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MACHINE CARE EFFECTIVEENERGY MONITRING MODEL BASED ON WIRELESS SENSOR NETWORKS

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Abstract:- *A wireless measurement and monitoring system for an electric drive system is realized using the ZigBee communication wireless standard for safe and economic data communication in industrial fields where the wired communication is either more expensive or impossible due to physical conditions. It is also possible to protect of the electric drive system against some faults such as over current, over voltage, higher temperature in windings. Therefore, controlling, monitoring, and protection of the system are realized in real time and it uses ZigBee wireless standard for remote data transmission along with Internet connectivity for assessment of the network-collected information. Therefore, the measuring devices and their respective sensors are studied accordingly. Algorithms have been developed allowing evaluation of additional parameters using data from the measurements held.*

Keywords: MEMS-based acceleration sensor, Wireless monitoring, Health monitoring.

INTRODUCTION

Health care is one of the primary applications for wireless networks composed of embedded sensors. Machine condition monitoring is the process of monitoring the condition of a machine with the intent to predict mechanical wear and failure. Vibration, noise, and temperature measurements are often used as key indicators of the state of the machine. Trends in the data provide health information about the machine and help detect machine faults early, which prevents unexpected failure and costly repair. With the rapid development of power industry, there is always mismatching between the power generation and the power consumption due to the unbalanced distribution of the resources.

As far as analyzed most of the machine monitoring system deals with the quality of the sensors employed, link/ node failure, data retransmission. Various parameters of machine care which includes current supplied, temperature developed inside the machine, vibrations produced by the machine, tilt angle ,lubricant oil level etc. These parameters are monitored and controlled by the operator by employing the concept of wireless sensor network.

With rapid development of sensor technology, MEMS and wireless communications, the wireless sensor network (WSN) has wide applications. The wireless system uses wireless sensor nodes to transmit the data to the monitoring server. The wireless sensor node consists of a short distance wireless transmission network (ZigBee 2.4GHz).The wireless sensor network (WSN) has been widely proposed as a solution to improve the reliability, productivity and safety of the system. However, despite the wireless sensors and WSN have numerous applications only a few developmental studies have been conducted on monitoring the machine body.

According to the experimental data, the wireless monitoring system can monitor the machine's running state effectively and accurately. The wireless monitoring system consists of a MEMS-based three-axis acceleration unit, wireless network with wireless nodes and the monitoring server terminal. The wireless system combines a long-distance wireless communication module that transfers the data to the remote server with a short-range wireless communication module located at the measurement device. This method of wireless system has been used in existing wireless monitoring systems. Finally, a series of experiments (such as comparing with the measuring angle, etc.) have been conducted to test the performance of the wireless monitoring system and analyzing the results.

Recent advances in micro-electro-mechanical systems (MEMS) technology, wireless communication and digital electronics have enabled the development of low cost, low power, multifunctional sensor nodes that are small in size and communicate untethered in short distances. These tiny sensor nodes, which consists of sensing, data processing and communicating components,

leverage the idea of sensor networks based on collaborative effort of large number of nodes. Sensor networks represent a significant improvement over traditional sensors.

WIRELESS SENSOR NETWORKS

Wireless sensor networks (WSN) are becoming very attractive for both telecommunication and network industry. These sensors can influence the understanding of the physical world around us by transmitting signals by sensing the field of influence of such devices. Such devices can then transmit electrical signals from the sensor through the network until the signal reaches the sink stage.

It is a group of specialized devices or sensors which are used to monitor different environmental conditions and to collect and organize that data at some certain central location. It detects and measures a number of physical conditions such as sound, speed, directions, pressure etc.

Wireless sensor network utilize an efficient form of technology that has no structure or rules or adhering to a specific standard. This makes it interesting for research and thus significant sources are being placed on its study by research scholars.

MEMS SENSOR

Accelerometers are useful for sensing vibrations in systems or for orientation applications. Accelerometers can measure acceleration on one, two, or three axis. 3-axis units are becoming more common as the cost of development for them decreases. MMA7361 is a three-axis analog accelerometer IC, which reads off the X, Y and Z acceleration as analog voltages. By measuring the amount of acceleration due to gravity. By sensing the amount of dynamic acceleration, the accelerometer can find out how fast and in what direction the device is moving.

