Parameter Monitoring Using Zigbee Protocol for Three Phase Induction Motor

Prof. Mahendra P. Bodkhe¹, Prof. K. N. Pawar²
¹Assistant Professor, Electronics & Telecommunication Department, L. G.N.S.C.O.E, Nashik, (MS), India
²Head, department of Electronics Engineering, S.S.V.P.S. B.S.D. C.O.E, Dhule, (MS), India

Abstract— This paper introduces a new technique, a wireless control and monitoring system for an induction motor using the Zigbee protocols”. We know induction motor is mostly used in the industrial applications; hence analysis of induction motor is much essential to find out utilization index of a motor for better performance. Hence monitoring and controlling of parameters of induction motor is necessary. This technique makes use of different sensors to measure the parameter of induction motor and the data is transmitted to the base station using Zigbee wireless protocol. By using the computer interface with Zigbee the motor can be started, stopped and it is also possible to protect the motor against some faults such as over current, over heating in windings, under/over voltage. Data acquisition system saves all received parameter data of the motor in database. Controlling, monitoring, and protection of the system are realized in real time. Hence use of the wireless communication technology (Zigbee) for control and monitoring of parameters of induction is demonstrated in this study.

Keywords— Induction motor, Zigbee protocol, wireless data communication

I. INTRODUCTION

In an industrial environment, because of their safe and simple structure, Three-phase induction motors are mostly used in industrial applications, to drive the mechanical systems used in most production processes. The performance of motor directly affects the product quality hence it is necessary to monitor its performance. Several controlling methods have been suggested to obtain a better controlling system for them. During the end of the 20th century, development in power electronics, electronics, and computer technology has started new progress in control technology and automation. As per Zhang P, in various systems or process control system mostly electrical motors are used, especially the induction motors, because of their suitability in system design in industry and many other advantages like energy, time, and sensitivity [2]. The performance of the motor depends on electrical parameters of the motor, that’s why high performance AC motor control methods are very sensitive to motor parameters.

As per Vas P, parameters of an induction motor can be measured by experiments like the locked rotor test and no load test [3, 4]. All electrical and non-electrical parameters like frequency, current, voltage, temperature, and speed of the induction motors are very important for a drive system. The performance of an induction motor is directly affected by whole fundamental qualities. If any parameter of induction motor changes then quality of product also changes, hence controlling the machines during the process of production continues to be a dangerous operation in some department of industry.

In this case, remote control and monitoring techniques becomes good solution. Wireless data communication is used in various industries, such as Wi-Fi, Bluetooth, 3G because it is capable of high data rate transmission. These devices use system resources a lot and are proportional to transmission speed. IEEE has developed 802.15.4 that is zigbee.

Zigbee is mostly used in industries in various ways because as per Yanfei L., Cheng W & Li J., Zhu X., Tang N., Sui J it supports devices having low cost, intelligent network topologies and energy saving [5, 6]. Zigbee is bidirectional data transmission wireless protocol that’s why data can be received or sent at the same time as well as lot of devices and machines can be controlled.

Why zigbee based system should be used? Because, traditional protection practices for detecting motor defects and protecting motors use various types of protection relays such as temperature relays, over current relays, electromagnetic switches, low and high current protection relays, contactors, and time relays. They increases cost of systems and reduce the efficiency and sensitivity of the system and increase the time for detecting faults. But in digital systems like zigbee based parameter monitoring system cost of system reduces, efficiency and sensitivity of the system increases as compare to traditional system.

As per Çolak Í, Çelik H. Sefa İ. & Bektaş, A., Bayındır R, in some case, motor parameters have been used to display the electrical and mechanical performance of the motor using a PC [13, 14].
In [14], all measurements related to the induction motor were done and protection against the failure of induction motor has been achieved by developing a real time monitoring system against the failure of induction motor. But cost of system is increased due to input traducers like temperature sensors or other sensors used to collect the voltage and current information from the motor network and transfer to the PC as per Bektaş, A., Çolak, İ., Bayındır, R. [14]. For the development of system, it consists of two sections hardware and software such as Atmel Atmega 8-16 PU microprocessor, a Zigbee 2-mW protocol, a wired temperature sensor manufactured by Maxim/Dallas firm and incremental encoder with 360 pulses per revolution, a 5/0.5 ampere current transformer manufactured by Entes, a 220/5 volt voltage transformer, a desktop computer, and Delphi Programming Package to design the interface program or X-CTU and for controlling the three phase induction motor through the PC use Zigbee protocol and microcontroller.

II. ZIGBEE CHARACTERISTICS

The IEEE 802.15.4 / Zigbee standard include the features of low power consumption, needed for only two major modes (Tx/Rx of induction motor), its high density of nodes for each network, low costs and simple implementation.

