CENTRALIZED UNDERGROUND CABLE FAULT DETECTOR

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ABSTRACT

Underground cables are prone to a wide variety of faults due to underground conditions, wear and tear, rodents etc. Diagnosing fault source is difficult and entire cable should be taken out from the ground to check and fix faults. The project work is intended to detect the location of fault in underground cable lines from the base station in km using a controller. To locate a fault in the cable, the cable must be tested for faults. 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. The prototype is modeled with a set of resistors representing cable length in km and fault creation is made by a set of switches at every known distance to cross check the accuracy of the same. The fault occurring distance, phase, and time is displayed on a 16X2 LCD interfaced with the microcontroller.

This project focuses on developing an underground cable fault detection system that uses a central hub to monitor the cables. The system consists of sensors connected to the cables, which continuously monitor the electrical parameters of the cables. When a fault occurs, such as a short circuit or open circuit, the sensors detect the change in parameters and send a signal to the central hub. The central hub processes the signals from the sensors to determine the location of the fault. It then alerts the maintenance team about the fault location, allowing them to quickly locate and repair the fault. This system reduces downtime and improves the overall reliability of the power distribution system.

The project implements this system using microcontrollers and wireless communication modules for sensor nodes. The central hub is equipped with a microcontroller and a communication module to receive data from the sensors and relay information to the maintenance team.

Keywords: Underground, fault detection, Central hub, Microcontrollers, Cost effective , Wireless communication, Alert system.

I. INTRODUCTION

In this project we proposed a fault localization model for the underground cable lines with Arduino. The purpose of this paper is to determine the distance from the base station's underground cable fault in kilometres. In this project we used simple concept of ohm's low. When a fault occurs in the system the distance located on liquid crystal display (LCD). Until the last decade, cables were designed to be placed above the head and, at present, there is no underground cable that is higher than the previous method. adverse weather conditions such as storms, snow, torrential rains and pollution does not affect on underground lines But when a fault occurs in underground lines it is difficult to locate the fault in underground cable. We will find the exact location of the fault. Now the world has become digitized so, the project is to detect exact location of the fault in digital form. Underground cabling system is a more common practice in many urban areas. Although the fault occurs for some reason, at that time, the repair process for this particular cable is difficult because of not knowing the exact location of the cable breakdown. Fault in cable can be classified in two groups: Open circuit fault:-In open circuit fault there is no current because there no conducting complete loop for current flowing that is I=0.in this fault supply voltage is equal to the output voltage. Open circuit fault is better than short circuit fault.. Short circuit fault:- In this fault output voltage is zero but current is same Further short circuit fault can be categorized in two types: Symmetrical fault:- In this fault :equal lead current and equal

phase shift. Unsymmetrical fault: - In this fault magnitude of current is not equal & phase shifting is not equal by 120 degree. Terminal method:- in this method used to detect the fault location in underground lines without any effort This method used to locate the type of circuit occurs; the voltage drop varies with the default length on the cable, as the current varies. A plurality of resistors is used to represent the cable and a DC voltage is supplied at one end and the defect detected by detecting the voltage variation the defect area to accelerate the tracking of the buried cable

II. LITERATURE SURVEY

Presented Design & Implementation Of Fault Identification In Underground Cables Using IOT This project is to determine the distance of underground cable fault from the base station in kilometres and displayed over the internet. Underground cable system is a common followed in major areas in Metro cities. While a fault occurs for some reason, at that time the fixing process related to that particular cable is difficult due to exact unknown location of the fault in the cable. This Technology is used to find out the exact location of the fault and to send data in graphical format to our website using a GSM module at the same time it display on the LCD screen.

The project uses the standard theory of Ohms law, i.e., when a low DC voltage is applied at the feeder end through a series resistor (Cable lines),then the current would vary depending upon the location of the fault in the cable as the resistance is proportional to the distance. In case there is a short circuit (Line to Ground), the voltage across series resistors changes according to the resistance that changes with distance .This is then fed to an ADC to develop precise digital data which the programmed microcontroller of the 8051 family displays in kilometres.

