International Journal of Research and Technology (IJRT)

International Open-Access, Peer-Reviewed, Refereed, Online Journal

ISSN (Print): 2321-7510 | ISSN (Online): 2321-7529

| An ISO 9001:2015 Certified Journal |

A Review of Underground Cable Fault Detector

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ABSTRACT

In urban areas, electrical cables run underground instead of running over, because it does not affect by any adverse effect of weather such as heavy rainfall, snow, thunder storm. Whenever a fault occurs within the underground cable, it is difficult to detect the exact location of the fault for the repair process of particular cable. The proposed system found the point of the exact location of fault. The paper uses the standard concept of Ohm's law i.e. when a low dc voltage is applied at the end of feeder through series resister (cable lines) then the current will vary depending on the location of the fault. Short in the cable. This system uses an Arduino microcontroller and a rectified power supply. In this case, the current detection circuit in combination with the resister is connected to the microcontroller with the aid of an ADC device to represent the length of wire in Km. Error creation is performed by a set of switches. The relays are controlled by a relay exciter IC, which is used to check cable line. A 16x2 LCD is used to display information. Also, one more feature is that using GSM the message of fault detection, location of fault and distance of fault from base station in kilometers this all information is send to base station. As soon as a fault occurs in a cable the buzzer produces the alarm to alert and to take an immediate action by field workers. Even when a fault is found to be present it is very difficult to detect the exact location of the fault. Due to which dogging of entire area has to do, for detecting and correcting the fault which in turn causes wastage of money and manpower. So, it is necessary to know the exact location of faults in the underground cables. So, we will move to find the exact location of fault. Now world has been digitalized so the paper is intended to detect the location of fault in digital form. The underground cable system is the most common practiced followed in many urban areas. While the fault occurs for some reason at that time the repair.

Keywords: Urban areas, Electrical cables, Fault Detection

1. INTRODUCTION

Underground cables play a vital role in modern electrical infrastructure, facilitating power distribution while minimizing visual clutter. However, faults in these cables can lead to service disruptions, safety hazards, and economic losses. Detecting and locating faults swiftly are essential for maintaining a reliable electrical grid. Arduino, known for its versatility and affordability, offers a promising solution for underground cable fault detection. This project aims to leverage Arduino's capabilities in data processing, analysis, and communication to design and implement an efficient fault detection system. The system comprises sensor modules for monitoring electrical parameters, a communication module for real-time data transmission, and a fault detection algorithm for analyzing sensor data. By utilizing Arduino's flexibility, the system can promptly detect faults, estimate fault locations, and communicate with maintenance personnel for timely intervention. In this context, the following sections will delve deeper into the components and functionalities of the underground cable fault detection system using Arduino, highlighting its significance in enhancing grid reliability, improving safety, and reducing operational costs.

Need of Underground Line Fault Detector

1. Invisible Faults: Unlike overhead power lines, faults in underground cables are hidden from sight, making them challenging to detect and locate.
2. Limited Accessibility: Accessing underground cables for inspection and maintenance is cumbersome and often requires excavation, causing inconvenience and downtime.
3. Safety Concerns: Undetected faults pose safety hazards to both the public and utility workers, potentially leading to accidents or injuries.
4. Economic Impact: Unplanned outages resulting from underground cable faults can disrupt businesses, industries, and daily life, leading to significant financial losses.
5. Operational Efficiency: Manual inspection methods are time-consuming, inefficient, and may not detect faults until they escalate into serious issues.
6. Early Fault Detection: Underground line fault detectors continuously monitor the electrical parameters of buried cables, allowing them to detect faults as soon as they occur. This early detection helps prevent prolonged outages and reduces the risk of equipment damage.
7. Accurate Fault Localization: By analyzing data from multiple monitoring points along the underground cable, fault detectors can accurately pinpoint the location of the fault. This precise localization minimizes excavation and repair time, reducing disruption to surrounding areas.

