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RFID Based Circuit Breaker for Line Safety

***Prof. Rajeshri Patil*[*1], *Spandan Mendhe*[*2], *Sarvesh Hiwrale*[*3], *Rutuja Yeole*[*4]**

[*1,2,3,4,] Electrical Department, Zeal College Of Engineering And Research, Pune, India.

ABSTRACT

The implementation of reliable safety measures in electrical systems remains a critical concern to mitigate the risks associated with line faults and potential hazards. In response to this challenge, this project presents the development and implementation of an RFID-based circuit breaker system aimed at enhancing line safety. Traditional circuit breakers, while effective, often lack real-time monitoring capabilities, leaving electrical systems vulnerable to undetected faults. Leveraging Radio Frequency Identification (RFID) Technology. The proposed system offers a novel approach to circuit protection by integrating RFID lags with circuit breakers for automated fault detection and isolation. This abstract outline, the methodology employed to design and implement the RFID-based circuit breaker system, highlighting its potential to revolutionize line safety in electrical systems. The project's results demonstrate the system's efficacy in promptly selecting and isolating line faults. Thereby minimizing downtime and enhancing overall safety.

Through a comprehensive discussion, this report evaluates the advantages, limitations, and implications of the RFID-based circuit breaker system, paving the way for full advancements in the field of electrical safety.

I. INTRODUCTION

This project aims to enhance the reliability of electrical systems, which is crucial for ensuring safety and minimizing downtime across various applications, from industrial settings to residential environments. The effective protection of electrical lines against faults and overloads is central to this goal, as such issues can lead to equipment damage, operational disruptions, and safety hazards. Traditionally, circuit breakers have been the primary means of line protection, providing a mechanism to detect and interrupt abnormal electrical currents. However, conventional circuit breakers often lack real-time monitoring capabilities and rely on manual intervention for fault detection and isolation.

To address these limitations, this project introduces an innovative solution: an RFID-based circuit breaker system designed to improve line safety and operational efficiency. Integrating Radio Frequency Identification (RFID) technology with circuit breakers represents a significant advancement in line protection, enabling automated fault detection and isolation in real-time. By embedding RFID tags within electrical components and infrastructure, the proposed system facilitates continuous monitoring and instant identification of line faults, thereby minimizing downtime and reducing the risk of equipment damage or safety incidents.

This introduction sets the stage for exploring the RFID-based circuit breaker system, outlining the motivation behind its development and highlighting its potential to revolutionize line safety in electrical systems. The subsequent sections of this report will delve into the methodology used to design and implement the system, present the results of testing and validation, and discuss the implications of this innovative approach for the field of electrical engineering. Through this endeavor, we aim to contribute to the advancement of safety measures in electrical systems and pave the way for future developments in automated fault detection and line protection.

II. LITERATURE REVIEW

RFID-based circuit breaker systems for line man safety are a relatively new technology, but they have the potential to significantly improve the safety of electric line workers. These systems use RFID tags to identify authorized workers and to control access to the circuit breaker. This helps to prevent accidental energization of the circuit breaker while it is being worked on. One example of such a system is described in the paper "Fingerprint Sensor Based Protection System for Electric Line-Man" by [International Journal of Scientific Research in Science and Technology]. This system uses a fingerprint sensor to authenticate authorized workers and an RFID tag to control access to the circuit breaker. If a worker's fingerprint matches the one on record, the RFID tag is enabled and the worker can then use the RFID tag to open the circuit breaker box. The system also includes an LCD display to provide feedback to the user.

Another example of an RFID-based circuit breaker system for line man safety is described in the paper "Password Based Circuit Breaker for Electrical Line Man Safety" by [International Journal of Scientific Research in Science and Technology]. This system uses a password to authenticate authorized

workers and an RFID tag to control access to the circuit breaker. If a worker enters the correct password, the RFID tag is enabled and the worker can then use the RFID tag to open the circuit breaker box.

The system also includes an LED to indicate whether the circuit breaker is on or off. Both of these systems have the potential to improve the safety of electric line workers by preventing accidental energization of the circuit breaker while it is being worked on. However, there are some potential drawbacks to these systems. For example, if an authorized worker loses their RFID tag, they will not be able to access the circuit breaker. Additionally, if the RFID tag is damaged or malfunctioning, it may not be able to disable the circuit breaker. Overall, RFID-based circuit breaker systems for line man safety have the potential to significantly improve the safety of electric line workers.

