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IOT CONTROLLED SMART DISTRIBUTION BOX

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ABSTRACT

This project introduces an IoT-controlled smart distribution box designed for enhanced energy management and convenience, boasting versatile features for both online and offline usage. Utilizing a NodeMCU microcontroller unit, the system integrates a 4-channel relay for load management via voice commands (Google Assistant, Amazon Alexa), manual switches, and programmable timers and schedules. An LCD 2004 display provides real-time feedback, while a PZEM004T sensor enables precise energy monitoring. Users can also set load limits, with notifications sent when thresholds are reached, further enhancing efficiency and safety. With these comprehensive capabilities, the system empowers users to optimize energy usage, promote sustainability, and simplify control of electrical appliances in residential and commercial settings..

I. INTRODUCTION

The evolution of smart technologies has revolutionized the way we interact with our surroundings, offering unprecedented levels of convenience and efficiency. In this context, the development of IoT-controlled smart distribution boxes represents a significant step forward in energy management and home automation. These innovative systems, powered by advanced microcontroller units like the NodeMCU, offer users a comprehensive solution for controlling electrical loads remotely and optimizing energy consumption.

By integrating features such as a 4-channel relay for versatile load control, support for voice commands through popular virtual assistants, and manual switches for offline usage, these smart distribution boxes cater to diverse user needs and usage scenarios. Additionally, the inclusion of programmable timers and schedules enables users to automate tasks and adapt to changing energy demands throughout the day.

Moreover, the integration of energy monitoring capabilities, facilitated by sensors like the PZEM004T, empowers users with real-time insights into their energy usage patterns. This not only promotes greater efficiency but also enables users to make informed decisions to reduce energy waste and lower electricity bills. Furthermore, the ability to set load limits and receive notifications ensures both safety and peace of mind, particularly in environments where electrical circuits may be prone to overload.

II. METHODOLOGY

The methodology employed in this research project centers around the development and implementation of an IoT-controlled smart distribution box, focusing on real-time monitoring and remote control functionalities. Key elements of the methodology include integrating the NodeMCU ESP8266 microcontroller and Blynk app, and inetegration of cadio, and analyzing the power consumption.

1. System Design:

Begin by conceptualizing the architecture of the smart distribution box, considering factors such as the selection of components (NodeMCU microcontroller, 4-channel relay, LCD 2004 display, PZEM004T sensor), and integration of communication protocols (Wi-Fi for IoT connectivity, Blynk server for data visualization).

2. Hardware Setup:

Assemble the hardware components according to the system design, ensuring proper connections between the NodeMCU, relay, LCD display, and energy monitoring sensor. Pay attention to power requirements and grounding to avoid electrical issues.

3. Software Development:

Develop firmware for the NodeMCU microcontroller using Arduino IDE or a similar platform. This involves programming functionalities such as load control, communication with external devices (e.g., LCD display), integration with IoT platforms (e.g., Blynk), and implementation of energy monitoring algorithms.

4. Integration of Voice Control:

Integrate voice control functionalities using APIs provided by Google Assistant and Amazon Alexa. This may involve setting up OAuth2 authentication, implementing voice command parsing, and establishing communication protocols between the microcontroller and virtual assistants.

5. Timer and Scheduler Implementation:

Develop features for setting timers and schedules using the microcontroller's internal clock or external real-time clock modules. Implement logic to trigger load activation/deactivation based on user-defined time intervals.

6. Load Limit Setting and Notification:

Implement functionality to set load limits and monitor energy consumption. Define thresholds for load limits and configure the system to send notifications (e.g., email, SMS) when these thresholds are exceeded, using appropriate APIs or services.

7. Testing and Debugging:

Conduct thorough testing of the system to ensure proper functionality and reliability. Test various scenarios, including manual control, voice commands, timer/schedule activation, and energy monitoring. Debug any issues encountered during testing and refine the firmware as needed.

Overall, this methodology ensures a systematic approach to the development and analysis of the IoT-based home automation and security system, focusing on meeting project objectives and ensuring optimal system performance.

III. MODELING AND ANALYSIS

The model and materials used in this study are presented in this section. The table below provides a detailed overview of the components utilized in the development of the IoT-Controlled smart distribution box .The model encompasses the integration of NodeMCU ESP8266 microcontroller, Blynk app, and Cadio selected sensors, and relay modules to enable real-time monitoring and remote control functionalities.

Table 1. Components Used in the IoT-Controlled smart distribution box

SN.	Component	Description
1	NodeMCU ESP8266	Microcontroller for internet connectivity
2	Blynk App	User interface for remote monitoring and control
3	Cadio App	User interface for remote monitoring and control
4	PZEM-004T Sensor	Electrical parameter reading
5	LCD 2004 display	Intrusion detection
6	4 Channel relay module	Remote control of household appliances
7	DC 5v Adapter module	Power Supply for all components
8	5A Lamps and Lamp holder	Representing the Loads connected to the system

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The analysis of the system performance involves testing the functionality and reliability of each component. Real-time monitoring capabilities are evaluated by assessing the accuracy of current, voltage, frequency, powerfactor by the PZEM-004T. Remote control functionalities are tested by verifying the responsiveness of relay modules in controlling household appliances. Data collected during testing is analyzed to assess system performance under various scenarios and conditions.