2. WORKING PRINCIPLE

An underground fault detector using Arduino typically operates based on the principle of measuring changes in electrical characteristics caused by faults in underground cables. Here's a simplified explanation of how it works:

1. Sensing Mechanism: The detector uses sensors to measure parameters such as voltage, current, or resistance in the underground cables. These sensors are typically placed at intervals along the cable's length.
2. Baseline Measurement: Initially, the system establishes a baseline measurement of the electrical characteristics when the cables are in normal operating conditions. This baseline serves as a reference point for detecting deviations caused by faults.
3. Continuous Monitoring: The Arduino continuously monitors the electrical parameters using the sensors. Any significant deviation from the baseline values indicates a potential fault along the cable.
4. Data Processing: The Arduino processes the sensor data using algorithms to analyze patterns and identify fault locations. Different types of faults (such as short circuits or open circuits) may result in distinct changes in the electrical characteristics, which the system can differentiate.

5. Fault Localization: Based on the analysis, the system determines the approximate location of the fault along the cable. This information can be displayed on a user interface or communicated to the operator for further investigation and repair.
6. Alerting Mechanism: When a fault is detected, the system triggers an alert, which could be in the form of visual indicators, sound alarms, or notifications sent to a monitoring station or mobile device.
7. User Interface: The detector may include a user interface, such as an LCD screen or a web-based interface, to display real-time data, fault locations, and system.

Overall, the underground fault detector using Arduino combines sensor technology, data processing, and fault detection algorithms to accurately locate faults in underground cables, helping to minimize downtime and facilitate timely repairs.

3. FAULT DETECTION METHOD

Transmission lines operate spreading power from a generating station to remote load centers. Due to the existence of lightning strokes, the system has some mis-operation like a short circuit with this problem line could be overloaded hence it can damage the equipment. Due to the occurrence of a fault, the phase voltage does decrease and enormous current flow, which could damage the equipment. In this condition, fault detection play important role which can interrupt in the system very quickly. In the transmission line, the fault is comprised of ten parts that could interrupt in the threephase system, single line to ground, line to line fault, double phase to ground and the last one is three phase faults. A single line to ground fault occurs when it makes contact with the ground during the occurrence of fault the impedance. Zag, has ome value it could not be considered zero impedance but still less than the impedance line.

The magnitude of the fault current is frequently increased as compared to the normal current that is operated, but the magnitude of voltage remains unchanged frequently. occurrence of each type of fault.

Type of Faults

- Fault category Design Occurrence (%) Simplicity
- Line-Ground L to G 85 Very low
- Line-Line L to L 8 Low
- Double line- Ground L-L-G 5 Moderate

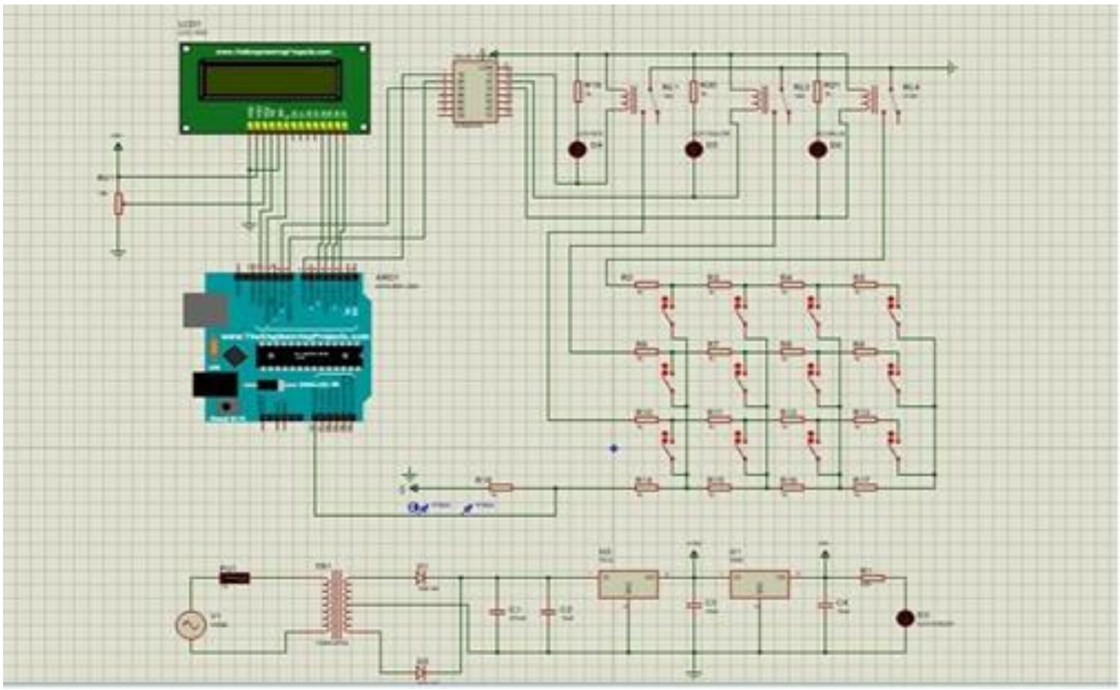
Three Phase 3ψ ≥2 Very high The series compensation is more efficient on transmission voltage that is essential to know because in series compensations have faced some technical problems when it is operated mainly with this problem is occurred like slow voltages and also high voltages These operational problems occurred due to a different type of caused like as line loading.

