National Aeronautics and Space Administration

Built-in Structural Diagnostics of Rotors Supported on Active Magnetic Bearings

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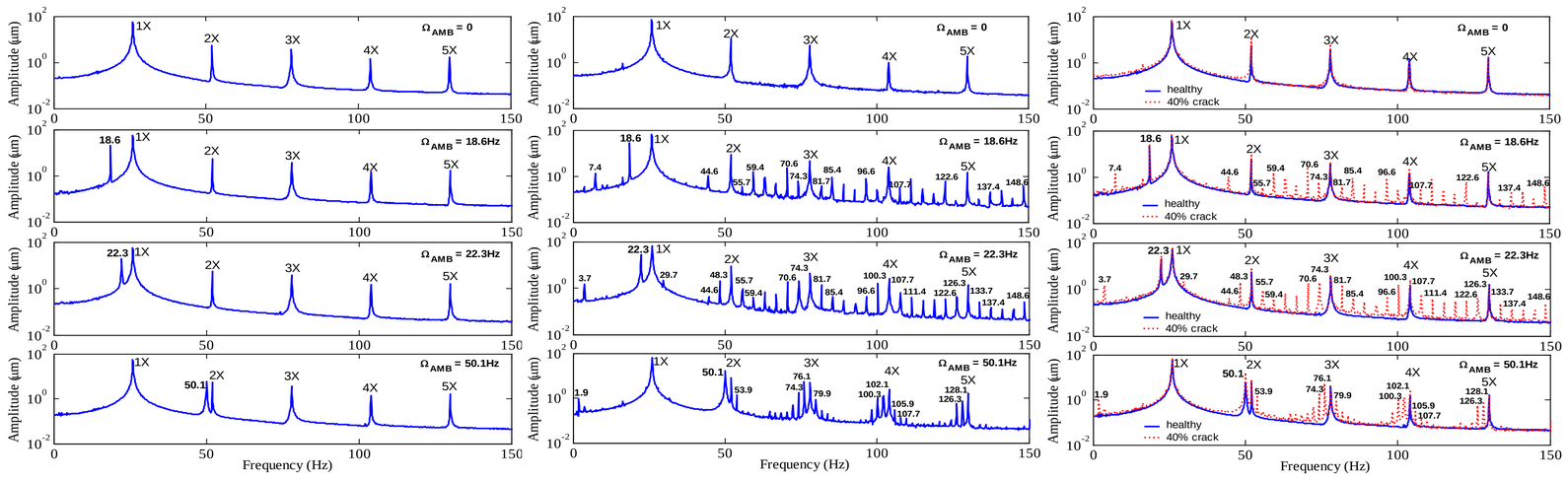
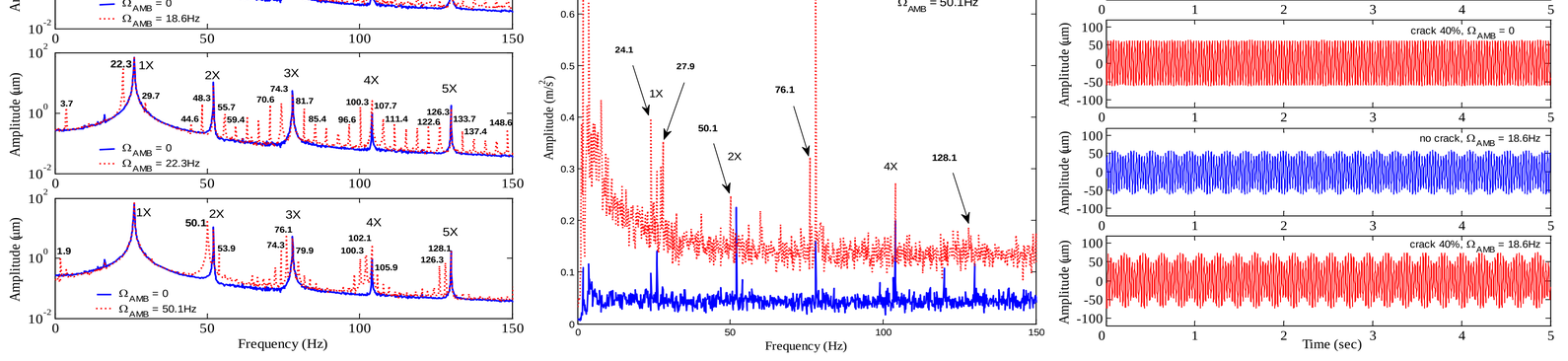
Abstract

