Self-Regulating Line Fault Detection & Its Location In Transmission Lines

Sibisagar.B, Surya.V.R, VigneshVijayaraghavan, Dr.SuriyaKrishnaan

Abstract: Overhead transmission line constitutes the major part of power transmission systems in India. Faults in overhead transmission lines are a common sight in rural and semi urban parts of this country this problem is addressed in this paper work. The line faults causes power disruption, damage to power equipment in some instances loss of life due to live wire and it is very difficult to determine the location of the line fault and to prevent power waste and any other casualties by preventing the flow of power.

Index Terms: Transmission line, Line Fault, Transient Fault, Fault Detection, Sensors, Internet of Things, and Cloud Server

1 INTRODUCTION

One of the major reasons for power loss and damage to power transfer equipment is due to transmission line fault. When a line fault occurs in rural India it is estimated to take around seven hours to be restored whilst major portion time is taken to locate the exact location of the fault since there is no efficient means to locate the fault precisely. There are three means due to which a fault may occur when voltage greater than desired voltage is transmitted or when voltage lesser than desired voltage is transmitted or when no current flows between any two points in a transmission line. In the proposed system each of this line fault problems is addressed independently. Arduino UNO microcontroller acts as the brain of this system where in it controls the functioning of the entire system. Voltage sensor, current sensor and temperature sensor is used to constantly measure the voltage, current and temperature respectively. The system is programmed in such a way that any variation crossing the upper and lower threshold of these key parameters will be immediately informed to the concerned electricity board such that precautions can be undertaken to prevent damage or control any further damage. These alert messages can be sent using GSM. Internet of Things can be used to obtain live status of the fault and can be used to cut of power supply to the affected region.

1.1 Motivation:

Power failures due to line faults are a very common sight in rural regions and semi urban regions of India. Power faults affect the livelihood a major portion of people, small and medium scale industries operating in the region. line faults are not restricted to just voltage fluctuations and it also includes live wire that could cause damage to living beings. The same issue can be addressed by detecting the locating the line fault using embedded system in this case a micro controller as the controlling system and controlling the power flow using IOT.

1.2 Contribution:

This paper work aims to detect line faults and locate the fault using Global Positioning System and the latitude and longitude of the same can be sent through GSM and the live status of the same can be monitored using IOT. Damages to Electrical components or living beings can be prevented by disconnecting the power supply to region experiencing the line fault. Upon completion the State electricity board will be able to receive immediate alert on the line fault with precise coordinates and will be able to control power flow to the region from the nearest substation.

2 RELATED WORKS

An adaptive impulse correlation filter (AICF) was made use of in order to filter the nose which was induced in the acquired ECG signal. The AICF was utilized in order to calculate the determinant signals, and portrayed improved performance in reflecting the critical signals, compared to other previously used methods, of ensemble averaging [1]. With a consideration towards diffuse optical transmission, an adapted method was proposed in order to determine the robustness of wireless optical communication system taking into account the presence of any obstacles in the specified work volume [2]. The authors here proposed a quality of link estimating resource allocation scheme in which WBANs are used as an effort towards maximizing the overall network efficiency and performance. The proposed work consists of two layers—temporal link quality measurement and sub-channel allocation among the wide range of available WBANs. As a primary work, the authors predicted the correlations among different aspects of link quality. Based on the data already available about correlated link qualities, the sub-channel allocation layer diverges the available bandwidth into several sub-channels in order to maintain the quality of service of the network[3]. In this paper, the authors briefly describe the introduction of WBAN and the proposed work focuses on the analysis of the routing protocol which provides clean data to classify, and compare the advantages and disadvantages of various available routing protocols. Secondly, problems and suggestions were put forward, which provided ideas for the design of follow-up routing [4]. The research provided the investigation details of sensor devices, physical layer, data

