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Monitoring and Faults Diagnosis in Wind Turbine by Using Zigbee Wireless Network

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Abstract: *The Wind Turbine blast is identified as a major problem against green energy. It is not only the threatening factor for the people but also causes dangerous hazard for human life. To overcome this problem and to increase the green energy, a simple system is introduced to monitor and prevent the fault occurrence in Small Wind Turbine. It collects all the parameters like temperature, vibration and oil level from main components of the turbine and sends it to the control room via wireless Zigbee. At Control room through LCD it is possible to view the current status of the Wind Turbine. In Case of fault occurrence indication automatically command will send to wind turbine section to overcome the fault than the fault occurrences can be prevented.*

Keywords: *wind turbine, monitoring and fault diagnosis, Temparature, Vibration, Oil, LCD Display.*

1. Introduction

The wind power industry has experienced large growth in the past years. The growth mainly focuses on a growing market, wind power's better economic conditions (because of political decisions), and the development of large wind turbines and offshore farms. One of the goals is to increase reliability for turbines. The issue is even more important for offshore farms, where service is difficult and expensive. The industry has incentive to make maintenance more efficient. In whatever way, Wind turbines are fault prone, that is they are given in harsh environment such as desert, plains apart from that they are difficult electromechanical system that are situated far away from the control centre. So the chance of fault happens and the side cause will be more, even it leads to power off. It is important to develop the remote controlling and defect diagnosis system to monitor the run time status and the identification of fault to improve the effort and the life time service of the wind turbine.

Wind turbine monitoring systems could be the answer for better wind power industry maintenance management and increased reliability. Such systems are commonly used in other industries. This System continuously monitors the performance of wind turbine parts, e.g., temperature, weather, and transformer, and helps determine the optimal time for specific maintenance. This paper investigates these systems' support for the wind power user. The Health Monitoring of wind turbines, with the aim of diagnosing degradation in different structural parts in wind turbines, has seen its relevance boosted in the operation and maintenance plans for wind turbine industry. As a consequence many researchers are studying the relationship between structural deterioration and the change in different structural dynamics properties associated to some resonances.

In this context, wind turbine manufacturers are clearly increasing efforts in wind farm maintenance in order to achieve more robust and reliable wind turbines under any condition and under any operating regime. Needless to say, this requisite is even more demanding in offshore sites where the maintenance operations are challenging practices involving, in many cases, logistics or access difficulties. A defect is detected, the less impact it has in the wind turbine OPEX (operation expenditure) rate. Therefore, any tool devoted to the task of predicting a relevant structural change at early stage contributes to improve the market competitiveness for a particular wind turbine. Science of early detection of warranty and reliability issues - a topic that is

This paper provides an open-source literature survey on the emerging science of early detection of warranty and reliability issues - a topic that is becoming critical to product life management for the automotive, aerospace and energy industries. An open-source literature survey from a variety of disciplines like reliability engineering, operations research, prognostic-health management, systems engineering, biostatistics, public health and epidemiology.

These are areas that have seen significant recent research activity in the development of early warning systems and algorithms. This paper provides an overview of current and promising techniques with a focus on their underlying statistical theory and related system architecture issues. The concept of the project is to develop a system used to diagnose the fault and monitor the parameters in wind turbine. The project is a special one considering fact that we can monitor parameters and diagnose the fault in a wind turbine from the control station, this project is based on a Zigbee protocol (i.e. message based protocol). Zigbee connects the wind turbine with the control station using wires. This system requires minimal power and provides reliable delivery of data between wind turbine and control station.

2. Introduction to Zigbee

ZigBee is a wireless communication used in Wind Turbine to send data to control room and to receive data from control room. It is based on a typical network architecture using an OSI model over an IEEE 802.15.4-2006. The ZigBee signals function like network signals and strictly similar to Bluetooth and Wi-Fi. ZigBee devices are meant for low power consumption these Devices put themselves to sleep when not in use, thereby conserving power. Hence this makes these devices ideal for battery-operated applications because they can last for a number of years before wanting fresh batteries. ZigBee is top in lucrative applications it scheme lends itself to detecting and monitoring applications and its practice in large scale wireless monitoring [4]. Hence it will be very much suitable for Wind turbine communication.

