



A Novel Topology for WSN Based Monitoring and Controlling of Induction Motor

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ABSTRACT—This paper describes monitoring and controlling of induction motor by using WSN method. In this approach, a microcontroller based hardware unit has been developed to continuously monitoring the parameters like current, voltage, temperature and speed of the motors. In a motor monitoring and controlling system the motor is connected with one microcontroller based hardware unit, Wireless sensor network with Zigbee communication protocol for collecting and storing data accordingly generating control signal to stop or start the induction motors through computer interface developed with Zigbee safe and economic data communication in industrial fields.

KEYWORDS: WSN, Zigbee, Monitoring and Controlling, Microcontroller

I. INTRODUCTION

Monitoring and controlling of induction motor have a challenging task for engineers in industries. 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. The hardware proposes a wireless control and monitoring system for an induction motor based on Zigbee communication protocol for safe and economic data communication in industrial fields. Microcontroller based system is used for collecting and storing data and accordingly generating control signal to stop or start the induction machine through computer interface developed with zigbee. Single Phase and Three Phase Induction machines are very popular in industries because of their vast applications. Hence it becomes necessary to protect them against faults so as to ensure uninterrupted operation and functioning.

Nowadays the automation has become a basic need for the industries. Induction Motors are the nerves of many industries. Hence Industrial automation is required for precise and accurate operation. The wired communication is more expensive or impossible due to physical conditions. A module, sensors monitors the parameters of induction machine and transmit the data through Zigbee Protocol.

II. METHODOLOGY

The proposed work aim is to achieve a advanced technique by using WSN based monitoring and controlling of induction motor. Various parameter controlling and monitoring systems are there for other types of machine, but in case of induction machine the controlling and monitoring systems are not extensively used due to high cost of installation and physical constraints. So as to overcome the limitations in monitoring and controlling of induction machines. Monitoring of all the parameters are done. Controlling is done by connecting a personal computer. A PC shows the overall process.

WSN NETWORK

Wireless sensor network system are autonomous and operate unattended also adaptive to the environment. The wireless system for monitoring purpose will not only reduce the overall monitoring system cost in term of facilities setup and labor cost, but always provide flexibility in system in term of distance or location. So these systems are widely used in military, hospitals, home and other commercial areas. According to these aspects the ZigBee becomes the new standard intended for low cost devices in automation, computer peripherals and home controls. ZigBee standard performs well at industrial environments the fundamental design and implementation of WSN featuring a high power transmission

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Zigbee based technology. The developed platform is cost-effective and allows easily in WSN systems and as well as the effect on reducing energy consumption.

ZIGBEE NETWORK

There are three network topologies which are used. They are Star Network, Cluster-Tree Network and Mesh Network⁵. Different network topologies built up by Zigbee devices like star topology, cluster tree topology and mesh network. For all network topologies, there can be only one coordinator in each network. In star topology there is a coordinator which is responsible for all over the network. All other devices are back-end devices and directly communicate with the coordinator. This topology is suitable for networks with a centralized device and for time critical applications.

MONITORING AND CONTROLLING SCHEME

The monitoring and controlling scheme of induction machine. A general block diagram of the proposed scheme is given in Figure. General Block Diagram of Monitoring and Controlling Scheme. The whole system is divided into two parts- transmitter and receiver. In the transmitter part a network of sensor and transducers are used to monitor the risky parameters such as voltage, current, temperature of stator winding and speed of the induction machine present at the plant location.

The monitoring data is simultaneously fed to the micro-controller. This data is transmitted efficiently and smoothly to receiver end through wireless Zigbee Communication Protocol (IEEE802.15.4 Standards). The micro-controller at the transmitter end is so programmed that if the monitoring parameters of induction machine come out of the desired or safety limit, a signal will be generated by the micro-controller which will energize the relay circuit and the contractor cuts the mains supply to the induction machine can be done from a remote.

