Smart UG Cable Fault Detector Using Remote Locator

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Abstract: Nowadays underground cables are used for overhead lines in urban areas. Locating the fault in the underground (UG) cable is tedious and there is a probability of damaging the insulation while digging the cable. The proposed system shows easy and smart fault detection by automating it using an ARDUINO controller. The basic concept of Ohm's law is applied at the feeder end through a series resistor. In the case of a short circuit of LL or LLG or LG, the current flowing in the faulty sections will vary depending on the length of the line. This paper aims at estimating the location of fault distance and intimating the personal through SMS (short message service). The data are sent to a dedicated website together with an onboard LCD by using a GSM module and Internet of Things (IoT).

Keywords: Electrical cable, Resistance, GSM, Wi-Fi modem, IoT (Internet of Things).

I. INTRODUCTION

One of the prime objectives of the 12th five-year plan (2012- In Urban areas due to the unavailability of land and space underground transmission is preferred than the overhead transmission system. The advantages of UG cable are 1. Copper loss is less than 2. Increased Space utilization 3.Low voltage Drop 4. Less maintenance costs 5. It is free from pollution, significant precipitation, snow, and storm, etc. However, during the fault location of the cable, it's hard to trace out the precise location of the fault. Nowadays people are used to gadgets and other digitalization. Hence, a digital method is used to trace out the precise location of the fault. The data is interconnected with a website and onboard LCD, GSM module and Internet of Things (IoT). The main reasons for cable fault are i) inconsistency ii) Damage iii) insulation failure and breaking of the conductor. Usually occurring faults are Short Circuit Fault, Open Circuit Fault, Earth Fault

As if the fault occurs, the repair associated with that exact cable fault is incredibly tough. To overcome this drawback, the smart underground cable fault detector is used. To trace out the faults in the buried cable, location and direction of flow are required. Meanwhile, it's very hard to search out a cable fault without knowing where the cable is. Before locating the fault, to begin with, the direction in which the cable is laid from the feeder end should be known. The realization of fault pursuit associated with locating the underground cable especially depends on the ability, statistics, and knowledge of that person. Described a method to trace out the cable fault distance from the base station using the Arduino board. The classic concept of the Ohms law was employed.It presented a system which includes current sensors, microcontroller, and Wi-Fi modem. This acts as a path to real serially communicate the real-time data towards the server.

Finally, it's interconnected with the assistance of the Internet of Things (IoT). From the server, these real-time data are often retrieved from laptops or smartphones. it's explained in [3], an algorithm to forecast the cable fault location between two adjacent manholes. On account of incipient faults, this algorithm works in a time-domain, which uses the info collected from power quality monitors. The fault location is estimated in terms of line impedance considering the arc voltage related to the faults. In proposing a system during which the fault creation is formed by a group of switches at every known distance in km. The fault distance is displayed in LCD interfaced with the microcontroller. The behavior of simultaneous fault signals in the distribution side UG cable using Discrete Wavelet Transform is proposed in.

The proposed system relies on finding the precise distance of UG cable fault from the bottom station (km). This project uses the Ohms Law. a coffee voltage DC is applied to the feeder end through cable lines. The voltage varies supported the situation of fault occurred within the cable. The variation of voltage depends on the resistance value of that cable. The signal is fed to the Arduino Microcontroller that is pre-programmed and also the fault distance is sent to the individual through SMS. Also, the info is shipped to a dedicated internet site by employing a GSM module, IoT.

II. EXISTING METHOD

Here some of the methods adopted earlier for cable fault detection are explained.

A. Online Method:

In this technique, the sampled current and voltages are utilized to figure out the faulty points.

B. Offline Method:

Here a special instrument is used to figure out the service of cable among the sphere. Offline techniques are:

1. Tracer technique
2. Terminal technique.

C.Tracer Method:

The fault of the cable is detected by walking on the cable in this technique. Magnetism or perceptible signal is applied to the cable to identify the fault. This system helps in the location of fault accurately.

D. Terminal Method:

This system is utilized to chase general areas of the fault on buried cable. The above methods give a solution for dealing with the problems only to alert the personnel.

Thanks to IoT for mitigating the problem. Through this, everything becomes interconnected and smart

From the previous researches, we will conclude that when we are talking about underground fault it becomes a hard job. Hence, within the proposed system fault switches are employed in conjunction with the underground cable. The sensed fault location is serially communicated towards the server with the assistance of the GSM module from where information is often retrieved through IoT.

