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A Wireless Process Monitoring And Control System With Zigbee

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ABSTRACT:*Recently wireless technology is getting popularity day by day in IT sector. Wireless Sensor Network (WSN) provides reduced cost, better power management, easy controls, high reliability and safety in industrial process monitoring and control. There are different WSN protocols available for industrial process monitoring and control: Bluetooth, Wi-Fi, GSM/GPRS, and ZigBee etc. According to IEEE standards ZigBee is mainly designed for industrial purposes with amazing mesh networking. It is also simpler and less expensive than Bluetooth, GSM/GPRS and Wi-Fi. In this work a prototype model of an industrial process monitoring and control system scheme is modeled by integrating ZigBee. In industry all process are monitored and controlled from a control room nearby the system. By using ZigBee protocol one can easily control more than 64,000 processes wirelessly within a distance of 1 mile. In this work a prototype model was designed where the speed and voltage of a DC series motor were monitored and controlled. Two ZigBee modules have been used, where the router module is connected with a DC motor in the machine lab and the coordinator module is interfaced with a PC. The voltage (0-20 volts) and speed (0-2500 rpm) of the DC motor were controlled with a PC from the control room which is almost 30m away from the system. There were few concrete walls (about 30 inch thick) between them. The results attributed that ZigBee protocol is feasible than the other conventional process monitoring and control system.*

KEYWORDS -*WSN, ZigBee, GSM/GPRS, Wi-Fi, Router, XCTU software.*

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I. INTRODUCTION

The field of wireless communications is diverse and it may be difficult to get a picture of the different technologies utilized in a certain field. In industry, the proposed and already employed technologies vary from short-range personal area networks to cellular networks and in some cases even global communications via satellite are applied. Recently, the use of wireless sensor networks (WSN) in industrial automation has gained attention. WSNs are technically a challenging system, requiring expertise from several different disciplines. Therefore, the information about important design criteria is often scattered. Additionally, characteristics for the industrial automation applications are often stricter than the other domains, since the failure of the communication system may lead to loss of production or even lives. Adopting WSNs for process monitoring and control provides reduced cost, better power management and ease in maintenance and effortless deployment in remote and hard-to-reach areas over traditional wired system [1].

II. THEORETICAL OVERVIEW

A. Literature Review

A project for monitoring the speed and torque in induction motors in real time by employing ZigBee based wireless sensor network. An embedded system is used for acquiring electrical signals from the motors in a noninvasive manner. The processing for speed and torque estimation is done locally. Embedded system is used to control the speed of the motor. The values calculated by the embedded system are transmitted to a monitoring unit through ZigBee based wireless sensor network. A paper on that project work was published on International Conference on Emerging Trends in Computing, Communication and Nanotechnology (ICE-CCN), 2013 [2].A wireless monitoring system for induction motor was realized using ZigBee. In that project work voltages, currents, powers, temperature of the motor were measured and monitored from the control PC in the control room. To implement this, a ZigBee module was connected to a programmed digital signal controller which would transmit the data to ZigBee coordinator which was connected to a PC through RS232 serial communication. A paper on that project work was published on IEEE Students' Conference on Electrical, Electronics and Computer Science 2014 (SCEECS 2014) [3].A parameter monitoring system for induction motors based on ZigBee protocol was developed, which was capable to perform such operations as running the motor though RF, stopping it, measuring and monitoring most parameters of the motor like phase currents, phase voltages, wiring temperature, speed. All of these values can be transferred to the host computer, displayed on the interface, represented graphically, transferred into an Excel file to store them for a longtime. A paper on that project work was published on Gazi University Journal of Science on 2011 [4].A digital system had been developed for condition monitoring, diagnosis and supervisory control for electric systems parameters like voltage and current using wireless sensor networks (WSNs) based on ZigBee. Its main feature is its use of the ZigBee protocol as the communication medium between the transmitter and receiver modules. It illustrates that the new ZigBee standard performs well industrial environments. A paper on that project work was published on International Journal on Computer Science and Engineering (IJCSE), 2011 [5].

