

Design and Realization of Automatic Fault Diagnosis System of Wind Turbine based on LabVIEW

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Abstract. The wind power as a clean energy has been researched and developed by many countries. The onshore wind turbine has difficulty to secure additional location by the depletion of good location and the increase in civil complaint. Therefore, it is essential to advance to the sea. However, the mechanical and electrical allowance that components of wind turbine must withstand was increase in a corresponding degree. The possibility of failure was increased, and then the secondary damage by limited access caused additional costs by locating offshore. In order to diagnose fault in advance and ensure the reliability of large wind turbine located in the sea, we apply the VI technology and the software LabVIEW2012 to develop an automatic fault diagnosis and condition monitoring system. We collect measured signal data and extract feature information of the classified fault and normal signals pattern through wavelet analysis. The extracted feature information is used as the input of neural network learning. In this experiment, the stator current of doubly-fed induction generator was used as the input signal. The real-time signal analysis was made through wavelet transform. And then, the information of classified signal pattern is used to design an automatic fault diagnosis system by using neural network algorithm.

Keywords: Wavelet Transform, neural network, automatic failure diagnosis, wind turbine condition monitoring system, LabVIEW

1 Introduction

Global action is also starting to address the issue of global warming. Thus, there was emerged wind power, for existing fossil-fuel energy sources of alternative energy. Over the past 20 years due to advances and matures in technology, wind turbines have become greater, and unit cost of wind power is falling. Therefore, unit costs of wind power are similar to existing fossil fuels, compared with other renewable energy costs. However, a larger turbine inevitably increases the height of the tower and blade length. Also, the components of wind turbine increase mechanical and electrical permit capacity. Consequently, it is inevitable problem that increased failure rate of turbine [1]. In Korea, the existing requirements for wind power have the difficulties on limitation of location and issues such as noise pollution. A power wind turbine needs greater capacity to ensure affordability in the market. Therefore, expansion into sea is necessary, but there are some problems for the operation of large wind turbines

at sea. First, mechanical and electrical failures are increased for larger wind turbine. Second, due to the constrained access environment by locating sea, the additional costs occur in secondary damage. Therefore, monitoring technology of wind turbine is essential for usability and reliability [2]. In this paper, failure of the wind turbine is determined through signal analysis based on wavelet transformation. In addition, real-time signal was analyzed by wavelet transformation. Feature information of classified signal pattern through signal analysis had been learned by using neural network algorithm to design the automatic fault diagnosis system.

2 Condition Monitoring Techniques of Wind Turbine

2.1 Wavelet Transform for Fault Signal Analysis

The wavelet transform can understand that input signals are separated into the set of the basis function. The set of basis function used to wavelet transform can be obtained through expansion, reduction and parallel transference of time axis about basis function of wavelet. Basis function of wavelet indicates band-pass filter of special form. And the relative bandwidth invariability of wavelet transform is satisfied by expansion and reduction of temporal axis about wavelet basis function. Thus, the scale is called instead of frequency band in wavelet transform. Unlike Fourier transform, wavelet transform includes high resolving ability about scale of signal.

Integration for entire signal of Fourier transform causes high-frequency component by diversion in the finite space, it's difficult to handle flexibly non-stationary function because the analysis about variation of frequency has limit. To overcome these demerits, various analytical methods were devised and wavelet transform among the rest is efficiently used [3]. After studying orthogonal basis functions, discrete wavelet transformation (DWT) is developed. DWT indicates two-space of separated frequencies for the signal analysis as below

$$x(t) = \sum_{n=-\infty}^{\infty} a_n(t) \phi_n(t) + \sum_{j=0}^{\infty} \sum_{n=-\infty}^{\infty} d_{j,n}(t) \psi_{j,n}(t) \quad (1)$$

where $a_n(t)$ is approximation component of the signal, and $\phi_n(t)$ represents low-pass filter (LPF). $d_{j,n}(t)$ is detail component, and $\psi_{j,n}(t)$ conducts high-pass filter(HPF)[4].

