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Cable Fault Detection Using IoT

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Abstract - *This paper deals with fabrication of an IoT device intended to detect the distance of fault in cable lines from the base station using an Arduino micro controller kit and display the result through a web page. In the urban areas, the electrical cable runs in undergrounds instead of overhead lines. Whenever the fault occurs in underground cable it is difficult to detect the exact location of the fault for process of repairing that particular cable. The proposed system finds the exact location of the fault. Cables are prone to a wide variety of faults due to underground conditions, wear and tear, rodents etc. Detecting fault source is difficult and entire line is to be dug in order to check entire line and fix faults. Here we propose a cable fault detection that detects the exact fault position over IoT that makes repairing work very easy. The repairmen know exactly which part has fault and only that area is to be dug to detect the fault source. The system detects fault with the help of potential divider network laid across the cable. Whenever a fault gets created at a point shorting two lines together, a specific voltage gets generated as per the resistors network combination. This voltage is sensed by the microcontroller and is updated to the user. The information conveyed to the user is the distance to which that voltage corresponds to. The microcontroller retrieves the fault line data and displays over LCD display, also it transfers this data over a network to display in a web browser.*

Key Words: IoT, Arduino, Cable fault, Web page, resistor network

1.INTRODUCTION

1.1 BACKGROUND

The main function of the electrical transmission and distribution systems is to transport electrical energy from the generation unit to the customers. Generally, when fault occurs on transmission lines, detecting fault is necessary for power system in order to clear fault before it increases the damage to the power system. Although the underground cable system provides higher reliability than the overhead line system, it is hard to seek out the fault location. The demand for reliable service has led to the development of technique of locating faults. Cable faults are damage to the cable which affects a resistance in cable. If allowed to persist, this can lead to a voltage breakdown. As the cable fault detection is the process of locating the periodic fault, a programmed arduino microcontroller will display the precise digital value of series resistance voltage drop converted by ADC in unit distance from the base station. This paper deals with arduino and LCD. This system greatly reduces the time and operates effectively

1.2 OBJECTIVE

The objective of this paper is to determine the distance of cable fault from the base station in unit distance using arduino board. The underground cable system is a common practice in many urban areas. While a fault occurs for some reason, at that time the repairing process related to that particular cable is difficult due to not knowing the exact location.

Cable fault detector is an advanced method for finding fault location in cables. In the present scenario when a fault occur, detecting fault source is difficult and entire line has to be dug in order to check entire line and fix faults. The main objective of our paper is to detect the fault location to reduce the time. So it avoids the difficulty in digging the entire line. Thus this paper reduces the effort and makes the work easy.

2. SYSTEM ANALYSIS

2.1 EXISTING SYSTEM

When electrical energy is generated in the generations stations, it is distributed to the different loads, i.e. cities, towns and villages for consumption then. The process involves stepping up the voltage to minimize the loss of energy in the form of heat. The stepped up voltage is distributed to grid stations where it is stepped down for distribution to the local transformers where it is finally stepped down and distributed to the consumers. The basic method of locating a cable fault depends on physically cutting and splicing the cable. Dividing the cable into successively smaller sections will enable you to narrow down the search for a fault. For example, on a 500-ft length, you would cut the cable into two 250-ft sections and measure both ways with an ohmmeter or high-voltage insulation resistance (IR) tester. The defective section shows a lower IR than the good section. You would repeat this "divide and conquer" procedure until reaching a short enough section of cable to allow repair of the fault. This laborious procedure normally involves repeated cable excavation

2.1.1 LIMITATIONS OF EXISTING SYSTEM

The present system has significant disadvantages. Today whenever a fault occurs in a cable, the entire cable has to be checked to find the fault location. It requires a lot of human effort and it is time consuming. It is practical only in the case of short distances. Also, there are possibilities of accidents during the repair work.. Overhead cables are vulnerable to lightning strikes which can cause

interruption. They use bare conductors and can cause damage if they break.. The maintenance cost of these lines is more and the voltage drop is also high.