B. ZigBee

ZigBee is a set of specifications created specifically for control and sensor networks. Built on IEEE 802.15.4, the standard for low data rate Wireless Personal Area Networks (WPANs), it was developed by the ZigBee Alliance, released in 2006. The ZigBee Alliance brings together public and private Industry leaders who sought to address the need for a single standard that would ensure the interoperability of proprietary wireless sensors and control systems both with each other and newer technologies. Such systems require low latency, low data rates, low cost and low energy consumption. [6].

C. Wireless Sensor Network

A Wireless Sensor Network (WSN) of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure e.t.c. and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, also enabling control of sensor activity. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring and so on.

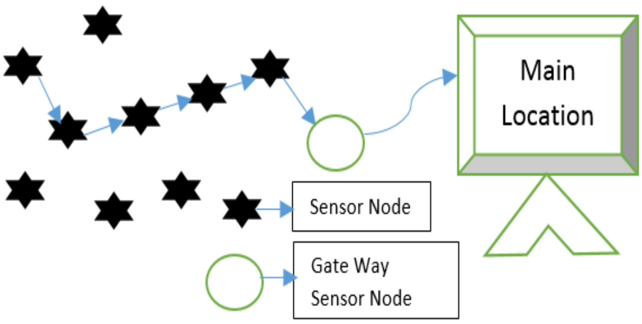

Figure 1: Typical Multimode Wireless Sensor Network.

III. METHODOLOGY BLOCK DIAGRAM

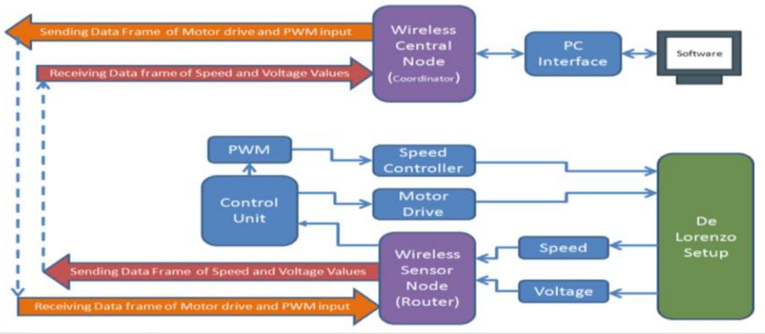

Figure 2: Entire system block diagram.

A. Working Principle

- To control the speed of the motor PWM technique is used here. Its main use is to control the power supplied to electrical devices, especially to inertial loads such as motors. The average value of voltage fed to the load is controlled by turning the switch between supply and load on and off at a fast pace. The longer the switch is on compared to the off periods, the higher the power supplied to the load [8].
- This PWM output is fed to the ADJUST pin of a voltage regulator LM317 as shown in the speed control circuit. At the input pin of LM317 24 V DC is supplied from the power supply. As a result from the output pin of LM317 0-20V variable DC is available which is fed to the motor input. By varying the pulse width of the PWM from the control PC the input voltage of the motor can be varied from 0-20V DC.
- To measure the input voltage buffer and voltage divider is used. The input voltage is fed to the AD0 pin of the XBee router module via buffer and voltage divider. Speed is measured similarly at the AD2 pin. From the XBee router digital value of speed and input voltage are transmitted to control PC wirelessly.
- The Speed and voltage of the motor can be monitored and controlled from PC. So the coordinator module was interfaced with PC. For USB interfacing PIC18F4550 microcontroller was used.

IV. NETWORK IMPLEMENTATION

A. Configuring Router with XCTU Software

The router module is configured using XCTU software. After launching the X-CTU the COM port (usually labeled as USB serial port (COM X)) is selected. Then the XBee module is checked by clicking 'Test'. After that 'ZIGBEE ROUTER API' mode is selected for router configuration from the function set option. From Fig. 3, in the 'PAN ID' option under Networking a preferable PAN ID (here 2001) is selected. The router is configured with this ID [9].