- *Sibisagar.B , Surya.V.R, VigneshVijayaraghavan are currently pursuing Bachelor degree program in Electronics and Communication Engineering in Easwari Engineering College, E-mail: officialsibi@yahoo.com, suryavr1811@gmail.com, vignesh2501@gmail.com.*
- *Dr. SuriyaKrishnaan is currently Assistant professor department of Electronincs and Communication Engineering in Easwari Engineering College, E-mail: suriyakrishnaan@gmail.com*

link layer, and radio technology aspects of BAN research. The authors also presented a crystal clear classification data of BAN projects that have been proposed till this very date. Finally, the works highlighted some of the design challenges and open problems that still needed to be addressed to make BANs truly unambiguous for a very wide range of applications [5]. In this work, the authors have presented an on-demand packet transmission scheme with simple implementation method thus taking the requirements of a BAN into considerations. Handling the event-based emergency traffic is the major concern in this model. The performance analysis of the proposed work is presented. The results portrayed some significant improvements in the overall efficiency and performance of a BAN [6]. In this paper, the following reviews such as fundamental mechanisms of WBAN including topology and architecture, routing protocols and the mechanism of wireless implant low-power Medium Access Control (MAC) are made. A detailed study about the proposed technologies for WBAN at Physical (PHY), MAC, and Network layers is portrayed and various useful solutions and their effectiveness are discussed for each layer. Finally, numerous applications of WBAN are highlighted[7]

3 SYSTEM MODEL

In our proposed system we make use of several sensors mounted at each end of the transmission lines. The sensors like current, voltage and temperature are placed very close to the line for proper detection of any faults. Even in that, the voltage sensor is put up very close to the line because the voltage linkage is the most common reason for most of the transmission line faults. One more reason for close proximity is that it could avoid any interference that is caused by the environment. The reading from the sensors is collected, aggregated and sent to the Arduino UNO controller which is placed at the end of the lines. Along with the sensors, GPS and GSM modules are also used. The controller will process the collected data from the sensors by comparing them with the threshold values which are programmed in the memory before setting up the controller. If there is an imbalance in the line is detected by the controller while processing the sensor data, the line's respective latitude and longitude are traced by the GPS module and initially transferred to the controller. When the controller receives the affected line's location details, it makes use of the GSM module to alert the concerned officials for instant action. Also, the controller shuts down the affected areas' powerfully to avoid accidents. The IoT module in the controller is used to update the status of the transmission line for every half an hour to the nearby allotted Electric board server.

4 PROPOSED SYSTEM

In the previously existed method, there is a risk to determine the fault point along the transmission line. And also cant able to find the fault location. This leads to drawbacks like a frequent change of hardware and even worse it led to a loss of human lives. In the proposed system, with the utilization of IoT (sensors) and embedded system, the overhead transmission line is monitored by wireless networks and the determination of the fault in the line become easy.

This made a faster recovery rate, avoid worse accidents and the setup is very feasible.

