International Journal of Research in Engineering, Science and Management
Volume 5, Issue 5, May 2022
https://www.ijresm.com | ISSN (Online): 2581-5792

Determination of Fault in Underground Cable by Using Murray Loop Method and GSM Module

Sandeep Maurya[1*], Omveer Singh[2]
[1,2]Department of Electrical Engineering, Gautam Buddha University, Greater Noida, India

***Abstract*: The methodology of planning a cable fault location sensor for underground cable fault detection is introduced in this review. The objective was to utilize an Arduino-based kit to recognize a shortcoming area from a sending or getting station with a couple of meters of accuracy. In metropolitan settings, the utilization of an underground cable-based supply infrastructure is typical. As indicated by the review, the framework utilizes the Murray circle standard to appraise the specific distance of the shortcoming in the underground wire to inside a meter's accuracy. At the point when a fault grows, for example, short circuit or an earth fault, the length of the fault of the link can be resolved utilizing the Murray loop's bridge. The significant calculations are performed by a microchip, which then, at that point, shows the issue distance. After the proper calibration and testing, the methodology accomplishes an accuracy of generally 85% in finding the defect.**

***Keywords*: Arduino, ADC, Murray loop, Underground cable fault.**

1. Introduction

Power dispersion networks are constantly evolving, and their integrity is becoming more important than ever before. The organization's complexity includes a number of components that could fail and disrupt electricity delivery to end users. Underground links have long been needed in many parts of the world due to abrupt spikes in demand for low and medium voltage circulation networks. Underground high voltage lines are being used in greater numbers because they are not affected by environmental factors such as heavy rain, hurricanes, snow, or pollution. Underground connections are now widely used in several metropolitan areas. In any instance, when a link flaw occurs, pinpointing the precise location of the flaw is extremely difficult due to the fact that the specific area of the connection issue is not widely known. As a result, this model is utilized to observe the shortfall zone for all intents and purposes. The requirement for locating the dangerous point in an underground link in order to facilitate repair, improve gadget consistency, and shorten the blackout period.

We frequently encounter short circuits, open circuits, and earth faults in underground cables, and identifying an issue without knowing the particular position associated with that link is quite difficult.

A. Short Circuit Fault

A short out occurs when two conductors in a link with protective disappointment come into touch. The conductors of the link come into contact with the ground in this deficient condition, preventing current from flowing through the heap.

B. Open Circuit Fault

When a conductor breaks, an open circuit situation occurs. When this happens, the current stops flowing through the conductor.

C. Earth Faults

An earth issue develops when the link protection is demolished by excessive pulling, pulling, or in any case, being twisted in ways it shouldn't be. Every conductor in the link links to the ground under this problem scenario, preventing current from flowing through the heap.

2. Murray Loop Test

Murray loop tests, Varley circle tests, and Pulse Echo tests are three simple strategies for finding cable shortcomings. This system utilized reasonable, essential hardware. These tests are utilized to pinpoint the area of an earth fault or a short circuit in an underground wire. But when the fault resistance is very high, the outcomes acquired in these investigations are unaffected by fault resistance. Murray Loop and Varley Loop Test are the two most generally used loop tests. These tests exhibit the bridge principle.

This test is utilized to find a fault in an underground cable by developing a Wheatstone bridge in it and estimating the resistance from find the fault. Nonetheless, in this investigation, we ought to utilize the wires' known length. Figures 1 and 2 portray the Murray circle test's expected association. The circuit associations for observing the issue area when a ground fault happens are displayed in Figure 1, and the circuit associations for observing the issue area when a short out fault happens are displayed in figure 2.

The damaged cable is connected to the sound cable utilizing a low resistance wire in this test since that resistance shouldn't influence the cable's all out resistance and it ought to have the option to flow the loop current to the bridge circuits without loss.

The ratio arms are shaped by the variable resistors R1 and

*Corresponding author: sandeep8maurya@gmail.com

R2. The variable resistors are acclimated to guarantee bridge balance. The galvanometer "G" is utilized to show the equilibrium. The complete loop resistance made by the sound cable and the damaged link is [R3 + RX].

