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Embedded System Integrated in to a Wireless Sensor Network for Online monitoring in Induction Motors

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ABSTRACT

Induction machines play a important role in industry and there is a demand for their reliable and safe operation. They are generally reliable but eventually do wear out. Faults and failures occurs in induction machines leads excessive down times and generate large losses in terms of maintenance, and this motivates the examination of condition monitoring. On condition monitoring involves taking measurements on a machine while it is operating in order to detect faults with the aim of reducing both unexpected failures and maintenance costs. This system surveys the current trends in on-line fault detection and diagnosis of induction machines. Condition monitoring of induction motors reduce the cost of maintenance and the risk of unexpected failures. In condition based maintenance, one does not schedule maintenance or machine replacement based on previous records or statistical estimates of machine failure. Rather, one relies on the information provided by condition monitoring systems assessing the machine's condition. Thus the key for the success of condition based maintenance is having an accurate means of condition assessment. Network for condition monitoring uses measurements taken while a machine is operating to determine if a fault exists. Different types of sensors can be used to measure signals to detect these faults. Various signal processing techniques can be applied to these sensor signals to extract particular features which are sensitive to the presence of faults.The project is to monitor the operating conditions of three-phase Induction motors. This system is based on a low-cost electronic device that can acquire and pre-process current, voltages and temperatures and speed transmit processed key-information related to the motor operation conditions using ZIGBEE wireless technology.Electrical motor operation monitoring is necessary for efficiency, maintenance, and repair view. The induction motor can be started and stopped wireless due to the computer interface developed with Zigbee. It is also possible to protect of the motor against some faults such as over current, higher/lower voltage, over temperature in windings, overloading of motor. In determine the applicability of the Zigbee technology to in field monitoring of induction motor. The Zigbee (WSN) network is able to sink operation-related data of many motors to one central point and do several calculations such power consumption, power factor, load factor, voltage and current unbalance Data has been provided which is able to read line currents, line-to-line voltages and temperatures. The importance of the proposed system is its intelligent, high reliability and low cost.

Index Terms— Embedded systems, Induction motors, ZigBee, wireless control and monitoring system.

1. INTRODUCTION

In an industrial environment, mechanical systems driven by electric motors are used in most production processes, accounting for more than two-thirds of industry electricity consumption. Regarding the type of motors usually employed, about 90% are three-phase ac induction based, mainly due to its cost effectiveness and mechanical robustness time required for the operations can be improved. Industrial automation in coordination with the Mechatronics gives more efficient performance. Mechatronics is the synergistic integration of sensors, actuators, signal conditioning, power

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electronics, decision and control algorithms, and computer hardware and software to manage complexity, uncertainty, and communication in engineered systems. In an industrial environment, mechanical systems driven by electric motors are used in most production processes, accounting for more than two-thirds of industry electricity consumption. Motor-driven systems use nearly 70 percentage of the total electric energy consumed by industry. On average, these motors operate at no more than 60% of their rated load because of oversized installations or under loaded conditions, and thus at reduced efficiency which results in wasted energy. About 90 % of the total motor electricity consumption is done with ac. three phase induction motors in the power range from 0.75 kW to 750 kW. A breakdown of the electricity consumption by end-use is given in Table 1. Induction machines are the majority of the industry prime movers and are the most popular for their reliability and simplicity of construction. Condition monitoring and diagnostics are very important issues in motor-driven and power electronics systems since they can greatly improve the reliability, availability and maintainability of the system.

As said above Induction motor is used in majority of the industrial applications. The main reason for the usage of IM is its reliability and simplicity of operation. Most of electrical energy is utilized by induction motors. And thus it is essential to monitor the performance of the motor without changing its operation. Here the system is introducing a new technique in which embedded system is integrated into the wireless network

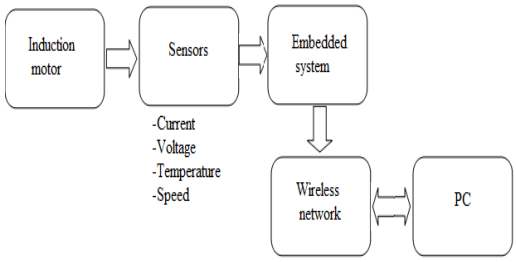
TABLE I: electricity consumption

TYPES OF LOAD	INDUSTRIAL SECTOR	TERITORY SECTOR
Motors	69%	36%
Lighting	6%	30%
Other	25%	34%

During this technique, different sensors are connected with the motor and the values are extracted using an ARM7 (Advance RISC Machine). It is then transmitted to the base station and at the base station a Graphical User Interface is given which give the user can interface with the system. The wireless protocol used is Zigbee.

2. METHODOLOGY FOLLOWED

The proposed system aims to monitoring the various parameters such as voltage, current, temperature, speed, torque and efficiency of induction motors in real time by using different sensors. An embedded system is used for acquiring electrical signals from the motor in a non-invasive manner, and then performing local processing for torque and efficiency estimation. The values calculated by the embedded system are transmitted to a monitoring unit. The protocol used here for the wireless transmission is zigbee.



ZigBee is a proprietary set of high level communication protocols designed to use small, low power digital radios based on the IEEE 802.15.4 standard for wireless personal area networking. The relationship Between IEEE 802.15.4 and ZigBee is analogous to that existing between IEEE 802.11 and the Wi-Fi Alliance. It is expected that the standard eventually will be open (i.e., available free to the public for academic or other noncommercial use), while remaining proprietary (i.e., requiring membership in the ZigBee Alliance for commercial use).