Conditions and voltage control adjusted. In series compensations system has used a capacitor. This capacitor one side has to effectively controlled otherwise it will be based on voltage problems. For this reason, we can use series compensation for decrease voltage problems otherwise most probably overvoltage can cause these problems. On the other hand, in series compensation increase the voltage when the lines are heavily loaded and also low voltages occurred on the line. And flashovers occur due to high voltages or shrink the lifetime of devices and caused short circuits. We can use series compensation as flows control of power.

On the other hand, in a series compensated line based on current and voltage inversions each the fault identification scheme for the series compensated by the fault and its magnitudes changes in fault voltages as a positive sequence and terms of fault current change as a positive sequence [8]. When in series compensated lines developed by the algorithm for fault currents and phase voltages to get the decisions by using EMTDC/PSCAD.

We can use capacitor or don't have used capacitor regarding the testing process of series lines by just changing the source capacity, fault resistance, the fault inception angle, power flow direction those are the different system condition. During the measure of current signals and voltage signals in both cases used fault location algorithm, two subroutines applied for locating faults and also for generalized fault loop. doesn't maintain any distance of the parameters. The using of parameter both-end signals for measuring asynchronously compensating bank and it mainly depends on the location of the bank. In the special types of faults can be recognized by used to ATP-EMTP for the compensated of double-circuit series line.

4. BLOCK DIAGRAM



The circuit is very simple, you can easily make this project with some basic electronics components.

1. Sensors: These devices, including voltage, current, and impedance sensors, measure electrical parameters of the underground cable.

2. Signal Conditioning: Raw sensor signals undergo processing (like amplification and filtering) to ensure accuracy and compatibility with the Arduino.

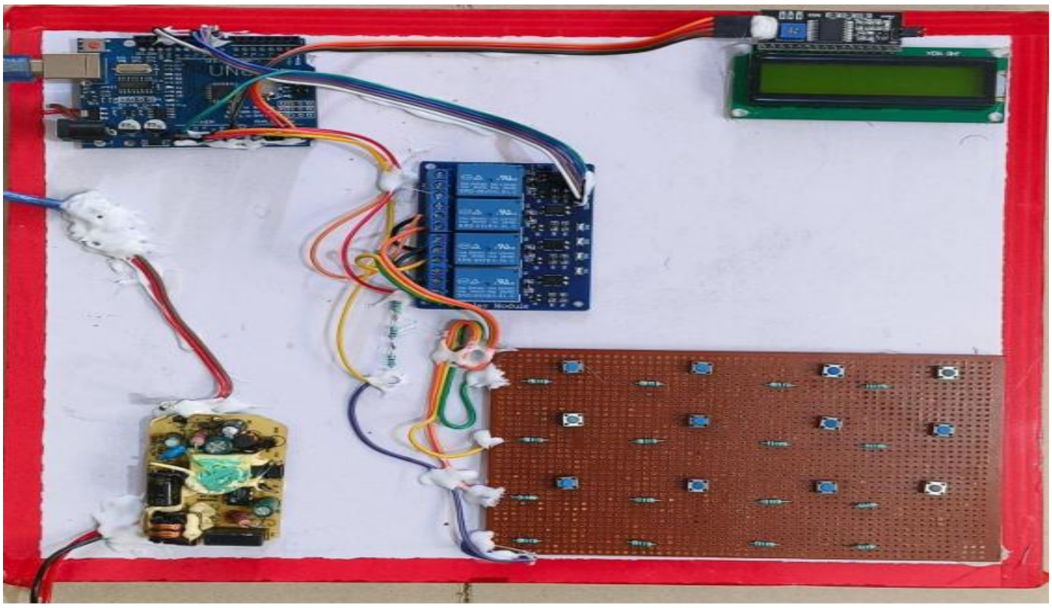
3. Arduino: Acts as the brain of the system, collecting data from sensors, executing a fault detection algorithm, and making decisions based on programmed logic.

