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UNDERGROUND CABLE FAULT DISTANCE LOCATOR

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ABSTRACT

In the downtowns, underground cables are used rather than of overhead transmission lines. It is hard to go through the specific spot of the shortcomings. As India become prominent as a progression country, civilized field is too boosting every day. The underground lines are beat under the same circumstances its uses additionally growing a result of its clear advantages such as lower line losses, lower maintenance cost and they are less powerless to the effects of serious climate. As it isn't clear it moves extreme to identify propel area of the shortcoming. In this proposed work we are trying to rectify this problem by proposing a method which is good enough to the digital world. The proposed system finds the exact location of the fault. This system uses an Arduino microcontroller kit and a rectified power supply. Here the current sensing circuits made with a combination of resistors are interfaced to Arduino micro controller kit to help of the internal ADC device for providing digital data to the microcontroller representing the cable length in kilometers. The fault creation is made by the set of switches. The relays are controlled by the relay driver. A 16x2 LCD display connected to the microcontroller to display the information. In case of short circuit, the voltage across series resistors changes accordingly, which is then fed to an ADC to develop precise digital data to a programmed Arduino micro controller kit that further displays exact fault location from base station in kilometers. Whenever a fault occurs in a cable the buzzer produces the alarm to alert and to take an immediate action by field workers.

Keywords :- *IOT, Arduino, Power Line.*

I. INTRODUCTION

Electricity becomes a basic need in our daily life. Mostly activities of our life style depend upon electricity. Electricity has been involved in our life style in such a way that it plays a very important role in every field. The transformer is decisive equipment in power system for transmission and distribution. In power system underground cables are used to transmit the electric power from generators. Stations to Distribution point then it is transferred to the consumer ends by overhead and underground cables. Underground cables have to suffer various problems due to aging and different types of faults. To overcome these problems in cables, lots of Research work has been done. Here we proposed a method to rectify these problems. There are so many online and offline methods available for detection of fault and life into underground cables. Murray loop, varley loop, ohm's law & Fourier transformation etc. methods are used for fault detection of earth or underground cables [2, 4].

Bundles of electrical conductors used to transmit power are called cables. Underground cables usually have one or more wires with suitable insulation and protective sheaths. Varnished

cambric or impregnated paper is often used for insulation. The disadvantage of overhead cables is that they are easily exposed to environments such as rain, snow, thunder, and lightning. This requires cables with reliability, higher safety, strength and better maintainability, which is why underground cables are favored in many areas, especially cities. Overhead line faults can be easily identified and corrected by simple observation, while underground cables are impossible, because they are deeply buried in the ground and it is not easy to find anomalies in them. Even if a fault is detected, it is difficult to determine the exact location of the fault, which results in the need to dig the entire area to find and repair the fault, resulting in loss of money and labor. Know the exact location of the fault in the underground cable. No matter what the fault is, the voltage on the cable will change drastically every time a fault occurs. We use this voltage change on the series resistance to detect faults.

• Murray loop method- This method, generally used for identifying the faults in earth cables. This test is based on the principle of Wheatstone bridge. By using this assessment, fault spot in an earth cable can be finding by arranging a Wheatstone bridge in it [8].

• Varley loop method.

• Ohm's Law.

• Fourier transformation. For power network stability it is obligatory to minimize the fault as fast as possible. For this precise (accurate) methods or procedures are needed with fast speed of operation, to identifying the fault, thereby power distribution might be removed in little period. The fault detection is very easy in overhead cables, while it is very complex in underground cables because for this numbers of techniques are limited.

Open circuit faults

These faults occur due to the failure of one or more conductors. The most common causes of these faults include joint failures of cables and overhead lines, and failure of one or more phase of circuit breaker and also due to melting of a fuse or conductor in one or more phases. Open circuit faults are also called as series faults. These are unsymmetrical or unbalanced type of faults except open circuit fault.