2.2 Neural Network Learning Algorithm of Back Propagation

The back propagation(BP) algorithm which also called error back propagation algorithm is used to be applied multiple neural network. BP is universal neural network algorithm used to various fields.

Fig. 1 shows a three-tier structure of BP neural network. The renewal of the connection strength is most important in the learning algorithm. The BP algorithm consists of the forward step and the backward step. As with other neural network

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learning algorithm, the learning is made by renewal of the connection strength. The input layer enters classified signal pattern through signal analysis into neural network. And it is multiplied with connection weights connected to the hidden layer. The multiplied values are passed to hidden layer. Through repetition of this process, the output of output layer is obtained. And error is calculated through the subtraction of the output and the target figure [5].

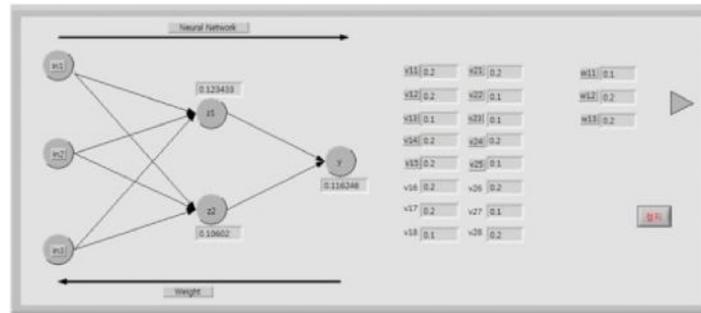


Fig. 1. Neural network processing.

3 Experimental Results of Automatic Fault Diagnosis System

In this paper, to implement automatic fault diagnosis of offshore wind turbine, we conducted an experiment to improve the reliability by suggesting neural network algorithm and wavelet transform based on CMS for signal analysis.

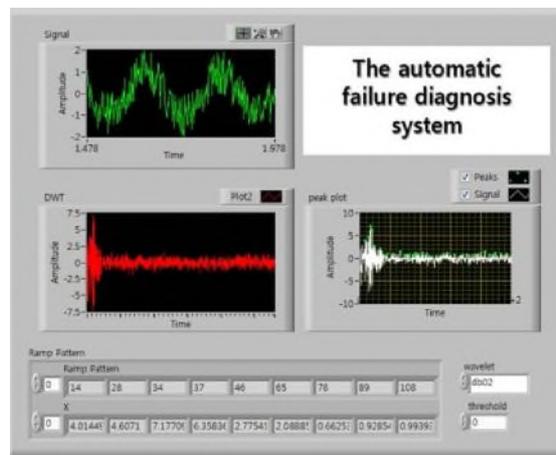


Fig. 2. Failure signal diagnosis based on LabView.

Fig. 2 shows the overall system of automatic failure diagnosis through learning using feature information of classified signal pattern. In this paper, we extracted peak

value of classified signal using peak detection function based on LabView for extraction of feature information. And, extracted feature information is used as input to the learning of neural network algorithm to implement automatic failure diagnosis system of offshore wind turbine. In this study, we early diagnose a complex fault signal that occurs over a long time rather than a simple failure. and there are aims to reduce secondary damage. Also, we look forward to applying to a variety of monitoring environments.

4 Conclusions

In this paper, wavelet transformation for signal analysis and neural networks is used to diagnose the faults of the wind turbine. Studying the neural network and automated failure-diagnosis can be done through the studied neural network that uses a wavelet transform. The experimental results of the neural network learning through the wavelet analysis are higher than the neural network, which using a Fourier transformer. This means that analysis ability is superior in signal analysis.

This system will be developed to work in real-time and will become a more reliable system. The final purpose of this system can be applied to many areas of the industry, and can accomplish important work in the faults diagnosis of wind turbine.

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