Structural damage localization using probabilistic neural networks

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A B S T R A C T

In this paper, the structural damage localization on a simple composite plate specimen is identified using probabilistic neural networks. First, the category to be identified is defined according to the structural location, and the number of categories is reduced by grouping neighboring elements to one category. Second, the state data of damaged structure are collected by a data collection system, and are utilized as feature vectors for the probabilistic neural network. Finally, the smoothing parameter in the probabilistic neural network is studied. When this trained network is subjected to the measured response, it should be able to locate existing damage. The effectiveness of the proposed method is demonstrated.

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1. Introduction

Structural damage may occur as a result of normal operations, deterioration or severe natural events. Any damage or cracks can seriously influence the structural stability and integrity [1]. Any belated discovery of structural failures will require expensive remedial measures [2]. Thus, an appropriate damage localization method to assess the likelihood of structural failures is needed to provide an alert as early as possible.

Previous studies have applied artificial neural networks (ANNs) with the back-propagation (BP) learning algorithm for structural damage localization [3,4]. The model provides a good knowledge acquisition tool for damage localization, however, without considering the real-time problem. Recent developments of artificial neural networks bred a new type of neural network capable of very fast training on real-time problems: probabilistic neural networks (PNNs) [5,6]. PNNs are a class of neural networks which implement a Bayesian decision strategy for pattern classification problems. A PNN requires less training time than the BP network and is very efficient because a PNN can easily generalize to new patterns. Compared with BP, for a given level of performance, the speedup is very efficient [7].

This paper applies a probabilistic neural network for locating structural damage based upon a set of data collected from an optical fiber sensor network and digital signal processing (DSP). The probabilistic neural network model and its architecture are described. Using the set of collected data, the smoothing parameter in the PNN is studied.

2. Materials and methods

2.1. Probabilistic neural network

The probabilistic neural network model, described by Specht [8], is a neural implementation of the Parzen [9] windows probability density approximation method. It is mainly suited to classification problems. Parzen's method is an attractive estimation procedure, as it is a fast and straightforward way of learning probabilities from a training set. And the nonparametric structure leads naturally to a neural implementation of the method.

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