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Underground Cable Fault Detection and alert

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Abstract: In this paper, it is intended to detect the location of fault in underground cables and alert the concerned authority in the control room. In the urban areas, electrical cables run underground instead of overhead transmission lines. Most of the European countries use underground cables for power distribution, whenever a fault occurs in underground cables it is difficult to detect the exact location of the fault since it is buried 2 to 4 feet underground, in this project we try to rectify this problem by proposing a solution which is suitable to the digital world.Here power resistors are used in place of underground cables. The fault is stimulated by using a set of toggle switches. A relay is used to trip the circuit in case of overloading and hence protecting the system from any further damage. A 16x2 LCD display is connected to the microcontroller to display voltage levels across the different lines and the load.In case of short circuit (Line to Ground), the voltage across series resistors change accordingly, which is then fed to an ADC to provide precise digital data to a programmed Renesas board that further displays the location of fault in meters. This information is sent to the operator through a text message by using a GSM module and also notifies the control room through an audio message by making use of a MP3 module linked with a speaker.

Keywords: Underground cables, Fault, Renesas board, GSM module, MP3 module.

I. Introduction

Till the last decade cables were connected overhead but now it is laid underground which is superior to earlier method. Because underground cables are not affected by any adverse weather condition such as storm, snow, heavy rainfall as well as pollution. But, when any problem occurs in cable, it is very difficult to find the exact location of the fault due to not knowing the exact location of the cable. Underground cable systems are more commonly practiced followed in many urban areas. Day by day, the world is becoming digitized so our project has proposed to find the location of fault in digital way. When the fault occurs, the process of repairing related to that particular cable is very difficult.

Fault in the cables occurs due to many reasons. like: dampness in the paper insulation, weakness of the cable, insulation failure, breaking of the conductor, Corrosion of sheath and Electrical puncture. To overcome this problem, here is a project namely underground cable fault detection and alert.

Undergrounding is the replacement of overhead cables providing electrical power or telecommunications, with underground cables[1].

But the use underground cable offers a variety of advantages. Some of the advantage**s** are listed below.

- It is less liable to damage during storm or bad whether condition.
- Offers low maintenance cost.
- Less voltage drop during normal operating condition and less chance of fault.

But the main disadvantage of underground cable is its cost of installation. For higher voltage, the cost of cable increases due to greater requirement of insulation as compared to overhead lines. Therefore, it is installed in area or localities where overhead lines cannot be installed.

Requirements of Underground Cable

There are various types of cable available but the choice of particular type depends on the operating voltage and service requirement. However, a cable must fulfill some of the basic requirement. Those requirements are as follows:

- The conductor used in underground cable shall be tinned copper or aluminum conductor of high conductivity. Stranding is very important to provide flexibility and increase current carrying capacity.
- The size of conductor shall be sufficient enough to carry load current without heating and appreciable voltage drop. The voltage drop shall be within the permissible range.

- The cable must have proper thickness of insulation to provide high degree of safety and reliability at operating voltage.
- It must have been provided with suitable mechanical protection to withstand rough handling during lying of cable.
- The material used in the manufacture of cable should be such that there is complete chemical and physical stability throughout [2].

II. Faults and Their Causes

2.1 Fault

Faults in cable can be classified in two groups:

- Open circuit fault
- Short circuit fault

➢ **Open Circuit Fault**

Open circuit faults are better than short circuit fault, because when this fault occurs current flows through cable becomes zero. This type of fault is caused by break in conducting path. Such faults occur when one or more phase conductors break.

Current will only flow in a circuit. That is, around a continuous path (or multiple paths) from and back to the source of EMF. Any interruption in the circuit, such as an open switch, a break in the wiring, or a component such as a resistor that has changed its resistance to an extremely high value will cause current to cease.

Effects

- Abnormal operation of the system
- Danger to the personnel as well as animals
- Exceeding the voltages beyond normal values in certain parts of the network, which further leads to insulation failures and developing of short circuit faults.

