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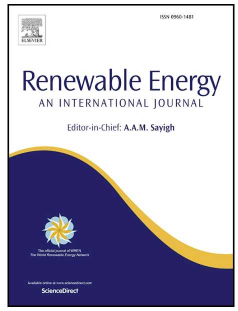

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Mostafa Rahnavard, Moosa Ayati, Mohammad Reza Hairi Yazdi, Mohammad Mousavi

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Finite Time Estimation of Actuator Faults, States, and Aerodynamic Load of a Realistic Wind Turbine

Mostafa Rahnavard, Moosa Ayati*, Mohammad Reza Hairi Yazdi, Mohammad Mousavi

School of Mechanical Engineering, Collage of Engineering, University of Tehran, North Kargar Street, Tehran, Iran

*Corresponding author: m.ayati@ut.ac.ir, Tel.: +982161119920, P.O.B.: 11155-4563

Abstract:

This paper provides finite time estimation of wind turbine actuator faults and unknown aerodynamic load. Furthermore, finite-time state estimation of drivetrain, generator, and pitch subsystems are addressed in the contrary of asymptotic state/fault estimation in previous works. A realistic wind turbine model, incorporating the aero-elastic FAST simulator, is considered as the simulation example. Generally, aerodynamic load is not measurable in real applications due to instrument limitations, then, it is considered as an unknown input in this study. A novel terminal sliding mode observer is introduced for finite-time estimation of generator/convertor states, faults, and unknown aerodynamic load. Pitch actuator hydraulic pressure drop is modelled as an additive fault, by introducing a fault indicator. Then, two cascaded sliding mode observers are exploited for each pitch subsystem, to provide finite time state and fault reconstructions. Sufficient number of design parameters helps to achieve desired accuracy and convergence time. Finally, simulation results authenticate finite time estimation of wind turbine states and simultaneous actuator faults.

Keywords: Fault detection and isolation, Fault reconstruction, Terminal sliding mode observer, Lyapunov stability theorem, Wind turbine.

1- Introduction

Nowadays, wind turbines (WTs) are the most growing renewable energy generators which contribute to the world power production in large scale as shown in Figure 1. Meanwhile, there is a strong demand on enhancing the reliability and efficiency as well as reducing the operation and maintenance costs [1].

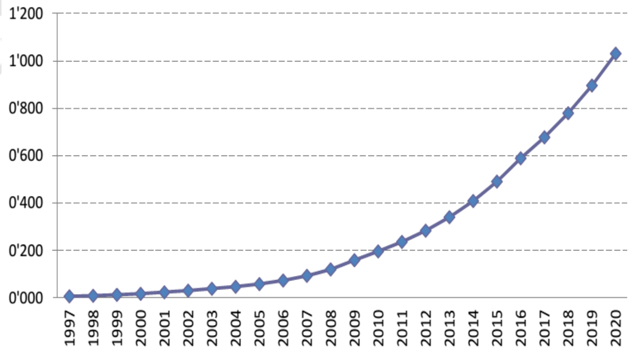

Figure 1: Total installed capacity of wind turbines during 1997-2020 [GW] [1].