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Underground Cable Fault Detection and Monitoring System

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Abstract: *Underground cables were widely used in the development of the power grid. Underground cables are susceptible to a variety of failures due to subsurface conditions, wear and tear, and rodents. Identifying the source of the fault is difficult because the entire line must be dug to verify the fault on the cable line. Mechanics know exactly which part is at fault and only that area needs to be dug to determine the source of the fault. This saves a lot of time and money and allows for faster maintenance of underground cable lines. The aim of this project is to determine the distance of an underground cable fault from the base station in km.*

Keywords: Underground, Fault , Detect , Money , Repairman, Save The Time

I. INTRODUCTION

A cable is a bundle of electrical conductors used to transmit electricity. An underground cable generally has one or more conductors covered with appropriate insulation and a protective sheath. Varnished batiste or impregnated paper are usually used for insulation. A fault in a cable can be any defect or inhomogeneity that redirects the current path or affects the performance of the cable. It is difficult to locate the fault in the underground cable. We find the exact location of the error. Since the world is now digitized, the project consists of finding the exact location of the error in digital form. Underground wiring systems are a more common practice in many urban areas. Although the error occurs for some reason, the repairing process for that particular cable is difficult at this point because : Open Circuit Fault: - In an open circuit fault, no current flows because there is no conductive complete loop for the current I=0 to flow. With this error, the supply voltage is equal to the output voltage. An open circuit fault is better than a short circuit fault. Short Circuit Fault: – In this fault, the output voltage is zero but the current is the same. Other short-circuit faults can be classified into two types: Balanced fault: - In this fault, the line current is equal and the current is equal phase shift. Unbalanced Fault: – In this fault, the current is not equal and the phase shift is not equal by 120 degrees. Terminal method: This method is used for detection.

The biggest problem was maintenance difficulties. It wasn't until the mid-1960s that technology was sufficiently advanced for a 345 kV high-voltage line to be laid underground. However, the lines were still filled with liquid. This led to significant maintenance, contamination and infrastructure problems. In the 1990s, the first solid cable transmission line was built, more than a mile long and more than 230 kV. It demonstrates the advanced technology in developed countries for preventing fires and reducing the susceptibility of power lines to failures during severe thunderstorms or severe snow or ice storms. An additional advantage of burial is the aesthetic quality of the landscape without power lines. Burial can increase the initial cost of power transmission and distribution, but it can also reduce operational costs.

II. LITERATURE SURVEY

Literature survey of underground cable fault detection

In this project, the distance of the underground cable fault from the base station is to be determined in kilometers. Underground cable systems are widespread in large parts of large cities. Also, if for some reason a fault occurs, the repairing process for that particular cable is difficult at this point because the exact location of the fault in the cable is unknown. This technology is used to find out the exact location of the error, which will be displayed on the LCD screen and send the SMS to the mobile phone at that time.The project uses the standard theory of Ohm's law, i. H. when a low DC voltage is applied across a series resistor (cable lines) at the feed end, the current will vary depending on the location of the fault in the cable as resistance is proportional to distance. In the event of a short circuit (line to ground), the voltage across the series resistors will change according to the resistance, which will change with distance. This is then fed to an ADC to produce precise digital data that the programmed 8051 family microcontroller displays in kilometers.

Presented Analysis of Underground Cable Fault Distance Locator.