Although open circuit faults can be tolerated for longer periods than short circuit faults, these must be removed as early as possible to reduce the greater damage.Open circuit faults may occur occasionally which is usually at cable joints.By checking the insulation resistance between the conductors. In the case it is a short circuit fault, the insulation resistance tester will indicate zero resistance, after that step, short and earth the three conductors of the cable at one end. Check the resistance between the conductors and earth and between individual conductors (at the other end). This procedure is carried out to check the open circuit faults.

➢ **Short Circuit Faults**

A short circuit can be defined as an abnormal connection of very low impedance between two points of different potential, whether made intentionally or accidentally.

These are the most common and severe kind of faults, resulting in the flow of abnormal high currents through the equipment or transmission lines. If these faults are allowed to persist even for a short period, it leads to the extensive damage to the equipment.

Effects

Arcing faults can lead to fire and explosion in equipments such as transformers and circuit breakers.

Abnormal currents cause the equipments to get overheated, which further leads to reduction of life span of their insulation.

The operating voltages of the system can go below or above their acceptance values that creates harmful effect to the service rendered by the power system.

The power flow is severely restricted or even completely blocked as long as the short circuit fault persists[3].

2.2. Fault Location Method

- ➢ Online Method:This method utilize process the sampled voltages& current to determine the fault points. Online method for underground cable is less than overhead lines.
- ➢ Offline method**:**In this method special instrument is used to test out service of cable in the field. There are two offline methods as following:
- ➢ Tracer method:In this method fault point is detected by walking on the cable lines. Fault point is indicated from audible signal or electromagnetic signal. It is used to pinpoint fault location very accurately. Example: 1) Tracing current method 2) Sheath coil method.

- Terminal method:It is a technique used to detect fault location of cable from one or both ends without tracing. This method use to locate general area of fault, to expedite tracing on buried cable. Example:1) Murray loop method 2) Impulse current method[5].

2.3Causes for Faults

Some of the major causes for cable failures are:

- Ageing.
- Wrong selection or application.
- Mechanical failures.
- Corrosion of sheath.
- Moisture in the insulation.
- Heating of cable.
- Fire and lightning surges.
- Electrical puncture.

III. Proposed System

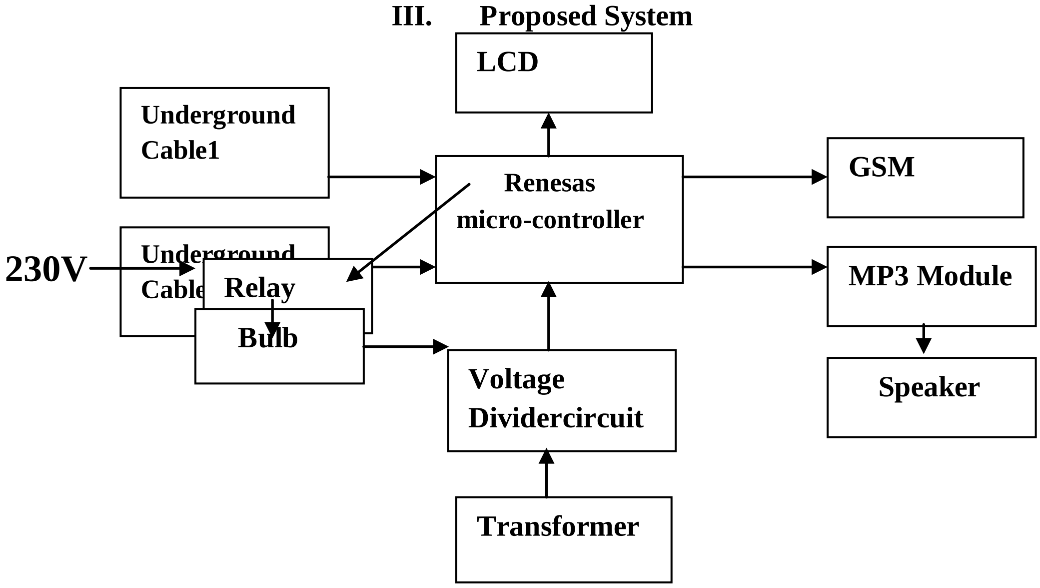

Fig.3.1 Block diagram

From the block diagram, the underground cables and all the other hardware components are connected to the microcontroller. Instead of underground cables we will be using power resistors to stimulate faults at different distances, the distance at which the fault occurs is determined by the microcontroller and depending on the voltage level across the resistors a is transmitted to the operator by making use of a GSM module, also the same message is announced in the control room by making use of a MP3 module which is linked to a speaker. The LCD is used to display the voltage levels of the different lines and load.

