

Smart Fault Intelligence in Underground Cable Systems: A Unified Detection, Identification, and Localization Framework

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Abstract— In power system the generated electrical energy is transmitted to the consumer premises with the help of overhead or underground transmission system. The underground system has several advantages as compared to overhead system but the major problem is we cannot able to detect the exact fault location. In order to overcome this problem, we proposing a new method that is underground cable fault location using IoT, by using this method we can detect the fault location from the base station in km.

Keywords— *Underground Cable, Micro-controller, Arduino Uno, IR Sensors, Voltage, Buzzer, Detection, GSM & GPS service, Google map.*

I. INTRODUCTION

The project endeavors to create a fault localization system for underground cable lines using Arduino technology, specifically targeting the determination of fault distances from a base station in kilometers. As urbanization favors underground cabling over traditional overhead lines, the challenge of fault detection and repair intensifies. By leveraging Arduino microcontroller, buzzer, and LCD technology, the project aims to streamline fault identification processes, significantly reducing repair durations for underground cable networks frequently afflicted by faults stemming from construction and other urban activities. Underground cable faults, including short circuit, open circuit, and power theft, pose significant challenges to electrical infrastructure. Short circuit faults result from insulation breakdowns, disrupting current flow and triggering circuit malfunctions. Open circuit faults interrupt electrical continuity, impeding current flow within circuits. Power theft exacerbates the situation, threatening financial losses and power supply reliability. Unauthorized techniques such as meter tampering and radio frequency devices contribute to energy theft, emphasizing the necessity for robust fault detection systems. Through Arduino-based fault localization, the project aims to address these challenges, enhancing the resilience and reliability of urban infrastructure by swiftly identifying and rectifying faults in underground cable systems. Underground cables are susceptible to various faults due to environmental conditions, wear and tear, and rodent interference. Locating fault sources is challenging, often requiring the entire cable line to be dug up for inspection and repair. This traditional approach is time-consuming, costly, and labor-intensive. The system aims to improve the efficiency of underground cable fault detection by swiftly identifying faults to minimize downtime, prevent damage, and ensure personnel safety. Integrating GPS enables precise location tracking of faults, while GSM facilitates immediate communication of fault details to relevant authorities for prompt resolution. This combined approach enhances the overall reliability and effectiveness of underground cable

networks by enabling quick response and resolution to faults as they occur. The system's scope includes applications in various industries relying on underground cables, such as power distribution, telecommunications, and transportation. It can be deployed in urban and remote areas, contributing to the overall reliability and maintenance.

II. PROPOSED SYSTEM

The identification and tracking of underground cable fault using GSM and GPS technique. The proposed system design is based on an Arduino Uno micro-controller. Arduino Uno serves as the central processing unit, gathering data from GPS to pinpoint fault locations precisely and utilizing GSM to transmit real-time alerts and data to a central monitoring system. This integrated system enables prompt detection of cable faults, facilitating rapid response and minimizing downtime, thus enhancing the reliability and efficiency of underground cable networks.

Following the initial check, the flowchart diverges into five main branches depending on whether a short circuit is detected. If a short circuit is found, the system proceeds to determine if an intruder or spark has also been detected. If an intruder has been detected, the system likely triggers an alarm or notifies the authorities. If a spark is detected, it might indicate an electrical issue and could potentially be a fire hazard. If no short circuit is detected, the system checks for an open circuit, power theft, or if a spark has been detected. An open circuit could indicate a wiring problem or a malfunctioning device.