III. DESIGN

To design a RFID based Circuit Breaker you will need the following components:

- Arduino microcontroller
- RFID reader
- Relay
- LED
- Breadboard
- Jumper wires
- RFID tag

Once you have all of the necessary components, you can assemble the system as follows:

1. Connect the RFID reader to the Arduino's serial pins RX and TX.
2. Connect the relay to the Arduino's digital output pin 12.
3. Connect the LED to the Arduino's digital output pin 13.
4. Connect a 5V power supply to the Arduino's 5V and GND pins.
5. Connect a ground wire from the relay to the Arduino's GND pin.
6. Connect a ground wire from the LED to the Arduino's GND pin.

Once you have completed with assembly of components, then you can assemble hardware system as follows:

- Arduino Uno
- RFID Module
- Relay Module
- LED
- Breadboard
- Jumper Wires
- Power Supply
- Circuit Breaker

Once you have completed with assembly of hardware assembly, you can assemble the main system as follows:

- Connect the RFID module to the Arduino Uno as follows:
  - RFID Module VCC to Arduino 5V pin
  - RFID Module GND to Arduino GND pin
  - RFID Module SDA to Arduino SDA pin
  - RFID Module SCL to Arduino SCL pin
- Connect the relay module to the Arduino Uno as follows:
  - Relay Module VCC to Arduino 5V pin

- Relay Module GND to Arduino GND pin
- Relay Module IN to Arduino D13 pin
  - Connect the LED to the Arduino Uno as follows:
  - LED Anode to Arduino D12 pin
  - LED Cathode to GND pin
  - Connect the circuit breaker to the relay module as follows:
    - Circuit Breaker NO to Relay Module NO
    - Circuit Breaker COM to Relay Module COM

IV. SYSTEM WORKING AND CIRCUIT DESIGN OF RFID

Working

Once the circuit is connected and the Arduino code is uploaded, the RFID module will start reading for RFID tags. If a valid RFID tag is detected, the Arduino will turn on the relay module, which will turn on the circuit breaker and the LED. If a valid RFID tag is not detected, the Arduino will turn off the relay module, which will turn off the circuit breaker and the LED. This circuit can be used to improve the safety of line men by preventing them from accidentally turning on live circuits. By using an RFID tag, only authorized personnel will be able to turn on live circuits.

Some of the software connections are needed to do after hardware assembly

- Arduino IDE Circuit:-

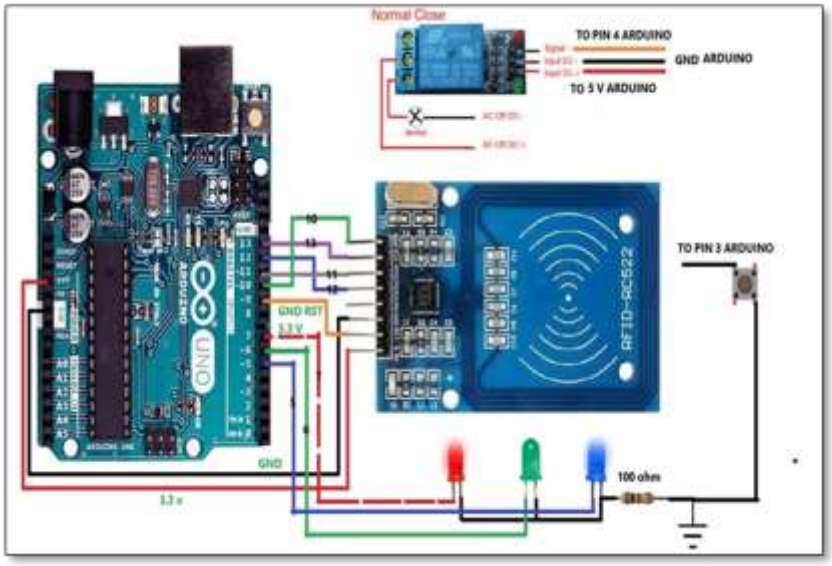
1. Connect the RFID reader to the Arduino using the following pins:
   - RFID reader SDA pin to Arduino pin 10
   - RFID reader SCL pin to Arduino pin 11
2. Connect the relay to the Arduino using the following pins:
   - Relay coil pin to Arduino pin 12
   - Relay common pin to the power supply positive terminal
   - Relay NO (normally open) pin to the circuit breaker control terminal
3. Connect the LED to the Arduino using the following pins:
   - LED anode pin to Arduino pin 9
   - LED cathode pin to ground

To use the circuit breaker, simply swipe the authorized RFID tag over the RFID reader. If the tag is authorized, the relay will turn on and the circuit breaker will be turned on. The LED will also turn on to indicate that the circuit breaker is on.

