WIRELESS DATA ACQUISITION AND CONTROL USING ADVANCED EMBEDDED PROCESSOR

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Abstract:

In this research aims to monitor and control the speed torque and efficiency in induction motors in real time by employing wireless sensor networks (WSNs). An embedded system is employed for acquiring electrical signals from the motor in a continuous manner, and then performing local processing for torque and efficiency estimation. The values calculated by the embedded system are transmitted to a monitoring unit through an IEEE 802.15.4 based WSN. At the base unit, various motors can monitor and control in real time. But the existing System only Monitor the torque and efficiency, the proposed system deals with the control of induction motor. For the real time application the processing speed must be higher in order to minimize the computation delay .In this paper ARM Processor proposed for high processing speed and more calculations. Existing system using PIC microcontroller which is slow as compared to the processing speed of ARM processor .This paper demonstrate that the advantage of ARM Processor, is it's Essential for this type of application.

Keywords: Wireless Sensor Network, Embedded System, ARM.

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I. INTRODUCTION

In industrial side, mechanical parts or 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 . Torque is important parameters for production machines. In several industry areas, torque measurements can find equipment failure, which makes their monitoring essential in order to avoid disasters in critical production processes. [1]. For decades, researchers have studied methods and systems for determining the torque in rotating shafts.

The torque is considered by two method: direct torque measurement in shaft and estimated torque measurement from motor electrical signals. In most cases, the methods for direct torque measurement on the shafts are the more accurate. However, they are highly invasive, considering the coupling of the measurement instrument between the motor and the load Moreover some of these techniques still have serious operational challenges. The estimated torque from the motor's electrical signals (i.e., current and voltage) makes the system less invasive, but it is lessaccurate when compared to direct measurement systems. There are problems, such as noise in signal acquisition, those related to numerical integration, and low levels of voltage signals at low frequencies. However, in many cases, high precision is not critical, and low invasiveness is required. This paper presents an embedded system for control the motor speed and determining torque and efficiency in industrial electric motors by employing WSNs technology. For a set of electric motors, current and voltage measures are gathered into an embedded system. Speed, Torque and efficiency results are then sent to a base unit for real-time monitoring system. This way, prevent the low-efficiency motors are detected and in cases of torque outbreaks.

We have adopted the Zigbee (IEEE 802.15.4) standard for wireless communication. Zigbee allows the formation of a large network of sensors, in various industrial segments, where the standard is expected to have a significant impact [5]. This standard has been employed also in the mechatronics field. In comparison with other standards such as WiFi(IEEE 802.11) and Bluetooth(IEEE 802.15.1), the IEEE 802.15.4 standard have advantages related to low power consumption, scalability, reduced time for node inclusion, and low cost. Bin Lu and Gungor [8] identify the synergies between WSNs and the noninvasive methods for motor analysis based on electrical signals. The main limitation of their system derives from the low data rate in IEEE 802.15.4WSNs, since they do not employ local processing unit. It is necessary to send a large amount of data when computing the preferred parameters. This limits, among other things, the frequency of data acquisition from sensors.

In a WSN with a large number of nodes, the situation becomes even worse, since all nodes share the same physical transmission medium. Furthermore, it should be taken into account the unreliability of communication inherent to wireless networks, which can cause the loss of transmitted data, hampering the parameters' estimation process. The system proposed in this paper does all the data processing locally, transmitting and receiving to the base unit only the targeted parameters previously calculated. Thus, there is a large reduction in the amount of transmitted data, enabling real-time monitoring and control of multiple motors, even with a high data rate acquisition in the analog-to-digital converters. This paper presents studies on the relation between the WSN performance and the quality of the communication medium in the network operating environment. As a result, we observed the correlation between packet error rate and spectral occupancy in the band used for communication.

The influence caused by the enclosure of new sources of interference in the environment is also analyzed. Through these studies and a theoretical analysis, it was demonstrated that employing nodes with local processing capabilities is essential for this type of application, reducing the amount of data transmitted over the large network and allowing monitoring even in high interference scenarios. In addition to this work provides insights for guiding the development of new technologies for industrial WSNs.

