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Active Control of Flow Separation and Structural Vibrations of a Wind Turbine Blade[1] VICTOR MALDONADO, MICHAEL AMITAY, WILLIAM GRESSICK, Rensselaer Polytechnic Institute — The feasibility of using arrays of synthetic jet actuators to control flow separation and blade vibrations of a wind turbine blade (S809 airfoil) model was explored in wind tunnel experiments. Using this technique, the global flow field over the finite span blade was altered such that at high angles of attack flow separation was mitigated. This resulted in a significant decrease in the vibration of the blade. In addition, flow control was implemented at low angles of attack using a spanwise distribution of active Gurney flaps, instrumented with synthetic jet actuators. The moments and forces on the blade were measured using a six component wall-mounted load cell. In addition, PIV technique was used to quantify the flow field over the blade. The structural vibrations were quantified using strain gauges, placed near the blade's root, and accelerometers, located near the blade's tip. Using synthetic jets, the flow over the blade was either fully or partially reattached, depending on the angle of attack, the spanwise location along the blade, and the Reynolds number. This resulted in a significant reduction in blade's vibrations, where the amplitude of the tip deflection was found to be proportionally controllable by either changing the momentum coefficient, the number of synthetic jets used, or their driving waveform.

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