Smartphones Take Control: A DIY Smart Home System Using ESP32 and Blynk

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Abstract
The rapid advancement of technology has significantly transformed modern living standards. This paper presents the development of a smart home system based on the Internet of Things (IoT) using ESP32 and Blynk. By integrating IoT technology, the system enables remote control of home devices, enhancing convenience, energy efficiency, and security. The study addresses the challenges of managing debounce delays and optimizing response times, which are critical for the effective operation of smart home systems. The findings suggest that a debounce delay of 50ms and 100ms offers optimal performance, ensuring accurate device control without significant delays. The project successfully demonstrates the potential of DIY smart home systems in improving daily life through technological innovation.

Keywords: Debounce Delay; IoT; Response Time; Smart Home System.

1.0 INTRODUCTION

1.1 Introduction

In recent years, the integration of Internet of Things (IoT) technology into smart home systems has revolutionized how users interact with and control their living environments. Platforms like Blynk have emerged as pivotal tools, enabling seamless connectivity and management of diverse IoT devices from a centralized interface. These systems offer unparalleled convenience, energy efficiency, and enhanced security by allowing remote control of home devices through smartphones and other smart devices. However, the effectiveness of smart home operations heavily relies on two crucial factors: debounce delays and response times. Addressing these factors is essential for ensuring the reliability and user satisfaction of smart home systems.

1.2 Problem Statement

Despite advancements in IoT technology facilitated by platforms such as Blynk, challenges persist in effectively managing debounce delays and optimizing response times within smart home environments. Debounce delays are critical in stabilizing input signals from physical switches or sensors, ensuring accurate recognition of user commands while minimizing false triggers. Without proper management, these delays can lead to unreliable device performance and user frustration. Meanwhile, response times, measured as the duration between user input and device action, directly impact the perceived responsiveness and reliability of smart home devices. Improving these aspects is essential for enhancing the overall user experience and achieving seamless smart home integration.

1.3 Research Questions

The primary focus of this study is to investigate how debounce delays and response times are managed in smart home systems utilizing the Blynk platform. Specifically, the research seeks to understand the methodologies employed for debounce delay implementation and analyze the factors influencing response times in Blynk-controlled devices.

1.4 Objectives

The objectives of this research are:

i. To examine how debounce delays are currently managed in smart home systems using Blynk.
ii. To suggest and test ways to improve response times, making Blynk-integrated smart homes more efficient and user-friendly.

2.0 Literature Review

2.1 Previous Study

The Fourth Industrial Revolution (4IR) marks rapid technological, industrial, and societal changes due to increased connectivity and intelligent automation (Schwab, 2016). One significant development in this era is smart home systems, which use IoT to control domestic appliances via electronic systems connected to the Internet. This includes controlling lights, fans, and switches through a central hub with a mobile app. Originating in 1966 with ECHO IV, IoT-based smart home systems have grown popular for their convenience (Wilson, 2014).

Smith and Jones (2018) highlight that smart home technologies significantly improve energy efficiency by optimizing energy use, which prevents electricity waste. These systems make daily life easier by automating routine tasks, thus enhancing convenience for users. Doe (2017) notes that users frequently forget to turn off lights and switches, leading to wasted electricity and increased costs. This forgetfulness can also raise the risk of fires due to overheating circuits from excessive energy use. Therefore, managing debounce delays and response times is crucial for ensuring the reliability and safety of smart home systems.

According to Brown and Green (2018), debounce delays stabilize input signals from physical switches or sensors, ensuring accurate recognition of user commands while minimizing false triggers. Effective management of debounce delays is essential for preventing false signals that could lead to unintended device actions.

Chen (2018) emphasizes the importance of optimizing response times in IoT applications. The duration between user input and device action, or response time, directly impacts the perceived responsiveness and reliability of smart home devices. Efficient response times enhance user experience and satisfaction.

