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Original Article

Real-time Embedded Based Circuit Breaker Monitoring Through IOT

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Abstract: *This project aims to implement an Internet of Things (IoT) based system for monitoring and controlling circuit breakers, which are crucial components in industrial electrical systems for protection and switching. As circuit breakers age and undergo numerous operations, concerns regarding their reliability arise. To ensure their reliability, preventive maintenance is typically carried out at fixed intervals. However, this approach results in unnecessary downtime and offline use of separate diagnostic equipment, even when the circuit breaker is healthy, leading to increased maintenance costs. Additionally, the traditional hardwired control logic used for circuit breaker control increases the size of control and metering cabinets, making it difficult to integrate IoT technology. The proposed system will address these issues and enable remote monitoring and control of circuit breakers, while also ensuring adherence to Lock Out Tag Out (LOTO) practices.*

Keywords: *Circuit Breaker, IOT, Downtime, LOTO.*

I. INTRODUCTION

In recent years, many major blackouts have been attributed to malfunctions or faulty operations of protective relays, which can trigger cascading outages and ultimately lead to power failures. This problem has prompted active research into traditional protective relays, which can have hidden failures and cause cascading outages. This project aims to address this issue by studying methods for modeling and online setting-checking of protective relays to detect hidden cascading outages caused by relay disoperation. By using an open source platform to continuously monitor and control the circuit breaker through IOT, the project aims to shift from time-based maintenance to as-needed maintenance, reducing overall maintenance costs and unnecessary downtime while ensuring adequate circuit breaker performance. The circuit breaker will be secured through a biometric-based local control for ON/OFF operations. This project will improve the reliability of the circuit breaker while reducing the need for maintenance.

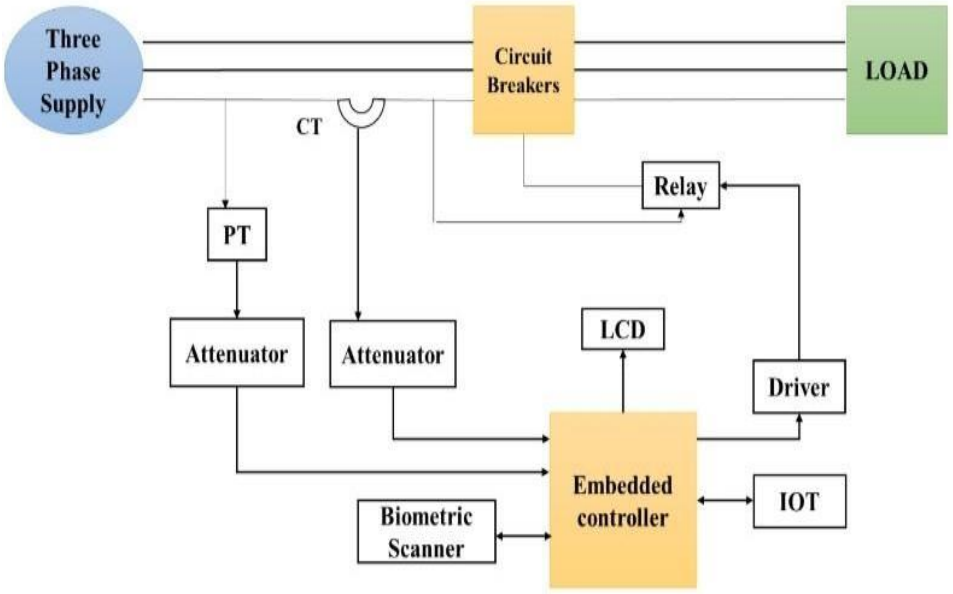
II. EXISTING METHODOLOGY

The project aims to enhance the safety of maintenance staff and line men while repairing electrical lines by designing a password-based circuit breaker. The circuit breaker can only be operated by authorized personnel through the use of a password, which is entered through a keypad and controlled by an ATMEGA32 microcontroller. The proposed concept ensures that line men can turn on and off the electrical line with the password, thereby avoiding accidents caused by the lack of proper communication between the maintenance staff and electrical substation staff. The system also allows for different passwords to be assigned to different electrical phase lines, with three outputs and three different passwords. This design helps to distribute the load between the city and village sides of the power system. The use of the Internet of Things (IOT) technology is proposed for the monitoring and control of circuit breakers. Regular preventive maintenance at fixed intervals is a general practice to ensure the reliable operation of circuit breakers, but this approach leads to unnecessary downtime and increases the maintenance cost. The proposed IOT-based monitoring and control of circuit breaker system can reduce the cost and improve the reliability of the operation. Hardwired control logic increases the size of the control and metering cabinet of the circuit breaker and prevents the integration of IOT technology.

