Early Fault Detection in Wind Power Model Using Wireless Sensor Networks

Kulveer Singh, Raspinderjit Kaur Kahlon

***Abstract*—: this paper represents the investigation of the defects in wind power model .Fault detection is done by using wireless sensor networks (WSN) . The WSN is consisted of two main components i.e. (1) Sensor Nodes and (2) base station. Sensors measures and transceivers gather information about changes in physical environment and pass it to the base station where it is stored.**

***Index Terms*— Wireless Sensor Network (WSN), Analog to Digital convertor (ADC), Fault Detection (FD), Wind Power Model (WPM)**

I. INTRODUCTION

Renewable energy technologies gives clean, abundant energy with little to no negative impacts on environment. Renewable energy is obtained from natural processes which are replenished regularly. It's self renewing resources are sun, wind, water, earth and plants. Renewable energy resources exist over wide geographical areas, in contrast with conventional energy sources which are present in limited number of countries. Development of renewable energy and energy efficiency will result in national security, environmental and economic benefits[1][2]. Increasing population and economic development has accelerated the rate at which energy and particularly electrical energy is demanded. Electricity generated by all methods such as thermal power plant, nuclear power plant etc, have consequences on our environment. Therefore to safeguard our environment we should switch to renewable energy technologies. Photovoltaic, biomass, tidal power plant as well as wind generation are attractive sources of energy because of their good effects on the environment.

The implementation of sustainable energy has rapidly increased over the country with the help of wind mills as Indian government has launched the go green campaign towards neat and clean world. As green house effect and uses of carbon emission based energy will be reduced by using sustainable energy.

Wind turbines produce rotational motion which readily convert the kinetic energy into another forms of energy such as electricity. Generated electricity is transmitted through transmission and distribution lines to the substation and then to homes, industries, business and schools.

Wind turbines are mounted on a tower about 100 feet (30 meters) or more above ground to capture the most energy. They can take benefit of the faster and less turbulent wind. Cut-in Speed for wind turbine is 2.5m/s and Cut-out Speed is 13m/s. Cut-in speed is the speed at which the windmill turbine starts producing the current and Cut-out Speed is the speed at which windmill turbine stops producing the current. Windmills capture the wind's energy with their propeller-type blade. They can be used as stand-alone applications, or they can be used in combination with a photovoltaic system.

For utility-scale, hundreds of wind turbines are usually built together to form wind farm. Several electricity suppliers today use wind plants to supply electricity to their customers. Stand-alone wind turbines are usually used for water pumping or communications. However, in windy areas wind turbines can also be used as a way to cut their electric bills by farmers, homeowners and ranchers.

However, wind power system is free of fuel and is beneficial for our environment but there are some problems being faced while setting up a wind farm.

(1). The initial investment on wind power plant and its high maintenance cost because of height of wind tower , down time cost due to non-availability of skilled technicians on time, are the factors forcing the rural people away from the installation of the wind power plant, even though the wind energy is non depleting resource available in abundance in rural areas.

(2). To solve the problem of the high initial investment the government of India is offering subsidies to rural people , but the high cost of maintenance is the problem still unattended.

(3). Installation and wiring cost is very high.

(4). Manual Fault detection takes longer duration.

However the above problems can be solved with wireless sensor networks (WSN). It will improve the overall performance. Wireless sensors will bring more reliability, more flexibility and more scalability to the design of wind power model[3][4][5].

WSNs are also advantages because they don't need extensive wiring. It reduces the cost of installation as wireless nodes eliminates connecting wires. It also helps in rapid installation of the infrastructure. Wireless sensor network is a technology which is suitable for low-power wireless measurement and control the applications[6].

II. FAULT DETECTION IN WIND TURBINE

In modern times as wind farms are getting aged their functions and maintenance issues are gaining importance. The wind industry has been affected by many failure in the main components of wind turbine, like main bearing, generator and gearbox. Analysis of the wind farm maintenance cost has shown that upto 40% of the cost can be related to unexpected failures of wind turbine components. Gearbox, electrical control, generator, yaw system, grid, hydraulic and blades are considered as most common failure components of the wind

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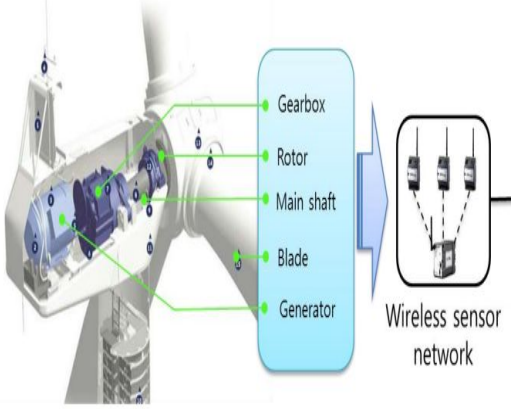
turbine. This requires high cost on emergency maintenance, physical designs, component testing, lots of time wastage and so on. Replacement of the components which have been failed demands high cost which directly affects the energy cost.