II. BACKGROUND

TORQUE ESTIMATION

In an induction motor, the air gap between stator and rotor, where occurs the electro mechanical conversion process. The Air Gap Torque is the conjugate formed between the rotor and the stator magnetic flux. In this method is used to estimate the motor shaft torque. According to the estimation of the Air Gap Torque can be performed by current and voltage measurements from the electric motor [13]:

Tag= P1.732{(ia-ib)∫ [vca+r(2ia+ib)]dt+(2ia+ib)

6 ∫ [vca+r(ia-ib)]dt}

— (1)

Where,

P= number of motor poles

I=motor line current in amps

V=motor line voltage in volt

R=armature resistance in Ω

The torque can be estimated by subtracting the losses occurring after the process of electro mechanical energy conversion from AGT, according to following equation.

Tshaft=Tag-Lmech-LRsl

ωrωr— (2)

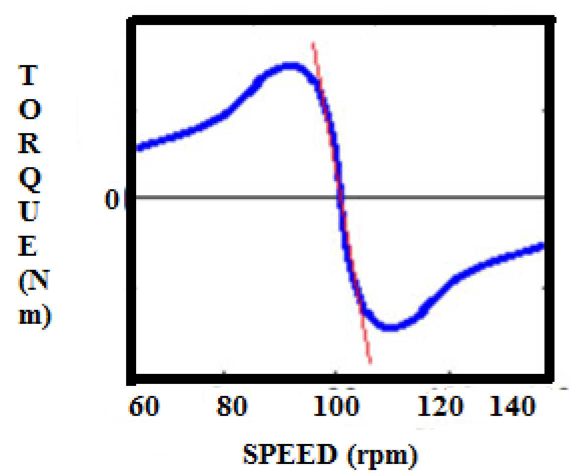

Figure.1 Relation between torque and speed

SHAFT SPEED ESTIMATION

Measuring the rotor speed directly ωr can be impractical in some cases. Several methods to use in sensor less rotor speed estimation have been proposed. However, it requires high rotor speed and stability [2]. The methods mentioned earlier do not work well when the speed is near to the synchronous speed and in dynamic systems with variable torque and vibration. A conventional induction motor has a speed variation of less than the synchronous speed when it is being used from no load to full load. In the normal operation region, close to synchronous speed, the motor presents an almost linear relationship between torque and its angular velocity (figure 1). Hence, a procedure for curve linearization can be adopted. To perform this linearization, two points are needed to relate torque and speed. These points can be when the torque is nominal and when it is zero.

EFFICIENCY ESTIMATION

The motor efficiency η can be estimated by the relation between the electrical power supply the motor (input power Pin) and the mechanical power supply to the shaft by the motor (output power Pout), according to the following equation:

$$\text{Efficiency} = \frac{Pout}{Pin} \quad (3)$$

III. WSN:

Wireless Sensor Network are formed by devices equipped with sensors and are capable of communicating via radio frequency. These sensors can produce responses the changes in physical conditions, it is temperature, humidity, or magnetic field. Specific types of WSNs, such as for industrial monitoring, have particular characteristics and specific application requirements. Therefore, the deployment of WSNs must necessary involves considerations of the targeted application.

In general, there are key features should be provided by the WSN, such as security, reliability, robustness, throughput, and sufficient determinism. These characteristics, the lack of reliability are the main reason why many users do not deploy wireless equipment. Much of this concern is related to the interference in the spectrum used by the wireless sensor networks for communication. Nodes in a wireless network may suffer interference from the coexistence with other network nodes, from other networks, and other technologies operating in the same frequency range. In industrial environments, there can be other sources of noise, such as thermal noise, and noise from motors and devices that cause electrical discharge [7]. The error characteristics presented in the wireless channel depend on the propagation atmosphere, the modulation, transmission power, frequency range, among additional parameters. In general, industrial wireless systems tend to have varying and often high error rates [1]. The Zigbee (IEEE 802.15.4) is well suited for WSN applications. It provideswireless communication with very low power consumption and low cost, for monitoring and control applications. It do not require high data transmission rate. There are some protocols that implement the network layer over the IEEE 802.15.4 standard, are responsible for the functions of sensing action.