In the receiver side it is given to the personal computer. The GUI used is visual basic, which act as data manipulator. There it is again converted to the actual value.

3. NEED OF WIRELESS MONITORING

A wireless control and monitoring system for an induction motor is realized using the Zigbee communication protocol for

- Safe and economic data communication in industrial fields.
- The wired communication is either more expensive or impossible due to physical conditions. The induction motor can be started and stopped wireless due to the computer interface developed with Zigbee.
- It is also possible to protect of the motor against some faults such as over current, higher/lower voltage, over temperature in windings, overloading of motor.
- Moreover, a database is built to execute online measurements and to save the motor parameters received by radio frequency (RF) data acquisition system. Therefore, controlling, monitoring, and protection of the system are realized in real time
- Since the wireless communication technology is used, controlling abilities of the system are increased and also hardware and the necessities of other similar equipment for data communication are minimized.
- Structured cabling and sensor deployment are usually more expensive than the cost of the sensors themselves. Besides the high cost, the

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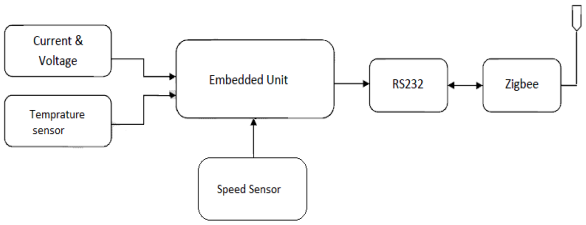
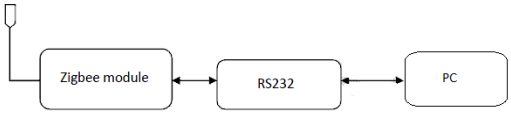
wired approach offers little flexibility, making the network deployment and maintenance a complex process.

4. SYSTEM DESCRIPTION

A. Induction Node



B. Control node



Monitoring of induction motor is essential for its better performance. For this purpose we have to acquire many parameters like voltage, current, speed, temperature & torque. All parameters must be acquired at fastest speed. For monitoring of all parameters sensors are used and sensors are connected to signal conditioning circuits to convert signals suitable form to be applied to embedded controller.

5. HARDWARE DESIGN

The system consists of an embedded system and data transmitting unit which is mounted near the motor. In the receiver side value of different parameters are given to personal computer. On transmitter side hardware is connected with the motor. It mainly has different sensors, ARM processor and zigbee module for wireless transmission.

A. Voltage & Current monitoring

Potential Transformer is used to sense voltage. The output of Potential Transformer is amplified and buffered to appropriate level and then given to the ADC, which is analog to digital converter. The ADC is interfaced with the micro-controller for calculation of respective voltages. The ADC has 8 different channels that can be selected by the micro-controller by giving appropriate select signal. To monitor the current the Current Transformer is used and the same thing is done for the current measurement as the voltage.

B. Temperature Monitoring

For monitoring the temperature the LM 35 IC is used and the voltage at the output is given directly to the ADC channel. LM 35 is the temperature sensor which gives 10mv change in voltage per degree centigrade. The LM35 series are precision integrated-circuit temperature Sensors, whose output voltage is linearly proportional to the Celsius temperature.

C. Speed monitoring

Tachogenerator is used to sense the speed of electric motor. Tachogenerator generate voltage proportional to the shaft speed. The tachogenerator gives a continuous voltage sign corresponding to the speed actual value of the electric machine to which it is coupled. The Tachogenerator is fitted with permanent magnets in the stator with the function of creating a magnetic field. An amplitude continuous voltage proportional to the speed, which depends on the rotation direction, is generated in the wound rotor. The outputs of all above parameters are displayed on the LCD display. We have interfaced the 16X2 LCD display with the ARM7 processor.

D. Microcontroller Unit

The main unit of processing unit is ARM7 which is used for local processing.ARM7 is a member of the ARM family of general-purpose 32-bit microprocessors The ARM family offers high performance for very low power consumption, and small size.The ARM architecture is based on *Reduced Instruction Set Computer (RISC)* The ARM7 uses a pipeline to increase the speed of the flow of instructions to the processor. The ARM7 core has Von Neumann architecture, with a single 32-bit data bus carrying both instructions and data.

E. ZigBee transmitter Unit

The protocol used for wireless transmission is zigbee.zigbee modules are ideal for applications requiring low latency and predictable communication timing. Providing quick, robust communication in point-to-point, peer-to- peer , and multipoint configurations, ZigBee multipoint products enable robust end-point connectivity with ease. Whether deployed as a pure cable replacement for simple serial communication, or as part of a more complex hub-and-spoke network of sensors, ZigBee modules maximize wireless performance and ease of development.the data collected from motor is processed by ARM7 and then transmitted to the base station. At the receiver end data is collected by the receiver and given to the computer.

6. CONCLUSION

The proposed system is a combination of advanced techniques and plant management process, aiming for goal through technical means. Wireless sensor network is used to transmit data collected from the machine to the base station. Visual basic is used for the graphical user interface. The total system gives an efficient mechanism for the measurement & monitoring of the parameters of the induction motor without interrupting the actual working of the system.

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