A relay is provided to trip the circuit in case of overloading condition. It can be stimulated as overloading by using different loads. When an over load is detected the microcontroller sends a signal to trip the circuit turning off the entire circuit. A voltage divider is provided to limit the voltage given to the microcontroller under a safe value. When the relay trips the circuit due to overloading a message is sent to the operator making him aware of the situation and a audio signal is broadcasted in the control room using the MP3 module [8].

Hardware Components

- Renesas microcontroller (RL78 series)
- Relay
- GSM module
- Voltage circuit
- Current transformer
- LCD
- MP3 module

- Speaker
- SD Card

Software Used

- CubeSuite+ IDE
- Renesas Flash Programmer
- Embedded C

IV. Results And Discussions

Initially when the circuit is turned on all the components are tested, the initial testing process of each component is explained.
LCD→ when the circuit is turned ON we get a message displayed on the screen that reads.
GSM→ when the circuit is turned ON a message is sent to the operator through the GSM module that reads "SYSTEM STARTS"
MP3→when the circuit is turned ON a message is announced with the help of MP3module and speaker that says "SYSTEM ONLINE"
LOAD→here as we are using bulbs for loads the bulb is turned ON so as to check if there is no open circuit on the load side.

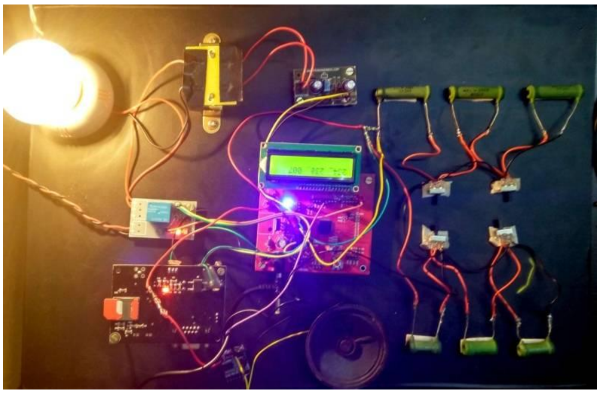

Fig.4.1 Working of the project

In this project, it is able to detect two types of faults, namely

- short circuit conditions and
- overloading conditions

The working process of both these methods are explained in detail as shown in fig.4.1.

- **DETECTING SHORT CIRCUIT CONDITION**

Here instead of underground cables , multiple power resistors are utilized as shown in the figure, as power resistors used are of different ratings voltage across each resistor is different ,these power resistors are connected through toggle switches.These Toggle switches have three terminals, two of these terminals are connected to respective leads of the power resistors and given to a supply through the renesas microcontroller board, the third terminal of all the toggle switches is connected to a common ground.
Therefore by changing the condition of the toggle switches it can simulate short circuit conditions. It has include two lines namely line one and line two. Each power resistor signifies distances of 200 meters
When the first toggle switch is opened depending on the voltage drop (about 2.20V to 2.28V) the renesas microcontroller detects that there is a fault at a distance of 200meters and an alert is made by the operator in the control room aware of the situation. The drop in voltage can be observed on the LCD screen.
When the second toggle switch is opened depending on the voltage drop (less than 1.25V) the renesas microcontroller detects that there is a fault at a distance of 400meters and an alert is made likewise.The drop in voltage can be observed on the LCD screen.The operator the control room is made aware of the situation at hand using two main components, namely the GSM module and the MP3 module.

❖ ALERT USING GSM MODULE

As soon as a fault occurs the operator receives a message in his mobile phone through the GSM module instantaneously alerting that there has been a fault which saves precious time required to debug the problem.

For example:

- If there is been a fault in line 1 at a distance of 200 meters , the operator receives the following message “L1 FLT AT 200Mtr” as shown in fig.4.2.