3.0 Methodology

3.1 Waterfall Model

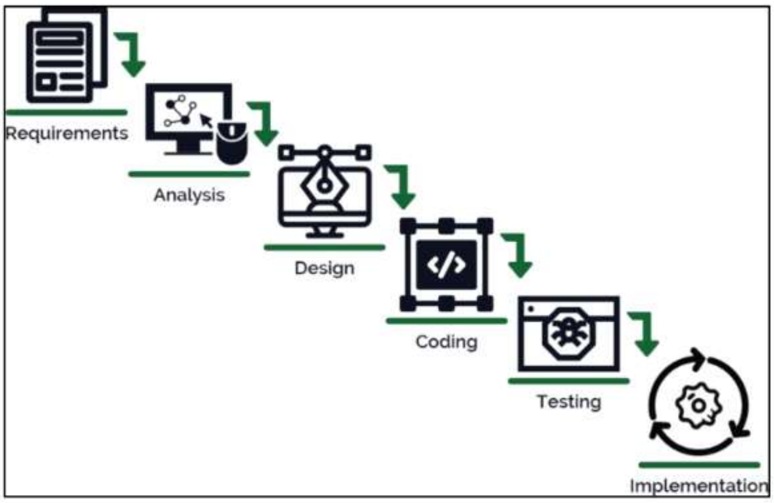

Figure 3.1: Waterfall Model with 6 stages (https://eugeniucozac.medium.com/waterfall-methodology)

This study used approach of waterfall model which are;
Stage 1- Requirement: Define and gather detailed requirements related to debounce
delays and response times in smart home systems using Blynk.
Stage 2 – Analysis: Design specifications for hardware DIY Smart Home.
Stage 3 – Design: Plan the hardware and software design for implementing debounce mechanisms and response time optimizations.
Stage 4 – Coding: Create coding for both physical and Blynk into functional code that effectively manages debounce delays and measures response times accurately.
Stage 5 – Testing: Conduct testing to validate debounce delay settings and response time optimizations under various conditions.
Stage 6 – Implementation: Sustain and continuously enhance the reliability,

