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Internet of Things Based Fault Detection in Underground Cables

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Abstract- In recent days, power systems are very complicated to deal with load requires raises and environmental check curbs the network. With the development of urban scale and creation of energy infrastructure, more cities build underground cables to substitute overhead lines from the view point of environment and safety. But it is facing few troubles like installation cost and fault area detection. Finding the precise spot of the error is tougher. In our proposed project, our objective is to improve the trustworthiness of a distribution system and accurate recognition of a faulted location and time of fault. In this work, the three phase voltage and current were monitored. It is IOT based technique where we collect the database and utilize it for monitoring purpose. If the error is located precisely is updated in cloud to facilitate the delay in recovery time reduction. The fault location is displayed through LCD. In addition, it also displays the voltage value at faulty cable and the current consumption through the line is displayed and monitored.

Keywords: *Internet of Things (IOT), Node MCU (ESP8266), Arduino, Transformers, Power transmission lines, Cloud Database, Web Application.*

1. Introduction

The electrical lines are increasing consistently, thus their dependability is as important rather previously. The complexity of the whole system consists of a number of elements which are prone to failure therefore may stop delivering electricity to all users. Subterranean cables have long been favored for the majority of small as well as medium power transmission lines in use worldwide. Since they cannot be vulnerable to environmental factors underground power lines are utilized. Even though the technology used for manufacturing of cable is expanding gradually, nevertheless effects exist that might lead to wire failure.

On the other hand, if wires are installed incorrectly, they could quickly be destroyed. or poor join, following damage can be caused by construction works. Error implies any flaw with contradiction, caused by breakage in conductor, insulation failings along with flaws which have consequences of cable functioning. Underground cables are preferred especially in urban areas. Due to their thick clay sealing, subterranean wires remain challenging to fault-find. Finding the exact site of a flaw is quite challenging, regardless of whether one is discovered. If the whole area is cleared to identify an issue within two different locations, resources and time were wasted. There are three types of fault occur in underground cable and they are series fault, shunt fault and earth fault.

1.1 Series fault

Such error happens if one or more conductors in cable breaks (open circuited) and leads to discontinuity. It is characterized by infinite resistance between the conductors.

1.2 Shunt fault

This fault occurs when one or more conductors in cable contact with each other (short circuited). It occur due to damage in insulation of cables. It is characterized by zero resistance between the conductors.

1.3 Earth fault

This fault occurs when any of conductors contact with earth. It occurs due to some reactions with soil or causes of vibration etc. It takes least resistive path and the flow of current is across ground.

There are more number of methods are available to find the fault like Murray Loop Method, Varley Loop method and so on but they are not effective as much. In this proposed work, the location of fault is identified exactly and updated in cloud along with the voltage values. As add on feature, it also monitors the three phase voltage values and current values and measures the current consumption. It is reliable and effective method.

2. Existing work

There are various methods to analyze and detect the fault location. Conventional techniques like Murray loop method, Varley loop method, Ohm's law method, Fourier transform etc. There are also other techniques which find the location based on the distance of substation point from main distribution units.

2.1 Murray loop method

This method [1] makes one Wheatstone bridge and compares the resistance by which the fault is found. This procedure involves connecting the defective wire to a valid low resistance ideal wire. Balancing of bridge is adjusted by variable resistors. At balanced condition,

$$\frac{R_1}{R_2} = \frac{R_3}{R_X} = \frac{R_1 + R_2}{R_2} = \frac{R_3 + R_X}{R_X}$$

$$=> R_X = \frac{R_2}{R_1 + R_2}(R_3 + R_X)$$

The total length of the cable is given as [3]:

$$L_X = \frac{R_2}{R_1 + R_2}L$$

Thus in Murray Loop Method, resistance is fixed and difficult to balance. The cable's size has to be identified which also causes temperature rise due to high voltage and current. Therefore this method is not accurate.

