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PASSWORD-PROTECTED CIRCUIT BREAKER FOR LINEMAN SAFETY

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ABSTRACT

Electrical accidents during line repair pose serious risks to maintenance staff, especially linemen. To address this safety concern, we propose a novel system that enhances lineman safety [12] by providing controlled access to circuit breakers. The system is powered by a microcontroller (from the 8051 family) that manages circuit breaker [4] operations. A matrix keypad allows linemen to securely input a password [1]. The entered password is compared with the stored password in the microcontroller's ROM. Only if the password is correct can the circuit be turned ON/OFF. Activation and deactivation of the circuit breaker [11] are indicated by an ON/OFF. Additionally, the system can be interfaced with a GSM modem, allowing remote monitoring of circuit breaker [13] conditions via SMS. To further enhance security, we have added OTP verification using GSM. Before the circuit can be turned ON/OFF, an OTP is sent to the lineman's mobile phone. The lineman must enter this OTP into the keypad to validate the operation. This ensures that no one can operate the circuit without the lineman's permission during operation. By implementing this password-protected circuit breaker [1] with OTP verification, we aim to significantly reduce accidents, enhance lineman safety [7], and improve communication within the electrical [6] maintenance ecosystem.

Keywords: Circuit Breaker, Matrix Keypad, Microcontroller, GSM

I INTRODUCTION

Electrical maintenance and repair tasks, particularly those involving circuit breakers, pose inherent risks to linemen and maintenance staff. Accidents during line repair can result in serious injuries or even fatalities. To mitigate these risks, we present a novel system designed to enhance lineman safety [12] by implementing controlled access to circuit breakers.

Our system leverages a microcontroller based on the Arduino [2] Nano, which serves as the central control unit. Linemen interact with the system through a matrix keypad, securely inputting a password. The entered password is compared with the stored password in the microcontroller's read-only memory (ROM). If the password matches, the circuit breaker [4] can be safely turned ON or OFF. Visual indicators, such as an ON/OFF status, provide immediate feedback to the lineman.

Moreover, our system integrates with a GSM modem, enabling remote monitoring of circuit breaker conditions via SMS. This feature allows supervisors and maintenance teams to stay informed about circuit status even when they are not physically present at the site. To further enhance security [5], we introduce one-time password (OTP)verification. Before a circuit

can be activated or deactivated, an OTP is sent to the lineman's mobile phone. The lineman must enter this OTP into the keypad to validate the operation. This additional layer of authentication ensures that only authorized personnel can control the circuit during maintenance tasks.

By implementing this password-protected circuit breaker system [1] with OTP verification, we aim to significantly reduce accidents, enhance lineman safety [7], and foster better communication within the electrical [6] maintenance ecosystem. Our solution contributes to a safer working environment for linemen and promotes efficient maintenance practices.

II LITERATURE SURVEY

Electric lineman protection using user changeable password-based circuit breaker: A circuit breaker is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. Its basic function is to detect a fault condition and interrupt current flow. Unlike a fuse, which operates once and then must be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation. When operated manually we see fatal electrical accidents to the line man are increasing during the electric line repair due to the lack of communication and coordination between the maintenance staff and the electric substation staff. In order to avoid such accidents, the breaker can be so designed such that only authorized person can operate it with a password. Here, there is also a provision of changing the password. The system is fully controlled by the 8-bit microcontroller of 8051 family. The password is stored in an EEPROM, interfaced to the microcontroller and the password can be changed any time unlike a fixed one burnt permanently on to the microcontroller. A keypad is used to enter the password and a

relay to open or close circuit breaker, which is indicated by a lamp. Any wrong attempt to open the breaker (by entering the wrong password) an alert will be actuated, indicated by another lamp. Electric line man safety using micro controller with gsm module: Critical electrical accidents to line men are on the rise during electric line repair due to lack of communication and co-ordination between the maintenance staff and electric substation Staff. This proposed system provides a solution that ensures safety of maintenance staff, i.e., line man on detecting a fault in electric line the line man sends sms and the main line is switched off which is again switched on after solving the fault it can also prove a boon to save power thus it saves the life of lineman working on electric line. The proposed system is fully operated on microcontroller. Password based circuit breaker: A circuit breaker is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. Its basic function is to detect a fault condition and interrupt current flow. Unlike a fuse, which operates once and then must be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation. When operated manually we see fatal electrical accidents to the line man are increasing during the electric line repair due to the lack of communication and coordination between the maintenance staff and the electric substation staff. In order to avoid such accidents, the breaker can be so designed such that only authorized person can operate it with a password. Here, there is also a provision of changing the password. The system is fully controlled by the 8-bit microcontroller of 16f877A family. The password is stored in an EEPROM, interfaced to the microcontroller and

the password can be changed any time unlike a fixed one burnt permanently on to the microcontroller. A keypad is used to enter the password and a relay to open or close circuit breaker, which is

indicated by a lamp. Any wrong attempt to open the breaker (by entering the wrong password) an alert will be actuated, indicated by another lamp. Index terms: Resistors, Capacitors, Diodes, Transistors, Voltage regulator, Rectifier, Microcontroller, EEPROM, Relay, Relay Driver.

