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UNDERGROUND CABLE FAULT DETECTION SYSTEM

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Abstract- *The Underground Cable Fault Detection System is intended to detect the location of fault in underground cable lines from the base station in km using Arduino. To locate a fault in the cable, the cable must be tested for faults. The prototype uses the simple concept of Ohms law. The current would vary depending upon the length of fault of the cable. In the urban areas, the electrical cables run in underground 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 locates the source of the problem. The prototype is built with a set of resistors representing cable length in kilometers, and faults are created by a set of switches at each known distance to ensure accuracy. In the event of a fault, the voltage across series resistors changes accordingly, which is then fed to an ADC to generate precise digital data, which is then displayed in distance by a programmed Arduino. A 16X2 LCD interfaced with the microcontroller displays the fault occurrence distance, phase, and time.*

Keywords: Relay, Arduino, Ohm's Law, LCD Display

1. INTRODUCTION

Power supply networks are expanding at a rapid pace, and their dependability is more important than ever. The network's complexity includes numerous components that can fail and disrupt power supply to end users. Underground cables have been used for many decades for the majority of the world's low and medium voltage distribution lines. Underground high voltage cables are becoming increasingly popular because they are unaffected by weather conditions such as heavy rain, storms, snow, and pollution. Despite the fact that cable manufacturing technology is constantly improving, there are still factors that can cause cables to fail during testing and operation. A cable in good condition and properly installed can last approximately 30 years. Cables, on the other hand, can be easily damaged by improper installation or poorly executed jointing, as well as subsequent third-party damage by civil works such as trenching or curb edging. Underground cables are susceptible to a wide range of faults as a result of underground conditions, wear and tear, rodents, and other factors. Detecting the source of the fault is also difficult, and the entire line must be dug in order to check and repair the faults. The potential divider network laid across the cable is used by the system to detect faults. When a fault occurs at a point where two lines are connected, a specific voltage is generated based on the resistor network combination. The microcontroller detects this voltage and updates the user. The distance to which that voltage corresponds is communicated to the user. The microcontroller retrieves the fault line data and displays it on the LCD, which displays the distance, phase, and time as well as the node's performance.

2. EXISTING METHODS:

Underground cables are used in power systems to transport electric power from generator stations to distribution points, where it is then transferred to consumer ends. Due to aging and various types of faults, underground cables face a variety of issues. A great deal of research has previously been done to overcome these problems in cables. We proposed a solution to these problems here. Previously, there were numerous methods available for fault detection. These methods are used to detect underground cable faults. They are

- Murray Loop method
- Sectionalizing method
- Thumping method

Murray Loop Method:

Murray loop method is primarily used to detect faults in earth cables. This scheme is based on the Wheatstone Bridge principle. A Wheatstone bridge can be used to locate a fault in an earth cable. Murray loop technique is used for fault exposure. This method is very simple. This method is used to detect short circuit faults in underground lines. This loop test is commonly used to locate faults in earth cables. This trial is based on the Wheatstone Bridge law. Using this experiment, a fault site in an earth cable can be found by arranging a Wheatstone bridge in it. In this scheme, we must first install a sound cable with the same length as the defective cable. The cable that has no errors is referred to as the sound cable, and we must short circuit the ends of the sound cable and the faulty cable.

We now connect a galvanometer between the beginnings of both the working and non-working cables. Now we connect two resistors across the working and non-working cables so that they are both variable. The entire loop will now be shaped like a Wheatstone bridge. Then one battery is connected to the ground. To balance the bridge, we adjust the resistance of both resistors until the galvanometer reads zero. By comparing the resistances, we will identify the weak point. We must understand the values of both resistances.

Sectionalizing Method:

Sectionalizing method necessitates physically cutting and splicing the cable, which can compromise its reliability. The cable must be divided into small sections in order to find the fault using this method. For example, on a 400-foot cable, the cable is cut into 200-foot sections, and readings are taken in both directions using an Ohmmeter or a high-voltage insulation resistance (IR) tester. If the reading on the IR tester is low, the cable is in bad shape. This procedure must be repeated until the fault location is found.