faults occur in Underground power cables occur due to some reasons is poor workmanship during cable laying,underground conditions, rodents etc. In addition, it is difficult to determine the source of the fault and it is necessary to dig the entire line to inspect and troubleshoot the entire line. Therefore, here we made a cable fault detection in IOT base broject, which detects the exact fault location with the help of ardino uno board , which makes repair work very easy. Mechanics know exactly which part is faulty and only need to dig in that area to determine the source of the fault. This saves a lot of time, money and effort and also enables faster maintenance of underground cables. We use IoT technology that updates the monitored error information on the internet. Whenever a fault occurs at a point that shorts two lines, a certain voltage is generated according to the network combination of resistors. This voltage is measured by microcontroller. The information transmitted to the user is error detection informationError location via IOT, which makes repair work very easy. Mechanics know exactly which part is faulty and only need to dig in that area to determine the source of the fault. This saves a lot of time, money and effort and also enables faster maintenance of underground cables. We use IoT technology that updates the monitored error information on the internet. when The fault occures in system the voltage, current, line impedance is change, and then detects the faults using a potential divider network placed across the cable. Whenever a fault occurs at a point that shorts two lines, a certain voltage is generated according to the network combination of resistors. This change voltage is captured the microcontroller and updated to the user. The information sent to the user is error detection and error location information via IOT, which makes repair work very easy. Mechanics know exactly which part is faulty and only need to dig in that area to determine the source of the fault. This saves a lot of time, money and effort and also enables faster maintenance of underground cables. We use IoT technology that updates the monitored error information on the internet. The system detects faults using the potential isolation network laid over the cable. Whenever a fault occurs at a point that shorts two lines, a certain voltage is generated according to the network combination of resistors. his voltage is captured by the microcontroller and updated to the user. The information transmitted to the user is error detection information

Static bypass system

Static Transfer Switches (STS) are designed to transfer power between independent single-phase or three-phase AC sources. Unlike traditional Automatic Transfer Switches (ATS), STS enables 20 times faster load transfer (typically 1/4 of a cycle), ensuring uninterrupted operation of even the most sensitive electronic equipment. Load retransmission to a preferred input source is virtually instantaneous (typically 100s). The main applications of STS are in automatic systems for the energy industry, power supply systems for the petrochemical industry, computer and telecommunications centers, operating rooms, intensive care units, automatic and security systems of smart buildings, as well as other equipment that is extremely sensitive to supply interruptions. Its high overload capacity and its transmission algorithm enable the fuse to trip quickly in the event of short circuits. As a result, the voltage immediately returns to normal to power other loads. The integrated transient voltage suppression system for SCR switches provides additional protection against damage to powered devices. Ability to build systems with redundancy (switching between independent power supply lines, different UPS devices and generators)

Features / Benefits of Static Bypass System

1. Short transfer time (typically 3 ms after line failure)
2. Elimination of voltage swells, sags and interruptions on loads (switch-over)
3. Protection against voltage variations out off range Switches are controlled by Fail-Safe CMOS Logic

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4. Internal redundancy for power supply systems and SCR drivers (eliminating failures in single points)
5. Easy to operate Easy to install Lowest MTTR (mean time to repair)
6. Low installation and maintenance costs
7. Bypass switches to provide continuous non-break operation during STS maintenance
8. Remote switching of power sources
9. Status indication for power supply system and STS

Arduino Based Underground Transmission Cable Fault Location System.

Locating transmission line faults requires enormous human effort and resources. Usually this process is time consuming and there is a risk of damaging the insulation when digging up the cable. This document offers a simple and secure alternative by automating the process of error detection and location. The project uses the simple concept of the OHM law, where a low DC voltage is applied at the feed end through a series resistor. When LL, 3L, LG, etc. short circuit, the current varies depending on the fault length of the cable. The voltage drop of the series resistance changes accordingly, which allows the exact location of the fault to be determined and the particular cable to be repaired. The proposed system finds the exact fault error in cable . This system is uses a Arduino microcontroller kit and a rectified power supply. Here the current sensing circuits made up of a combination of resistors are connected to the Arduino microcontroller kit to use the internal ADC device to provide the microcontroller with digital data representing the cable length in kilometers. Error generation is done by the set of switches. The relays are controlled by the relay driver system. A 16x2 LCD display is connected to the microcontroller to display the fault location, fault type, and fault regarding information. In the incident of a short circuit befall, the voltage across the series resistors changes accordingly to failt distance, which is then fed to an ADC to provide precise digital data to a programmed in Arduino microcontroller kit, which also displays the exact fault location in kilometers from kit connecting station

Underground Cable Fault Detection using Arduino nano.

