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UNDERGROUND CABLE ACOUSTIC FAULT ROUTE TRACKING AND DISTANCE IDENTIFYING IN COAL MINE USING INTERNET OF THINGS

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ABSTRACT

The present research paper is focus on to determine the distance of underground cable fault from the base station in kilometers and displayed over the internet. Underground cable system is a common practice followed in major urban areas. While a fault occurs for some reason, at that time the repairing process related to that particular cable is difficult due to exact unknown location of the fault in the cable. Proposed system is used to find out the exact location of the fault and to send data in graphical format to a dedicated website together with on board LCD display using a GSM module. We use the standard theory of Ohms law, i.e., when a low DC voltage is applied at the feeder end through a series resistor (Cable lines), then the current would vary depending upon the location of the fault in the cable as the resistance is proportional to the distance. In case there is a short circuit (Line to Ground), the voltage across series resistors changes according to the resistance that changes with distance. This is then fed to an ADC to develop precise digital data and send it to displays in kilometers.

Key words: Microcontroller, LCD, IoT, GSM module, Underground Cables

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1. INTRODUCTION

Now day's underground cables have been widely implemented due to reliability and environmental concerns. To improve the reliability of a distribution system, accurate identification of a faulted segment is required in order to reduce the interruption time during fault, [1] [2] [3] i.e., to restore services by determining a faulted segment in timely manner. In the conventional way of detecting a fault, an exhaustive search in larger-scale distance has been conducted. This is time-consuming and inefficient. Not only that the manpower resource is not utilized, but also the restoration time may vary depending on the reliability of the outage information. As such, deriving an efficient technique to locate a fault can improve system reliability. Use of underground power cable is expanding due to safety considerations and enhanced reliability in the distribution and transmission systems in recent times. Due to safety reasons and high power requirements in densely populated areas, use of underground cable has seen a sharp hike in recent times .Till last decade's cables were made to lay overhead& currently it is lay to underground cable which is superior to earlier method. Because the underground cable are not affected by any adverse weather condition such as storm, snow, heavy rainfall as well as pollution. But when any fault occur in cable, then it is difficult to locate fault. So we will move to find the exact location of fault. Now the world is become digitalized so the project is intended to detect the Location of fault in digital way. The underground cable system is more common practice followed in many urban areas. While fault occurs for some reason, at that time the repairing process related to that particular cable is difficult due to not knowing the exact location of cable fault.[4] [5]

The aim of this project is to determine the distance of underground cable fault from base station in kilo meters. This project uses the simple concept of ohm's law. When any fault like short circuit occurs, voltage drop will vary depending on the length of fault in cable, since the current varies. A set of resistors are therefore used to represent the cable and a dc voltage is fed at one end and the fault is detected by detecting the change in voltage using analog to voltage converter and a microcontroller is used to make the necessary calculations so that the fault distance [5] [6] is displayed on the LCD display.

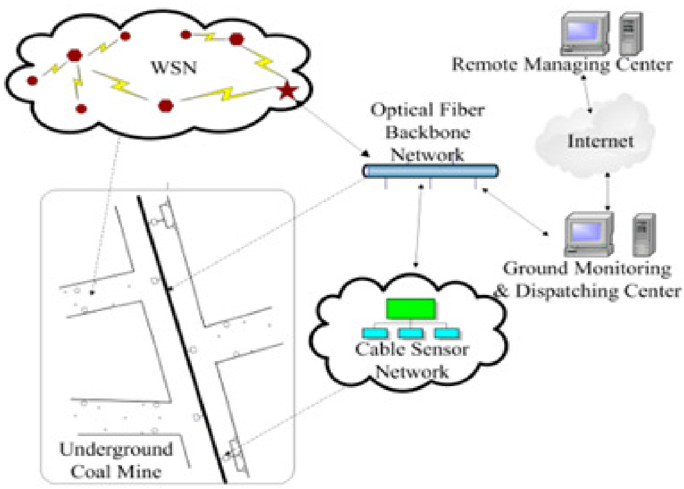

Figure 1 Block Diagaram

2. LITERATURE REVIEW

In an electric power system, a fault is detected by any abnormal electric current follow. For example, a short circuit is a fault in which current bypasses the normal load. An open-circuit fault occurs if a circuit is interrupted by some failure. In three-phase systems, a fault may involve one or more phases and ground, or may occur only between phases. In a "ground fault" or "earth fault", charge flows into the earth. The prospective short-circuit current of a fault can be calculated for power systems.