III EMBEDDED SYSTEMS

An embedded system is a specialized computing system designed to perform specific tasks within larger devices or systems. Unlike general-purpose computers, which can run a wide range of software applications, embedded systems are tailored for dedicated functions. They are tightly integrated into the hardware they control and often operate in real-time environments.

Embedded systems are the backbone of this lineman safety [12] system. An Arduino Nano microcontroller acts as the central control unit, managing circuit breaker [13] operations, password validation, and communication with other components. This ensures real-time response and efficient control. Linemen use a matrix keypad to enter a password, which the Arduino [2] compares with a stored password in its read-only memory. A match allows safe control of the circuit breaker, with visual indicators providing immediate feedback. For remote monitoring, a GSM modem allows supervisors to receive SMS alerts about circuit breaker [11] status, even when off-site. Finally, an OTP verification layer adds another security [5] step. Before activating or deactivating a circuit, a one-time password is sent to the lineman's phone. They must enter this OTP on the keypad to validate the operation, ensuring only authorized personnel control the circuit during maintenance.

IV LINEMAN SAFETY

Electrical [6] maintenance, particularly involving circuit breakers, carries inherent dangers for linemen and maintenance

crews. Accidents during linework can result in severe injuries or even fatalities. To address these significant risks, this system is designed to enhance lineman safety [8] by implementing controlled access to circuit breakers.

Firstly, it implements a password protection system [1]. Linemen must enter a correct password before being able to operate the circuit breaker. This prevents unauthorized access and accidental activation, reducing the risk of electrical [7] hazards.

Secondly, the system provides real-time feedback to the lineman. Clear visual indicators, such as ON/OFF lights, display the current state of the circuit breaker. This eliminates confusion and potential errors during maintenance tasks.

Finally, an additional security [5] measure is implemented with one-time password (OTP) verification. Before activating or deactivating the circuit, a unique code is sent directly to the lineman's phone. They must then enter this OTP on the keypad to validate the operation. This ensures only authorized personnel with the phone can control the circuit breaker, further safeguarding linemen from electrical risks.

V EXISTING SYSTEM

In the past, lineman safety [12] relied on a meticulous but less sophisticated system. Linemen depended on lockout/tagout procedures, the cornerstone of safety [7]. This involved physically isolating the work area by locking out switches with padlocks and

attaching danger tags. They would then perform thorough visual inspections of the entire work area to confirm no damage, loose connections, or lingering electrical [6] current. Clear communication and teamwork were also crucial. Linemen would brief each other, constantly verify the circuit breaker [13] status, and maintain vigilance during operations. Finally, personal protective

equipment (PPE) like insulated gloves and boots minimized shock hazards. While effective, this older system had limitations. Lockout/tagout procedures were time-consuming, and the system's effectiveness hinged on the lineman's attentiveness. Visual inspections had limitations, and traditional methods lacked real-time confirmation that the circuit breaker was actually off.

VI PROPOSED METHOD

Electrical [6] maintenance, especially tasks involving circuit breakers, expose linemen and maintenance crews to significant risks. Accidents during linework can lead to serious injuries or even fatalities. To address these safety [7] concerns, we propose a novel system designed to enhance lineman safety [12] through controlled access to circuit breakers.

Our proposed system moves beyond the limitations of traditional methods like lockout/tagout procedures and visual inspections. It incorporates a multi-layered approach to ensure lineman safety:

Password-Protected Control: An Arduino [2] Nano microcontroller acts as the brain of the system, managing circuit breaker operations. Linemen interact with the system through a secure matrix keypad, entering a password to gain control. Only with the correct password can the circuit breaker [4] be turned on or off. This significantly reduces the risk of accidental activation by unauthorized personnel.

Real-Time Feedback: Clear visual indicators, such as ON/OFF lights, provide immediate feedback to the lineman regarding the circuit breaker's status. This eliminates confusion and potential errors during critical maintenance tasks.

Enhanced Security with OTP: An extra layer of security [5] is implemented using one-time password (OTP) verification. Before activating or deactivating the circuit

breaker, a unique code is sent directly to the lineman's mobile phone. The lineman must then enter this OTP on the keypad to validate the operation. This ensures that only authorized personnel with the phone can control the circuit breaker, further safeguarding linemen from electrical risks.