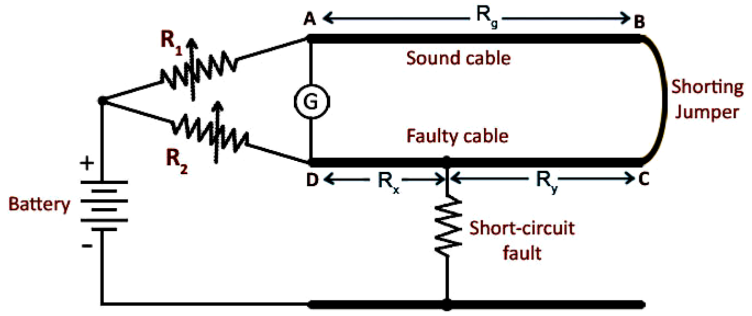

Figure 1: Murray loop method

2. 2 Varley loop Method

This method [2] also makes one Wheatstone bridge and compares the resistance by which the fault is found without knowing the cable length. This procedure involves connecting the defective wire to a valid low-resistance ideal wire. Balancing of bridge is adjusted by variable resistors.

$$\frac{R_3 + R_X}{R_{S1}} = \frac{R_1}{R_2} = R_1 R_{S1} = R_2 R_3 + R_2 R_X \dots$$

$$fracR_3 R_X + R_{S2} = \frac{R_1}{R_2} => R_2 R_3 = R_1 R_X + R_1 R_{S2} \dots$$

$$R_X = \frac{R_1(R_{S1} - R_{S2})}{R_1 + R_2}$$

Thus Varley Loop Method is valid for cable with uniform sections [5]. This heating increased as a result of a substantial electric power. Therefore this method is suitable for circuit with less current.

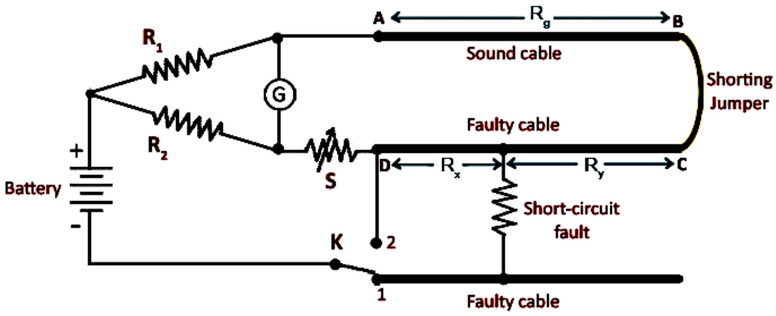

Figure 2: Varley loop method

2.3 Ohm's law method

In this technique, an OHM's law is applied to find the short circuit fault [5]. A DC voltage is experienced at the feeder end over a series of resistor and current gets varied depends on the length of the faulty cable. The voltage drip crosswise gets adjusted accordingly and this value is utilized in detection of fault area. This method includes set of resistors which indicates its length in kilometers, so a series of relays is placed at every few kilometers to inspect faults. The voltage drop on the feeder resistor is fed to an ADC and make up the exact digital information which the microcontroller will show the equivalent distance in kilometers. According to this technique [6], if a defect arises, the electrical voltage decrease will vary according to the distance in the wire it is. The length estimate technique typically determines the error location employing evaluation factors to explore every possible defect distances [7]. The detecting technique is put under test through a variety of issues and different criteria. Various failure durations, levels of sound, as well as system parameters are studied while using the range assessment technique.

3. Proposed work

In this proposed work, the fault in underground cables is found with the help of Node MCU module. The power is transmitted from the distribution station to the substation points. The power from the transformer is fed into Node MCU module which is located in between the main and sub points. This technique is based on IOT. Thus the status of cable is sent to database and updated regularly. This data is later used for monitoring the occurrence of fault.

The voltage from three phases (RBY) is observed and monitored. If fault occurred in any of three phases, the message about the fault will be displayed in the monitoring screen. To get the exact location of the fault zone, the Global Positioning System (GPS) is used where it shares the exact fault location. Cases like less power supply in cables due to any breaks and bend or no power passing through the cable will be detected and reported.