This article proposes a fault location model for ground current. The aim of this method is to find the exact location of fault point in kilometers of the underground cable and also fault types. This article uses the simple concept of current transformer theory (CT theory). When a fault such as a short circuit occurs, the voltage drop varies depending on the length of the fault in the cable. As the current varies, a current transformer is used to calculate the varying current. The signal conditioner manipulates the fault occures in system the system voltage change and a microcontroller performs the necessary calculations to display the fault distance from arduino board devices. These error details are then sent to the mobile phone via SMS.

III. PROCEDURE

The power supply has an AC power supply, transformer, rectifier and voltage regulator. AC power is supplied through the step-down transformer. The transformer transfers electrical energy between circuits by electromagnetic induction. By using the transformer we can increase or decrease the AC voltage in power applications. The step-down voltage goes to the rectifier unit. A rectifier is used to convert an AC power Powered by a DC power supply. Bridge rectifiers are used in this project. This DC voltage is fed to the controller unit. The regulator keeps the voltage constant. Here we use the 7805 voltage regulator which maintains the 5V DC supply. This voltage is give to the Arduino kit. A program has been written that will stop the system from operating if a fault occurs in the cable. Otherwise the system works as usual. Nowadays, integrated systems are no longer functional without Arduino Uno.Regulator maintains the constant voltage. Here we use 7805 voltage regulator which maintain the 5V DC supply,Thisvoltageis fed to the Arduino kit. A program was written if any fault occurs in the cable, then it will divert working of the system. Otherwise the system works as usually. Now days allembedded systems are not works without Arduino Uno.

The circuit consists of a power supply, a 4-line display, an Arduino, and a resistance measurement circuit. To trigger errors manually in the kit, error switches are used. Approximately 12 fault switches are used, arranged in three rows with each row having 4 switches. The 3 rows represent the 3 phases, namely R, Y and B. The fault switches have 2 positions: "OFF fault" position (f) and "ON position" (NF). The main part of the underground cable fault detection circuitry is the low resistance measurement. It is built with a constant current source of 100mA. It can measure very low resistance values as the cables have a resistance of around 0.01 ohms/meter. For 10 meters the cable resistance is 0.1 ohms. Resistances up to 50 ohms can be measured with this circuit.

The maximum cable length can be up to 4 kilometers. Starting from the reference point, three sets of resistors are connected in series. These three sets of resistors represent the three phases and neutral. Short-circuit faults, symmetrical and asymmetrical faults can be determined using this method. This project uses three resistors in series (e.g. R10, R11, R12, R12, R17, R16, R14, R21, R20, R19, R18 and R25), one for each phase. Each series resistance value is selected with represents to resistance of the underground cable for a certain distance, etc. Here four resistances in series represent 1-3 km. The value of each resistor is 10,000

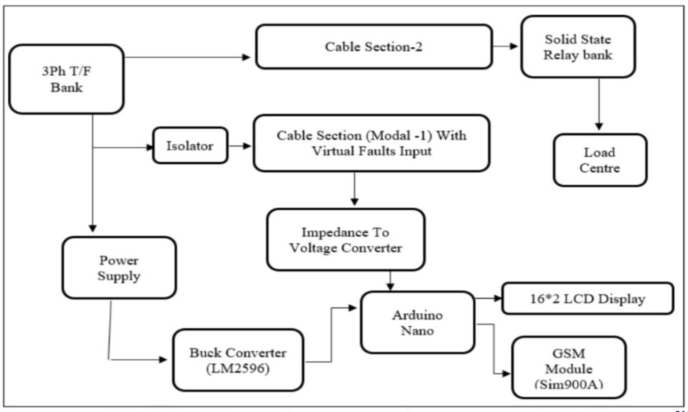
One relay for each phase R, Y and B as three relays are used and the common points of the relays are grounded and the NO points are connected to the inputs of R17, R21 and R25 forming the input of the three phase cable. Since the supply required for the relays is higher than that of the Arduino, a relay driver is used to increase the supply and provide it to the relays. A 230 VAC supply is applied to the transformer and from there it is stepped down to 12 VAC. From the transformer, the alternating current is converted to direct current as it flows through a bridge rectifier. The 12VDC then goes to the voltage regulator where it is converted from 12VDC. The 5VDC voltage regulator also converts the variable DC supply to a constant DC supply. This 5V DC is used to power the Arduino and the LCD. The LCD is powered by the voltage regulator