Short circuit faults

A short circuit can be defined as an abnormal connection of very low impedance between two points of different potential, whether made intentionally or accidentally. These are the most common and severe kind of faults, resulting in the flow of abnormal high currents through the equipment or transmission lines. If these faults are allowed to persist even for a short period, it leads to the extensive damage to the equipment. Short circuit faults are also called as shunt faults. These faults are caused due to the insulation failure between phase conductors or between earth and phase conductors or both. The various possible short circuit fault conditions include three phases to earth, phase to phase, single phase to earth, two phases to earth and phase to phase. In single line to ground fault, fault occurs between any one of the three lines and the ground. In double line to ground fault, fault occurs between any two of the three lines and the ground. In line-to-line fault, fault occurs between any two lines. When fault occurs, there is an abrupt change in voltage.

In this paper we have study few techniques to minimize the various problems related to the underground cables but these techniques are not very efficient to detect the problem [3]. The principle highlight of the electric transmission and dispersion frameworks is to stir electric vitality

from the age unit to the clients. For the most part, while flaw happens on transmission follows, identifying deficiency is significant for quality machine while in transit to clean blame before it will expand the harm to the power device in spite of the way that the underground link framework gives preferable dependability over the overhanging line gadget, it is miles tough to search out the issue territory. It has been discovered that the wavelet change is fit for researching the impermanent sign produced in quality framework. So, we have proposed a new technique to diminish the fault related harms in underground cables. And the accuracy of our proposed scheme is high as compare to the range of methodologies. In this paper we have used IOT based technique with Google database for the fault exposure by means of the help of Arduino Module. It is totally based on IOT. The accuracy and efficiency of our proposed scheme is more as evaluate to the other techniques.

II. RELATED WORK

There are lots of methodologies to identify shortcomings in power lines. In the current era faults are major problems in the power transmission lines. For better power quality and continuity of power it is necessary to reduce the faults from power lines as soon as possible. So many methods are proposed related to fault identification and reduction in power system. Some of them are explained here for example Murray loop method, Ohm's law method and many more \

Murray Loop Method

For Fault exposure Murray loop technique is used. This scheme is very straightforward. For observation or exposure of short circuit faults in underground line this method is used. These two loop tests (Murray & Varley Loop) are usually used for identifying the faults in earth cables. This trial is based on the law of Wheatstone bridge. By using this experiment, fault site in an earth cable may be finding by arranging a Wheatstone bridge in it. In this scheme we first need to connect a sound cable of same length as of defective cable. Sound cable means the cable without any error and we have to short circuit the ends of both the cables (sound cables & faulty cable) [5]. Now we connect a galvanometer in between beginning of both working cable & not working cable. Now we connect two registers crosswise the working cable & not working cables in such manner that these both the registers are variable. Now the entire loop will form as a Wheatstone bridge. Then we attach one battery via the ground. For balancing the bridge, we regulate the value of both the registers till the galvanometer shows the zero value. We shall carry out the shortcoming spot by comparing the resistances. We should have the values of both the resistances [1, 6].

Primary techniques: Feedback pulse method, travelling wave method, and impedance system. Junction of two diverse transmission mediums, approaching waves will deliver yield a reflected wave and come back to the first stipulation [9]. This rule has applied in the Time Domain Reflection procedure with the imminent medium being the conductor of a conductor and the approaching medium where the interference of the line at cut off, where the convergence of the two mediums is the function of event of short out.

Travelling wave method: The wave spread course of action [4, 5] measure the production time of the wave coming about because of the event of a happening on the transmission line. Voltage or flow of charge information can be utilized. This tactic requires very precise time organization when the occurrence area is resolved, When the episode wave on the power lines or on the other hand at abundant areas on the electrical framework. Working experience shows that,

this policy is exceptionally exact and the probability of issues is ceaselessly found. To decide the area of the issue, a heartbeat is useful to the transmission line. Contingent upon the greatness and the stage point, we can settle on the situation of the deficit. Reflector strategy to decide cut off in the control network is appeared in [1, 4]. The intelligent heartbeat comprises of two primary sorts, voltage and flow heartbeats. The qualities of those heartbeats are lofty recurrence and lofty plentifulness. In request to acquire the reflect heartbeat from the short out deficiency point, the estimating gear must have a decent class with an adequate inspecting time (barely any kHz) and a vast estimating plentifulness (a few kV).

