REVOLUTIONIZING APPLIANCE AUTOMATION: ESP32 AND BLYNK

Helen Grace Gonzales
University of Science and Technology of Southern Philippines, C.M. Recto Ave., Lapasan, Cagayan de Oro City, Philippines
*Correspondence: Email: helengrace.gonzales@ustp.edu.ph

ABSTRACT*: In light of recent data from the Bureau of Fire Protection (2020), which indicates that approximately 14,000 fire incidents in various countries were caused by unattended appliances overheating and electrical connection malfunctions, this study focuses on automating and monitoring appliances. The aim is to design user-friendly appliances with efficient automation capabilities that prioritize safety, energy conservation, and accessibility, allowing control over a wide range of devices. This paper presents the primary objective of developing a low-cost, innovative, and secure automation system based on smartphones. The appliances are designed to interact with a standalone ESP32 board through relays connected to its input/output ports. Through the accompanying mobile application, users can conveniently monitor the activated outlets. Wireless transmission between the smartphone and the ESP32 board facilitates seamless communication.*

Keywords: Smartphone-based, Mobile application, an automated system (ESP32*)*

1. INTRODUCTION

The development of automated systems for appliances has gained significant attention due to their ability to provide convenience and control to users. The Automated System for Appliances using ESP32 and Blynk Application is a study that focuses on creating a mobile app-controlled device for monitoring and operating appliances through Android devices. While numerous automated systems exist, many suffer from safety issues stemming from miscalculations and faulty wiring, leading to property damage. Additionally, a majority of these systems lack integration with the Internet of Things (IoT), relying solely on Bluetooth technology with a limited range.

To address these challenges, this study proposes an innovative approach that integrates ESP32, a standalone microcontroller board, with the Blynk Application to enable safe and efficient appliance automation. By connecting appliances to the ESP32 board through relays, users can control their devices remotely via an Android device. This smartphone-based automation system offers accessibility, energy-saving features, and a user-friendly interface.

The concept of automation has gained popularity, driven by its extensive capabilities and ease of use through Android phone and tablet connectivity. It allows for the control of various electrical devices, including lighting systems and other household appliances, through a home network or remote internet access. Wireless technologies such as GSM, Wi-Fi, and Bluetooth have been introduced to facilitate automation, with Wi-Fi being a preferred choice due to its compatibility and widespread availability in modern devices.

Energy conservation is a key motivator for consumers, as it not only reduces utility bills but also contributes to a more sustainable future. The study of the Automated System for Appliances aims to address energy wastage by ensuring that electricity is used only when necessary. For example, the system can automatically turn off lights when a room is vacant, minimizing unnecessary power consumption. This study also aims to overcome the inconvenience caused by the positioning of switches in inaccessible locations.

To fulfill the objectives of this study, the researchers gathered information from articles and the internet to develop a convenient, accessible, safe, and portable automated system. The materials were thoroughly tested before implementing the prototype. The study focuses on designing the automated system, developing and implementing the prototype using IoT applications such as the Blynk app and MIT App Inventor relay, and evaluating the functionality, safety, usability, and acceptability of the prototype.

The significance of this research lies in its potential to reduce electricity bills, automate appliances for the convenience of individuals, particularly the elderly and those with disabilities, and prevent casualties resulting from electrical malfunctions. By creating a mobile app-controlled device through the integration of ESP32 and the Blynk Application, this study aims to offer a cost-effective solution with broader accessibility.

The following sections will delve into the design parameters, development strategy, evaluation parameters, and conceptual framework of the Automated System for Appliances using ESP32 and Blynk Application. The statement of the problem will identify the specific challenges addressed by this study, while the objectives will outline the intended outcomes. Furthermore, the scope and limitations of the study will be discussed, along with the definition of key terms to ensure clarity in understanding the concepts used throughout the research.

2. LITERATURE REVIEW

The implementation of wireless technology has always posed challenges to achieving an economical solution for home automation systems. Interoperability and complete integration of household appliances within a unified environment remains difficult to achieve.

In their research, the authors explored the concept of controlling objects over the internet using a 6LOWPAN-based power electronic switch circuit. In contrast, the researcher utilized an ESP32 microprocessor and the Blynk application [3]. The study on a home automation system using Arduino Uno proposed the idea of communicating between mobile phones and appliances through a Bluetooth module connected to Arduino. This contribution holds immense value for the community. Their approach focused on a low-cost and scalable design, with an emphasis on ensuring that new devices can be easily incorporated into the system. In comparison, the researcher employed an ESP32 microprocessor along with the Blynk application, utilizing both Wi-Fi and Bluetooth capabilities [4].

The research on a smart energy-efficient home automation system using IoT presented a solution that enables users to access and control home equipment from anywhere. The system incorporated an internet connectivity module connected to the main power supply unit, allowing remote access over the internet.