3.2. Block Diagram

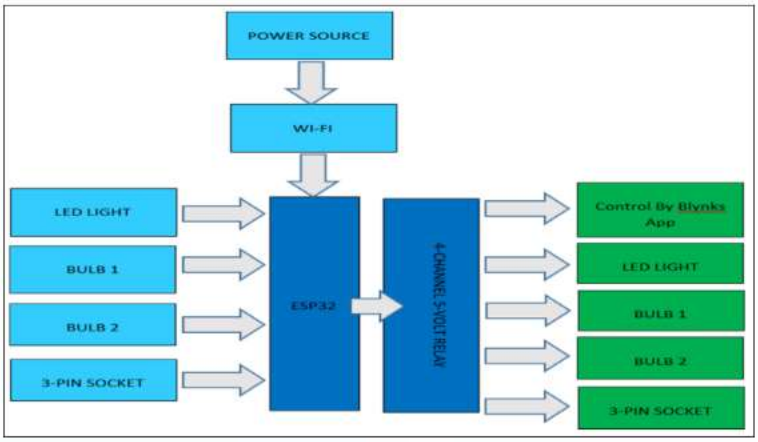

Figure 3.2: Block Diagram of DIY Smart Home

3.3 Circuit Diagram

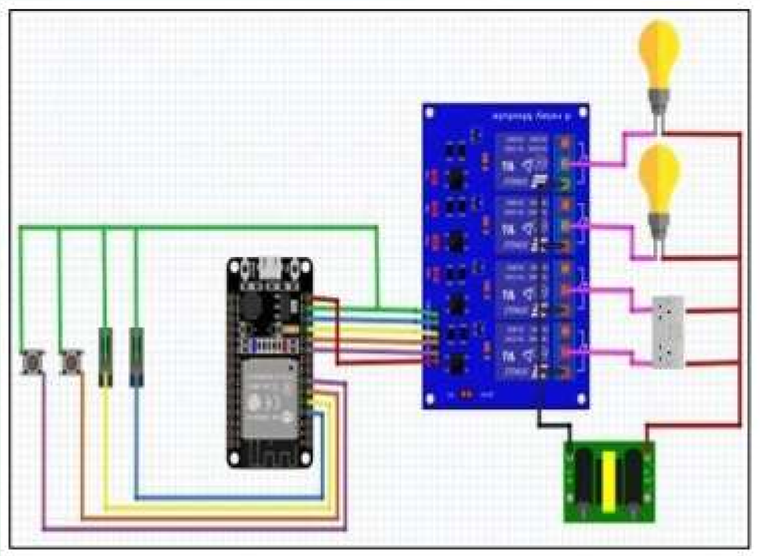

Figure 3.3: Circuit Diagram

3.4 Flow Chart

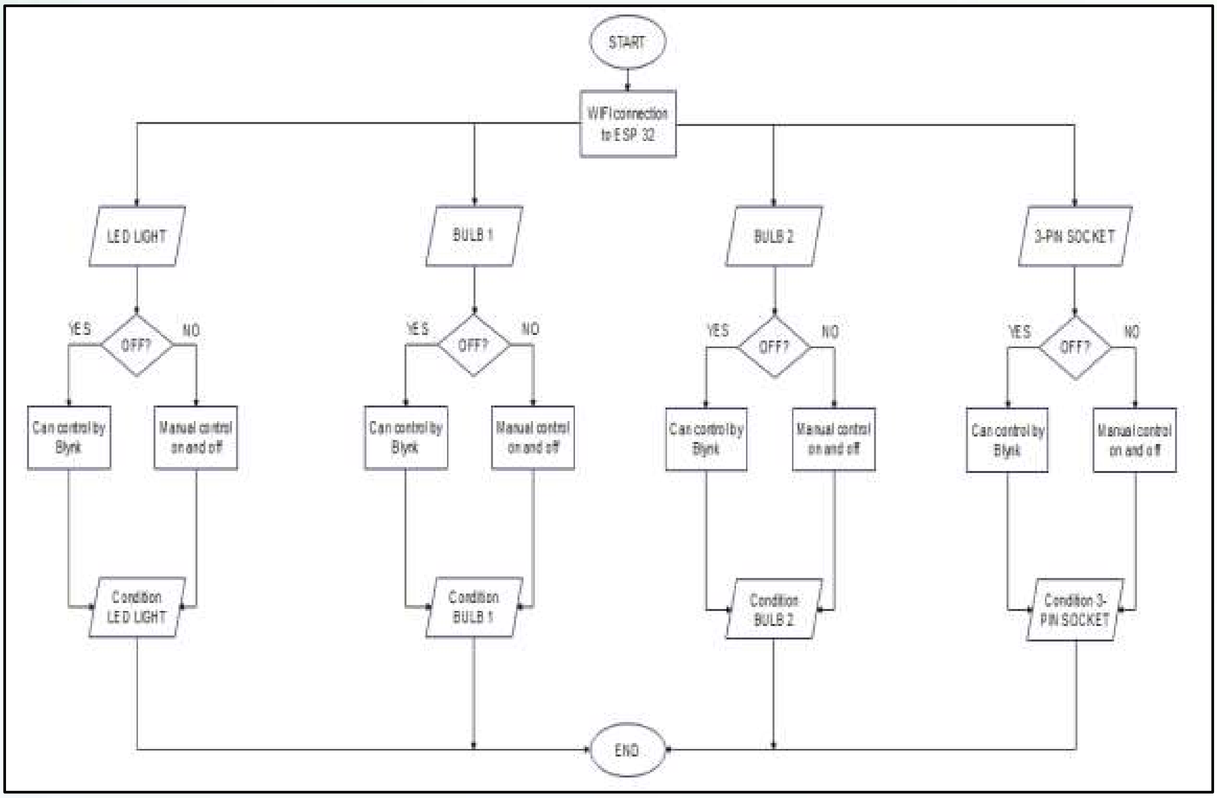

Figure 3.4: Flowchart of DIY Smart Home

3.5 Blynk App and Product DIY Smart Home

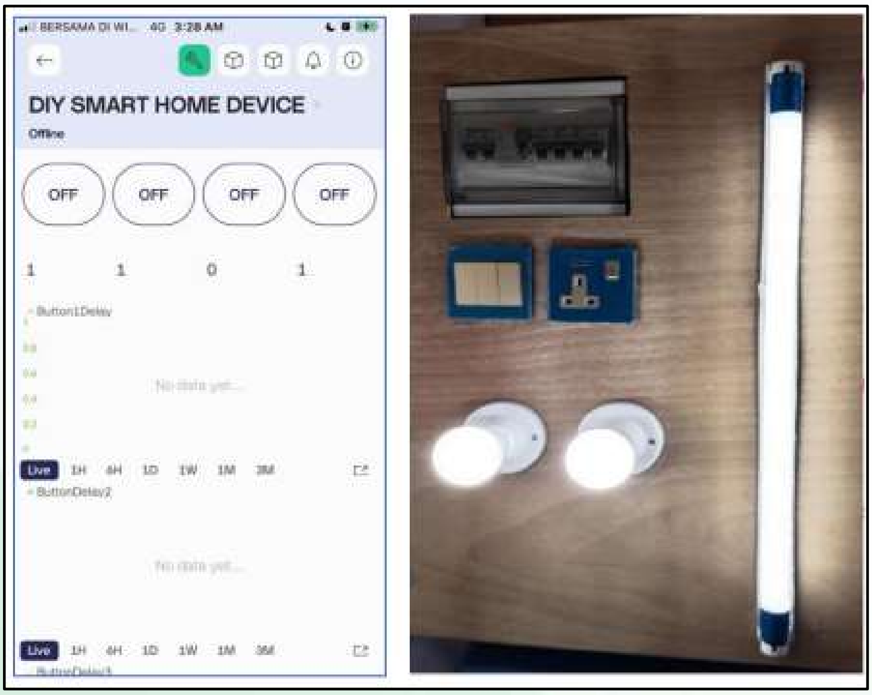

Figure 3.5: Blynk App and Product DIY Smart Home

4.0 DATA AND ANALYSIS

4.1 Sample data testing

Test Number	Debounce Delay	Button Press Time (ms)	Button Release Time (ms)	False Signals Detected	Remarks
1	25ms	1	1	1	Minor bounce detected
2	25ms	1	1	0	No bounce detected
3	25ms	1	1	2	Multiple bounces detected
1	50ms	1	1	0	No bounce detected
2	50ms	1	1	0	No bounce detected
3	50ms	1	1	0	No bounce detected
1	100ms	1	1	0	No bounce detected
2	100ms	1	1	0	No bounce detected
3	100ms	1	1	0	No bounce detected

Table 4.1: Sample data of three difference debounce delay

This table examines the effects of different debounce delays (25ms, 50ms, and 100ms) on the performance of button presses and releases in a smart home system. The focus is on detecting false signals (bounces) and ensuring accurate button state detection. 25ms Debounce Delay: This delay is not consistently effective. Minor bounces and multiple bounces were detected in some tests, indicating that 25ms might be too short for reliable debounce performance. 50ms Debounce Delay: This delay consistently eliminated bounces across all tests, making it a reliable choice for most applications. 100ms Debounce Delay: This delay also effectively eliminated bounces.

4.2 Graph Super Chart Blynk App

Figure 4.1: Graph debounce 25ms and on-off button

Graph Debounce 25ms Figure 4.1, the graph with a 25ms debounce delay shows frequent false signals when the on-off button is pressed. The system struggles to accurately detect the button state, leading to unreliable performance.