3. Related Works

The maintenance of offshore Wind Turbine and its failure rate is very high by using the wireless sensor networks for environment monitoring and key components cluster based distribution of wireless sensor network topology the failure rate scan be reduced. The necessity of monitoring and making automation of Wind Turbine with fault diagnosis system and the CAN Bus which is used as Interface module to communicate the monitored parameters between the Wind Turbine and the control centre with the help of RS-232 Serial Communication. Here GPRS is used to transfer the data from wind turbine section to control room. The importance renewable energy and its monitoring technologies of wind turbines facilitate the prevention of accidental and component or structure failure. The acquisition of data under different conditions can be time and cost consuming. Low-cost, low power wireless sensors have materialized as a window for these applications. Economical and flexible wireless sensors networks can be installed within a large structure to evaluate the response and performing monitoring algorithms. In this paper, wireless sensors are deployed into a wind turbine farm to monitor the structures to present models of wind turbine behavior and response to loading and controlling the generator parameters by getting even to rewrite the control algorithm from the system. Methodology to manage the mechanical vibration and temperature from Small Wind Turbine (SWT) with a protection tool developed for preventive maintenance and to avoid catastrophic failure. The triple axis accelerometer.

4. Proposed System

The core objectives of this proposed management of small wind turbine system are to detect the present health condition of the machine, to prevent catastrophic failures caused by the various components of the wind farm, to improve the power quality before the problem is corrected, to predict the severity level of fault, and to estimate the useful life of the machine. The use of this type of health monitoring system helps to reduce the failure frequency and amount of downtime, maximize the utilization of the wind turbine, and minimize the maintenance overhead and cost due to production lost. Moreover, under the wireless sensor network system, there is no need to install wiring for data collecting and monitoring, thus eliminating the cost of installation and maintenance that would be required by communication cables. The overall performance and reliability of the wind form is improved dramatically.

4.1. Wind Turbine Section

At Wind Turbine Section the System is developed to prevent Wind Turbine blasting hazards. The block diagram Fig explains the hardware components which are placed in the Wind Turbine. In this system the sensor sense the parameters values and send the data to the ARM Controller. The ARM is based on RISC architecture it simple design enables more efficient multi-core CPUs and higher core counts at lower cost, providing higher processing power and improved energy efficiency for servers and it reduces costs, heat and power usage this makes data acquisition and processing from the sensor and send it to the Control room via wireless ZigBee. The temperature sensor senses the temperature and send the data to control room at control room through LCD it is possible to view the current status of the Wind Turbine.

The speed sensor senses the rotational speed from the Generator shaft; the level sensor senses the lubricant oil level from the Wind Turbine components and vibration sensor sense the occurrence of higher vibration in any part of the Wind Turbine components. All this parameter data are send to the control room Section via wireless ZigBee. The display unit is placed is in the Wind Turbine section to show the parameters details which acts as the reference for operator in case of checking the working condition, are for any other revamping parts in the Turbine.

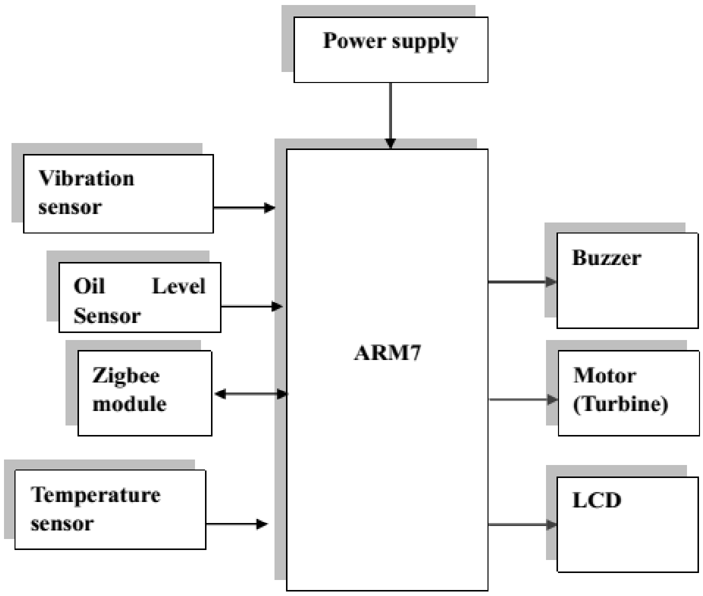

Fig1. *Block diagram of proposed system*

4.1.1. ARM Microcontroller

Microcontroller is a heart of this project. ARM 7 is suitable microcontroller for this proposed embedded system. LPC2148 is ARM 7 controller used in this project. The main feature of LPC2148are as follows,