The researchers aimed to enhance the security and intelligence of home automation systems, leveraging the ubiquity of internet connectivity. However, power consumption remains a significant concern worldwide.

The researcher also benefits from this study as it provides a foundation for monitoring objects through wireless connections. While the research focused on a multimodal application controlled via Google Assistant's voice recognition or a web-based application, the researcher employed an ESP32 microprocessor and the Blynk app [5].

The GSM-based home automation system described a setup where a GSM module was connected to the Arduino board at both the receiver and transmitter ends. The system featured a graphical user interface for remote control of loads.

Their research explored the realm of remote-controlled home automation systems, utilizing GSM technology extensively. Furthermore, the user was required to wear a device on their finger, tilting it at specific angles to convey commands.

The researcher also found relevance in this research as it provided insights into controlling objects over the internet. However, the researcher utilized an ESP32 microprocessor for controlling appliances, distinct from the Arduino UNO used in the study [6].

3. THE DESIGN

This project aims to design an automated system for appliances that results in safe and convenient implementation. To establish the design of the prototype, the researchers of the Automated System for Appliances using ESP32 and Blynk Application gathered some information from various sources such as articles and the internet about an automated system for appliances and the necessary components for the prototype according to its uses.

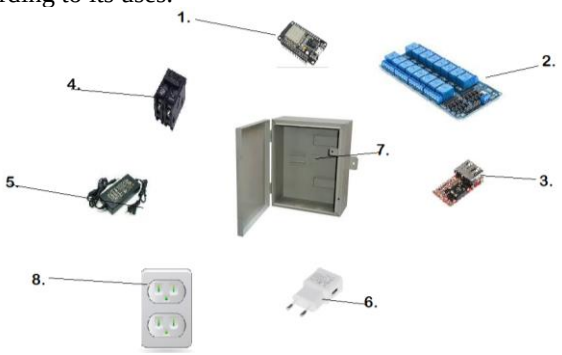


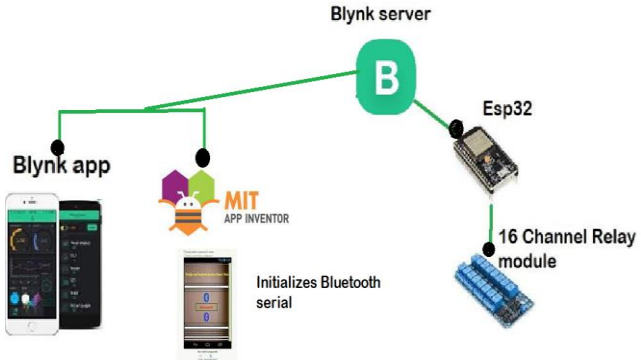
Figure 1. Exploded view of the prototype

To determine the placement of the components to use, Figure 1 below shows the exploded view of the prototype.

1. ESP32 (Microcontroller)
2. 16 Channel 5V DC Relay module
3. Buck converter 12V to 5V
4. 15Ampere circuit diagram
5. 12 Volts power supply
6. Adapter 5V/ 1A
7. 300mmX 250mmX150mm Enclosure Box
8. Female Socket ion.

4. SYSTEM DESIGN PROCEDURE

Figure 2 above showed the procedure of the system, and the Blynk application platform used in the study, hence the



researcher can quickly build an interface for controlling and monitoring the hardware components. The researcher also used the MIT app inventor to initialize Bluetooth serial for those users who don't have access to an internet connection in their areas, suddenly Bluetooth has only a 100-meter range. MIT app inventor also can create a platform that is convenient, hence by dragging and dropping the blocks in creating a platform that the researcher used for the prototype.

The researcher used the Blynk server as the response in all the communications between the smartphone and hardware. ESP32 is the microcontroller that reads the commands through the serial port and it compares the command from the Android phone to the code written in the ESP32. If it matches the command the corresponding goes high. The relay module receives the signal from the ESP32 and activates or deactivates the load.

Circuit diagram

The circuit shown below in **Figure 3** below is the entire circuit of the system. It will respond in accordance with the microcontroller where the code is written through the C++ programming language. The microcontroller reads the commands through the serial port that is connected between the ESP-32 and 16-channel relay module pin. The purpose of the buck converter is to step down the 12V power supply to get the exact input of the relay module which is 5V. The female outlets' researchers customize so that the user can control the outlets. The circuit breaker line two is connected to the relay module and line one is connected to the female outlets, hence the top priority of the prototype is safety performance and convenience to the user that all the appliances are safe and not led to casualties.

The researcher was able to achieve the right circuit diagram by testing and researching from various sources such as articles, kinds of literature, and internet sources.