4.1 Technical Specification:

FIGURE 1.
ARDUINO UNO PIN DIAGRAM

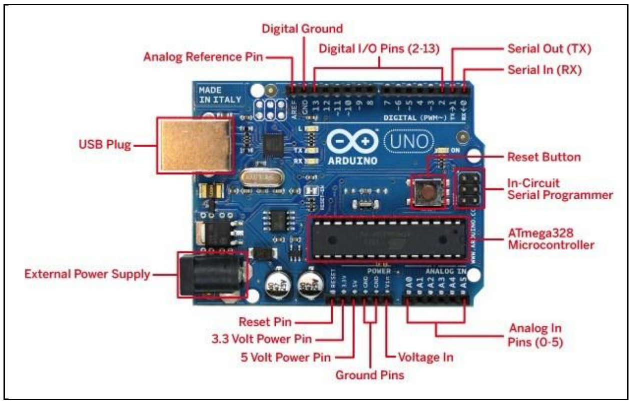


TABLE
CONTROLLER SPECIFICATION

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm
Weight	25 g

4.2 Hardware:

The hardware model designs in Arduino are licensed under a Creative Commons Attribution-Share-Alike 2.5 licence, and are accessible in software and development format on the Arduino website. The Arduino 328 comprises of 14 optical I / O pins at the peak, 6 analog input pins at the lower right, and the battery connector at the lower center. Many Arduino boards consist of an 8-bit Atmel AVR microcontroller with differing quantities of flash memory, pins and software.The boards use individual or double-pins or female headers that allow connections to be programmed and inserted into other circuits. It can be connected to external devices named covers. Most of the boards are equipped with a 5V linear regulator and 16 MHz crystal osciler or ceramic resonator, other machines, like the LilyPad, are operating at 8 MHz and excluded from the on-voltage regulator due to unusual form factor constraints. All of these systems may be managed independently using an I2C serial bus. A bootloader is provided in Arduino microcontrollers which simplifys the loading of software into the flash memory of the device. The optiboot bootloader is the main bootloader for the Arduino UNO. Boards are filled through a serial computer with software instructions. Some Arduino serial boards provide a level shifter circuit for switching between RS-232 and TTL .The Arduino boards are currently being designed by USB, which is introduced using USB-to-serial adapter chips like FTDI FT232. Such modules, such as later Uno modules, substitute a FTDI chip with a distinct AVR chip that includes USB-to-serial firmware that can be reprogrammed from its ICSP header. Many models such as the Arduino Mini and the unauthorized Board are fitted with the reversible USB-to-Serial connector, Bluetooth, and other methods. When the regular in-system programming (ISP) is used with conventional microcontroller devices, instead of the Arduino IDE. An approved Arduino Uno R2 with I / O positions details is used. Many I / Os of the microcontroller are shown on the Arduino board for other circuits. The Uno currently provides 14 digital I/ O pins, six of which can generate modulated pulse-width signals and six analog inputs that can also be used as six digital I / O pins. Such pins are on the 0.1 (2.54 mm) header on top of the plate. Even commercially available are different plug-in device covers. The Arduino Nano and Arduino compliant Bare Bones Boards and Arduino Boards can provide male header pins to plug into solderless breadboards on the underside of the board.

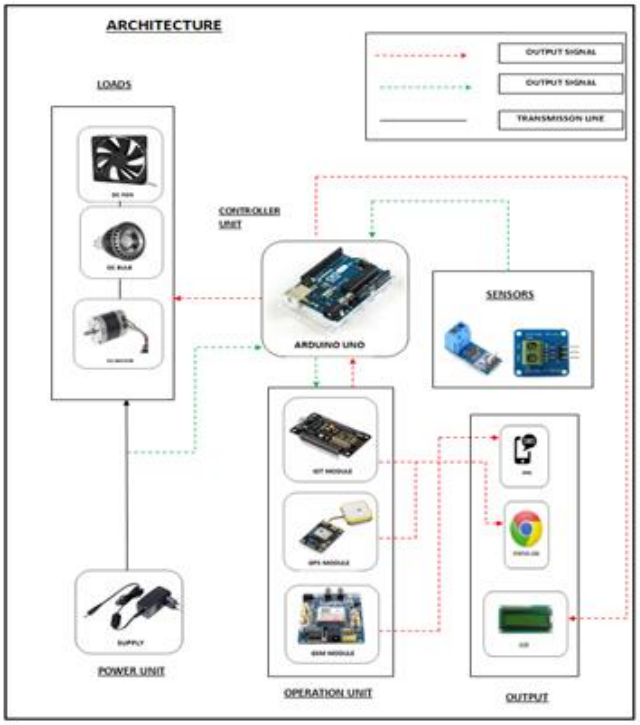
4.2.1 Sensor:
These are the devices that are used to sense and react to different kinds of signals. Sensor implementation is a great method for different parameter measurements.