The accelerometer is very easy interface to an Arduino Micro-controller using 3 analog input pins, and can be used with most other micro controllers, such as the PIC or AVR. The sensor works on power between 3.3V to 6VDC, therefore the sensor requires a very low amount of power. MEMS helps in monitoring the health of the machine by measuring their vibrations during running state. MEMS technology is used in various sectors like automotive industry [5][6].

HEALTH CARE SYSTEM OF MACHINE

Machine condition monitoring is the process of monitoring the condition of a machine with the intent to predict mechanical wear and failure [11]. Vibrations, noise, and temperature measurements are often used as key indicators of the state of the machine. Trends in the data provide health information about the machine and help detect machine faults earlier, which prevents unexpected failure and costly repair**.** Machine's vibration is very essential in diagnosing and detecting any fault or deviation from the normal condition [8]. Proper machine condition monitoring can result in prolonged life of machine and lower maintenance costs.

EXISTING SYSTEM

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 [13]. 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. [7]

PROPOSED SYSTEM

The general structure of the developed wireless sensor system is presented in below. It consists of one wireless data collection module (ZigBee coordinator device), end-devices (measuring devices), database server which is accessed via local server and a module for system control and data visualization. The coordinator device reads data measured from remote end-devices and retransmits them to the database server. The wireless connection between end-devices and the coordinator device is facilitated through their ZigBee modules. The database server and the coordinator device can be connected in through a personal computer.

In this machine care system various parameters of the machine that includes current supply, temperature developed, vibrations produced, lubricant oil measurement are obtained with the help of various sensors. The data from these sensors are collected and transmitted to the database to monitor and control the system through a wireless sensor network over the ZigBee communication [2][4]. This system is effective as it employs the ZigBee platform that consumes low amount of

energy and the machines are monitored in a continuous manner thereby avoiding the data loss.

The software used for formatting the program is MPLAB IDE. MPLAB IDE runs as a 32-bit application on MS Windows, is easy to use and includes a host of free software components for fast application development and super-charged debugging. Types of Sensors employed are,

- Temperature sensor
- Current sensor
- Liquid sensor
- MEMS sensor

BLOCK DIAGRAM

The block diagram of the machine care monitoring system consist of two units. They are

- 1. Measurement and display unit.
- 2. Monitoring Unit.

Measurement and Display Unit

The sensors are connected to their suitable power supply. The temperature developed within the machine system is measured by placing LM35 analog temperature sensor.

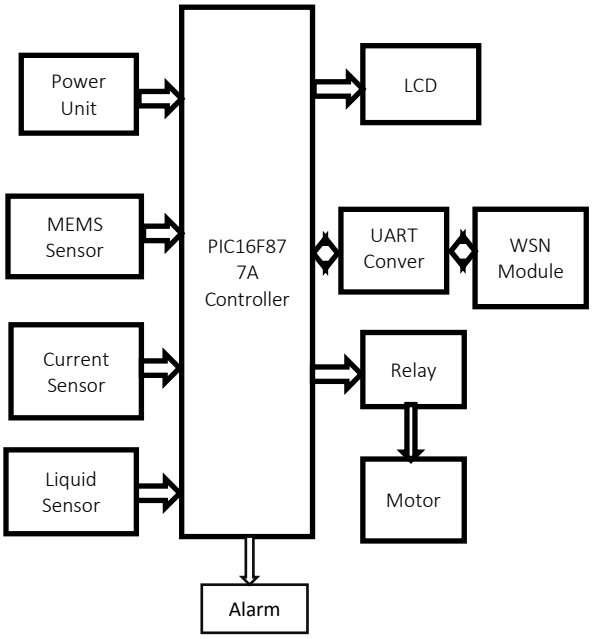

Figure: 1 Block Diagram of Motor Unit

The sensors are connected to their suitable power supply. The temperature developed within the machine system is measured by placing LM35 analog temperature sensor. The vibrations produced are measured by MEMS – MMA7361 [14].It is an accelerometer used to measure the speed. The current passing through the system is measured by CT1270 current sensor. The lubricant oil level is measured by liquid sensor.

There consist of relay unit to regulate proper current flow. All These data from the sensors are calculated and are displayed on LED unit. Each sensor is provided with a threshold value. When the sensor analyze values more than the threshold then it will alarm the system through the buzzer.

