ABSTRACT

Condition assessment and damage detection at the earliest possible stage of the engineering infrastructures, such as buildings, bridges, nuclear structures, mechanical and aerospace structures is crucial to prevent potential catastrophic events and for the planning of repair and rehabilitation of these structures. Current nondestructive damage detection (NDD) techniques are either visual or localized experimental techniques. These methods require that the damage region be known a *priori*, and the segment of the structure being examined must be easily accessible. Because of these limitations, these methods can detect damage on or near the surface of the structure. Further, these methods are usually time consuming and expensive.

Due to the global nature of the dynamic characteristics, damage detection from the changes in the dynamic properties of a structure has received considerable attention from the research community. These methods try to utilize the fact that the presence of damage changes the local stiffness, mass and damping distribution and has an influence on the global behavior of the whole structure.

The aim of the thesis is to investigate the problem of structural damage detection from the changes in the dynamic properties or response of the structure using various stationary/ non-stationary signal processing techniques.

A comprehensive experimental modal analysis of a cantilever beam, having single/ multiple open cracks of different crack depth/ crack depth combinations, is carried out to investigate the effect of localize damage on the modal frequencies of the different vibration modes.

Often the most important features associated with the structural damage are characterized by the non-stationary, nonlinear nature of the measured response. Wavelet analysis, which is a relatively recent tool for non-periodic, non-stationary signal processing, is explored to quantify the damage state of a three-dimensional frame structure from the simulated acceleration time-histories.

The combined approach of empirical mode decomposition, a data driven technique which decompose a signal into a set of locally symmetric functions with respect to the mean, and Hilbert transform is also examined for damage assessment of the frame structure.

The time-frequency distributions represent the energy of a signal simultaneously both in the time and frequency domain and offer reliable information about the signal structure. Present investigation explores various linear/ bilinear time-frequency distributions, such as spectrogram, scalogram and the members of the generalized Cohen's class for damage identification of the frame structure from the simulated acceleration data.

Keywords – Structural health monitoring, frequency domain, modal parameters, experimental modal analysis, single/ multiple cracks, cantilever beam, wavelet analysis, measurement noise, frame structure, empirical mode decomposition, Hilbert transform, time-frequency distributions, Cohen's class.