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Automatic Fault Detection and Location of Transmission Lines using IoT

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Abstract

Energy leakage is one of the major problems that the corporation faces in recent times. Bringing this leakage under control is next to impossible with the electrical transmission lines running millions of miles across the country. Only way to solve this problem is to come up with a mechanism that can detect the fault in an electricity transmission line automatically and intimate the authorities with a specific location. Through this project you will develop a device that uses sensors to sense the incoming & outgoing values and detect anomalies. And, the system will be integrated with the IoT mechanism, to intimate the responsible people real time with the location information and scale of leakage with an App.
Keyword- IoT, Energy Leakage, Automatic Fault Detection

I. INTRODUCTION

Currently, the electric power infrastructure is highly vulnerable against many forms of natural and malicious physical events [1], which can adversely affect the overall performance and stability of the grid. Additionally, there is an impending need to equip the age-old transmission line infrastructure with a high-performance data communication network, that supports future operational requirements like real time monitoring and control necessary for smart grid integration [2], [3]. Many electric power transmission companies have primarily relied on circuit indicators to detect faulty sections of their transmission lines. However, there are still challenges in detecting the exact location of these faults. Although fault indicator technology has provided a reliable means to locate permanent faults, the technical crew and patrol teams still must physically patrol and inspect the devices for longer hours to detect faulty sections of their transmission lines. Wireless sensor-based monitoring of transmission lines provides a solution for several of these concerns like real time structural awareness, faster fault localization, accurate fault diagnosis by identification and differentiation of electrical faults from the mechanical faults, cost reduction due to condition based maintenance rather than periodic maintenance, etc. These applications specify stringent requirements such as fast delivery of enormous amount of highly reliable data. The success of these applications depends on the design of cost effective and reliable network architecture with a fast response time. The network must be able to transport sensitive data such as current state of the transmission line and control information to and from the transmission grid. This research provides a cost optimized framework to design a real time data transmission network. To monitor the status of the power system in real time, sensors are put in various components in the power network. These sensors can take fine grained measurements of a variety of physical or electrical parameters and generate a lot of information. Delivering this information to the control center in a cost efficient and timely manner is a critical challenge to be addressed in order to build an intelligent smart grid. Network design is a critical aspect of sensor-based transmission line monitoring due to the large scale, vast terrain, uncommon topology, and critical timing requirements. Mechanical faults, cost reduction due to condition-based maintenance rather than periodic maintenance, etc. The use of sensor networks has been proposed for several applications like mechanical state processing and dynamic transmission line rating applications [4]-[6]. To monitor the status of the power system in real time, sensors are put in various components in the power network [10]– [9]. The hierarchical model proposed in, offers a very expensive solution with the idea of deploying cellular transceivers on every tower. While such a network can provide extremely low latency data transmission, this model is highly cost inefficient as it incurs huge installation and subscription costs. The only work that addresses the problem of finding optimal locations of cellular transceivers is presented [11], [12]. The paper presents a digital fault locator by dynamic system parameter estimation for a double end fed transmission line. The authors of [13] and [14] were the first to propose a two-level model specifically for supporting the overhead transmission line monitoring applications. But considering the topological constraints posed by the transmission lines, the low band-width, low data rate wireless nodes would fail to transmit huge amount of data in a multi hop manner. In these works, the goal is to deploy multiple different sensors in critical and vulnerable locations of the transmission line to sense mechanical properties of its various components and transmit the sensed data through a suitable wireless network to the control center. However, most of these works address this theme at a very high level of abstraction. Small-scale real-world deployments of wireless sensors include tension monitoring using load cells [5]-[7], and power conductor surface temperature monitoring, sago meter, etc. This paper deals with the application of artificial neural networks (ANNs) to fault detection and location in extra high voltage (EHV) transmission lines for high speed protection using terminal line data. The proposed neural fault detector and locator were trained using various sets of data available from a selected power network model and simulating different fault scenarios (fault types, fault locations, fault resistances and fault inception angles) and different power system data (source capacities, source voltages, source angles, time constants of the sources) [8].

There are many courses of faults in power transmission leading to power outages, if not properly managed. Notable among them includes:

- Faults at the power generation station
- Damage to power transmission lines (tree falling on lines)
- Faults at the substations or parts of distribution subsystem
- Lightening Types of transmission line faults: Power system's faults may be categorized as shunt faults or series faults

A. Single Line-to-Ground Fault

The most common type of shunt faults is Single Line-to-ground faults (SLG). This type of fault occurs when one conductor falls to the ground or gets into contacts with the neutral wire. It could also be the result of falling trees in a rainy storm. This type could be represented as shown in Fig 1 below.