Development

The aim of the study is to develop an automated system for appliances that is safe and convenient for users

Figure 2. System design procedure

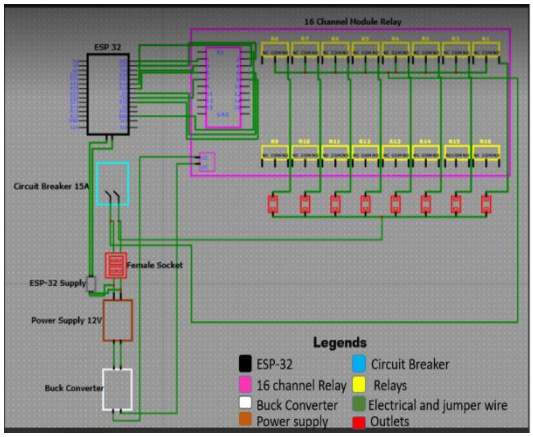


Figure 3. Circuit diagram

Hardware Development

Attaching the control system components, electrical wiring, and safety measures is the priority in the prototype. The main purpose of this study is to develop an automated system for Appliances using ESP-32 and Blynk applications.

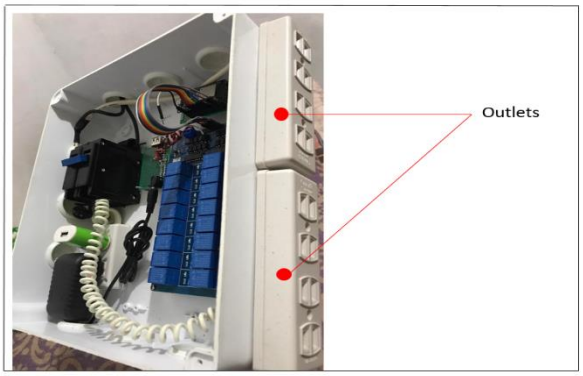


Figure 4. Top view of the prototype

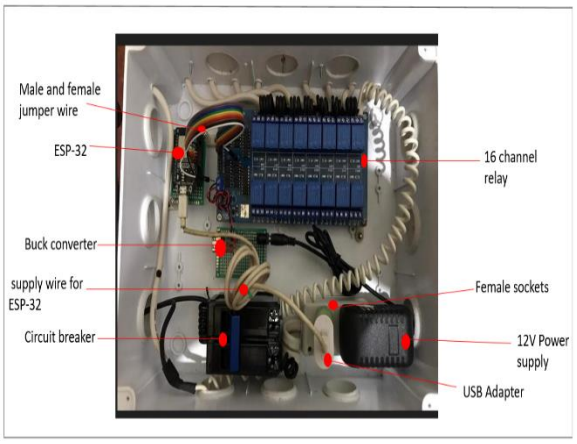


Figure 5. Isometric view of the prototype

In **Figure 4** above shows the overall proposed design of the automated system for appliances using ESP-32 and the Blynk application in the top view. This prototype is used to control the devices that are plug-in and monitored in the Android device.

In **Figure 5** above, you can notice that the researcher used an outlet it's because for study purposes, hence the study is not yet implemented in any research setting.

Software Development

This part discusses the flow in the software implementation of the system which covered the second objective of this research: To develop and implement the prototype by utilizing Internet of Things (IoT) applications such as the Blynk app and MIT app inventor relay; necessary electrical devices and ESP32 microcontroller that involves computer programming.

The researcher used the MIT app inventor, which is easy to create a platform. It contains blocks that are dragged and dropped at the desired blocks in the corresponding place. The Arduino IDE is used to write, compile, and upload codes directly into the microcontroller. The Arduino IDE supports C++ which the researcher used as the main programming language of the automated system. The ESP32 reads the command through the serial port and it compares the command from the Android phone to the code written in the ESP32. If it matches the command the corresponding output pin goes high. The relay module receives the signal from the ESP32 and activates the load. There are two remote control that is shown below, for Bluetooth (**Figure 6 and Figure 7, below**) and Wi-Fi connection.

Figure 6. Blynk application remote platform

Figure 7 below shows the remote platform. Wi-Fi can extend the range of radio signals that the user will not depend on Bluetooth which has a short-range of a signal. The device can connect its either personal hotspot to our mobile phones or wireless router. The researcher used the Blynk application platform as a server to control the ESP32 via the internet. It allows the researcher to quickly build the interface for controlling and monitoring the hardware projects from iOS and Android devices. The application responds quicker if the internet connection is fast.

The ESP32 has a built-in Bluetooth module, it has short-range wireless communication technology with a range of up to 100 meters. If the user is in the house or the range of Bluetooth, no need to use Wi-Fi because it consumes data for data users. **Figure 7** below shows the Bluetooth remote platform.

After setting up the hardware and software, In **Figure 8** below the researchers combine them to ensure that the subsystems function together as a system. Input, the microcontroller needs to connect to the desired internet connection it's either a mobile hotspot or a home network. Wi-Fi configuration happens only once if the internet connection was lost. After connecting to the

Blynk server, initialize Bluetooth ESP remote and connect. The Bluetooth becomes a Bluetooth server.

