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Secured Circuit Breaker Operation Using GSM Module in Distribution Sub-Stations

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ABSTRACT: The objective of this paper is to protect linemen from abrupt electric shocks while they are working. Because linemen frequently come into contact with live wires, there is already a considerable risk of serious mishaps. However, many of these mishaps can be prevented if linemen and substations work together effectively. The project's goal was to offer a solution that would guarantee maintenance workers' safety and is provided by using multiple-aided methods which could provide line-man visual and audio approval of the lines power supply . Here, as soon as the lineman notices an electric line fault, an SMS is sent to the GSM Module through the lineman authorized mobile number, which turns the required line off in the substation, while the problem is being fixed and turn it back on after rectifying the fault minimizing the possibility of occurring an accident

KEYWORDS: Lineman protection, Electrical safety, GSM module, minimizing accident occurrence probability. Distribution sub-stations.

I. INTRODUCTION

In an industrial electrical system, circuit breakers are utilized for both switching and protection. Therefore, a circuit breaker's ability to operate reliably is crucial. A circuit breaker failure can seriously harm an industrial electrical system, resulting in lost revenue and even fatalities. Because they must carry rated or fault power, have several mechanical and electrical components, and use arc quenching techniques, circuit breakers are put under a lot of stress when they operate. Because of this, the circuit breaker ages over time and with repeated use. This calls into question the dependability of the circuit breaker's operation. Regular preventative maintenance is performed at predetermined times to ensure the dependability of the circuit breaker.

As part of a preventative maintenance program, circuit breakers are periodically removed from service and their parameters, such as spring charge motor current, close coil current, and trip coil current, are measured with specialized diagnostic equipment. To further guarantee its health, visual inspection and cleaning of its parts—such as the working mechanism, tripping coil, closing coil, spring charging motor, fixed contact, and moving contact—are done. Despite the circuit breaker being in good condition, the system experiences increased downtime due to the time-based maintenance method. Furthermore, the cost of maintaining circuit breakers goes up when specialized diagnostic tools are used.

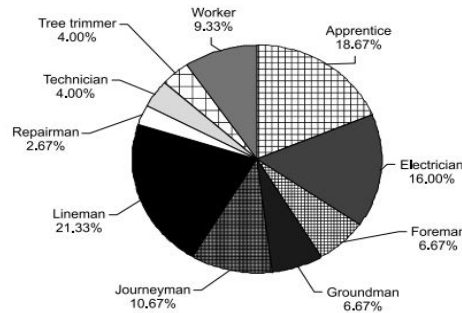


Fig .1 Fatal electrical accidents (in %) for each work speciality

II. MOTIVATION

Due to increasing number of accidents to the electrical lineman, proposed system is used to reduce the electrical accidents occurring to the lineman in a significant manner , through the access of circuit breaker directly to the lineman Mobile through GSM module.

III. OBJECTIVES

- To reduce lineman electrical accidents.
- To provide accessibility to line man before electrical works.
- To provide electrical feasibility.

IV. LITERATURE REVIEW

In [1] the author discussed about the advancement of remote-control technology has paralleled the growth of communication technology. This paper introduces a prototype for controlling electric appliances via SMS using the GSM protocol. The choice of GSM is attributed to its platform independence. The setup involves the utilization of GSM SIM 900 and Arduino to control a relay module. Commands sent via SMS dictate the operation of the relay module, with feedback confirming the execution of the command sent back to the mobile device. To validate the system, ten distinct command strings were tested, each resulting in the relay executing the corresponding action and providing feedback on the previous command.

In [2] the paper discussed about protecting electrical circuits from damage caused by overloading or short circuits, an automatic electric switch, known as a circuit breaker, is utilized. However, manual interventions, such as during power line repairs, can pose lethal electrical hazards to cable workers due to a lack of communication between repair personnel and power station workers. This project aims to address this issue by designing a circuit breaker that requires authorization via a password, thus minimizing risks. The system is controlled by Arduino, ensuring complete oversight. Activation of the circuit breakers, toggled by a flashlight, necessitates inputting the password through a keypad. Additionally, remote control via the Global System for Mobile Communications (GSM) circuit is implemented, reducing time wastage in managing the system.

Ankush Tondan et.al [3] discussed about password-based circuit breaker system using GSM technology is proposed, featuring a microcontroller, GSM module, and keypad. The microcontroller validates user passwords and controls the circuit breaker. GSM enables remote access via mobile devices, enhancing security and convenience, especially in remote locations. The system allows password resets and provides security notifications. Tested successfully, it proves effective and efficient.

Sumit Sahora et.al [4] typically involves devices connecting to each other or the internet. However, in this case, GSM technology is used instead of the internet to control industrial and home appliances for safety, status monitoring, and security. GSM enables remote appliance control, conserving manpower by providing wireless access. It establishes standardized wireless communication between consumers and industry without needing a separate communication

network. Although not instantaneous, the process is relatively quick, with a time delay of around 0.7 seconds between sending an SMS and activating the device.