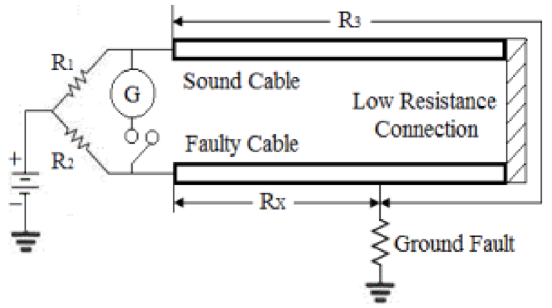

Fig. 1. Circuit connection of Murray Loop test for ground fault

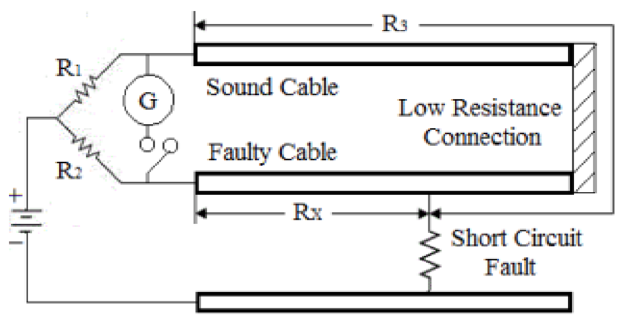

Fig. 2. Circuit connection of Murray Loop test for short circuit fault

When everything is all together,

$$\frac{R1}{R2} = \frac{R3}{RX} \Rightarrow \frac{R1 + R2}{R2} = \frac{R3 + RX}{RX}$$

$$\Rightarrow RX = \frac{R2}{R1+R2}(R3 + RX)$$

Whenever the cross-section area of both the sound cable and the defective cable is equivalent, the conductors' resistances are proportionate to their lengths. Along these lines, assuming that LX is the distance between the test ends and the faulty cable's fault end, and L is the total length of the two cables, the expression for LX is as per the following:

$$\Rightarrow LX = \frac{R2}{R1 + R2} L$$

The above test is only valid if the cable lengths are known. The fault resistance in the Murray Loop Test is fixed and can't be changed. Adjusting the bridge is likewise difficult. Thus, the fault position can't not entirely set in accurately. Because of high voltage or high current, the ongoing dissemination by means of the cable would deliver temperature rises. The balance collapses in the event that the resistance varies as indicated by temperature. Accordingly, we'll have to bring down the voltage or current in this circuit.

3. System Design

The accompanying parts are remembered for this framework plan:

- Arduino
- LCD display
- Relay
- GSM module

1) Arduino

Arduino is an open-source equipment board with a variety of open-source libraries that can be used to link its on-board microcontroller to a variety of devices and peripherals such as LEDs, automobiles, LCDs, keypads, Bluetooth modules, GSM modules, and a variety of other things. Arduino is essentially a microcontroller, but it also includes external connectors for connecting to other devices, as well as an inbuilt programmer that can be used to programme Arduino using the Arduino IDE programming on a PC.

2) LCD display

LCD is becoming increasingly popular as a replacement for LEDs because to the following reasons: numbers, characters, and pictures can all be displayed. This is in contrast to LEDs, which are limited to numbers and a few characters. Taking everything into account, the CPU should re-energize the LED so that it can continue to display the data.

3) Relay

Electromechanical or electronic switches, relay drive transfers open and shut circuits. When a hand-off contact is frequently open (NO), an open contact (OC) exists when the handoff is not initiated. Transfers supervise one electrical circuit by using contacts from another circuit to open and close.

4) GSM module

A GSM modem, often known as a GSM module, is a physical device that connects to a remote location via the GSM portable cell phone era. A modified Global System for Mobile Communiqué (GSM) module is used to gauge remote radiation via the Short Messaging Service (SMS). This module might collect sequential data from radiation detection devices such as an overview metre or an area detector and deliver it to a number server as an SMS message.

4. Methodology and Implementation

Bridge approaches for finding faults in underground cables utilize an altered Wheatstone circuit, in which direct current is utilized to measure resistance and the distance of the issue is determined as a level of the whole line length. Murray and Glaser bridges compute the distance to the fault utilizing comparative ideas.

A Murray bridge loop for finding cable deficiencies. Notwithstanding the risky wire, one solid conductor should be associated with the estimation circuit's termination. The resistance of the outer loop wires in the circuit, which interface the protections at the front and the conveyors at the link end, ought to be close to nothing. The guide resistances per unit length of cable can be utilized to work out issue lengths from resistor values.

