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Low-Cost ZigBee® Distributed Transformer Monitoring System Based OnZigbee Technology

[1]Avula Mounika, [2]K.Karthik
[1]M.Tech, Balaji Institute of Technology & Science,Telanagana, India
[2]Assistant Professor,Dept. of ECE, Balaji Institute of Technology & Science, India

ABSTRACT: The paper develops and implements a novel fault indicator for distribution automation to achieve significant and immediate improvement in reliability and hence service to theelectricity customers. The proposed fault indicator is designed based on ZigBee communication. ZigBee has been designed to possess general-purpose protocol with low cost, low power consumption and self networking; and therefore, it is very suitable for constructing the communication network in distribution automation and therefore smart grids in the future. A fault detection and identification system is also designed to find out the fault location effectively and efficiently after a fault occurred. The communication system is responsible for transmitting and receiving data amongst these controllers. This communication system is based on ZigBee technology, which is a low cost and low power consumption device. However, its main limitation is the low data transfer rate. It is helpful to achieve faster recovery following a fault in the network.

Index Terms—Zigbee module, Arduino controller.

I. INTRODUCTION

Generally when a fault occurs in transmission line, unless it issevere it is unseen. But gradually these minor faults can leadto damage of transformer and can turn havoc to human life. Itmay also initiate fire. Present day in India, we do not have asystem in hand that would let us know in real time once a faultoccurs. Matter of concern is that since we do not have a realtime system, this leads to damage of the underlyingequipment's connected and turns out to bea threat to human around. In order to avoid suchincidents to the maximum extent, maintenance or checking ofthe transmission lines are generally carried out on a frequentbasis. This leads to increased manpower requirement. The factremains that the real intention of this is not met as many atimes line failure may be due to rain, toppling of trees whichcannot be predicted. Like in Western Ghats where thetransmission lines are usually drawn amidst the forest andplaces like Chirapunjee where massive rainfall almost setseverything standstill. It is necessary to understand the gravityand after effects of a line failure.Communication network deployment is one of the mostimport footstones for distribution automation, since itprovides signal exchanges media between different devicesinstalled in different locations. Recently, many governmentsdeploy ubiquitous IT project, which aims to combine thelatest wireless network and wide-band technologies etc. toaccomplish a ubiquitous wireless communication network.There are many kinds of wireless network, and ZigBee, alow-speed LR-WPAN (Low-Rate Wireless Area PersonalNetwork) based on IEEE 802.15.4 standard, is one of them.ZigBee has been designed to possess general-purposeprotocol with low-cost and low-power- consumptionwireless communication.

The ZigBee application profileincludes home automation, industrial plant monitoring,commercial building automation, automatic meter reading,telecom services/m-commerce, wireless sensor networks,personal home and hospital care and so on In powerengineering applications, the use of wireless technology canprofit distribution automations and smart grids by integratingZigBee networks into Advanced Metering Infrastructure(AMI), fault monitoring.Most of customer service interruptions are due to failuresin distribution branches; however, distribution automation ismainly focused on distribution feeders. In distributionautomation, the fault section can found out by protectionequipment composed of

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supervisory control and dataacquisition system, feeder remote terminal unit, remoteterminal unit, feeder terminal unit, directional over-currentdevice and so on. The protection devices cannot mountdensely on the feeder due to the higher building cost. In orderto improve reliability, some fault indicators with mechanicalflag change or LED display flashing while over-currentoccurred are mounted on distribution branches instead.

Although the fault indicators are useful, it needs the repairersalong the distribution branches to check the mechanical flagchange or LED display flashing to find out the fault location.Therefore, the paper integrates the ZigBee communicationinterface into the traditional fault indicators to reinforce theircapability. A fault detection and identification system is alsodesigned; thus, the fault location can be found out effectivelyand efficiently after a fault occurred. Experimental resultsdemonstrate the validity of the proposed system.

II. PROPOSED FRAMEWORK

The concept of integrating the proposed ZigBee-Basednovel fault indicators into developing a fault detection andidentification system for distribution branches is shown inFig.1. The proposed fault detection and identification systemare composed of several novel fault indicators and a rear-endprocessing system. Using Fig. 1 as an example, if a faultoccurred on “Fault (1)”, the fault current will be detect byfault indicators 2 and 3 and then these two indicators will bein “Fault Mode”. Fault indicators 2 will transmit “FaultInformation (2)” to fault indicators 3 which is acted as arouter in this situation and then re-transmit “FaultInformation (2)” to the rear-end processing system. Faultindicators 3 will also transmit “Fault Information (3)” torear-end processing system.

