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Self-Regulating Line Fault Detection and Location in Transmission Lines

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Abstract: ***In the present time scenario, where we use cables and optical fibers for data transmission along with power transmission, locating the flaws and faults in the transmission lines has become a necessity. Transmission lines are among the essential fragments of power systems. Being exposed to climatic fluctuations makes them the most vulnerable fragment. There may be numerous reasons that originate faults in the lines, such as temperature escalation, lightning strokes, even drizzles and fog because insulated carriers to wear out mechanically. It is indispensable to locate the fault point to restore the power at the earliest. Excellence in power delivery is achieved only if the time enforced in determining the flaw point in the line is limited. Accordingly, an authentic access is essential to figure out the literal location of the fault in the transmission line. This project introduces an accurate and adequate approach for determining the location of the line fault. It illustrates how the use of GSM and GPS along with ARDUINO UNO can relatively reduce the human labor and increase the accuracy whilst downsizing the obligatory time.***

Keywords: ***Arduino UNO, GPS, GSM, Microcontroller.***

I. INTRODUCTION

In a larger electrical or mechanical system, there is a small fragment called a computer system which is otherwise known as an embedded system, it comprises of different computer constraints with a dedicated function. It plays a major role in today's electrical and mechanical world as it is a major component in controlling the various devices which are in common use today. Applications of embedded systems are present in different streams like aeronautics, telecommunication, finance, etc. The traits of embedded system are reliability, efficiency, stability, etc. Transmission lines are the carriers of either electricity or electric signal over large distances. They transmit the signal from the generating units to various distributing points. There are different types of transmission lines such as coaxial cables, optical fibres, etc. Itis a combination of conductors illustrating certain characteristics due to distributed inductance and capacitance. When a voltage is swiftly applied to an end of a transmission line, both voltage and current propagate approximately at the speed of light along the line. Faults in transmission lines can be caused due to various reasons. Some of these can be due to increment in temperature, disturbance in the ideal conditions of voltage and current flow, equipment failure, human errors, etc. There are mainly two types of faults. They are Symmetrical and Unsymmetrical faults. The effects of such faults can be loss of equipment's, electrical fires, danger to operating personnel, etc. To date, there are many pieces of research conducted in the field of fault detection. Some of these are:

- IOT besides with solar panels,
- GPS monitoring
- Alienation coefficient-based approach
- By using finite impulse response artificial neural network (*FIRANN*)
- By using HAAR Wavelet Transform

The proposed system here enables the rectification of faults in the transmission lines by simple technique comprising a combination of GPS and GSM. In 2018, Saurabh Jangir et al proposed the idea of using Alienation Coefficient Technique [3] for fault detection, which works for a quarter cycle period, for successive cycles. The obtained result of this calculation is compared with a threshold value, which is fixed for reference, in turn increasing its time consumption making it a tedious work. This alienation coefficient is calculated for three phase current. Furthermore, the resultant is worked upon to classify the faults. This in turn causes a number of difficulties and complexities which is solved in this explained idea. Later, in 2019, Afaneen Anwar et al proposed multiple faults detection in transmission lines [2]. Large number of current and voltage values are taken into account and further compared. In 2010, Denio T. Silva et al proposed the idea of using current values in shield wires [8] for tracing the location of fault in the lines. Here there is a compulsion of using the Rogowski coils, a communication structure, and a computer.

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In 2016, Ankita Nag et al proposed the approach of using Artificial neural network for fault detection [10], both in underground cables as well as overhead lines. It uses Levenberg Marqadt Algorithm for calculations. In 2017, S. Suresh et al brought up the idea of using internet of things for detection and monitoring of fault in transmission lines [4]. This approach best works for low bandwidth flow, as bandwidth increases the prototype components need to be changed for the same. In 2019, P. Sanjeevi Kumar et al gave the approach of using advanced digital signal processing [1]. The obtained signals are passed from PSCAD/EMTD simulation software, further it is passed from MATLAB Signal Processing Toolbox employing time-frequency distribution (TFD), which is restricted for time-frequency domain.