III. PROPOSED SYSTEM

The fig. 1, fig. 2 shows the working of the proposed system. In the proposed system fault switches are connected along with the underground cable. Whenever we press the switch, the fault is created, and the Arduino which is already pre-programmed senses the voltage changes and the fault distance is calculated. Arduino coding is done by using embedded C language and Arduino software. The LCD which is interfaced with the Arduino displays the fault occurring region and the fault distance is sent to the respective person through mobile. Also, these data are sent to a dedicated website by using a GSM module and IoT. A webpage is created by using Freeboard.io open-source software. The fault is indicated to the person by an alarming signal using a buzzer system.

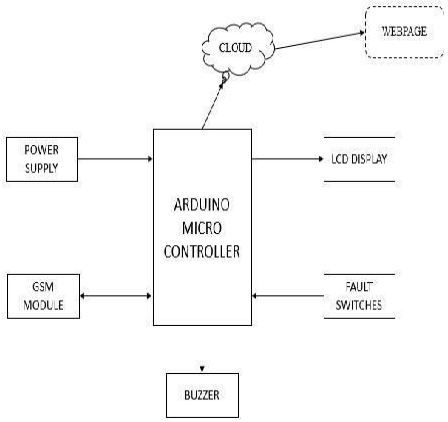

Fig-1. Block Diagram

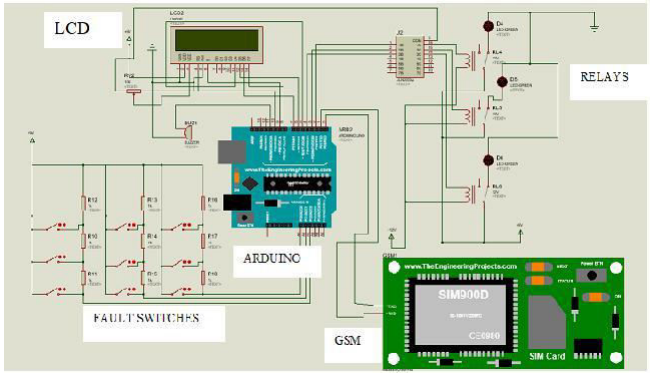

Fig-2. Circuit Diagram of Proposed Method

IV. ALGORITHM

The step by step procedure of Smart UG cable fault detector is shown in Fig 3.3. The input and output ports are initialized in the Arduino microcontroller and GSM is Configured. The algorithm will check the faults in an underground cable. If any fault encountered the controller will send intimation.

The results are viewed during an LCD. The fault distance is shipped to the respective person through mobile. Also, the fault distance is going to be displayed within the website

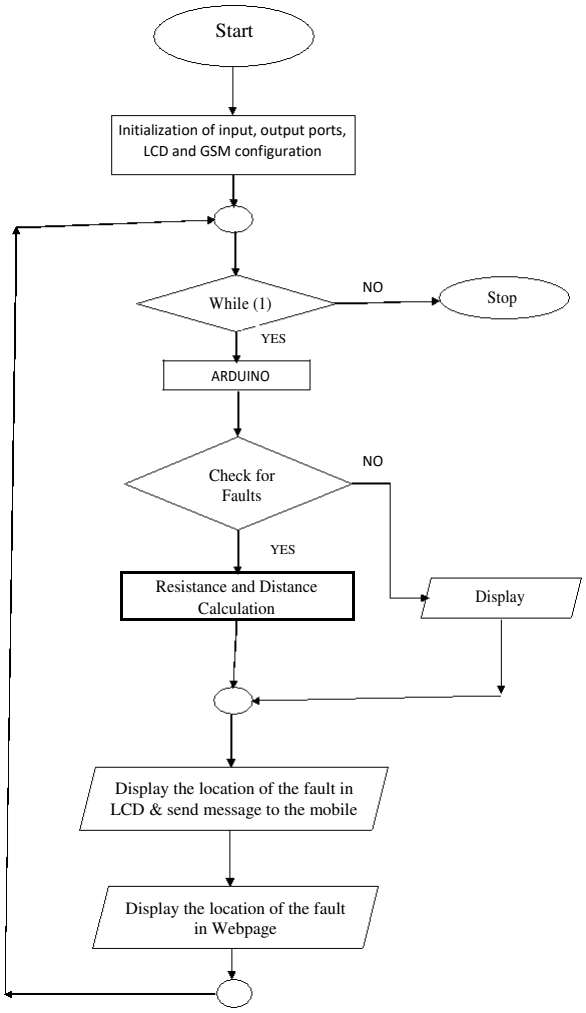

Fig-3. Work Flow Chart

CALCULATION OF UG CABLE RESISTANCE:

The ac cable resistance can be calculated by using the following equation 1.

$$Rac=Rdc\ (1+Ys+Yp) \rightarrow \text{eqn.1}$$

The dc cable resistance can be calculated by using the following equation 2.

$$Rdc =((1.02 * 106 * \rho(1 + \alpha(\theta - 20))))/ \rightarrow \text{eqn.2}$$

V. SIMULATION DIAGRAM

The proposed technique of a Smart UG cable fault detector is connected by using PROTEUS version 8 software. The Arduino tool is employed for coding the simulation. Fig 4 shows a simulation diagram for 3 phase Underground cable. The Simulations results are justified with the hardware results which are described in the following sections. Fig 5 shows the Hardware section of the Smart UG cable Fault Detector.

