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Vibration-based damage identification of plate structures via curvelet transform

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ABSTRACT

This paper presents a new method based on curvelet transform to assess damage location in plate structures. The curvelet transform was developed over the last few years in an attempt to overcome inherent limitations of traditional multiscale representations such as wavelets. In this research, curvelet transform has been employed due to its favorable performance in detecting line feature. The formulation of discrete curvelet transform using unequally-spaced fast Fourier transforms for plate damage detection was investigated. The proposed method was applied to a four-fixed supported rectangular plate containing one or two damages with arbitrary length, depth and location. Thereafter, the damage was detected in the plate using the proposed method. By way of comparison between location obtained from the proposed method and simulation model, it was concluded that the method is sensitive to damage. Moreover, the performance of the method has been verified through using experimental modal data of a plate.

1. Introduction

Largely due to the increasing application of the structural damage detection, it has received noticeable attention over the last few years. Major infrastructures like bridges, tunnels, plants and other structures, as well as mechanical systems such as airplanes are a few to name where health monitoring becomes of strategic importance.

Damages cause some changes in the physical properties of structures like mass, stiffness and damping at damaged locations. Consequently, these changes make dynamic characteristics such as natural frequencies, mode shapes and damping ratio of the structure to deviate from its initial pre-damage condition [1].

For many years, damage identification methods have been studied by a number of researchers. Lynn and Kumbasar [2] applied Green's function to analyze free vibration behavior of cracked rectangular plates. Hirano and Okazaki [3] used Fourier series to study vibration characteristics of rectangular plates with crack. Cawley and Adams [4] extended a method for detecting imperfections in a frequency response function plate, on the basis of changes in frequency. Bayissa and Haritos [5] proposed a new damage identification technique based on the statistical moments of the energy density function of the vibration responses in the time-scale domain. Pandey et al. [6] stated that absolute alters in the curvature mode shapes are localized in the area of damage which can be applied to detect damage in a structure. Cornwell et al. [7] extended the modal energy method which was originally developed for damage detection in one-dimensional structures to plate structures.

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