Neural Network Implementation of Industrial Motor Health Monitoring and Control System Using Wireless Sensor Network

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ABSTRACT:
Electrical machines play an important role, the use of medium-sized electric machines burned every year around about 20%. In addition, because of electrical failure, damage caused by accident’s even at home appliances as well as factory production cause the indirect economic losses even greater. Hence we propose a novelty system based on Artificial Neural Network Control (ANNC) which will take care of all the test analysis need for safety standards (vibration, torque, voltage, current, power consumption bearing test and etc.,) of a AC/DC devices with its own training and testing principle of operation. Recently, Artificial Neural Network (ANN) has gained momentum as a controller for non linear systems. The complete test system is modeled in Matlab / Simulink. The test results have been analyzed for both steady state and dynamic conditions. It is evident from the results that the proposed ANN controller gives promising results than the PI, PID control.

Keywords: ZigBee network, sensors, End-device, Coordinator device, embedded system.

I. INTRODUCTION

Motor protection devices, have a number of drawbacks, not the protection of a good motor, very difficult to promote. Using of integrated circuits without CPU produce the motor fault detector, although the current overrun and lack phase fault can be judged, current increase mainly as a criterion, the protection of the principle of a rough, the actual motor failure are the time and ambient temperature function of the electrical current, causing the accident.

At the same time, fault conditions cannot store data records and cannot be set in accordance with the actual load current, therefore not accurate, reliable and without visual convenience when used, is not conducive to the exclusion of failure, often refusing to move, severe burning motor. With the digital computer, electronic technology, the rapid development of integrated circuits, computer monitoring and control system to replace the traditional monitoring and control system is ripe.

The focus in most industry is shifting from scheduled maintenance to the predictive maintenance by constantly observing and predicting the machine condition in advance. Most industrial motors are being monitored which either provide warning signals or shut down the system before any catastrophic failure occurs. Though they are able to prevent permanent damage to the machine, they can neither predict the usable life of the equipment nor provide the severity level of the problem. This resulted in the need of an advance system called Cost effective wireless health monitoring system.

II. LITERATURE SURVEY

WI- Fi, 3G, Bluetooth, ZigBee are the example of Wireless communication which is capable of high data transmission rate. These devices use system resources a largely and are proportional to transmission speed. The Institute of Electrical and Electronics Engineers (IEEE) developed 802.15.4 standards and helped the production of ZigBee protocol and devices that support this protocol. As a result, ZigBee supported devices have intelligent network topologies, low-cost, and are have energy saving features. So that they have their own place in daily life and industrial companies in number of ways [6]. A various number of devices and machines can be controlled along with data transmission and reception at the same time with ZigBee.
wireless technology. So, system running can be achieved without any trouble [7]. In the literature, many numbers of methods has been used for monitoring, running and detecting electrical & mechanical defects in electric drives.

Traditional protection practices for detecting electric drive defects uses various types of protection relays such as temperature relays, over current relays, electromagnetic switches, low and high current protection relays, time relays and contactors. If the traditional protection methods are compared with the computer-based methods, traditional methods considerably reduce the sensitivity and efficiency of the system because many of the mechanical parts including in the system increase the time for detecting defects. Another disadvantage of the traditional protection methods is their cost. We know that traditional methods increase the cost of systems while a digital system decreases it.

There are many publications on detection of the mechanical defects of induction motors in the literature [4]. In some studies, electric drive parameters have been used to display the electrical and mechanical performance of the drives through a PC. In [11], a real time monitoring system has been developed against the failure of electric drive. All measurements related to the electric drive were done. However, it was realized that the cost is increased due to use of sensors to collect the current and the voltage information from the network and transfer them to the computer by an analogue/digital converter card.

A. ZigBee characteristics

ZigBee is a short-distance, simple-structured, low power, and low-transmission rate wireless communications technology. It has a transmission range of 100 m and uses the free 900 MHz and 2.4 GHz transmission frequencies. ZigBee has a transmission rate of 20 Kbps to 250 kbps; its network structure has Master/ Slave attributes and can provide the function of two-way communication. Currently, ZM03 uses the 2.405–2.480 GHz frequencies; in addition, due to the low transmission rate and small amount of data transmitted, the sending and receiving time is kept low.

In non-work mode, ZigBee is placed in sleep mode. In the conversion time between work and sleep modes, only 15 ms are needed for normal sleep activation time and only 30 ms are needed in the equipment search time, making ZigBee fairly power-saving. The MAC level of ZigBee utilizes a talk-when-ready collision prevention mechanism: data is transmitted immediately when there is need, and each transmitted data packet is confirmed to be received by receiver and is responded to with a confirmation message; if a confirmation message is not received in response, then a collision has occurred and the data packet is transmitted again. This method greatly increases the reliability of the system’s data transmission. In addition, a ZigBee network can include a maximum of 255 nodes, making it highly expandable [10].

B. Comparison of ZigBee with other wireless services

In comparing ZigBee with other wireless communications technologies in terms of the wireless communications technology faces of area networks and personal networks, 802.11- series technologies (Wi-Fi) are centered on wireless local area networks (WLAN) for use in data transmission. On the other hand, Bluetooth, UWB, and ZigBee are wireless personal area networks (WPAN) technologies. The Bluetooth standard has a transmission rate of hundreds of Kbps and is thus appropriate for data transmission; it also has the QoS mechanism for voice applications.

