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Substation Parameters Monitoring using ZigBee Technology with Microcontroller Interfacing

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***Abstract*—With PLC SCADA, the parameters that are be monitored is done being physically present within the substation premises. ZigBee technology is used in monitoring of substation parameters remotely with Microcontroller interfacing without being physically present in the substation premises. Two ZigBee modules are used for interfacing of substation parameters with the Microcontroller and Arduino Uno kit is used as the Microcontroller in the proposed scheme. Proteus software is used for making schematic circuit diagram for the proposed scheme. This paper aims on how to receive the substation parameters as input using ZigBee module from the mains supply and how remote monitoring between two ZigBee modules can be done using XCTU software. Also, how ZigBee modules are connected with the Arduino Uno kit and different sensors and the same values are that are on the input side are reflected back on the output side.**

Keywords—Arduino Uno;ZigBee modules; ZigBee Technology

I. INTRODUCTION

In many countries, communication based controlling and monitoring architecture is used in smart grid to save power. Communication network may be wired or wireless. Communication through wired interface is very intricate and hard to implement or install. Wireless interfaces are chosen because they are easy to organize and install.

Furthermore, ZigBee has some technical advantages over Bluetooth, Wi-Fi, Infrared Rays etc. ZigBee is a kind of low power-consuming communication technology for coverage area surrounded by 200m, with a data rate ranging from 20Kbps to 250Kbps, it is appropriate for use in home area networks, mainly for the remote control of electric home appliances.

For remote power control and monitoring, many wireless technologies are: Infrared rays, Wi-Fi, WLAN, Bluetooth, and ZigBee. However, ZigBee is suitable for remote power control and monitoring due to large coverage area up to 200m or more and with transmission rate ranging from 20Kbps to 250Kbps.

II. LITERATURE SURVEY

Some of the old research papers had been reported in which only control of power [1] or only control of electric loads [2] were done.
In further study, MCU based power control module [1] was used or PIC based control [2] was done or Arduino kit [3] has been used for monitoring the agricultural processes in the agricultural fields were done.

Also, various communication protocols were used like Bluetooth, Wi-Fi and ZigBee [2] or using Bluetooth, Ethernet, GSM, and PC with GUI [1] or simply ZigBee Technology [3].

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III. MOTIVATION BEHIND THIS TOPIC

Presently, the technology used by substation personnel are PLC-SCADA which is there in the control room within the substation premises. In PLC-SCADA, he has to remain alert continuously and whenever abrupt condition takes place, he has to take quick decisions and manually take precautionary measures in order to prevent the system from damage.

This research will be useful when the substation operator personnel won't be available physically in the substation premises. Instead, he will be able to keep a close eye on what is happening in the substation by continuously getting the measured data of the parameters to be observed on his mobile remotely than when he was in the substation.

Also, if there is any change or deviation of the measured data of parameters, then he will be notified with a warning or alarm signal but still he don't have to worry as the microcontroller will take care of the situation by its own.

Now, there are various communication protocols that are used for monitoring purpose like Bluetooth, Wi-Fi and ZigBee. But ZigBee is preferred over them as data can be accessed wirelessly from long or remote distance than that for Bluetooth and Wi-Fi and also, it has low power consumption than the other two communication protocols.

For obtaining the measured data of the parameters, Laptop or Monitor is used which will remotely receive all the parameters and hence it will be easy for the operator

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personnel to keep a close eye on what is happening in the substation.

IV. PROPOSED SCHEME

In this scheme, two Arduino UNO kits having ATmega 328P microcontroller and two ZigBee modules one as receiver and transmitter will be used for controlling purpose and monitoring purpose. Particular Hall effect current sensor was chosen that converts AC load current or AC supply current value into corresponding DC voltage value to be fed to the Arduino UNO analog port. Also, a transformer is chosen such that phase voltage of the supply mains is stepped down to low values that is used for feeding it to the Arduino UNO analog port. Receiver and Transmitter are used to involve in data transfer and communication in coordination with Arduino kit.

The whole system is on load and the parameters are measured continuously and hence if there are any changes or deviations in the parameters specified in the proposed measurement parameters from their maximum limit or minimum limit which would have been set by the substation personnel, then the microcontroller on the transmitter side receives the values of voltage and current from supply mains and transmits the received values to the transmitter ZigBee and transmitter ZigBee will send the data wirelessly to the receiver ZigBee.

