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Underground Cable Fault Monitoring System

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Abstract: *This paper is proposing a method to find the faults in the underground cable using microcontroller(esp32). The aim of this paper is to determine the exact location of fault with latitude and longitude. When any fault occurs in underground cable the voltage will be fluctuate because current at that point will varies. This paper presents the working model of the device that can help humans to find faults in underground cable where human presence is dangerous due to environmental conditions. Hence we can inspect the faults under such circumstances. Though there were several approaches are there to find faults in underground cable ,this paper is going to find it in a simpler way and more efficiently using voltage sensors.*

Keywords: Microcontroller, Fault, Voltage, Underground Cable

I. INTRODUCTION

For the real time world wide voltage distribution lines, underground cables are used widely because they are less exposed to environmental issues and hence damage of the cables would be less. Underground cables have been widely used in power distribution networks because they are laid in underground so they will get better security than overhead lines because they are less exposed to storms, lightning and earthquakes. It is less expensive, social friendly and maintenance cost is low. But the only problem is to find the faults and breakages in them.

II. EXISTING SYSTEM

In power systems, underground cables are used to transmit electric power from generator stations to distribution points, and then it is transferred to consumers. However, underground cables can face various problems such as aging and different types of faults. To address these issues, numerous research works have been conducted in the past. Various methods are available for detecting faults in underground cables, including the Murray Loop method, Sectionalizing method, and Thumping method.

2.1 Murray loop Method

The Wheatstone bridge-based Murray loop method is primarily used for detecting faults in earth cables. This approach involves arranging a Wheatstone bridge to identify the fault location in an earth cable. To begin the process, a sound cable of equal length to the faulty cable is placed alongside it. The sound cable is then short-circuited along with the faulty cable, and a galvanometer is connected between the starting points of both cables. Two variable resistors are also connected crosswise to the working and non-working cables to form the Wheatstone bridge. Finally, a battery is connected via the ground, and the resistors are adjusted until the galvanometer reads zero, allowing the fault location to be identified.

2.2 Sectionalizing Method

The Murray loop method, however, has a significant disadvantage in that it involves cutting and splicing the cable, which can adversely affect its reliability. To detect faults in the cable, it must be divided into smaller sections, usually around 200-ft in length. The resistance of each section is then measured in both directions using an Ohmmeter or a high-voltage insulation resistance (IR) tester. If the IR tester's reading is low, then the cable is deemed to be in a fault condition. This process is repeated until the fault location is identified

2.3 Thumping

The Thumping method is a fault detection technique that depends on detecting noise. When a high voltage is applied to a faulted cable, it produces an arc due to high currents that generate a loud noise that can be heard. Compared to the Sectionalizing method, Thumping is a simpler method, but it requires a high current at a voltage as high as 25 KV to produce an underground noise. Furthermore, the high currents applied to the cable can cause an increase in the cable's temperature, which can potentially damage the cable insulation.

III. PROPOSED SYSTEM

In this proposed system, the ESP-32 microcontroller is connected to the power supply with the help of an AC adapter. The ESP-32 microcontroller can be connected with the help of a mobile hotspot. The microcontroller can be programmed with the help of an FTDI cable, and the code will be dumped into the ESP-32 microcontroller. The code consists of the locations and also the latitude and longitude of the cable that gets faulted. The ESP-32 module will update the status on the IoT beginner webpage with both the latitude and longitude of the fault cable. The code can be run through the Arduino IDE and then dumped into the ESP-32 module. The ESP-32 will also give the fault location of the cable between nodes also. In this proposed system, along with the ESP-32 microcontroller, the voltage sensors play a vital role. The adapter will give a certain voltage (12 volts) to the sensors, but the sensors will convert to 5 volts, and then the voltages will be displayed on the LCD screen on the ESP-32 microcontroller. The LCD will display the voltages.

Based on the number of voltages, the LCD displays those many voltage values. If there are any voltage changes, the system will give us an update of the voltages through the LCD screen.

There are many cases where faults occur in the system.

