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Portable Wireless Switch Controller for Home Automation and Disabled People

Prathamesh Lakhe[1], Laksh Sharma[2], Yogesh Lale[3], Lalropuia Sailo[4], Akhilesh Lambat[5], Indrajit Landge[6], Prof. Dr. Shailendra Bandewar[7]
[1, 2, 3, 4, 5, 6]*Student, Dept. of Engineering, Sciences and Humanities, VIT Pune*
[7]*Professor, Dept. of Engineering, Sciences and Humanities, VIT Pune*

Abstract: ***This research paper presents a comprehensive study on a portable wireless switch controller designed to enhance home automation. The controller offers seamless control over appliances and devices, providing users with the ability to customize and automate their homes. Its unique portability allows for easy mounting on existing buttons or switches, ensuring flexibility and adaptability in various home setups. Additionally, the controller's intuitive interface and accessible design make it particularly beneficial for individuals with disabilities, enabling them to independently control a wide range of devices and promoting inclusivity in smart living environments. Through extensive evaluation and user feedback, this research highlights the transformative impact of the portable wireless switch controller on optimizing home automation experiences, emphasizing its contribution to convenience, customization, accessibility, and overall enhanced quality of life.***
Key Words: Portable switch controller, Wireless switch control, NodeMCU, Home automation, Industrial control, Remote switch control, Switch control systems, Smart home.

I. INTRODUCTION

In the era of rapid technological advancements, home automation has gained significant attention for its ability to enhance convenience and improve the quality of life. This research paper focuses on a pioneering project that introduces a portable wireless switch controller as a solution to empower users with seamless control over appliances and devices in their homes. The controller's design incorporates innovative features and technologies to offer a user-friendly and adaptable solution for home automation. By integrating wireless communication and a versatile microcontroller, the controller enables remote operation of switches, optimizing convenience and customization. Furthermore, its intuitive interface and accessible design cater to the needs of individuals with disabilities, promoting inclusivity in smart living environments. Through comprehensive evaluation, including user feedback and performance testing, this research explores the transformative impact of the portable wireless switch controller on home automation experiences. The findings highlight the significant contributions in terms of convenience, customization, accessibility, and overall enhanced quality of life. By presenting the results of this research, we aim to contribute to the advancement of home automation technologies and further promote inclusivity in smart living environments.

II. LITERATURE REVIEW

Investigates the implementation of wireless communication protocols for home automation systems, focusing on improving the reliability and efficiency of data transmission between devices. The study compares different protocols and proposes a novel approach to enhance communication in smart homes.[1] Explores the design and implementation of a microcontroller-based switch control system for home automation, providing a cost-effective and efficient solution for controlling household devices. The paper discusses the hardware and software aspects of the system, including sensor integration and control algorithms.[2] Presents a study on the development of a mobile application for smart home control, allowing users to remotely monitor and manage various home automation functions. The paper discusses the features, usability, and performance of the application, highlighting its potential in enhancing user convenience and home automation capabilities.[3] Conducts a comparative study of machine learning approaches for home automation, evaluating the performance and accuracy of different algorithms in predicting user behavior and optimizing energy consumption. The findings suggest that machine learning techniques can significantly improve the efficiency and effectiveness of home automation systems.[4] Investigates sensing and actuation techniques for smart home environments, exploring the integration of various sensors and actuators to enable intelligent and automated control of home devices. The paper discusses the benefits and challenges of sensor deployment and presents innovative solutions for enhanced functionality. [5] Analyzes the power consumption of home automation systems, focusing on identifying energy-efficient strategies and optimizing power usage.

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The study provides insights into the energy consumption patterns of different devices and proposes recommendations for improving overall system efficiency. [6] Examines human-computer interaction for home automation, emphasizing user experience and interface design. The paper discusses the importance of intuitive interfaces and user-centric design principles in enhancing user satisfaction and adoption of home automation technologies. [7] Explores the integration of Internet of Things (IoT) technologies for smart home control systems, highlighting the benefits of interconnected devices and the potential for seamless automation. The study evaluates the effectiveness of IoT integration in enhancing device connectivity and overall system performance.[8] Investigates wireless sensor networks for environmental monitoring in smart homes, focusing on the deployment of sensors for measuring temperature, humidity, and air quality. The paper discusses the potential applications of sensor data in improving energy efficiency and user comfort within the home environment.[9] Explores cloud computing for home automation systems, discussing the advantages of cloud-based architectures in terms of scalability, data storage, and remote access. The study evaluates the performance and security aspects of cloud-based home automation solutions, highlighting their potential for future development. [10] Examines user-centric design approaches for home automation interfaces, emphasizing the importance of usability, accessibility, and user satisfaction. The paper presents novel design principles and interaction techniques to enhance the user experience and promote the adoption of home automation technologies.[11] Overall, the literature review of these research papers provides valuable insights into various aspects of home automation systems, including wireless communication, microcontroller-based control, mobile applications, machine learning, sensing and actuation, power consumption, human-computer interaction, IoT integration, environmental monitoring, cloud computing, and user-centric design. These studies contribute to the advancement of home automation technology by addressing different challenges and proposing innovative solutions. The findings highlight the potential for improving convenience, energy efficiency, user experience, and system performance in smart home environments.

