IOT BASED UNDER GROUND CABLE FAULTS DETECTION SYSTEM

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Abstract:

Nowadays, underground cables are facing huge variety of faults due to weather conditions, wear and tear, rodents etc. Determining the fault source is challenging and entire cable could be taken out from the ground to check and fix faults. The project work's intention is to detect the location of fault in underground cable lines from the base station in km using Node MCU and AT89S52. To find the location of a fault in the cable, the cable must be tested for all the faults. This system uses the simple concept of Ohms law. The current would vary depending upon the length at which fault on the cable is detected. Whenever the fault occurs in underground cable it becomes difficult to find the exact specific location of the fault so that the process of repairing that specific cable can be conducted. The proposed system finds the exact location of that fault. The system is then modeled with a set of resistors representing cable length in km and generation of the fault is done by a set of switches placed at every known distance to cross check the accuracy of the system. When a fault is detected, the voltage across series resistors varies accordingly, which is then transferred to an ADC to develop precise digital data for a programmed microcontroller that further displays fault location in distance. A 16X2 LCD interfaced with the microcontroller is used to display the fault location.

Keywords: *Cable fault detection, Node MCU, AT89S52*

1. INTRODUCTION

Power supply networks are growing continuously and their reliability is getting more important than ever. The complexity of the entire network comprises numerous components which will fail and interrupt the power supply facility for end user. For most of the worldwide operated low voltage and medium voltage distribution lines, underground cables have been used for several decades. Underground high voltage links are utilized more since they are not impacted by climate conditions, overwhelming precipitation, tempest, day off contamination. Despite the fact that the Cable assembling innovation is being improved consistently, there are still impacts which may make the cable to fail the test and operation. However, cables cab easily be damaged by incorrect installation or poorly jointing, or by subsequent external damage caused by civil works such as trenching, digging or curb edging. It is easy to detect and correct the faults in overhead line by mere observation but is impossible to do so in an underground cable. These cables are buried deep inside the soil it is not easy to detect the faults in them. Even if a fault is detected it still becomes very difficult to detect the exact location of that fault. This leads to digging of the entire channel to detect and correct the fault which in turn causes waste of money and manpower. So, it is necessary to know the exact location of the defects in the underground cables. Whatever the fault is, the voltage of the cable has the tendency to change abruptly according to ohm's law.

1.1 Faults in Underground Cables

a) Open circuit faults

These faults occur due to the failure of one or numerous conductors. These occur due to an opening in the circuit. The common causes of these openings include joint failures in the cables, failure of one or more phase of circuit breaker or because of melting of a fuse or conductor in one or many phases. Open circuit faults are also known as series faults. These are unsymmetrical or unbalanced sort of faults except the open circuit faults.

b) Short circuit faults

A short circuit is often defined as an abnormal connection of very low impedance between two points of varied potential whether made deliberately or accidentally. These are the most common and severe kind of faults, resulting in the flow of abnormal large currents through the equipment or transmission lines. If these faults are allowed to persist even for a short time, it can severely damage the equipment. Short circuit faults are also known as shunt faults. These faults are caused because of the insulation failure between phase conductors or between earth and phase conductors or both. The various possible short circuit fault conditions are: phase to phase, single phase to earth, two phase to earth and phase to phase to phase. In single line to ground fault, fault occurs when any one of the three lines is short circuited with the ground.

c) Earth Fault

When the conductor of the cable comes in contact with earth, it is called earth fault or ground fault. To identify this fault, one terminal of the megger is connected to the conductor and the other terminal connected to earth. If megger indicates zero reading, it means the conductor is earthed. The same procedure is repeated for other conductors of the cable [4,6].

This project is used to detect the location of fault in digital way. Locating the faulty point in an underground cable helps to facilitate quicker repair, improve the system reliability and reduced outage period.

