Underground Cable Fault Detection Device Using GSM, GPS, Technology

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Abstract- To ensure reliable power delivery, underground power cables are widely used. However, faults in these cables can arise due to various factors, such as construction activities, natural events like earthquakes, or other disturbances. Locating the precise position of these faults in underground lines is a significant challenge, making maintenance complex and time-consuming. This project aims to develop a fault detection device that locates underground cable faults and uses GSM technology to communicate fault details to the relevant authority. Additionally, it displays the fault's distance in kilometers on an LCD, and Messaging a clear indication of the fault location.

Key Words: Underground Cable Faults, GSM Module, Microcontroller, LCD Display, GPS Module.

1. INTRODUCTION

In Urban areas, underground power cables are widely used due to advantages over overhead lines, including improved aesthetics, increased safety in adverse conditions, and reduced susceptibility to damage from natural events like storms. However, faults in underground cables can arise due to various reasons such as excavation work, natural disasters, or wear and tear. Faults in cables are characterized by:

- Physical damages due to external activities,
- Weakness or wear in the cable Structure,
- Deviations in current flow due to inconsistencies.

Such faults lead to interruptions in power distributions, and without a precise location of the fault, repair process can be both time-consuming and labor-intensive. Hence, identifying the fault location accurately is crucial for minimizing power outages, improving network stability, and enhancing system maintenance efficiency.

This Project introduces a fault detection system for underground cables that uses GSM Technology to notify the Authorities about detected Faults.

When fault occurs in cable, it is difficult to locate that Specific fault and where it happens So, this project focuses on identifying faults in underground cables through a digital approach, aimed at optimizing repair efficiency and reducing system downtime. By accurately pointing fault locations, it becomes easier to restore power quickly, improve overall network stability, and limit blackout durations.

This project contains a set of resistors representing cable length in Meter's to find the distance of fault in Meter's and fault creation is made by a set of switches at every known Meters. The fault generated at specific distance and therefore the respective phase is displayed on a LCD and messaging on Registered Number including Fault type and location of Faults.

