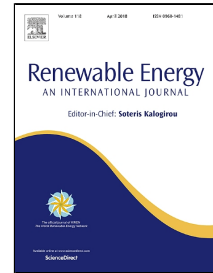


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Model-based fault detection, fault isolation and fault-tolerant control of a blade pitch system in floating wind turbines

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1 **Model-based fault detection, fault isolation and fault-tolerant control of a blade pitch system in**  
2 **floating wind turbines**

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8 **Abstract**

9 This paper presents model-based fault detection, fault isolation, and fault-tolerant control schemes  
10 focused on blade pitch systems in floating wind turbines. Fault detection, isolation, and  
11 accommodation techniques are required to achieve high power capture efficiency and structural  
12 reliability in floating wind turbines. Faults in blade pitch systems should be detected at an early stage  
13 to prevent catastrophic failures. To detect faults of the blade pitch systems, a Kalman filter is designed  
14 to estimate the blade pitch angle of the system. The fault isolation algorithm is based on inference  
15 methods and capable of determining the fault type, location, magnitude and time. The fault-tolerant  
16 controller based on a reconfiguration block with a virtual sensor and shutdown mode controls the  
17 floating wind turbine to avoid unexpected external loads. The proposed methods are demonstrated in  
18 case studies with stochastic wind and wave conditions that considering different types of faults, such  
19 as biases and fixed outputs in pitch sensors and stuck pitch actuators. The simulation results show that  
20 the proposed methods can detect and isolate multiple faults effectively at an early stage. Additionally,  
21 the effectiveness of the fault-tolerant control systems for different load cases for single and multiple  
22 fault conditions is verified by numerical simulations.

23 **Keywords**

24 Floating wind turbine, fault detection and isolation, fault-tolerant control, Kalman filter, Virtual  
25 sensor

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28 **Abbreviations**

|    |      |                                      |
|----|------|--------------------------------------|
| 29 | FDI  | fault detection and isolation        |
| 30 | FTC  | fault-tolerant control               |
| 31 | FWT  | floating wind turbine                |
| 32 | LMI  | linear matrix inequality             |
| 33 | MF#  | number (#) of multiple faults        |
| 34 | NC   | nominal PI control                   |
| 35 | NREL | National Renewable Energy Laboratory |
| 36 | NTM  | normal turbulence model              |
| 37 | NWP  | normal wind profile model            |
| 38 | PAS  | stuck in pitch actuator              |
| 39 | PSB  | bias value in pitch sensor           |
| 40 | PSF  | fixed value in pitch sensor          |
| 41 | TF   | time of fault occurrence             |

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