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# IoT BASED UNDERGROUND CABLE FAULT DETECTION SYSTEM

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## Abstract

Most of the time, burying high-voltage cables underground is their main advantage in the market. It allows the companies to maintain pollution resistance and other security measures. In addition, a weather forecast is also enhanced when using such cable lines. Thus, they are also the ones mostly chosen for the external safety and weather stability. The irony of the whole situation is that in spite of their awesome benefits, the cables can still be affected by the wrong method of installation, poor jointing, third-party excavation activities, abrasion, environmental stress, and animal interference. Often the process of finding these faults and repairing them is very difficult, it consumes a lot of time and money. The system is the fastest fault detection device, as certified by the experiment, and this leads to a reduction of the machine stop time and the maintenance costs, thus, the reliability of the modern power distribution networks is maintained. This article presents a fault detection and diagnosis system for underground cables based on the Internet of Things (IoT) that intends to solve the aforementioned problem. Devices with the proposed system, such as voltage divider circuits, enable the detection of variations in the fault voltage and are connected to the cable. ESP32 microcontroller handles all of the signal processing work, fault location in kilometers, and communication of the result to the user. The data can be accessed on the liquid crystal display (LCD) and are simultaneously sent to the Blynk cloud database by the wireless module for remote monitoring and archiving.

## 1. INTRODUCTION

First of all [1], power electricity that is dependable and efficient, is just about the essentials of life in this era, and underground power cables are those that have the biggest share in the fact that the supply is stable and without any interruptions. The only method to reduce the time of outages to the minimum and retain a distribution network system that is resilient is by a very prompt fault detection as well as the exact location of the fault when it is found. An important factor in the success of the IoT technology is the ease of its identification as the precise solution for the problem in question, and the recognition by the industry, that it has done so largely over the last few years. IoT-based systems, which implement smart sensors, data analytics, and wireless communication are revolutionizing the traditional way of monitoring significantly. They, for instance, through the real-time tracking and automated fault detection, not only have a faster response time but also keep a greater overall efficiency to a large extent as the downtime has been lowered considerably. Most of the time [2], power cables meant for underground distribution of electricity are just buried in the soil or installed in protected ducts. Such a product guarantees the long life of the cable and the least possible number of faults. In spite of this, these faults in underground systems, locating and fixing them is a huge problem because the conductors cannot be seen. The fault detection process can in many instances be similar to the needle in a haystack finding process. Over time, several methods, and also expensive diagnostic tools have been developed, which greatly facilitate fault detection. However, the claim that no single method or even a combination of methods could be considered as the "best" ones is still true. The different fault types determine the use of different methods to achieve safety, accuracy, and effectiveness in fault localization as well as the non-damage of the cable. The next section is about the fault genres that are happening in underground cables.

## 2. PROBLEM STATEMENT

Underground [3] cables have really become an indispensable part of the power distribution system of the modern world and the reasons for such a statement are quite clear. Not only do cables enhance safety and reliability, but they also protect the network from environmental disturbances, such as pollution, heavy rains, and storm. However, they are still creating lots of problems in the areas of fault detection and maintenance. In contrast, underground cables are completely covered, thus a person cannot simply do a check or a supervision of their condition directly. When the malfunction happens by short-circuiting, insulation leakage, or mechanical injury to the cable, locating the fault becomes a very difficult and long process. The traditional means of power network fault detection are largely reliant on human intervention during inspection, extensive sectional testing, and the use of large and complicated measuring instruments. Not only these methods decelerate the process of power restoration, but they also escalate the operational costs. The delay in outage period, system reliability decreasing, utilities losing money, and consumers experiencing inconveniences are some of the consequences that follow. Additionally, faults may result from poor installation practices, joint failures, digging done by the third parties, environmental stress, or even rat attacks that have complicated the fault identification process so much. Hence, it is totally mandatory that a decision be taken towards the installation and use of a reliable, automated, and accurate fault detection system for underground cable faults that can locate the faults in a very short time. The adoption of such a system will undoubtedly reduce the time for which the network has to be de-energized thus it will lessen maintenance activities, elevate safety, and improve the reliability of power distribution networks.

## 3. LITERATURE SURVEY

L.Kurinjimalar et al [1] The authors of the paper mention that despite the advantages that buried cables have over aerial lines, one of the significant problems is the precise fault location. As a solution to this problem, they present a fault indicator system based on the Internet of Things, which utilizes Ohm's Law to locate the fault in the distance from the base station in kilometers. Thus the malfunction in underground cables, which are extensively utilized in urban areas, can be expediently detected and repaired but are difficult to locate when they occur.

Abrar et al [2] . describe how underground cables are buried and are subjected to numerous faults due to environmental damage and wear which make it difficult to carry on repairs since the cables are usually dug up along their entire length. They want to be able to accurately locate the faults with their project which is the node controller system. The system is able to locate the exact faults positions by the method of modeling the cable as resistors and simulating faults. After the fault data is wirelessly transmitted with the aid of IoT technology and Wi-Fi module, the underground cable faults can be easily and remotely monitored.

Jayachandran et al [3] In their work, they clarified the IoT Based Smart Underground Cable Fault Detector . The authors have developed a diagnosis system using the Internet of Things (IoT) technology, which is capable of detecting the underground cable faults and also to localize the faults. The system through a quicker fault detection, therefore, intends to cut down the required time, money and the amount of work that has to be done in order to the area fixed. The IoT-based method involved the use of a set of voltage dividers that were installed on the cable to find the fault. In the case of a fault due to a short circuit between two cables, a voltage is produced, which is recorded by the ESP32 microcontroller. This microcontroller sends the location of the fault in kilometers to the user. The information collected is shown on a liquid crystal display (LCD) and is sent online through a Wi-Fi module to the Blynk cloud database for storage and further processing.