III. PROPOSED METHODOLOGY

This project shows a conceptual implementation of password-based Circuit Breaker Monitoring & Control which will reduce the size of the circuit breaker & facilitate the concept of as needed maintenance approach. Moreover, this will eliminate the concern regarding security vulnerability of third party system as the platform is open source. The proposed system facilitates automated circuit breaker monitoring & control that diagnose the electrical and mechanical health of circuit breaker in real time. The breaker is manual control through Bio-metric based controlling system. The authorized person will control the breaker will turn ON/OFF. This is a shift in the maintenance paradigm from time-based maintenance to as-needed maintenance. This shift comes with the benefit of maintaining adequate circuit breaker performance while reducing overall maintenance costs & unnecessary downtime.

Figure 1: Circuit Breaker Block Diagram



A. Components Used

- Embedded Controller(Atmega328)
- Circuit Breaker
- Potential Transformer
- Current Transformer
- Attenuator
- Driver ULN2003
- Relay
- LCD
- IoT
- Arduino IDE software
- Embedded C
- PHP

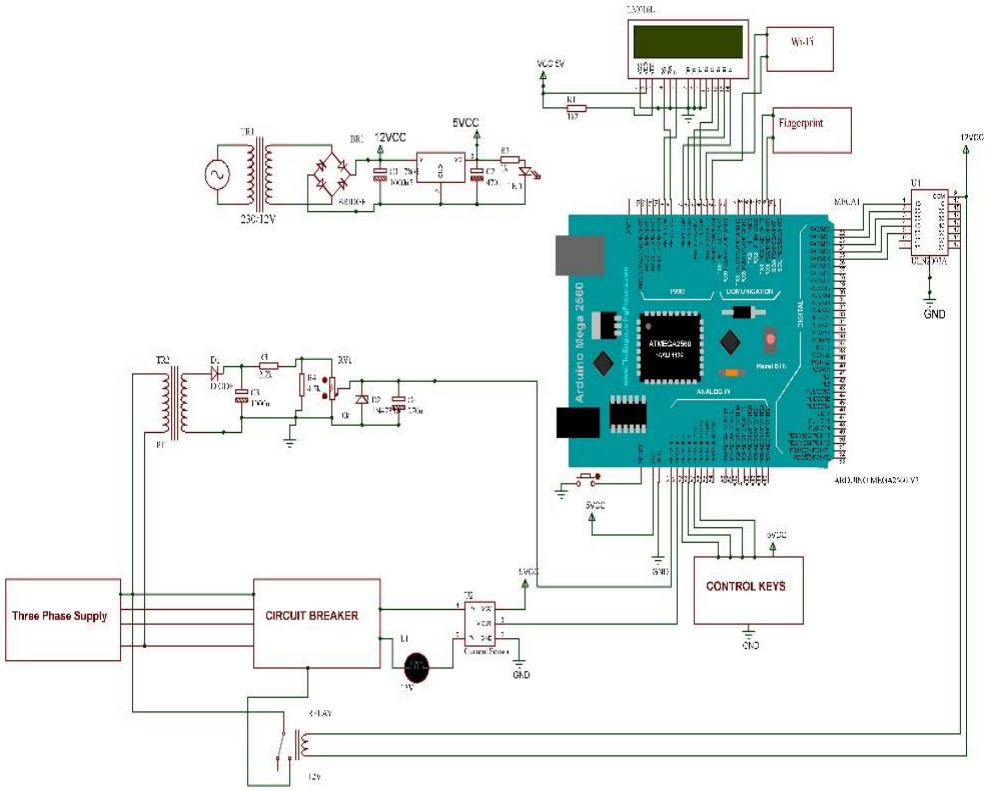


Figure 2: Circuit Diagram

IV. WORKING DESCRIPTION

- The power is divided into two sections. The first is the supply unit, and the second is the breaker unit. The microcontroller is powered by a 5v supply.
- The controller used in this project is ATmega 2560.
- Three-phase power is supplied by a Potential Transformer (PT) and a Current Transformer (CT)
- The CT reduces the high current value to a small measurable value.
- The PT reduces the high voltage value to a small value that can be measured with an ordinary voltmeter. The attenuator on the PT side reduces voltage using a voltage divider and a half-wave rectifier before passing it to the microcontroller for voltage measurement.
- The attenuator on the CT side is used to reduce current using shunt resistance and a half-wave rectifier before passing it to the microcontroller for current measurement.
- A biometric scanner is used for security. For example, when a maintenance worker switches the switch to local mode for maintenance, he must enter his fingerprint in order to turn on the breaker. This ensures the safety of the maintenance worker during his work; without this security, no one else can turn on the power supply.
- An LCD display is used to show power supply details such as voltage and current parameters. When using the local mode, it also shows whether the access is approved or denied.
- A driver IC is used to provide a regulated supply of 12V to the relay in order to operate it.
- The Relay controls the circuit breaker by receiving a signal from the microcontroller.
- A circuit breaker cuts off power when a fault occurs and can be activated in either local or remote mode.There are two modes available for the control of circuit breaker. One is called local mode and the other is called remote mode.
- Local mode is controlled by the person directly on the circuit's location
- Remote mode is controlled by the main authority via IoT. Through the microcontroller, the IoT collects data on circuit breaker status, voltage and current parameters, and sends it to a cloud server that the main authority can access.
- The wifi module device that collects and sends data to the cloud server is the ESP 8266.
- The Internet of Things allows for remote control of circuit breakers.

V. RESULT

The embedded based circuit breaker monitoring using IoT is designed to regulate a circuit breaker by utilising a biometric for the safety of electric workers, and a lineman can access the system by placing his finger into a fingerprint scanner.. With the repair of electric lines, there are an increasing number of serious electrical mishaps. These mishaps are the result of poor coordination and communication between the workers at the electric substation and the maintenance team. The lineman's security is its own hand in this proposed method. The line man will continue to manage whether the line is turned on or off. An ATmega2560 microcontroller. The microcontroller is interfaced with a biometric scanner to punch a finger. The fingerprint that was scanned is compared to the fingerprints that are already stored in memory. Just the line can be turned ON/OFF if the fingerprint match is accurate. Moreover, the ESP8266 wi-fi module is connected to the microcontroller. It is used to keep an eye on both the individual using a system alongside its entire behaviour. An internet website created with PHP software keeps track of all system activity. It keeps track of the system's health and displays recent system users. It can also be operated remotely. We can use IOT to remotely turn on and off the system in an emergency.