4.2.1.1 Voltage Sensor:
Voltage Sensor SKU: 29802 is used in the working model, it makes use of potential divider to lower any voltage by a factor of 5. It helps you to use the analog feedback of a microcontroller to measure voltages far greater than that which can be perceived. Based on the theory of pressure resistance points, this module will reduce the input stress of the red terminal by a maximum of 5 times. The main Arduino analog input voltage is 5 V, meaning that this circuit has a fixed input voltage of 5 Vx 5= 25 V (if the input voltage for a 3.3 V device would be 3.3 Vx 5= 16.5V). The sensor simulation resolution of the Arduino AVR chip has 10 bit AD and thus the input voltages of that circuit will be greater than 0.00489 Vx 5= 0,02445 V.

4.2.1.2 Current Sensor:
The current sensor used here is ACS712-30A, it is a component that is used for detecting electric current in the line. An analog or current-voltage or even a digital output may be the signal produced. The produced signal can then be used to show the calculated current in an ammeter, or it can be retained for further study in a data acquisition network, or it can be used for control purposes. Hall Effect Current Sensor is a type of current sensor focused on the Hall Effect phenomena discovered by Edwin Hall in 1879. Hall Effect Current Sensors may calculate all kinds of current signals (i.e. AC, DC or pulsating current). These sensors are already commonly used in many industries due to their broad uses and the quality of feedback they offer, which can be controlled. ACS712 Current Sensor Module-30A can identify a current flow of up to 30A. Sensing and monitoring current flow is a critical feature in a broad variety of applications, including over current safety circuits, battery chargers, switching mode power supplies, optical watt meters, programmable current sources, etc. ACS712 Current Sensor Module-30A is based on the ACS712 sensor, which can measure AC or DC current precisely. The actual AC or DC that can be measured can be up to 30A, and the current signal can be interpreted through the analog I / O port of the microcontroller or Arduino.

4.2.1.3 Temperature Sensors:
The LM35 series are precision integrated-circuit temperature instruments with a maximum voltage linearly proportional to the Centigrade value. The LM35 unit has a benefit over the Kelvin adjusted linear temperature sensors because the consumer is not needed to remove a significant constant voltage from the display for easy Centigrade scaling. The LM35 system needs no external adjustment or trimming to have normal sensitivity of ±1⁄4 ° C at room temperature and ±3⁄4 ° C over a complete −55 ° C to 150 ° C temperature spectrum. Lower cost is achieved by wafer-level trimming and adjustment. The low-output impedance, linear performance, and precise inherent configuration of the LM35 system make it especially simple to interpret or monitor circuitry interfaces. The system is equipped with a single power supply or with a plus or minus supply. As the LM35 unit draws just 60 μA from the source, it has a very small self-heating temperature of less than 0.1 ° C in still air. The LM35 system is designed to work over a temperature range of −55 ° C to 150 ° C, whereas the LM35C system is designed at −40 ° C to 110 ° C (−10 ° with better accuracy The LM35-series devices are available in hermetic TO transistor sets, whereas the LM35C, LM35CA and LM35D devices are included in the TO-92 plastic transistor kit. The LM35D system is offered in a small-8-lead surface-kit and aTO-220 plastic case.

FIGURE 2.
SYSTEM ARCHITECTURE



4.3. Software:
The microcontroller Arduino is programmed using software called Arduino Software IDE. This platform is made available with a text editor for putting up instructions, dialogue area, console, common function toolbar, and menu series. The appropriate microcontroller is chosen using the Tools menu. Usually, the ATmega on the Uno board is integrated with a preprogrammed bootloader which helps to upload new code without the utilization of an external hardware programmer. STK500 protocol is used for communication. The bootloader can also be bypassed with the help of the ICSP header along with Arduino ISP. The firmware source code for ATmega16U2 is available in repositories of Arduino. The ATmega16U2 is provided with a DFU bootloader.