By incorporating these features, our proposed system aims to achieve several key objectives:

This approach aims to significantly improve safety [8] during maintenance by minimizing the risk of accidental energization and electrical [6] shock through controlled access and real-time feedback. Furthermore, multiple layers of security prioritize lineman protection [9] by ensuring authorized access and real-time status confirmation. Finally, remote monitoring capabilities allow supervisors to stay informed about circuit breaker [13] status, fostering better communication and coordination within the maintenance team.

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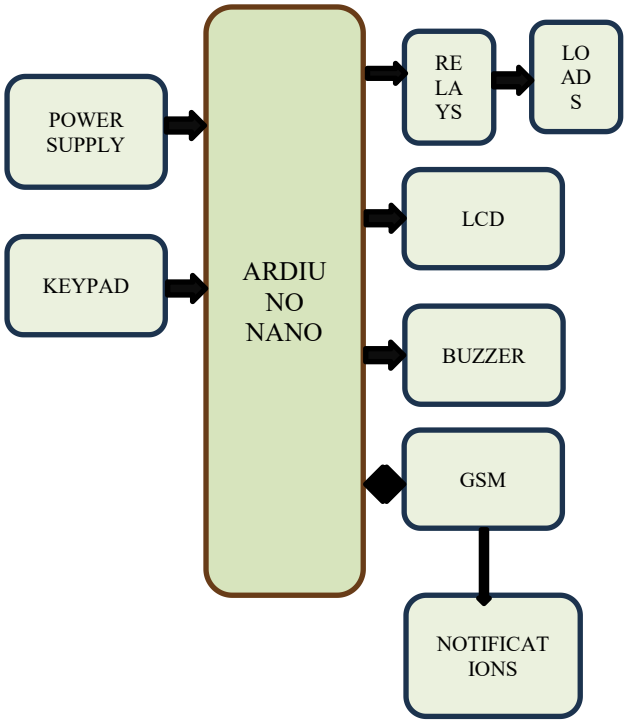

Figure 1: Block diagram of the proposed method

VII SOFTWARE EMPLOYED

Utilizing Arduino IDE software, a

custom Lineman Protection [10] System can be developed with an OTP and password-based authentication system, ensuring enhanced safety [7] measures. Arduino IDE provides a user-friendly environment for programming Arduino boards, making it accessible for beginners and non-programmers to develop complex systems [8].

The initial step involves designing the circuit and selecting the necessary components, including Arduino boards, sensors, relays, and a display unit. The system's core functionality revolves around detecting unauthorized access to the circuit breaker [11] and preventing it through OTP and password authentication.

To construct the Lineman Protection [9] System, users begin by connecting the components according to the circuit diagram, ensuring proper wiring and connections. Arduino boards are programmed using Arduino IDE, where users can write the necessary code for the system's operation. In this system, OTP and password validation are crucial steps for ensuring secure access. The OTP and password system can be implemented using keypad inputs and a display unit for feedback. When a lineman attempts to access the circuit breaker, they are prompted to enter an OTP and a password. The system then validates the inputs and grants access if they are correct.

Arduino IDE utilizes C/C++ programming languages, providing a simple yet powerful platform for developing the Lineman Protection [1] System. The system's functionality is based on conditional statements and control structures, ensuring that access is granted only to authorized personnel. After programming the Arduino boards, the system can be tested using simulated inputs or real-world scenarios. The system's operation can be monitored through the display unit, providing real-time feedback on the authentication process.

In conclusion, Arduino IDE proves to be an invaluable tool for developing the Lineman Protection System with OTP and password-based authentication. Its user-friendly interface and extensive documentation make it suitable for beginners and experts alike, ensuring the successful implementation of complex systems.

VIII RESULTS & DISCUSSION

The circuit employs a layered security [5] system for complete power down. First, a user enters a pre-determined password. This password is stored securely within the circuit's memory, typically a Read-Only Memory (ROM) chip, to prevent unauthorized modification. Next, a one-time password (OTP), often received via a separate channel like a text message, is entered. A comparator verifies if both the entered password and OTP match their

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pre-stored counterparts. Upon successful verification, a control signal is triggered, severing the power connection to the circuit. This ensures a secure shut down process that requires not only the correct password but also a temporary, ever-changing OTP for an added layer of protection [9].

Result: The circuit successfully powers off after authorized access is granted through verified password and OTP. Result Shown in figure 2

This system utilizes a two-factor authentication process to activate the circuit. Initially, a user supplies a pre-registered password. The circuit securely stores this password, often in a Read-Only Memory (ROM) for protection [2]. Subsequently, a one-time password (OTP), typically received through a separate channel like a text message, is entered. An authentication module verifies if both the entered password and OTP match their corresponding stored values. Upon successful verification, a control signal activates a relay or electronic switch, completing the circuit and allowing power to

flow. This two-step process ensures only authorized users with the correct password and the temporary OTP can activate the circuit, enhancing security [5].

