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Under Ground Cable Fault Detection Using IoT

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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 paper work is intended to detect the fault in underground cable lines from the base station to another substation using a Microcontroller. To locate a fault in the cable, the cable must be tested for faults and fault creation is made by a set of switches at every known distance between two substations. In case of fault, the voltage drops and changes accordingly, which is then fed to a programmed microcontroller IC that further displays on IOT fault. IOT is used to display the information over Internet using the Wi-Fi module ESP8266. A webpage is created using HTML coding and the information about occurrence of fault is displayed in a webpage or also can use android application for same.*

For the real worldwide operated voltage distribution lines underground cables have been used from many years. In order to reduce the sensitivity of distribution networks to environmental influences underground voltage cables are highly used. Underground cables have been widely used in power distribution networks due to the advantages of underground connection. Underground cable system is a common practice followed in urban areas. While a fault occurs due to many reasons in the cable, at a time of removing or repairing process, there is difficulty in locating also nearby location of the fault. The system proposed in this project is used to find out the sub area location of the fault and display it to the dedicated application over internet using Wi-Fi module.

Key Words: HTML, IoT, Microcontroller, Wi-Fi Module.

1. INTRODUCTION

Power supply networks are growing continuously and their reliability getting more important than ever. The complexity of the whole network comprises numerous components that can fail and interrupt the power supply for end user. For most of the worldwide operated low voltage and medium voltage distribution lines, underground cables have been used for many decades. Underground high voltage cables are used more and more because they are not influenced by weather conditions, heavy rain, storm, snow and pollution.

Even though the Cable manufacturing technology is improving steadily, there are still influences which may cause cable to fail during test and operation. A cable in good condition and installed correctly can last a lifetime of about 30 years. However, cables can be easily damaged by incorrect installation or poorly executed jointing, while subsequent third-party damage by civil works such as trenching or curb edging. Fault in cable is represented as any defect and inconsistency, caused by breaking of conductor and failure of insulation and weakness or non-homogeneity that affects performance of cable.

Bundle of electrical conductors used for carrying electricity is called as a cable. An underground cable generally has one or more conductors covered with suitable insulation and a protective cover. Commonly used materials for insulation are varnished cambric or impregnated paper. Fault in a cable can be any defect that can break the path of the performance of the cable. So it is necessary to correct the fault. Power transmission can be done in both overhead as well as in underground cables. But unlike underground cables the overhead cables have the drawback of being easily prone to the effects of rainfall, snow, thunder, lightning etc. This requires cables with reliability, increased safety, ruggedness and greater service.

Underground cables are preferred in many areas especially in urban places. When it is easy to detect and correct the faults in overhead line by mere observation, it is not possible to do so in an underground cable. As they are buried deep in the soil it is not easy to detect the abnormalities in them. Even when a fault is found to be present it is very difficult to detect fault. This leads to debugging of the entire area to detect fault between two sub section unit, which in turn causes wastage of money and manpower.

2. OBJECTIVE

The objective is to determine the cable fault and its location using IOT and microcontroller board.

In the present scenario when a fault occurs, detecting fault source is difficult and entire line has to be dug in order to check entire line and fix faults. The main objective is to detect the fault nearby location to reduce the time. So, it avoids the difficulty in digging the entire line.

The basic idea is to read the voltage using sub unit from different place. Hence it will detect the fault with help of sub unit. In this implementation we are using 3 sub units in transmission line and with help of switch we are creating transmission line. Once any fault occurs, from that point the next sub unit will not able to update status. So fault will be from that point to next sub unit. We will able to see the status

of all unit in a common IOT app from anywhere around the world.

3. BLOCK DIAGRAM

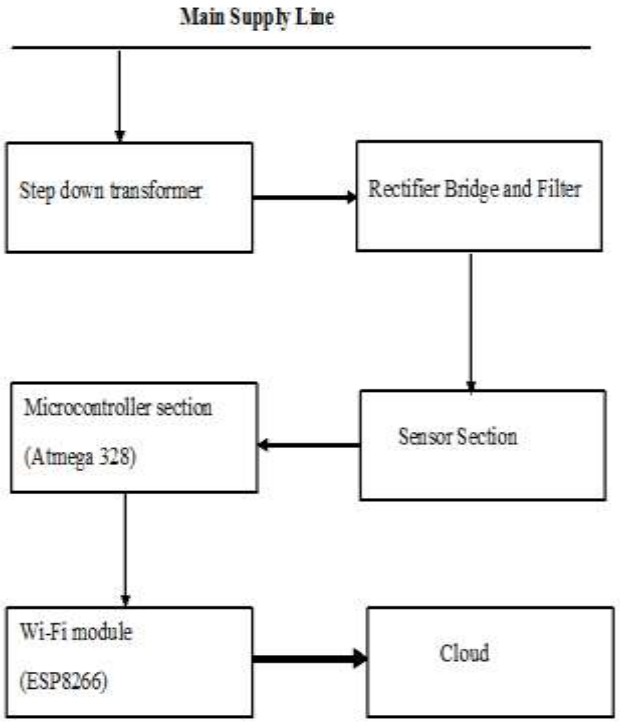

Fig -1: Block Diagram of Proposed System

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.