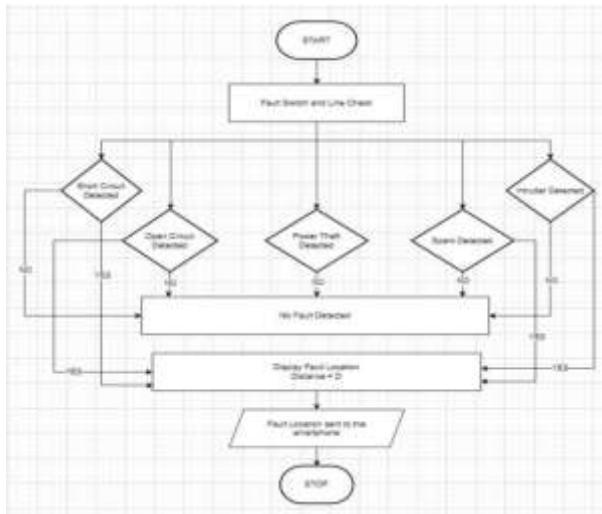


Fig.1. Working flow chart of the proposed system

Power theft would likely trigger an alarm to notify the authorities. If a spark is detected here, it might again indicate an electrical issue. If none of these faults are detected, the flowchart concludes that “No Fault Detected” and the system stops. Overall, the flowchart diagram depicts a system that can detect a variety of faults, including short circuits, open circuits, power theft, and sparks. Depending on the specific fault detected, the system may trigger an alarm, notify the authorities, or simply indicate that a fault has occurred.

III. HARDWARE PROTOTYPE AND TESTING

A. Components

The major components that are utilized to develop the hardware prototype are listed below:

- 1) Micro-Controller (Node MCU ESP8266)
- 2) Liquid Crystal Display (16 x 2 LCD)
- 3) Voltage Sensors
- 4) Buzzer
- 5) IR Sensors (LM358 comparator)
- 6) Wire Jumpers (Male & Female Jumpers)
- 7) Current Sensors
- 8) 12-0-12, 1000MA Transformer
- 9) Circuit Breaker

B. Building Hardware Prototype

Commonly people have been using business voltage (230V). This voltage is adventure down through development down transformer. Transformer is an electrical device that trades electrical imperativeness between in any event two circuits through electromagnetic induction. Generally, transformers are used to addition or decreasing the voltages of trading stream in electric power applications. These adventure down voltage goes to rectifier unit Rectifier is just an electronic contraption which used to change over an AC supply into DC supply. This endeavor we were using length rectifier. 12V AC supply is changes over into 12V DC supply. These voltage moves to the controller unit. Controller is an electrical contraption which is used to keep up a reliable voltage. Here we were using two voltage controllers. Explicitly voltage controller 7812 and voltage controller 7805. 7812 voltage controller keeps up the 12V DC supply. This voltage is adequate to work hand-off unit and 7805 voltage controller keeps up the 5V DC supply. This voltage is used to manage the Arduino unit. We moved the program in the unit. Program was created if any fault occur in the connection, immediately will open the exchange terminal and isolate that messed up line in a manner of speaking. Rest of various lines works normally. By and by a days embedded system changed meteorically. Arduino is the pushed variation of embedded structure. This Arduino has adequate sorts yet we picked Arduino Uno.

This Arduino Uno serves to developed many impelled variations of Arduino Uno makes straightforward condition .it successfully to get various contraptions using consecutive port. Next, we move the hand-off. Move is just an electrical contraption here which went about as a switch if any fault occur in the line, will isolate the line using hand-off. The connector of the exchange moves from commonly close direct to the routinely open conduct. We viably find the fault and to isolate the accuse line. Show unit is partner the Arduino pack which is used to where the fault occurs and to demonstrate to itself.