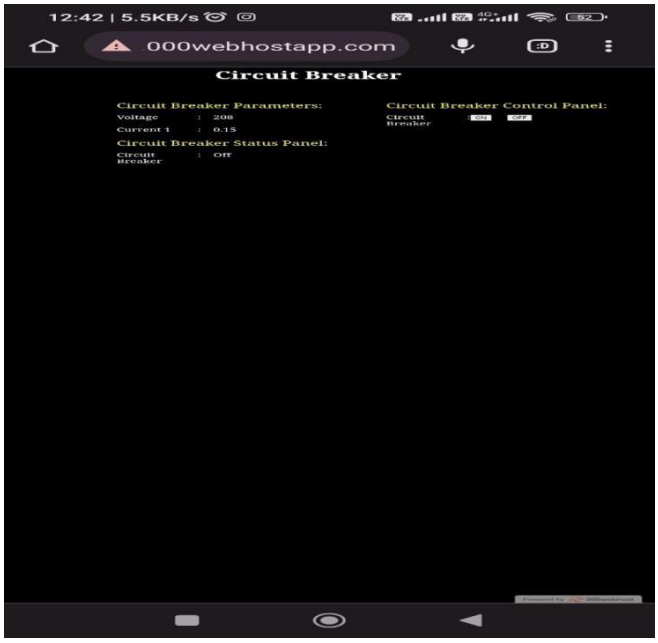


Figure 3: Hardware Kit

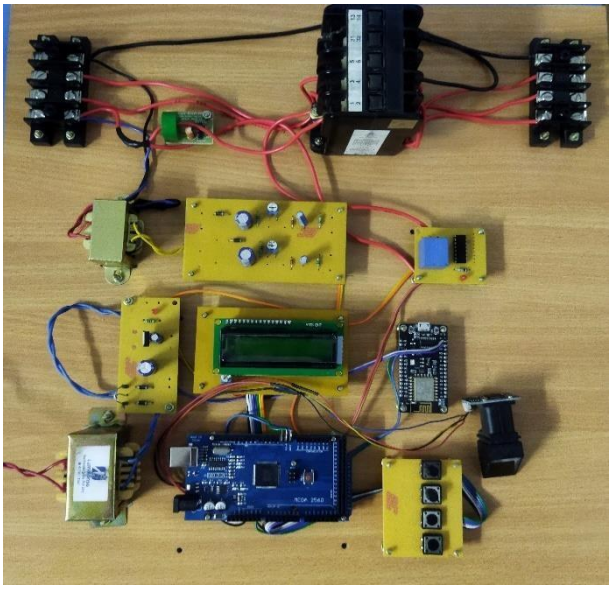


Figure 5: IOT Page

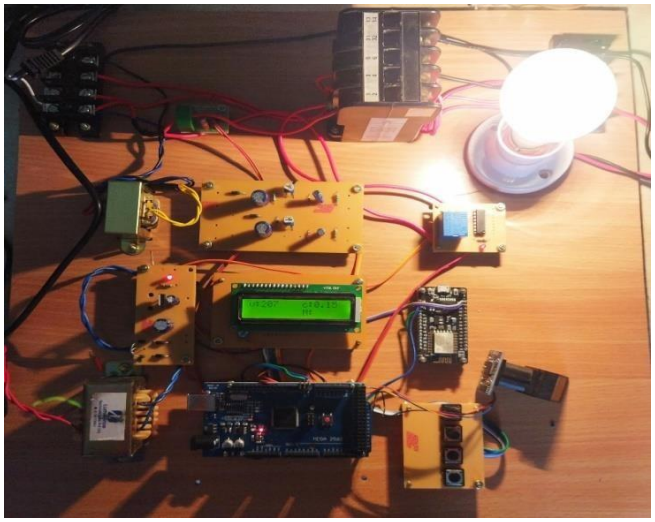


Figure 4: On Working

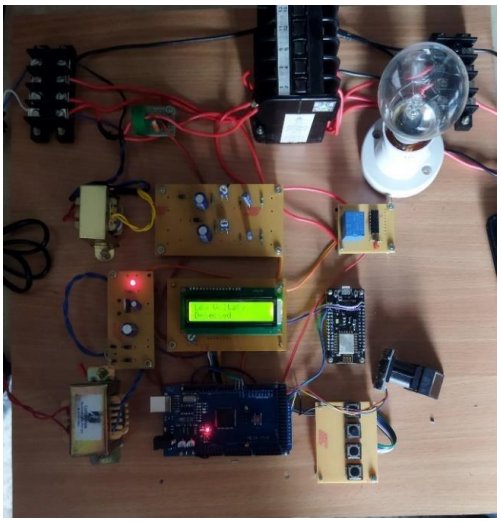


Figure 6: On Low Voltage

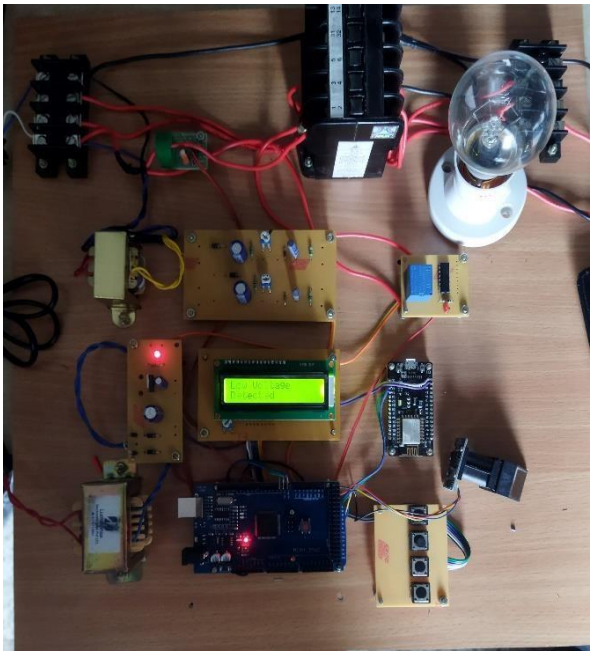


Figure 7: On High Voltage

VI. CONCLUSION

Finally, we can conclude that this system provides a solution that ensures that only the lineman has control over the system, thereby eliminating the possibility of someone else interfering with it. Instead of going to each circuit breaker source, the lineman can simply work the loads from the main hub. For the demonstration, a prototype module is built, and the results are deemed adequate. We can make circuit breakers intelligent by utilising the internet of things, ensuring their smooth operation and making their data accessible to all users. Additionally, system downtime and maintenance time are reduced, while system security is enhanced. The use of intelligent electronic components provides operators with data at their fingertips, allowing them to make adjustments in accordance with system requirements. As a result, it is a very useful and secure way to use circuit breakers. The project work has been designed and developed successfully.

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