The recommended approach finds the fault in its accurate position. The model is worked with a progression of resistors that show link length in kilometers, and faults are made by a bunch of changes at each known distance to guarantee rightness. The Murray loop bridge is first brought into a reasonable state. To get the bridge to a balanced state, the variable resistor is utilized to change the opposition. The relays are wired across the variable resistor's terminals. At the point when the bridge is adjusted, the relays will be actuated (tripped) by a signal gave from the microcontroller. The relay module circuit is associated with the microcontroller. The microcontroller's analogue pins are associated with the information pins of the hand-off module, which contains the transfer to be incited. The Arduino board gives power to the relay module's Vcc pin. Subsequently, the relay contacts are associated, as represented in the circuit outline in figure 3. The required activity performs sufficiently in light of the fact that these contacts enact as indicated by the directions took care of by the Arduino microcontroller.

The microcontroller will then be given the fair obstruction esteem. The adjustment of obstruction will then, at that point, be quickly moved to the link's inadequate distance. The application was made to robotize the framework. Similar information is moved by GSM to the capable power's telephone, which is associated with the Arduino. Figure 3 given below shows the methodology in block diagram.

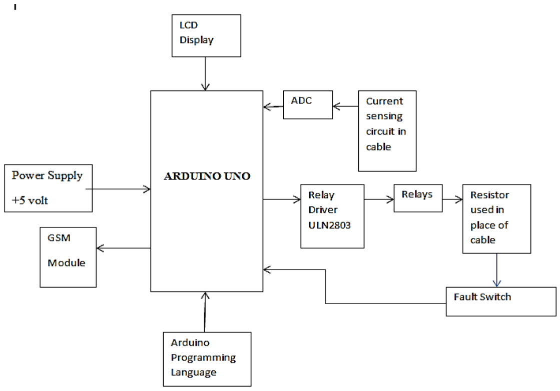

Fig. 3. Block diagram of underground cable fault distance locator system

The algorithm for the program is as the following:

- Step 1: Start.
- Step 2: Set the flag variables, as well as the pin modes and variables (pot resistance).
- Step 3: The ADC reads the voltage analogue.
- Step 4: Check the voltage level.
- Step 5: Set pins A1, A2, A3 high and low to pin A4 when voltage is zero, and read analogue voltage across the resistance (pin A4).
- Step 6: Converting voltage to the resistance value.
- Step 7: Print the resistance value and the k value for the balanced bridge constant.
- Step 8: If the voltage is greater than 0, make A1, A2, and A3 low and A4 high.
- Step 9: Halt.

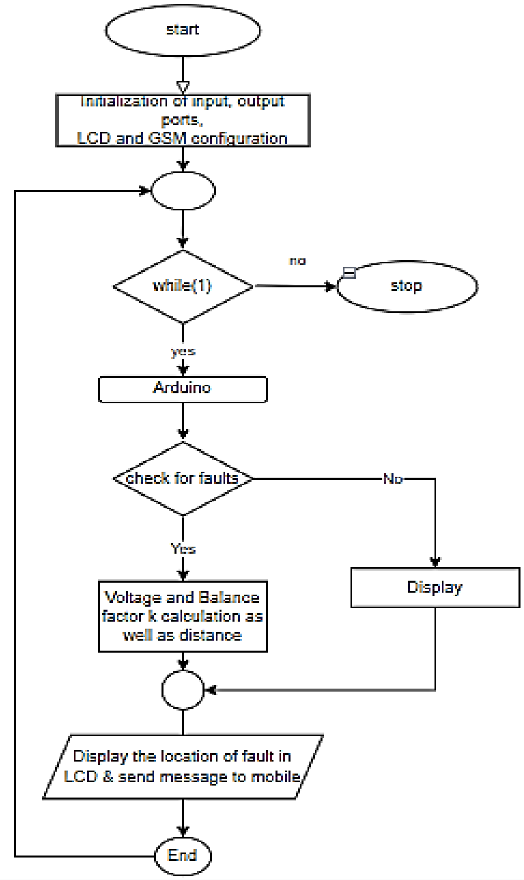

Fig. 4. Flow chart

5. Simulation Results

Proteus 8.5 expert programming is utilized to reenact the issue location gear, and the issue measurements are introduced on the LCD.

