Underground Cable Fault Detection using GPS Technology

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***Abstract*: The main goal of this project is to use Arduino to detect errors and anomalies in underground cables. The main idea behind the work of this project is the law of resistance. On the branch side, when a DC voltage is applied, the current value changes according to the location of the cable fault. In the event of a short circuit (such as LG or LL failure), the change in the voltage value measured on the resistor will be fed to the Arduino's onboard ADC. This value is processed by the Arduino and calculates the error related to the distance of the base station. This value is sent to the LCD screen connected to the Arduino board and displays the exact location of the base station fault in kilometers for all three phases. The project consists of a set of resistors equal to the length of the cable. The emergency switch is placed every known kilometer to manually trigger the error. Finally, the distance to the damaged part can be determined.**

***Keywords*: Fault and Location Detection, Open Circuit, Short Circuit, Arduino, GPS**

Abbreviations:
RE_Status, YE_Status, BE_Status: Line to Earth Faults
RY_Status, YB_Status: Line to Line Faults
Dis: Fault Distance from the Base Station
1: Fault occurred
0: No Fault

1. Introduction

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. There may be defects or interruptions in the cables, which cause the current path to deviate or affect the performance of the cables. Therefore, faults must be eliminated. Electricity can be transmitted through overhead cables and underground cables. 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.

2. Faults in Underground Cables

Open Circuit Faults

These faults arise because of the failure of one or more conductors. The maximum common reasons of those faults consist of joint failures of cables and overhead lines, and failure of 1 or greater section of circuit breaker and additionally because of melting of a fuse or conductor in a single or extra phases . Open circuit faults also are referred to as as series faults. These are unsymmetrical or unbalanced form of faults besides 3 phase open fault.

Short Circuit Faults

A short circuit can be defined as an abnormal connection between two points of different potentials that has a very low impedance, intentionally or unintentionally. These are the most common and severe types of failures that cause high abnormal currents to flow through equipment or transmission lines. If these errors persist, even for a short period of time, they can cause serious damage to the equipment. Also called shunt faults. These faults are caused by insulation faults between the conductive phases or between the grounding conductor and the phase conductors or between the two. Various possible short circuit conditions include three-phase ground, conductor-to-conductor, single-phase ground, two-phase ground, and conductor-to-conductor. A single wire to ground short circuit will cause a short circuit between one of the three wires and ground. In the case of a double ground fault, a fault occurs between two of the three lines and the ground. In the case of a conductor-conductor short circuit, a fault occurs between one line and two lines. In the event of a fault, the voltage will change sharply .If not corrected in time, this voltage change will cause serious damage to the system. The straightforward step in troubleshooting is to isolate the faulty part from the rest of the system.

3. Literature Review

Abhishek Pandey, Nicolas H. Younan presented a paper on underground cable fault detection and identification in which fourier analysis was used. The techniques of impedance calculation through sending end voltage and differential voltage can be used for differentiating among the distinct forms of cable defects from phase information. It needs study to be carried out to locate the best way of visualizing the results, mainly the magnitude response.[1]

A. Ngaopitakul, C. Pothisarn, and M. Leelajindakrairerk introduced the simultaneous fault behavior in underground distribution cables using DWT. They used ATP / EMTP for simulation, and used DWT to analyze characteristic signals. Various case research were carried out which includes the single fault and simultaneous fault.[6]

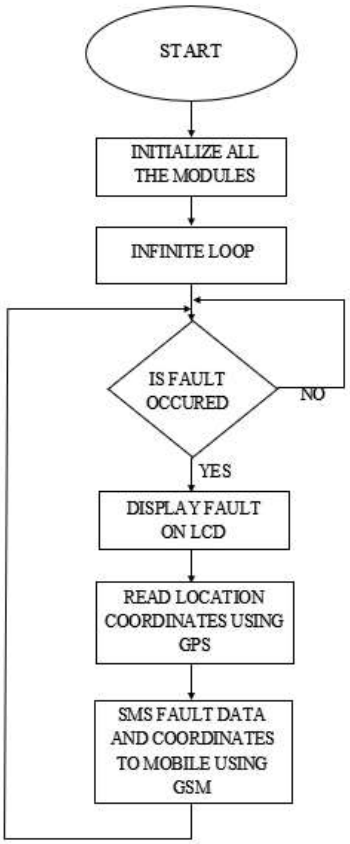
S. Navanitan, J. J. Soragan, W. H. Sue, F. Macpherson, P. F. Gale proposed an automatic fault location method based on TDR, which uses data from existing TDR instruments.[2]

H. Shateri, S. Jamali et al. presented an impedance-based fault location method for phase-to-phase and three-phase faults. In this way, the impedance measured by the distance relay and the superimposed current factor are used to locate the fault location. It is very sensitive to the accuracy of the measured impedance and the superimposed current factor.[4]

Furthermore, previously only single fault was determined. Now after using more advanced prototype we are enabled to find two faults namely L-L and L-G faults. With the use of Arduino which is cheaper than its counterpart helps in making the project more cost efficient.

