



UNDERGROUND CABLE FAULT DETECTION SYSTEM USING IoT

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Abstract - The Underground Cable Fault Detection System Using IoT is intended to detect the exact 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. IoT has its major contribution in fault diagnosis and prediction of the physical devices by analyzing the device without the knowledge of the physical manufacturing system. 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 the process of repairing that particular cable. The proposed system finds the exact location of the fault. We use Ohms law principle to detect and verify failures over the internet by authorities, here the Arduino board that is an IoT component functions as a machine brain and handles the sensor data. The machine detects errors by using the future cable-wide divisor network. When a failure occurs when two lines are cut, a certain voltage will be generated according to a combination of the resistance network. The fault occurring node and the exact location is sent to the user through IoT using Ubidots platform.

Keywords - Relay, Arduino, Ohm's Law, IoT, Ubidots

I. INTRODUCTION

Power supply networks are constantly expanding, and their dependability is more critical than ever. The whole network's complexity includes several 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 voltage and medium voltage distribution lines. Underground high voltage cables are increasingly being used since they are not affected by weather conditions such as strong rain, storms, snow, and pollutants. Even though 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 fitted can survive for roughly 30 years. However, cables can be easily damaged by incorrect installation or poorly executed jointing, as well as subsequent third-party damage by civil works such as trenching or curb edging.

As a result, we offer a cable fault detection over IOT that detects the exact position of the defect over IOT, making repair work much simpler. The worker knows exactly which part has the fault and only that area is to be dug to detect the fault source. This saves a lot of time, money and efforts which allows to service underground cables faster. We use IOT technology that allows the authorities to monitor and check faults over internet. The system detects fault with the help of potential divider network laid across the cable. Whenever the fault 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 the voltage corresponds. The microcontroller retrieves the fault line data and displays over LCD display, also it transfers this data over internet to display online through Ubidots platform.

II. EXISTING TECHNIQUES

Underground cables are used in power systems to convey electric power from generator stations to distribution points, where it is subsequently delivered to consumer ends. Underground cables suffer a variety of issues owing to aging and other forms of defects. A lot of study has already been done to solve these challenges with cables. We provided a solution to these issues here. Previously, there were numerous methods for detecting faults. These approaches are used to detect faults in underground cables.

They are

- Murray Loop method
- Sectionalizing method
- Thumping method

Murray Loop Method:

This technology is mostly used to locate flaws in earth cables. This system is based on the Wheatstone bridge principle. A Wheatstone bridge can be used to pinpoint the location of a problem in an earth cable. The Murray loop approach is used to expose faults. This procedure is quite simple. This approach is used to detect short circuit defects in subterranean power lines. This loop test is commonly used to detect defects in earth cables. This trial is founded on Wheatstone Bridge law. This experiment may be used to locate a fault in an earth wire by arranging a Wheatstone bridge in it. In this scheme, we must first install a sound cable of equal length to the defective cable. The cable with no errors is referred to as a sound cable, and we must short circuit the ends of the sound cable and the problematic cable. Now we attach a galvanometer to the beginnings of both the functional and non-working cables. Now, we connect two resistors across the working and non-working connections in such a way that both resistors are changeable. The full loop will now create a Wheatstone bridge. Then, via the ground, we connect one battery. To balance the bridge, we adjust the values of both resistors until the galvanometer reads zero. We will identify the weak point by comparing the resistances. We need to know the values of both resistances.

Sectionalizing Method:

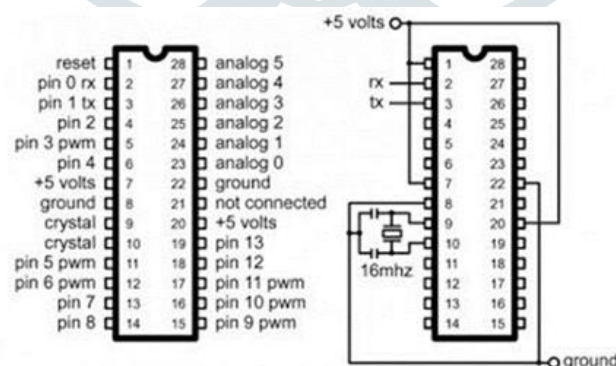
This procedure entails physically cutting and splicing the cable, which can compromise its reliability. The cable must be separated into small portions in order to detect the defect using this procedure. For example, on a 400-foot cable, the wire is cut into 200-foot portions, and readings are taken 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 method must be repeated until the fault site is identified.