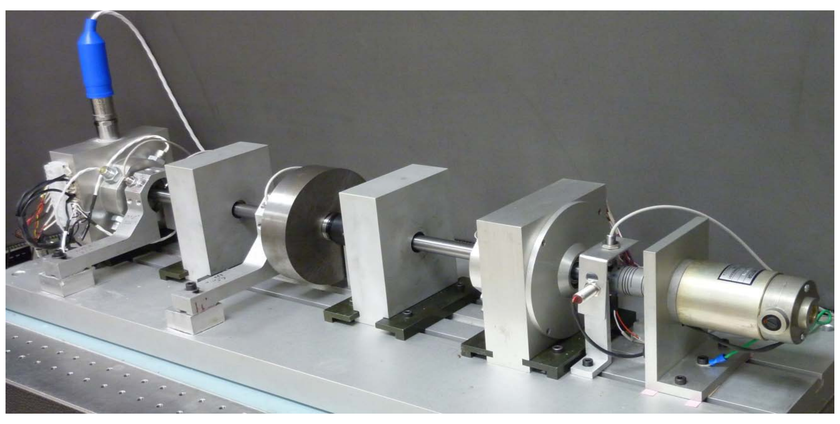
An innovative approach to the on-line structural health monitoring of rotors supported on active magnetic bearings (AMBs) is proposed. The new technology utilizes built-in diagnostics features of AMBs to detect the presence of transverse crack on the shaft. In addition to providing pure levitation, the rotor supporting bearing serves as *diagnostic* excitation force actuator. The structurally damaged system, when interrogated by specially selected force excitation, exhibits very unique response frequencies in the vibration spectrum. The obtained results demonstrate that the presented on-line health monitoring approach can be very effective for detection of the structural damage in propulsion components.



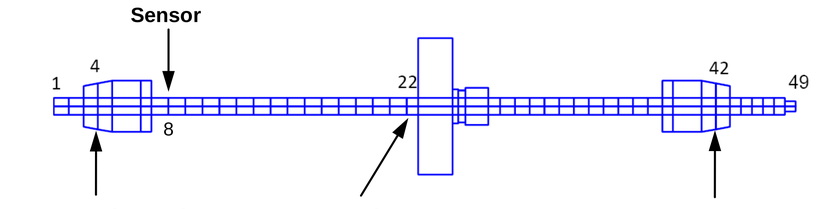
Experimental responses of rotor: spin Ω=26 Hz, excitation force 5 N with various frequencies, (a) healthy rotor, (b) 40% cracked rotor, and (c) comparison between healthy and cracked rotors



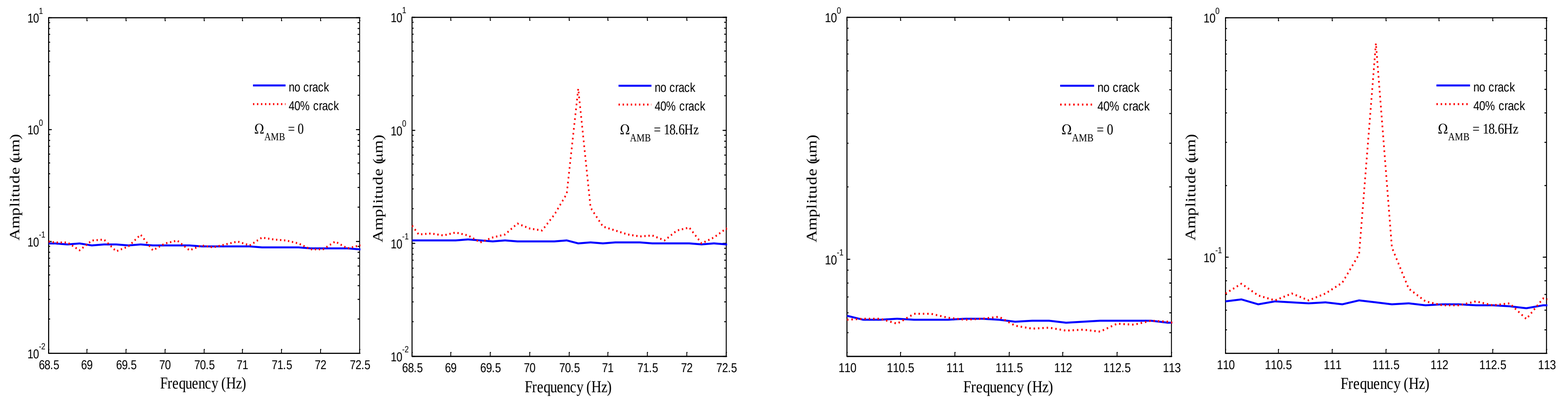
Experimental responses of rotor at spin Ω=26 Hz, (a) comparison of 40 % cracked rotor with and without excitation force 5 N, (b) accelerometer data for healthy and cracked rotor, (c) time responses of healthy and cracked rotors