1.2 Internet of Tings

The evaluation of IoT in the electrical Power Industry transformed the way things performed in usual manner. IoT increased the use of wireless technology to connect power industry assets and infrastructure in order to lower the power consumption and cost. The applications of IoT are not limited to particular fields, but span a wide range of applications such as energy systems, homes, industries, cities, logistics, heath, agriculture and so on. Since 1881, the overall power grid system has been built up over more than 13 decades, meeting the ever increasing demand for energy. Power grids are now been considered to be one of the vital components of infrastructure on which the modern society depends. It is essential to provide uninterrupted power without outages or losses. It is quiet hard to digest the fact that power generated is not equal to the power consumed at the end point due to various losses. It is even harder to imagine the after effects without power for a minute. Power outages occur as result of short circuits. This is a costly event as it influences the industrial production, commercial activities and consumer lifestyle. Government & independent power providers are continuously exploring solutions to ensure good power quality, maximize grid uptime, reduce power consumption, increase the efficiency of grid operations and eradicate outages, power loss & theft. Most importantly, the solution should provide a real-time visibility to customers on every penny paid for their energy. There is an increasing need of a centralized management solution for more reliable, scalable, and manageable operations while also being cost effective, secure, and interoperable. In addition, the solution should enable power providers and utilities to perform effective demand forecasting and energy planning to address the growing need for uninterrupted quality power [5].

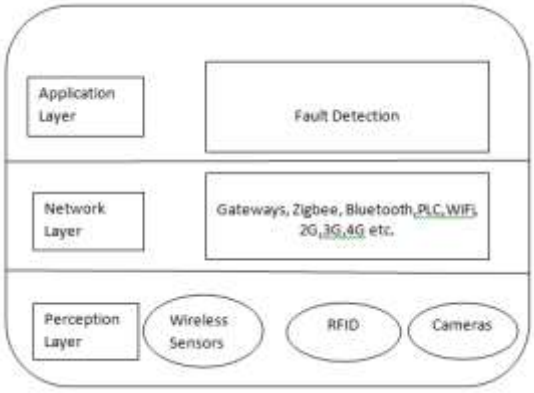


Figure: Architecture of IoT

2. EXISTING SYSTEM

In general, fault location techniques for underground cable network can be categorized in two groups:

a) Tracer method: The tracer method is an exhaustive way to locate a faulted segment by ―walking‖ through the cable circuits. A faulted segment can be determined from audible or electromagnetic signals and requires dispatching crew members to the outage area. There have been various techniques largely used in the industries, including the tracing approach through acoustic, electromagnetic or current.

b) Terminal method: The terminal method is a technique used to determine a fault location of a distribution cable network from one or both ends without tracing exhaustively. A bridge technique is one of the most popular terminal methods that link with a resistor to determine a fault location .It is a technique used to detect fault location of cable from one or both ends without tracing.

2.1 Disadvantages of existing system

1. The main disadvantage is that the underground cables have higher initial cost and insulation problems at high voltages. Another main drawback is that, if a fault does occur, it is difficult to locate and repair the fault because the fault is invisible.

2. Angular value required time to read so some delay occurs.

3. PROPOSED SYSTEM

The proposed system is an IOT enabled underground cable fault detection system. The basic principle behind the system is Ohms law. When fault occurs in the cable, the voltage varies which is used to calculate the fault

distance. The system consists of Wi-Fi module, Microcontroller.

The power supply is provided using step-down transformer, rectifier, and regulator. The current sensing circuit of the cable provides the magnitude of voltage drop across the resistors to the microcontroller and based on the voltage the fault distance is located [1,2].