Zigbee characteristics:-

- 2.4 GHzv and 868/915 MHz dual PHY modes.
- This represents 3 license-free bands: first 2.4-2.4835 GHz, second 868-870 MHz and last 902-928 MHz. The number of channels chosen to each frequency band is fixed at 16 the higher frequency band is relevant worldwide, and the lower band in the areas of North America, Europe, Australia and New Zealand.
- Low power utilization.
- Most data rates permissible for each of these frequency bands are fixed as 250 kbps @2.4 GHz, 40 kbps @ 915 MHz, and 20 kbps @868 MHz.
- It has a high throughput and low latency for low duty cycle applications (<0.1%)
- Channel access using Carrier Sense Multiple Access with Collision Avoidance (CSMA - CA)
- Addressing space of up to 64 bit IEEE address devices, 65,535 networks
- 50m typical range
- Fully reliable “hand-shaked” data transfer protocol.
- Different topologies as illustrated below: star, mesh, peer-to-peer

III. ZIGBEE NETWORK TECHNOLOGY

The ZigBee is the new short range, low power, wireless networking technology for many applications also it is research topic in short-distance wireless communication technology. It is widely used in industry, monitoring and control of agricultural area, home and building automation, automatic control, hospital and other fields [15-22]. Because its advantages like low power, low cost, self-organization etc. It is best specified the bottom three layers (Physical, Data Link, and Network), its transmission distance is more than 10 m and it is compatible with the 2.4GHz and 900MHz frequency bands. As per Gang Z., Shuguang L it is two-way communication technology this technology has great potentials in sensing and control applications [23]. The ZigBee network layer supports star, tree and mesh topologies as shown in Figure.1.
In mesh network coordinators are responsible for starting the network and for choosing certain key network parameters but the network may be extended through the use of ZigBee routers. Routers can be used to extend the network. As per Li J., Zhu X., Tang N. Sui J, a mesh network allows full peer to-peer communication. If a node fails another route is used for the data delivery [25].

IV. THE PROPOSED WIRELESS INDICATION MOTOR MONITORING SYSTEM

A powerful wireless monitoring system has been achieved for an induction motor by using zigbee wireless protocol. The basic block diagram is as shown in fig (2). Its consist of two sections 1) Hardware and 2) Software

A. Hardware

In this section zigbee protocol is used to setup wireless communication link between PC and Induction motor control circuit. By using zigbee device data is transmitted from PC to control unit and control unit consist of microcontroller and sensors, Speed and other parameters of motor controller.

Hardware section consists of the following
1) The test rig used in the present study consists of a 0.37 kW/1400 rpm three-phase IM.
2) Three voltage transformers with transformation ratio of 220/5 V connected to each phase of IM.
3) Three current transformers with transformation ratio 5/0.5 connected to each phase of IM.
4) A temperature sensor with transformation ratio of 10 mV for each 10°C increase in temperature a DS18B20 programmable wired digital temperature sensor manufactured by Maxim/Dallas firm.
5) An incremental encoder with 360 pulse per revolution used for measuring the rotor speed,
6) AC to DC conversion card.
7) Atmel Atmega 8-16 PU microcontroller and relays.
8) Three phase induction motor

Three signals for voltages, three signals for currents and one signal for temperature are used as input values to A/D module inside microcontroller and one signal for speed is used as digital input to microcontroller. Software and measurements of these signals are explained in subsection software section.

B. Software

X-CTU is used to provide a simple-to-use graphical user interface. It is a Windows-based application, and it is provided by Digi. X-CTU is supported to all windows based personal computers running operating system windows 98SE and above. When you launch, X-CTU window appears on screen and four tabs across the top of the program as shown in figure 3. Every tab has a different function. First tab is for PC Settings, second for Rage Test, third for Terminal and last for Modem Configuration.

- PC Settings: It allows user to configure and select the desired COM port, it means to fit the radios settings.
- Range Test: It allows a user to perform a range test between two radios.
- Terminal: It allows access to the computers COM port with a terminal program, as well as its allows the ability to access the radios’ firmware by using AT commands
- Modem Configuration: It allows the ability to program the radios’ firmware settings through a graphical user interface as well as it allows user to change firmware versions.

C. Packet Data and Size

By using X-CTU we can send 32 bytes data packet and this data packet can be adjusted in either text or the size sent.
V. CONCLUSIONS

In this way a parameter monitoring system for induction motor using Zigbee protocol is realized and tested. It is capable of performing some operations like running the motor through RF, measuring, stopping it, monitoring and controlling all the parameters of the induction motor such as phase voltages, phase currents, winding temperature, speed. All parameter values are transferred to the controlling computer and by using GUI all these parameter values are displayed on the monitor graphically and stored into excel file for a long time monitoring.

It can be used not only for industrial applications but also for educational purposes and it can be adapted in experimental researches successfully

REFERENCES