Thumping Method:

To detect the fault, thumping method relies on noise. When a high voltage is applied to a faulty cable, an arc is formed due to high currents. This arc generates enough noise to be heard. This method is simpler than Sectionalizing, but it requires a high current at a voltage of up to 25 KV to produce underground noise. When high currents are applied to a cable, the temperature of the cable rises. The high temperature will cause the cable insulation to deteriorate.

3. SYSTEM HARDWARE:

3.1. Arduino UNO:

An Arduino Uno microcontroller board is based on the 8-bit ATmega328P microcontroller. Along with the ATmega328P, it includes other components to support the microcontroller, such as a crystal oscillator, serial communication, a voltage regulator, and so on.

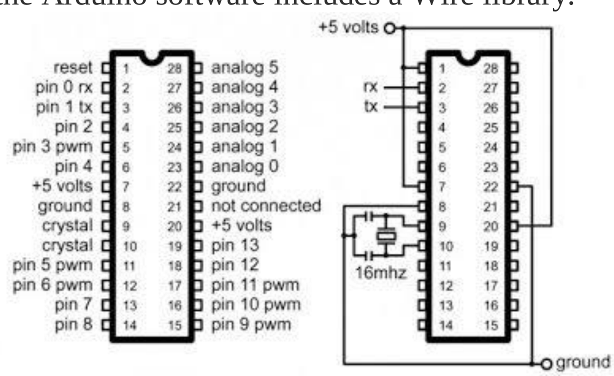
The Arduino Uno has 14 digital I/O pins (six of which can be used as PWM outputs), six analog I/O pins, a USB connection, a power barrel jack, an ICSP header, and a reset button.

A computer, another Arduino board, or other microcontrollers can be used to communicate with Arduino.

The ATmega328P microcontroller supports UART TTL (5V) serial communication via digital pins 0 (Rx) and 1 (Tx) (Tx). The serial communication is channelled over USB by an ATmega16U2 on the board, which appears as a virtual com port to software on the computer. The ATmega16U2 firmware relies on standard USB COM drivers and does not require an external driver. On Windows, however, an.inf file is required.

The Arduino software includes a serial monitor that allows simple textual data to be sent and received from the Arduino board. The Arduino board has two RX and TX LEDs that will flash when data is transmitted via the USB-to-serial chip and USB connection to the computer (not for serial communication on pins 0 and 1).

A Software Serial library enables serial communication on any digital pin of the Uno. I2C (TWI) and SPI communication are also supported by the ATmega328P. To make use of the I2C bus easier, the Arduino software includes a Wire library.



3.2. RELAYS:

A relay is a switch that is powered by electricity. To operate their internal mechanical switching mechanism, they frequently employ an electromagnet (coil) (contacts). When a relay contact is open, the power for a circuit is turned on when the coil is activated. Relays allow one or more higher current circuits to be controlled by a low current circuit. The use of thinner cables to connect the control switch to the relay saves weight, space, and money. Relays enable power to be routed to a device over the shortest possible distance, resulting in less voltage loss. Heavy gauge cable is only required to connect a power source to the device (via the relay). The relay in this case is programmed to cut the high-current load lines.

3.3. LCD:

LCD (Liquid Crystal Display) is a type of flat panel display that operates primarily through the use of liquid crystals. LCD's definition is derived from its name. It is made up of two different states of matter: solid and liquid. A liquid crystal is used to generate a visible image on an LCD.

When compared to cathode ray tube (CRT) technology, LCD technologies allow for much thinner displays. In an LCD television, pixels are turned on and off electronically by rotating polarized light using liquid crystals.

LCDs are used in a variety of applications, including LCD televisions, computer monitors, instrument panels, cockpit displays in aircraft, and indoor and outdoor signage.

