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Damage Detection of Irregular Plates and Regular Dams by Wavelet Transform Combined Adoptive Neuro Fuzzy Inference System

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Abstract

This paper presents a technique for irregular plate and regular dam damage detection based on combination of wavelet with adoptive neuro fuzzy inference system (ANFIS). Many damage detection methods need response of structures (such as the displacements, stresses or mode shapes) before and after damage, but this method only requires response of structures after damage otherwise many damage detection methods study regular plate but this method also studies irregular plate. First, the structure (irregular plate or regular dam) is modeled by using ANSYS software, the model is analyzed and structure's responses with damage are obtained by finite element approach. Second, the responses at the finite element points with regular distances are obtained by using ANFIS. The damage zone is represented as the elements with reduced elasticity modules. Then these responses of structures are analyzed with 2D wavelet transform. It is shown that matrix detail coefficients of 2D wavelet transform can specified the damage zone of plates and regular dams by perturbation in the damaged area.

Keywords: Damage detection, Wavelet, Wavelet transform, fuzzy.

1. INTRODUCTION

In order to improve the sustainability of a building, it is necessary to pay more attention to the health of the structure, even in the buildings which have been normally designed for 100 years. Overloading, unauthorized uses, exposure to bad environmental conditions, and other unpredictable cases are among the factors affecting the demolition of a structure. Damage detection method has been an interesting topic in various fields for many researchers in recent years. Wavelet analysis is a mathematical method and a signal processing tool which is used with time frequency analysis to provide more information and details about the signals that cannot be analyzed by Fourier analysis. This method has various applications in many fields including civil, mechanical, and aerospace engineering, especially for structural damage Detection and structural health monitoring [1]. A simplified survey of governing theory on the wavelet transform and ability of wavelets to determine crack (damage) in the 2D continuum structures is presented in this paper, which only requires knowledge about response from the damaged structure.

Al-khalidy et al. published paper about damage detection using wavelet analysis [2,3]. Kim and Melhem investigated a cracked beam specimen subjected to cyclic fatigue loads [1]. Yam et al proposed a method for damage detection of composite structures using combination of vibration responses, wavelet transform and artificial neural networks [4]. Lotfollahi-Yaghin and Koohdaragh suggested wavelet packet energy rate index to find out the characteristics of the crack [5]. Balafas, and Kiremidjian presented the development and validation of several novel data-driven damage sensitive features based on the Continuous Wavelet Transform [6]. Obrien et al. investigated a method for damage detection using a moving force identification algorithm [7]. Yu et al. studied damage detection in a six-bay truss bridge model and used the fuzzy C-means clustering algorithm to categorize features for structural damage detection [8]. El-Gebeily and Khulief developed methods for inner damage identification in pipes under noisy conditions for cracked beams with utilizing the vibration mode shapes [9].

A simplified survey of governing theory on the wavelet transform and ability of combination of wavelet transform with ANFIS to determine damage in the irregular 2D continuum structures is presented in this paper, which only requires knowledge about response from the damaged structure. In other words, there is no need for information about the original undamaged (healthy) structure. In addition, by analyzing signal response from the static loads, the damage is locally specified.