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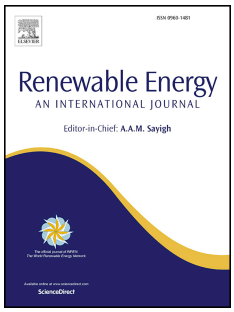

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Robust Fault Estimation For Wind Turbine Energy Via Hybrid Systems

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Abstract- The rapid development of modern wind turbine technology has led to increase demand for improving system reliability and practical concern for robust fault monitoring scheme. This paper presents the investigation of a 5MW Dynamic Wind Turbine Energy System that was designed to sustain condition monitoring and fault diagnosis with the goal of improving the reliability operations of universal practical control systems. A hybrid stochastic technique is proposed based on an augmented observer combined with eigenstructure assignment for the parameterisation and the genetic algorithm (GA) optimisation to address the attenuation of uncertainty mostly generated by disturbances. Scenarios-based are employed to explore sensor and actuator faults that have direct and indirect impacts on modern wind turbine system, based on monitoring components that are prone to malfunction. The analysis is aimed to determine the effect of concerned simulated faults from uncertainty in respect to environmental disturbances mostly challenged in real-world operations. The efficiency of the proposed approach will improve the reliability performance of wind turbine system states and diagnose uncertain faults simultaneously. The simulation outcomes illustrate the robustness of the dynamic turbine systems with a diagnostic performance to advance the practical solutions for improving reliable systems.

Keywords- Fault estimation; wind turbine; eigenstructure; genetic algorithms; optimisation; augmented robust observers

1. INTRODUCTION

The increasing advancement in modern wind power technologies as alternative source of power formation expands the concerns of component maintenance repairing. Faults diagnosis is significant for reliable continuous operations and maintenance of turbines chiefly on the remote access [1]. The unexpected changes in the monitored-system parameters could degrade the performance efficiency or decrease the availability of turbines that could increase the unhealthy system state thereby causing unplanned downtime period [2] or cause intermittent interruption during normal operations. Modern industrial wind turbine (WT) systems are becoming sophisticated and complexity in nature due to increased automation processes and technological advancements. Healthy condition monitoring and fault diagnosis are of great importance to WT operative systems that help to sustain faults prediction maintenance. Furthermore, the idea of fault diagnosis is to detect and determine faults location as well as the extent in the systems. However, the faults estimation or reconstruction extensively provides advanced information about faults that identifies the intensity of the behavior. The turbines faults can occur in various components, like the sensors or actuators parts of monitored parameters subject to normal operations. Early detection of unexpected changes from the standard working operations could save the turbine from unforeseen hazards thus improving the performance [3] and [4] is significant to the system. The obtainable information from condition monitoring can allow preventive maintenance to spontaneously help in the prediction of machine faults occurrence for the satisfactory response.

Therefore, an immense demand exists to improve online condition monitoring to allow prompt fault diagnosis, increase systems reliability and safety operation, reduce unscheduled downtime and maintenance or repair costs as well as to increase the system availability. Robust fault diagnosis has been a critical concern in fault community over the last few decades. However, system uncertainty is practically inevitable and continuously increases the chances of false alarms occurring. Based on this concern, there should be a unique approach, in distinguishing between faults and disturbances ascertain on a robust modelling solution to improve overall systems performance. The need to challenge the system robustness is to design an advanced condition monitoring and fault diagnosis to certainly monitor the behaviour of WT in the presence of disturbances. The practical applicability of fault diagnosis is quite challenging due to the presence of inevitable environmental disturbances and noises that activate the continuous request to attenuate the systems effects. Some key ideas suggest to completely get rid of uncertainty effects like disturbances on the fault indicator i.e., residuals and several methods were also, proposed to challenge this problem [4]. Furthermore, as pointed out in work regarding robust fault diagnosis suggestions was made to partially decouple uncertainty with the goal of reducing operations/maintenance costs and practically to improve the robustness of the observed systems.

It is vital to recognise that uncertainty could degrade the diagnostic performance of an ordinary fault diagnosis. The expense of wind turbine diagnoses and repairs costs can be lessened by emerging robust fault diagnosis systems [5] to improve systems. Observation is crucial in the model-based robust fault diagnosis approach, involving system input and output information to monitor the relationship between the estimated output signal and the real output system, then to analyse the outcomes. Hence, the purpose of the wind turbine robust fault monitoring yields an event of unexpected abnormality changes from the normal state and reduces the