Announcing the Final Examination of Garrett Lopp for the degree of Doctor of Philosophy

Time & Location: December 13, 2018 at 12:00 PM in ENG2 202A
Title: Vibration Reduction of Mistuned Bladed Disks via Piezoelectric-Based Resonance Frequency Detuning

Recent trends in turbomachinery blade technology have led to increased use of monolithically constructed bladed disks (blisks). Although offering a wealth of performance benefits, this monolithic construction removes the blade-attachment interface present in the conventional design, thus unintentionally removing a source of friction-based damping needed to counteract large vibrations during resonance passages. This issue is further exacerbated in the presence of blade mistuning that arises due to small imperfections from otherwise identical blades. These imperfections are unavoidable as they originate from manufacturing tolerances and operational wear over the lifespan of the engine. Mistuning is known to induce vibration localization with large vibration magnitudes that render blades susceptible to failure induced by high-cycle fatigue, thus leading researchers to investigate alternate means of reducing blade vibrations.

One such method, termed Resonance Frequency Detuning (RFD), reduces vibration associated with resonance crossings by selectively altering the blades’ structural response. This method utilizes the variable stiffness properties of piezoelectric materials to switch between available stiffness states at some optimal time as the excitation frequency sweeps through a resonance. For a single-degree-of-freedom (SDOF) system, the performance is well defined. This work extends the RFD concept to more realistic applications when the SDOF assumption breaks down, such as in cases of blade mistuning. Mistuning is inherently random; thus, a Monte Carlo analysis performed on a computationally cheap lumped-parameter model provides insight into RFD performance for various test parameters. An experimental investigation utilizing an academic blisk provides validation. Each blade incorporated two optimized piezoelectric patches to target the vibration modes of interest: one set of patches provided the traveling-wave excitation typically experienced by blisks; the other set provided the stiffness-state switching to reduce vibration. Successful experimental implementation provides a significant step forward for RFD as a viable vibration reduction approach as applied towards more realistic operating scenarios.

Major: Mechanical Engineering

Educational Career:
Bachelor’s of Aerospace Engineering, BS, 2013, University of Central Florida
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Committee in Charge:
Jeffrey L. Kauffman, Chair, Mechanical and Aerospace Engineering
Seetha Raghavan, Mechanical and Aerospace Engineering
Felipe A. C. Viana, Mechanical and Aerospace Engineering
Necati Catbas, Civil, Environmental, and Construction Engineering

Approved for distribution by Jeffrey L. Kauffman, Committee Chair, on November 29, 2018.

The public is welcome to attend.