2. CIRCUIT DIAGRAM:

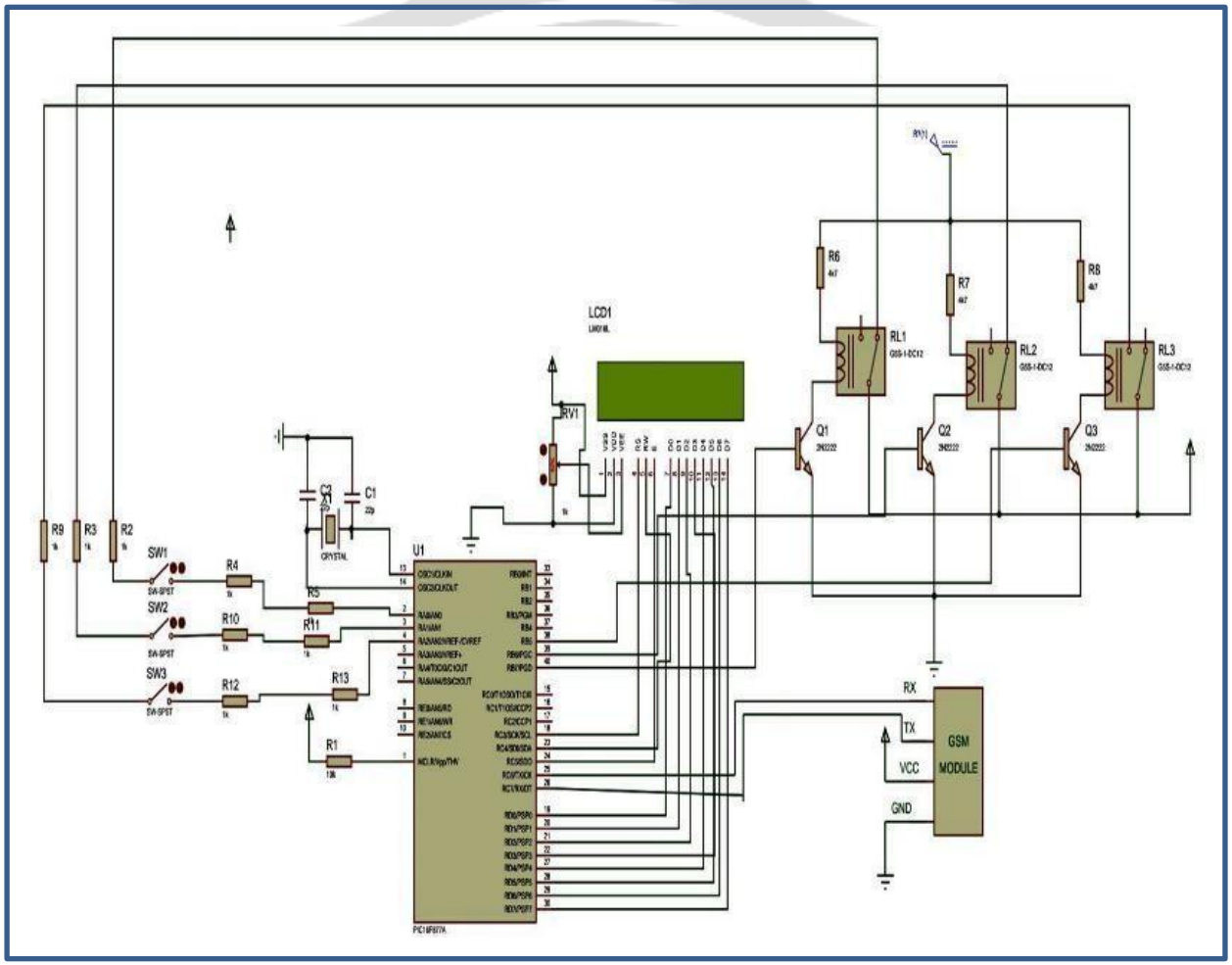

Fig -1: Circuit Diagram of the System

3. WORKING PRINCIPLE:

The project utilizes a straightforward fault detection Method where a low DC voltage is applied along the underground cable simulation.

When a fault occurs, such as a line-to-line (LL), three-line (3L), or line-to-ground (LG) fault, it changes the current flow through the system. This change in current is detected and converted to a voltage signal, which is then sent to an Analog- to-Digital Converter (ADC) to generate digital data. The programmed microcontroller processes this data to determine the fault's distance in Meters, displaying the result accurately.

The control unit includes the ADC, which takes input from the current-sensing component and converts it to a digital signal that the microcontroller processes.

The microcontroller calculates the fault distance and operates a relay driver to control the relay switches for cable phase connections. The part of cable is represented by the set of resistors along with switches. Current sensing part of cable represented as set of resistors & switches are used as fault generators to show the fault at each location. This part senses the change in current by sensing the potential drop. Next is controlling part which comprises of analog to digital converter which receives input from the current sensing element, converts this voltage into digital signal and feeds the microcontroller with the signal. The microcontroller is also a part of the controlling unit and makes necessary computations regarding the distance of the fault.

Additionally, when a fault is detected, the microcontroller triggers the GSM module to send a text message to a registered mobile number, providing details of the fault type and its exact distance from the source.