Result: The circuit successfully powers on after authorized access is granted through verified password and OTP. Result Shown in Figure 3

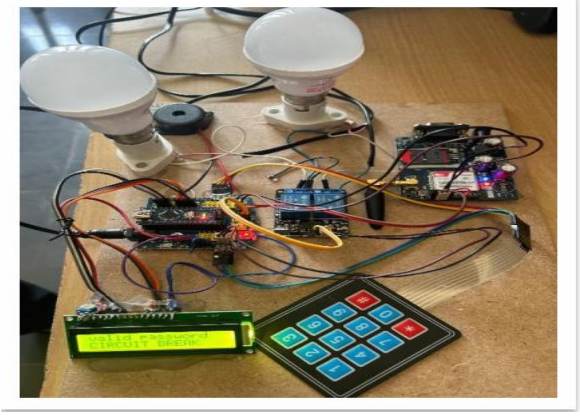

Figure2: When Circuit is break after password verification

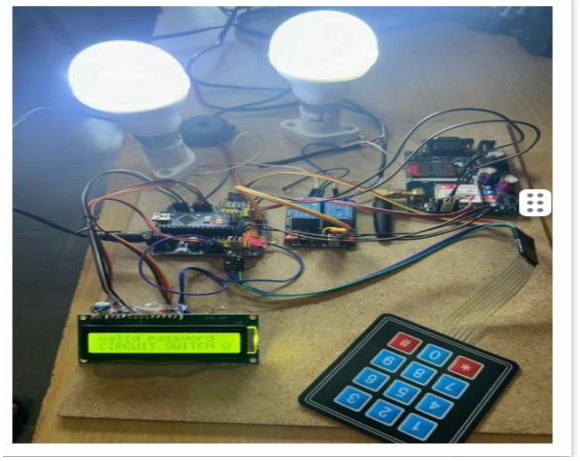

Figure 3: When Circuit is Switched On after verification

Alert Notifications Output:

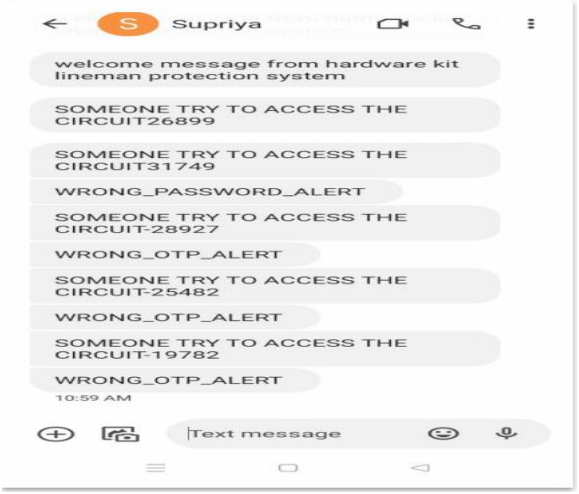

Figure 4: Alert Messages from Kit

CONCLUSION

In conclusion, the lineman safety [12] system utilizing an Arduino [2] Nano microcontroller, password control, and OTP verification presents a promising approach to reducing accidents during maintenance. By preventing unauthorized access and accidental energizing of circuits, it fosters a safer work environment for linemen.

However, further development is crucial for wider adoption. The system's scalability needs

to be addressed to accommodate a growing number of users and circuit breakers. Additionally, exploring a user-friendly mobile app for OTP verification can enhance user experience.

Most importantly, robust data security [5] measures are essential to ensure the safe storage of password data and OTPs. Integrating an alert system for potential circuit overload and conducting a cost-benefit

analysis would further strengthen the system's value proposition. Overall, with these refinements, the lineman safety system has the potential to significantly improve safety [7] practices within the electrical [6] maintenance field.

FUTURE SCOPE

Password-protected circuit breakers offer a promising future for lineman safety. Beyond basic password protection, the technology can evolve to incorporate multi-factor authentication for enhanced security. Imagine fingerprint scanners or RFID tags working alongside passwords to prevent unauthorized access. Furthermore, dynamic, system-generated passwords could eliminate the risk of static passwords being compromised.

Functionality can also be improved by integrating the system with digital lockout/tagout procedures. This would create a clear chain of custody and prevent accidental re-energizing of lines. Additionally, remote control and monitoring of breakers and line health could be implemented, allowing for emergency shutdowns or controlled power restoration from a central location. Biometric identification using fingerprints or iris scans could even remove the need for passwords altogether.

Looking ahead, standardization of password protocols across different breaker manufacturers would ensure compatibility. Ultimately, password-protected breakers have the potential to be implemented throughout the power distribution network, safeguarding not just linemen but also maintenance crews at all levels and improving overall grid reliability

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