4. User Interface: Provides a means for users to interact with the system, typically through an LCD display or smartphone app, showing real-time data and fault alerts.
5. Power Supply: Supplies reliable power to all components, ensuring continuous operation of the fault detection system.

This block diagram outlines the key components and their roles in an underground cable fault detection system powered by Arduino, showcasing the system's ability to monitor, analyze, and respond to faults in underground cables.

5. WORKING PROJECT

Before attempting to find underground cable faults on direct hidden primary cable, it is essential to know where the cable is situated and what direction it takes. If the fault occurs on the secondary cable, then knowing the exact route is even more critical. Since it is extremely difficult to find a cable fault without knowing where the cable is, it makes sense to master cable locating and tracking before start the fault locating process. The success of fault tracking and locating of an underground cable is mainly depends on the skill, knowledge and experience of that person. Although tracing of the cable can be an intricate job, it will very likely become even more complex as more underground plant is installed. It is just as important to understand how the equipment works.



The project is currently in the off mode, signifying that the final output is inactive.

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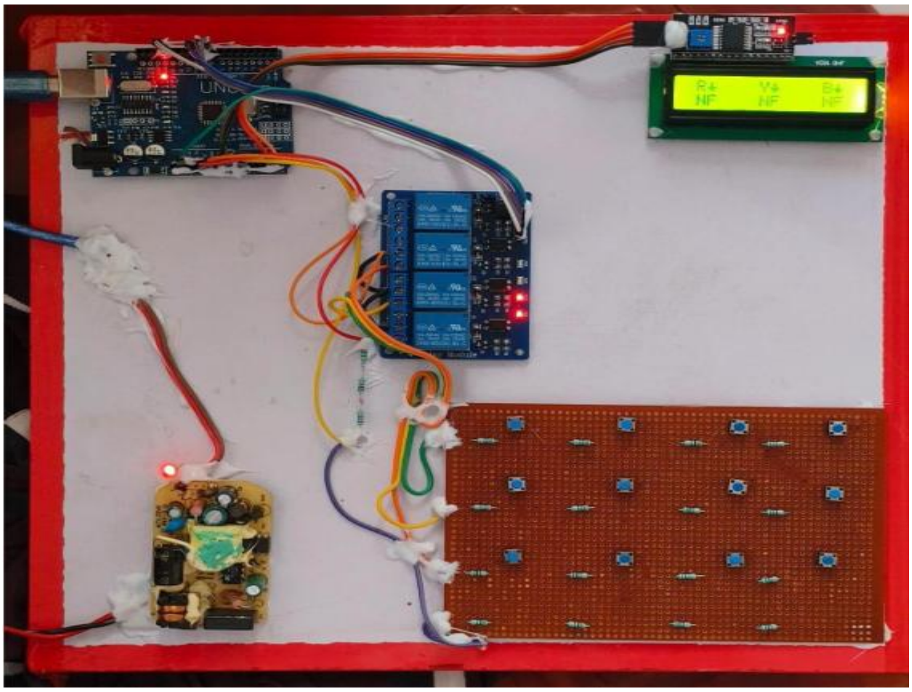
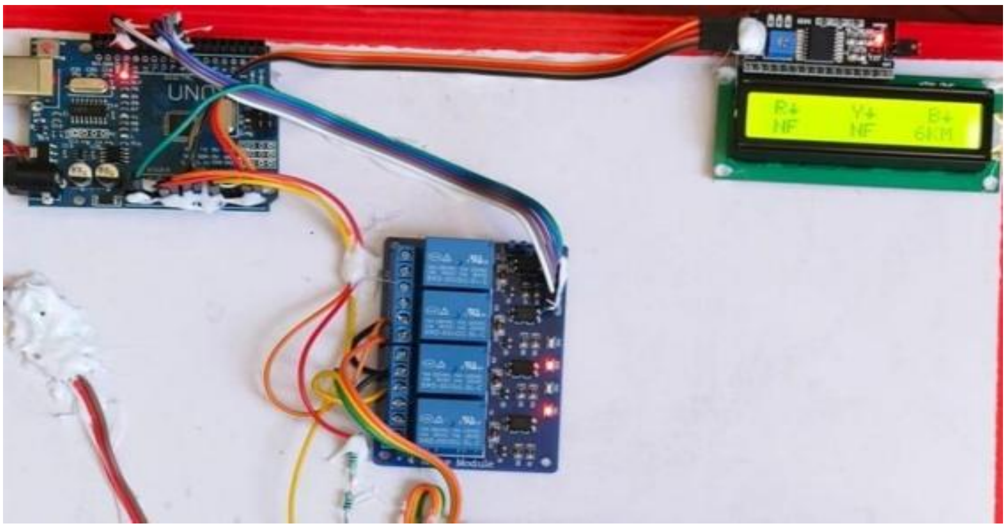