In [5], the author discussed about the era of rapid electronic technology advancement, microcontrollers play a crucial role in various control applications, both in households and industries. This hardware project aims to explore relay control mechanisms essential for automated control systems. Three different techniques are presented: relay control using adjustable LM317 voltage regulators, closed-loop control with a temperature sensor (LM35) and relay actuator, and an Arduino-based room temperature sensor application. Each technique is simulated and designed, with PCB layouts created using Express PCB software. The project proves to be accurate, cost-effective, and suitable for industrial applications or as a teaching module in industrial automation or mechatronics courses, utilizing a regulated 12V, 2A power supply.

In [6], the author discussed about the wireless communications and their rapid growth, becoming essential to modern life. Mobile communication, in particular, has seen significant expansion, with GSM (Global System for Mobile Communications) emerging as a leading technology. Initially deployed in Europe, GSM operates in the 900 MHz band and has become one of the most widely used cellular systems globally. This paper surveys GSM's evolution and its role as a second-generation wireless cellular system. While early systems primarily provided voice services, modern GSM systems offer diverse transmission options. The paper briefly covers GSM's system configuration, major attributes, service features, architecture, channel and frame structure, security features, and data capabilities.

Christoforos N. Hadjicostis et.al [7] discussed about the monitoring schemes that are able to detect and identify failures in power transmission lines by analyzing binary status information from relay and circuit breakers.

In [8], focuses on remotely controlling electrical loads using a GSM module. By leveraging GSM networks, an embedded system is designed to control appliances and devices locally, with input and output peripherals. Users can effectively manage household or office equipment via SMS commands sent from their mobile phones, receiving status updates in return. The core concept involves receiving coded SMS messages to activate or deactivate home electrical appliances through communication between the GSM module and a microcontroller switching circuit.

Vijaya Vikas Ranpise et.al[9] discusses about GSM-based circuit breaker enhances line worker safety during repairs. Only authorized personnel can control it with a password, changeable as needed. It's ATMEGA-controlled, allowing password entry via GSM when away and via keypad when present. A relay controls the breaker, with status shown on a lamp and LCD. Wrong passwords trigger alerts via GSM.

G. Chandana et.al [10] discussed about circuit breaker that protects electrical circuits from damage caused by overload or short circuits by interrupting current flow. Unlike fuses, it can be reset. However, manual operation has led to an increase in fatal accidents during repairs due to poor communication. To address this, circuit breakers can be password-protected, ensuring only authorized personnel can operate them. This enhances worker safety. The system is controlled by an 8-bit microcontroller and uses a keypad for password entry, a relay to control the breaker, and a lamp for status indication.

V. PROPOSED MODEL

The methodology employed in this paper outlines the development and testing of a password-based circuit breaker system integrated with a GSM module for remote operation. The system was designed with components including a microcontroller, relay, and GSM module, with a focus on ensuring secure and reliable operation. Password implementation involved techniques for secure password input, storage, and verification within the system, with robust security measures to prevent unauthorized access. Integration of the GSM module facilitated remote communication with the system, enabling users to control the circuit breaker via SMS commands. The experimental setup involved configuring the hardware components, implementing software algorithms, and conducting rigorous testing to evaluate system functionality, reliability, and security. Testing procedures encompassed various scenarios to assess performance under different conditions, with data collected for analysis. Results indicated satisfactory system operation in terms of response time, reliability, and security, with any encountered issues addressed accordingly. Through comprehensive testing and analysis, the methodology provided insights into the effectiveness and practicality of the password-based circuit breaker system operated via GSM, serving as a foundation for further research and development in the field.

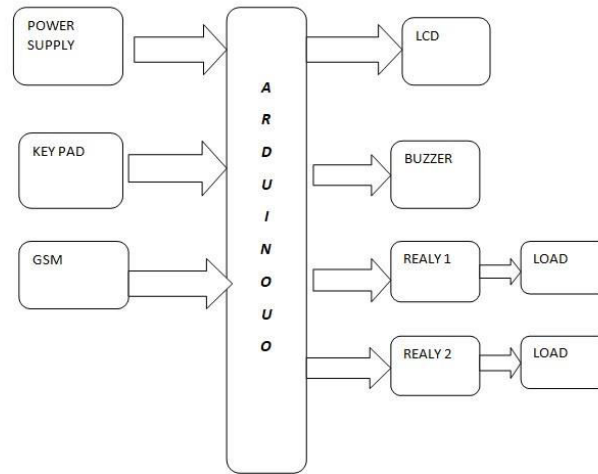


Fig:5.1(work flow of the proposed model)

In this model we use various integration of components by which the GSM module is used to receive commands from the authorized service provider by the electrical department , so that he could turn off the power through the line he is going to work.

The commands which could be given for operating relay are , let’s assume there are 2 lines. These have commands like

- ONE -Line 1 ON
- TWO- Line 1 OFF
- CB-Line 2 ON
- PA-Line 2 OFF

The working components of the models are as follows.

1.AURDINO

Overview The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.



Fig: 5.2(Arduino Uno)

2.Power Supply

The input to the circuit is applied from the regulated power supply. The a.c. input i.e., 230V from the mains supply is step down by the transformer to 12V and is fed to a rectifier. The output obtained from the rectifier is a pulsating d.c voltage. So, in order to get a pure d.c voltage, the output voltage from the rectifier is fed to a filter to remove any a.c components present even after rectification. Now, this voltage is given to a voltage regulator to obtain a

pure constant dc voltage.

