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Underground Cable Fault Detection System by Using IoT

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Abstract- The objective of this paper is to determine the location of the fault in underground cable lines from the source station to the exact location of the fault in kilometers. Whenever a fault occurs in the underground cable line for some reason, the repairing process relating to that faulted cable becomes difficult owing to the lack of a proper system for tracking the exact fault location and the type of fault that occurred in the cable. For this, a system has to be developed to find the exact location of the fault in the distribution system for all the three phases R, Y & B for a different type of situations of faults. Here in this paper single line to ground, double line to ground & three-phase faults have been considered. Therefore, the basic concept of Ohm's law is found suitable in principle to develop a fault location tracking system. Based on the Ohm's Law, it is found that the resistance of the cable is proportional to its length under constant conditions of temperature and the cross-section area and therefore if a low DC voltage is applied at the feeder end through a series of resistor in cable lines, the current would vary depending upon the location of a fault in the cable**.** Whenever the fault occurs in the underground cable it is difficult to detect the accurate location of the fault for the process of repairing that particular cable. The proposed system finds the exact location of the fault. The fault occurring distance, phase, and time are displayed on a 16X2 LCD interfaced with the microcontroller. IoT is used to display the information over the Internet using the Wi-Fi module ESP8266.

Keywords- Underground cable system, fault detection circuit, Ohm's law, Atmega16 microcontroller, location method, IoT WiFi module

I. INTRODUCTION

In the urban areas, the electrical cable runs underground instead of overhead lines. Whenever the fault occurs in the underground cable it is difficult to detect the exact location of the fault for the process of repairing that particular cable. The proposed system detects the exact location of the fault and by the means of Wi-Fi modem its serially communicated towards the server. Since the problem that occurs in underground cables is a big problem till now. As it is very difficult to find the exact location of the fault location manually, which suddenly affects the efficiency of the cable wire due to the losses occurred. Till now many techniques had already been implemented in order to detect the fault in cable wire. But the problem came up is how to detect the fault in cable wire when it is underground, and how to access or retrieve those data related to faulty location whenever it is required. In order to fill those gaps, we proposed the system which detects the exact location of the fault and through the means of Wi-Fi modem its serially communicated towards the server.

Various faults in cables

- Single line fault: When there is a break in the conductor of the cable, it is called a single line fault of the cable. The single line fault can be checked by Megger. For this purpose, the three conductors of the 3-core cable at the far end are shorted and earthed. Then resistance between each conductor and earth is measured by a megger. The megger will indicate zero resistance in the circuit of the conductor that is not broken. However, if the conductor is broken, the megger will indicate infinite resistance in its circuit.
- The line to line fault: When two conductors of a multi-core cable come in electrical contact with each other due to insulation failure, it is called line to line fault. The two terminals of the megger are connected to any two conductors. If the megger gives zero reading, it indicates a line to line fault between these two conductors. The same step can be repeated for other conductors taking two at a time.
- Earth fault: When the conductor of the cable comes in contact with the earth, it is called earth fault or ground fault. To identify this fault, one terminal of the megger is connected to the conductor and the other terminal connected to the earth. If the megger indicates zero reading, it means the conductor is earthed. The same procedure is repeated for other conductors of the cable. This project is used to detect the location of the fault in a digital way. Locating the faulty point in an underground cable helps to

facilitate quicker repair, improve the system reliability and reduced outage period.

II. EXPERIMENTAL

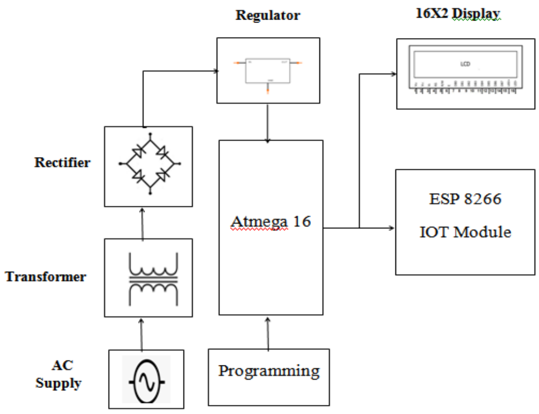

Fig. no. 1: Block diagram of the system

The proposed system is an IoT enabled underground cable fault detection system. The basic principle behind the system is Ohm's law. When the fault occurs in the cable, the voltage varies which is used to calculate the fault distance. The system consists of a Wi-Fi module, Microcontroller, and Real-Time Clock. The block diagram of the fault detection system is shown in Figure 2. The power supply is provided using a step-down transformer, rectifier, and regulator. The current sensing circuit of the cable provides the magnitude of the voltage drop across the resistors to the micro-controller and based on the voltage the fault distance is located.

The project uses the simple concept of Ohms law where a low DC voltage is applied at the feeder end through a series resistor. The current would vary depending upon the length of the fault of the cable in case there is a short circuit of LL or 3L or LG etc. The series resistor voltage drop changes accordingly which are then fed to an ADC to develop precise digital data in which the programmed micro-controller would display the same. This is a proposed model of an underground cable fault distance locator using a micro-controller. It is classified into four parts DC power supply part, cable part, controlling part, display part. DC power supply part consist of an ac supply of 230V is step down using a transformer, bridge rectifier converts ac signal to DC and the regulator is used to produce constant dc voltage. The cable part is denoted by a set of resistors along with switches. The current sensing part of cable represented as a set of Potentiometer are used as fault creators to indicate the fault at each location. This part senses the change in current by sensing the voltage drop. Next is the controlling part which consists of analog to digital converter which receives input from the current sensing circuit, converts this voltage into a digital signal and feeds the microcontroller with the signal. The microcontroller also forms part of the controlling unit and makes necessary calculations regarding the distance of the fault. The microcontroller also drives a relay driver which in turn controls the switching of a set of relays for proper connection of the cable at each phase. The display part consists of the LCD display interfaced with the microcontroller which shows the status of the cable of each phase and the distance of the cable at the particular phase, in case of any fault.