Impedance system. The process of decisive the fault site is based on the estimate of the flow of charge and the voltage together with the data of the total resistance of the line for the period of the operation instantly before the short circuit occurred to calculate the fault site. The impedance system [6] really depends on the shortcoming resistance and inaccuracy in the case of too much fault resistance [10]. The technique of aggregation can be separated into two categories:

(i) based on a wiring and

(ii) Based on two terminals depends on the number of terminals at which the voltage and flow data are composed. This scheme frequently used with digital reserve relays is situated on the shield side of 110kV line.

Programs uploaded in Arduino UNO kit to detect faults from the underground cables. When a fault occurs in the underground cables, we can find out faults through Arduino controller kit. LCD display which displays the faults in Kilometer. In this project we created faults manually. Cable has many types. Every cable has different resistance which depends upon the material used. The value of the resistance is depending upon the length of the cable. In here resistance is the leading role of the project. If any deviation occurs in the resistance, the value of the voltage will be changed that particular point is called FAULT. We are finding out those faults.

TYPES OF FAULTS

Generally, there are different types of faults. Frequently occurring faults are given below

- Short Circuit Fault
- Open Circuit Fault
- Earth Fault Short Circuit Fault A short circuit fault occurs when there is an insulation failure between phase conductors or between phase conductor(s) and earth or both. An insulation failure results into formation of a short circuit path that triggers a short-circuit conditions in the circuit. Open Circuit Fault An open-circuit fault occurs if a circuit is interrupted by some failure. If the circuit is not closed that is called open circuit fault. Earth Fault An earth fault is an inadvertent contact between an energized conductor and earth or equipment frame. The return path of the fault current is through the grounding system and any personnel or equipment that becomes part of that system.

III. PROPOSED METHODOLOGY

Underground fault detection deals with finding the exact fault location from the base station. Cables have some resistance. We are mainly focusing that resistance. Resistance can vary with respect to the length of the cable. If the length of the cable increases, the value of the resistance will also increase. If any deviation occurs in the resistance value, we call that as fault point and

that point can be identified with the help of Arduino technology. That fault point represents the standard of distance (kilometer) from the base station and the value is displayed by the display unit.

BLOCK DIAGRAM DESCRIPTION:

We uploaded the program in the kit. Program was written and if any fault occurs in the cable, immediately it will open the relay terminal and disconnect that faulty line only. Rest of the other lines operates normally. Arduino is the advanced version of embedded system. These Arduino has ample types but we selected Arduino UNO. It easily adapts to other devices using serial port. Relay is nothing but an electrical device that acts as a switch; if any fault occurs in the line, it will disconnect the line using relay. The connector of the relay moves from normally closed conduct to normally open conduct. we can easily find the fault and disconnect the faulty line. Display unit is connected to the Arduino kit which is used to display where the fault occurs. Once faults occur in the cable, the display unit displays the exact fault location and also displays which phase is affected in the cable and how long it's affected and buzzer system is used to create an alerting signal. Buzzer systems create an alerting sound signal, once the fault occurs in the underground cable.