The rating of the transformer used is 230/12V. A voltage regulator converts the 12V supply to 5V to supply the Arduino and fault switches. The 12V is given to the relay coil. The SIM-900 GSM Module is used to give network to the Arduino and also for sending the SMS. Another transformer is used for supplying 9V to the GSM module. With these components, the hardware of the Smart UG cable Fault Detector is implemented and the obtained results are compared with the simulation results which are discussed as follows.

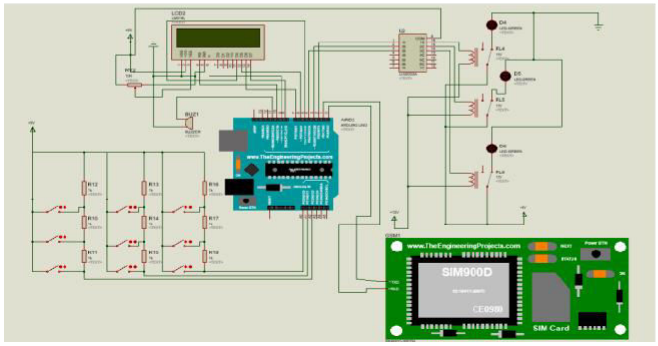

Fig-4. Simulation Diagram

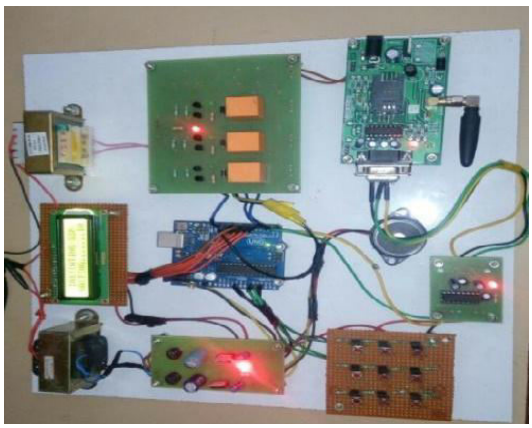

Fig- 5. Prototype Model

VI. CASE STUDY

CASE I: OPERATION UNDER IDEAL CONDITION

Fig 6. (a)It shows the simulation output of Single phase underground cable under ideal condition. It is often seen from the Fig 4.3 a) that the LCD is displaying No-FaultNo-Fault within the Cable.

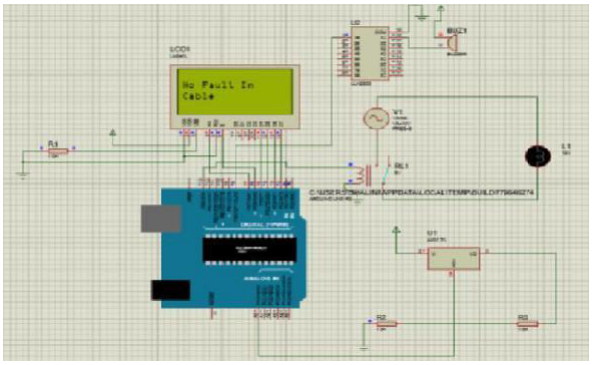

Fig-6(A) Simulation Results For Single Phase Underground Cable Without Fault.

Fig-6(B) Hardware Results For Single Phase Underground. Cable Without Fault

CASE II: OPERATION UNDER FAULT CONDITION

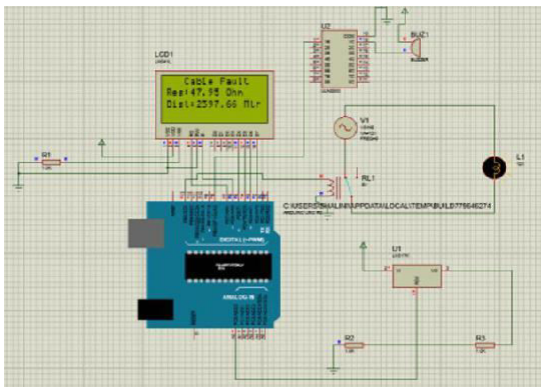

Fig 6.(C). Simulation Results Of Single Phase Underground Cable Under Fault.