If a fault is induced by actuating any of the 12 switches (to the F position), they will force conditions such as LG, LL, LLG faults depending on the switch actuation. As a result of the error, there is a change in the voltage value. This voltage value measured across the resistor is fed to the Arduino's ADC. The Arduino uses this value to calculate the distance. Finally, the distance of the interference from the base station is displayed in kilometres

IV. COMPONENTS USED IN MODEL

COMPONENTS	RATINGS
Transformer	230/12V
Arduino Nano	Atmega328p
Resistor	10ohm
Resister	180ohm
LED	3mm
SIM900A	BC547
Inductor	100mhenry
Switches	ON/OFF 205A
Relay	12V
Diode	1n4007
Filter Capacitor	470
Connecting Wires	0.25sq.mm

4.1 Block Diagram



4.2 Block Diagram Description

- **Power supply:** For powering al the controllers and communication devices power supply is used. This power supply is of SMPS (switch mode power supply) type. Having output voltage in the range of 3.3v to 24v. For our operation we need 5v regulated output.
- **Transformer bank:** Our project model is designed for 3phase cable model. So for safer operating voltage we need to step down the incoming voltage to a safe limit. Thus transformer is used for voltage step down purpose having primary voltage as 230v AC Single phase and output voltage 12V AC at 500mAmp.
- **Solid state circuit breakers**: Solid state circuit breakers are uses for static bypass purpose under the fault condition. If fault occurs on the main cable it is very important to share the load .thus to maintain the reliability of supply alternative cable is used. Thus, to from one cable unit to another static solid state circuit breakers are used.
- **Healthy cable unit:** To maintain the reliability of power at the receiving end under the fault condition on the main cable unit another alternative cable unit is used. Known as healthy cable unit
- **Electrical modal of cable:** For proper analysis of the fault in the cable we need a exact electrical model of the cable with actual design parameters. So that accuracy in fault location tracking is possible.
- **Load:** the consumer end where power is to be maintained constantly reliable.
- **Cable parameters measurement unit**: In this section all the parameters of the cable is to be measured and analyzed by controller for proper analysis of the fault.
- **Arduino controller**: For analysis of the fault and cable parameters a digital controller is used. After analysis fault types and its distance from reference point controller develops a small report regarding fault type.
- **Bluetooth module**: For transferring the fault analysis report form the controller to the mobile phone of maintenance engineer or control room wireless communication using Bluetooth module.

V. FUTURE SCOPE

The future scope for an underground cable fault detection system project is quite promising. With the increasing demand for reliable and efficient power transmission systems, the need for effective fault detection systems is growing rapidly. Here are some potential areas of future development for such a system: In this project we use Arduino to determine the exact location of the short circuit fault in the underground cable from the feed end in km. In the future, this project can be implemented to calculate impedance using a capacitor in an AC circuit to measure open circuit errorIn this project we use Arduino to determine the exact location of the short circuit fault in the underground cable from the feed end in km. In the future, this project can be implemented to calculate impedance using a capacitor in an AC circuit to measure open circuit error

1. **Integration with IoT:** The integration of underground cable fault detection systems with the Internet of Things (IoT) can provide real-time monitoring and remote-control capabilities, enabling faster fault detection and response times.
2. **Use of AI and Machine Learning:** The use of Artificial Intelligence (AI) and Machine Learning (ML) can help to improve the accuracy of fault detection and reduce false positives. This can also enable the system to learn and adapt over time to improve performance.
3. **Wireless Communication:** The use of wireless communication technologies such as Wi-Fi, ZigBee, and Bluetooth can help to eliminate the need for physical connections between the detection system and the control center, making the system more flexible and easier to deploy.
4. **Smart Grid Integration:** The integration of underground cable fault detection systems with smart grid technology can help to create a more efficient and reliable power distribution system by enabling real-time monitoring and control of power flows.

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