II. REVIEW CRITERIA

Using Alienation Coefficient Technique for fault detection, works for a quarter cycle period for successive cycles. The obtained result is compared with a threshold value, increasing its time consumption making it a tedious work. This alienation coefficient is calculated for three phase current. Furthermore, the resultant is worked upon to classify the faults.

III. METHODOLOGY

In the proposed approach as seen in Fig. 1, there are reductions in the human labor along with increasing the accuracy of fault location. Here, authors have explained the changes that occur in the voltage and current values while transmission. There can be different factors affecting the changes in the ideal flow of current and voltage in the lines. Authors have proposed the simplest and easiest techniques till yet to avoid accidents as well as to reduce time consumption to locate the line fault. As it provides the accurate location of the fault in the line through GPS and GSM to the provider, in the form of longitude and latitude, this model can be used to locate the fault in the lines, located at quite a distance. The proposed system acknowledges the input current and voltage signals, which is then further worked upon to extract the fault, to detect it and to finally identify it. The fault is further classified and its location is sent to the provider's phone number as a text message.

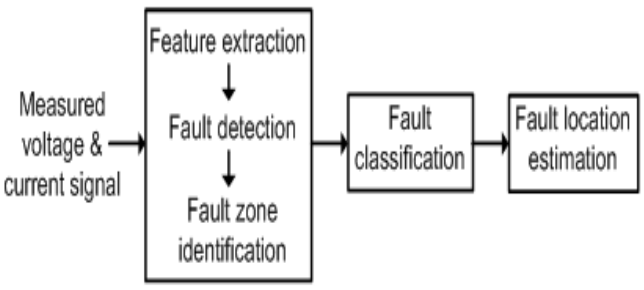

Fig. 1. Methodology for the proposed system

IV. SYSTEM ARCHITECTURE

In this module, we are using different techniques which at last sum up to provide the desired results. The ideal conditions are checked for a particular transmission line. The values of current and voltage flow are taken into account. These values can be displayed in the model as well as in the provider's desktop. The change in the temperature marks the fault in the line, if it reaches above the maximum limit, a text message is sent to the provider's telephone number that "Temperature is high", with the help of GSM. If there is a fault, that is if the transmission line breaks, the continuation of display of current and voltage values is stopped. The LED display attached to the model displays "LINE FAULT DETECTED" and the same is sent to the provider's telephone. Now, with the help of GPS, the breakage in the line is located and its latitude and longitude are sent to the provider and are displayed on the LED screen as well. With the help of latitude and longitude, the provider can send the technician to resolve the issues in the line. The prototype is home friendly as it works on the home load. As the home load is alternating, a bulb is attached to mark the current flow in the line. However, here it works as a load. Other components used in the prototype works on the direct current, for which a rectifier is used to convert the input alternating to the direct current. As well as the input alternating current is of very high value.

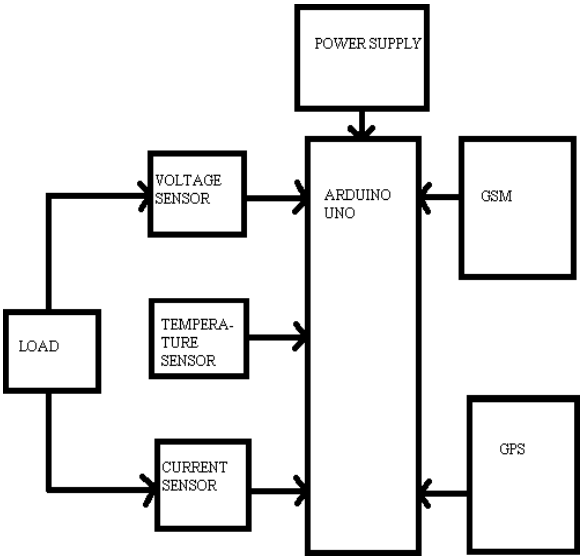

Fig. 2. Block diagram of the proposed system

V. MODULE DESCRIPTION

This model is divided into different parts or sections, namely modules. There are mainly six modules present. They are:

1. Load
2. Voltage Sensor
3. Current Sensor
4. Temperature Sensor
5. Arduino UNO
6. GSM
7. GPS
8. LCD Display

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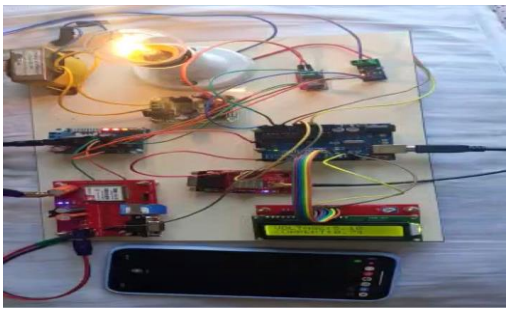

Fig. 3. The proposed module

A. *Load*

For input load we are using 240V in our prototype. But as the other components that are GPS, GSM works on 12V, we are using a step-down transformer. The transformer decreases the input domestic load to 12V.The transformer is connected to the power supply board, which consists of a rectifier as well. A bulb is fitted to show the continuous input supply. If there is a fault the bulb diffuses, to show that there is no current flow in the line. This bulb is then attached with a rectifier to convert the input alternating current to the direct current supply, which is essential for other components in the prototype to function.

Fig. 4. Load used in the prototype

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B. *Voltage Sensor*

Here it is used for measuring power quality, load sensing, fault detection, etc. It comprises a divider which decrements the input voltage by a factor of 5. It measures the voltage supplied to the prototype in ideal conditions and thus the results are presented on the screen of the service provider by GPS and GSM. If there is any fault in the line due to any reasons, this sensor stops working immediately, showing the pause in the service provider's screen to make him aware of the fault.

Fig. 5. Voltage sensor in the prototype

C. *Current Sensor*

Here it provides the value of input current in the line is ideal as well as in fault condition. Overcurrent can cause a huge fault too. It can sense on both alternating and direct current. This is the second component in the prototype which works only in the ideal conditions like the voltage sensor. It senses the direct current obtained from the rectifier, until any fault is occurred. It provides continuous supply of current value in the transmission line on the service provider's screen. In case of fault, it stops functioning along with the voltage sensor.

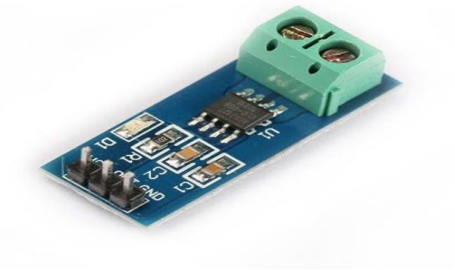

Fig. 6. Current sensor used in the prototype

D. *Temperature Sensor*

It is used to monitor the temperature throughout the transmission line. If the temperature reaches the saturation level, it informs the concerned provider about the same. In here, the saturation level is set to 35 deg Celsius. If the temperature in the transmission line reaches above 35 deg Celsius, irrespective of the reason, this prototype sends a direct text message to the service provider's phone number without any further delay. The text is cited as TEMPERATURE IS HIGH, which gives the idea to the provider to look for the reasons as well as to resolve the issue as soon as possible to terminate any further chances of fault occurrence in the line.

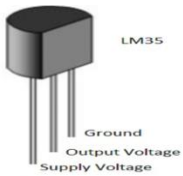

Fig. 7. Temperature sensor used in the prototype

E. *Arduino UNO*

Arduino UNO is a microcontroller, which has both direct and alternating input as well as output. There are in total 14 pins in an Arduino. It is connected to the desktop with the help of a USB cable to upload its source code. It is connected with GPS, for location accuracy. The source code is in the Arduino software (IDE) format, which is uploaded to the Arduino board. The code is written in embedded C language. As it helps in performing the specific tasks by the microcontroller, the source code written for this prototype consists of the provider's number, temperature saturation level, along with instructions for the GSM and GPS used.