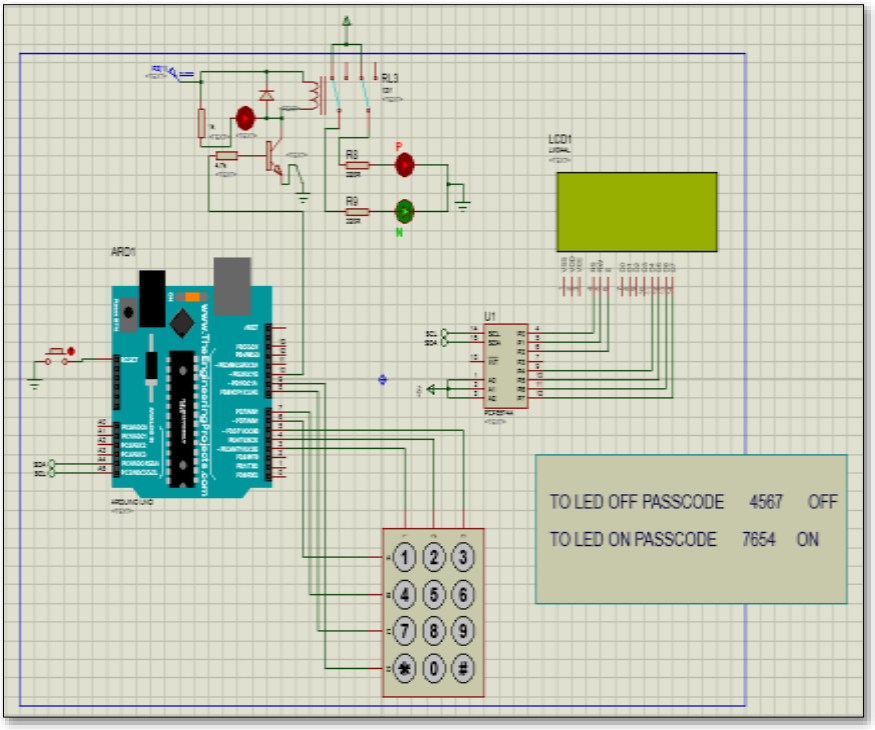
Safety

It is important to note that this is just a simplified design of an RFID-based circuit breaker for lineman safety. In a real-world application, additional safety features such as interlocking and emergency shutoff switches should be implemented.

Circuit diagram of RFID based Circuit Breaker



V. Simulation



Simulation of RFID based Circuit Breaker

VI. Pseudocode for Implementing an RFID-based Circuit Breaker System

STEPS	DESCRIPTION	CODE SNIPPET
1.Set up	Initialize communication protocols and RFID sensor, and set up the LED pin as output	- Begin Serial communication at 9600 baud rate - Initialize SPI communication - Initialize RFID sensor (MFRC522) - Set LED pin as output (Pin 8) - Print initial message to Serial monitor

2.Main loop	Continuously check for new RFID card presence and handle the read card accordingly	- Check if a new RFID card is present - If no card is present, return - If card is present, read the card's serial number (UID)
3.Read UID	Read and display the UID of the RFID card on the Serial monitor	- Print "UID tag :" to Serial monitor - For each byte of the UID, print it in HEX format
4.Process UID	Check if the read UID matches the authorized card and toggle the LED accordingly	- Convert UID to a string and print "Message :" to Serial monitor - If UID matches the authorized card: - If LED is off, print "Authorized access", turn LED on, set flag a to 0 - If LED is on, print "Authorized access", turn LED off, set flag a to 1 - If UID does not match, print "Access denied"

VII. CONCLUSION

The RFID-based circuit breaker system represents a significant advancement in electrical engineering, particularly in enhancing line safety and fault protection. By integrating RFID technology with circuit breakers, the system offers real-time fault detection and isolation, automated operation, and improved reliability and efficiency. Continuous monitoring through embedded RFID tags enables instant fault identification and prompt mitigation, reducing downtime and equipment damage risks. Testing has demonstrated the system's effectiveness, and future research can further optimize its performance and explore broader applications. This innovative approach holds great promise for revolutionizing electrical system safety and operational efficiency across various industries.

VIII. FUTURE SCOPE

Enhancements to the RFID-based circuit breaker system include the use of multiple RFID tags to identify different personnel or electrical circuits, enabling more granular control. Remote monitoring capabilities can be added, allowing supervisors to ensure the safety of line workers and confirm circuit breakers are tripped before work begins. The system can also feature an automatic reset function, enabling workers to resume tasks without supervisor intervention. Incorporating wireless communication between the Arduino and RFID reader would enhance portability by eliminating wires. Additionally, integration with systems like SCADA or work order management would improve coordination between line workers and supervisors, streamlining operations and ensuring safety.

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