The UWB (ultra wideband) has high-speed and QoS, making it appropriate for multimedia applications. Characteristics of the ZigBee standard include low power and low-cost, so it fits the control and sensing needs in industry, family, and medicine; ZigBee does not have high requirements for data transmission rate and QoS. In addition, in comparing the currently- popular Bluetooth technology and ZigBee, ZigBee consumes far less power than Bluetooth; due to its low power consumption, ZigBee has a lower transmission rate compared to Bluetooth. In terms of the expansion flexibility of network node quantity, ZigBee has very strong capability in range expansion due to its support of mesh topology. Fields of application for ZigBee include family automation, family security, overall medical care in hospitals, and industrial automation. ZigBee can be used in conjunction with products such as home appliances, consumer electronics, PC peripherals, and sensors, providing functions such as home appliance sensing, wireless PC peripheral control, and home appliance remote control [10].

TABLE IOMPARISION OF BLUETOOTH, IEEE 802.15.4 & IEEE 802.11[9]
III. DESIGN GOAL

In this section, we discuss the sensor system used to monitoring the mechanical parts. Sensor system used to store the performance of the mechanical parts is wired or wireless. Several advantages are using the wired sensor systems [1]. Transmitting data with very high bandwidth and high sampling rate also possible. It is impossible to measure movable rotating parts.

Wireless sensors having lot of benefit in the location of sensing and installation is unrestricted. So we focused on using wireless sensor system used to monitoring mechanical wear out parts. Hou and Bergmann [2] designed a wireless sensor system to log the operating signals of vibration, temperature, load and speed of the induction motor. In this paper mainly focused on neural networks to perform on sensor feature extraction and fault diagnosis. This approach used to reduce the amount of data transmitted over the wireless network it’s compared with transmitting raw data signals of motor machinery. Another approach [3] installed Zigbee wireless module and sensing component of machinery parts. Another study discussed [4] wireless sensor system based industrial environment and using dynamic power management technique to identify the remaining life time of the systems. Another approach [5] focused on radio.

Frequency Identification (RFID) based technology to transmit data with a low sample rate. Final method [6] using frequency hopping spread spectrum with Bluetooth to avoid wireless interference. The data are transmitted to audio signal (i.e. Bluetooth earphone) using best effort approach but does not provide guarantee to data integrity and receiver side correctness. Recently proposed many wireless sensor system designs does not discussed about the wireless communication quality. For that reason, all suffer from wireless interference and data loss is possible for existing system design. In building simultaneous multiple wireless sensor communication could be worsened.

To provide guarantee of all the measured data can be transferred from the wireless sensor to the data server. The data transmission purpose the integrate reliable communication protocol then it store all the transmitted data in the permanent storage if it lost means again it retransmitted the data.

The design goals of the proposed system are follows:
1) The measured data of wireless sensor must able to transmitted data to the data server is 100% accurate.
2) Data transmission interference is avoided for wireless sensor systems
3) It provides better communication performances.
4) No data loss or distortions is tolerable.
5) It’s low cost hardware design, to increase the performance of manufactures of mechanical parts that integrate this system in this future.

IV. SYSTEM DESIGN AND ARCHITECTURE

The objective of this research is to advance the field of condition monitoring and fault diagnosis for induction motors. This involves processing the signals produced by induction motors, classifying the types and estimating the severity of induction motors faults. A typical process of condition monitoring and fault diagnosis for induction motors consists of four steps: data acquisition, signal analysis, fault detection and post-processing. In this project, a novel method of condition monitoring and fault diagnosis for induction motor is proposed using hybrid intelligent techniques based ANN. ANN is trained by improved algorithm to extract the feature of motor parameters. The extracted features with different frequency resolutions are used as the input of ANN for the fault diagnosis. The experimental results demonstrate that the proposed method improves the sensitivity and accuracy of the ANN-based methods of condition monitoring and fault diagnosis for induction motors.

<table>
<thead>
<tr>
<th>Protocols</th>
<th>ZigBee</th>
<th>Bluetooth</th>
<th>Wi-Fi</th>
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<tbody>
<tr>
<td>IEEE</td>
<td>802.15.4</td>
<td>802.15.1</td>
<td>802.11a/b/g</td>
</tr>
<tr>
<td>Power consumption</td>
<td>Very low</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>No. of nodes</td>
<td>65000+</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>Throughput Max</td>
<td>250 kb/s</td>
<td>1 mb/s</td>
<td>11-54 mb/s</td>
</tr>
<tr>
<td>Range</td>
<td>100m</td>
<td>10m</td>
<td>300m</td>
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</tbody>
</table>
VI. CONCLUSION

Through various fault conditions analysis of the course motor running, and using of mathematical models and simulate the process of motor temperature. Full advantage of the single-chip system resources realize intelligent motor protection and form a fully functional, practical intelligent performance monitoring system with a small number of Peripheral devices. Thermal model of low voltage motor is also establish, achieve a variety of motor fault General protection, as well as monitoring the operation of the motor. After testing the various parts of the hardware, the system can achieve the required accuracy of the monitoring, stable Operation, the use of effective, are in line with the target-site requirements to ensure reliable operation of the system, the promote a certain value.

REFERENCES

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