

IoT Based Control & Monitoring of Electrical Circuit Breaker

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ABSTRACT

This project presents a safety-focused IoT-driven circuit breaker that implements HTTP Authentication to restrict system access to authorized personnel only. Historically, a high frequency of electrical fatalities among field technicians has been linked to miscommunication or lack of coordination with substations. To mitigate this risk, this initiative utilizes a NodeMCU ESP8266 Wi-Fi module to bridge the gap between hardware and digital control. By connecting to a dedicated IoT web server, operators can manage electrical loads from any location using an internet-capable device. Security is maintained through a mandatory login portal, ensuring only those with the correct credentials can interact with the interface. Once authenticated, the user gains the ability to toggle the state of connected loads globally. The primary advantage of this internet-based approach is the superior communication speed compared to traditional remote systems. By streamlining the interaction between the operator and the power infrastructure, this technology significantly reduces the likelihood of accidental electrocution, making it an essential tool for modern industrial safety.

Keywords: - NodeMCU ESP8266, Relay Module, Transformer, Contactor, Electrical Loads.

1. INTRODUCTION

In industrial electrical infrastructures, the dependability of circuit breakers is paramount, as they serve a dual role in both operational switching and system protection. Malfunctions in these units can have catastrophic consequences, ranging from substantial financial deficits to the loss of life. These devices are subject to progressive wear caused by repetitive mechanical movement, electrical loading, and the intense thermal stress of arc quenching.

The current industry standard relies on preventive maintenance, a strategy where breakers are periodically decommissioned to evaluate health indicators. Technicians typically use specialized equipment to monitor parameters such as spring charging motor performance and trip coil current. While these manual inspections and cleaning routines ensure the hardware is sound, this time-based methodology has notable drawbacks:

- **Operational Inefficiency:** Systems are often taken offline unnecessarily, leading to avoidable downtime for perfectly functional equipment.
- **High Overheads:** The requirement for niche diagnostic tools and manual labor significantly increases operational costs.
- **Technological Rigidity:** Most legacy systems utilize hardwired control logic, which results in bulky control cabinets and creates a barrier to **Internet of Things (IoT)** integration.

Ultimately, this traditional framework lacks the flexibility required for rapid circuit modifications and prevents stakeholders from accessing the real-time data necessary for informed, proactive decision-making.

1.1 Objectives

- The main objective of this paper is to use open source platform to control the circuit breaker.
- There 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.

2. WORKING PRINCIPAL

The NodeMCU ESP8266 Board is powered by dc 5v supply. The GPIO pins 5, 4, 14, and 12 are connected to 4 inputs of 4 channel relay module as per circuit diagram. We have written code and upload the code in Arduino IDE.

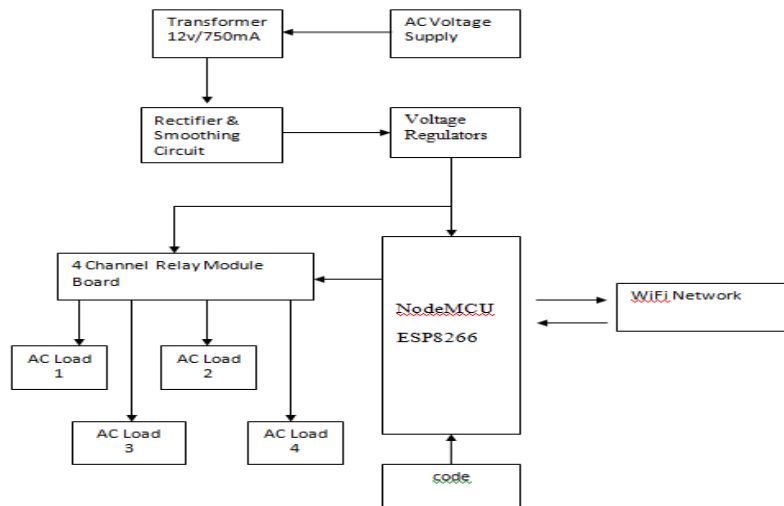


Fig - 5: Block Diagram

The code and its working as below,

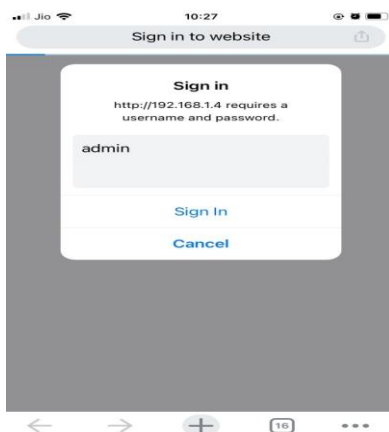


Fig - 6: Login Page

After typing the right username and password, we will get access to the web server.

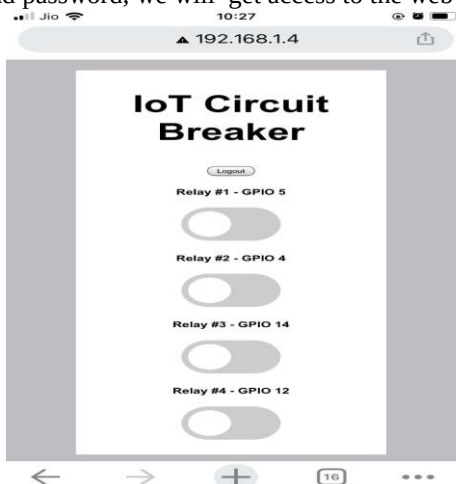


Fig - 6: Web Page after Login

How the Code Works:

Network Credentials

For connecting NodeMcu to our wifi network we need to insert our network credentials in the following lines:

```
const char* ssid = "REPLACE_WITH_YOUR_SSID";  
const char* password = "REPLACE_WITH_YOUR_PASSWORD";
```

Setting Your Username and Password:

In the following variables set the username and password for your web server. By default, the username is admin and the password is also admin. We can change it to anything.

```
const char* http_username = "admin";  
const char* http_password = "admin";
```

Logout Button:

In the index.html variable we should add some HTML text to add a logout button. In this example, it's a simple logout button without styling to make things simpler.

```
<button onclick="logoutButton()">Logout</button>
```

When clicked, the button calls the `logoutButton()` JavaScript function. This function makes an HTTP GET request to your ESP32/ESP8266 on the `/logout` URL. Then, in the ESP code, you should handle what happens after receiving this request.

Handle Requests with Authentication:

Every time as we make a request to the ESP32 or ESP8266 to access the web server, it will check whether we've already entered the correct username and password to authenticate.

Basically, to add authentication to web server, we just need to add the following lines after each request:

```
if(!request->authenticate(http_username, http_password))  
    return request->requestAuthentication();
```

These lines continuously pop up the authentication window until you insert the right credentials.

Demonstration:

After uploading the code to ESP32 or ESP8266 board. Then, open the Serial Monitor and press the on-board RST/EN button to get its IP address. Open a browser local network and type the ESP IP address. The following page should load asking for the username and password. Enter the username and password and we will get access to the web server.

5. CONCLUSIONS

Consequently, this project successfully realized an advanced IoT-based management system for electrical circuit breaker featuring integrated HTTP authentication. The final prototype demonstrates consistent operational reliability, allowing for seamless relay manipulation via a dedicated web server. Through rigorous implementation and testing, the system has proven its effectiveness in providing secure, remote control over electrical loads.

6. REFERENCES

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