- On Rev1 boards: The solder jumper attaches into the board back (near the Italian map), and then the 8U2 re-establishes.

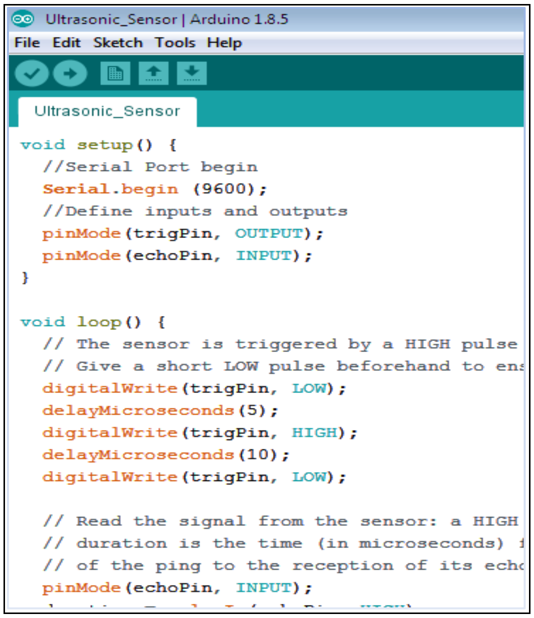
- On Rev2 or later boards: There is a resistor that pulls the 8U2/16U2 HWB line to the bottom, making it easy to use DFU mode.

4.4. Process:
In the IDE initially, a new file is created. In the newly created file, the appropriate code is typed in the Writing Sketch. After the completion of the code, it is compiled and checked for errors using the Verify tool. Then the error-free code is configured into the board with the Upload IDE tool. In case of an external programmer being used, the shift key must be held while uploading the code. The necessary libraries are added to the code. The Libraries advances the existing code by adding additional functionalities when working with hardware or data manipulation. However, these uploaded libraries take up space in the board memory. In Arduino IDE software there already exists a list of libraries in the reference portion. Even the libraries can be downloaded and made use in the code with the help of the Library Manager.

4.5. Embedded C:
Embedded C is the language used to code the Arduino Microcontroller. It is the mostly used programming language for electronic gadgets. This language is used to process the instruction directly by the processor itself. The libraries are added to the code using the keyword #include. In coding, only two functions are used majorly they are setup () function and loop () function. The setup function is used to run the code only once and all the data type declarations and functions are coded there. Whereas in the loop function the loops, conditional statements, and inbuilt/user-defined functions are declared. The functionality is a set of statements that are required for a particular purpose. A programming language is often considered a compilation of one or more features. There are basic elements and grammatical rules in any language. The programming of C languages is optimized for variables, character sets, data types, keywords, expressions, etc. The C-language extension is regarded as an embedded C programming language. According to above, the built-in programming in C often has several extra functions, such as data forms, keywords and header files, etc., defined by the name of the #include <microcontroller name.h>. The configuration of the microcontrollers for every form of operating system is special. While there are other operating systems in operation, such as Windows, Ubuntu, RTOS, etc., RTOS has many benefits for the production of embedded devices.

4.6. Communication:
Arduino Uno can move data between computers and microcontrollers. The microcontroller used here has UART TTL (5V) which is exclusive to serial communication. The wireless pins 0 (RX) and 1 (TX) are intended for this reason. ATmega16U2 is used to channel serial communication via USB and is rendered as a virtual com on the software portion of the device, the firmware is equipped with all normal USB COM drivers needed for the application no additional drivers are necessary, although a.inf file is needed for Windows. The program of the microcontroller i.e. IDE is equipped with a serial monitor that allows easy text data transfer within and outside the device. The RX and TX LEDs on the board will flash as data is transmitted via USB to the serial chip and the USB link to the Device. I2C (TWI) and PSI Communication are also provided by the ATmega328. Included is the Arduino Soft-Software (IDE) a Wire library to ease the use of the I2C bus. Use the SPI library for SPI contact.