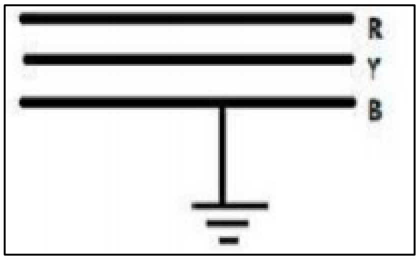

Fig. 1: Single line-to-ground fault

B. Line-to-Line Fault

The second most occurring type of shunt faults is the Line-to-Line fault (LL). This is said to occur when two transmission lines are short-circuited. As in the case of a large bird standing on one transmission line and touching the other, or if a tree branch happens to fall on top of two power transmission lines.

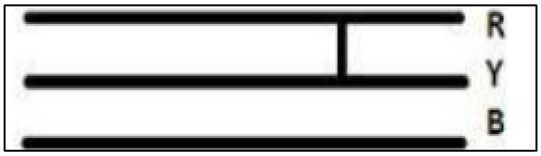

Fig. 2: Line to Line Fault

C. Line-to-Ground Fault

The third type of shunt fault is the Double Line-to-Ground fault (DLG) in figure below. This can be a result of a tree falling on two of the power lines, or other causes.

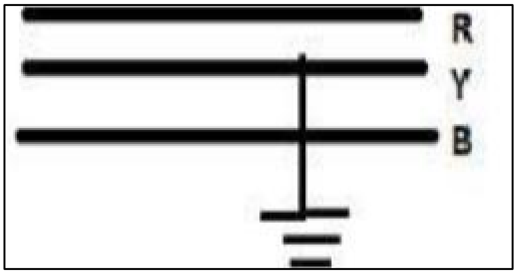

Fig. 3: Line to ground fault

D. Balance Three Phase

The fourth and the real type of fault is the balanced three phases, which can occur by a contact between the three power lines in many different forms.

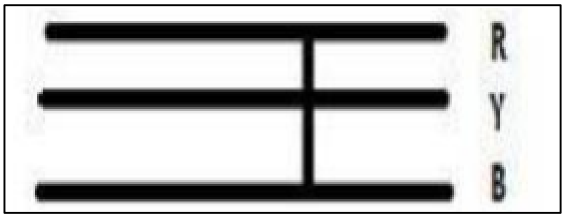

Fig. 4: Balance three phase

II. BLOCK DIAGRAM

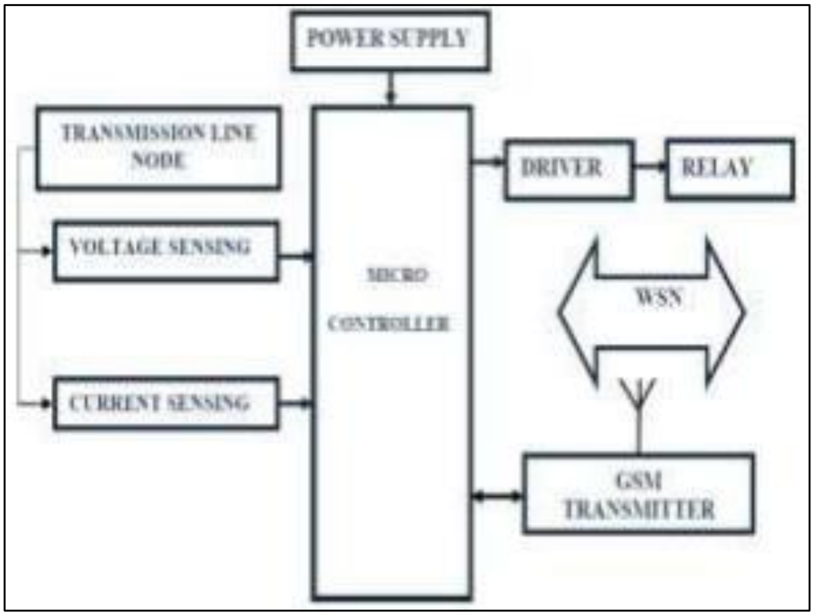

Fig. 5: Block Diagram

III. COMPONENTS FOR THE PROPOSED SYSTEM

This section highlights the state-of- the art devices that will be needed to implement the system. These devices will provide the much-needed attributes for the new system: robustness, low cost, efficiency, accuracy and low power.

A. Microcontroller

A microcontroller (MCU) is a small computer on a single integrated circuit (IC) containing a processor core, memory, and programmable input/output peripherals. Program memory is also often included on the chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general-purpose applications. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, and power tools [1,2].

B. The PIC16F877 Microcontroller

Programmable Intelligent Computer (PIC) is a family of Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC1640 originally developed by General Instrument's Microelectronics Division. The PIC16F877 falls in the mid-range of the PIC family of microcontrollers and finds use in a wide range of applications in diverse fields since it is readily available. It also has many pins (40 pins) with a maximum of three functions per pin which makes it much easier to use as compared to others with limited pins and a high number of functions per pin. It also has an optimal cost-to-performance ratio. The above-mentioned desirable characteristic of the PIC16F877 microcontroller coupled with the fact that it has an in-built Analog to Digital Converter and enough program memory to store the control algorithm, have largely affected its choice for the design of the automatic fault detection and location system discussed in this work.