The design of any circuit begins with a block diagram. It helps us to design the sections of the circuit individually and then at the end put them together to have a complete circuit, ready for use. In this circuit first our requirement is to check 220 volt AC supply status. Firstly we have to convert 220 volt AC to 5 volt DC because our microcontroller can read up to maximum 5 volt DC supply. For step down the supply we are using here is the step down transformer. This transformer will convert 220 AC to 12 volt AC. The next step is converting this AC to DC. For that we are using full wave bridge rectifier and filter for smooth. So now this is 12 volt DC and then using 7805 voltage regulator for convert the 12 volt to 5 volt. After this process this output of voltage regulator will be connected with microcontroller GPIO pin. So microcontroller will able to read the status of supply using that connected pin. According to status of that pin the microcontroller will update the status on IOT cloud. From that we will able to see the status from anywhere of world location.

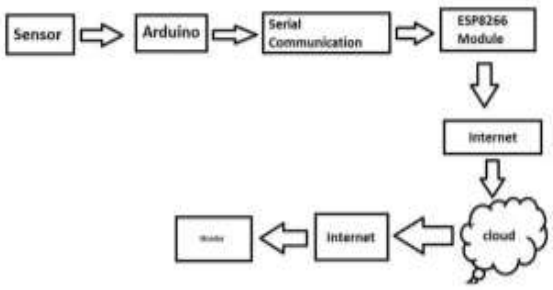


Figure: System Flow Chart

This project is composed of an arrangement of series resistors representing a cable, a step down transformer (230/12 volts), a bridge rectifier to convert 12 volts AC (alternating current) into 12 volts DC (direct current), regulator, LCD, AT89S52 microcontroller and Node MCU to remotely forward the data over internet. The complete model/project is energized through power circuit which is composed of step down transformer, bridge rectifier and regulator ICs, this project uses 2 different voltage level 12V (for Relays and relay driver IC) and 5V (for AT89S52 and other components). Arduino is compiled with C language, when circuit is turned on start its programming cycle and sends signal to relay IC to operate relay. When Arduino executes its program cycle then all three cables are scanned with a delay of 500ms. During this scan if any switch is closed (fault is created), Current gets path to ground through relay contact. This flow of current causes drop in voltage, depending upon the path of current, resistance offered and relying on location of fault the drop in voltage is recorded and transferred to the analog pin of Arduino UNO board and it is programmed with C language, executes and processes all the input data and converts analog raw data into simplified digital data using ADC.

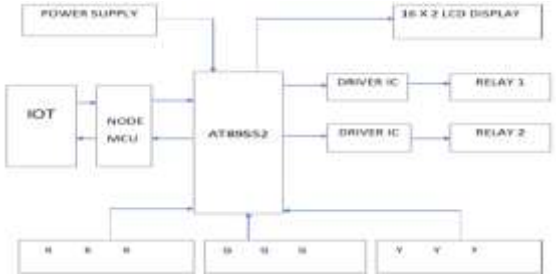


Figure: Block diagram

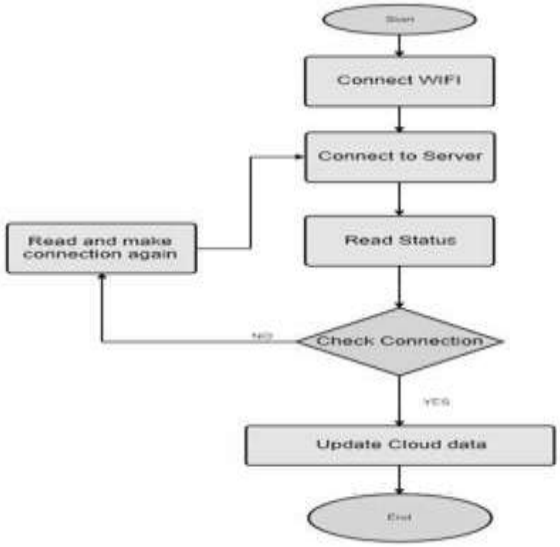


Figure: Flow Chart

Digital data is displayed into the 16*2 LCD along with its phase and location of fault. The block diagram of underground cable fault detection and displays over mobile system through messaging. This project circuit diagram comprises of varied blocks like an influence supply block, Arduino UNO block, multiplexed relays, fault switches, LCD display. Hence, this proposed project can be helpful in detecting the accurate location of the fault and also for sending the information to a mobile

system in text messaging format along with displaying over an LCD display.