FIGURE 3.
ARDUINO INTEGRATED DEVELOPMENT ENVIRONMENT



4.7. ATmega 328P:

4.7.1_ Power:
The Arduino Uno board may be attached through a USB link or through an external power supply. The source of power is picked automatically. External (non-USB) control may either come from an AC-to-DC converter (wall-wart) or from a charger. The connector may be linked by adding a 2.1 mm center-positive plug to the power jack of the frame. The lead from the battery may be threaded into the GND and Vin pin headers of the POWER connector. The board will run from 6 to 20 volts on an external supply. Furthermore, because it is filled with less than 7V, the 5V pin can provide fewer than 5 volts and the board may become unstable. When more than 12V is used, the voltage regulator can overheat and harm the device. The suggested range is between 7 and 12 volts.

The power pins are as follows:

Vin
When an external power source (contracted to five Volts of the USB attaching or other regulated power source) becomes input voltage into the Arduino / Genuino plate. You can provide voltage by this pin or you can control it via this pin if you supply voltage through the power socket.

5V
This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. We don't advise it.

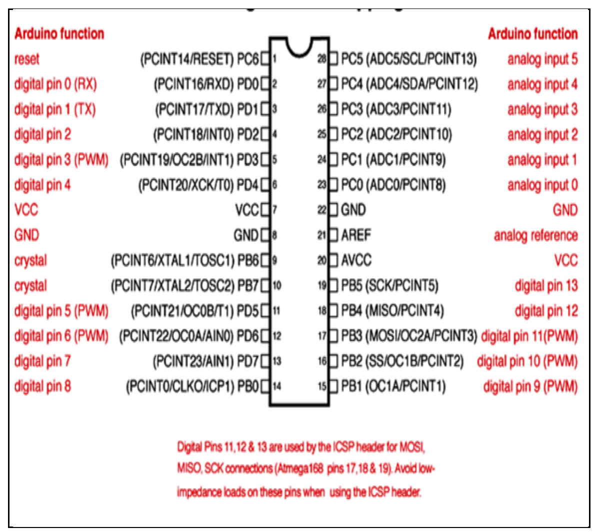
3V3
An on-board regulator output of 3,3 volts. The estimated average production is 50 mA.
GND Ground pins

IOREF
This pin on the Arduino / Genuino board establishes the voltage relation for which the microcontroller works. A correctly designed shield will read the IOREF pin voltage and choose the correct power source or allow the 5V or 3.3V output voltage translators to operate.

MEMORY
The ATmega328 has a total of 32 KB (the boot loader occupies 0.5 KB). There are also 2 KB SRAM and 1 KB EEPROM

INPUT AND OUTPUT:
Refer to the Arduino pin mapping for the ATmega328P ports. The Atmega8, 168 and 328 are equally described. The Arduino Mini is based on a smaller physical IC unit, which includes two ADC pins that are not present in the Arduino DIP kit.

FIGURE 4.
ARDUINO I/O PIN CONFIGURATION



5 RESULT AND DISCUSSION
We achieved the planned performance. We were trying to position the loads along the fault transmission track. In order to experience our experiment in practice, we initially linked the loads to the optimal power supply. The loads used here are the DC fan, the light and the DC motor. The relay is used to separate the supplies to the feed. The platform also comprises of a Arduino Uno microcontroller, an IoT board, a GSM board, a GPS module, an LCD panel, wires and sensors. The system contains the present monitor, the voltage system and the temperature sensor. When the supply is on, all the loads work seamlessly without any interference. When the thread is broken or bent, i.e. the wires. The secure parameters of the line would be disrupted. Sensors sense the weakness of the line by detecting current, voltage and temperature values. At the runtime, the microcontroller is equipped with a

reasonable threshold for the above parameters. The following in which the value of the parameter dropped,