C. The GSM Modem

A modem (modulator-demodulator) is a device that modulates an analog carrier signal to encode digital information and demodulates such a carrier signal to decode the transmitted information. The goal is to produce a signal that can be transmitted easily and decoded to reproduce the original digital data. The GSM Modem comes with a serial interface through which the modem can be controlled using attention (AT) command interface. An antenna and a power adapter are provided. The basic segregation or working of the modem is as follows: [5]

- Voice calls
- Short Message Service (SMS)
- GSM Data calls
- General Packet Radio Services (GPRS)

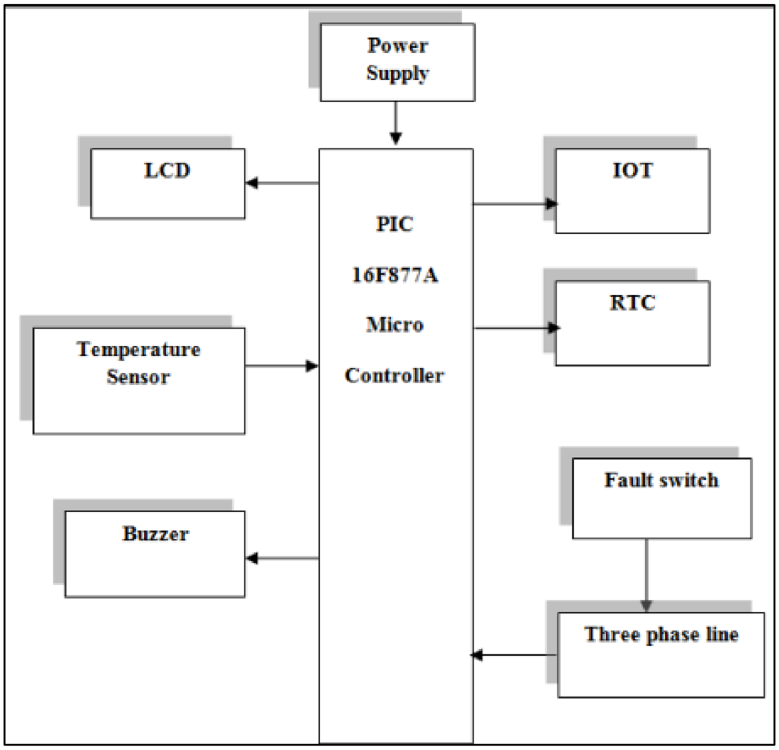

Fig. 6: Transmitter Section

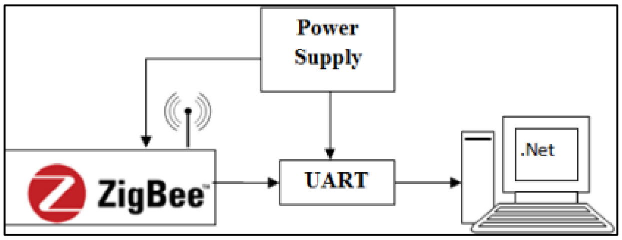

Fig. 7: Receiver section

IV. WORKING EXPLANATION

To attain our concept, need to use pic16f877a controller, voltage sensor, current sensor, speed sensor, buzzer, temperature sensor, LCD. The project is assembled with a set of resistors representing cable length in KMs and fault creation is made by a set of switches at every known KM to cross check the accuracy of the same. The voltage drop across the feeder resistor is given to an ADC which develops a precise digital data which the programmed microcontroller would display the same in Kilo meters. The fault occurring at what distance and which phase is displayed on a 16X2 LCD interfaced with the microcontroller. If the temperature higher than the threshold value at that time buzzer and LCD will give intimation. Calculated values are sends to the internet with help of IOT.RTC is used here to time and date reference, that when the event occurs.

V. ADVANTAGES

- Devices are enabled by wireless communication.
- Coverage area is large compared to the existing system.
- Less number of components and manual observation. So, it is economically reliable and low cost.

VI. APPLICATION

- Used in transmission line.
- Used in textile mills.
- Used in food industry.

VII. CONCLUSION

In this paper, present an optimal formulation for a cost optimized wireless network capable of transmission of time sensitive sensor data through the transmission line network in the presence of delay and bandwidth constraints. Our analysis shows that a transmission line monitoring framework using WSN is indeed feasible using available technologies. The proposed method with formulation is generic and en-compasses variation in several factors such as asymmetric data generation at towers, wireless link reliabilities, link utilization dependent costs, non-uniform cellular coverage characteristics and requirements for cost optimized incremental deployment. The evaluation studies show that the main bottleneck in cost minimization is wireless link bandwidth. Further, in cases of increasing flow bandwidth, the limited wireless link bandwidth leads to a feasible but expensive design due to increased dependence on cellular network to satisfy constraints. In the existing system the reliability of fault detection is poor. The method proposed now provides us a cheap and highly reliable way to locate the faults in the three phase transmission lines and also supports data storage. Hence this method can be implemented to detect the faults and retrieve the corresponding data anytime.

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