IEEE802.15.4 standard defines three frequency bands: 868 MHz, 915 MHz, and 2.4 GHz . In this research, we have considered only the 2.4-GHz band. In an IEEE 802.15.4 network, there are two types of nodes: full function device (FFD), and reduced function device (RFD). The FFD nodes can act as network coordinator or end node. The coordinator is responsible, among other functions, for the initialization, address allocation, network maintenance, and the recognition of all other nodes.

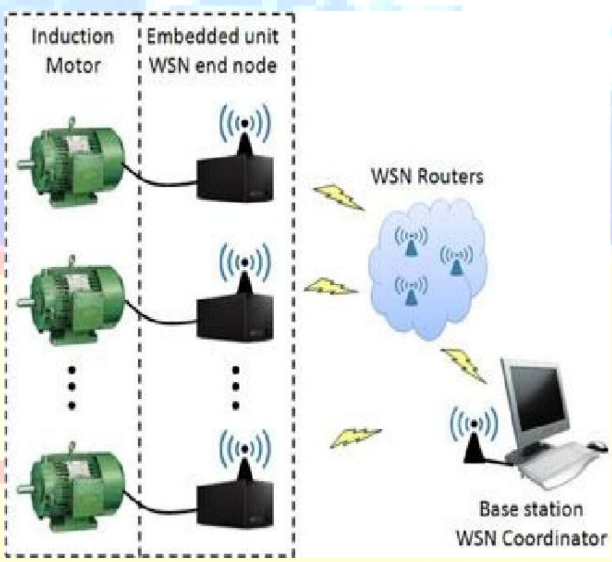

Figure. 2 Embedded systems integrated into WSN

IV. PROPOSED METHOD

In this paper proposed method for Industrial machineries monitor and control the speed torque and efficiency in induction motors in real time, by using wireless sensor networks (WSNs). In an embedded system can also perform the function of intermediate routers between nodes, without the intervention of the coordinator.

The sensor sensing various parameter and that data send to ADPU. The ADPU gives the control signal to input and output channel.

Embedded system used in ARM processor.ARM is a RISC(Reduced Instruction Set Computer) based computer processor. ARM processors require significantly fewer transistors than processors that would typically be found in a traditional computer. In this ARM processor calculate the targeted value. Current transformer is provided to sense the exact current flowing in distributed power line. Voltage transformer is measure the voltage in that line. Signal conditioning unit is used an equivalent voltage and current to the embedded unit. In this value are transmitted to WSN

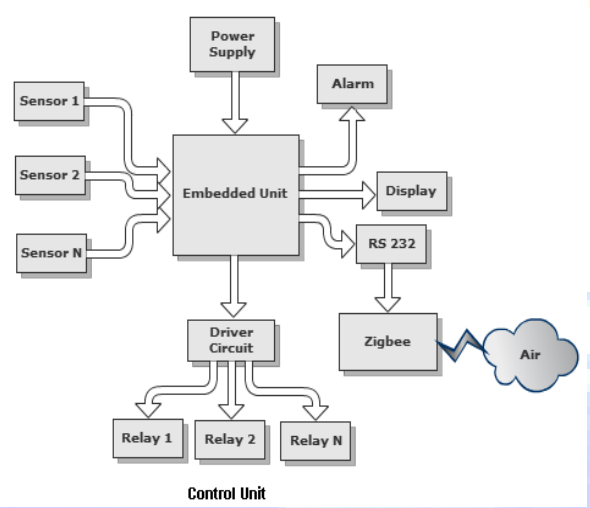

Figure . 3 Block diagram of the embedded system

In control unit, we are using relay to control the machines. Transmitted signals are received by processor and it converts it into electrical signal and using some driver circuits to control the relays operation. For example, if the no load condition the motor speed limit in the machine exceeds the maximum level means the speed sensor senses the speed and sends it to processor and the processor automatically triggers the relay circuits to turn off the motor..

Sensors are used to monitor the machines health condition Sensor inputs are given to the processor and the processor outputs are converted to RS232 standards and transmits it through air using zigbee. Display units such as computer or LCD are used to display the readings sent by processor.