Presented Analysis of Underground Cable Fault Distance Locator . Underground cables are prone to a wide variety of faults due to underground conditions, wear and tear, rodents etc. Also detecting fault source is difficult and entire line is to be dug in order to check entire line and fix faults. So here we propose cable fault detection over IOT 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. This saves a lot of time, money and efforts and also allows to service underground cables faster. We use IOT technology that updates the monitored fault information to internet. 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 information regarding faults detection.

Arduino Based Underground Transmission Cable Fault Location System. The transmission line fault location requires intense human effort and resources. Typically this process is time consuming and while digging the cable there is a risk of damaging the insulation .This paper provides a simple and safe alternative by automating the process of fault detection and location. The project uses the simple concept of OHMs law where a low DC voltage is applied at the feeder end through a series resistor.

The current would vary depending upon the length of fault of the cable in case there is a short circuit of LL or 3L or LG etc. The series resistor voltage droop changes accordingly which detects the exact location of the fault for process of repairing that particular cable. The proposed system finds the exact location of the fault. This system uses an Arduino micro controller kit and a rectified power supply. Here the current sensing circuits made with a combination of resistors are interfaced to Arduino micro controller kit to help of the internal ADC device for providing digital data to the microcontroller representing the cable length in kilometres.

The fault creation is made by the set of switches. The relays are controlled by the relay driver. A 16x2 LCD display connected to the microcontroller to display the information. In case of short circuit, the voltage across series resistors changes accordingly, which is then fed to an ADC to develop precise digital data to a programmed Arduino micro controller kit that further displays exact fault location from base station in kilometres. The project in future can be implemented by using capacitor in an AC circuit to measure the impedance which can even locate the open circuited cable.

Presented Underground Cable Fault Detector Using GSM. The main aim of the project is to detect and locate the fault in underground cable . In the urban areas, the electrical cable runs in undergrounds instead of overhead lines. Whenever the fault occur the repairing process becomes difficult. It is very difficult to identify the exact location of the fault in underground power cable line. This project will ensure a shorter response

time for technical crew to rectify these faults . Fault occur due to short circuit fault, low voltage fault , high voltage fault. Previously proposed technique is used to identify short circuit fault only. This project is used to detect not only detect short circuit fault but also detect ,low voltage fault, high voltage fault. The system developed here works on the basis of Ohm's law. The proposed technique is used not only for identification but also it is used to send the detail information about the fault to the authority using GSM and also it cut the power supply on that particular location for the security of the people .It also used to display the type of the fault in LCD display. Whenever a fault occurs in a cable the buzzer produces the sound to alert and to take an immediate action

Underground Cable Fault Detection using Raspberry Pi and Arduino. This paper proposes fault location model for underground power cable using raspberry pi and the Internet of Things which is based on the internet, which means the information will be transferred through the internet access. The aim of this method is to determine the distance of underground cable fault from base station in kilometres and also find the location of that faulty place. This paper uses the simple concept of Current Transformer Theory (CT Theory). When any fault like short circuit occurs, voltage drop will vary depending on the length of fault in cable; since the current varies Current Transformer is used to calculate the varying current. The signal conditioner manipulates the change in voltage and a microcontroller is used to make the necessary calculations so that the fault distance is displayed by IOT devices. These fault details are after sent to any access point through the internet and displayed

III. SYSTEM ANALYSIS AND DESIGN

A. Existing System:

Existing underground cable fault detection systems typically consist of sensors placed along the cables to detect anomalies, a communication system to transmit data to a central monitoring station, and algorithms to analyze the data and locate faults. When a fault is detected, an alarm is triggered to alert maintenance personnel. Maintenance involves locating and repairing the fault, which often requires digging up the cables. These systems also include data logging and analysis tools to track sensor data over time and integrate with existing cable management systems. The goal of these systems is to improve the reliability and safety of underground cable networks by detecting faults quickly and accurately, minimizing downtime, and ensuring efficient operations.

Limitations of Existing System:

- Cost
- Complex installation
- Integration
- Device Compatibility
- Customization
- Communication protocol
- Efficiency of time

B. Proposed System:

The proposed underground cable fault detection system consists of sensor nodes connected to the underground cables and a central hub for monitoring and fault detection. The system utilizes wireless communication for data transmission between the sensor nodes and the central hub.Each sensor node is equipped with sensors to monitor the electrical parameters of the connected cable, such as voltage, current, and impedance. The sensor nodes are powered by batteries and are designed to operate autonomously for an extended period.