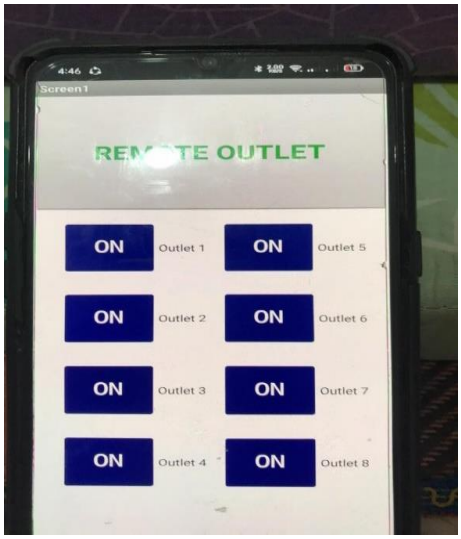


Figure 7. MIT App inventor and Bluetooth remote platform

Program Flow Chart

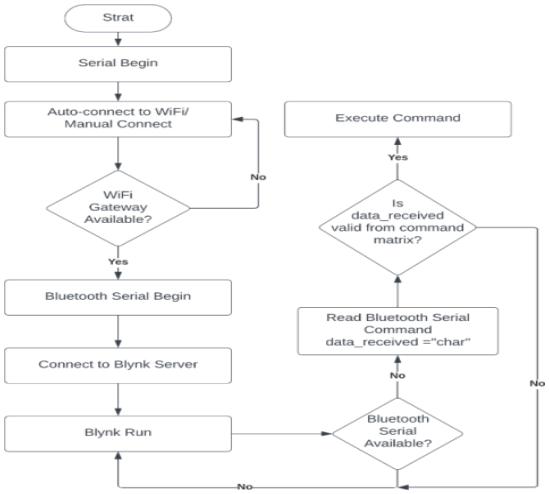


Figure 8. Program flow chart

The Implementation

In this phase, the researchers must test each material and component of the system for a high-quality prototype in order to enhance development and execution while considering the recommendations cited in the studies, journals, and articles that were searched. After proving that the automated system worked properly, the researcher implemented the system at Cugman Elementary School located in Zone 3 Cugman, Cagayan de Oro City.

4. CONCLUSION

Based on the gathered information and the implementation of the system as shown in **Figure 9** below, we can draw an initial conclusion. The "Automated System for Appliances Using ESP32 and Blynk Application" offers a flexible and user-friendly interface, distinguishing it from other automation systems. This system integrates mobile devices into the automated setup, comprising a Bluetooth/Wi-Fi module, ESP32 microcontroller, and relay circuits. The communication between the Android phone and the ESP32 microcontroller occurs through Wi-Fi, enabling efficient utilization of the limited display space on mobile devices. Our paper introduces a low-cost, secure, easily accessible, self-configuring, and remote-controlled solution.

The proposed approach successfully achieves the objective of remote appliance control using Wi-Fi/Bluetooth technology to connect system components, effectively meeting user needs and requirements. Compared to existing systems, the Wi-Fi/Bluetooth-enabled solution offers remote control, enhances home security, and proves cost-effective.

Figure 9. Prototype Implementation

Therefore, we can conclude that the desired goals and objectives of the "Automated System for Appliances using ESP32 and Blynk Application" have been accomplished. We have discussed the system design and architecture, and the implemented prototype demonstrates the fundamental level of home appliance control and remote monitoring. Notably, the proposed system surpasses commercially available home automation systems in terms of scalability and flexibility.

5. REFERENCES

[1] Panth, Sharon and M Jivani. “Home Automation System (HAS) using Android for Mobile Phone.” (2013)

[2 Nevon Projects. “Home Automation using Android Phone.” Nevon Solutions Pvt.Ltd, Electronics|Software Mechanical Kits. (2012)

[3] Roshan Gosalia, Student, MPSTME, Darshil Gala, Studen, MPSTME, Ami Munshi, Mentor, Asst.Prof, MPSTME. “Android Based Home Automation System” vol. 9, (2018)

[4] Tajammal Waqas, Aqil Javeed, Rabiya Waheed, Sadia Manzoor. “Home Automation.” Technical Report, Master of Science in Physics, University of Sahwal (2020)

[5] Javier Castro, James Psota. "Home Automation System" final project for 6.111 at M.I.T,6.111: Introductory Digital Systems Laboratory Final Project Massachusetts Institute of Technology (2011)

[6] Rajeev Piyaree. "Bluetooth Based Home Automation system using Cellphone"IEEE-Transactions-on-Consumer-Electronics, Department of Electrical & Electronics Engineering Fiji National University (2011)