In this image, the LCD display illustrates the three phases of the wire where faults may occur when the project is operational. Currently, there are no indications of any faults, as reflected in the LED display showing R-phase, Y-phase, and B-phase. When the project initializes without any faults, the LCD display presents the following information:

1. The LCD screen shows the three phases of the wire, indicating normal operation.
2. Each phase (R, Y, B) is displayed on the LCD, signifying that there are no faults detected.
3. The LCD provides a clear indication that the system is functioning without any faults. This initial display on the LCD assures users that the project has started successfully and is operating under normal conditions, with no faults present in any phase of the wire.



THIS IS OUTPUT WHEN FAULT GENERATED ON B PHASE

In the depicted scenario, the LCD display provides a visual representation of the three phases of the wire. Currently, a fault has been detected on the B phase, and the LCD displays the fault range, indicating a distance of 6km on the B phase. This represents the operational status of the project under full working conditions. Moreover, the system incorporates a functionality whereby users can induce faults manually. By pressing the button associated with the R phase, a fault is generated on the R phase, and the LCD promptly updates to reflect this change. Additionally, the fault system offers three preset ranges—4km, 5km, and 6km—which are configurable through the Arduino code. This flexibility enables users to adjust the fault detection parameters according to specific requirements or environmental conditions.

6. CONCLUSION

In conclusion, underground fault detection using Arduino presents a promising solution for enhancing the reliability, efficiency, and safety of underground cable networks across various industries and sectors. Here are some key conclusions:

1. Cost-Effective Solution: Arduino-based systems offer a cost-effective alternative to traditional fault detection systems, making them accessible for a wide range of applications and budgets.
2. Customizable and Scalable: Arduino platforms provide flexibility in configuring detection parameters and can be easily scaled to accommodate different sizes and complexities of underground networks.
3. Real-Time Monitoring: The real-time monitoring capabilities of Arduino-based systems enable prompt identification and response to faults, minimizing downtime and reducing the risk of damage to infrastructure.
4. Remote Accessibility: Integration with wireless communication modules enables remote monitoring and control of underground networks, enhancing operational efficiency and facilitating proactive maintenance.
5. Versatility: Underground fault detection using Arduino finds applications in diverse industries, including electrical power distribution, telecommunications, transportation, oil and gas, and smart city infrastructure.
6. Educational Value: Arduino-based fault detection systems serve as valuable educational tools, offering hands-on experience in sensor integration, data analysis, and system development for students and professionals alike.
7. Energy Efficiency: Arduino boards are designed for low power consumption, ensuring continuous operation without significantly increasing energy costs.
8. Improved Infrastructure Resilience: By detecting faults early and facilitating timely repairs, underground fault detection using Arduino contributes to improving the resilience and reliability of critical infrastructure networks.

Overall, underground fault detection using Arduino holds great promise for addressing the challenges associated with maintaining and managing underground cable network ultimately leading to enhanced operational efficiency, reduced downtime, and improved safety across various industries and sectors.

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