Implementation of Arduino Based Condition Monitoring of Wind Turbine

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Abstract

Wind energy is a clean and the cheapest renewable energy source in the world. The wind turbines are very expensive components in wind farms. The maintenance of wind turbine components takes more money and time. The efficiency of power production depends upon the reliability of the wind turbine. For these reasons, a reliable condition monitoring system is essential for wind turbine to minimize downtimes and increase productivity. The aim of this paper is to monitor the wind turbine parameters and to improve the early fault detection. Wind turbine monitoring system collects the parameters such as Speed, Temperature, vibration, voltage and current from wind turbine by using respective sensors. The condition monitoring system collects data from sensors and the data are periodically updated in the control room. Arduino Uno board is used for monitoring and control operations. The Arduino Uno board is interfaced with LabVIEW software. If any anomalous condition occurs, the SMS will be sent to the operator by using the GSM Module.

Keywords: Wind turbine, Sensors, Arduino Uno, LabVIEW, GSM.

1. Introduction

The need for electricity production has increased all over the world in recent years. The variable pricing of fuels and global warming has increased the growth of wind power production. In India, the installed capacity of wind power was 25,088 MW in the year 2015. Wind energy is the cheapest renewable energy source. But the wind turbine components are very expensive. The repair and replacement cost of wind turbine components increases the cost of power production. Therefore, the cost of operation and maintenance of wind turbines are need to be minimised. Thus the effective condition monitoring system is able to give signal for early faults. Wind Turbines are placed commonly in remote locations. The external variations severely affect the operational conditions of the wind turbine and it causes mechanical stress into the turbine. The Condition Monitoring system is necessary to decrease
the failure rate of wind turbine components and downtimes. The proposed system provides the information about the physical conditions of the wind power systems. The various parameters like speed, temperature, vibration, current and voltage are measured periodically by using sensors. The sensors are placed on the components of the wind turbine. The measured values are monitored continuously to check if any deviations occur. The alarms are used for indication of fault. The objective of the project is to increase the consistency of wind turbine.

The interfacing to personal computer (PC) is done by using an Arduino Uno board. Arduino Uno is a microcontroller based board which is an open source hardware and development software. A software tool Labview (Laboratory based Virtual Instrumentation) has been used for real time monitoring. The proposed system is implemented in Labview software. The continuous monitoring of wind turbine components improves the early fault detection. The GSM (Global System for Mobile communication) Module is used to intimate the measured values to the operator with an SMS.

1.1 Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega168 or Atmega328. It is easily programmable and low cost microcontroller board. The Arduino uno board is interfaced with Labview.

![Figure 1: Arduino Uno Board](image)

It has 14 digital input/output pins (of which 6 pins can be used as PWM outputs) and 6 analog inputs. It consists of a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.
2. Proposed system

![Block diagram of Proposed System](image)

**Fig 2** Block diagram of Proposed System

2.1 Temperature Sensor

The LM35 temperature sensor is used to measure the wind turbine temperature. It has an output voltage that is proportional to the Celsius temperature. The LM35 temperature sensor does not require any external calibration.

![LM 35 Voltage Sensor](image)

**Fig 3** LM 35 Voltage Sensor

LM 35 is a low cost sensor and suitable for remote applications. The LM35 have low output impedance, linear output, and precise inherent calibration. It is easy to interface the sensor with readout or control circuits. It can be used with single power supplies, or with plus and minus supplies. The LM35 is graded to operate over a −55˚ to +150˚C temperature scope.

2.2 Vibration Sensor

A piezoelectric sensor is used to measure vibrations of the wind turbine components. A piezoelectric sensor is a device that uses the piezoelectric effect. It is used to measure the changes in pressure, acceleration, strain or force by converting them to an electrical charge. Piezoelectric technology is insensitive to electromagnetic fields and radiation. Whenever a structure moves, it experiences acceleration. A piezoelectric sensor can produce a charge when it is physically accelerated. The produced charges are proportional to the applied force. It offers high
frequency response, high transient response and high output.

2.3 Proximity Sensor

Fig. 4. Proximity Sensor

Inductive proximity sensors operate the principle of inductance. When a metal object moves into the field of detection, Eddy circuits are formed in the metallic object. It is magnetically push back and reduce the sensors oscillation field. The detection circuit of the sensor monitors the oscillator’s strength and gives an output from the output circuit when the oscillator becomes reduced to an enough level.

2.4 GSM Module

The GSM Module is used to provide information about the conditions of the wind turbine to the operator. It sends SMS to the operator in case of any abnormal situations. It has been built up with a standard RS232 interface which can be used to conveniently interface the modem to micro controllers and computers. This is a plug and play GSM Modem with a serial interface. We can perform the tasks like sending SMS, make and receive calls, and perform other GSM operations by using simple AT commands from microcontrollers and computers. The parameters can be displayed in the PC placed at the control room.

Table 1. List of AT commands

<table>
<thead>
<tr>
<th>Task</th>
<th>AT command</th>
</tr>
</thead>
<tbody>
<tr>
<td>Send SMS</td>
<td>AT+CMGS</td>
</tr>
<tr>
<td>Read SMS</td>
<td>AT+CMGR</td>
</tr>
<tr>
<td>Write SMS</td>
<td>AT+CMGW</td>
</tr>
<tr>
<td>Delete SMS</td>
<td>AT+CMGD</td>
</tr>
</tbody>
</table>

2.5 LabVIEW Software

LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a graphical programming language from National Instruments. The LabVIEW programs are called Virtual Instruments. Each VI contains two windows such as Front panel and Block Diagram. Front panel includes software controls and indicators such as buttons, sliders, LEDs, and charts. The block diagram contains the graphical source code. Front Panel objects appear as terminals on the block diagram.

The LabVIEW Interface for Arduino (LIFA) gives access to control sensors and get data through an Arduino microcontroller. Arduino microcontroller acts as an I/O engine that interfaces with LabVIEW through a
serial connection. This data from Arduino is easily sent to LabVIEW without adjusting the communication, synchronization. The LabVIEW software is used to develop the custom data acquisition. The program measures the temperature, speed, vibration, voltage and current of wind turbine. The measured values are graphically displayed by using LabVIEW.

![Fig. 5 Block diagram of Temperature sensor](image)

The wind turbine temperature is measured by using LM35 sensor. The output voltage is proportional to Celsius temperature. In Front Panel window, the thermometer icon displays the temperature value. The measured value is compared with set point data. If the measured value exceeds the limit, the indicator goes ON. The warning
message will be sent to the operator.

![Image of a block diagram]

Fig. 7. Block diagram of voltage and current sensor

The wind turbine parameters are continuously measured by using sensors. The values are displayed in graphical form using LabVIEW. The values are stored in database for data analysis.

3. Conclusion

A condition monitoring system is developed to measure the parameters of the wind turbine. The Wireless communication enables the remote controlling system of all these parameters from control room.

References