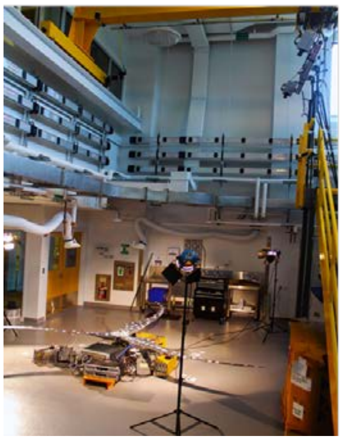
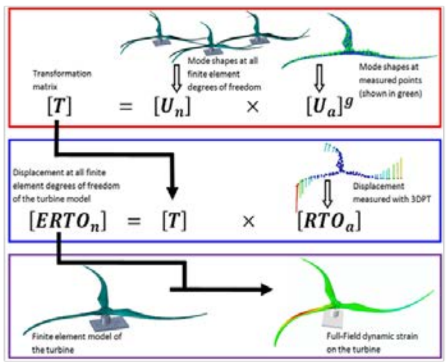
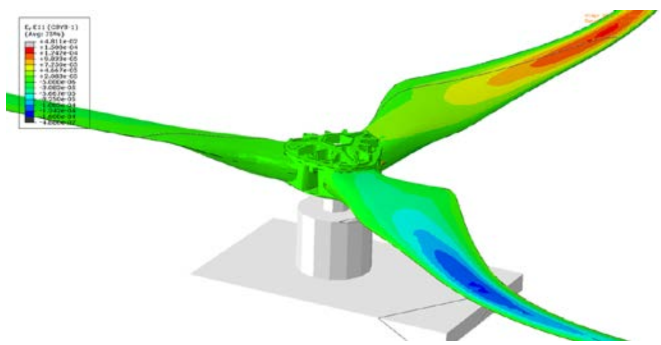
Structural Dynamics and Acoustic Systems Laboratory
University of Massachusetts Lowell
http://sdasl.uml.edu

PHD DISSERTATION – JAVAD BAQERSAD

A Non-Contacting Approach for Full Field Dynamic Strain Monitoring of Rotating Structures Using Photogrammetry, Finite Element, and Modal Expansion Techniques







Within this work, a unique expansion algorithm was extended and combined with finite element (FE) modeling and an optical measurement technique to identify the dynamic strain in rotating structures. The merit of the approach is shown by using the approach to predict the dynamic strain on a small non-rotating and rotating wind turbine. A three-bladed wind turbine having 2.3-meter long blades was placed in a semi-built-in boundary condition using a hub, a machining chuck, and a steel block. A finite element model of the three wind turbine blades assembled to the hub was created and used to extract resonant frequencies and mode shapes. For the non-rotating optical test, the turbine was excited using a sinusoidal excitation, a pluck test, arbitrary impacts on three blades, and random force excitations with a mechanical shaker. The response of the structure to the excitations was measured using three-dimensional point tracking. A pair of high-speed cameras was used to measure the displacement of optical targets on the structure when the blades were vibrating. The measured displacements at discrete locations were expanded and applied to the finite element model of the structure to extract the full-field dynamic strain. The new expansion approach is able to extract dynamic strain all over the entire structure, even inside the structure beyond the line of sight of the measurement system.

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