Fig. 8. Arduino used in the prototype

F. *GSM*

Global System for Mobile Communications (GSM) as the name suggests, is used in cellular networks and specifically 2G networks. It describes and defines the protocols of 2G. There is a sim card tray, by using which we can send the text messages to the provider's telephone. The model which we are using in this prototype is applicable for 12v DC input only. In the source code, we provide the telephone number of the service provider, along with AT (attention) Commands. These commands enable the GSM to send the text messages to the concerned provider.

Fig. 9. GSM sensor used in the prototype

G. *GPS*

Global Positioning System (GPS), provides the user with location, position or navigation, as it is satellite-based. In this prototype, it provides us with the latitude and longitude of the location where the fault has occurred. This same information is passed to the provider with the help of GSM. It can work anywhere, without getting affected by changing weather conditions. GPS is available in different sectors like military, automation, etc. due to its accuracy in the navigation and location. It is used to track down the devices, vehicles, ships, planes, etc.

Fig. 10. GPS sensor used in the prototype

H. LCD Display

The LCD display used in this prototype is used to display the ideal current and voltages value in the ideal conditions and at the time of fault it displays the latitude and longitude of the fault location. It is also used to display the condition of temperature raise, when the temperature of the transmission line reaches or crosses the threshold value assigned in the source code by the service provider. In this prototype, a 16*2 LCD display is used, which have 2 lines with the space for 16 characters in each line. This type of LCD display is very common in electronics world as it can be used in any prototype depending on the needs.

Fig. 11. LCD display used in the prototype

VI. RESULT AND DISCUSSION

A. Outcome

The text messages shown in Fig. 12 are sending to the provider both for temperature raise as well as fault location using GPS and GSM. Here, because of GPS the obtained latitude and longitude defines the accurate location of the fault.

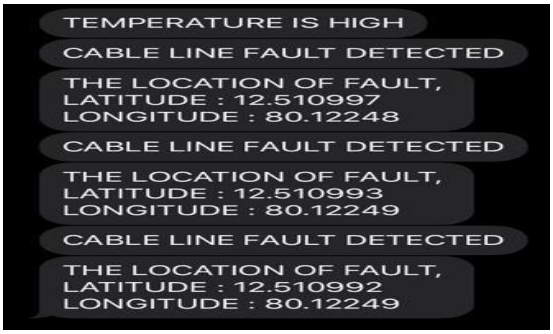

Fig. 12. Output of the proposed system

B. Inference from the Output

The revived overture allows the tracking of the overhead transmission lines using GSM. Fault locations are marked with the help of GPS. This idea proposes a compact, accurate, and easier monitoring module, which helps in decrementing the human labor. There is no such heavy, hard calculation which in turn saves time, and fault resolution can be done faster. The use of GSM and GPS enables the provider with accurate data of fault location. It improves the outdated approaches which caused possibilities of loss of human life. There is no need to replace the hardware frequently.

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VII. CONCLUSION AND FUTURE SCOPE

As there are numerous advancements in the field of communication and transmission, manual labor is decreased day by day. Thus, the proposed prototype provides an accurate location without any complex calculations and thus cutting back the time consumption. There is an incredible reduction in the wear ability of the devices. It is highly compact which makes it easy to monitor and recover. It covers the drawbacks in the previous researches besides providing an easier and advanced approach. It is still yet the simplest approach in fault detection in the lines. For future scope, this prototype can be fixed for changing weather conditions along with reduced latency and auto control unit.

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AUTHORS PROFILE

Ambrisha Sharma, is a final year B. Tech student in SRM Institute of Science and Technology, Chennai. After completing her class 12th from Gyan Jyoti Academy, Bhopal, she was keen in studying Engineering, her interest in communication sector encouraged her in pursuing Electronics and Communication as her major. In colleges she started learning coding languages and is working in the same field.

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