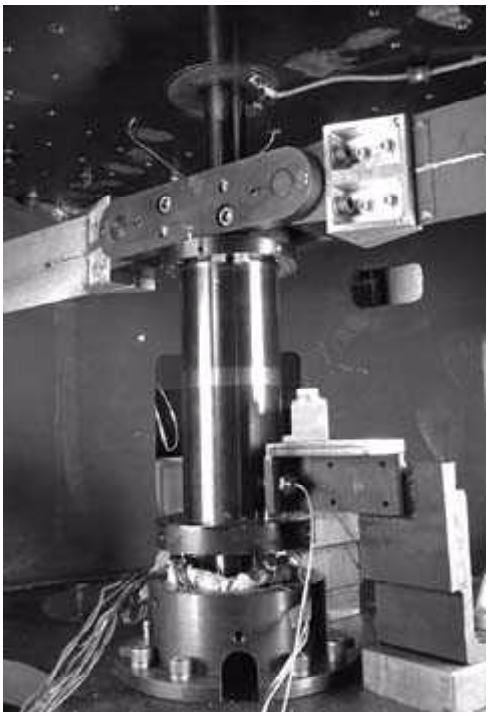
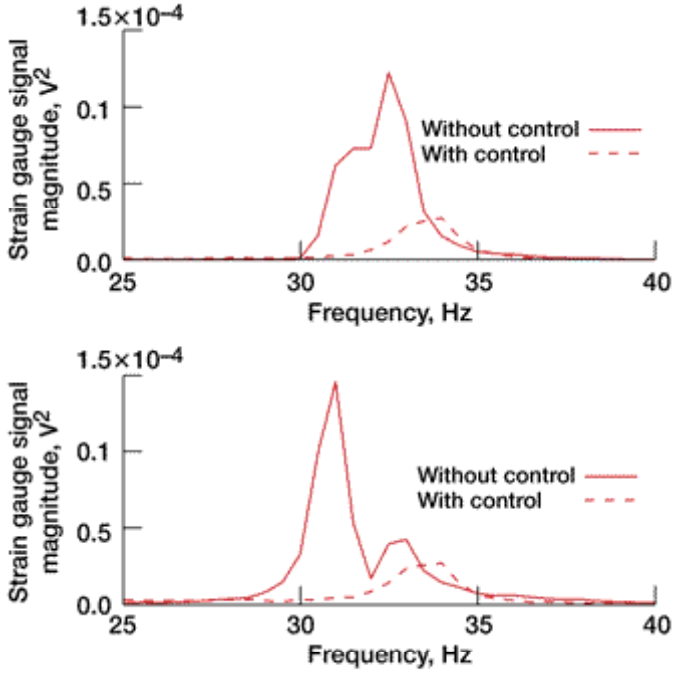
Active Blade Vibration Control Being Developed and Tested



A two-bladed rotor, oriented vertically, which is supported by a radial active magnetic bearing used for active blade vibration control in the NASA Glenn Dynamic Spin Rig facility.



Power spectral density of strain gauge signals for flat plates using the active blade vibration control system with and without strain gauge feedback to the magnetic bearing, for a nonrotating shaft. Top: Blade B. Bottom: Blade A.

Gas turbine engines are currently being designed to have increased performance, lower weight and manufacturing costs, and higher reliability. Consequently, turbomachinery components, such as turbine and compressor blades, have designs that are susceptible to new vibration problems and eventual in-service failure due to high-cycle fatigue. To address this problem, researchers at the NASA Glenn Research Center are developing and testing innovative active blade vibration control concepts. Preliminary results of using an active blade vibration control system, involving a rotor supported by an active magnetic bearing in Glenn's Dynamic Spin Rig, indicate promising results (see the photograph). Active blade vibration control was achieved using feedback of blade strain gauge signals within the magnetic bearing control loop. The vibration amplitude was reduced substantially (see the graphs). Also, vibration amplitude amplification was demonstrated; this could be used to enhance structural mode identification, if desired. These results were for a nonrotating two-bladed disk. Tests for rotating blades are planned.

Current and future active blade vibration control research is planned to use a fully magnetically suspended rotor and smart materials. For the fully magnetically suspended rotor work, three magnetic bearings (two radial and one axial) will be used as actuators instead of one magnetic bearing. This will allow additional degrees of freedom to be used for control. For the smart materials work, control effectors located on and off the blade will be considered. Piezoelectric materials will be considered for on-the-blade actuation, and actuator placement on a stator vane, or other nearby structure, will be investigated for off-the-blade actuation. Initial work will focus on determining the feasibility of these methods by performing basic analysis and simple experiments involving feedback control.

Further development will include a detailed design of the system along with an extensive test and evaluation plan.

Reference

1. Johnson, Dexter; Brown, Gerald V.; and Mehmed, Oral: A Magnetic Suspension and Excitation System for Spin Vibration Testing of Turbomachinery Blades. AIAA Paper 98-1851, 1998.

Find out more about the research of Glenn's Structural Mechanics and Dynamics Branch http://structures.grc.nasa.gov/5930/.

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