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Intelligent circuit breaker design and implementation for electrical current sensing and monitoring

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Abstract

Electric shocks sustained when repairing power lines have been the main cause of the recent increase in electrical accidents involving linemen. Lack of communication between the maintenance staff and the electrical substation frequently leads to these events. A system utilizing the NodeMCU ESP8266 that enables remote control (ON/OFF) of electrical wires is suggested in order to improve linemen's safety. To turn the power supply on or off in this system, the lineman or maintenance personnel logs into the Blynk program. In the event that an electrical line issue is identified, the lineman can use the Blynk app to turn off the power source, securely make the required repairs, and then turn the power back on. LEDs are used to show the relay's ON/OFF status, and an LCD screen also shows it. The lineman only needs to log out of the Blynk program after doing the work.

Introduction

Electricity continues to be vital despite the increasing manufacturing and use of electrical devices [1]. Traditional electrical distribution panels function as central nodes that transmit electricity to different appliances in household and business settings in Ghana, where hydroelectric power is the main energy source [2]. These buildings are powered by the national utility provider, and as the primary supply line ends at the distribution board, it acts as an interface between the end consumers and the main power supply [3][4]. In a building's electrical architecture, distribution panels are essential for controlling and safeguarding several electrical circuits that branch off of a single main line [5]. By separating problematic circuits, including those impacted by short circuits [6], they improve system reliability without affecting other network segments. They also offer a way to keep an eye on how much energy is being used at home [7]. To safeguard individual circuits, early systems used fuses, which needed to be changed when they blew because of problems like overloads, ground faults, or short circuits [8]. Resettable protection with increased load-handling capability was made possible by the invention of circuit breakers [9]. Traditional breakers employ thermal bimetallic trip mechanisms [10][11], which can be a little slow—depending on the overload level, they may take minutes to operate [12][13]. Faster isolation techniques are necessary because such delays might result in serious circuit damage when excessive current continues [14]. Moreover, manual resetting is necessary for

conventional panels once issues have been fixed [11].

Many circuit breaker solutions have been created over time to guarantee steady operation of DC circuits. Mechanical, solid-state, and hybrid breakers are the three primary types of these; hybrid designs provide the best technical performance [15][16].

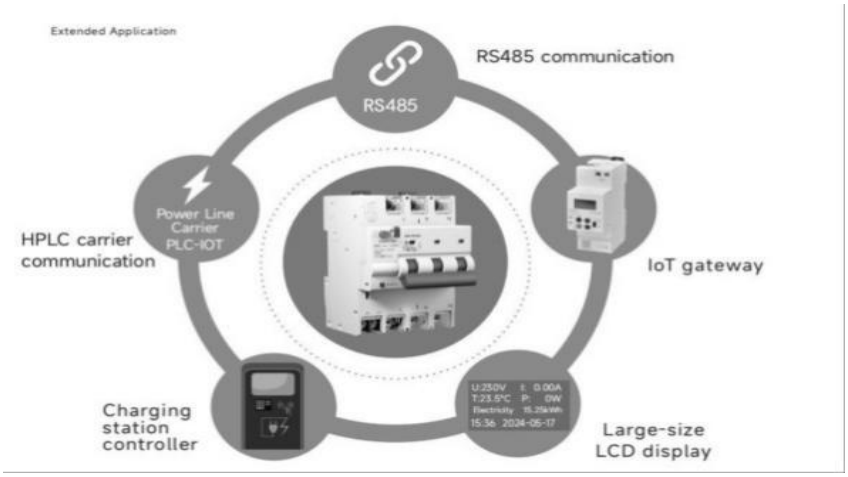

Fig. 1 Intelligent Miniature Circuit Breaker

OBJECTIVE

Designing a wireless, automated system that allows users to remotely reset Miniature Circuit Breakers (MCBs) using Bluetooth technology is the aim of the Intelligent MCB Reset Mechanism with Bluetooth Integration. With this system, users may use an Android application to send a reset instruction to an ESP32 microcontroller, which will then activate a servo motor to automatically return the MCB to the ON position. The goal of the project is to reduce the requirement for manual involvement in circuit breaker resets while simultaneously improving convenience and safety. This device enhances electrical circuit management in both home and commercial settings by offering a more effective and user-friendly method.

PROPOSED METHODOLOGY

Block Diagram

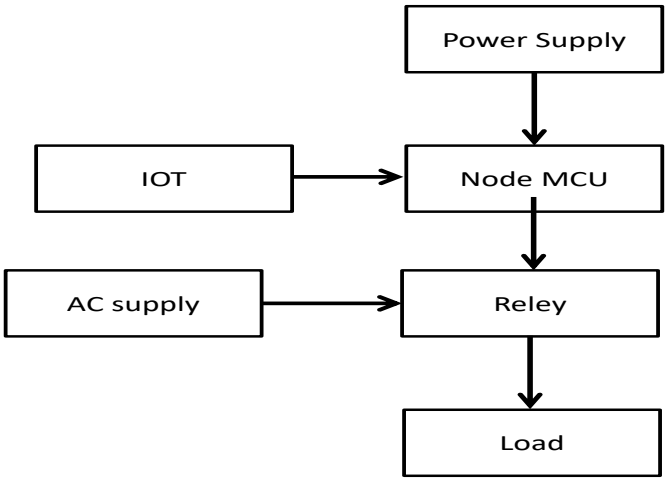

Fig. 2:- Block Diagram

The core of the suggested system is the microcontroller, which processes user input obtained through the Internet of Things platform and regulates the ON/OFF state of electrical loads. With the help of a Wi-Fi module and the Blynk application, several loads can be controlled at once. A mobile hotspot is used to link the system to the internet, enabling smooth communication between the Blynk app and the microcontroller. Although Blynk has an easy-to-use interface, users must first register and configure control widgets in order to manage the linked loads. To turn the circuit on or off, the microcontroller signals the relay module after receiving input. Additionally, an LCD module shows the load's current status for the user's reference. To power the load, the relay module's normally open (NO) pin is linked to an external AC power source. When the microcontroller triggers the relay, it completes or interrupts the circuit by attracting or releasing its armature, turning the load ON or OFF automatically without the need for human interaction. Relays work on electromagnetic principles

ADVANTAGES

1. **Remote Control** – Operate circuits via smartphone apps.
2. **Real-Time Alerts** – Instant notifications during faults.
3. **Auto Trip & Reset** – Automatically trips on faults and restores after normalcy.
4. **Improved Safety** – Reduces risk of shocks and fire.
5. **Energy Monitoring** – Tracks power usage for efficiency.
6. **Multi-Load Control** – Manages multiple devices at once.
7. **User-Friendly** – Easy to use with mobile apps.
8. **Low Maintenance** – Cuts down manual checks and repairs.

CONCLUSION

An Intelligent Miniature Circuit Breaker (IMCB) intended for domestic application has been developed and reported in this study. To increase a distribution panel's intelligence, the technology combines a microprocessor with existing sensors. It continuously checks the circuit's current flow and trips the breaker automatically if the current rises above a set threshold. The system automatically reestablishes the connection when the current level reaches a safe range. Furthermore, when a circuit trip happens, a GSM module is used to notify the user in real time. Temperature sensors will be added to this system in the future to track the heating levels of electrical cables, reducing the risk of fire threats brought on by overheating. Additionally, the integration of Artificial Intelligence (AI) will offer predictive analysis, such as calculating the user's electricity cost by analyzing their past patterns of energy consumption.

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