Case 1: If the fault occurs between voltage sensors 1 and 2,

The LCD screen will show that the voltage of sensor 1 is the same,but the second and third sensors will be shown as 0 volts due to the breakage of the wire (fault). Due to the fault cable in between voltage sensor 1 and voltage sensor 2, the LCD will display the fault as "fault @1,2" on the screen. Then the ESP-32 module updates the status to the IOT webpage using the Internet.

Case 2: If the fault occurs between sensors 2 and 3,

The LCD screen will show that the voltage of sensor 1 and sensor 2 is the same, while the voltage of sensor 3 will be shown as 0 volts due to the fault between sensor 2 and sensor 3. The LCD will display "fault @2,3" on the screen. Then the ESP-32 module will update the status on the IOT web page.

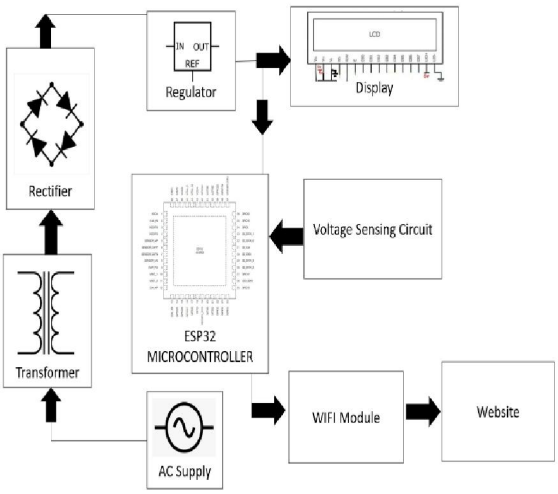

Fig 3.1: Block Diagram of Proposed System

Case 3: If the fault occurs both between voltage sensor 1, voltage sensor 2, and voltage sensor 3,

The LCD screen will show that the voltage of the sensors is the same,but the voltage becomes 0 when it comes to sensors 2 and 3. In this case, the fault will be rectified prior to At first, the fault in between 1 and 2 sensors will be rectified, and then the monitor will show the fault at 2 and 3 sensors, and then it can also be rectified as we know the exact location of the fault cable. With the help of the IOT web page alone,the location of the fault cable can be found.

IV. HARDWARE DESCRIPTION

4.1 ESP32

The ESP32 is a cost-effective system-on-chip microcontroller that offers both single and dual-core variations of the 32-bit Xtensa LX6 microprocessor from Tensilica. It features integrated Wi-Fi and Bluetooth connectivity, with data rates of up to 150Mbps, and includes power amplifiers, low-noise receive amplifiers, antenna switches, and filters that simplify hardware design.

IoT projects, whether small DIY projects or complex industrial applications, require internet connectivity. The ESP8266 is a suitable choice for projects requiring Wi-Fi connectivity, while the ESP32 offers Bluetooth connectivity, high-resolution ADCs, DACs, serial connectivity, and advanced features for more complex applications.

Both the ESP8266 and ESP32 are popular among developers due to their affordability, ease of use, and availability of development boards and resources. They can be used for various applications such as home automation, sensor networks, smart farming, and industrial automation.

Fig 4.1: ESP32 Microcontroller

4.2 Power Supply

A power supply is an electronic device that converts one voltage to another voltage while delivering power. In electronic systems, power supplies are crucial components as they provide the necessary energy to drive the circuitry. Therefore, it is essential to design the power supply carefully to ensure that it provides stable and sufficient voltage to the load.

In amplifier circuits, the power supply plays a critical role in determining the performance of the amplifier. If the power supply cannot meet the amplifier's peak demands or provide a stable voltage, the amplifier's output will be affected, regardless of the amplifier's design.

For valve amplifiers, the power supply must provide a DC high-tension supply for the amplifier and one or more low-tension supplies for the heaters. Typically, the pre-amplifier and power amplifier will derive their power supply from the same source, which is usually integral to the power amplifier. However, this is not always the case.

In recent years, there have been software tools available to designers to help create efficient power supply designs. For example, the Power Supply Unit Designer Version 2 freeware can speed up the design process. However, designers still need to have a good understanding of the underlying principles of power supply design to create an optimal design.