Voltage range - 3 to 13V

Temperature range- 0 to 70CAny one of the two situations happens where a failure arises. Whether the value of the function is greater than or lower than the consistent threshold value. This threshold shall be defined on the basis of the components present in the working model. As per the observation here, the line is cut such that the voltage and current value is zero, which is smaller than the threshold value that has been powered. The controller mechanism sensed the data and automatically turned off the load. The controller shows the state of the line parameter that LCD and constantly updates it to the IOT server, which can be tracked using web application applications. The device is also designed to warn the power failure. This happened as GPS was used to locate and submit the coordinates for the latitude and duration of the fault to the correct cell phone utilizing a GSM app. The information is changed on the IoT file.

FIGURE 5.
LCD WITH PARAMETERS VALUES

In Figure 4, the LCD is used to show the state of the transmission line, and enables the consumer to know the precise values of the sensor in real time. The monitor displays measurements of voltage in volts, current in ampere and temperature in celsius. In fact, this LED will also be used with the GPS module's latitude and longitude readings

FIGURE 6.
SENSOR VALUES OF ACTIVE LINE

```
COM3
VOLTAGE: 12.01 CURRENT: 3.85 TEMP: 31
VOLTAGE: 12.18 CURRENT: 4.22 TEMP: 31
VOLTAGE: 12.06 CURRENT: 3.92 TEMP: 31
VOLTAGE: 12.01 CURRENT: 3.77 TEMP: 31
VOLTAGE: 12.16 CURRENT: 4.51 TEMP: 31
VOLTAGE: 12.01 CURRENT: 3.85 TEMP: 31
VOLTAGE: 12.16 CURRENT: 4.73 TEMP: 31
VOLTAGE: 12.04 CURRENT: 4.14 TEMP: 31
VOLTAGE: 12.06 CURRENT: 4.07 TEMP: 31
VOLTAGE: 12.08 CURRENT: 4.29 TEMP: 31
VOLTAGE: 12.18 CURRENT: 4.44 TEMP: 31
VOLTAGE: 12.04 CURRENT: 4.00 TEMP: 31
VOLTAGE: 12.01 CURRENT: 3.85 TEMP: 31
VOLTAGE: 12.04 CURRENT: 3.85 TEMP: 31
VOLTAGE: 12.04 CURRENT: 3.85 TEMP: 31
VOLTAGE: 12.13 CURRENT: 4.22 TEMP: 31
VOLTAGE: 12.01 CURRENT: 3.70 TEMP: 31
VOLTAGE: 12.04 CURRENT: 3.85 TEMP: 31
VOLTAGE: 12.01 CURRENT: 3.63 TEMP: 31
VOLTAGE: 12.04 CURRENT: 4.07 TEMP: 31
VOLTAGE: 12.06 CURRENT: 4.00 TEMP: 31
VOLTAGE: 12.18 CURRENT: 2.15 TEMP: 31
VOLTAGE: 12.01 CURRENT: 3.85 TEMP: 31
VOLTAGE: 12.16 CURRENT: 4.51 TEMP: 31
```

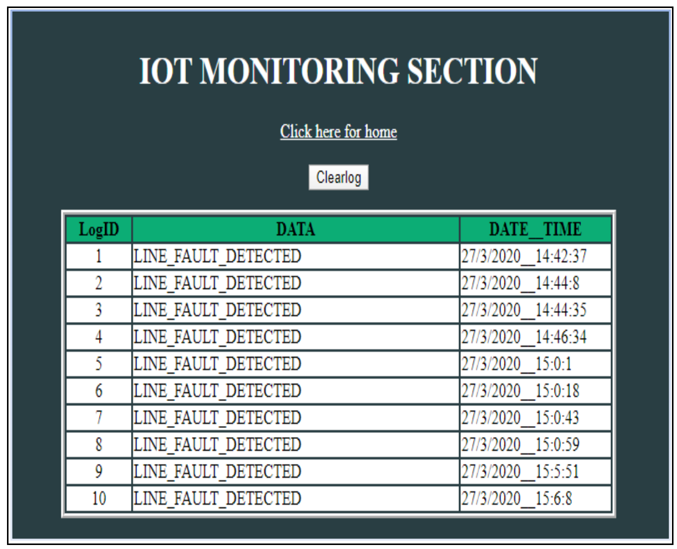
In Figure 5, the parameters of the sensor while the line is functioning properly. The interest is kept up to date until it is manually halted.