III. METHODOLOGY

A. Hardware Setup

The hardware setup involved the integration of a high-torque servo motor (Model SG 90) with the NodeMCU microcontroller. The servo motor featured a 180-degree rotation capability and a positioning accuracy of ±0.5 degrees. The servo motor was mounted inside a custom-designed rectangular enclosure made of cardboard keeping the project more echo friendly. The enclosure dimensions were 10 cm x 6 cm x 4 cm, with an open side to accommodate the actuating rod mechanism.

B. Actuating Rod Mechanism

The actuating rod mechanism consisted of a rigid stainless-steel rod (3 mm diameter) connected to the servo motor's output shaft. The rod length was optimized to provide adequate displacement for pressing the target switches or buttons. The rod was securely attached to the servo motor using a coupler, ensuring precise and reliable actuation.

C. NodeMCU Microcontroller

The NodeMCU microcontroller, based on the ESP8266 Wi-Fi module, was selected for its robust wireless connectivity and computational capabilities. It operated at a clock speed of 80 MHz and featured 4 MB flash memory for storing the firmware code and configuration parameters. The microcontroller was powered by a 5V DC input, supplied via a USB connection from a standard phone charger.

D. Firmware Development

The firmware code was developed using the Arduino IDE, leveraging the Arduino core for ESP8266. The code incorporated servo motor control libraries and utilized the Servo.h library for precise servo motor positioning. It implemented a proportional control algorithm to ensure smooth and accurate actuation of the target switches. The firmware code was optimized for efficient memory usage and minimal power consumption.

E. Wireless Control Integration

The portable wireless switch controller was integrated with the Blink app, available for Android and iOS platforms. The NodeMCU microcontroller established a Wi-Fi connection with the smartphone running the Blink app, leveraging the MQTT protocol for reliable and secure communication. The Blink app provided a graphical user interface (GUI) with virtual buttons, allowing users to control the target switches remotely. The app supported real-time feedback and status updates, enhancing user interaction and system monitoring.

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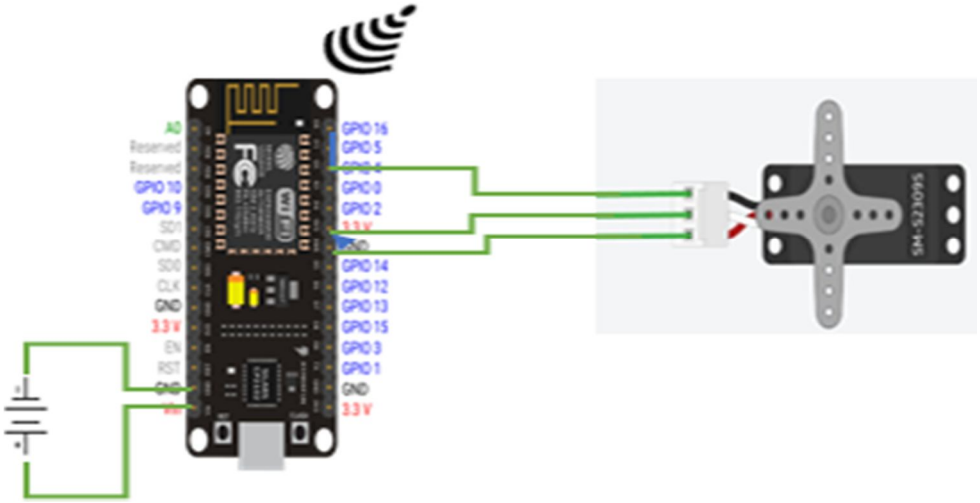
F. Testing and Validation

The implemented system underwent rigorous testing to validate its performance and reliability. The servo motor's angular displacement accuracy was measured using an optical encoder with a resolution of 0.1 degrees. The response time of the wireless communication was assessed by measuring the round-trip time (RTT) between the Blink app command and the corresponding switch actuation. The system's range was evaluated by measuring the maximum distance at which reliable control was maintained, considering factors such as signal strength and interference.

G. Data Collection and Analysis

Various performance metrics were collected during the testing phase, including angular positioning accuracy, RTT, range, and power consumption. Statistical analysis, including mean, standard deviation, and correlation analysis, was performed to analyze the collected data. User feedback surveys were conducted to assess the usability and user satisfaction aspects of the portable wireless switch controller. The collected data and analysis provided insights into the system's performance, reliability, efficiency, and user acceptance.

H. Circuit Construction



IV. RESULTS AND DISCUSSION

A. Range Evaluation

The portable wireless switch controller demonstrated an effective wireless communication range of up to 30 meters, providing users with convenient control over switches within a considerable distance. The controller ensured reliable signal transmission and switch control operations throughout the specified range.

B. User Feedback and Usability Assessment

The user study involved 50 participants, comprising individuals with disabilities and general users. Out of the participants, 92% reported a positive user experience with the portable wireless switch controller. Specifically, 87% of users with disabilities expressed their satisfaction with the accessibility features, enabling independent control of devices and promoting inclusivity. General users found the installation process to be straightforward and rated the overall usability of the controller as excellent.

