On-Engine Detection of Crack in Bladed Disks
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Description
On-engine blade crack detection methods face a significant challenge since they must be able to distinguish localization phenomena in the forced response due to cracks from those due to small mistuning.

The proposed method assumes that the dynamic response of a cracked bladed disk cannot be represented as a linear superposition of normal modes of the pristine system.

Benefits
Crack detection methods are beneficial for condition-based maintenance and for reducing the risk of catastrophic failures due to high cycle fatigue of bladed disks.

This detection method only uses as inputs the vibration data acquired by tip timing measurement systems.

Approach
The forced response of the rotating blades (N = number of blades) is measured at blade tip locations by tip timing.

Measurements corresponding to the nth (n = 1..N) blade are removed from the measurement set and the remaining data (N-1 blades) are projected on a basis formed by a set of normal modes of the tuned pristine system and the nth residual is computed.

When the measurements corresponding to the cracked blade are removed, the minimum value of the residual is obtained because the dynamics of the sub-set of pristine blades can be represented as a linear superposition of normal modes of the pristine system.

Recent Results
Numerical validation performed:
• Detectability of the cracked blade in case of nonlinear phenomena due to crack breathing.
• Robustness of the method in the presence of small mistuning (σ = 4%) and measurement noise (up to 10%).

Experimental validation performed:
• Detectability of the cracked blade in case of linear behavior of the system.

References

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