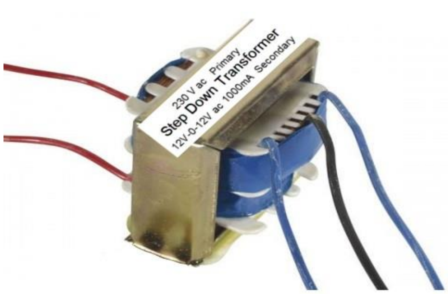
LCDs (Liquid Crystal Displays) are used in embedded system applications to show various system parameters and status.

The LCD 16x2 is a 16-pin device with two rows of 16 characters each.

LCD 16x2 can be used in either 4-bit or 8-bit mode. It is also possible to make your own characters. It has eight data lines and three control lines that can be used for control.

3.4. STEP DOWN TRANSFORMER:

By increasing the electrical current, step-down transformers reduce the voltage incoming to the site. This is accomplished by converting the high incoming voltage in the primary winding to the lower voltage required in the secondary windings. Step-down transformers are typically used in electricity distribution networks to convert a power station's output voltage to that required for high voltage transmission and back down again for use in homes, factories, and offices. The stepdown transformer is used in this case to reduce the high voltage to low voltage while increasing the electrical current. The step-down transformers have a very important function in a power system. They lower the voltage level and adapt it to energy consumers.

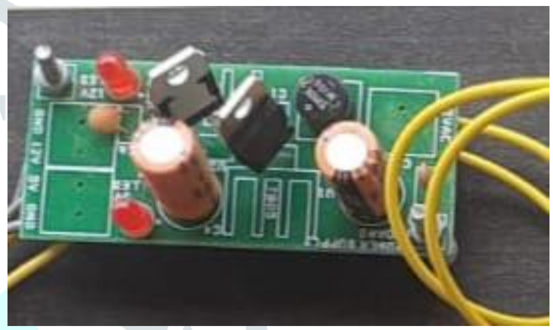


3.5. NODE MCU:

Node MCU is an open-source platform based on the ESP8266 that can connect objects and allow data transfer via the Wi-Fi protocol. Another method for developing NodeMCU is to use a well-known IDE, such as the Arduino IDE. Using the Arduino development environment, we can also create applications for NodeMCU. This makes it easier for Arduino developers to learn a new language and IDE for NodeMCU. We can connect it to serial devices such as I2C enabled LCD displays, Magnetometer HMC5883, MPU-6050 Gyro meter + Accelerometer, RTC chips, GPS modules, touch screen displays, SD cards, and so on using such serial protocols.

3.6. BRIDGE RECTIFIER:

The bridge rectifier is a type of full-wave rectifier that converts alternating (AC) current to direct (DC) current using four or more diodes in a bridge circuit configuration. A suitable bridge rectifier is selected based on the load current requirements. When choosing a rectifier power supply for an appropriate electronic circuit's application, component ratings and specifications, breakdown voltage, temperature ranges, transient current rating, forward current rating, mounting requirements, and other considerations are taken into account.



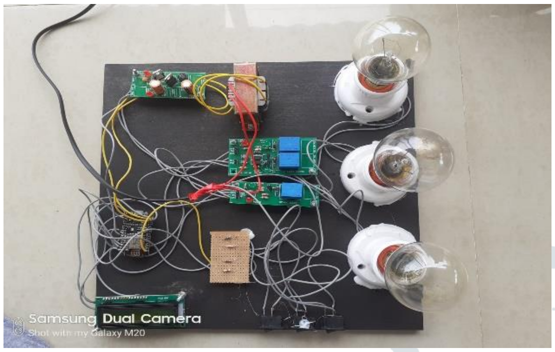
4.WORKING OF PROPOSED METHOD:

Underground cables are subjected to a variety of defects as a result of underground stresses, wear and tear, rodents, and other factors. It is also difficult to identify fault sources. To inspect and repair the failure, the entire line must be dug up. As a result, we propose an Underground Cable Fault Detector that detects the exact location of the defect and simplifies repair. To locate the source of the problem, the repairmen know which component is faulty and only the region must be dug. This saves a lot of time, money, and effort while also allowing for simple underground cable maintenance. This saves time, money, and effort while also allowing for simple cable maintenance in the underground.