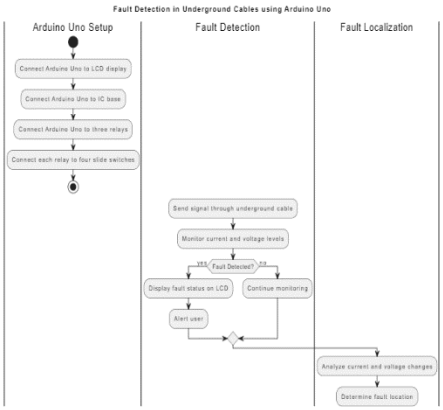
The central hub serves as the control center of the system. It receives data from the sensor nodes and processes it to detect and locate faults in the underground cables. The hub is equipped with a microcontroller for data processing and a wireless communication module for receiving data from the sensor nodes.When a fault occurs, such as a short circuit or open circuit, the sensor nodes detect the change in electrical parameters and send a signal to the central hub. The central hub analyzes the data received from the sensor nodes to determine the location of the fault.Upon detecting a fault, the central hub sends an alert to the maintenance team, indicating the location of the fault. The maintenance team can then quickly locate and repair the fault, minimizing downtime and ensuring the uninterrupted supply of power.

Overall, the proposed system provides an efficient and cost-effective solution for underground cable fault detection, improving the reliability of power distribution systems.

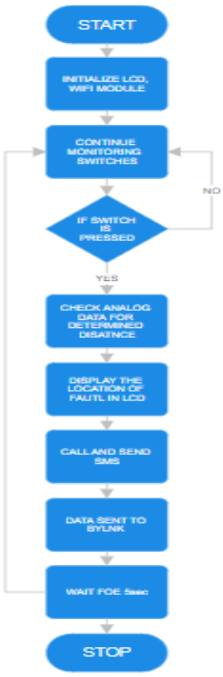
Advantages of proposed System:

- Less maintenance
- It has higher efficiency
- Less fault occurs in underground cables
- Cost efficient
- This method is applicable to all types of cables ranging from 1kv to 500kv
- Operating range is large

C. Execution Flow:



IV SYSTEM DESCRIPTION



The underground cable fault detection system consists of sensor nodes attached to underground cables and a central hub for monitoring. Each sensor node monitors the electrical parameters of the cable it's connected to, such as voltage and current. When a fault occurs, like a short circuit, the sensor node detects the change in parameters and sends an alert to the central hub. The hub processes this data to determine the fault's location and alerts maintenance teams for repairs. This system helps reduce downtime and improve the reliability of underground cable networks by quickly detecting and locating faults.

A . HARDWARE AND SOFTWARE REQUIREMENTS:

Hardware Requirements:

- Arduino UNO
- LCD Display
- Relay
- Resistor
- Diode
- Switches
- LED
- IC Base

Arduino UNO: The Arduino UNO can be used as the main microcontroller for the sensor nodes and the central hub. It can read data from sensors, process fault detection algorithms, and communicate with other components.

LCD Display: The LCD display can be used to show real-time data and status information, such as the current status of the system, detected faults, and sensor readings.

Relay: Relays can be used to control power to the sensor nodes and other components. They can also be used to trigger alarms or alerts in case of a fault detection.

Resistor: Resistors are used in various circuits to limit current flow, set voltage levels, or protect components from damage.

Diode: Diodes can be used to protect circuits from reverse voltage or to control the direction of current flow.

Switches: Switches can be used as input devices to manually control the system or to reset the system after a fault has been repaired.

LED: LEDs can be used as status indicators to show when the system is active, when a fault is detected, or when maintenance is required.

IC Base: IC bases are sockets used to mount integrated circuits (ICs). They can be used to easily replace ICs if they become damaged or need to be upgraded.

Software Requirements:

Arduino IDE: The Arduino IDE (Integrated Development Environment) is used for programming the Arduino microcontrollers (such as the Arduino UNO) that are used in the sensor nodes and the central hub of the system. The IDE provides a simple and easy-to-use interface for writing, compiling, and uploading code to the Arduino boards. It also includes libraries and examples that can be used to interface with sensors, communicate wirelessly, and process data, making it well-suited for developing the software components of the project.

