Active Aerodynamic Blade Distributed Flap Control Design Procedure for Load Reduction on the UpWind 5MW Wind Turbine

David G. Wilson[*], Brian R. Resor[†], Dale E. Berg[‡]

Sandia National Laboratories, P.O. Box 5800, Albuquerque, NM 87185

Thanasis K. Barlas[§], Gijs A.M. van Kuik[¶]

Delft University of Technology, Delft, The Netherlands

This paper develops a system identification approach and procedure that is employed for distributed control system design for large wind turbine load reduction applications. The primary goal of the study is to identify the process that can be used with multiple sensor inputs of varying types (such as aerodynamic or structural) that can be used to construct state-space models compatible with MIMO modern control techniques (such as LQR, LQG, H_∞, robust control, etc.). As an initial step, this study employs LQR applied to multiple flap actuators on each blade as control inputs and local deflection rates at the flap spanwise locations as measured outputs. Future studies will include a variety of other sensor and actuator locations for both design and analysis with respect to varying wind conditions (such as high turbulence and gust) to help reduce structural loads and fatigue damage. The DU_SWAMP aeroservoelastic simulation environment is employed to capture the complexity of the control design scenario. The NREL 5MW UpWind reference wind turbine provides the large wind turbine dynamic characteristics used for the study. Numerical simulations are used to demonstrate the feasibility of the overall approach. This study shows that the distributed controller design can provide load reductions for turbulent wind profiles that represent operation in above-rated power conditions.