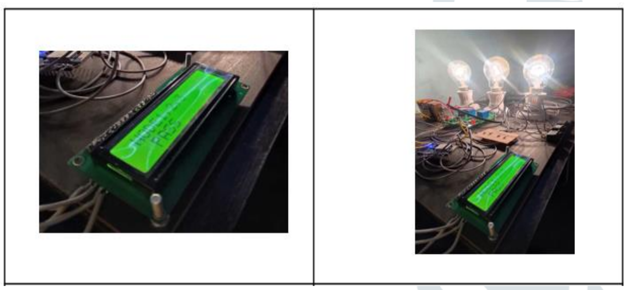
Here, the Ohms law principle is used by to detect and verify failures over the internet, and the Arduino board, an IoT component, functions as a machine brain and handles sensor data. Errors are detected by the machine using the future cable-wide divisor network. When two lines fail, a voltage is generated based on the combination of the resistance network with nodes 1, 2, 3. This voltage is sensed by the microcontroller and modified. The distance corresponding to this voltage is communicated to the consumer. The microcontroller collects fault line data and displays it on an LCD monitor so that the consumer can quickly identify the location of the fault on each node.

5. RESULT:

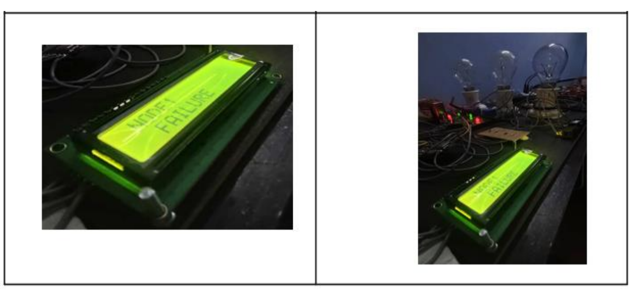
The results can be seen on the LCD monitor, which shows when each node fails (represented using light bulb).



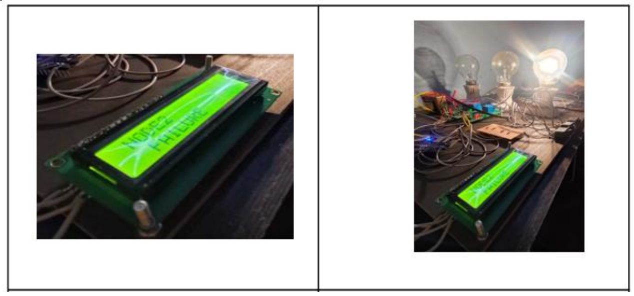
The output -1 is shown in the figure below when all of the nodes 1, 2, 3 are fault-free and all of the light bulbs are lit.



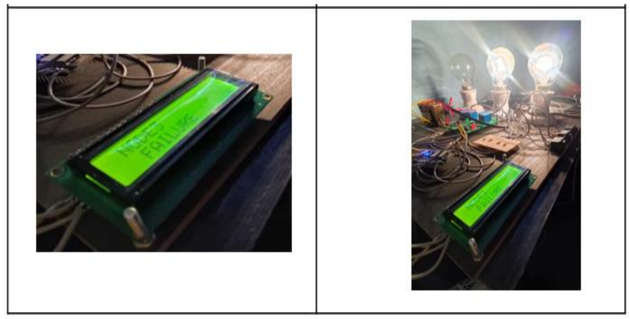
The output - 2 is shown in the figure below which indicates that when node 1 fails, the light bulbs representing nodes 1, 2, and 3 will not light up.



The output - 3 is shown in the figure below which indicates that when node 2 fails, the light bulb representing node 1 will only glow while the remaining bulbs for node 2, 3 will not glow.



The output – 4 is shown in the figure shown which indicates that when node 3 fails, the light bulbs representing nodes 1, 2 will only glow.



6. CONCLUSION:

Faults in cables can be easily identified using this Underground Cable Fault Detector. The nodes that are used with the help of relays (switches) are placed at a specific distance, which aids in identifying the fault in the cables. The disadvantage of identifying cable faults has been overcome by the use of this Underground cable fault detection system.

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