4. METHODOLOGY

4.1 Power Supply Section

A power supply circuit is a very basic circuit in learning electronics. The power supply which we will design here is very basic and it is a linear technology based design which will go through each design step. The design of any circuit begins with a well-made general block diagram. It helps to design the sections of the circuit individually and then at the end put them together to have a complete circuit which is ready for use.

The four main sub blocks are: Transformer, Rectifier Circuit, Filter and Regulator

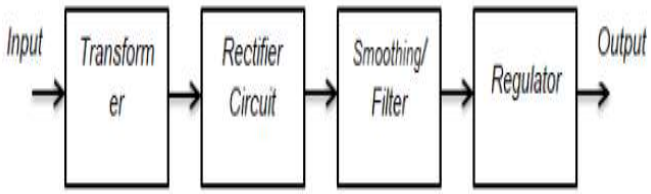

Fig -2: Block Diagram of Power Supply Section

4.2 Input Transformer

A transformer is a device that is used to step up or step down the AC voltages level, keeping the input and out power the same. AC coming to your home has the voltage level of 220/120 V. We need the input transformer to step down the incoming AC to our required lower-level which is close to 5V (AC). This lower level is further used by other blocks to get the required 5V DC. Since we are using the main supply voltage which is too dangerous. We must never touch any of the terminals with bare hands or with bad instruments and must have a good and decent non-contact voltage tester and use it to always be sure of which line is the live wire coming to the transformer.

4.3 Rectifier Circuit

A rectifier circuit is the combination of diodes arranged in such a manner that converts AC into DC voltage. The transformer still didn't step down the voltage to 5V DC. The stepped-down voltage is still AC and need to convert it into DC for a good rectifier circuit. Without the rectifier circuit, it is not possible to have the required output 5V DC voltage.

4.4 Filter

A capacitor filter is used when we need to convert a pulsating DC into pure or to remove distortion from signal. Nothing is ideal in practical electronics. The rectifier circuit converts the incoming AC to DC but it does not make it a pure DC. The output of the rectifier is pulsating and is called pulsating DC. This pulsating DC is not considered good to power up sensitive devices. The rectified DC is not very clean and has ripples and the job of the filter is to filter out these ripples and to make the voltage compatible for regulation. A rule of thumb is DC voltage must have less than 10 percent ripples to be regulated perfectly. The best filter in our case is the capacitor and the capacitor is used to charge the storing

device. Actually it can be best used as a filter. It is the most inexpensive filter for our basic 5V power supply design.

4.5 Regulator

A regulator is the integrated circuit used to give a constant output voltage regardless of input voltage changes. Voltage regulation is very important because we do not need a change in output voltage when the load changes. An output voltage independent of the load is always required. The regulator IC not just makes the output voltage independent of varying loads, but also from line voltage changes.

5. FLOWCHART

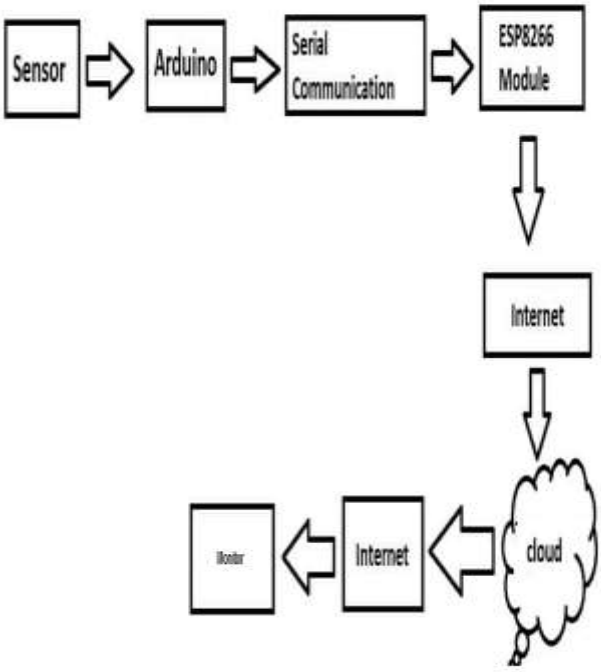

Fig -3: System Flowchart

For the real worldwide operated voltage distribution lines underground cables have been used from many years. In order to reduce the sensitivity of distribution networks to environmental influences underground voltage cables are highly used. Underground cables have been widely used in power distribution networks due to the advantages of underground connection. Underground cable system is a common practice followed in urban areas. While a fault occurs due to many reasons in the cable, at a time of removing or repairing process, there is difficulty in locating also nearby location of the fault. The system proposed in this project is used to find out the sub area of the fault and display it to the application over internet using Wi-Fi module.