V. EXPERIMENTAL RESULT

SOFTWARE EXPERIMENTAL RESULT

We used an embedded system into a WSN for online dynamic torque speed and efficiency monitoring and control in industrial machineries. In figure. 4 the torque value are gathered in real time by using Zigbee technology. In this section software use in MATLAB IDE or MicroC.

It is very important to conduct performance studies of wireless systems in industrial environment, mainly due to the lack of reliability inherent to wireless networks. Therefore, this paper presents a study on the performance of the proposed WSN in order to observe

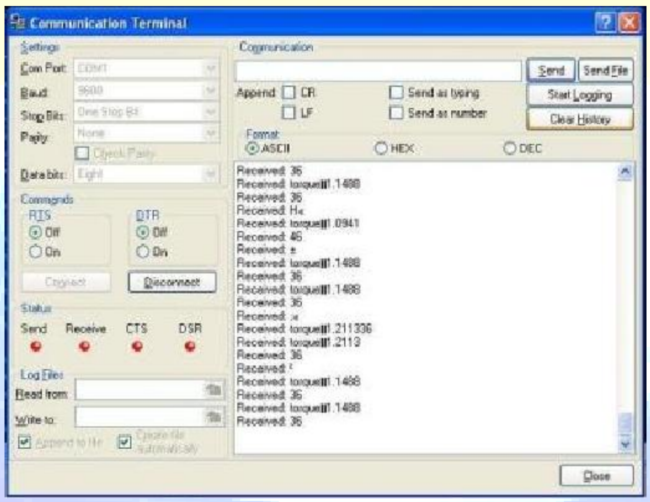

Fig.4 Torque value

its limitations and provide recommendations when developing new solutions for achieving better performance of such systems.

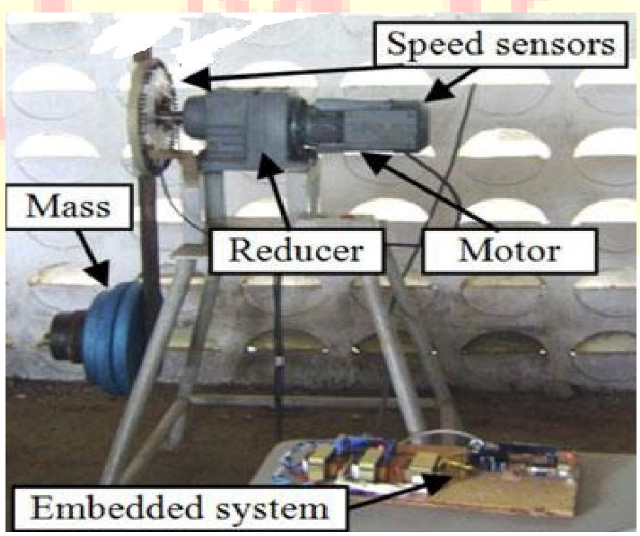

Figure.5 Proto type of Hardware kit

Embedded Systems is a special purpose computer system/board, which encapsulates all the devices such as processor, memory, interface and control in single package or board to perform only a specific application tasks.

In modern world, embedded systems have become an indispensable part of our life. Use of embedded systems has become so common in our day to day life that every one of us uses them.

VI. CONCLUSION

In this method mainly used to control the motor speed. The Air Gap Torque method to estimate shaft torque and motor efficiency in real time. The calculations for estimating the targeted values are done and then transmitted to a monitoring embedded or base unit through an IEEE 802.15.4 WSN.

The data transmission is difficulties in the WSN in some circumstances, the system was able to provide useful monitoring information, since all processing is done locally (i.e., only the information already computed is transmitted over the network). Without local processing, it might be impossible to use the WSN technology for this particular application, considering an unreliable transmission medium. Allied to the local processing capacity, other techniques can be developed to mitigate interference in those environments, leading to better communication performance.

As future work, we intend to conduct more detailed performance studies, considering a network with a larger number of nodes in an industrial plant.Can be extended the distance range of the wsn by using zigbee PRO.

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