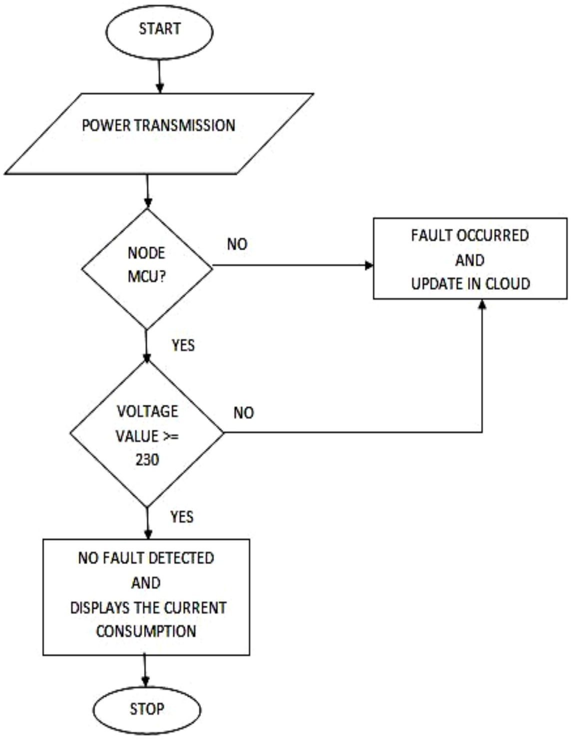

Figure 3: Flowchart of proposed work

The entire database is stored in cloud so that we need not require more storage unit to retain the data for future use. And the data are retrieved from cloud through web server and displayed in the application screen. The fault is reported along with the voltage value which triggered the fault in cable. Along with the voltage value in individual phase displayed in LCD interfaced with device, the current consumption at the load also recorded and displayed. Each transformer or sub points are connected with individual Node MCU module. Thus the fault over any points will be monitored without any interventions.

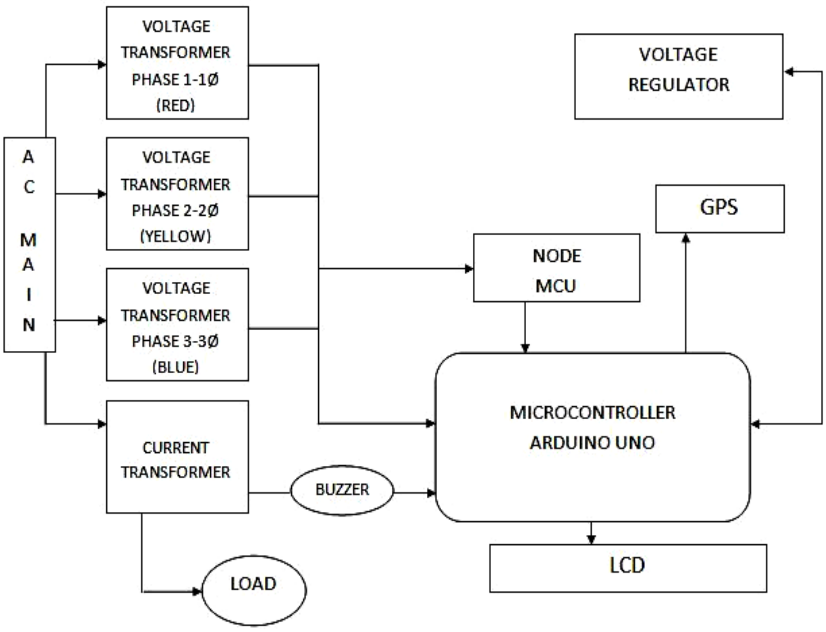

Figure 4: Block Diagram of proposed work

4. Result

In this project, we used Node MCU Wi-Fi module which updates the status of cable in the cloud. These data is monitored through web application and android application. Here we use Blynk application to monitoring the cable based on the data retrieved from cloud. The three cases are considered namely stages one with Red color, stage two with yellow color, and stage three with blue color of the main power supply cable. The consumed current value also displayed along with voltage value in UG cable.

In figure 5 shows the result when there is no fault occurred in underground cables.