In power systems, protective devices detect fault [6] conditions and operate circuit breakers and other devices to limit the loss of service due to a failure. In apply phase system, a fault may affect all phases equally which is also called symmetrical fault. If only some phases are affected, the resulting asymmetrical fault becomes more complicated to analyze because the simplifying assumption of equal current magnitude in all phases is no longer applicable. The analysis of this type of fault is often simplified by using methods such asymmetrical components. A symmetric or balanced fault affects each of the three phases equally. In transmission line faults, roughly 5% are symmetric. This is in contrast to an asymmetrical fault, where the three phases are not affected equally. An asymmetric or unbalanced fault does not affect each of the three phase’s equally Power transmission and distribution lines are the vital links that achieve the essential continuity of service of electrical power to the end-users.

Transmission lines connect the generating stations and load centers. Faults are caused either by insulation failures and conducting path failures. Most of the faults on transmission and distribution lines are caused by overvoltage due to lighting and switching surges or by external conducting objects falling on overhead lines. Birds, tree branches may also cause faults on overhead lines [7] [8].

Other causes of faults on overhead lines are direct lightning strokes, aircraft, snakes, ice and snow loading, storms, earthquakes, creepers etc. In the case of cables, transformers, generators the causes may be failure of solid insulation due to ageing, heat, moisture or overvoltage, accidental contact with earth.

3. TECHNIQUES OF FAULT LOCATION

In general, fault location techniques for underground cable network can be categorized in two groups:

1) Tracer method: - The tracer method is an exhaustive way to locate a faulted segment by “walking” through the cable circuits. A faulted segment can be determined from audible or electromagnetic signals and requires dispatching crew members to the outage area. There have been various techniques largely used in the industries, including the tracing approach through acoustic, electromagnetic or current.

2) Terminal method: - The terminal method is a technique used to determine a fault location of a distribution cable network from one or both ends without tracing exhaustively. A bridge technique is one of the most popular terminal methods that link with a resistor to determine a fault location.

It is a technique used to detect fault location of cable from one or both ends without tracing. This method use to locate general area of fault, to expedite tracing on buried cable.

Fodt Sensor (Fiber Optic Distributed Temperature Sensor) **To Fault Detection of Xlpe Insulated Underground Cable** The FODT sensor, which is applied to fault detection of XLP Einsulated underground cable in resistance grounded power system, can find fault point immediately. .

Fault in cable can be classified in two groups

1) Open circuit fault:

Open circuit faults are better than short circuit fault, because when this fault occurs current flows through cable becomes zero. This type of fault is caused by break in conducting path. Such faults occur when one or more phase conductors break.

2) Short circuit fault: Further short circuit fault can be categorized in two types:

A) Symmetrical fault: Three-phase fault is called symmetrical fault. In this all three phases are short circuited.

4. TYPES OF CABLES

1. Cable types are basically defined as low-, medium- and high voltage cables. The most common designs of medium- and high voltage cables are shown below. According to the cable type, different requirements to cable testing, cable fault location as well as maintenance strategy are defined.
2. Three-conductor cables have been in use in the lower voltage ranges. The tendency of the last year's show the shifting to single-core systems as they are lower in price, lower in weight and cheaper in regards to repair costs.
3. Furthermore oil impregnated or oil filled cables are used less and less, as the environmental sustainability cannot be guaranteed. Especially in industrialized countries, these cable types have been replaced and are no more installed.
4. On the other hand a high demand for maintenance of those cables is given as the installed oil-insulated networks do show up a lifetime of 50 years and more.
5. Today mainly XLPE insulated cables are used. The improvement of the XLPE insulation material combined with the modern design of the cable enable to manufacture cables even for the extra high voltage level.

Figure.2. 3-core EPR, incl. 3-core XLPE 11kV 1-core XLPE 115kV Data line, radial type

All kind of low-, medium- and high voltage cables are delivered and stored on cable drums. The maximum available cable length is mainly specified by the diameter (1-core ore 3-core cable) and the voltage level of the cable.

CABLE FAULTS

1. A cable fault can be defined as any defect, inconsistency, weakness or non-homogeneity that affects the performance of a cable. All faults in underground cables are different and the success of a cable fault location depends to a great extent on practical aspects and the experience of the operator.
2. To accomplish this, it is necessary to have personnel trained to test the cables successfully and to reduce their malfunctions.
3. The development of refined techniques in the field of high voltage testing and diagnosis, in addition to the variety of methods for locating power cable faults, makes it imperative that qualified and experienced engineers and service operators be employed.

4. In addition, it is important for the trained personnel to be thoroughly familiar with the fundamentals of power cable design, operation and the maintenance.
5. The purpose of this document is therefore to be an additional support to the user manuals of the different equipment's concerning all aspects of the fault location in order to make up a volume of reference which will hopefully be useful for operators and field engineers.

5. GLOBAL SYSTEM FOR MOBILE (GSM)

The words, "Mobile Station" (MS) or "Mobile Equipment" (ME) are used for mobile terminals Supporting GSM services. A call from a GSM [14] mobile station to the PSTN is called a "mobile originated call" (MOC) or "Outgoing call", and a call from a fixed network to a GSM mobile station is called a "mobile Terminated call" (MTC) or "incoming call".

