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Automatic Power Line Fault Detector

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Abstract: Automatic power line fault detection is a device that detects, identifies and locates the fault present in the power distribution line caused by various natural or manmade forces. This project mainly focuses on the section of power line that connects the transformer with customers. These faults are directly affects the customers so that it must be found out and rectified as fast as possible. This is done by placing individual units on certain points of the power line which consists of set of voltage and current sensors. Using sensor values, the system checks whether there is any fault is present on the line or not.

Keywords: Distribution line, Power line fault, GSM-SMS, Fault location.

I. INTRODUCTION

Power transmission lines run though several natural conditions those results in various electrical faults caused by lightning, bird, tree and so on. Since these faults are possible to fail the power supply quality, they should found out and rectified appropriately. Fault detection is essential to the safe operation of electric power transmission and distribution system. Without some sort of fault detection the automated removal of short circuits from a transmission system is impossible. As a result these faults might persist until essential electrical equipment is damaged or destroyed. A variety of methods of detecting and locating faults on power transmission lines exist. Most of these methods utilize the measurements from voltage and current transformers at substations or switching stations to perform their analyses. This examines the effectiveness of using magnetic field sensing coils as alternative measurement devices for the purpose of fault detection and location. Most analysis methods rely on the values of either current or voltage phases measured by means of current or voltage transformers at substations or switching stations.

In addition to categorizing these fault location methods by the way in which they locate faults, they can also be classified into one terminal and two terminal based on whether they require information from one end or both ends of the transmission line respectively.
In contrast to transmission lines, distribution lines are non-homogeneous, with branches and loads along the line which makes fault location difficult. Recently several fault location methods are proposed like travelling wave based methods, impedance based methods, voltage based methods and knowledge based methods. Impedance based methods are attractive because of their low implementation cost and accuracy particularly in one terminal measurements. Knowledge based methods uses artificial intelligence to estimate the fault location. Voltage based methods uses database search and pattern recognition algorithms to identify the fault location. This method is very complicated hence seldom used.
The chapter 2 defines the causes, after effects and precautions related to faults present in power line. This chapter also illustrates the adaptability of proposed idea over the existing system.
The chapter 3 gives the various related works carried out by several persons or institution that led a way to this project. It goes through various techniques and components which may be employed for implementing this project. The chapter 3 gives the detail description of this project. It deals with the block diagram, circuit diagram, PCB design and the software part of this project.

II. INEFFICIENCY OF PRESENT SYSTEMS

In our country the power line fault is a serious issue and we detect and locate those faults manually. When fault is appears in the transmission line, the users should inform the authorities and they have to disconnect the power immediately. There are many technologies that are proposed by various engineers but almost all of them are not practical especially in very high voltage lines as well as junctions. The wavelet transform method for fault location is an accurate method but is expensive and complex. It is difficult to implement in real time. The faults present in the power line can be of different categories. Line to Line Fault (In the case of three phase Lines), Line to Neutral Short Circuiting, Line to Ground fault, Open circuit faults. In the upcoming sections we will discuss these faults in detail. These faults can also be expressed as transient faults, symmetrical fault and persistent fault.

A transient fault is a fault that is no longer present if power is a disconnected for a short time. Many faults in overhead power lines are transient in nature. At the coherence of a fault power system protection operates to

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isolate area of the fault. A transient fault will then clear and the power line can be returned to service. Typical examples include the momentary tree contact, bird or another animal contact, lightning strike and conductor clash. In transmission and distribution system an automatic re-close function is commonly used on overhead lines to attempt to restore power in the event of transient fault. This functionality is not as common on underground systems as faults there are typically of a persistent nature. Transient faults may still cause damage both at the site of the original fault or elsewhere in the network as fault current is generated.

A persistent fault does not disappear when power is disconnected. Faults in underground power cables are often persistent. Underground powerlines are not affected by trees or lightning, so faults, when they occur, are probably due to damage. In such cases, if the line is reconnected, it is likely to be only damaged further.

Asymmetric, symmetrical or balanced fault which affects each of the three phases equally. In transmission line faults, roughly 5% are symmetry. This is in contrast to an asymmetric fault, where the three phases are not affected equally. In practice, most faults in power systems are unbalanced. With this in mind, Symmetric faults an be viewed as somewhat of an abstraction; however, as asymmetric faults are difficult to analyse, analysis of asymmetric faults is built up from a thorough understanding of symmetric faults.

III.AUTOMATIC POWER LINE FAULT DETECTION

In present systems, there are no simple and effective techniques to automate the fault detection and location. This process is generally carried out manually as they get information about fault from the side of users. The immediate action to be done is to switch of the power supply.

