Online Non-Intrusive Wind Turbine Fault Diagnosis

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Abstract

Online fault diagnosis is an effective means to reduce wind turbine operating and maintenance costs and improve wind turbine reliability and performance. Most existing technologies for wind turbine fault diagnosis require additional expensive sensors and data acquisition equipment to implement. Most of these sensors are mounted on the surface or are buried in the body of wind turbine components, which are difficult to access during wind turbine operation. The use of additional sensors and equipment also increases the capital costs and complexity of wind turbine systems. Moreover, the sensors and equipment are inevitably subject to failure, which could cause additional problems with system reliability as well as additional operating and maintenance costs. Therefore, it is desirable to develop a nonintrusive, lower-cost, more effective, more reliable technology to fully exploit the benefits of online fault diagnosis for wind turbines. The aim of this project is to develop a new technology for online nonintrusive wind turbine fault diagnosis. The proposed technology is based on advanced signal processing and statistical process control techniques. It only uses generator electrical measurements and does not require any additional sensors and data acquisition equipment. It is able to detect some major types of faults in wind turbines and can be easily integrated into existing wind turbine control, protection, and monitoring systems. The proposed technology will offer a means to achieve condition-based, effective, smart maintenance for wind turbines. It represents a significant technology advance to help achieve 20% wind energy scenario and will benefit various sectors of society.

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Wind energy is capable of becoming a major contributor to the nation's electricity supply over the next decades. Wind energy to electric power conversion is carried out by a wind turbine system. Many wind turbines are situated on high towers, installed in remote rural areas, and distributed over large geographic regions. Consequently, inspection and maintenance for wind turbines requires significant cost. To make wind energy competitive with traditional forms of energy resources for electricity generation, it is necessary to minimize the maintenance costs and improve the reliability of wind turbines. The most efficient way to achieve this objective would be to perform maintenance based on actual conditions of wind turbines instead of regular inspection and predetermined schedules which are the current practice in the wind power industry.

This project aims at developing a new technology for online wind turbine fault diagnosis. The proposed technology is based on advanced signal processing and statistical process control techniques. It does not require any additional sensors and data acquisition equipment and can be easily integrated into existing wind turbine control, protection, and monitoring systems. Using the proposed technology, the actual conditions of wind turbines can be evaluated online. Therefore, the proposed technology offers a means to achieve condition-based, effective, smart maintenance for wind turbines. This will reduce the operational costs and improves the reliability and capacity factor of wind turbines and make wind energy a reliable, cost-effective source for clean electricity generation. The proposed technology represents a significant technology advance to help achieve 20% wind energy scenario and will benefit various sectors of society and the national economies.