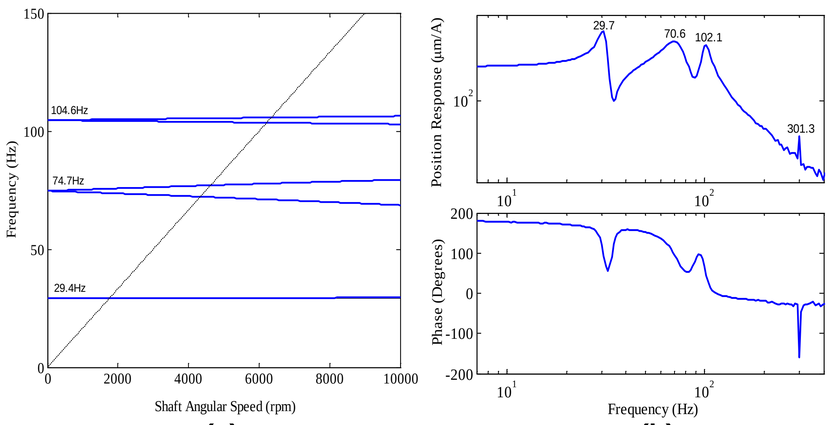
Experimental Crack Detection Test Rig



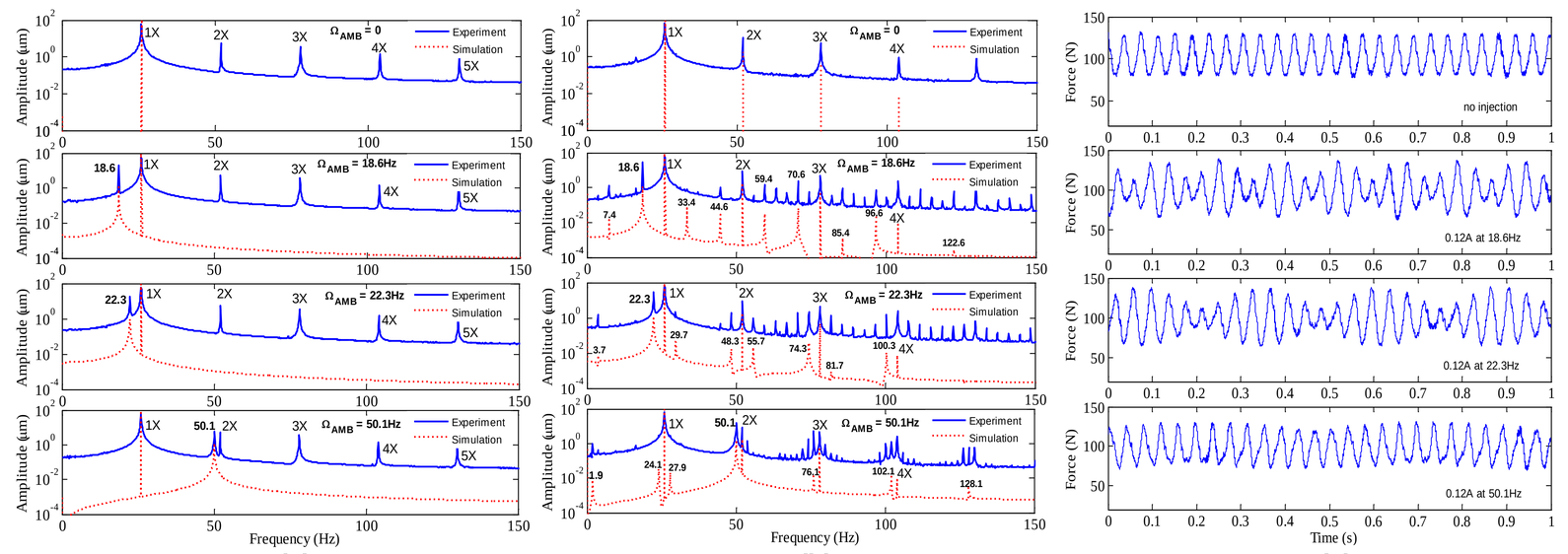
Experimental rotor and FE model



Experimental responses of the healthy and 40% cracked rotors without and with excitation force of 5N near the combinational frequency 70.6 Hz (a) and 111.4 Hz (b)



(a) Campbell diagram and (b) measured Bode plot for rotor on AMBs



Comparison between the measured and simulated responses with and without excitation force for the healthy rotor (a), and 40% cracked rotor (b), measured total magnetic force (c)