SCADA Data Based Wind Turbine Fault Diagnosis

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Abstract

The reliability requirements of wind turbine (WT) components have increased significantly in recent years in the search for a lower impact on the cost of energy. In addition, the future of the wind energy industry passes through the use of larger and more flexible wind turbines in remote locations, which are increasingly offshore to benefit stronger and more uniform wind conditions. The future of the wind energy industry passes through the use of larger and more flexible wind turbines in remote locations, which are increasingly offshore to benefit stronger and more uniform wind conditions. The cost of operation and maintenance of offshore wind turbines is approximately 15–35% of the total cost. Of this, 80% goes towards unplanned maintenance issues due to different faults in the wind turbine components, therefore, condition monitoring is crucial for maximum availability.

In this work, without using specific tailored devices for condition monitoring but only increasing the sampling frequency in the already available sensors of the SCADA system, a data-driven multi-fault diagnosis strategy is contributed. An advanced WT benchmark is used. That is a 5 MW modern WT simulated with the FAST (Fatigue, Aerodynamics, Structure and Turbulence) software and subject to various actuators and sensors faults of different type. The measurement noise at each sensor is modeled as a Gaussian white noise.

First, the SCADA measurements are pre-processed and feature transformation based on multiway principal component analysis (MPCA) is realized. Then, 10-fold cross validation support vector machines (SVM) based classification is applied. In this work, SVMs were used as a first choice for fault detection as they have proven their robustness for some particular faults but never accomplished, to the authors' knowledge, at the same time the detection and classification of all the proposed faults taken into account in this work. To this end, the choice of the features as well as the selection of data are of primary importance.

Simulation results show that all studied faults are detected and classified with an overall accuracy of 98%. Finally, it is noteworthy that the prediction speed allows this strategy to be deployed for real-time condition monitoring in WTs.

Key words

Machine learning, support vector machines, fault diagnosis, health monitoring, wind turbine.

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