PIC microcontroller known as Peripheral Interface Controller is used to integrate and control the components of the system. PIC 16F877A is used in the machine care system [3].

Working of Monitoring Unit

The monitoring unit is shown in Fig: .The data from the LED display is transmitted to the transceiver over WSN that act as a transmitting antenna through a UART cable.

ZigBee communication is employed which provide low energy consumption [2] with wide area usage when compared over other networks like Wi-Fi which have a short range of coverage. From transmitting antenna it is then transmitted to the receiving antenna that is connected to the database of the computer system.

Visual Basic software along with MPLAB IDE is used to visualize the parameters of the machine system by graphically representing the data. The machine unit is monitored by continuous display and recording of data in the computer database [6]. When there is any damage or failure within the system it can be monitored in the display unit and the motor can be controlled (switched ON/OFF) from the database system itself.

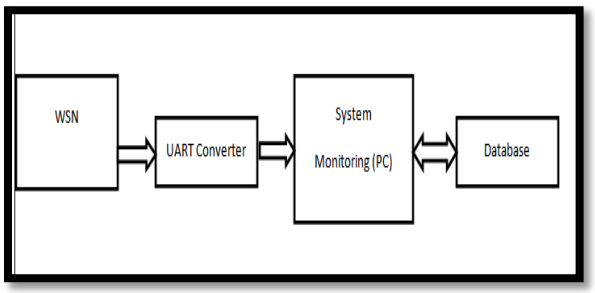

Figure: 2 Monitoring Unit

RESULT

The output results of the machine care monitoring model can be visualized in Visual Basic VB. Visual Basic, also referred to as "VB," is designed to make software development easy and efficient, while still being powerful enough to create advanced programs.

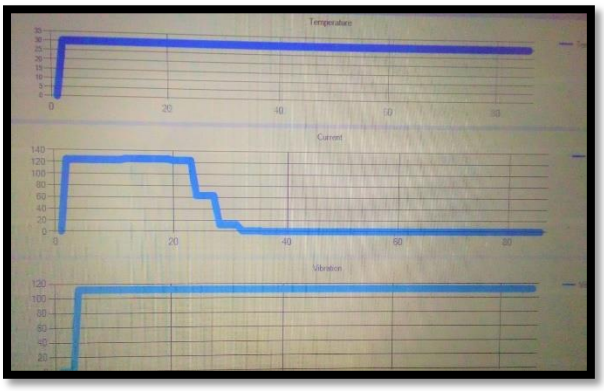

Figure 3: Graphical representation of data collected from sensors

The constant graphical representation shows the machine's running condition without any deviation while the abrupt changes in the graph indicates that the machine is undergoing some faults which has to be rectified immediately. The running machine can be stopped from the system without any interface to the machine which reduces the risk of damage to machine. The readings of the parameters like temperature current and vibration are simultaneously indicated.

CONCLUSIONS

In this paper, we presented an integrated WSN hardware software platform for machine and structural monitoring. The custom module was based on a wireless IEEE 802.15.4- compatible microcontroller, with MEMS sensors for capturing vibration and audio data, and a humidity/temperature sensor for environmental conditions.

Although the experiments performed in both motor test rigs showed a reliable data collection, the long download times make it interesting to explore the feasibility of using compression algorithms or basic fault detection mechanisms on the node itself, to avoid sending a large amount of data that contributes to battery depletion.

FUTURE SCOPE

In future a model can be developed on Knowledge Based Systems Model for Machine Health Monitoring has many modules based on various maintenance aspects like Preventive Maintenance, Condition Based Maintenance, etc., with each module having sub-modules containing information about detailed aspects of machine maintenance.

The decisions are based on the standard inputs from vibration standards. The field vibration data like displacement, velocity, acceleration are acquired from suitable vibration sensors placed at strategic locations on the machines. The data is fed to the system by the maintenance personnel and the machine health is assessed almost instantaneously. There is enough scope for further enhancement of the system. The present system is developed for off-line conditions, in which machine vibration data is fed to knowledge system by the user manually. On-line knowledge based system could be developed so that machines are monitored on continuous basis and remedial maintenance actions are initiated so that performance is enhanced, downtime decreased and overall performance is enhanced.

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