Wind turbine condition monitoring based on SCADA data using normal behavior models - DTU Orbit (05/11/2019)

This paper is part two of a two part series. The originality of part one was the proposal of a novelty approach for wind turbine supervisory control and data acquisition (SCADA) data mining for condition monitoring purposes. The novelty concerned the usage of adaptive neuro-fuzzy interference system (ANFIS) models in this context and the application of a proposed procedure to a wide range of different SCADA signals. The applicability of the set up ANFIS models for anomaly detection was proven by the achieved performance of the models. In combination with the fuzzy interference system (FIS) proposed the prediction errors provide information about the condition of the monitored components. Part two presents application examples illustrating the efficiency of the proposed method. The work is based on continuously measured wind turbine SCADA data from 18 modern type pitch regulated wind turbines of the 2 MW class covering a period of 35 months. Several real life faults and issues in this data are analyzed and evaluated by the condition monitoring system (CMS) and the results presented. It is shown that SCADA data contain crucial information for wind turbine operators worth extracting. Using full signal reconstruction (FSRC) adaptive neuro-fuzzy interference system (ANFIS) normal behavior models (NBM) in combination with fuzzy logic (FL) a setup is developed for data mining of this information. A high degree of automation can be achieved. It is shown that FL rules established with a fault at one turbine can be applied to diagnose similar faults at other turbines automatically via the CMS proposed. A further focus in this paper lies in the process of rule optimization and adoption, allowing the expert to implement the gained knowledge in fault analysis. The fault types diagnosed here are: (1) a hydraulic oil leakage; (2) cooling system filter obstructions; (3) converter fan malfunctions; (4) anemometer offsets and (5) turbine controller malfunctions. Moreover, the graphical user interface (GUI) developed to access, analyze and visualize the data and results is presented.