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IDENTIFICATION OF DAMAGED CONFIGURATIONS IN A TRUSS-TYPE STRUCTURE

Abstract

In this paper, an efficient and reliable procedure based on the Wavelet Packet Transform (WPT) for the identification of damage configurations in a truss-type structure is developed. We propose the use of an algorithm in which the energy of every packet node is exploited for the realization of a pattern recognition procedure based on the Euclidean distance in order to identify the different damages configurations. The capability of identifying the presence or the location of a damage in a space structures can be considered as a major advantage for the maintenance of a space orbiting systems, namely in the presence of impact with space debris. Damage is simulated in the truss structure by removing/adding masses at the corners of the last floor of the structure. The structure is then subjected to a dynamical loading case. During the experiment the time history of the structural response is acquired and the WPT is applied to analyze the signals obtained by using accelerometers located on the vibrating aluminum framework. The wavelet analysis is performed by means of Daubechies 4 wavelet function. The resonance frequencies of the structure are obtained both experimentally and numerically through the implementation of a finite element model of the system under analysis. The obtained results show that the first three resonance frequencies do not constitute a sensitive feature for the identification of the different damaged configurations, showing that for small variation of configuration the Fourier transform gives not enough evidence of the modifications induced by the damage and, as a consequence, cannot be used as a way of detecting the presence of a varied configuration due to the presence of a damage. On the contrary, a Wavelet function analysis of the time histories of the different configurations yields satisfactory results in terms of damage identification also when just one sensor is used. The truss-type structure, being a real structural system, features geometric asymmetries and manufacturing imperfections: moreover, uncertainty affects the values of the Young modulus of the constitutive material and of the tightening torque associated to the screws in the different bars is present. We can therefore consider this structure as partially "unknown" and thus representative of a real case study, to prove the validity of a wavelet approach for damage identification purpose in real-world applications. The proposed pattern recognition procedure of different damaged configurations is demonstrated to be effective for the purpose of the investigation.