In conclusion, power supplies are critical components in electronic systems, and their design is essential to ensure stable and sufficient voltage is delivered to the load. A well-designed power supply is crucial to the performance of the amplifier, and designers need to understand the underlying principles of power supply design to create an optimal design.

4.3 Buzzer

A buzzer or beeper is a type of audio signalling device that can be mechanical, electromechanical, or piezoelectric. These devices are typically used to signal alarms or confirm user input, such as a mouse click or keystroke. Buzzer sound is produced by applying DC voltage, generating a consistent single tone. With a well-designed resonant system, buzzers can be used in applications requiring high sound volumes. Future Electronics stocks a range of buzzer types, categorized by sound level, frequency, rated voltage, dimension, and packaging type.

When there is any voltage drop the buzzer will automatically will give us an alert,with that we can able to know the fault.

4.4 DC Voltage Sensor

A DC voltage sensor is an electronic device that detects, monitors, and measures the voltage supply of an electrical component. This sensor converts voltage measurements into signals that can be recorded by a specialized electronic device or read manually by an observer. To ensure accuracy, it is important to connect multiple voltage sensors used in a circuit to a common earth. DC voltage sensors use Magnetic Modulation to measure DC voltage and provide an output signal that is proportional to the input voltage.

These sensors can be used for continuous DC voltage monitoring. They are fixed onto a PCB by soldering the secondary circuit pins and can also have an integrated primary connection. The voltage detector signals the presence of a voltage higher than a limit, with galvanic insulation between primary and secondary circuits. Voltage sensors equipped with a microcontroller improve the accuracy, precision, and consistency of readings, and come pre-calibrated. The stored calibration (in Volts) is automatically loaded when the Voltage Sensor is connected.

The voltage sensors will convert the input voltage into physical signal. by taking certain input voltage, the voltage sensors will work. If there is any abnormal changes in voltages, the voltage sensor will update the status of the voltage drop to the ESP32 Microcontroller.

Fig 4.2:DC Voltage Sensor

V. SOFTWARE DESCRIPTION

5.1 Embedded C

Embedded C is a language that addresses the performance differences between Standard C and embedded hardware and application architecture. It adds primitives that are required by signal-processing applications and are commonly provided by DSP processors. The design of support for fixed-point data types and named address spaces in Embedded C is based on DSP-C, which is an industry extension of C used by various DSP manufacturers in their compilers since 1998. Embedded C extends the C language to support freestanding embedded processors by utilizing the multiple address space functionality, user-defined named address spaces, and direct access to processor and I/O registers, all of which are common for small embedded processors used in consumer products. Embedded C introduces fixed-point and saturated arithmetic, segmented memory spaces, and hardware I/O addressing. The description presented here focuses on the extensions from a language-design perspective.

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5.2 Arduino IDE

The Arduino Integrated Development Environment (IDE) is a free and open-source software used to write and upload code to Arduino boards. Its user-friendly interface makes it accessible to both novices and experienced users.

Currently, there are two versions of the Arduino available: IDE 1.x.x and IDE 2.x. The IDE 2.x is a newer major release with a more modern and powerful interface than the previous version. It includes advanced features such as improved code highlighting, code auto completion, and a built-in serial monitor for debugging.

One significant difference between the two versions is that IDE 2.x has higher minimum system requirements, including a 64-bit operating system and at least 8GB of RAM. However, it offers a more optimized and efficient experience in programming and debugging compared to IDE 1.x.x.

In conclusion, both versions of the Arduino IDE are excellent options for programming Arduino boards, with the choice between them depending on the user's preferences and system requirements.

VI. RESULTS

The Underground cable fault Monitoring System is designed as per block diagram given in Fig:3.1. the developed version of Kit is given below.