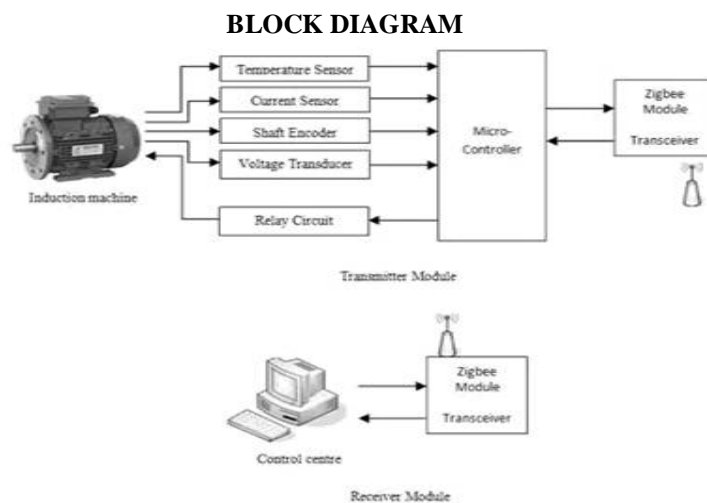


Fig 1 Block Diagram

III. SYSTEM DESCRIPTION

First of all power supply is given to all the required module. Sensors like sensors are connected to the Microcontroller. The wireless system for monitoring purpose will not only speed, voltage current and vibration reduce the overall monitoring system cost in term of facilities setup and labour cost, but always provide flexibility in system in term of distance or location. Zigbee transmitter is connected to the microcontroller unit, so that if there is any changes in sensors from the set values a signal is passed to the receiver(Personal Computer). Once a signal is received, a protection unit controls the induction motor.

The data received at the receiver end is transferred to computer system through MAX232 interface. Thus a continuous monitoring of the parameters of location far away from the actual working location. If the user anytime wants to start or stop the induction machine, a signal will be given by the computer system present at the receiver end, which is communicated at the transmitter end through Zigbee protocol. In turn the micro-controller unit present at plant location, generates a signal which energizes and de-energizes the relay circuitry to stop and start the induction machine respectively. Thus this system not only monitors the operation of induction machine but also protects it from the severe



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faults that commonly occur.

SENSOR

This unit consists of several sensors and transducers used to detect the predetermined parameters of the induction motor. In this work, mainly monitor four parameters of induction machine that are Voltage, Current, Temperature of Stator Windings and Speed of Operation.

VOLTAGE MONITORING

First, a 220V/6V step -down transformer is used to transform V_{in} into a lower ac voltage V_1 . The V_1 of the transformer is fed to voltage transformation unit which transforms the input consists of diode, Zenner diode and resistive divider network.

CURRENT MONITORING

Current flowing through induction machine can be measured through the Hall Effect current sensor (A1120). A current sensor is a device that detects electrical current (AC or DC) in a wire, and generates a signal proportional to it. Hall-Effect current sensors can sense both AC and DC magnetic fields and can generally be specified to operate over a frequency range of DC to several thousand Hertz.

TEMPERATURE MONITORING

Temperature of stator winding can be measured through Dallas DS1820 Direct to digital temperature sensor. The Dallas Direct-to-Digital Temperature Sensors measure temperature through the use of an onboard proprietary temperature measurement technique.

SPEED MONITORING

Speed of revolution of induction machine can be measured using shaft encoder wheel and sensor. An encoder is a rotational transducer that converts angular movement into digital impulses.

MICROCONTROLLER UNIT

The PIC16FXX series has more advanced and developed features when compared to its previous series. The important features of PIC16F877 series Features: High performance RISC CPU. ONLY 35 simple word instructions.

All single cycle instructions except for program branches which are two cycles. Operating speed: clock input (200MHz), instruction cycle (200ns). Up to 368×8bit of RAM (data memory), 256×8 of EEPROM (data memory), 8k×14 of flash memory. Pin out compatible to PIC 16C74B, PIC 16C76, PIC 16C77. Eight level deep hardware stack. Interrupt capability (up to 14 sources). Different types of addressing modes (direct, Indirect, relative addressing modes). Power on Reset (POR). Power-Up Timer (PWRT) and oscillator start-up timer. Low power- high speed CMOS flash/EEPROM. Fully static design. Wide operating voltage range (2.0 – 5.56) volts. High sink/source current (25mA). Commercial, industrial and extended temperature ranges. Low power consumption (<0.6mA typical @3v-4MHz, 20µA typical @3v-32MHz and <1 A typical standby).

ZIGBEE TRANSMITTER MODULE

The XBee RF Modules are designed to operate within the ZigBee protocol and support the unique needs of low-cost, low-power wireless sensor networks. The modules require minimal power and provide reliable delivery of data between remote devices. The modules operate within the ISM 2.4 GHz frequency band. It operates over a range of 100-200 meters.

The receiver module consists of a Zigbee RF module which is connected to computer system through M AX232. Thus the monitoring data received by Zigbee module is directly transferred to computer system.