A. Fundamentals

In some systems, this is only automated using relays or ELCBs. The proposed system is an Automatic Power Line Fault Detector that can easily and accurately detect and locate the fault occurred in the power line. It consists of a line unit as well as a master station. The system makes use of voltage and current transformers which are placed at different points on the line to detect the fault. Detection includes checking whether the line is faulty or not and if it is, then identifying in which category this fault falls. This is found out by checking the values of current and voltage transformers. The obtained result is then transmitted to master station so that it can continuously monitor the status of lines. If the line is faulty, the master pushes the line after the faulty one to open. Thus fault occurred at a point on the line will not affect the next sections of the line. The location where which the fault is occurred is also predicted using this system.

B. Design Equations

To design the system we have to consider the design equations. The design equations are used for taking necessary actions whenever a fault is present on the power distribution line.

When the power line is having no fault present on it when ever,

$$Ip=In \quad (1)$$

and both are below threshold. If the line is open circuited then,

$$Ip=In=V=0 \quad (2)$$

Where Ip and In are the phase and neutral currents and V is the phase to neutral voltage. The condition for short circuit can then be,

$$Ip>Threshold \quad (3)$$

and that for ground fault is,

$$Ip>In \quad (4)$$

C. Block Diagram of System

The block diagram of both post unit and main unit are separately analyzed here. The block diagrams of both post and main unit are shown below. A typical power distribution line is powered by transformers placed at certain locations. The transformer secondary will be star connected so that it will have a set of three phase lines and neutral line. Each single phase customer get supply from a phase line and a neutral line. It is important to note that this arrangement is quite complex and is difficult to locate faults. To analyze the fault, here we use a small circuitry called post unit which is mounted on various points in the line. Individual post unit will examine its input voltage and load current and using suitable algorithm it finds the fault if any. The post units always send the status of line to main unit which is placed at the transformer end. Post unit also cuts the connection to subsequent section whenever a fault occurs.

The main unit also consists of set of sensors that give the status of line at that point and it accepts the information received from the post units. It sends information to the authorities of power provider about the fault including its type and location if it finds the line faulty. Power for the post units to work can be provided by using solar panels so that the unit will very efficiently work. An LCD is placed in all the units which will display the status at that point of power line. The status include the main power supply, voltage and current at that point, identification number of that unit, fault type if any etc. The complete unit is controlled by a micro controller.

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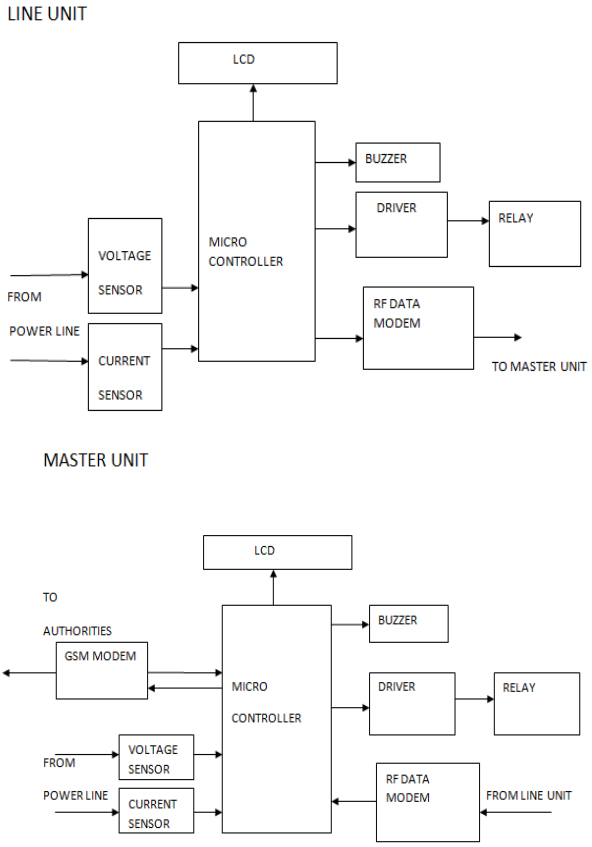

It mainly divided in to two sections: The line unit and the Master unit. The two sections are connected wirelessly. Both are powered by DC power supply. The power supply can be a DC battery or a solar panel. The line unit consists of mainly a microcontroller, voltage and current sensors, Driver, Buzzer, RF modem, LCD and relay. The whole system contains several line units which are placed in different points in the transmission line. The main function of line unit is to find the faults in the transmission line and inform the corresponding location to the master station.