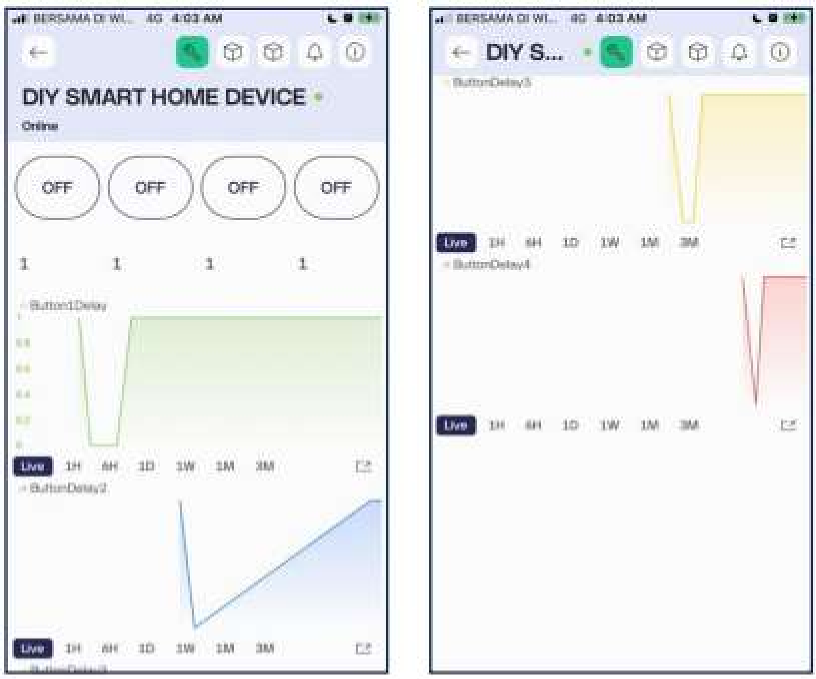

Figure 4.2: Graph debounce 50ms and on-off button

Graph Debounce 50ms Figure 4.2, the graph with a 50ms debounce delay demonstrates a significant reduction in false signals. The system becomes more reliable in detecting the button state, balancing effectiveness and responsiveness. This setting offers a marked improvement over the 25ms delay.

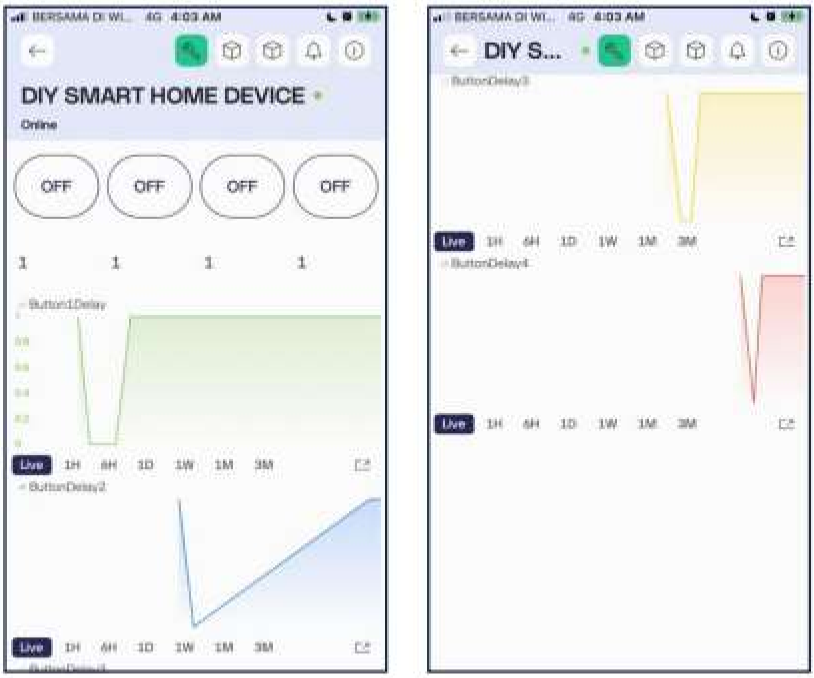

Figure 4.3: Graph debounce 100ms and one-off button

Graph Debounce 100ms Figure 4.3, the graph with a 100ms debounce delay shows a further decrease in false signals compared to the 50ms setting. While this setting provides the highest accuracy in button state detection, it introduces a slight delay that may affect responsiveness in some applications.

5.0 Conclusion and Recommendation

5.1 Conclusion

Based on the findings, a debounce delay of 50ms and 100ms appears to be a robust choice for balancing debounce effectiveness and responsiveness in Blynk-integrated smart home systems. It consistently prevents false signals without introducing significant delay. If currently using a 25ms debounce delay and experiencing issues with false signals, transitioning at least to a 50ms delay is advised. This adjustment is likely to improve the accuracy of button state detection and overall system reliability. Continuously monitor and refine debounce settings based on real-world performance metrics. Consider adjusting debounce delays further based on specific environmental factors and user interaction patterns.

5.2 Recommendation

For future project recommendations, the project can be improved with:
i. Transition from Lower Delays
ii. Standardize Debounce Delay
iii. Continuous Monitoring and Refinement

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Waterfall Methodology https://eugeniucozac.medium.com/waterfall-methodology