It can be seen from the Fig 6. (b) The LCDs INITIATING GSM WAITING under ideal condition. Since no faults are initiated. Fig 6. (c) It shows the simulation output for Single phase underground cable with fault. The controller senses the change in resistance and changes the ADC value.

The ADC output is measured as a distance in the meter as shown. Then, the relay is opened and the buzzer gives an alarm.

In the hardware setup, for fault identification at every 1 Km length of the cable 1 KΩ resistor is used. Table I shows the values of voltage, distance, resistance and ADC output of the controller under different fault conditions. For instance, if we look from the leftmost switch, the third switch is pressed, it will create short circuit fault and exclude the 3KΩ resistances from the circuit so the fault distance is 3km from the feeder end as shown in Fig 6. (d).

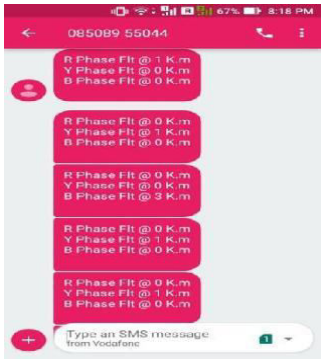

Fig 6.(D). Hardware Results Of Three Phase

Underground Cable Under Fault.

S. No.	Switch closed	Voltage across series resistor (V)	Distance at which Fault occurred (Km)	Resistance of the cable (KΩ)	ADC Output
1	SW1	3.30	1 Km of first cable	3	180
2	SW5	4.00	2 Km of second cable	2	204
3	SW9	4.40	3 Km of third cable	1	230

Table 1.Table of Results

Fig 6. (e) The proposed system shows the precise location of fault distance in Km and shipped to the individual through SMS via GSM module.

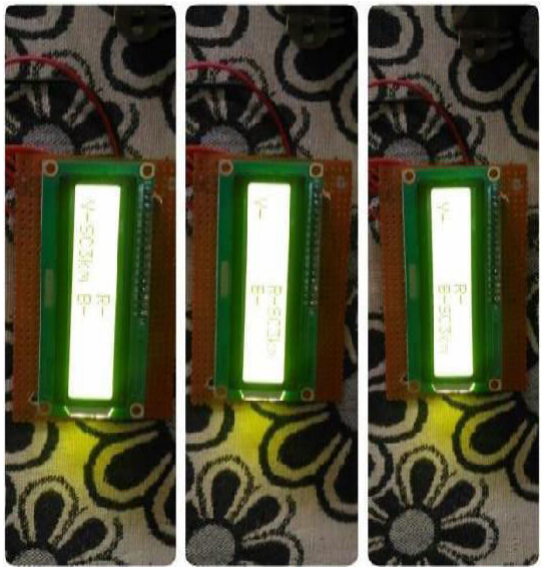

Fig 6.(e). Message Notification.

The same information with cable resistance is additionally sent to a fanatical website and therefore the respective person can retrieve the info from the server at any time. The output when the second switch is pressed is shown in Fig 6. (f).

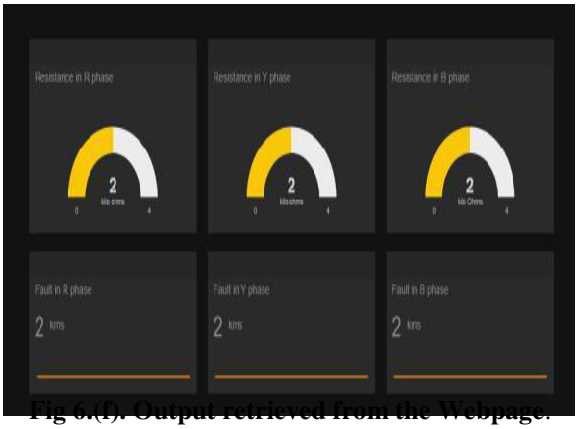

Fig 6.(f). Output retrieved from the Webpage.

VII. CONCLUSION

Detecting the exact location of the fault in underground cables is a big task. The exact location of the open circuit fault and short circuit faults are identified from the proposed system.

The data is sent to a dedicated website and alert the respective person through SMS by using a GSM module and IoT. On account of a fault in the cable, the Buzzer alarm is used to alert the person if he is not using the mobile. The following are the merits of the proposed system:

- Less Maintenance
- This method applies to all types of cables
- It can detect all types of faults
- Cost-effective
- Less complexity
- More safety

This prototype can be able to sense the exact location of different faults like earth, short and open circuit fault in UG cables from the feeder end. In the future, this project will be able to detect even minute faults occurring in any region. This work can also be extended to detect faults by calculating impedance at each phase.

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