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An Efficient Method of Fault Detection and Classification for Wind Power Generator

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Abstract. In recently, wind power generation has become an effective renewable energy technology. But failure of wind turbine has been frequently and more serious, and need more costs of operation and maintenance on account of continuing to achieve large-scale. To solve this problem, it is necessary to research and develop the remote monitoring system. It consists of data acquisition, data analysis and fault diagnosis. For data acquisition, there are various sensors employed to collect the signal from wind turbines. Wireless Sensor Network (WSN) to collect and transmit data on the status of individual parts in real-time and they diagnose faults through a signal analysis system. To extract feature information of the classified fault and normal signals pattern, wavelet analysis and neural network were applied.

Keywords: wavelet transform, neural network, WSN, failure diagnosis, wind turbine monitoring system

1 Introduction

Recently, wind power energy, compared with other renewable energy sources, gets an excellent evaluation in terms of sustainability, efficiency, and stability [1]. However, due to the establishment of large-scale of wind power generation complexes, and the enlargement of height of tower and size of blade for wind turbines, the cost of maintenance was required more than the cost of energy production. To monitor and analyze wind turbines' operational status in real-time, the remote monitoring system was employed [2]. The system was collected and transferred data using WSN Ethernet gateway in order to overcome the environment of positional constraints. We proposed a method of fault diagnosis to the acquisition signal using a signal pattern classification method. And this method based on wavelet transform [3] processing and neural network algorithm [4].

2 Proposed method for fault detection and classification

The system used to monitor wind turbine condition analyzes data collected from vibration sensors installed in turbine' major components, including the generator,

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gearbox, main bearing, shaft, and yaw system. Wind turbines that are offshore, however, the WSN (Wireless Sensor Network) environment is established to address limitations in access to the sea; the vibration signals of the individual parts can be collected, transmitted, and analyzed remotely through the wireless network. Signal data collected in this manner are used to judge whether there is a fault through application of a signal analysis method in the remote monitoring system.

The wavelet transform is used for noise rejection in signal analysis part. Because of constrained environments, the signal analysis of large wind turbines were substituted for input signal. In Fig. 1, signal analysis part is the noise rejection for input signal using the wavelet transform.

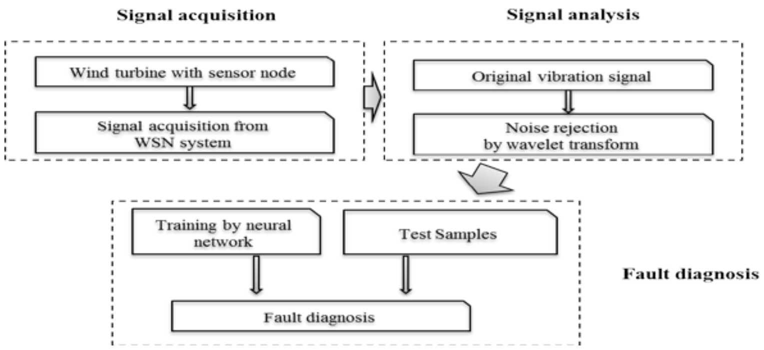

Fig. 1. Noise removal using the wavelet transform.

In this paper, for analyzing the fault signal (such as stator imbalance, bearing fault, rotor fault, et al.), the neural network training was applied on vibration signal processing. The neural network learning was performed with respect to generator vibration, unbalanced rotor and bearing misalignment fault signals. Figure 2 shows the block diagram of the entire system suggested in this article. It have three parts, signal acquisition, signal analysis, and fault diagnosis.

3 Experimental Results of Automatic Fault Diagnosis System

For experimental test, 9 input layers and 3 output layers per failure cause sample applied in order to estimate the damage more precisely. The learning rate is 0.01 and the target error is set as 0.005 and the weights were initialized randomly. The first test sample is unbalanced rotor system, the second one is bearing misalignment fault, and the third one is loose roller bearing, as shown in table 1. For these failure cause samples, the output data of through the neural network were (001), (010) and (100), respectively.

Table 1. Samples of test data of failure cause for neural network input data.

Fault samples	I1	I2	I3	I4	I5	I6	I7	I8	I9	Failure cause
S1	0.0	0.0	0.0	0.01	0.93	0.04	0.05	0.0	0.0	unbalanced rotor system
S2	0.0	0.0	0.0	0.01	0.39	0.5	0.1	0.0	0.0	bearing misalignment fault
S3	0.92	0.01	0.0	0.0	0.03	0.05	0.0	0.11	0.01	loose roller bearing

Table 2. Output data of neural network.

Out layer			Failure cause
-0.0021	-0.0153	1.0194	unbalanced rotor system
0.0033	0.9973	0.0408	bearing misalignment fault
0.9965	0.0037	-0.0596	loose roller bearing

3 Conclusion

To test the efficiency of the proposed algorithm, learning was performed with three fault signals: unbalanced rotor system, bearing misalignment fault and loose roller bearing. The results showed that the BP algorithm was more efficient in terms of recognition ratio and recognition time than the general neural network learning algorithms. The proposed method may be applied to the analysis of mechanical and electrical faults in various industries.

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