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B.Karuna Sree et al[4]. have come up with a fault detection system which is monitoring the current that the underground cables pass through, to be able to detect faults. Every cable is given a maximum current value, thus in the case of a short circuit the current will be skyrocketing and if there is a break in the circuit the current will be zero. Current transformers get the current; it is then changed into a voltage signal that the Arduino reads. The Arduino is the one that receives and processes the data thus making the fault identification visible on the LCD and LEDs. Besides this, the system employs relays which are used for changing the power supply from the faulty phase to the one that is healthy, thus a continuous power supply can be achieved by the users. In addition, there is a manual fault-clearing switch that enables the operator to reset the system after the repair work is done.

Shingrut et al[5] have explained in their paper about a project, which is designed to identify the distance of the underground fault cable in kilometres from the base station and the same is displayed over the internet. An underground cable system is a standard practice in most major metro cities areas. When a fault occurs, at that particular moment the repairing process of that cable is hard because the fault's exact location is unknown in the cable. It is a new technology that can accurately locate the fault and at the same time a GSM module is used to send graphical data to the website and also a display is given on the LCD screen.

Harikrishna et al[6].have explained in their paper about a project that underground cables are frequently damaged due to various environmental factors and the attack by rodents. The locating of the fault precisely in a cable is usually a very difficult process. As a result, large parts of the cable have to be dug up, which not only takes a lot of time but also a considerable amount of money is wasted. Besides that, there are different methods like sectionalizing, thumping, and the Murray loop. However, these methods are generally slow and expensive. The authors decided to develop an IoT-based underground cable fault detection system which can not only locate the fault remotely but also be able to save the time and the resources by the way of allowing the repair to rest only on the exact faulty area.

Rakesh et al[7] introduced a method based on Ohm's Law for the identification of faults in underground cables. Local current changes when a short circuit is the source of the fault, at the feeder end, consequently. Reading this via its Analog-to-Digital Converter (ADC), an Arduino captures these current variations by voltage measurement across a resistor. The system, using this information, figures the fault point and shows on an LCD how many kilometers from the base station the fault is. The device represents the cable with resistors for different lengths, and the fault switches are installed at the certain distance to simulate the faults for the fault distance to be detected accurately.

Esha Lohar et al[8]. developed the technology for identifying faults in underground cables which are generally laid in cities to avoid weather-related damages. They employ Ohm's Law in their method: the current varies if a short circuit location is found when a low DC voltage is applied. An Arduino microcontroller through an ADC reads the current changes, resistors representing the lengths of the cables in kilometers. The faults have been caused by the use of switches, and a relay exciter IC manages the test. The 16x2 LCD display can be used to find out the exact location of the fault and help messages with the description of the fault type and distance are sent via GSM to the base station. In case the fault occurs, a buzzer will immediately sound to alert the field workers for further actions.

Prabha et al[9]. designed a system based on IoT to track the exact location of the fault in underground cables from a base station with the help of Arduino. Essentially, the system uses Ohm's Law in which the current varies according to the fault's position in the cable. As most urban areas have underground cables, it is extremely necessary to locate the faults in a short time in order to carry out the repair work on time. Arduino, which is the system's central processing unit, receives the data from the sensors and a fault is detected by the use of the resistor network when the two lines are cut. The fault details are then posted on the net for the police to have a quick and easy access.

Divya Sugathan et al[10] explains the usage of resistors to simulate the length of the cable in kilometers as well as switches to represent the faults at known locations in this document. Generally, underground cables that are extensively installed in areas such as hospitals, roads, and educational institutions are more reliable than overhead wires since they are less exposed to harsh weather and pollution. But, finding the faults in the underground cables that cannot be seen is a big problem. The most frequent faults are short circuits, open circuits,

and earth faults, while open circuits are resulted from the breakdown of the conductor. Their project is to be able to pinpoint the fault locations with accuracy to make the fault fixing process easier.

## 4. CONCLUSION

IoT-based systems for identifying underground cable faults offer a novel, efficient, and reliable method for overseeing and maintaining electrical networks. These systems utilize sensors, microcontrollers, and IoT connectivity to notify teams in real-time about faults (such as short circuits or line-to-ground faults), pinpoint the fault along the cable's length, and relay that information to a maintenance crew remotely. This will minimize downtime, decrease labor costs, and improve system dependability. The setup of IoT systems enables ongoing monitoring, data logging, and analysis that improve predictive maintenance and avert catastrophic failures. Despite challenges such as sensor accuracy, environmental factors, and communication reliability, advancements in IoT technology will enhance characteristics like precision and scalability. In summary, IoT solutions for detecting underground cables provide a significant advancement for a SMART or automated electrical distribution system. Additionally, monitoring based on IoT enables predictive maintenance by examining past fault data, identifying patterns, and forecasting a cable failure prior to its occurrence. An anticipatory work process minimizes unforeseen disruptions, boosts service reliability, and optimizes resource distribution for utility companies. Monitoring through IoT enhances safety by reducing the necessity for manual inspections in hazardous locations, such as underground facilities or areas with high voltage. Upcoming advancements could involve the adoption of cutting-edge technologies like a machine-learning algorithm for identifying faults, a wireless sensor network for remote regions, and cloud data analytics to enhance decision-making processes. Additional options for enhancing system sustainability involve energy-efficient and self-sustaining sensors. With these advancements, IoT driven underground cable fault identification systems may turn into a vital component of smart grid infrastructures to enhance the resilience, intelligence, and automation of power distribution network.

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