Blynk App: The Blynk app is a mobile application that allows for easy monitoring and control of IoT (Internet of Things) devices, including Arduino-based projects. In the underground cable fault detection project, the Blynk app can be used as a user interface to display real-time data from the sensor nodes and the central hub. It can also be used to send alerts to the maintenance team when a fault is detected, providing a convenient and user-friendly way to interact with the system.

B. IMPLEMENTATION

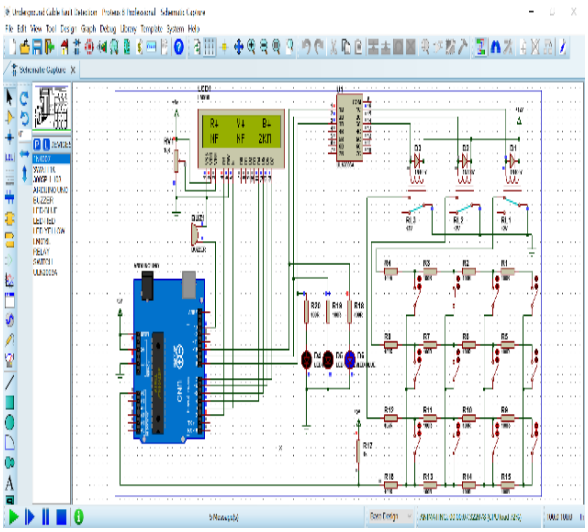
The circuit consists of a power supply, 4 line display, arduino and resistance measurement circuit. To induce faults manually in the kit, fault switches are used. About 12 fault switches are used which are arranged in three rows with each row having 4 switches. The 3 rows represent the 3 phases namely R,Y and B. The fault switches have 2 positions-No fault position(NF) and fault position(F).Main component of the underground cable fault detection circuit is low value resistance measurement. It is constructed using a constant current source of 100mAmps. It can measure very low value resistance as the cables have around 0.01 Ohm/meter resistance. For 10meter cable resistance becomes 0.1 Ohm. This circuit can measure resistance up 50 Ohm, Maximum cable length it can check up to 4 kilometres.

So starting from the reference point 3 sets of resistances are placed in series. These 3 sets of resistances represent the three phases and the neutral. Short circuit faults, Symmetrical and unsymmetrical faults can be determined by this method. This project uses three set of resistances in series(ie)R10R11-R12-R12,R17-R16,R14R21,R20-R19-R18-R25 one for each phase. Each series resistor represents the resistance of the underground cable for a particular distance and so here four resistances in series represent 1-3kms.Value of each resistance is 10kΩ.

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 and being the three phase cable input. As supply needed for the relays is higher than that of the arduino, Relay driver is used to boost the supply and provide it to the relays. A 230V AC supply is applied to the transformer from where it is stepped down to 12V AC From the transformer the alternating current gets converted into direct current when it passes through a Bridge wave rectifier .The 12V DC then goes to the voltage regulator where it gets converted from 12V DC to 5V DC Voltage regulator is used also converts the variable Dc supply into constant DC supply. This 5V DC is used to supply power to the arduino and the LCD Power supply to the LCD is given from the voltage regulator.

When fault is induced by operating any of the 12 switches (to F position),they impose conditions like LG,LL,LLG fault as per the switch operation. As a result of the fault, there is a change in voltage value. This voltage value measured across the resistance is fed to the ADC of the Arduino. Using this value, the arduino computes the distance. Finally the distance of the fault from the base station is displayed in kilometre.

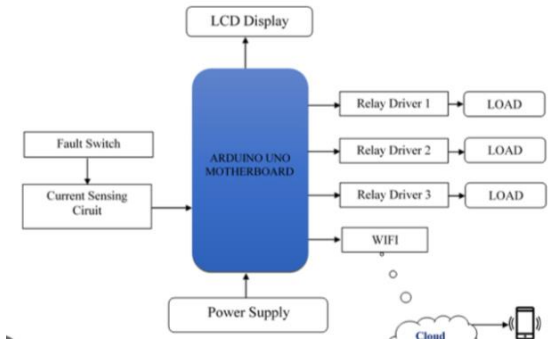
System Design:



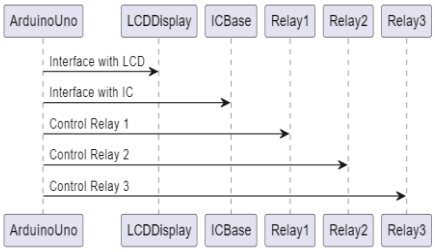
Future Trends:

Future trends for underground cable fault detection include advancements in sensor technologies for improved fault detection, integration of AI and machine learning for predictive maintenance, blockchain for data security, IoT for remote monitoring, energy harvesting for sustainability, big data analytics for better fault prediction, AR and VR for maintenance visualization, 5G for faster data transmission, smart grid integration for efficiency, and standardization for interoperability.