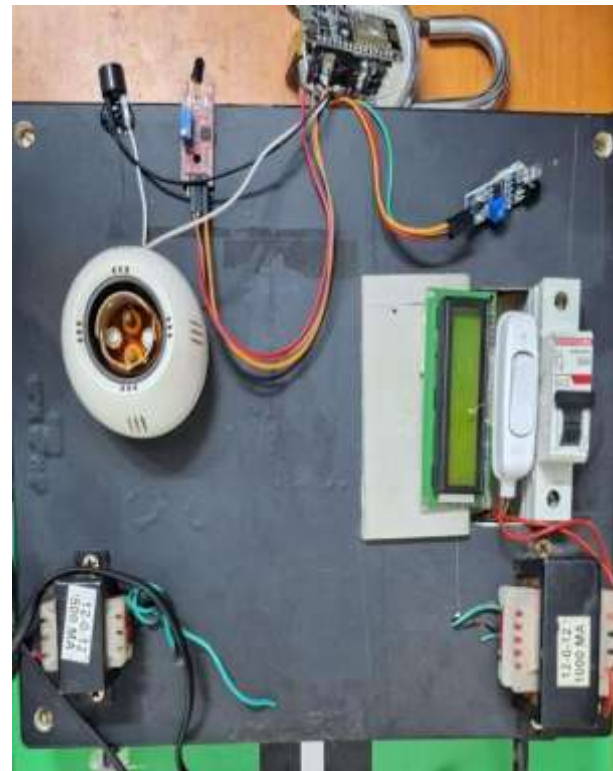


Fig.2. Hardware Prototype Initialization

IV. RESULTS AND DISCUSSIONS

This prototype can be able to sense the precise location of different faults like earth, short and open circuit fault in UG cables from the feeder end which has been confirmed by the results from testing the hardware prototype.

The Arduino microcontroller triggers to continue the search for the fault in tree lines. The fault switch turns off means there is no fault occurs and the relay grounded the current flow in the lines. When the fault switch turns on, the Arduino microcontroller detects the Line-to- Ground fault and illustrates the fault in the LED display.

For the line-to-line fault, the device system will continue to check again. If any fault occurs, it will identify the fault and track it as shown in Fig 5 and the system will generate notification with the distance of the fault and inform the dedicated person's cell phone number as shown in Fig 5. The micro- controller will continuously check for the distance and location of the fault and send it to the dedicated cell number using GSM and GPS modules.

Whenever there is no fault in the underground cable, it displays on LCD that the system is in “good condition” by indicating the normal voltage and current values. When a fault occurs on the line, it displays the type of fault on the system whether it is open circuit, short circuit fault etc. Also an notification is sent by using GSM System to the registered user for alerting purpose. Once the fault is cleared, it displays on LCD again as “good condition” which automatically sends notification indicating that the fault is cleared. After getting the fault location data it is sent to mobile number using GSM module. The notification includes distance of location and the fault location and it can be clearly monitored in Google Maps.

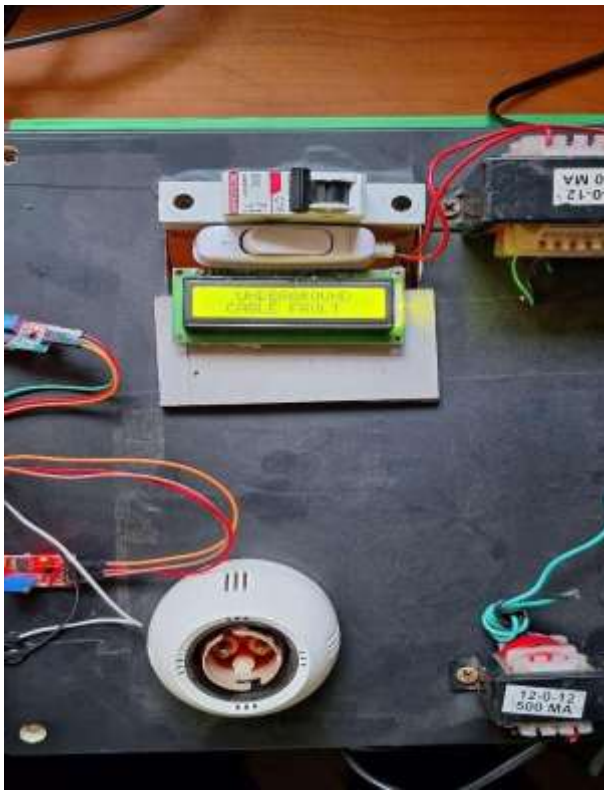


Fig.3. Hardware Prototype testing (Detection)

