Sensor comparison study for load alleviating wind turbine pitch control

As the size of wind turbines increases, the load alleviating capabilities of the turbine controller are becoming increasingly important. Load alleviating control schemes have traditionally been based on feedback from load sensors; however, recent developments of measurement technologies have enabled control on the basis of preview measurements of the inflow acquired using, e.g., light detection and ranging. The potential of alleviating load variations that are caused by mean wind speed changes through feed-forward control have been demonstrated through both experiments and simulations in several studies, whereas the potential of preview control for alleviating the load variations caused by azimuth dependent inflow variations is less described. Individual or cyclic pitch is required to alleviate azimuth dependent load variations and is traditionally applied through feedback control of the blade root loads. In many existing studies, the performance of an advanced controller is compared with the performance of a simpler controller. In this study, the effect of three measurement types on the load alleviating performance of the same cyclic pitch control design is studied. By using a baseline cyclic pitch controller as test bench, the effect of the different measurement types on the controller performance can be assessed independent of control design. The three measurement types that are considered in this study are as follows: blade root out-of-plane bending moment, on-blade measurements of angle of attack and relative velocity at a radial position of the blades, and upstream inflow measurements from a spinner mounted light detection and ranging (LiDAR) sensor that enables preview of the incoming flow field. The results show that for stationary inflow conditions, the three different measurement types yield similar load reductions, but for varying inflow conditions, the LiDAR sensor-based controller yields larger load reductions than the two others. The results also show that the performance of the LiDAR sensor-based controller is very sensitive to uncertainties relating to the inflow estimation. Copyright © 2013 John Wiley & Sons, Ltd.
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