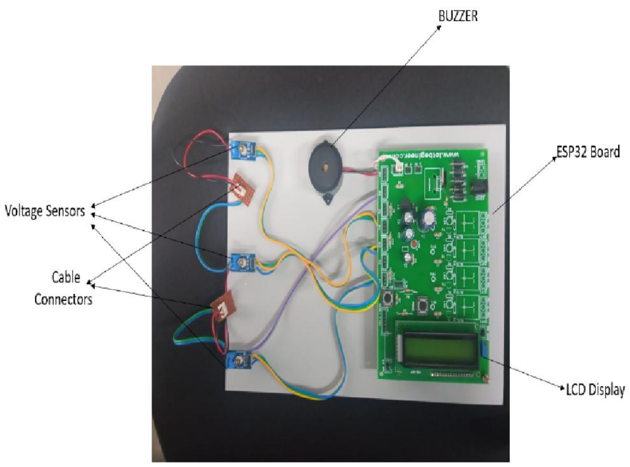

Fig 6.1: Underground cable fault Monitoring System

However when a fault occurs in underground cable.the voltage at the fault will be varies and voltage at the fault Point will be zero and it will be displayed in two ways.one is in LCD display and other one is in Iot Webpage.

Fig 6.2: LCD display when fault occur

The Information regarding the faults will be updated to Webpage with Exact Location Coordinates(Latitude and Longitude) will be updated in the Webpage along with time and date of the faults.

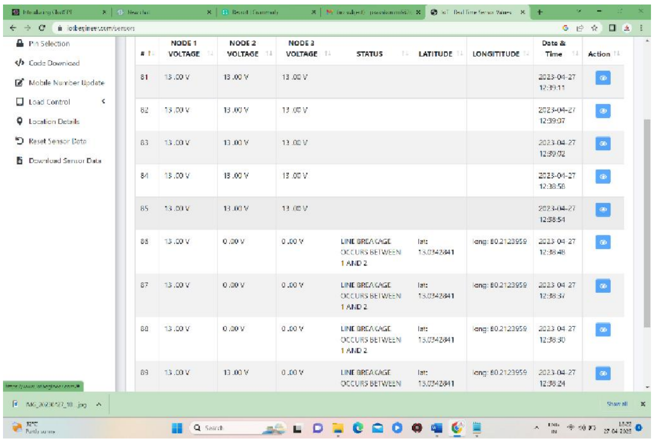

Fig 6.3: Iot webpage for Monitoring

#	NODE 1 VOLTAGE	NODE 2 VOLTAGE	NODE 3 VOLTAGE	STATUS	LATITUDE	LONGITITUDE	Date & Time	Action
81	13 .00 V	13 .00 V	13 .00 V				2023-04-27 12:39:11	
82	13 .00 V	13 .00 V	13 .00 V				2023-04-27 12:39:07	
83	13 .00 V	13 .00 V	13 .00 V				2023-04-27 12:39:02	
84	13 .00 V	13 .00 V	13 .00 V				2023-04-27 12:38:58	
85	13 .00 V	13 .00 V	13 .00 V				2023-04-27 12:38:54	
86	13 .00 V	0 .00 V	0 .00 V	LINE BREAKAGE OCCURS BETWEEN 1 AND 2	lat: 13.0342841	long: 80.2123959	2023-04-27 12:38:48	
87	13 .00 V	0 .00 V	0 .00 V	LINE BREAKAGE OCCURS BETWEEN 1 AND 2	lat: 13.0342841	long: 80.2123959	2023-04-27 12:38:37	
88	13 .00 V	0 .00 V	0 .00 V	LINE BREAKAGE OCCURS BETWEEN 1 AND 2	lat: 13.0342841	long: 80.2123959	2023-04-27 12:38:30	
89	13 .00 V	13 .00 V	0 .00 V	LINE BREAKAGE OCCURS BETWEEN	lat: 13.0342841	long: 80.2123959	2023-04-27 12:38:24	

Fig 6.4: Readings of webpage

VII. CONCLUSION

The drawback of the Existing System is we cannot find the fault of the Underground cable with Exact Location and also Continuous Monitoring is not possible. These drawback can be over comed by this paper that is we can find the exact location of fault with GPS coordinates and also it will monitor the cables continuously.

VIII. FUTURE SCOPE

This paper only presents how to find the location of the fault. In Future it may be possible to have a secondary connection in the underground.

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