- 16-bit/32-bit ARM7TDMI microcontroller.
- 8 kB to 40 kB of on-chip static RAM and 32 kB to 512 kB of on-chip flash memory.
- Two 10-bit ADCs provide a total of 14 analog inputs, with conversion times as low as 2.44 ms per channel.
- CPU operating voltage range of 3.0 V to 3.6 V (3.3 V ± 10 %) with 5 V tolerant I/O.

4.1.2. Power Supply

A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU. The term is most commonly applied to electrical energy supplies, less often to mechanical ones and rarely to others.

4.1.3. Temperature Sensor

LM35 converts temperature value into electrical signals. LM35 series sensors are precision integrated-circuit temperature sensors whose output voltage is linearly proportional to the Celsius temperature. The LM35 requires no external calibration since it is internally calibrated. . The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range.

The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air.

Features

- Calibrated directly in ° Celsius (Centigrade)
- Linear + 10.0 mV/°C scale factor
- 0.5°C accuracy guaranteed (at +25°C)

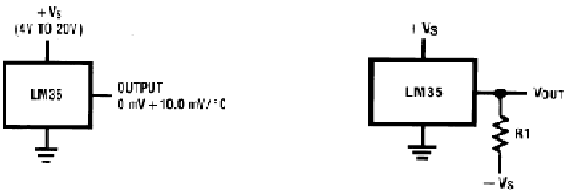

Fig2.*The characteristic of this LM35 sensor is: For each degree of centigrade temperature it outputs 10milli volts.*

4.1.4. Vibration Sensor

Vibration sensors allow you to detect orientation or inclination. They are small, inexpensive, low-power and easy-to-use. If used properly, they will not wear out. Their simplicity makes them popular for toys, gadgets and appliances. Sometimes they are referred to as "mercury switches", "tilt switches" or "rolling ball sensors" for obvious reasons.

They are usually made by a cavity of some sort (cylindrical is popular, although not always) and a conductive free mass inside, such as a blob of mercury or rolling ball. One end of the cavity has two conductive elements (poles). When the sensor is oriented so that that end is downwards, the mass rolls onto the poles and shorts them, acting as a switch throw.

Tilt switches used to be made exclusively of mercury, but are rarer now since they are recognized as being extremely toxic. The benefits of mercury is that the blob is dense enough that it doesn't bounce and so the switch isn't susceptible to vibrations. On the other hand, ball-type sensors are easy to make, wont shatter, and pose no risk of pollution.

Fig3. *Vibration sensor*

4.1.5. Oil Level Sensor

A tank unit (sheet metal / aluminum die cast type) is a instrument to indicate level of Fuel in tank. It is used in all kind of vehicles / stationary engines which have tank of any kind.

It normally consists of:

- Float (NBR type/PU type) with level arm
- Potentiometer

4.1.6. Liquid Crystal Display

LCD stands for **L**iquid **C**rystal **D**isplay. LCD is finding wide spread use replacing LEDs (seven segment LEDs or other multi segment LEDs) because of the following reasons:

- The declining prices of LCDs.
- The ability to display numbers, characters and graphics. This is in contrast to LEDs, which are limited to numbers and a few characters.
- Incorporation of a refreshing controller into the LCD, thereby relieving the CPU of the task of refreshing the LCD. In contrast, the LED must be refreshed by the CPU to keep displaying the data.