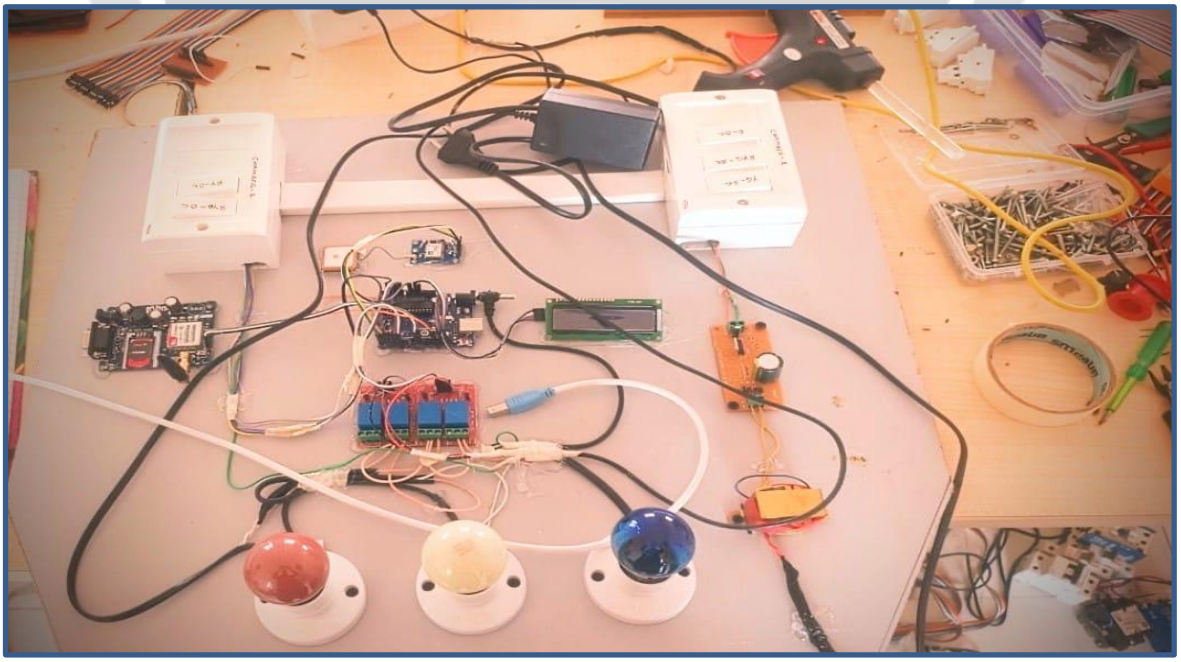

Fig -2.1: Pictorial view of the System

4. COMPONENTES USED

4.1 Power Supply

The power supply circuit is designed to convert standard 230V AC power to a regulated 12V DC output. This starts with a step-down transformer that reduces the 230V AC to 12V AC. A bridge rectifier circuit, built with four diodes, converts this AC voltage to a pulsating DC voltage. The DC output from the rectifier then passes through a capacitor filter, which removes any residual AC components to produce a smoother DC voltage. This filtered DC is then fed into a voltage regulator, which provides a stable 12V DC supply required for the project components.

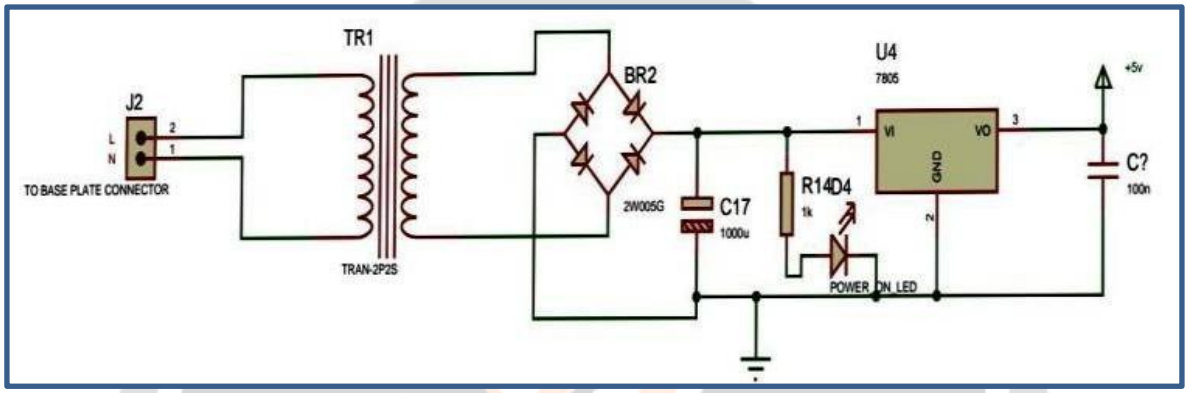

Fig -2: Circuit Diagram of Power Supply

4.2 Voltage Regulator

A voltage regulator is used to ensure a constant output voltage level. In this project, a steady 12V DC supply is necessary, achieved using a 7812 voltage regulator. In the 7812 designation,"78" signifies a positive voltage regulator, and "12" denotes the regulated output voltage of 12V. The L78xx series of regulators, known for their three-terminal design, is commonly used for stable DC outputs and is ideal for applications requiring consistent voltage for sensitive components.

4.3 Microcontroller (ATmega328P)

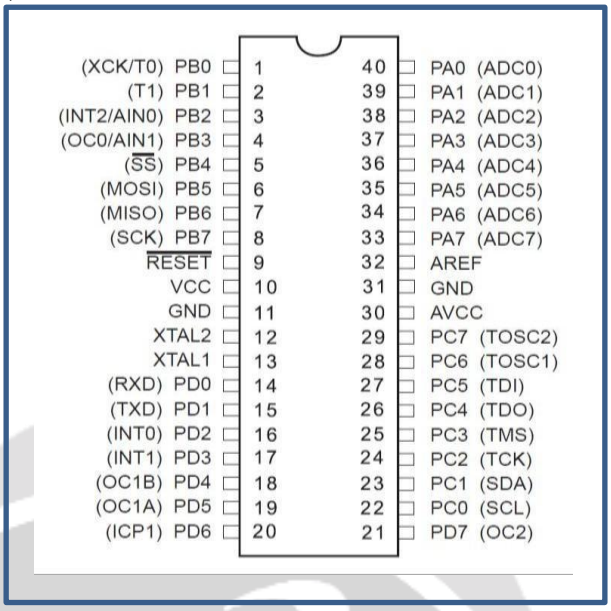

Fig -3: Pin Diagram of Microcontroller

The ATmega328P microcontroller used in the Arduino UNO is available in a 28-pin package. It has 3 I/O ports (Port B, Port C, and Port D) and offers 24 I/O pins in total, with 14 digital I/O pins (6 of which support PWM) and 6 analog input channels (10-bit resolution for ADC). The ATmega328P includes two external interrupts and three timers (two 8-bit timers and one 16-bit timer), allowing for flexible control and timing functions.

