NOVEL SPECTRAL AND HIGH ORDER SPECTRAL TIME-FREQUENCY NONLINEAR TECHNOLOGIES FOR EARLY DAMAGE DETECTION

L. Gelman[1], O. Drabych[1], I. Petrunin[1], P.R. White[2]
[1]Cranfield University, School of Engineering, Cranfield, MK43 0AL, UK
email: l.gelman@cranfield.ac.uk, fax: 44 (0) 1234 754797
[2] Institute of Sound and Vibration Research,
University of Southampton, Highfield, Hants, UK

Early monitoring of the integrity of structures that form part of cultural heritage is important for heritage preservation. Damage to any structure that symbolizes the culture of a nation is an incalculable loss. Fortunately, new damage technologies are making it possible to protect against such losses through early monitoring of integrity. The main vibration technologies used for early monitoring of structural integrity include impact technology using a hammer or mobile shaker, swept sine technology using a mobile shaker and ambient technology using random vibration excitation.

*The conventional **linear** vibration technique based on resonance frequency shifts which is commonly used for damage detection unfortunately can't provide early damage detection.*
*In most materials used in these structures, the **nonlinear** properties are strictly linked with the level of damage. Damage in structures normally manifests themselves through an increase in the non-linearity of system response. Therefore, **nonlinear** vibration techniques are an important part of early monitoring of integrity of structures.*

A novel adaptive technique, the short time chirp-Fourier transform are considered for resonance detection in these structures. The nonlinear techniques, the classical stationary and two novel non-stationary higher order spectra – the wavelet bicoherence and the adaptive chirp-Fourier bicoherence – are considered for damage detection in these structures. A new non-traditional approach to damage detection is also presented. This paper accumulates 8 year experience (in the US and UK) in using this new approach for damage detection. It is shown that the proposed nonlinear techniques are more effective for early damage detection than the classical technique. We shall also discuss the use of dynamical measures employed to characterise nonlinear systems s tools for assessing the integrity of a structure.

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