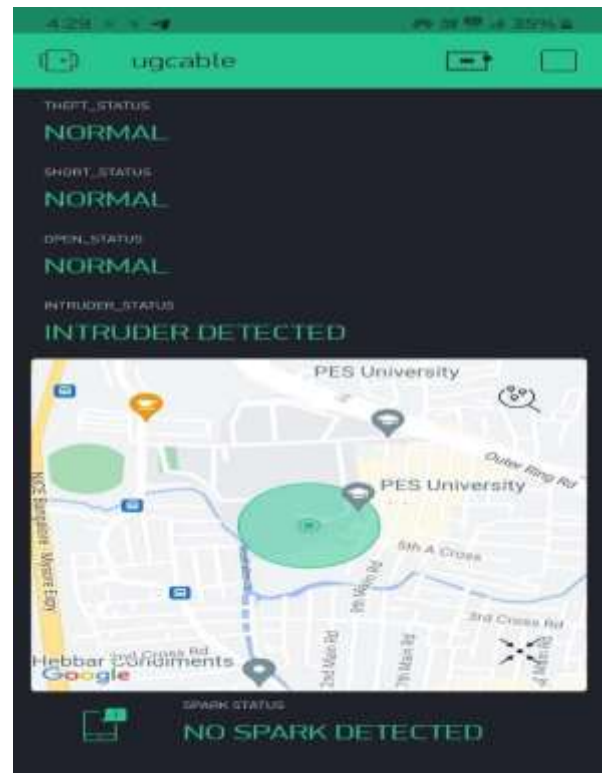


Fig.5. Testing information on Smartphone

V. CONCLUSION

We build and test an Arduino micro-controller-based system for detecting and identifying underground cable faults using GPS and GSM techniques. The constructed prototype is shown good results in identifying and tracking defects in subterranean cables. The suggested method is a modification of the traditional subterranean cable fault detector that locates the exact location on a Google map in addition to detecting the cable fault. There is much space for development and enhancement in this GPS and GSM-based subterranean cable fault monitoring and identification system. Features like IoT implementation and improved sensing methods for UG cable minute defect detection could be added. The sensing mechanism has to be more sensitive for practical use.

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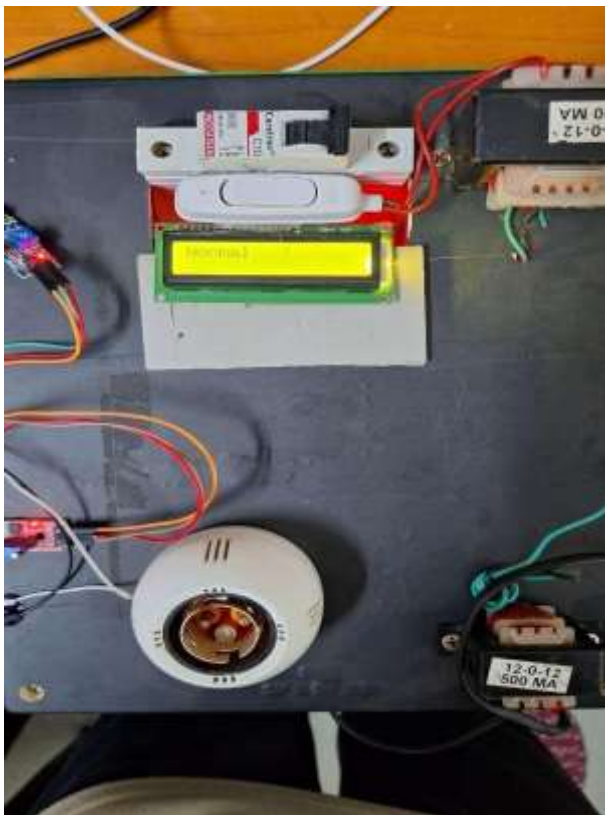


Fig.4. Hardware Prototype Testing - Normal

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