Structural Dynamics and Acoustic Systems Laboratory
University of Massachusetts Lowell
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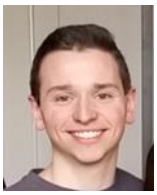
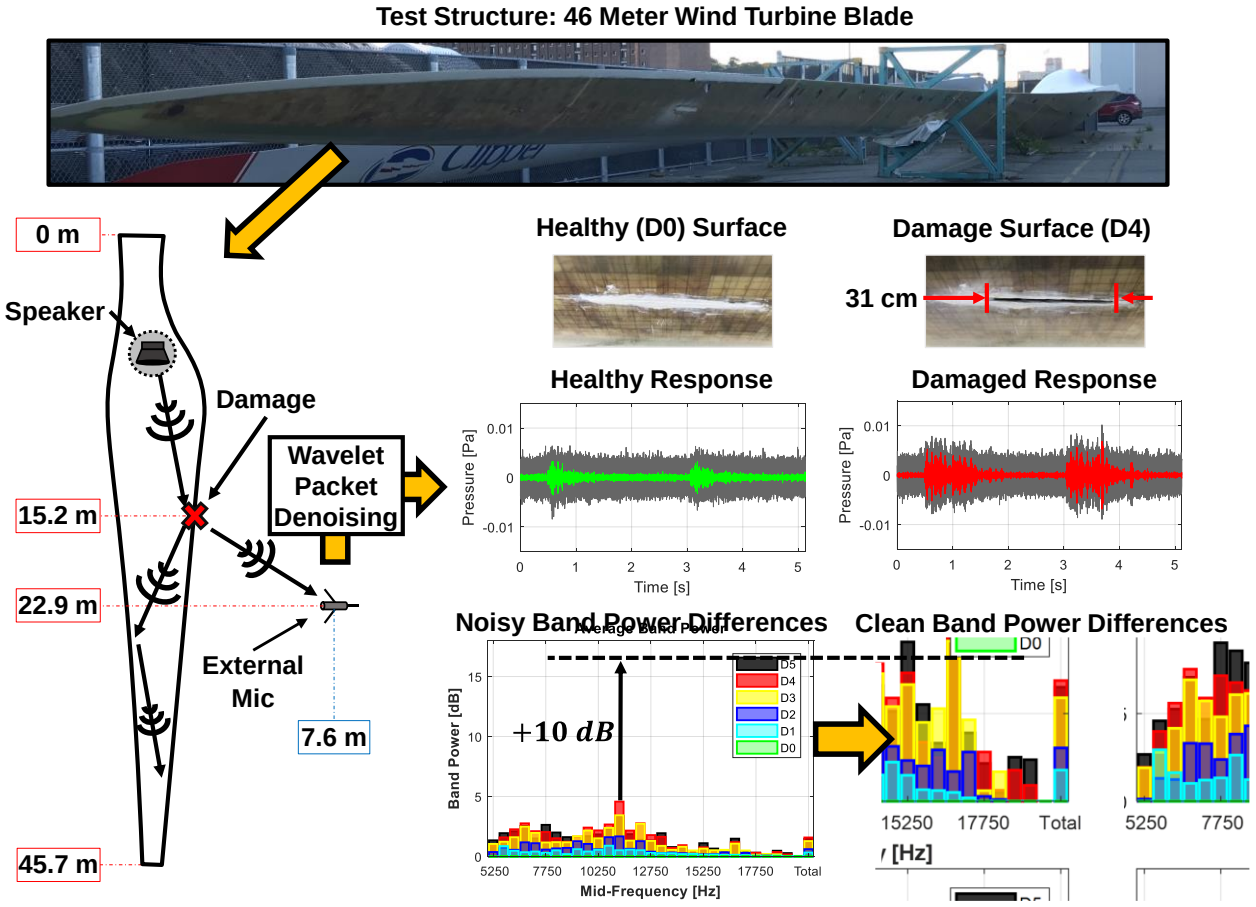
PHD DISSERTATION – CHRIS BEALE



Development of an Acoustics-Based Structural Health Monitoring Technique for the Conditional Assessment of Operational Wind Turbine Blades



The wind industry continues to experience high demand and technological advances yielding wind turbines both larger in quantity and size. Larger wind turbine blades consequently undertake harsher operational fatigue loads and environmental conditions further increasing the probability of failure in a component already prone to failure. Numerous damage detection techniques have been investigated to provide a feasible structural health monitoring (SHM) solution for wind turbine blades and still a viable solution is yet to be established. This research proposes a novel acoustics-based SHM technique that relies on damage-induced changes in acoustic transmissibility across the walls of structural cavities as a potential solution.

The technique has been demonstrated on a 46 meter wind turbine blade to evaluate the damage detection performance. The figure above illustrates the approach in which the 46 meter blade is internally excited by loud speakers. Acoustic energy is transmitted across the boundaries of the structure and measured by external microphones. Advanced wavelet-based denoising algorithms are applied to the data to adaptively remove noise overlapping the transmitted signal in both time and frequency. Spectral estimates are computed from the cleansed responses and subtracted by an established baseline estimate. The overall technique has shown favorable success in the ability to cleanse the measured responses, improve spectral estimates, and detect damage.

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