2.2 PROPOSED SYSTEM

Our paper aims in finding the exact location of the fault. The paper uses the standard concept of Ohms law i.e., when a low DC voltage is applied at the feeder end through a series resistor (Cable lines), then current would vary depending upon the location of fault in the cable. In case there is a

short circuit (Line to Ground), the voltage across series resistors changes accordingly, which is then fed to inbuilt ADC of Arduino board to develop precise digital data for display in unit distance. Cable fault detector deals with finding the exact fault location from the base station. It also notifies about the fault when it occurs. It can be also used for underground transmission. Cables have some resistance. We are mainly focusing that resistance. Resistance can vary with respect to the length of the cable. If the length of the cable is increased, the value of the resistance will also increase. If any deviation occurs in the resistance value, we will call that point as fault point and find that place with the help of arduino technology. That fault point is represented in unit distance from the base station and the value is displayed.

2.2.1 Advantages of Proposed System

- Detects accurate fault location
- Reduced human effort
- Time saving and faster maintenance
- Can be used for both underground and overhead cables
- Less software requirements

2.3 SOFTWARE AND HARDWARE REQUIREMENTS

2.3.1Hardware Requirements

The most common set of requirements defined by any operating system or software application is the physical computer resources, also known as hardware. The hardware requirements required for this paper are:

- LCD DISPLAY: LCD (Liquid Crystal Display) is the technology used for displays in notebook and other smaller computers. Like light-emitting diode (LED) and gas-plasma technologies, LCDs allow displays to be much thinner than cathode ray tube (CRT) technology. LCDs consume much less power than LED and gas-display displays because they work on the principle of blocking light rather than emitting it. LCD is an Alphabetic Display. It means that it can display Alphabets, Numbers as well as special symbols. Thus LCD is a user friendly display device which can be used for displaying various messages.

- Relays: A relay is a simple electromechanical switch made up of an electromagnet and a set of contacts. Relays are found hidden in all sorts of devices. It is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal.

- Transformer: Electrical power transformer is a static device which transforms electrical energy from one circuit to another without any direct electrical connection and with the help of mutual induction between two windings. It transforms power from one circuit to another without changing its frequency but may be in different voltage level. A transformer is a device that is used to either raise or lower voltages and currents in an electrical circuit. In modern electrical distribution systems, transformers are used to boost voltage levels so as to decrease line losses during transmission. It is used to control the voltage. There are step up and step down transformers

- Diodes: The most common function of a diode is to allow electric current to pass electric current in one direction while blocking the current in the opposite direction . Thus, the diode can be viewed as an electronic version of a check valve .This unidirectional behaviour is called rectification and is operated within a rated specified voltage level. A diode only blocks current in the reverse direction while the reverse voltage is within a limited range otherwise reverse barrier breaks and the voltage at which this breakdown occurs is called reverse breakdown voltage.

- Voltage Regulator: A voltage regulator is designed to automatically maintain a constant voltage level. It generates a fixed output voltage of a preset magnitude that remains constant regardless of changes to its input voltage or load conditions.

- Resistors: A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element .In this paper a series of resistors represent the cables.10 kilo ohm resistors are used.

- Capacitors: A capacitor is a passive two-terminal electrical component that stores electrical energy in an electric field. It is a device used to store an electric charge, consisting of one or more pairs of conductors separated by an insulator.

- At mega AVR series Microcontroller: AVR was one of the first microcontroller families to use on-chip flash memory for program storage.
- LEDs: Represent which line is active
- Slide switches: Create fault manually
- Arduino board: Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.
- Ethernet Shield: The Ethernet shield allows an Arduino board to connect to the internet using the Ethernet library and to read and write an SD card using the SD library.

2.3.2 Software Requirements

Software Requirements deal with defining software resource requirements and pre-requisites that need to be installed on a computer to provide optimal functioning of an application. These requirements or pre-requisites are generally not included in the software installation package and need to be installed separately before the software is installed. The software requirements that are required for this paper are:

- Arduino programming language
- Arduino Software (IDE): The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software.
- HTML is the standard markup language for creating Web pages.HTML stands for Hyper Text Markup Language.HTML describes the structure of webpages using markup.HTML elements are building blocks of HTML pages.HTML elements are represented using tags