4. HARDWARE COMPONENTS

4.1 Arduino

The Arduino UNO is the greatest electronic and coding board to get started. Arduino is a platform for open source construction of electronics devices. The Arduino is a physically programmable circuit board and a software package that is either used on your computer to create and upload computer codes to the physical board or IDE. Arduino boards consist of an Atmel 8-bit AVR microcontroller with varying amounts of flash memory, pins, and features. The 32-bit Arduino Due, based on the Atmel SAM3X8E was introduced in 2012. The boards use single or double-row pins or female headers that facilitate connections for programming and incorporation into other circuits. These may connect with add-on modules termed shields. Multiple and possibly stacked shields may be individually addressable via an I²C serial bus. Most boards include a 5 V linear regulator and a 16 MHz crystal oscillator or ceramic resonator. Some designs, such as the Lily Pad, run at 8 MHz and dispense with the onboard voltage regulator due to specific form-factor restrictions.

Figure: Arduino

4.2 IoT Module (ESP8266)

It is an open sources firmware and advancement packs to fabricate IoT items. It incorporates firmware that sudden spike in demand for ESP8266 Wi-Fi SoC and equipment that has an ESP-12 module. The unit has simple (A0). It additionally has computerized (D0-D8) pins on the board. It even helps sequential ports correspondences, for example, SPI, UART, I2C and so forth.

Figure: Node MCU

4.3 LCD Display

LCD (liquid crystal display) is the technology used for displays in notebook and other smaller computers. Like light-emitting diode (LED) and gas-plasma technologies, LCDs allow displays to be much thinner than cathode ray tube (CRT) technology. LCDs consume much less power than LED and gas-display displays because they work on the principle of blocking light rather than emitting it.

Figure: LCD display

4.4 Relay

It is a electromagnetic device which is used to drive the load connected across the relay and the o/p of relay can be connected to controller or load for further processing.

Figure: Relay

And we also used Step Down Transformer, Rectifier, Filter, Voltage Regulator, Switches and Connecting Wires.

4.5 Software Components

Arduino IDE The Arduino integrated development environment (IDE) is a cross-platform application for (Windows, macOS, Linux). The Arduino IDE supports the languages C & C++. Arduino also simplifies the process of working with microcontrollers.

Embedded C Embedded C is a set of language extensions for the C programming language. It addresses commonality issues that exist between C extensions for different embedded systems. It includes a number of features not available in normal C, such as fixed-point arithmetic, named address spaces and basic I/O hardware addressing. Embedded C uses most of the syntax and semantics of standard C.

4.6 Thing Speak Cloud

It is an IoT stage that is intended to empower significant associations among individuals and things. It includes constant information assortment, information investigation, information preparing, and information perception utilizing an associated Social Networking Service (SNS) by means of an open source API to help different stages. It serves to handily move information from installed gadgets like Arduino, Raspberry PI, Node MCU, and so forth additionally, it upholds different dialects and conditions. Our proposed framework peruses and sends sensor information utilizing Thing Speak. The primary target is to plan and execute a robotized framework and to picture detected data as graphs. The information acquired can be seen all around the world anyplace, whenever.

5. RESULTS

The work automatically updates the status of every substation on IOT. The time of occurrence of fault is determined with the help of microcontroller and ESP8266 Wi-Fi module in a webpage or web application. The system helps to quickly repair the fault and to revive back the power system.