4.4 Relay

Relay is used as a sensing device which senses the fault to send a trip signal to circuit breaker which isolates the faulty section. A relay is an automatic device by which an electrical circuit is indirectly controlled and is supervised by change in the same or another electrical circuit. Numerical relay, Static relay and electromagnetic relay are the various types of relays. The relays periodically scan the three phases and send the signal to the PIC18F877A Microcontroller controller. 12V is the rating of each relay.

Fig -4: Sugar Cube Relay

4.5 LCD Display

16×2 LCD has 16 Columns and 2 Rows. There are tons of combinations of LCD's are available like, 8×1, 8×2, 10×2, 16×1, etc. but the most common one is the 16×2 LCD. So, it will have total 32 characters and each character will be made of 5×8 Pixels. It has Operating Voltage 4.7V to 5.3V and Current consumption is 1mA. It has two rows and each row is able print 16 characters. Each character is built by a 5×8-pixel boxes. It can operate on both 8-bit and 4-bit mode.

Fig -5: LCD Display

4.6 GSM Module

GSM (Global System for Mobile Communication) is a digital module telephone system that is popularly used in many parts of the world. In GSM modem a wireless modem and a GSM wireless network works together. This utilizes the GSM standard for cellular technology. Here, one end has a wired connection which helps to receives and transmits data while the other end is connected to a RF antenna. The GSM modem acts like a cellular phone and transmits text and voice data it communicates GSM through SIM.

GSM module can communicate to PIC Microcontroller using normal serial USART Protocol. For serial communication baud rate of GSM Module and Microcontroller must be same.

GSM (SIM 900_AT): The SIM900 has SMT module in which it contains complete Quad-band GSM/GPRS solution which can be embedded in customer applications. Featuring an industry-standard interface, the SIM900 delivers GSM/GPRS 850/900/1800/1900MHz performance for Data, voice, SMS and Fax during a small form factor and with low power consumption. SIM900 can fit most of the space requirements within the M2M application with dimensions of 24mm x 24mm x 3 mm.

SIM900 is meant a reality single-chip processor integrating AMR926EJ-S core. As per the customers application Quad - band GSM/GPRS module comes with a size of 24mmx24mmx3mm, SMT type suit. An embedded Powerful TCP/IP protocol stack Based upon mature and field-proven platform, backed up by our support service, from definition to design and production GSM, which stands for Global System for Mobile communications, retrieve the world's most widely used cell phone technology. Cell phones use a cell phone service carrier's GSM network by searching for cell phone towers in the nearby area.

The "AT" or "at" prefix is always set at the beginning of each Command line. The AT command set implemented by SIM900 is a combination of GSM07.05, GSM07.07.

4.7 GPS Module

In this project, the GPS module allows precise identification of fault locations detected at 30 meters and 60 meters from the starting point, enabling maintenance teams to reach exact locations quickly. this GPS module is suitable for embedded applications that require location tracking. The integration of GPS data with GSM notifications enhances fault detection by including real-world coordinates, making fault location details more accessible for quick repairs.

5. ADVANTAGES

- Lower tree-trimming cost.
- Enhanced Reliability: Increased reliability during severe weather such as wind storm damage will be greatly decrease for underground system, and provide minimal damage during flooding and storm surge
- During severe weather lesser the destruction.
- Far fewer transient interruptions.
- Boost up Public Safety.
- Motor vehicle accidents reduces.
- Live-wire contact injuries decreases.
- Potentially-Reduced Maintenance and Operating Costs.

6. DISADVATNDES

The only disadvantage of underground cable is that it has high preliminary cost and insulation issues at high voltages.

7. APPLICATION OF SYSTEM: -

Underground cable Fault Detection.

8. CONCLUSION

The short circuit fault at a specific distance within the underground power cable is found to rectify the fault efficiently using fault switch and straight forward concept of Ohm's law and Voltage Divider Rule is used. The fault displays on the LCD screen and sends message to user. Underground cables are susceptible to a good sort of faults thanks to underground conditions such as wear and tear, rodents etc. Also detecting fault source is difficult and full line is to be dug so as to see entire line and fix faults. So here we propose underground cable fault detection to detects the exact fault position. The repairmen know exact location of fault and which part is to be dug to detect the fault source. This saves a ton of time, money and effortsand also allows to faster service to underground cables. The system detects fault with the assistant of voltage divider network laid across the cable. Whenever a fault occurs, a specific voltage is generated as per the resistors network combination. This voltage is sensed by the PIC microcontroller and inform the user about fault through GSM.

8. REFERENCES

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