Block diagram:

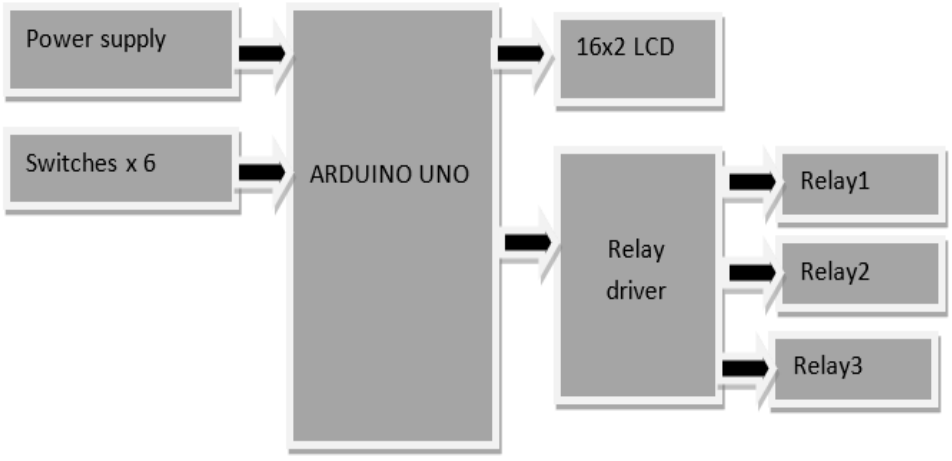

Fig1. Block Diagram of proposed cable fault detector system

HARDWARE DESCRIPTION

Aurdino UNO: The Arduino Uno is a microcontroller board based on the Microchip ATmega328P microcontroller. It consists of digital and analog pins that may be interfaced to various boards and circuits. The board has 14 digital and 6 analogy pins, and is programmable with Arduino IDE the Arduino board can be powered by the external 9 volts battery or by USB cable. The inputs to the Arduino are power supply, XOR. It collects the data from input and accordingly gives commands to Relay and LCD display.

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Fig 2. Aurdino Uno

Relay: A Relay is an electrically operated switching device as it works to isolate or change the state of electric circuit from one state to another. It consists of set of input terminals and operating contact terminals.

POWER SUPPLY UNIT

Power supply is a very important part of electronic circuit. This circuit requires fixed +5 V supply so to fix this voltage we need voltage regulator. In this work we used IC7805 as voltage regulator. A voltage regulator generates a fixed output voltage of a preset magnitude that remains constant regardless of changes to its input voltage or load conditions. There are two types of voltage regulators: linear and switching. Here we make use of a linear regulator employs an active pass device (series or shunt) controlled by a high gain differential amplifier. It compares the output voltage with a passive reference voltage with a precise reference voltage and adjusts the pass device to maintain a constant output voltage.

LCD DISPLAY

Liquid Crystal Display (LCD) is an Alphabetic Display it means that it can display Alphabets, Numbers as well as special symbols thus LCD is a user-friendly Display device which can be used for displaying various messages unlike seven segment display which can display only numbers and some of the alphabets. The only disadvantage of LCD over seven segment display is that seven segment is robust display and can be visualized from a longer distance as compared to LCD. Here we have used 16 x 2 alphanumeric displays.

BUZZER

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as mouse click or keystroke.

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Circuit diagram:

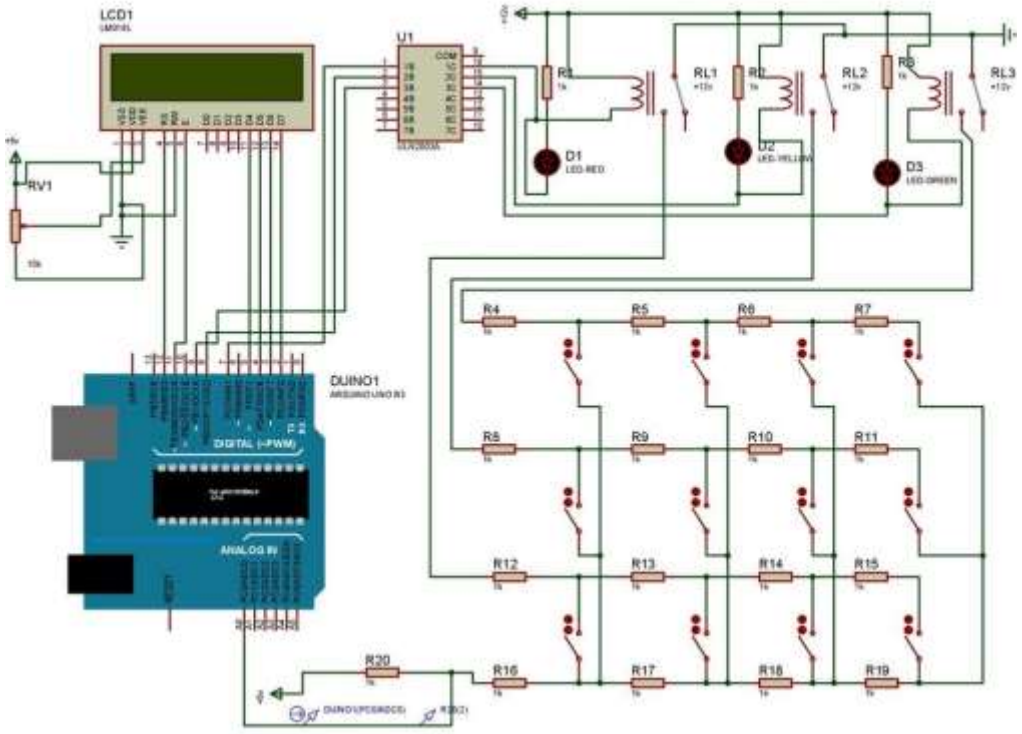

Fig 3. Simulation Diagram without Fault

SOFTWARE DESCRIPTION

PROTEUS SIMULATOR

Proteus is software for microprocessor simulation, schematic capture, etc. It is developed by Lab center Electronics. The following are the system components of proteus

- ISIS Schematic Capture – a tool for entering designs.
- PROSPICE Mixed mode SPICE simulation – industry standard SPICE3F5 simulator combined with a digital simulator.
- VSM – Virtual System Modelling lets co simulate embedded software for popular micro-controllers alongside hardware design.
- System Benefits Integrated package with common user interface and fully context sensitive help.

Proteus Virtual System Modelling combines mixed mode SPICE circuit Simulation, animated components and microprocessor models to facilitate co-simulation of complete microcontroller-based designs. This is very useful and user friendly to handle the components. A distinctive feature of the package Proteus Professional is the possibility of modelling of the programmable devices: Microcontrollers, Microprocessor, DSP and others. Additionally, the package of Proteus Professional is a system design of printed circuit boards.

ARDUINO SOFTWARE

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuine hardware to upload

programs and communicate with them. Programs written using Arduino Software (IDE) are called sketches. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom right-hand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

CALCULATION OF UNDERGROUND CABLE RESISTANCE:

The ac cable resistance can be calculated by using the constants, skin effect proximity effect Rac=Rdc(1+Ys +Yp) The dc cable resistance can be calculated by using the constants, resistivity temperature coefficient cross-sectional area Rdc=((1.02*10^6*ρ)(1+α(θ-20)))/s

SKIN EFFECT: The tendency of an ac current to become distributed within a conductor such that the current density is nearer the surface of the conductor and decreases with greater depth in the conductor.

PROXIMITY EFFECT: Proximity effect is the tendency for current to flow in other undesirable patterns-loops or concentrated distributions-due to the presence of magnetic fields generated by nearby conductors.

IV. RESULT AND DISCUSS ION

Underground cables offer an affordable and justifiable solution for critical parts and in some cases the entire length of overhead high voltage power lines. With appropriate technology used in appropriate places, the environmental impact of underground cables can be minimized.