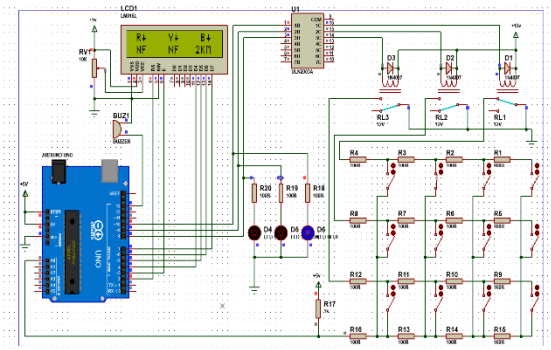
C. DATA FLOW DIAGRAM



D. SEQUENCE DIAGRAM



E. CIRCUIT DIAGRAM



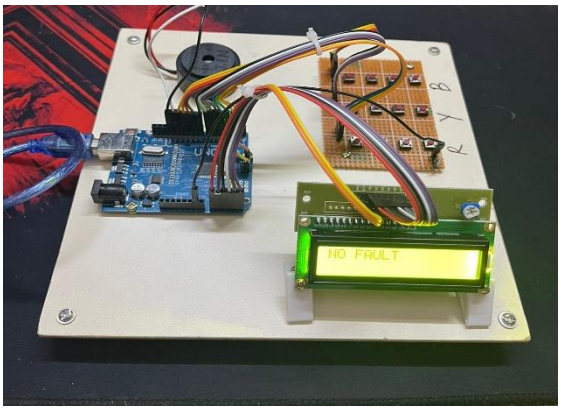
V. RESULTS & DISCUSSION

Results:

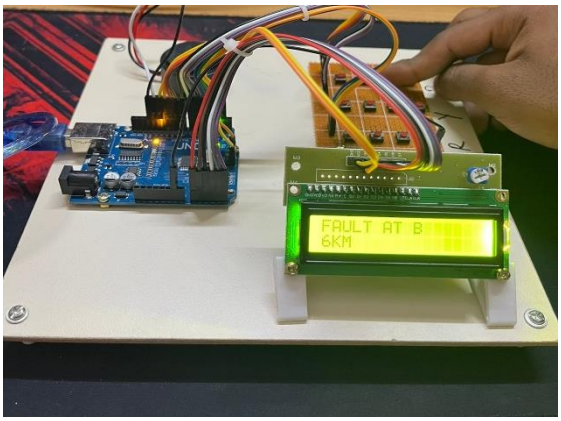
The hardware setup of fault detection system is to measure the actual distance of fault and individual switch is connected in zone to give fault in this proposed system which is sensed by relay that transfer the fault to Arduino UNO and hence distance of fault is displayed by 16x2 LCD display.

Following results has been obtained by doing different case study.

Case1: if there is no fault in underground cables the display unit will display line normal.



Case2: if there is any short circuit fault in any of 3 lines with in the range then the system will alert the user and display the fault.



Here the fault is detected at B line at 6km so user will get alert by showing kms and line.

Case3: if there is all three-line short circuit fault with in different kms range then the system will alert the user and display all faults detected, all three phase relay goes switch off which is indicated by LED.

VI. CONCLUSION

This project described the IoT Technology Based Underground Cable Fault Distance Detection System Using ATmega328P Microcontroller in software and hardware simulation form and results were successful. A full-fledged prototype model had been implemented as a proof of concept to realize and understand the real time scenarios in underground cable system. Through this prototype simulation model the proposed architecture had been demonstrated that can effectively satisfy the requirement of exact fault location detection in the underground cable system and it is believed that this model can be a promising technology to solve future fault location detection problem.

VIII. REFERENCE

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