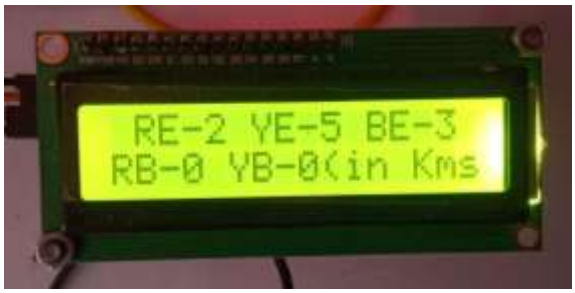
4. Working

This project is based on the simple concept of Ohm's law, in which a low DC voltage is applied to the feeder end of the circuit through series resistor. The current would change depending upon the distance of the fault (in kilometer) from the base station, in case there is a Line-Line fault or Single Line-Ground fault. The voltage drop across the series resistor changes according to the detected fault which is fed to the ADC to convert it into digital data which will be sent to the Arduino and then the distance of the fault from base station (in kilometer) will be displayed on the LCD. In this project, the cable length (in kilometer) is represented by set of resistors and fault is generated by a set of switches at every known distance to check its accuracy. This project is divided into 4 parts – DC Power Supply, Cable, Controlling, and Display Part. A constant DC Supply of 12 V is provided to the system. The cable is represented by the set of resistors and faults will be generated using the switches. The change in current due to change in potential drop will be sensed in this part. Arduino and the ADC (Analog to Digital converter) comprise the controlling part. The input of ADC will be from the current sensing element. ADC will convert this voltage into digital data and will be fed to Arduino. All the necessary calculations regarding distance of fault from base station will be done by Arduino. Arduino also controls the switching of relays for interconnection of cables at each phase. In case a fault occurs, LCD will display what type of fault has occurred, what is the distance of fault location from the base station and an SMS will be sent to the user showing above mentioned information along with the latitude and longitude of the fault location using GPS and GSM.



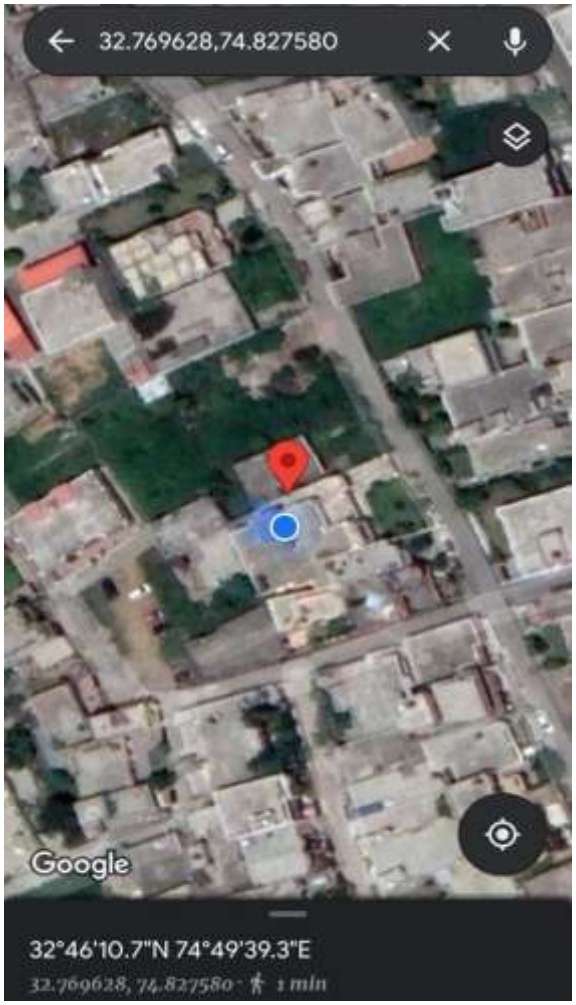
5. Result

As stated, the fault that is detected is displayed on the LCD. The GSM sends the fault report via SMS to the registered mobile number. The fault report contains the distance (Dis) of fault from the sub-station along with co-ordinates of the occurrence of fault (which is calculated by the GSM modem). If we search about the co-ordinates in the google maps, the application not only provides the exact location but also provide with the necessary route to the place of fault thereby the engineers can quickly repair it.



Result 1

Result 1 is taken at Roop Nagar, Jammu, Jammu and Kashmir. The result consists of an SMS, image of Google maps and LCD. The SMS shows that three Line-Earth Faults has occurred in the cable. One fault has occurred in the R phase at a distance of 2 Km from the base station, the second fault has occurred in the Y phase at a distance of 5 Km from base station and the third fault has occurred in the B phase at a distance of 3 Km from the base station. It also shows the latitude and longitude of the location of the fault. These latitude and longitude are entered into the Google maps and the live location is found. The LCD also displays that three Line-Earth faults have occurred at a distance of 2 Km in R phase and 5 Km in Y phase and 3 Km in B phase.



Result 2

Result 2 is taken at Durga Nagar, Jammu, Jammu and Kashmir. The result consists of an SMS, image of Google maps and LCD. The SMS shows that two Line-Line Faults has occurred in the cable. One fault has occurred between R phase and Y phase and the second fault have occurred between Y phase and B phase. The distance of the both the faults from the base station is 2 Km. It also shows the latitude and longitude of the location of the fault. These latitude and longitude are entered into the Google maps and the live location is found. The LCD also displays that two Line-Line faults have occurred at 2 Km distance each.

6. Conclusion

In this paper we discuss maximum of the content material of our project. In this paper, we located the precise area of short circuit fault within the underground cable from feeder result in kilometers using Arduino microcontroller. For this, we used easy idea of Ohm's law to calculate the fault location. This circuit is fabricated to discover open circuit fault, short circuit fault and earth fault. Once faults arise within the cable, the display unit shows the precise fault area that displays which section is affected within the cable and how long it is affected.

7. Future Scope

In this paper we come across the precise area of short circuit fault within the underground cable from feeder result in kilometers using Arduino. In future, this project may be applied to calculate the impedance through the use of a capacitor in an AC circuit and therefore measure the open circuit fault.

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