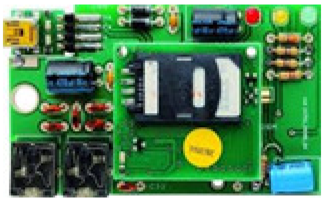

Figure 3 GSM Module

6. INTERNET OF THINGS (IOT)

The **Internet of things** (**IoT**) is the inter-networking of physical devices, vehicles (also referred to as "connected devices" and "smart devices"), buildings, and other items embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data. In 2013 the Global Standards Initiative on Internet of Things (IoT-GSI) defined the IoT [11] [12] as "the infrastructure of the information society. "The IoT [13] [15] allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, virtual power plants, smart homes, intelligent transportation and smart cities.

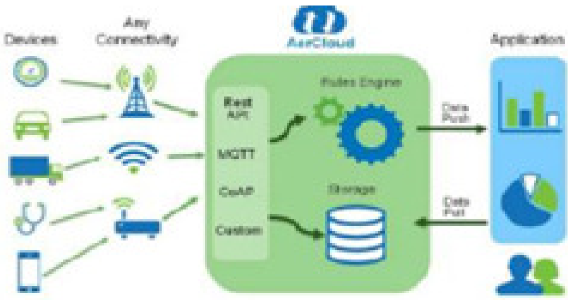

Figure 4 IOT Architecture

7. IMPLEMENTATION

Cable Fault location procedure

Cable fault location as such has to be considered as a procedure covering the following steps and not being only one single step.

1. Fault Indication.
2. Disconnecting and Earthing.
3. Fault Analyses and Insulation Test.
4. Cable Fault Pre-location.
5. Cable Route Tracing.
6. Precise Cable Fault Location (Pinpointing).
7. Cable Identification.

Cable Fault Types

Fault between core-core and core - sheath

1. Low resistive faults (R < 100 - 200 Ω)
   1.1. Short circuit
2. High resistive faults (R > 100 - 200 Ω)
   2.1. Intermittent faults (breakdown or flash faults)
   2.2. Interruption (cable cuts)

Defects on the outer protective shield (PVC, PE)

1. Cable sheath faults

Most of the cable faults occur between cable core and sheath. Furthermore, very frequently blown up open joint connections or vaporized cable sections can cause the core to be interrupted. To figure out whether such a fault is present, the loop resistance test shall be done. By using a simple multi-meter, the continuity in general can be measured. The easiest way to perform this test is to keep the circuit breaker at the far end grounded.

Cable Route Tracing

1. Cable route tracing is applied to determine the exact route of the underground cable. Depending on the availability of cable laying maps, route tracing is of very high importance as prior step to cable fault pin-pointing.

2. Route tracing can be performed either active or passive. At live cables the harmonics of the mains frequency can be heard as „mains hum".

Signal detection

Above the ground, the electromagnetic signal transmitted via the audio frequency generator can be measured along the cable trace. Depending on the pick-up coil direction, the signal can be coupled differently.

1. Maximum method

The detecting coil is horizontal to path of line. Maximum audio signal is directly above the line. The maximum method is used for cable routing as well for terrain examination.

2. Minimum method

The detecting coil is vertical to the path of the line. The minimum audio frequency signal is directly above line. The minimum method is used for depth determination measurement as well for exact cable tracing and pin pointing

Depth Measurement according to the Minimum Method

For the depth determination with a simple surge coil, the characteristic of an isosceles triangle

- First determine the exact position of the cable.
- Subsequently, the coil has to be rotated to 45°
- The minimum audio-frequency signal is heard at the depth “d” at corresponding distance from the path of the cable. Instruments designed specifically for route tracing are operated with two integrated antenna covering the functions of minimum and maximum methods well as depth determination.

8. CABLE FAULT PIN-POINTING

Acoustic Fault Location

1. Acoustic Fault Location in direct buried cables

- For pin-pointing of high resistive and intermittent faults in buried cables the acoustic method is used to pin-point the exact fault location.
- As signal source, a surge generator is used in repetitive pulsing mode. High energy pulses which are released by a surge generator (SSG) force a voltage pulse to travel along the cable.
- At the fault the flashover happens. This causes a high acoustic signal that is locally audible. Depending on the pulse energy, the intensity of the acoustic signal varies.