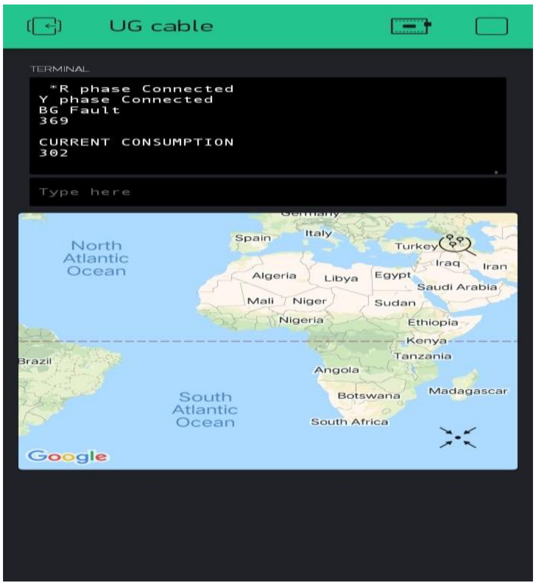

Figure 5: When there is no fault in UG Cables

In figure 6 shows the result when the fault is detected due to voltage value exceeds 230 V and identified the location of fault zone.

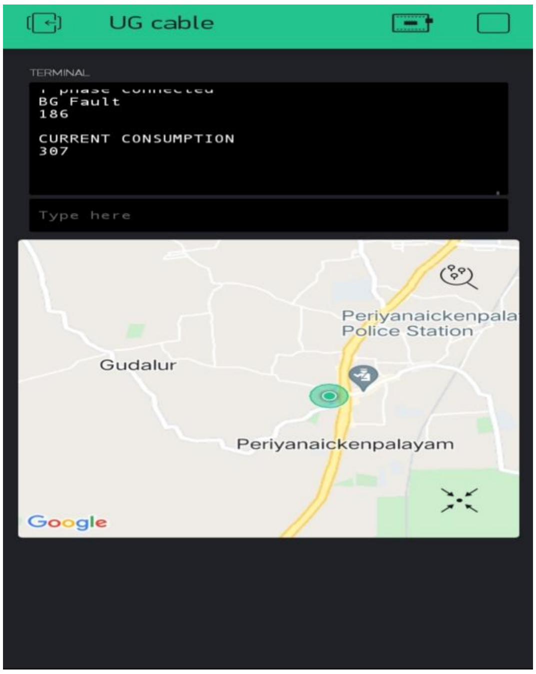

Figure 6: When there is a fault detected in UG Cables

In figure 7 shows the result when there is a fault occurred in underground cables and voltage value exceeds 230 V and shows exact location.

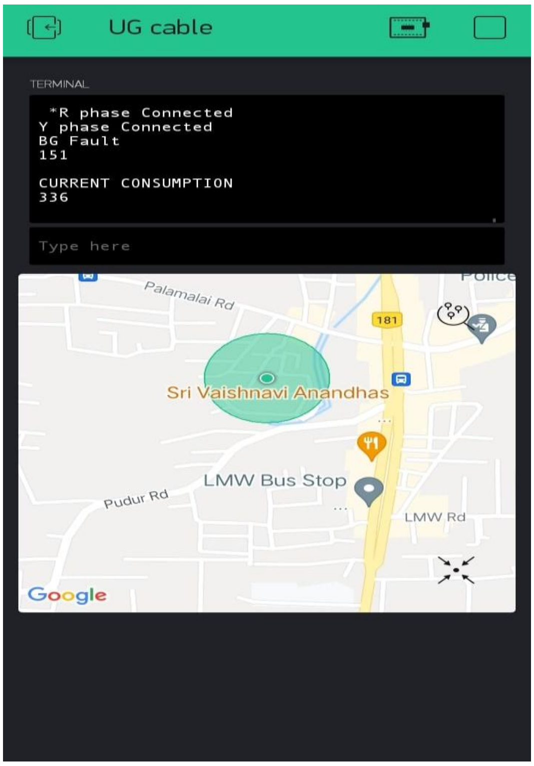

Figure 7: When there is a fault in phase of UG Cables with exact location

5. Conclusion

This proposed work gives the solution for fault detection in underground cables. This makes fault detection easier and the time taken to find the fault zone is also reduced then compared to other methods. This uses Node MCU module to make interaction between device and internet in this digital world. This technique gives best results and accuracy. The speed of operation is enhanced so that it leads to continuity and stability of transmission. It is more reliable because all communication takes place via Internet of Things (IOT). This can observe several points at the same time so that the efficiency is achieved.

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