The microcontroller on the receiver side receives values from the receiver ZigBee and the microcontroller is connected with buzzer at one of the digital pins so that if there are any changes or deviations in the parameters specified in the proposed measurement parameters from their maximum limit or minimum limit which would have been set by the substation personnel on transmitter side will be reflected proportionately on the receiver side and hence the buzzer gives the alarm signal and thus the substation operator will receive the measured values of the parameters through the receiver continuously and the controller will control the parameters within the safe limits so that the power system may not lose the stability.

Below figure shows the proposed scheme for monitoring and controlling purpose.

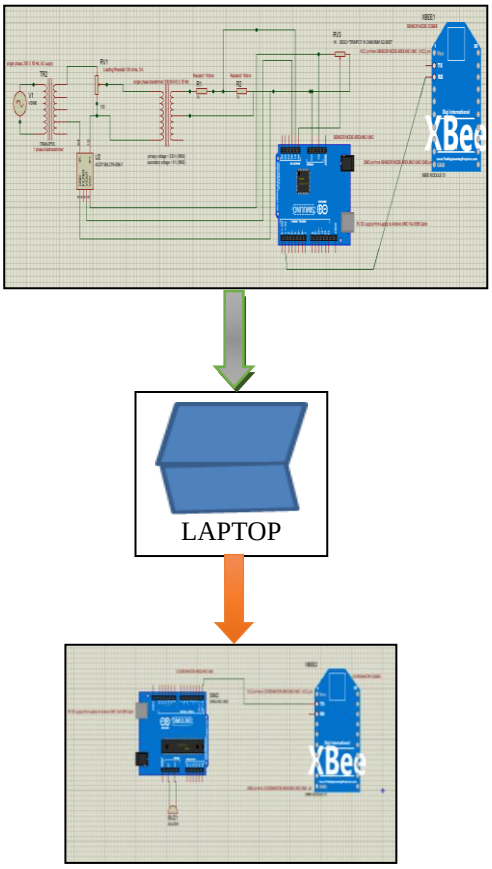

Fig. 1. Proposed Scheme of the whole system

V. TOOLS USED

For observing the transmitted values from transmitter side to receiver side, controlling the received data and to upload the specific programs into two Arduino UNO, Arduino software was used. Also, for interfacing and establishing communication between two ZigBee radio modules, XCTU software was used. For making of circuit diagram blocks of Arduino UNO and ZigBee module that are shown in above figure, Proteus software was used in order to show the schematic diagram for connections of two Arduino UNO boards with two ZigBee radio modules.

VI. RESULTS AND CONCLUSION

It was observed that the values of voltage and current were transmitted by the transmitter ZigBee to receiver ZigBee in the form of data packets. The table below shows the values of voltage and current on the transmitter side.

TABLE I. VOLTAGE AND CURRENT VALUES ON THE TRANSMITTER SIDE OF THE PROPOSED SCHEME

Dimmerstat settings (Volts)	**Readings on Transmitter side**			
	Current sensor readings (Volts)	***Ammeter readings (Amperes)***	***Transformer readings (Volts)***	***Voltage across 1KΩ resistor readings (Volts)***
100	0.036	0.6	4.24	2.062
150	0.054	1.25	6.37	3.055
200	0.073	1.65	8.49	4.15
230	0.085	1.92	9.71	4.85

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The table below shows the values of voltage and current on the receiver side.

TABLE II. VOLTAGE AND CURRENT VALUES ON RECEIVER SIDE OF THE PROPOSED SCHEME

Dimmerstat settings (Volts)	**Readings on Receiver side**			
	Decimal values	***Hexadecimal values***	***Voltage (Volts)***	***Current (Amperes)***
100	435	01B3	2.06	0.034
150	643	0283	3.05	0.050
200	871	0367	4.13	0.070
230	1023	03FF	4.85	0.083

It is clear from the above two tables that data on the transmitter side is received on the receiver side and is controlled successfully using a buzzer as an indicator so that preventive measures can be taken to avoid loss of stability of the power system or grid.

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