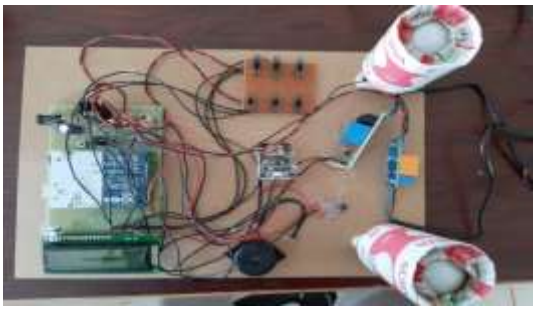


Figure: Hardware Prototype

5.1 Fault on under cable line - 1

Figure: LCD Screen output

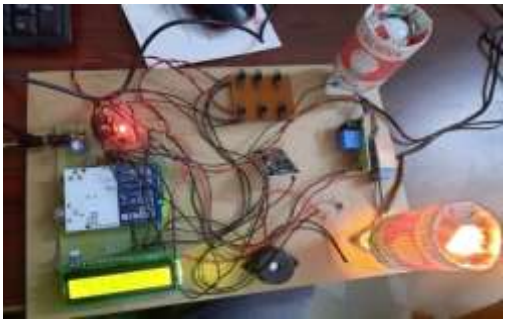


Figure: Fault on under cable line - 1

5.2 Fault on under cable line - 2

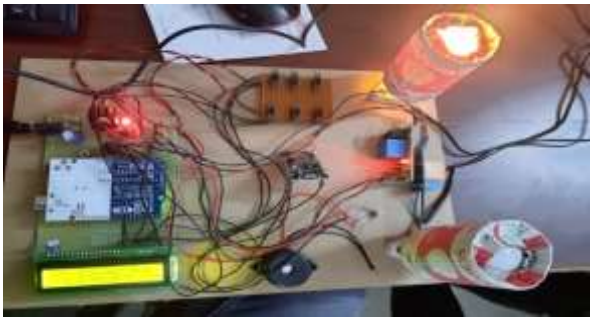
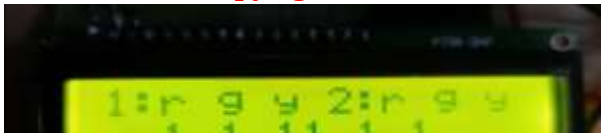


Figure: Fault on under cable line - 2



5.3 No Fault

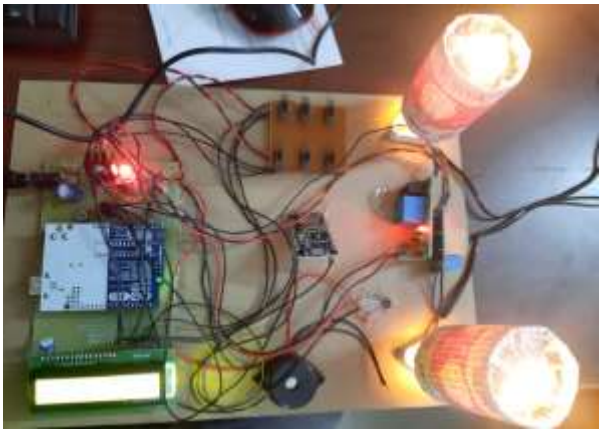


Figure: No fault on under cable line

Figure: Data uploaded to IoT cloud

5.4 Advantages

- Detects accurate fault sub location
- Reduced human effort
- Time saving and faster maintenance
- Less software requirements
- Applicable to all types of cable
- Cost effective
- Less complexity

5.5 Applications

- Monitoring fault in underground cable line
- Monitoring fault in industrial line
- Monitoring fault in residential line
- Monitoring fault in overhead cable line

CONCLUSION

The developed hardware of underground cable fault distance locator is an economical and effective in protecting house-hold instruments and competitive marketing, tracking fault quickly, facilitating service, reliability and maintenance, diminishing the cost and production losses, improving the power availability for consumers and assisting the future maintenance plans and schedules by analyzing the location of these faults to prevent power outages and blackouts. The implementation of node MCU in the hardware allows operator remotely to visualize faults on the LCD and at the same time isolate the circuit until the fault is cleared.

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