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Author: Dr. Davide Nardi
University of Rome "La Sapienza", Italy, davide.nardi@uniroma1.it

APPLICATION OF WAVELET PACKET TRANSFORM IN A DAMAGE PATTERN RECOGNITION PROCEDURE FOR COMPOSITE BEAMS AND TRUSS-TYPE ALUMINUM STRUCTURES

Abstract

In this paper, an effective and robust procedure based on the Wavelet Packet Transform (WPT) for the estimation of damaged configurations in a cantilever composite beam and in a truss-type aluminum structure is performed. The proposed study is based on the use of an algorithm in which the energy of every wavelet packet node is exploited for the realization of a pattern recognition procedure, such that the identification of damaged configurations of different extent is achieved. Damage is simulated removing point-shape masses placed on the structures . The structures employed can be considered as partially "unknown", i.e. in terms of the exact value of the Young modulus of the constitutive materials, and thus representative of a real case study, in order to test the validity of a wavelet approach for damage identification purposes in real-world frameworks. The application of a wavelet transform-based approach overcomes a more standard analysis based on the Fourier transform in terms of suitable damage sensitive features. Infact, a damage pattern recognition based on the value of the resonance frequencies of the different damaged configurations, would produce poor results due to the close values of such modal parameters. WPT is applied to analyze the time histories acquired using accelerometers located on the vibrating frameworks, in order to extract the energy of packet node, regarded as damage sensitive features. A statistical analysis of the energy of the wavelet packets based on Linear Discriminant Analysis (LDA), is necessary to effectively employ the data for pattern recognition purposes. Finally, a correlation index based on the Mahalanobis distance between the features of different damage scenarios and a reference pattern is used. The analysis based on several numbers of time histories available is carried out, showing very interesting implications from a real-world activities point of view. Such a procedure is accomplished even when just one sensor is used. Results show that the proposed methodology yields excellent results of damage identification both for different kind of damages than for the time instant when the various simulated damaged configurations occur.