Flutter Control and Aeroacoustics of Wind Turbine Blades

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This project targets the following problems in Wind Turbine (WT) blades: manufacturability, handling, flutter, crack propagation and sound radiation. This is achieved using three integrated approaches. The first approach is by constructing the blade in a modular fashion "interconnected sections", which improves the manufacturability and reduces handling difficulties of the blades. The second approach is by embedding a topologically optimized viscoelastic network within and along the blade sections to maximize the damping at the flutter frequencies. The third approach is by introducing periodic impedance mismatch along the interior of the blade hull to generate stop bands at the flutter frequencies. The research team members have implemented similar techniques on rotating beams subject to dynamic excitation. The second and third approaches will eliminate flutter, reduce dynamic stresses on the blade, and mitigate crack propagation "crack localization". The different approaches are complementary to each other in order to achieve a dynamically and statically stable blade which is efficiently manufactured and handled. The radiated sound from the WT can travel into long distances affecting the surrounding residential areas. The sound radiation and propagation away from the WT shall be investigated in order to assess the noise impact on the neighboring residential areas to the possible locations for WT farms in Egypt. Mitigation actions shall also be suggested.