The master station consists of a Microcontroller, GSM modem, RF data modem, driver, relay etc. Initially, when the system is powered, the controller reads the sensor values that is, the phase current, neutral current and the voltage values. The controller first check for open circuit fault and then short circuit fault and finally for ground fault. If any one of the above mentioned fault is present, the controller gives information to cut the relay. In the case of post unit, if the phase current, neutral current and the voltage across the two lines are equal to zero, then the system directly cut the relay assuming open circuit condition. If this condition is not met, the circuit then check whether the phase and neutral currents are gone above a certain threshold or not. If yes, the system assumes short circuit condition and the relay gets cut. If this condition is wrong it will check whether the phase and neutral currents are equal. If no, the system assumes ground fault and cut the relay. If this condition is also false, the system again check the sensor values again repeats the process. If one ofthe above conditions are met that shows the line is faulty, the system suddenly cuts the relay and sends the information to main unit. Similar to post unit, the main unit also check its sensor values and if one of the condition that corresponds to any of the fault, the system suddenly cuts the relay and sends as SMS to authorities. If the sensor values show no fault at the main unit side, the unit check for the information came from the post units. If any of the post units is identified as faulty, the main unit sends an SMS to authorities including the type of fault along with the identification number of post where which the fault is identified. To check for short circuit fault, we need to assign a threshold above which if the current increases, the system assumed short circuit condition. If the connected load is very much higher, it is desirable to cut the relay so as to avoid further destruction. If the threshold is too large, even if the current is goes very much high, the relay may not cut causing the chance of destroying the devices connected to it. If the threshold is too low, unwanted relay cuts may occur which will adversely affect the customers. The threshold must be designed carefully to avoid unwanted switching of relay while protecting the system.

VI. RESULT AND DISCUSSIONS

The system designed successfully for detecting and locating power line faults caused by various destructing forces which may be natural or manmade. The set of current and voltage sensors attached with the post and main units help in monitoring the line continuously. The relay disconnects the faulty section of line from mains so as to minimize accidents. This is achieved with the help of a micro controller that will produce control signals to cut the relay whenever a fault is found out. All the units are named by using an identification number so that under which unit the fault is found can be easily identified.

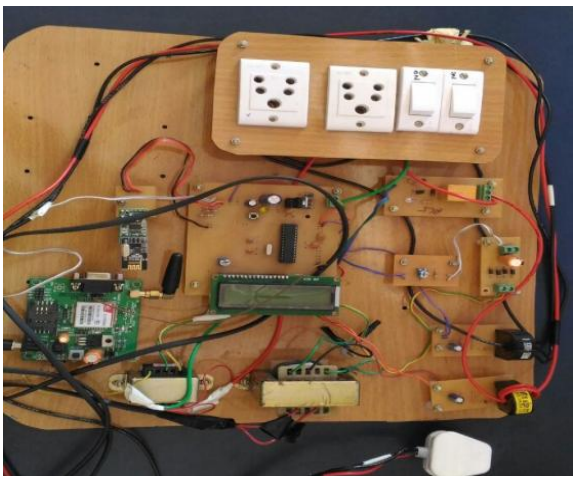

Fig. Hardware of Main unit

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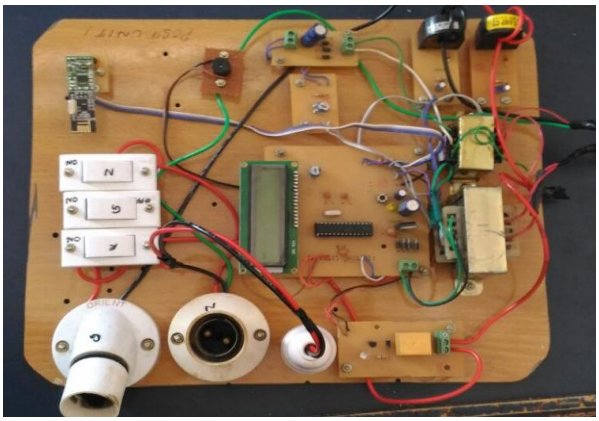

Fig. Hardware of Post Unit

In the prototype we have designed, the variation in voltage is shown by varying a potentiometer so that it is simple to demonstrate the working of this project. In real time implementation, this variation will be due to faults thus a sensor that can sense relatively large range of voltage values and with fast response must be used.

V. CONCLUSION AND FUTURE SCOPE

The motivation behind this project was difficulties due to faults detection and location in power distribution lines. Power lines in our country are subjected to faults due to various forces and it is very difficult to identify and maintain it in short interval of time. This may cause many electrically induced accidents and hence must be prevented. This project finds a solution for this problem by implanting a set of units on various points on power distribution line and measuring the instantaneous values continuously. The fault can easily be detected, identified and located using this arrangement. This system can help the authorities to maintain the power line easily and can avoid line fault induced accidents up to a limit. The performance of this system can be improved by replacing the RF modem by advanced Zigbee technology. We can use solar panels for powering the individual units instead of batteries. In the case of systems containing large number of post units, the connection between each post unit to main unit can be replaced by connecting post unit serially and then to main unit. This will reduce complexity and number of connections.

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