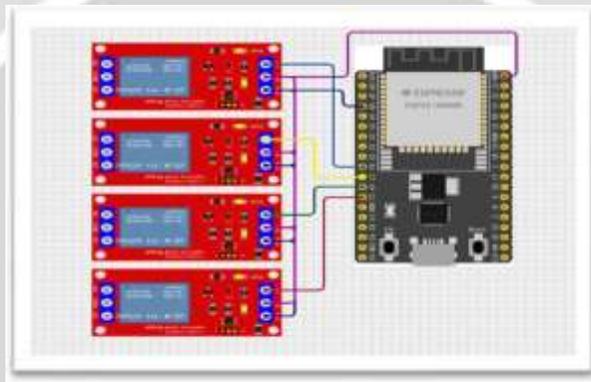


Figure 4: Circuit Diagram of ESP32 with Blynk IoT

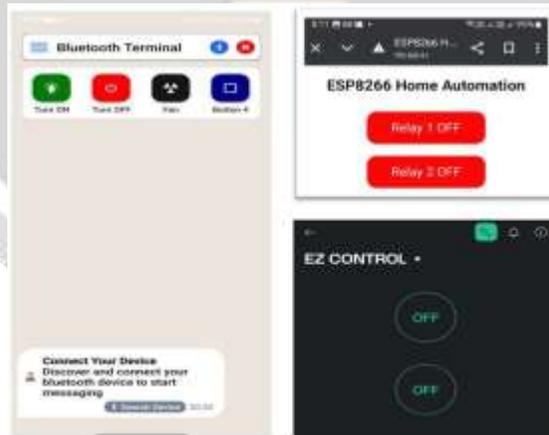
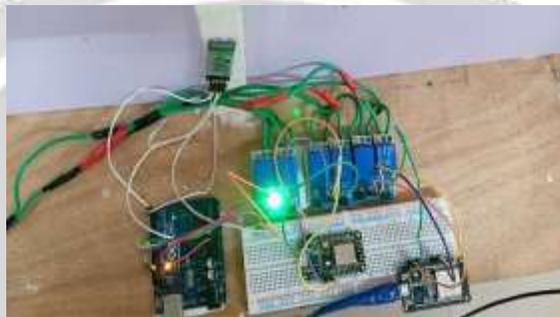


Figure 5: Screenshots of 3-Interfaces

Figure 6: Final hardware setup photo



Figure 7: Final working prototype



Every figure will help readers see the real hardware implementation, control interfaces, and wiring.

4. RESULTS AND DISCUSSION

Criteria	Bluetooth	ESP8266	ESP32 + Blynk
Range	~10 meters	Wi-Fi range	Unlimited
Internet	Not Required	Not Required	Required
UI Type	Bluetooth App	Web Browser	Blynk Mobile App
Ease of Use	Very Easy	Moderate	Easy
Ideal Scenario	Single Room	Local Area Network	Remote/Cloud Access

4.1 Advantages

- Combining three popular IoT platforms
- Easy-to-use controls through a browser or mobile app
- Supports both online (ESP32) and offline (Bluetooth, ESP8266) modes.

- Modular and expandable to add more relays or sensors
- Educational value for project demonstrators and IoT learners

4.2 Limitations

- A reliable internet connection is necessary for ESP32 and Blynk setup.
- IP access and user networks are necessary for ESP8266 control.
- Bluetooth control is restricted by device pairing and distance.

5. CONCLUSION

This paper describes a small, adaptable automation system that makes use of three main IoT control strategies. The ESP8266 offers browser-based control in Wi-Fi zones, the ESP32 with Blynk offers sophisticated cloud automation with app-based interfaces, and the Arduino with Bluetooth offers straightforward offline control for small spaces. Modular scaling and implementation are made possible by the independent operation of each module. The system is affordable, dependable, and appropriate for use in homes, classrooms, or prototyping.

By bridging the gap between simple automation and intelligent control, this multi-platform IoT solution provides useful insights into platform selection based on user requirements and technical limitations.

6. FUTURE SCOPE

- Integration with voice assistants such as Alexa and Google Assistant
- Sensor integration for smart environment response (e.g., PIR, DHT11, LDR)
- Energy-saving algorithms and automated scheduling
- Connectivity to home security systems
- Creation of a mobile application that integrates all three control modes

7. REFERENCES

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