HARDWARE COMPONENTS

- ATmega 16 IC
- IoT Module ESP8266
- 7805 IC
- LCD Display
- Resistors, Capacitors, miscellaneous components like Cables, Connectors, diodes, LED, switch, potentiometer.

SOFTWARE COMPONENTS

- Proteus 8
- AVR Studio 4

Fig no.2: WiFi Module

ESP8266 WiFi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi ability as a WiFi Shield offers (and that just out of the box) The ESP8266 module is an extremely cost-effective board with a huge, and ever-growing, community. This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application-specific devices through its GPIOs with minimal development up-front and minimal loading during run time. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, which is designed to occupy minimal PCB area. The ESP8266 supports APSD for VoIP applications and Bluetooth co-existence interfaces, it contains a self-calibrated RF allowing it to work under all operating conditions and requires no external RF parts.

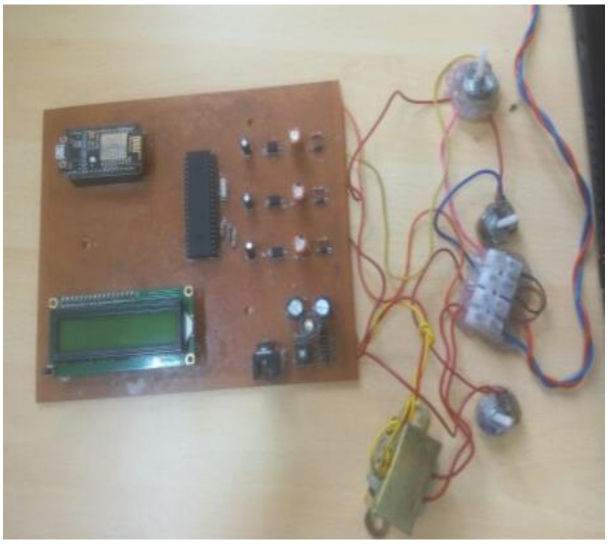

Fig.no.3:Hardware Module

Proteus circuit description:-

Various components used in the system are basically a current potentiometer, ATmega16, Wi-Fi modem, LCD display. The potentiometer is used for varying resistance of the cable. Here we have used ATmega16. ATmega16 will receive the input from the optocoupler and according to it, the controller circuit will perform some set operations like displaying of data in LCD display which is interfaced with it or serially communicating the real-time data through Tx pin of the microcontroller. Wi-Fi module acts as a medium that connects any of the physically assembled systems with the internet and transmits the data in the server. The wiFi module which is usually interfaced with ATmega16 is ESP8266. Now coming to its pin configurations, it consists of 8 pins but the pins which are actually used are Tx pin, Rx pin, CHPD pin, Vcc, Gnd. CHPD is the enable pin which is an active-high pin and by giving input HIGH it enables Wi-Fi and connects the system with the internet and any of the sensed values can be serially transmitted to the server. LCD display used here is 20X 4 which is a flat panel display which uses a group of LED and writes the sensed value in its display screen and in the circuitry itself there is a facility through which we can control the LCD brightness and intensity. At last when the code was implemented in ATmega16 then the real-time data was serially communicated in the server and the information from the server can be retrieved in mobile or laptop through IoT.

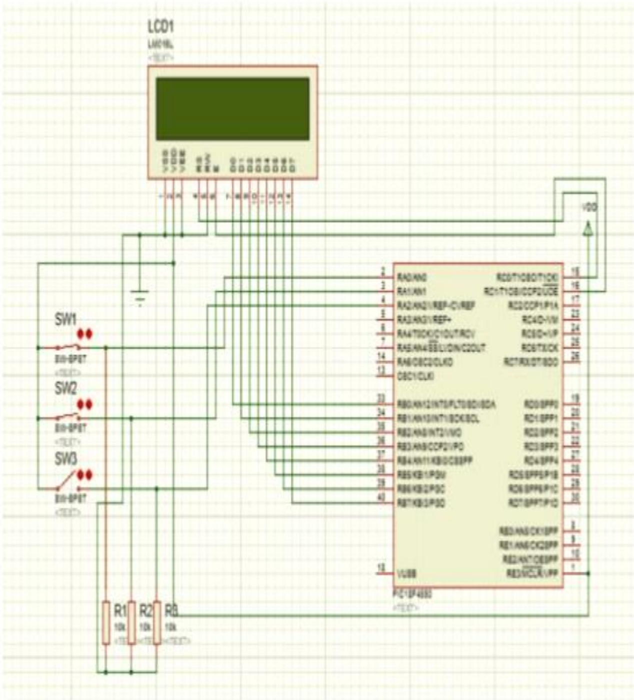

Fig. No.3: Proteus simulation circuit

III. CONCLUSION

In this work, a simplified method is proposed for detecting the location of cable faults in the underground area. We discover the position or location of faults and also find the accurate distance from the breaker point. The line to line, single line, line to ground fault in the underground cable is located using simple concepts of Ohms law to rectify the fault efficiently. The work automatically displays the phase and the exact location of fault with the help of ATmega16, microcontroller and ESP8266 Wi-Fi module, on a web page. The benefits of accurate location of fault are, fast repair so as to revive back the power system, improvement in the system performance, reduction in the operating expense and reduced time needed to locate the fault in the field.

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