HARDWARE

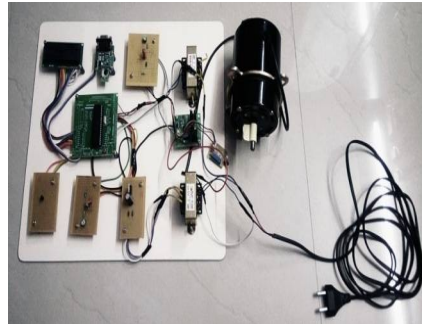


Fig 2 Hardware

IV. CIRCUIT DIAGRAM

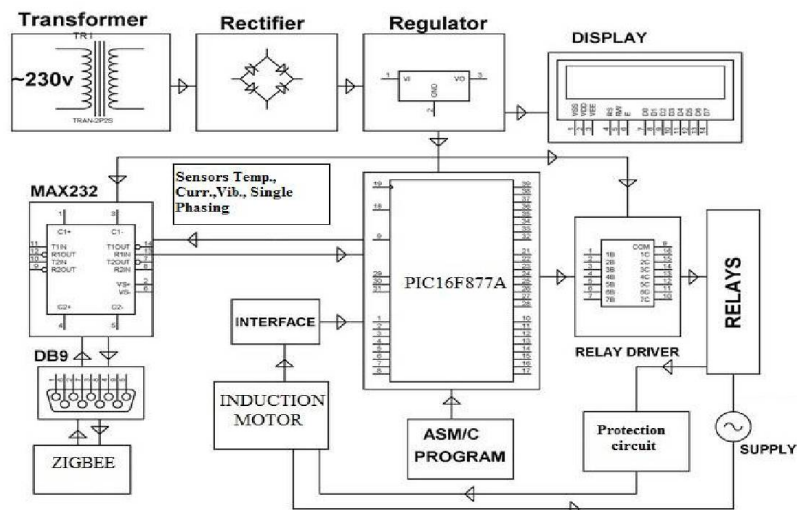


Fig 3 Circuit Diagram

CIRCUIT DIAGRAM EXPLANATION

230V AC supply is step downed and rectified using rectifier and then filtered for pure DC without any oscillations. LCD display is connected to the port C and port D of PIC16F877A. Microcontroller reads all inputs such as temperature, currents, The XBee RF Modules are designed to operate within the ZigBee protocol and support the unique voltages and speed and sends data to base station using zigbee module. It is mainly monitor the four parameters of induction machine that are Voltage, Current, vibration and Speed of operation needs of low-cost, low-power wireless sensor networks. The receiver module consists of a Xbee RF module which is connected to computer system through MAX232. Thus the monitoring data received by Zigbee module is directly transferred to computer system.

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V .RESULTS AND DISCUSSION

In fig 4 shows the Motor is monitoring position.



Fig 4 Motor Monitoring

A. SPEED

In the Fig 5 the Motor Parameter speed is monitored



Fig 5 Speed Sensing

B. TEMPERATURE

In the fig 6 the motor temperature is monitored and the value is shown in the LCD display



Fig 6 Temperature Sensing

C. VOLTAGE

In the fig 7 the motor performance factor voltage is monitored.



Fig 7 Voltage Sensing

D.CURRENT

In the fig 8 the motor performing parameter current is monitored and the value is displayed in the LCD.

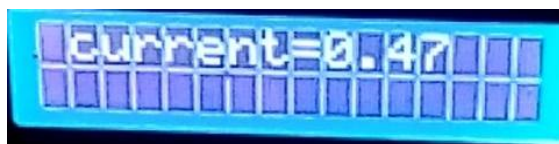


Fig 8 Current Sensing

In the Table 1 the motor performance factors are tabulated and the normal values are monitored and displayed in the LCD .



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NORMAL VALUES OF INDUCTION MOTOR

Sl.No.	Description	Single phase	Three Phase
1	Voltage	230 volts	415volts
2	Current	1 Amps	5 Amps
3	Winding Temperature	45° C	50° C
4	Speed	1400 rpm	1440 rpm

Table 1 Normal Condition of Induction Motor

The motor abnormal condition is identified by using the proposed system and the abnormal values are tabulated and the preventing steps are taken based upon the below tabulation.

Sl. No.	Description	Single phase	Three phase
1	Voltage	250 volts	450 volts
		170 volts	370 volts
2	Current	> 1 A	> 5 A
3	Winding Temperature	> 45° C	> 50° C
4	Speed	1500 rpm	1500rpm

Table 2 Abnormal Conditions of Induction Motor

APPLICATIONS

This WSN based 3 phase induction motor system mainly applied in the large scale industrial area due to its automated control technique. Industrial pumps & fans Elevators and cranes. Cement and rubber mills. In generating and distribution station, this method for its fast response. The whole system may be very useful to colleges and research institutes that have vocational, technical, and industrial education.

ADVANTAGES

The main advantage of this concept in this proposal is automation. The operation of this system is quick due to its monitoring and controlling can be done by same system. There is no necessity for the manual control. The developed platform is cost-effective and allows easily in WSN systems and as well as the effect on reducing energy consumption.

VI. CONCLUSION

The approach discussed in the paper has achieved the target to monitoring and controlling system of induction motor WSN based with Zigbee protocol is achieved and tested successfully. It is capable of performing some operations like running the motor through control interface, measuring parameters, stopping, monitoring all the parameters of the induction motor such as phase voltages, phase currents, winding temperature, power, speed, vibration.

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