Thumping Method:

To detect the defect, this 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 approach is simpler than Sectionalizing, but it requires a strong 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.

III. HARDWARE DESCRIPTION**1. ARDUINO UNO:**

Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button. Arduino can be used to communicate with a computer, another Arduino board or other microcontrollers. The ATmega328P microcontroller provides UART TTL (5V) serial communication which can be done using digital pin 0 (Rx) and digital pin 1 (Tx). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. There are two RX and TX LEDs on the Arduino board which will flash when data is being 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 allows for serial communication on any of the Uno's digital pins. The ATmega328P also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus.



2. RELAYS:

A relay is an electrically operated switch. They commonly use an electromagnet (coil) to operate their internal mechanical switching mechanism (contacts). When a relay contact is open, this will switch power ON for a circuit when the coil is activated. Relays allow a low current circuit to control one or more higher current circuits. Thinner cables can be used to connect the control switch to the relay thereby saving weight, space and cost. Relays allow power to be routed to a device over the shortest distance, thereby reducing voltage loss. Heavy gauge cable only needs to be used to connect a power source (via the relay) to the device. Here the relay is designed to cut the high-current load lines.



3. LCD:

LCD (Liquid Crystal Display) is a type of flat panel display that operates primarily with liquid crystals. LCD gets its definition from its name. It is a mixture of two states of matter, solid and liquid. A liquid crystal is used to create a visible image on an LCD. When compared to cathode ray tube (CRT) technology, LCD technologies enable displays to be much thinner. The pixels in an LCD television are turned on and off electronically utilizing liquid crystals to spin polarized light. LCDs are utilized in a variety of applications, including LCD televisions, computer monitors, instrument panels, cockpit displays in airplanes, and indoor and outdoor signs. LCDs (Liquid Crystal Displays) are utilized in embedded system applications to show various system characteristics and status. The LCD 16x2 is a 16-pin device with two rows of 16 characters each. LCD 16x2 can be utilized in either 4-bit or 8-bit mode. It is also possible to make your own characters. It features eight data lines and three control lines that can be used for control.



4. STEP DOWN TRANSFORMER:

By boosting the electrical current, step-down transformers reduce the voltage entering to the site. This is accomplished by converting the high input 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 utilized in this case to reduce the high voltage to low voltage while increasing the electrical current.



5. NODE MCU:

Node MCU is an open-source platform based on the ESP8266 that can link objects and allow data transfer over 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 may connect it to serial devices such as I2C equipped 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.



6. BRIDGE RECTIFIER:

The bridge rectifier is a form of full-wave rectifier that converts alternating (AC) current to direct (DC) current by using four or more diodes in a bridge circuit topology. A suitable bridge rectifier is chosen based on the load current requirements. When selecting 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.