Power supply networks are growing continuously and their reliability getting more important than ever. The complexity of the whole network comprises numerous components that can fail and interrupt the power supply for end user. For most of the worldwide operated low voltage and medium voltage distribution lines, underground cables have been used for many decades. Underground high voltage cables are used more and more because they are not influenced by weather conditions, heavy rain, storm, snow and pollution. Even though the cable manufacturing technology is improving steadily, there are still influences which may cause cable to fail during test and operation. A cable in good condition and installed correctly can last a lifetime of about 30 years. However cables can be easily damaged by incorrect installation or poorly executed jointing, while subsequent third party damage by civil works such as trenching or curb.

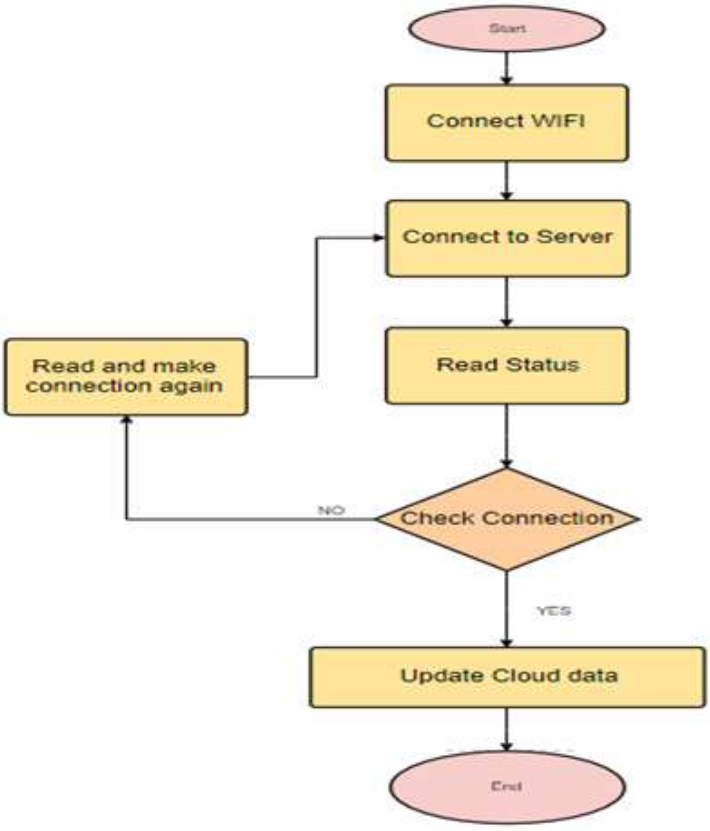

Fig -4: Flowchart of Working Process

Main supply will apply to step down transformer which results in decrease in power. The power will be applied to rectifier bridge for the conversion of ac to dc. The signal passes through the filter and then it will be passed through the voltage sensor (voltage divider or voltage regulator). The microcontroller checks the status and the information are sent to the cloud.

6. HARDWARE AND SOFTWARE COMPONENTS

6.1 Hardware Components

- **ATmega328 Microcontroller**

The ATmega328 is a single-chip microcontroller. It has a modified Harvard architecture 8- bit RISC processor core. ATmega328 is low-powered and a low-cost micro-controller. ATmega328 has 32KB internal built-in memory. Atmega328 is faster as it uses lesser number of clock cycles for instruction execution.

- **Arduino Nano**

Arduino Nano is a small, compatible, flexible and breadboard friendly Microcontroller board, developed by Arduino.cc in Italy, based on ATmega328p / Atmega168. It comes with exactly the same functionality as in Arduino NANO but quite in small size. It comes with an operating voltage of 5V and the input voltage can vary from 7 to 12V.

- **IoT Module (ESP8266)**

The ESP8266 is a low-cost Wi-Fi microchip and 1 MiB (Mebibyte) of built-in flash, allowing single-chip devices capable of connecting to Wi-Fi. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections. The ESP8266 is a small WIFI module built around the ESP8266 chip that can connect microcontroller to the internet wirelessly for a very small cost. Interfacing the ESP8266 with an Arduino and perform some basic functions like connecting it to a WIFI network.

- **Other Components**

Step Down Transformer, Rectifier, Filter, Voltage Regulator, Switches and Connecting Wires.

6.2 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.

7. 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.

8. APPLICATIONS AND ADVANTAGES

8.1 Applications

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

8.2 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

9. CONCLUSIONS

The work automatically sends data to cloud about fault with the help of Atmega328 and ESP8266 Wi-Fi module in a webpage or IOT application. Underground high voltage cables are used more and more because they are not influenced by weather conditions, heavy rain, storm, snow and pollution. However, cables can be easily damaged by incorrect installation or poorly executed jointing, while subsequent third-party damage by civil works such as trenching or curb edging. Fault in a cable can be any defect that can break the path of the performance of the cable. So it is necessary to correct the fault. Underground cables are preferred in many areas especially in urban places. With the help of this system, we can get to know the location of the fault in the cable which are buried under ground.

Therefore, this system does not lead to debugging of the entire area to detect the fault. Hence, the expenditure and manpower gets reduced. The benefits of fault are fast repair to revive back the power system and improves the system performance. It reduces the operating expense and the time to detect the faults in the field. The Arduino microcontroller works based on the output of power supply status. The IOT module is vital due to which it can quickly update the status on IOT and many substation which can be done through common app of IOT.

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