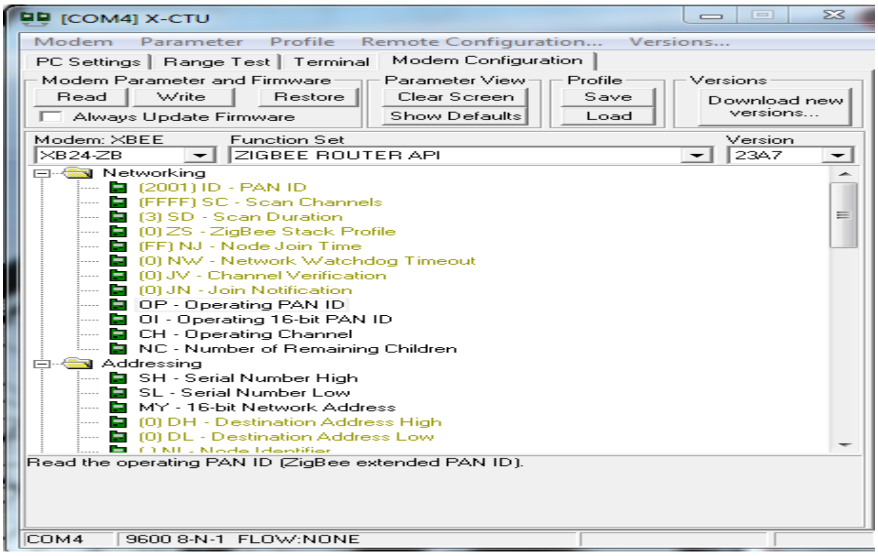

Figure 3: PAN ID while configuring one module as router with X-CTU

The coordinator module is configured as central node using XCTU software in the similar process. After launching the X-CTU the COM port (usually labeled as USB serial port (COM X) is selected. Then the XBee module is checked by clicking 'Test'. After that 'ZIGBEE COORDINATOR API' mode is selected for coordinator configuration from the function set option. From Fig. 4, in the 'PAN ID' option under Networking PAN ID same as router (here 2001) is selected. Then the coordinator is configured with this ID.

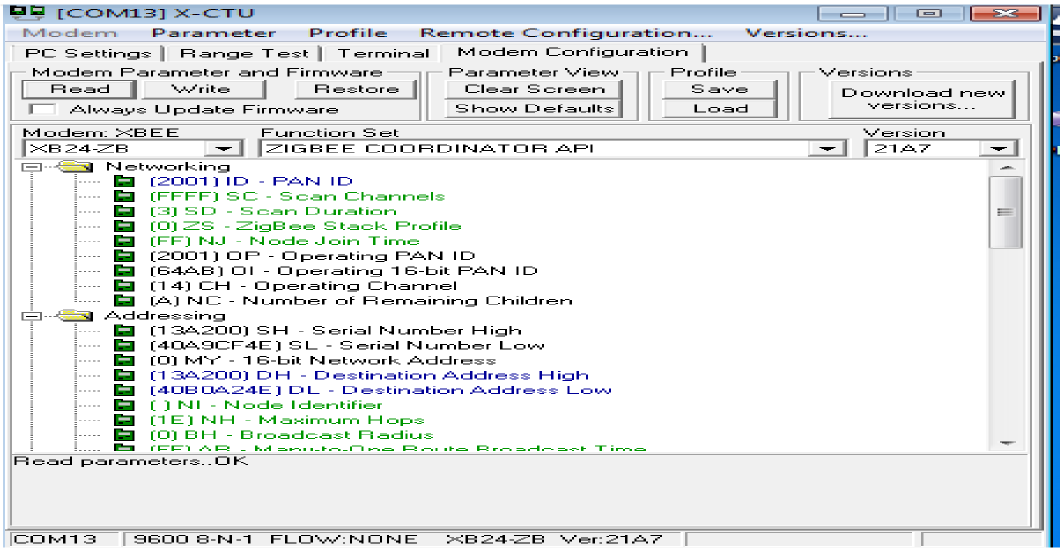

Figure 4: Configuring one module as coordinator with X-CTU

To monitor and control the speed and voltage from PC, software is designed using Microsoft Visual Basic 2010. It has two windows in two tabs i.e. Control Window and Data Acquisition Window.