7. GPS MODULE:

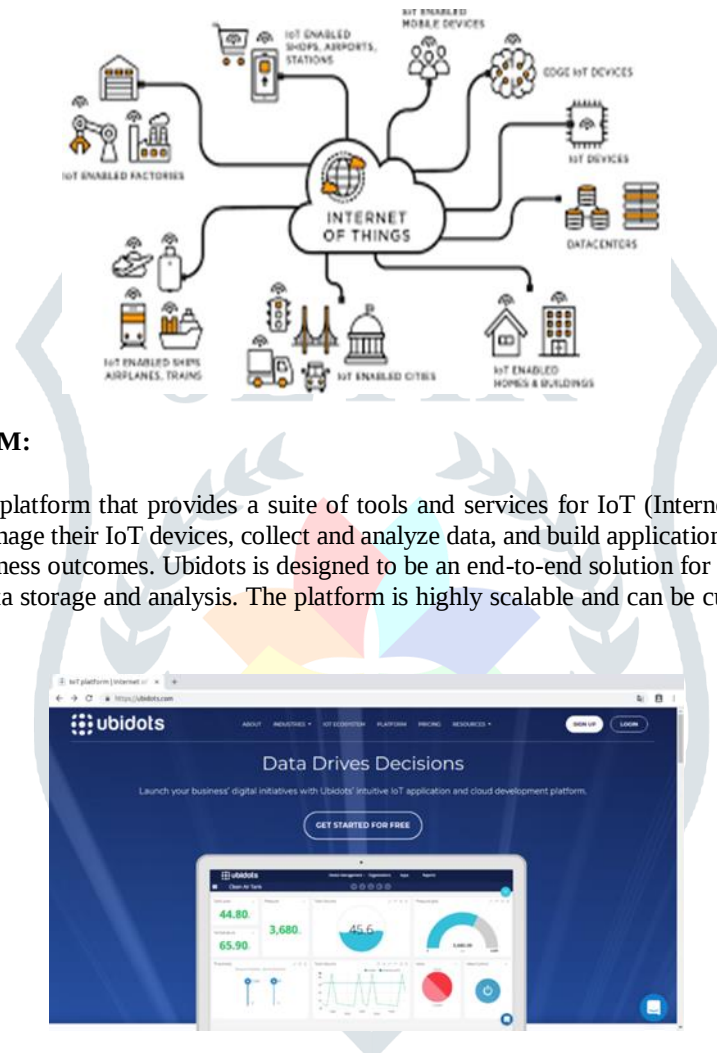
A GPS module, also known as a Global Positioning System module, is a device that receives GPS satellite signals and uses those signals to calculate its precise location and time. A GPS receiver and an antenna are normally included in the module, but other components such as a microprocessor, memory, and interfaces for interfacing with other devices may also be included. GPS modules can be used for a variety of purposes, including: GPS modules are widely used in navigation systems for cars, boats, and aircraft, as well as handheld GPS devices for outdoor activities such as hiking and camping. GPS modules are frequently used in emergency services such as search and rescue to help locate people in difficulty. Precision agriculture makes use of GPS modules to help farmers maximize their usage of fertilizers, herbicides, and water by mapping the exact location and terrain of their fields.



IV. SOFTWARE DESCRIPTION

1. INTERNET OF THINGS(IoT):

The Internet of Things (IoT) is a network of physical devices, vehicles, buildings, and other objects equipped with sensors, software, and network connectivity. These devices can gather and exchange data with one another as well as with other systems via the internet. The IoT devices range from simple sensors and actuators to large machines and vehicles. They can be found in a variety of settings, including homes and offices, as well as factories, farms, and public spaces. Sensors in IoT devices are meant to detect environmental changes such as temperature, humidity, light, sound, motion, and other variables. They are also capable of measuring physical parameters such as pressure, speed, and acceleration. The data acquired by these sensors is subsequently transmitted to a central system or cloud-based platform for processing and analysis. This data can be utilized to remotely monitor and control systems, automate operations, and obtain insights into the behavior of objects and their environments.



2. UBIDOTS IoT PLATFORM:

Ubidots are a cloud-based platform that provides a suite of tools and services for IoT (Internet of Things) applications. They enable users to connect and manage their IoT devices, collect and analyze data, and build applications that leverage this data to create new services and improve business outcomes. Ubidots is designed to be an end-to-end solution for IoT projects, offering everything from device connectivity to data storage and analysis. The platform is highly scalable and can be customized to meet the needs of a wide range of IoT applications.



V. WORKING OF PROPOSED METHOD

Underground cables due to underground stresses, wear and tear, rodents, etc. They are subjected to a variety of defects. It is also difficult to detect fault sources. To inspect and repair the failure, the whole line has to be dug. We, therefore, propose an Underground Cable Fault Detector that detects the exact position of the defect and simplifies the repair. IoT has its major contribution in fault diagnosis and prediction of the physical devices by analyzing the device without the knowledge of the physical manufacturing system. To locate the root of the problem, the worker knows which component is defective and the region to be dug. This saves a lot of time, money, and effort and enables simple underground cable maintenance. This saves a great deal of time, money, and effort and allows for easy cable maintenance in the underground.