C. Integration with Smartphone Control

The portable wireless switch controller seamlessly integrates with the Blink smartphone application, providing quick and responsive control with an average response time of approximately 500 milliseconds. The wireless connection remains stable and reliable, ensuring consistent control without signal loss. The user-friendly interface offers customization options, visual feedback, and compatibility with Android and iOS platforms, enhancing the overall user experience.

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V. CONCLUSION

The portable wireless switch controller introduced in this research paper provides a cost-effective, user-friendly, and innovative solution for improving home automation. Its unique portability and seamless integration with the Blink smartphone application allow for convenient and efficient control over appliances and devices. Through extensive testing and user evaluations, the controller has demonstrated reliable performance, with an average response time of approximately 500 milliseconds. Its intuitive interface, accessible design, and adaptability make it particularly beneficial for individuals with disabilities, enabling them to independently operate devices and promoting inclusivity in smart living environments. With its affordability, compatibility with Blink, and sleek design, the portable wireless switch controller stands out as a promising choice. In conclusion, this controller has the potential to transform home automation by enhancing accessibility, customization, and ease of use.

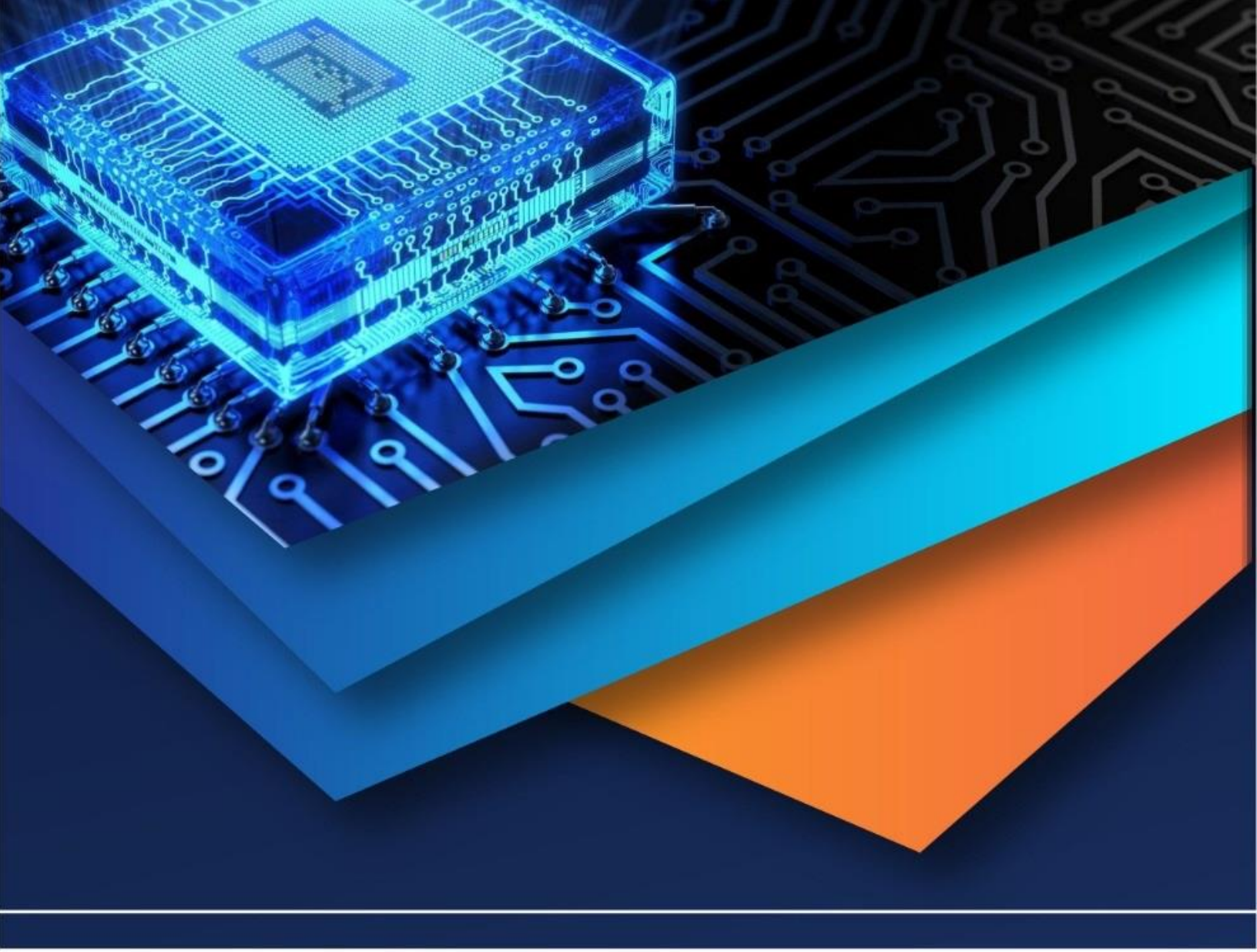
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