FIGURE 7.
SENSOR VALUES OF DAMAGED LINE

```
VOLTAGE: 0.00 CURRENT: 2.37 TEMP: 31
VOLTAGE: 0.00 CURRENT: 2.22 TEMP: 31
VOLTAGE: 0.00 CURRENT: 2.44 TEMP: 31
VOLTAGE: 0.00 CURRENT: 2.00 TEMP: 31
VOLTAGE: 0.00 CURRENT: 2.15 TEMP: 31
VOLTAGE: 0.00 CURRENT: 1.92 TEMP: 31
VOLTAGE: 0.00 CURRENT: 2.07 TEMP: 31
```

In Figure 6, the parameters of the sensor when the line is broken or impaired by other factors.

FIGURE 8.
LINE FAULT DETECTION THROUGH IOT SERVER



IOT MONITORING SECTION

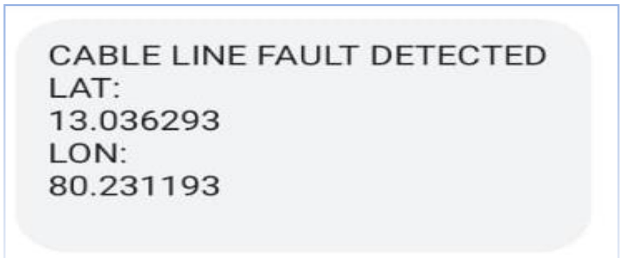
Click here for home

Clearlog

LogID	DATA	DATE_TIME
1	LINE_FAULT_DETECTED	27/3/2020__14:42:37
2	LINE_FAULT_DETECTED	27/3/2020__14:44:8
3	LINE_FAULT_DETECTED	27/3/2020__14:44:35
4	LINE_FAULT_DETECTED	27/3/2020__14:46:34
5	LINE_FAULT_DETECTED	27/3/2020__15:0:1
6	LINE_FAULT_DETECTED	27/3/2020__15:0:18
7	LINE_FAULT_DETECTED	27/3/2020__15:0:43
8	LINE_FAULT_DETECTED	27/3/2020__15:0:59
9	LINE_FAULT_DETECTED	27/3/2020__15:5:51
10	LINE_FAULT_DETECTED	27/3/2020__15:6:8

In Figure 8, The IoT module includes a live server to monitor if there is a line fault. For our project, we use the domain under the www.iotclouddata.tech/744 URL. It sets the status log for our transmission line with date and time. You may access this service from any web-based client program.

***FIGURE 9**.*
TEXT MESSAGE FROM GSM MODULE



In Figure 9, when there happens a breakdown in the transmission line, the latitude and longitude of the affected point get recognized through the GPS module and these important points are sent as SMS to the approved cellular telephone thru the GSM module. The statistics is transferred via the air medium with the help of the GPS antenna.

6 CONCULSION

With this operating model we assume that the flaw can be quickly identified and that the reactive control shutdown will not contribute to any harm to the load. The paper proposed upon implementation would play a vital role in power transmission as it would make it easier to detect the location of any line fault. It reduces the time, capital and labor involved in the detection of fault and power transmission to the affected region can be stopped to save power. This module can be constructed and installed easily hence can be installed in any region that uses overhead transmission lines. Using this device the time taken to restore power to the affected region decreases significantly.

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