Fault :- It is conclusion of the object without completing its tasks[7]. Failure occurring in wind turbine are

- High temperature oil, wearing, fatique, oil leakage, insufficient lubrication, braking in teeth, displacement in the gear box.
- Crack formation, fatique, vibration and foundation weakness in tower.
- Fire and yaw error in nacelle.
- Deterioration, cracking and adjustment error in blades.
- Spalling, wear, defect of bearing shell and rolling in bearings.
- Fatique and crack formation in shaft.
- Wearing, electrical problems, slip rigs, winding damage, rotor asymmetries, bar break, overheating and over speed in generator etc[8].

When any fault occurs in the wind turbine, it is very time consuming and difficult task to find particular problem in particular turbine. But with the help of wireless sensor networks (WSN) as the problem occurs its comes in notice.



III. THE ARCHITECTURE OF WSN SYSTEM

Wireless sensor networks (WSN) are dimensional distributed autonomous sensors to monitor physical conditions and to pass their data through the network to main location. It is the novel technology which has drawn the attention of researchers from a few years. It has developed with the advancement of data processing, wireless communication technology, micro-electronic and computing. The main aim of WSN is to perform distributed sensing tasks particularly for applications such as smart space, humidity, air speed, temperature, vibration, sound, pressure, blood pressure and heartbeat of a person and etc. The growing interest for wireless sensor network (WSN) is attributed to new applications enabled by large scale network of small devices[9][10].

Wireless sensor networks (WSN) is made up of large number of sensors which are autonomous small devices with several constraints such as the battery power, communication range, computation capacity and range and of at least one base station. They are also provided with transceivers to collect information from its environment and passes it to the base station , where the gathered information can be stored and is available for the end user[11].

In most cases, the sensors forming these networks are installed randomly and are left unattended and expected to perform their missions properly and efficiently. As a result of this random installation, the WSN has most often varying degrees of node density along the area. The sensors with which the networks are formed are extremely energy-constrained and hence the sensor network is also energy constrained. The communication devices on the sensors are small in size and have limited range and power.

The WSN are consisted of two main components:

1. Sensor Nodes and
2. Base Station (Central Gateway)

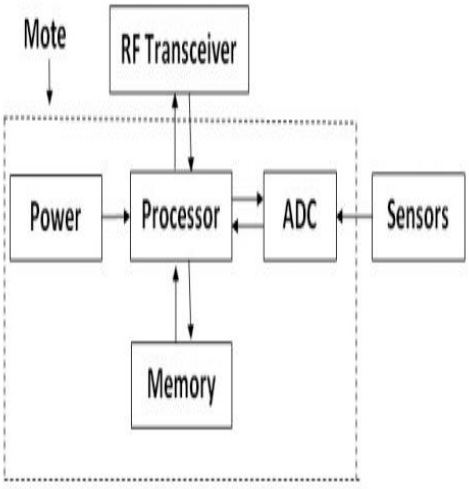


Figure - block diagram of a sensor node

Sensor nodes are mostly built of few sensors and a mote unit as shown in fig. Sensor is a device that senses the information from its surrounding and passes it to mote. Sensors are mostly used to measure the changes in the surrounding physical environmental parameters such as temperature, pressure, humidity etc and changes in health parameters of a person such as blood pressure and heartbeat. Mote is consisted of processor, battery , A/D converter for connecting it to sensor and a radio transceiver for designing an ad hoc network. Mote and sensor together forms a Sensor Node. Sensor network is a wireless ad-hoc network of the sensor nodes. Multi-hop routing algorithm is supported by each sensor node and operates as forwarder for relaying data packets to the base station.[12]

The base station links sensor network to other networks. It is consisted of a processor, antenna, radio board and USB interface board. For the communication with wireless sensor nodes it is preprogrammed with the low-power mesh networking software. Installation of the base station in the wireless sensor network is very important as all the sensor nodes send their data to the base station for the processing and decision making. Coverage of sensor node, energy conservation and reliability issues are taken in care during installation of base station in sensor network. Usually base stations are supposed static in nature but in some scenarios they are supposed to be mobile to collect data from sensor nodes[10][14].

IV. DIFFERENCE

Wind turbine with wireless sensor network (WSN)	Wind turbine without wireless sensor network (WSN)
Its maintenance and operational cost is low. Low installation cost. High efficiency. High mobility. High expansibility. Highly reliable. It's down-time is less. Flexible networking.	Its maintenance and operational cost is high. High installation cost. Low efficiency. Low mobility. Low expansibility. Less reliable. It's down-time is high. It requires complicated wiring .

CONCLUSION

With the depletion of the conventional energy sources, the use of renewable energy technologies whenever possible will be advantageous for both environment and the economy. With this intent, in this paper we demonstrated the use of wireless sensor networks for early fault detection in wind power model. Wireless sensor network system indicates the faulty conditions of the wind farm immediately. It improves the overall performance. It will bring more reliability and flexibility. The use of WSN also eradicates the problem of scalability. Lowered costs will be achieved by reducing wiring and installation by using WSN.

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