The model presented in this study serves as a framework for the development and implementation of IoT controlled smart distribution box. Through rigorous testing and analysis, the effectiveness and reliability of the system components are evaluated, providing insights into the potential applications and benefits of IoT technology in enhancing home management and security.

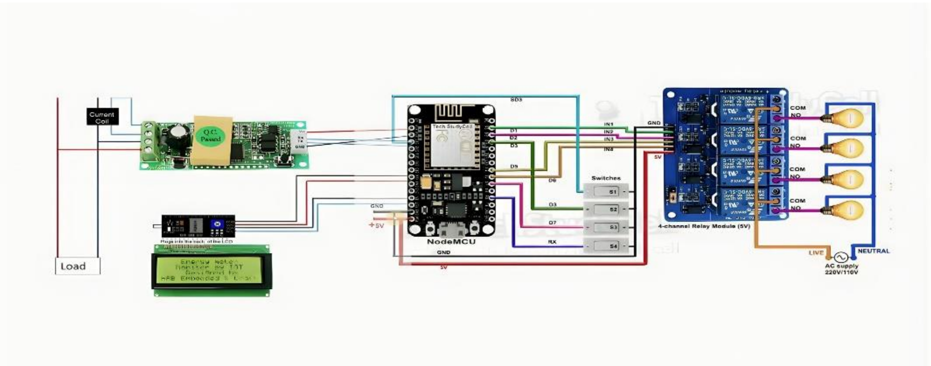

Figure 1: Circuit Diagram.

IV. RESULTS AND DISCUSSION

The results and discussion of the IoT-Controlled smart distribution box are presented in this section. The findings are organized into subsets with short, revealing captions to facilitate understanding and analysis.

Sensor Performance Evaluation:

- The performance of sensor, including the Blynk for energy monitoring, PZEM-004T sensor for measuring electrical parameters, like current, voltage, and power factor, Frequency, Power, Energy Consumption, was evaluated under various conditions.
- Discussion: The sensors demonstrated accurate and reliable performance in detecting the various electrical parameters, contributing to the overall effectiveness of the system.

Real-time Monitoring Capability:

- Real-time monitoring capabilities of the system, facilitated through the integration of NodeMCU ESP8266 and the Blynk app, were assessed for Current, Voltage, Power, Energy, Frequency, and power factor.
- Discussion: The system exhibited robust real-time monitoring capabilities, allowing users to access up-to-date information and receive notifications on excessive power usage when its breach its limit.

Remote Control Functionality:

- The remote control functionality of the system, enabled by relay modules and integrated with the Cadio app interface, was tested for controlling household appliances.
- Discussion: Remote control functionalities were found to be responsive and reliable, providing users with convenient access to appliance control from anywhere with internet connectivity.

Google Assistant and Alexa integrability:

- The Cadio is an external server that is helpful for controlling the household equipments through the internet. The cadio server is available in the google home and alexa also.
- Discussion: User feedback was positive, indicating high levels of satisfaction with the system's performance, ease of use, and effectiveness in enhancing home automation and security.

System Reliability and Stability:

- Feedback from users regarding system usability, functionality, and overall satisfaction was collected and analyzed to assess user experience.

- Discussion: User feedback was positive, indicating high levels of satisfaction with the system's performance, ease of use, and effectiveness in enhancing home automation and security.

V. CONCLUSION

In conclusion, this project has addressed the pressing need for advanced home automation and power monitoring systems through the development of an IoT-based solution. By integrating NodeMCU ESP8266 and the Cadio and the Blynk app, alongside a suite of carefully selected sensors, the system provides users with remote monitoring and control capabilities for electrical parameters.

As IoT technologies continue to evolve and become more accessible, the potential for smart distribution boxes to transform energy management in both residential and commercial settings is immense. By providing users with actionable insights into their energy consumption patterns and offering intuitive control interfaces, these systems are poised to play a key role in shaping the future of smart homes and sustainable living.

The IoT-controlled smart distribution box represents a versatile and efficient solution for modern energy management needs, offering users unprecedented control, convenience, and sustainability in managing their electrical appliances and promoting a greener, more efficient future.

VI. REFERENCES

[1] G. Suciu, L. Necula, R. Iosu, T. Usurelu and M. Ceaparu, "IoT and Cloud-Based Energy Monitoring and Simulation Platform," 11th International Symposium on Advanced Topics in Electrical Engineering (ATEE) 2019.

[2] S. Wasoontarajaroen, K. Pawasan and V. Chamnanphrai, "Development of an IoT device for monitoring electrical energy consumption," 9th International Conference on Information Technology and Electrical Engineering (ICITEE) 2017.

[3] M. Rokonuzzaman, M. I. Akash, M. Khatun Mishu, W. -S. Tan, M. A. Hannan and N. Amin, "IoT-based Distribution and Control System for Smart Home Applications," IEEE 12th Symposium on Computer Applications & Industrial Electronics (ISCAIE) 2022.

[4] J. B. Leite and M. Kezunovic, "Integrating IoT Devices with Distribution Energy Management System by Harmonizing Their Logical Models Using IEC Standards 61970/61968 and 61850," IEEE Power & Energy Society General Meeting (PESGM) 2023.

[5] Sanzid Hossain Tayef, Md. Muhidur Rahman, Md. Abu Bakkar Sakib, "Design and Implementation of IoT based Smart Home Automation System", 2021 24th International Conference on Computer and Information Technology (ICCIT) –January 2022.