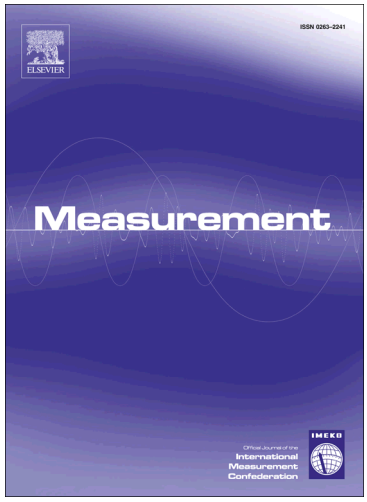

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Development of Comprehensive Heterodyne Effect Based Inspection (CHEBI) Method for Inclusive Monitoring of Cracks

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ABSTRACT

Early detection of developing structural cracks is extremely important in improving safety and reducing maintenance costs in structural, aerospace, chemical, petrochemical, gas, and oil industries. Nonlinear structural health monitoring methods, such as wave modulation spectroscopy (NWMS), can detect the cracks in their early stages of development. Such methods usually rely on the combination of a high and a low-frequency, vibro-acoustic, excitation for defect detection. However, a priori knowledge of the characteristics of the crack is required for selection of the appropriate frequency combination. In this study, the Comprehensive Heterodyne Effect Based Inspection (CHEBI) method is proposed to address this issue. The CHEBI method applies ascending and descending broadband frequency sweeps simultaneously to study the response of the structure in wide ranges of frequencies in the time-frequency domain. Therefore, it eliminates the need for multiple experimental tests to find appropriate combinations of the high and the low-frequency components. The proposed method detected cracks from 1 mm to 25 mm in length on a dog-bone shaped aluminum specimen. These results confirmed that the CHEBI can be successfully applied for detection of cracks with varying severities without the need for adjustment of the excitation frequencies.

Keywords: Structural Health Monitoring (SHM), Nonlinear Wave Modulation Spectroscopy (NWMS), Heterodyning Effect, Crack Detection, Smart Structures

1. INTRODUCTION

Structural health monitoring (SHM) techniques have been successfully used in structural, aerospace, chemical, petrochemical, gas and oil industries to reduce the maintenance cost and to improve the safety of the operations. SHM methods are generally divided into two groups: active and passive. Passive methods only use sensors in the monitoring process and detect the problems from the variations in the received signals which are caused by creation/growth of cracks, debondings, and corrosions [1]–[4]. Active methods apply a known excitation by using