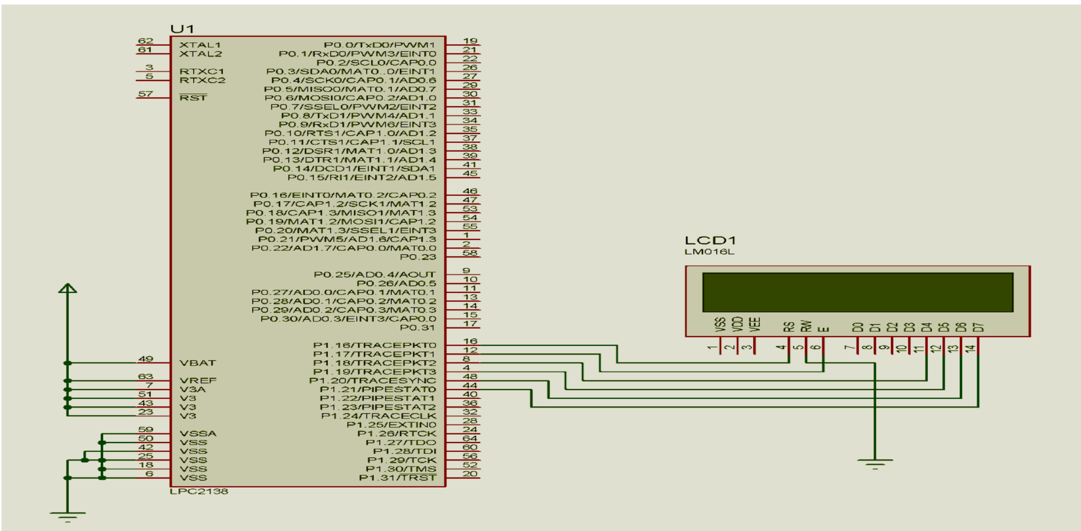

Fig4. *LPC2148 controller interfacing with LCD diagram*

4.1.7. Buzzer

Piezo buzzer is an electronic device commonly used to produce sound. Light weight, simple construction and low price make it usable in various applications like car/truck reversing indicator, computers, call bells etc. Piezo buzzer is based on the inverse principle of piezo electricity discovered in 1880 by Jacques and Pierre Curie. It is the phenomena of generating electricity when mechanical pressure is applied to certain materials and the vice versa is also true. Such materials are called piezo electric materials

4.1.8. DC-Motor

Electric motors are used to efficiently used to convert electrical in to mechanical energy. magnetism is the basis of their principles operation. They use permanent magnets, electromagnets, and exploit the magnetic properties of materials in order to create these amazing machines. DC Motor has two leads. It has bidirectional motion If we apply +ve to one lead and ground to another motor will rotate in one direction, if we reverse the connection the motor will rotate in opposite direction. If we keep both leads open or both leads ground it will not rotate (but some inertia will be there). If we apply +ve voltage to both leads then braking will occurs.

4.2. Control Room Section

At control room section via LCD it is possible to view the current status of the Wind Turbine. The receiver ZigBee receives the data from the Wind Turbine and it is connected to PC using Serial Communication RS232.Whenever the fault occurs in the Wind Turbine according to the type of fault the comment will be sent from the PC to Wind Turbine to overcome the fault and to prevent blasting hazard.

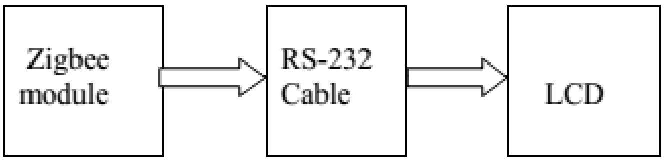

Fig5. *Control room section*

In case of any fault occurrence like Temperature hike it is identified easily and immediately a comment will be sent from the control room to Wind turbine and the cooler will be switched on to reduce the temperature. Else if there is higher vibration immediately Turbine will be shut down and manual operation will be conducted to recover that fault. If the rotational speed is higher due to storm than immediately turbine speed will be reduced by applying electric breaks and system will be shut down to save the wind turbine blades from damages. For the case of lesser lubrication the auto lubrication process is implemented here. In this the DC motor will be switched on automatically which pumps the oil and fills the lubricant in appropriate parts of the Wind turbine.

5. Result and Conclusion

The fault identification is done and the parameters are measured through the CAN interface module the monitored data is analyzed and send to LCD through RS232 cable. The location and the type of faults are analyzed before it occurs and are transmitted from wind turbine to the control centre through zigbee network . The proposed system enables the monitoring and prevention of higher vibration, rise in temperature as well as lesser lubrication of the Wind Turbine using the developed methodology to avoid blasting hazard. Thus the ZigBee Wireless communication enables the remote controlling system of all these parameters from control room through monitoring in LCD.

The effect of harsh condition and the nature of large electromechanical system are the causes of fault to be occurred in the wind turbine. It is very important perform the monitoring and fault diagnosis of wind turbine parameters.

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