Fig.4.2 fault at line 1

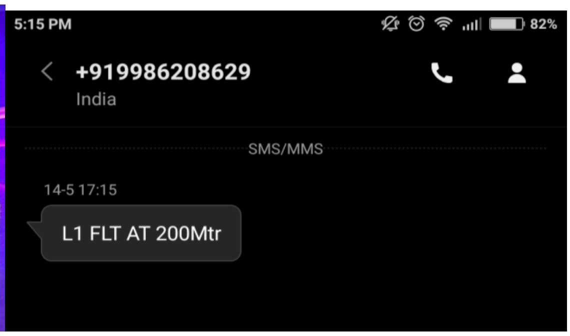

Fig.4.3 Message to operator

- If there is been a fault in line 2 at a distance of 400 meters, the operator receives the following message “L2 FLT AT 400Mtr”.

❖ ALERT USING MP3 MODULE

As soon a fault occurs the same message that has been transmitted to the operator through the GSM module is also announced in the control room with the help of a MP3 module and a speaker , thereby alerting everyone to the situation at hand and help taking precautionary measures without any delays.

For example:

- If there is been a fault in line 1 at a distance of 200 meters, the control room is alerted with an announcement saying “fault at line 1 at 200 meters preceded by a siren”
- If there is been a fault in line 2 at a distance of 400 meters, the control room is alerted with an announcement saying “fault at line 2 at 400 meters preceded by a siren”

❖ ALERT USING GSM MODULE

As soon as an overload is detected the relay trips and the circuit is disconnected from the supply, this way the rest of the circuit is protected from the faulty part. Simultaneously the operator receives a message at mobile phone through the GSM module instantaneously alerting that overload has occurred.

i.e. when system is overloaded the operator receives the following message “OVERLOAD DETECTED”. as shown in fig.4.4.

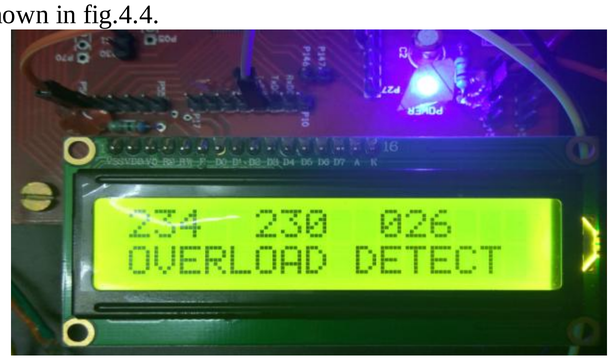

Fig.4.4 Overload condition

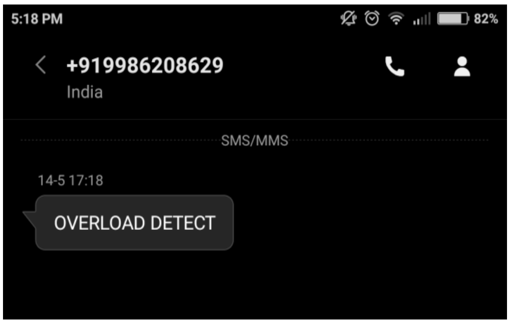

Fig.4.5 Message to operator

❖ ALERT USING MP3 MODULE

As soon as overload occurs the same message that has been transmitted to the operator through the GSM module is also announced in the control room with the help of a MP3 module and a speaker , thereby alerting everyone to the situation at hand and help taking precautionary measures without any delays i.e. when system is overloaded the following message is announced in the control room.“Overload detected preceded by a siren”.

V. Conclusion

This paper proposed the designed using structured modeling and is able to provide the desired results. It can be successfully implemented as a Real-Time system with certain modifications. Science is discovering or creating major breakthrough in various fields, and hence technology keeps changing from time to time. Going further, most of the units can be fabricated on a single along with microcontroller thus making the system compact thereby making the existing system more effective. To make the system applicable for real time purposes components with greater range needs to be implemented. This paper "Underground cable fault detection using voice Alerts" has been successfully designed and tested. Integrating features of all the hardware components have been developed . Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly, using growing technology the project has been successfully implemented.

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