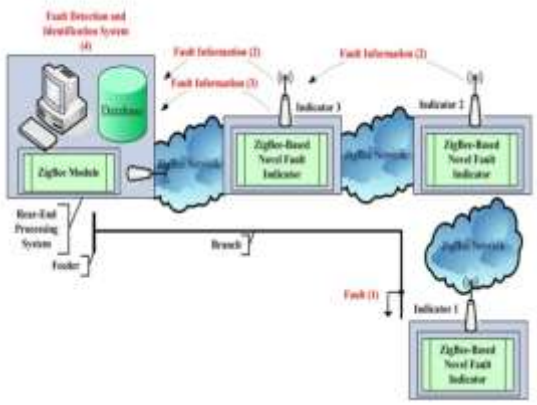

Fig.1 Concept of the Fault Detection and Identification Systemol.

The fault current detecting module is composed of two presets and LED. The presets with higher and lower rated interrupting currents,abbreviated as SW1 and SW2, are used to detect theabnormal and normal currents of a distribution branch,respectively. In general, the higher rated interrupting currentis set approximately the rated short-circuit current, such as10A or 6A, of a distribution branch, and the lower ratedinterrupting current is set the minimum recovery current(12A as usual).

ZigBee and IEEE 802.15.4 are standards-based protocols that provide the network infrastructure required for smart meter network applications.Fig.2 shows the basic block diagram of fault indicatorusing ZigBee protocol.

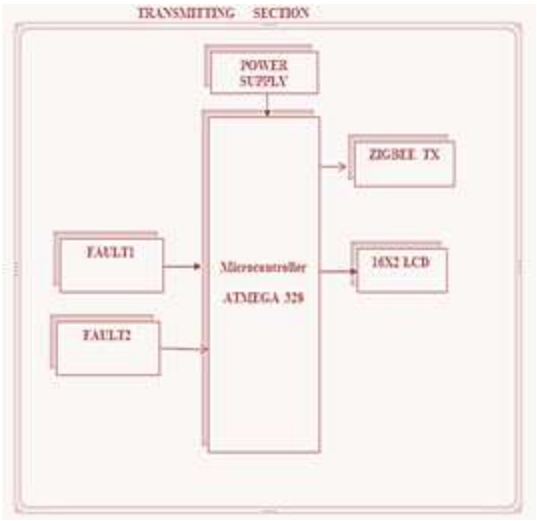

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Fig.2 Block diagram of fault indicator using ZigBee protocol

In this paper,the rear-end processing system employs ZigBee coordinatorto initiate, construct and maintenance the wireless networkfor the proposed fault detection and identification system.Other fault indicators employ routers or end devices asrequired. With theautomatic networking characteristic ofZigBee, an novel fault indicator serving as a node willcommunicate with the ZigBee coordinator of rear-endprocessing system and then the ZigBee network can beconstructed sequentially. After the ZigBee network wasconstructed, the proposed fault indicators can send the faultinformation to the ZigBee coordinator and then theinformation can be displayed on HMI.

A. Arduino ATMega328

The Arduino Uno is a microcontroller board based on the ATmega328. It has a 16 MHz ceramic resonator, 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a USB connection, a power jack, an ICSP header, and a reset button. This board is very simple and can be easily used, everything you need to support the microcontroller is in this board, just plug it in a computer via USB cable and power using an AC-to-DC adapter or battery to get started.

B. Zigbee:

It is the wireless device for transmitting and receiving purpose or simply it called as Transceiver. Zigbee is based on the IEEE802.15.4 protocol. The range of the Zigbee is covered as 100m. It range is 10 times better than bluetooth device so it can be more preferable one in wireless device. The data rate is very low for transmission while using this device.

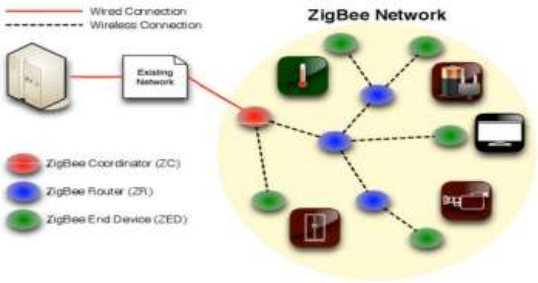

Fig.3.Zigbee netwrk overview

III. RESULTS AND DISCUSSION

The software of the unit is composed of the initialization and data communication. Initialization includesinitialization of the input/output ports, data direction flow, setthe ADC channels and reset all related memory locations thatare going to be used in the operation.

Fig.4. X-CTU Software

Data communication means transfer of measured data from end device tocoordinator unit. X-CTU is a Windows-based application provided by Digi used for programming the Zigbee module as shown in fig.4

IV. CONCLUSION

It is reported that most of customer service interruptions are due to failures in distribution branches; however, distribution automation is mainly focused on distribution feeders. Although some fault indicators are mounted on distribution branches, it needs the repairers along the distribution branches to check the mechanical flag change or LED display flashing to find out the fault location. A fault detection and identification system was also designed to identify the fault location automatically and efficiently. Since the cost of the

proposed novel fault indicator is low, it can be densely mounted on distribution branches to reduce the time for fault detection and identification.

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