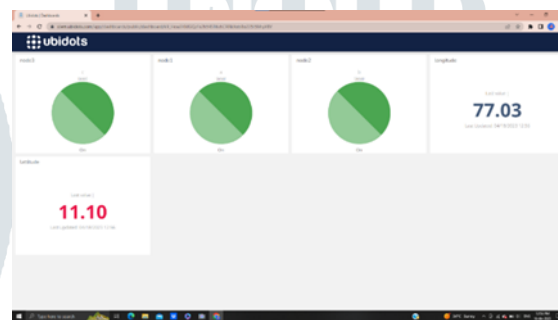
We use Ohms law principle to detect and verify failures over the internet by authorities, here the Arduino board that is an IoT component functions as a machine brain and handles the sensor data. The machine detects errors by using the future cable-wide divisor network. When a failure occurs when two lines are cut, a certain voltage will be generated according to a combination of the resistance network with nodes 1, 2, 3. The microcontroller senses this voltage and is modified. The information that the consumer receives is the distance that corresponds to this voltage. The microcontroller collects fault line data and displays the exact location, phase and time as an alert message through IoT using Ubidots platform. Ubidots can be used to enhance this process by providing additional capabilities such as real-time monitoring and automated fault detection.

VI. RESULT

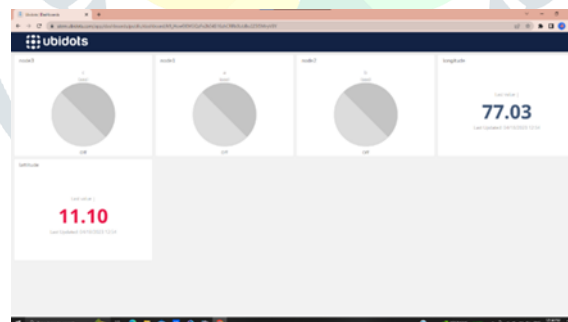
The results are displayed on the Ubidots platform which represents the failure that occur in each node. It also displays the exact location by the latitude and longitude value.



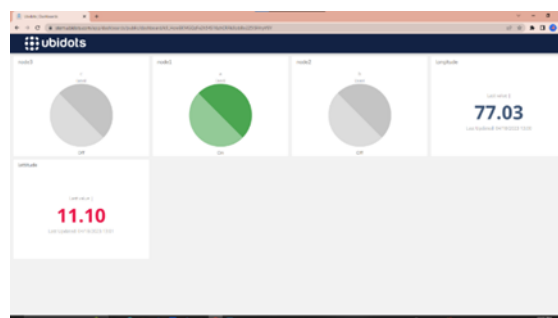
The output -1 for when all the nodes 1, 2, 3 has no fault, it represents 3 nodes with green color as shown in the figure below.



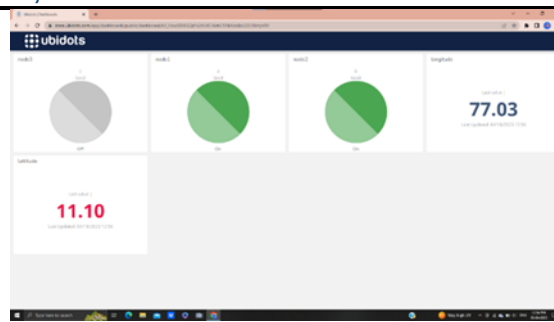
The output - 2 for when node 1 has fault, all the nodes will be representing as none as shown in the figure below.



The output - 3 for when node 2 has fault, the node 1 will only glow with green color remaining node 2, 3 will be representing as none as shown in the figure below.



The output - 4 for when node 3 has fault, the nodes 1, 2 will only glow with green color is shown in the figure below.



VII. CONCLUSION

By using this Underground Cable Fault Detection System using IoT, the faults occurring in cables can be easily identified along with their exact location using Ubidots platform. The nodes that are being used with the help of relays (switch) are placed at a certain distance, helps to identify the fault in the cables. The drawback in identifying the cable faults have been overcome by using this Underground cable fault detection system using IoT.

VIII. REFERENCES

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