Below figure 5 shows screenshot of Designed system,

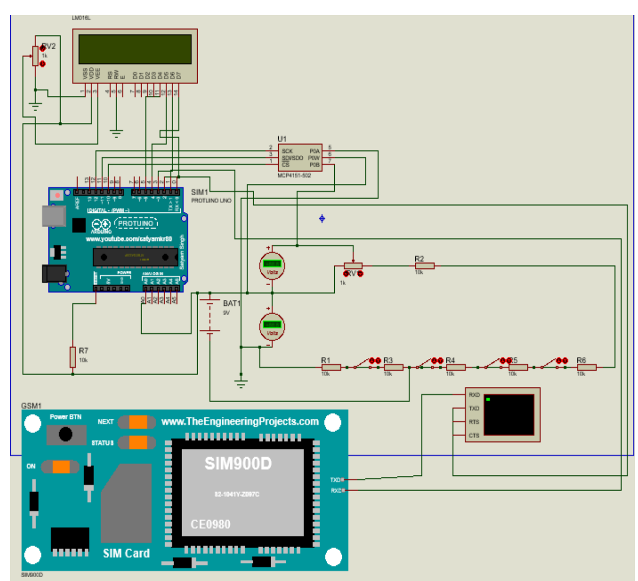

Fig. 5. Designed system

And below table shows comparison between actual and calculated distance of fault in Murray loop test method.

Table 1
Comparison between actual and calculated distance of fault in Murray loop test method

S.No.	Actual Distance to fault in (Km)	Calculated Distance to fault in (Km)
1	1.0	1.05
2	2.0	2.14
3	3.0	3.23
4	4.0	4.12
5	5.0	5.34

6. Conclusion

The objective of this project was to utilize an Arduino microcontroller to explore the most common way of recognizing the specific area of a circuit fault in underground cables from the feeder end in a couple of meters.

The Arduino microcontroller is utilized to identify changes in the bridge circuit's output voltage. The bridge is adjusted at an unexpected obstruction in comparison to the typical circumstance when a link imperfection happens. The voltage across the microcontroller's simple information ports is then created utilizing that resistance, and the problem area is determined utilizing a calculation. The Murray loop test project hopes to find the defect by estimating resistance, which may then be converted into distance utilizing a calculation. The issue distance from the source end is then shown in the LCD show utilizing the microcontroller. The distance of an underground cable fault from the base station is determined in kilometers and conveyed by SMS to a remote telephone utilizing the GSM module.

References

[1] Butler-Purry, Karen L., et al. "Experimental investigation of short circuit faults leading to incipient behavior and failure of a distribution system." IEEE PES Power Systems Conference and Exposition, 2004. IEEE, 2004.
[2] AbdulKareem A, Awosope CO, Awelewa AA. The use of three-phase fault analysis for rating circuit breakers on Nigeria 330 kV transmission lines. Journal of Engineering and Applied Sciences. 2015; 11(12):2612-22.
[3] Ayokunle AA, Peter OM, Isaac AS. Artificial neural networks for intelligent fault location on the 33-KV Nigeria transmission line. Artificial Neural Networks for Intelligent. 2017; 54(3):147-55.
[4] Samuel, I.A., Olajube, A., Awelewa, A.A. and Utibe, B., 2019. Arduino Microcontroller Based Underground Cable Fault Distance Locator. International Journal of Mechanical Engineering and Technology, 11(4).
[5] Pooja, P. S. M. Lekshmi, "Fault Detection and Technique to Pinpoint Incipient Fault for Underground Cables," International Journal of Engineering Research and General Science paper, 4.5, 2014.
[6] Dhekale PM, Bhise SS, Deokate NR, Suryawanshi RR. Underground Cable Fault Distance Locator using Arduino and GSM Module. Novateur Publications, International Journal of Innovation and Research in Engineering and Technology, 2015 Mar; 2(4).
[7] Samuel, I. A., Ayobami Olajube, A. A. Awelewa, and Bassey Utibe. "Smart Arduino Microcontroller Based Underground Cable Fault Distance Locator," International Journal of Mechanical Engineering and Technology, vol. 10, no. 3, 2019.
[8] Abdul Kareem A, Awosope CO, Awelewa AA. The use of three-phase fault analysis for rating circuit breakers on Nigeria 330 kV transmission lines. Journal of Engineering and Applied Sciences. 2016; 11(12):2612-22.
[9] Pandey A, Younan NH. Underground cable fault detection and identification via fourier analysis. In 2010 International Conference on High Voltage Engineering and Application, 2010 Oct. 11, pp. 618-621.
[10] Shirkoohi G., & Hasan, K. (2010, November). Enhanced TDR technique for fault detection in electrical wires and cables. In 2nd Int. Symposium on NDT in Aerospace, pp. 1-6, London South University.