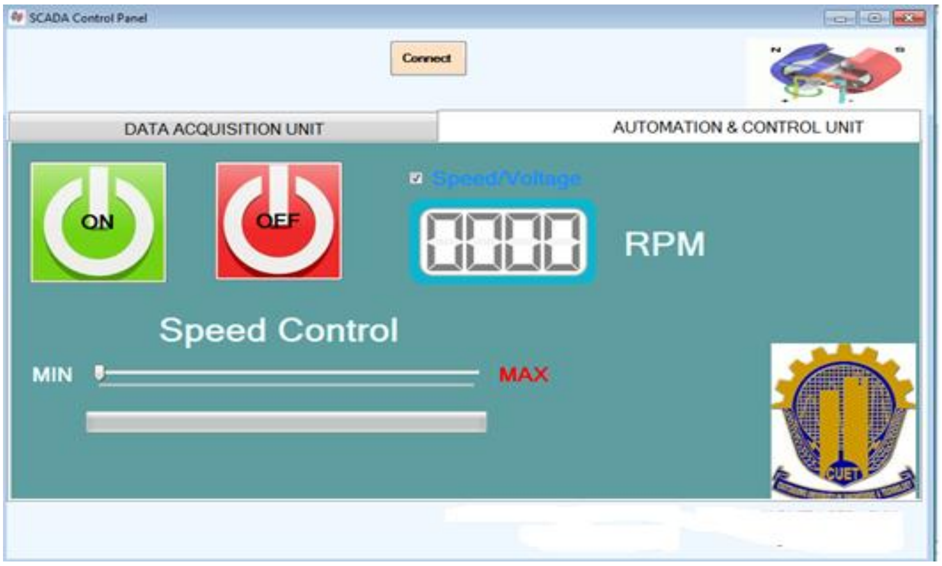

Figure 5: Speed control window

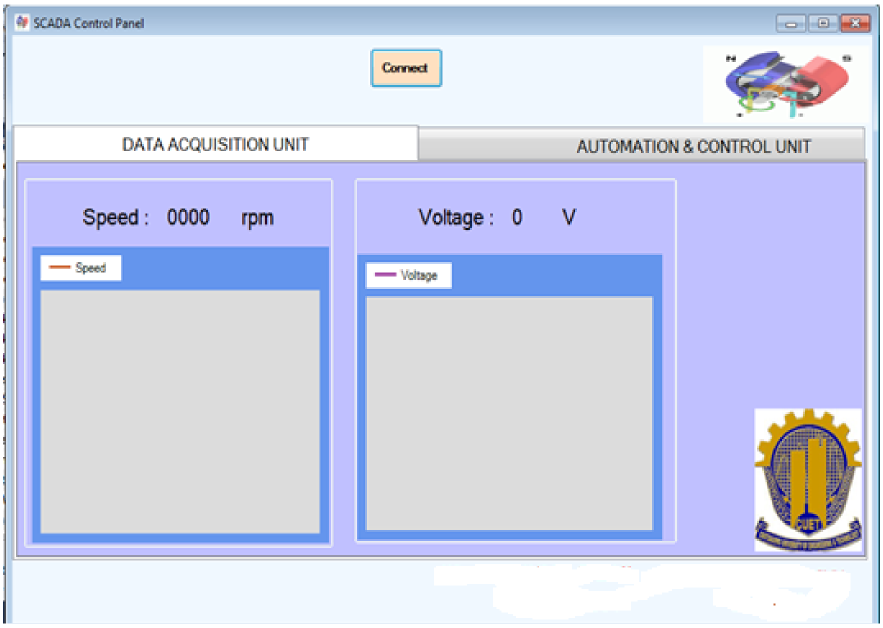

Figure 6: Data aqisition window

V. RESULTS

The system designed and implemented in this project was tested successfully and gave satisfactory results. Its monitoring performance, controlling performance and comparison with other existing system are discussed below:

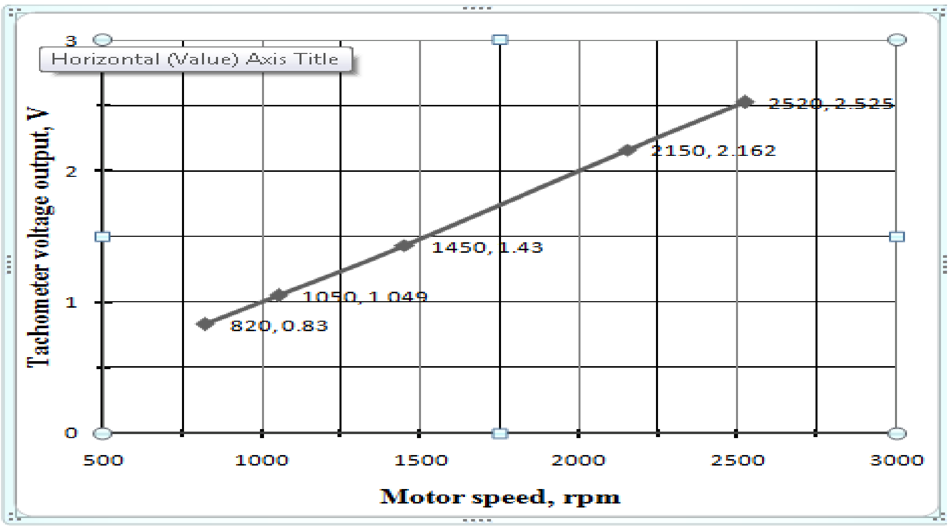

Figure 7: Tachometer voltage output vs. Motor speed curve.

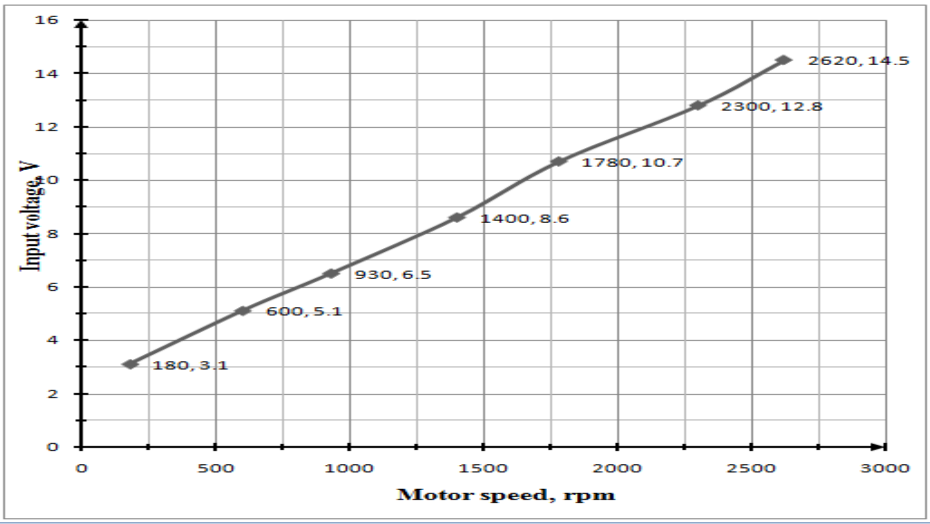

Figure 8: Input voltage vs. Motor speed curve.

VI. CONCLUSION

In this project a prototype model of industrial process monitoring and control scheme was designed based on ZigBee wireless protocol. Necessary software and hardware were designed to interface the model with PC. The whole model was implemented with De Lorenzo DC Series Motor. The performance of the prototype model with ZigBee wireless sensor networking was tested and satisfactory results were found during the tests.

A. Limitations

The maximum range covered with obstacles (50 cm thick concrete wall) was only 30m, hence to monitor and control any specific device line of sight distance is an important factor. Low data speed and initial high cost of ZigBee it not suitable for controlling the process in longer distances.

B. Future work

- Designing a more complex network by adding more different zones and process.
- To implement motor protection system
- Temperature, current, powers, vibration, humidity, chemical parameters can also be monitored by adding more sensors.

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