3. GENERAL DESCRIPTION

3.1 Product Perspective

Nowadays underground cable system is quite common in many urban areas wherein it becomes very difficult to repair in case of any faults because finding the exact location of the fault in such cable system is quite difficult. With the proposed system, finding the exact location of the fault is possible. The system consists of two parts. An LCD display and a web page. This paper uses a standard concept of Ohms law, i.e., when a low DC voltage is applied at the feeder end through series resistor (assuming them as cable lines), then the current would vary depending upon the location of the fault in the cable. In case of a short circuit (line to ground), the voltage across the series resistors changes which is then fed to an ADC, to develop a precise digital data that gets displayed on the LCD. The paper is assembled with a set of resistors representing cable length in km and fault creation is made by a set of switches at every known km to cross check the accuracy of the same. The fault that occurs at a particular distance is displayed on the LCD interfaced to the microcontroller. When the switches are open, a difference in resistance occurs and the distance is calculated. The exact distance is displayed in the LCD in unit distance. The web page will notify the faults.

3.2 Product Functionality

- Arduino:

  Arduino is a single-board microcontroller meant to make the application more accessible which are interactive objects and its surroundings. In cable fault detector the arduino board acts as a server. The paper consists of a series of resistors. These resistors are used to represent the cables which are the current carrying conductors. Options are provided on the web page to choose the cable that we want to check right now. Once we select any particular cable the LED corresponding to that cable glows indicating the active line. Fault creation is made by a set of switches. When the switch is open it means that there is a fault. With the help of the arduino the resistance value is read and the distance is calculated. The calculated distance is displayed on the LCD display and the web page.

- Ethernet shield:

  The Arduino Ethernet is a microcontroller board based on the ATmega328. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz crystal oscillator, a RJ45 connection, a power jack, an ICSP header, and a reset button. Pins 10, 11, 12 and 13 are reserved for interfacing with the Ethernet module and should not be used otherwise. This reduces the number of available pins to 9, with 4 available as PWM outputs. An optional Power over Ethernet module can be added to the board as well.

- To use the shield, mount it on top of an Arduino board (e.g. the Uno). To upload sketches to the board, connect it to your computer with a USB cable as you

normally would. Once the sketch has been uploaded, you can disconnect the board from your computer and power it with an external power supply. Connect the shield to your computer or a network hub or router using a standard Ethernet cable (CAT5 or CAT6 with RJ45 connectors). Connecting to a computer may require the use of a cross-over cable (although many computers, including all recent Macs can do the cross-over internally).The shield must be assigned a MAC address and a fixed IP address using

- The Ethernet. begin() function. A MAC address is a globally unique identifier for a particular device. Current Ethernet shields come with a sticker indicating the MAC address you should use with them. For older shields without a dedicated MAC address, inventing a random one should work., but don't use the same one for multiple boards. Valid IP addresses depend on the configuration of your network. It is possible to use DHCP to dynamically assign an IP to the shield. Optionally, you can also specify a network gateway and subnet

4. CONCLUSION

Distribution of the electrical energy is done via electrical cables. These cables are prone to a variety of failures. It is a difficult task to identify the faults in these cables. The paper is done to detect the location of fault in cable lines from the base station to exact location in kilometres using an Arduino. In the urban areas, the electrical cable runs in undergrounds instead of overhead lines. Whenever the fault occurs in underground cable it is difficult to detect the exact location of the fault for process of repairing that particular cable. The proposed system can be used for underground and overhead cables as well. This system uses an Arduino uno board. Here the current sensing circuits made with a combination of resistors are interfaced to Arduino. The fault creation is made by the set of switches. We have proposed a low-cost solution to enhance the remote monitoring capability of existing industrial system. Thus, the paper on Underground cable fault detection using Arduino was done and the distance of the fault from the base station in kilometres was displayed on the LCD and webpage. In this paper faults up to a distance of 4km can be detected. When the fault switches are operated to fault condition then the phase corresponding to that particular switch is considered as the faulty phase. So, the faulty section can easily be located. It is secure, robust and low-power consuming. It can operate on multiple channels so as to avoid interference with other wireless devices or equipment's in the industry. By using Arduino controller, we can find our fault location. Once faults occur in the cable, the display unit displays the fault location. This display will show at what distance the fault occurred.

5. FUTURE SCOPE

We use an Ethernet shield to establish connection to the web page. If we use a Wi-Fi module instead of an Ethernet shied then we can make it wireless. With the help of an SD card we can develop a better user interface. In the future it can be used to find the error in open circuit faults

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