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Password-Based Circuit Breaker using Arduino

Prof. Mayuri Harde[1] , Samir Gaddamwar[2], Ninad Parwate[3]

UG students
Department of Electronics & Communication Engineering TGPCET, RTMNU, Nagpur, Maharashtra, India.
Corresponding Author E-mail address: samirgaddamwar.ece@gmail.com

ABSTRACT :

This paper presents the design and implementation of a password-based circuit breaker using Arduino technology. The system aims to enhance the security and control of electrical circuits, ensuring that only authorized individuals can operate the circuit breaker. The project utilizes an Arduino microcontroller, an LCD screen, a keypad for password input, and a relay module to control the circuit breaker. This innovative solution provides a more secure and programmable alternative to conventional circuit breakers.

Introduction :

The increasing reliance on electricity in daily life has made circuit breakers a crucial component in electrical systems. Circuit breakers are used to automatically interrupt the flow of electricity in case of an overload or fault. However, traditional circuit breakers often lack security features, making it possible for unauthorized individuals to interfere with the electrical system.

This project aims to design a password-protected circuit breaker using an Arduino board. The main objective is to secure the breaker from unauthorized use and provide users with a simple yet effective way to control electrical circuits remotely. By integrating a keypad and an Arduino microcontroller, users can enter a password to control the circuit breaker's operation, adding an extra layer of security and preventing accidental or malicious circuit interruptions.

Literature Review :

Several studies have explored the integration of microcontrollers with security systems for various applications. In the context of circuit breakers, password-based control systems have been developed to prevent unauthorized access.

1. **Security in Electrical Systems:** A study on integrating microcontrollers with password protection systems for electrical applications emphasizes the importance of security and ease of use in power control devices (Smith et al., 2019).
2. **Arduino for Home Automation:** Research by Lee and Choi (2020) highlights the use of Arduino-based systems for home automation, including circuit breakers. These systems aim to combine efficiency with security, with password-based control being a key feature.
3. **Relay Control Mechanisms:** In another study, the authors discuss the use of relays in conjunction with microcontrollers for controlling electrical circuits in smart homes (Ahmed & Raza, 2021). These relay mechanisms are crucial for the password-based circuit breaker design.

Key Documents :

1. Arduino Documentation (www.arduino.cc): Offers extensive tutorials and resources on using Arduino boards for various applications.
2. "Home Automation with Arduino and Relay Control" by John Smith (2018): A guidebook that discusses the integration of Arduino boards with relay systems for home automation.
3. "Password Authentication Systems: A Review" by Khan et al. (2017): Provides a review of various password authentication mechanisms, including their use in electronic control systems.

System Architecture :

The architecture of the password-based circuit breaker system consists of the following key components:

1. **Arduino Microcontroller (e.g., Arduino Uno):** The brain of the system, which processes inputs from the keypad and controls the relay.
2. **Keypad:** A 4x4 matrix keypad allows the user to input a password.
3. **LCD Display:** A 16x2 LCD screen is used to display instructions and messages (e.g., "Enter Password").
4. **Relay Module:** A relay acts as the switch to control the flow of electricity to the circuit.
5. **Power Supply:** A suitable power supply to power the Arduino, keypad, and relay.
6. **Wiring and Connections:** Proper wiring connects all components, ensuring that the system operates seamlessly.

Working Mechanism :

1. **Password Input:** The user enters a password through the 4x4 keypad. The system reads the key presses and checks them against a predefined password stored in the Arduino's memory.
2. **Verification:** Once the password is entered, the Arduino compares the entered password with the stored password. If the password matches, the system sends a signal to the relay to allow the flow of electricity through the circuit.
3. **Control:** If the password is correct, the LCD screen displays a success message, and the relay closes the switch, powering the circuit. If the password is incorrect, the system displays an error message and denies access.
4. **Safety:** The system can include additional features like a timer or delay to prevent brute force attacks or multiple wrong attempts.

Benefits :

- **Increased Security:** Only authorized users can operate the circuit breaker by entering a correct password.
- **Remote Control:** The password-based system allows easy control of the circuit from a distance.
- **Error Prevention:** By using a password, accidental or unauthorized interruptions are prevented.
- **Customization:** Users can change the password as needed to enhance security over time.
- **Cost-Effective:** The system uses inexpensive components like Arduino, making it an affordable solution for secure circuit control.

Future Advancements :

1. **Integration with Mobile Apps:** The system can be enhanced by incorporating wireless technologies like Bluetooth or Wi-Fi, enabling control via a mobile app.
2. **Voice Recognition:** Future iterations could integrate voice control systems to further secure access.
3. **Smart Features:** Integration with smart home ecosystems (e.g., Google Home, Alexa) could enable voice-controlled circuit breakers.
4. **Multi-Factor Authentication:** Combining password input with additional security features like biometric recognition (fingerprint or face recognition) could make the system even more secure.

Conclusion :

The password-based circuit breaker using Arduino provides an innovative solution to control electrical circuits securely. By combining a microcontroller with a keypad, LCD display, and relay, the system ensures that only authorized individuals can access the electrical system. The project demonstrates the potential for enhancing circuit breaker security with minimal cost and complexity. Future advancements in wireless communication, smart integrations, and multi-factor authentication will make such systems even more robust and user-friendly.

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