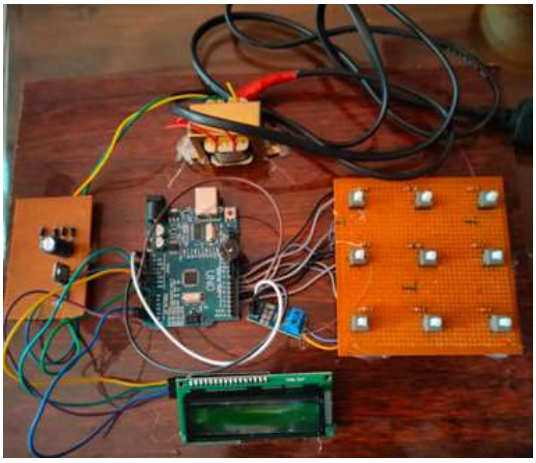

Fig 4. Cable fault kit

The above figure shows the whole architecture of the proposed Cable fault distance locator using Aurdino uno.

V. CONCLUSION

This project is intended to detect the exact location of circuit fault in the underground cables from the feeder end in km by using an Arduino microcontroller. The Arduino microcontroller works based on the output of the cable resistance. Relay helps to separate the faulty line from healthy line.

The project detects only the location of the circuit fault in underground cable line, but it can also be extended to detect the location of an open circuit fault. To detect an open circuit fault,

capacitor is used in ac circuits which measures the change in impedance and calculate the distance of the fault.

REFERENCES

[1]. Raghu Raja Kalia, Preeti Abrol, 'Design and implementation of wireless live wire fault detector and protection in remote areas', IEEE,(2014),vol. 97,No.17

[2]. B. Clegg, Underground Cable Fault Location. New York: McGraw- Hill, 1993.

[3]. M.-S. Choi, D.-S. Lee, and X. Yang, "A line to ground fault location algorithm for underground cable system," KIEE Trans. Power Eng., pp. 267–273, Jun. 2005.

[4]. E. C. Bascom, "Computerized underground cable faultlocation expertise, "in Proc. IEEE Power Eng. Soc. General Meeting, Apr. 10–15,1994, pp. 376–382.J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rded., vol. 2. Oxford: Clarendon, 1892, pp.68–73.

[5]. K.K. Kuan, Prof. K. Warwick, "Real-time expert system for fault location on high voltage underground distribution cables", IEEE PROCEEDINGS-C, Vol. 139, No. 3, MAY 1992.

[6]. Tarlochan S. Sidhu, Zhihan Xu, "Detection of Incipient Faults in Distribution Underground Cables", IEEE Transactions on Power Delivery, Vol. 25, NO. 3, JULY 2010.

[7]. J. Densley, "Ageing mechanisms and diagnostics for power cables—an overview," IEEE Electr. Insul. Mag., vol. 17, no. 1, pp. 14–22, Jan./Feb. 2001.

[8]. T. S. Sidhu and Z. Xu, "Detection of incipient faults in distribution underground cables", IEEE Trans. Power Del., vol. 25, no. 3, pp. 1363–1371, Jul. 2010.

[9] C. F. Jensen, "Fault in Transmission Cables and Current Fault Location Methods," Springer Theses Online Location of Faults on AC Cables in Underground Transmission Systems, pp. 7–18, 2014.

[10] T. S. Sidhu and Z. Xu, "Detection of Incipient Faults in Distribution Underground Cables," IEEE Transactions on Power Delivery, vol. 25, no. 3, pp. 1363–1371, 2010.

[11] L. H. Son, S. Jha, R. Kumar, J. M. Chatterjee, and M. Khari, "Collaborative handshaking approaches between internet of computing and internet of things towards a smart world: a review from 2009– 2017," Telecommunication Systems, vol. 70, no. 4, pp. 617–634, 2018.

[12] M. Khari, A. K. Garg, A. H. Gandomi, R. Gupta, R. Patan, and B. Balusamy, "Securing Data in Internet of Things (IoT) Using Cryptography and Steganography Techniques," IEEE Transactions on Systems, Man, and Cybernetics: Systems, vol. 50, no. 1, pp. 73–80, 2020