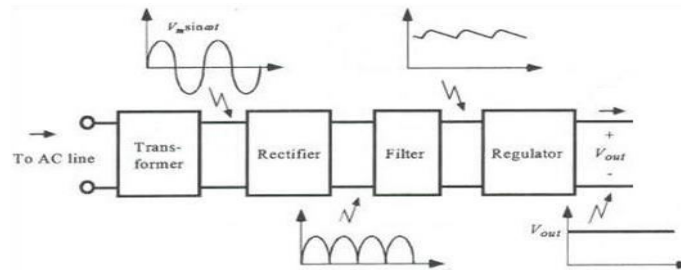


Fig :5.3 (Block diagram of power supply)

5.2.1 Step- Down Transformer

A Stepdown Transformer is the one which reduces the output voltage that means it functions for converting high voltage with low current into a low voltage with high current. Usually, DC voltages are required to operate various electronic equipment and these voltages are 5V, 9V or 12V. But these voltages cannot be obtained directly. Thus, the a.c input available at the mains supply i.e., 230V is to be brought down to the required voltage level. This is done by a transformer. Thus, a stepdown transformer is employed to decrease the voltage to a required level.

5.2.2 Rectifier

The output from the transformer is fed to the rectifier. It converts A.C. into pulsating D.C. The rectifier may be a half wave or a full wave rectifier. In this project, a bridge rectifier is used because of its merits like good stability and full wave rectification.

5.2.3 Filter

Capacitive filter is used in this project. In power supplies, capacitors are used to smooth (filter) the pulsating DC output after rectification so that a nearly constant DC voltage is supplied to the load. The pulsating output of the rectifiers has an average DC value and an AC portion that is called ripple voltage. Filter capacitors reduce the amount of ripple voltage to a level that is acceptable. In a filter circuit the capacitor is charged to the peak of the rectified input voltage during the positive portion of the input.

5.2.4 Voltage Regulator

As the name itself implies, it regulates the input applied to it. A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. The voltage regulator monitors the current drawn by the load and increases or decreases the voltage accordingly to keep the voltage level constant

5.3.LCD/DISPLAY

As the name itself implies, it regulates the input applied to it. A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. The voltage regulator monitors the current drawn by the load and increases or decreases the voltage accordingly to keep the voltage level constant.

5.4. Load

When working with power electronics, quite often the right piece of test equipment is an old-fashioned incandescent lamp. They make good ballast resistors and dummy loads for a variety of devices.



Fig:5.4(Light Loads)

4.Relay

A relay is an electrically operated switch. Relay is special switch designed to allow a small circuit to control a large circuit. These devices use a solenoid to control a heavy-duty switch. The wiring for the solenoid may require only 0.5amp to activate, while the switch it controls carries 10 to 30 amps. This device allows the high-current devices to keep localized in one place; this is good for added fire safety and keeping dangerous voltage current as far away from people as possible. Many relay use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relay are used where it is necessary to control a circuit by a low-power.

5.GSM

GSM (Global System for Mobile communication) is a digital mobile telephone system that is widely used in Europe and other parts of the world. GSM uses a variation of Time Division Multiple Access (TDMA) and is the most widely used of the three digital wireless telephone technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1,800 MHz frequency band. It supports voice calls and data transfer speeds of up to 9.6 kbit/s, together with the transmission of SMS (Short Message Service).

VI. RESULTS & DISCUSSION

This project is arranged in such a way that maintenance staff or lineman has to enter the password to ON/OFF the electrical line. Now if there is any fault in electrical line then lineman will switch off the power supply to the line by entering the password and comfortably repair the electrical line, and after coming to the substation lineman switch on the supply to the particular line by entering the password.

Operation of relay can be done using the mobile of the line man which involves sending a command through the mobile the GSM module present in the prototype helps in receiving the command and sends a electric signal to the relay module present in the respective line in which the lineman is working and relay senses the electrical signal and trips the circuit in the circuit breaker.

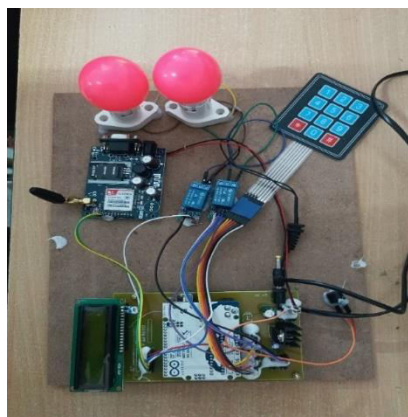


Fig :6.1 (proposed working model)

VII. CONCLUSION

Our proposed model results in the secured operation of circuit breaker by operating the relay of a breaker. The operation involves in the processing of GSM module to access the circuit breaker remotely, as our main aim is to provide a solution to line man over head transmission lines operations, which can be done through the line-man which is visually and sound aided model. This model provides a complete confirmation about the power supply through the line.

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