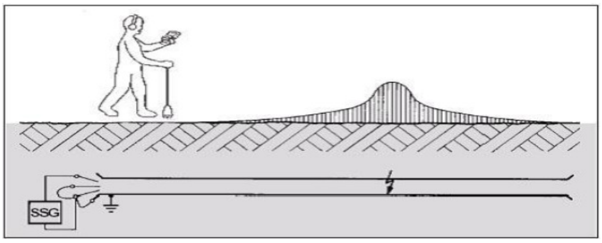

Figure 5 Schematic Connection and Shape of Acoustic Signal – Acoustic Fault Location

Figure 6 Cable Fault, 1-Core 11kv XLPE Cable

Pin-Pointing Of Cable Faults in Pipe Arrangements

When cables are laid in pipes the acoustic signal is no more audible right above the cable fault. The acoustic signal in that case is travelling through the air in the pipe and therefore only audible at both ends of the pipe or on the manhole covers. By means of the previously carried out cable fault pre-location, the section of pipe can be determined. Up to today, the final step to determine the exact fault position in the pipe was very difficult or by most pick-ups sets impossible. The latest model of pick-up set UL/BM therefore uses a special feature to determine the exact fault position also in manhole arrangements.

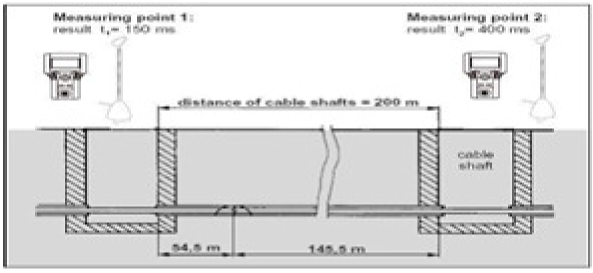

Figure.7 Manhole Arrangement, Cable Laid In PVC Pipe, Acoustic Signal Only Audible on Manhole Cover

Acoustic Fault Location at Manholes

1. For this method, no additional instrument is requested. Every latest UL receiver offers the mode of pinpointing in manhole arrangement.
2. In a first step, the ground microphone is placed on the first manhole cover, where the acoustic signal and the magnetic signal are shown up in a certain propagation time value. By confirming the signal, this value is stored in the receiver

Figure.7.1 UL30 Display, Manhole Mode, Display of Two Propagation Time Values Used

In a second step, the ground microphone is placed on the second manhole cover. Also at this location, the ground microphone can pick-up an acoustic signal and the magnetic signal that is showing up in a second propagation time value. By entering the distance between the manholes, via the propagation time ratio over the distance, the direct distance to the fault in the pipe is indicated.

9. RESULTS

After the implementation of project „Display of underground cable fault detection using Internet of Things(IoT) [13] and Global system for mobile(GSM) subscriber get the output in kilometers in the form of SMS once mobile number is registered and in SMS it consists of GPS [14] location of fault generated as follows,

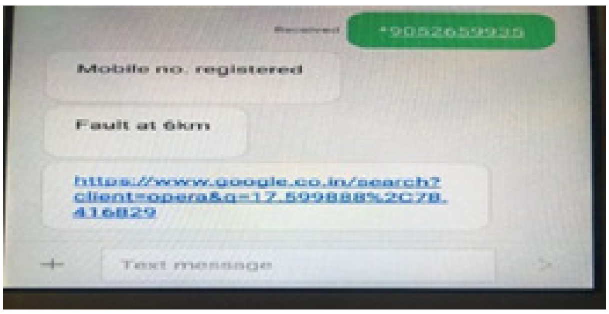

Figure 8 Output through SMS Reception

There will be two messages send to registered mobile number. They are a message showing the fault at a certain distance or a node and other message showing the link for GPS location where fault is occurred as follows.

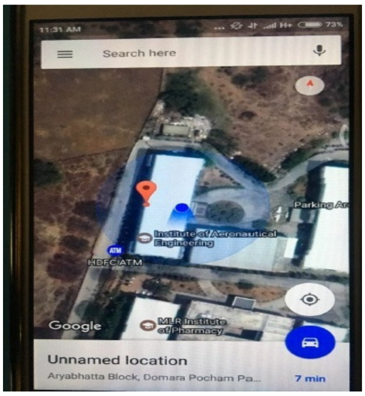

Figure 9 GPS Location

Hence the output i.e., underground cable fault is displayed by both global system mobile (GSM) and global positioning system (GPS).

10. CONCLUSION

The project “display of underground cable fault distance over internet (IoT) of things and GSM” is successfully tested and implemented which is the best economical, affordable energy solution to common people. This can be used for many applications in rural areas where power availability is less or totally absence. As India is a developing country where energy management is a big challenge for huge population. In this project we detect the exact location of short circuit fault in the underground cable from feeder end in km by using microcontroller8051.for this we Use simple concept of ohm’s law so fault can be easily detected and repaired

FUTURE SCOPE

In this project we detect only the location of short circuit fault in underground cable line, but we also detect the location of open circuit fault, to detect the open circuit fault capacitor is used in ac circuit which measure the change in impedance & calculate the distance of fault.

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