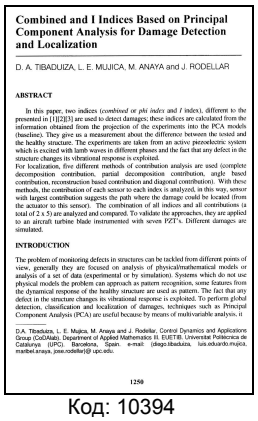

Combined and I Indices Based on Principal Component Analysis for Damage Detection and Localization

D. A. TIBADUIZA, L. E. MUJICA, M. ANAYA and J. RODELLAR

ABSTRACT

In this paper, two indices (*combined* or *phi index* and *I* index), different to the presented in [1][2][3] are used to detect damages; these indices are calculated from the information obtained from the projection of the experiments into the PCA models (baseline). They give as a measurement about the difference between the tested and the healthy structure. The experiments are taken from an active piezoelectric system which is excited with lamb waves in different phases and the fact that any defect in the structure changes its vibrational response is exploited.
For localization, five different methods of contribution analysis are used (complete decomposition contribution, partial decomposition contribution, angle based contribution, reconstruction based contribution and diagonal contribution). With these methods, the contribution of each sensor to each index is analyzed, in this way, sensor with largest contribution suggests the path where the damage could be located (from the actuator to this sensor). The combination of all indices and all contributions (a total of 2 x 5) are analyzed and compared. To validate the approaches, they are applied to an aircraft turbine blade instrumented with seven PZT's. Different damages are simulated.

INTRODUCTION

The problem of monitoring defects in structures can be tackled from different points of view, generally they are focused on analysis of physical/mathematical models or analysis of a set of data (experimental or by simulation). Systems which do not use physical models the problem can approach as pattern recognition, some features from the dynamical response of the healthy structure are used as pattern. The fact that any defect in the structure changes its vibrational response is exploited. To perform global detection, classification and localization of damages, techniques such as Principal Component Analysis (PCA) are useful because by means of multivariable analysis, it

D.A. Tibaduiza, L. E. Mujica, M. Anaya and J. Rodellar, Control Dynamics and Applications Group (CoDAlab). Department of Applied Mathematics III. EUETIB. Universitat Politècnica de Catalunya (UPC). Barcelona, Spain. e-mail: (diego.tibaduiza, luis.eduardo.mujica, maribel.anaya, jose.rodellar)@ upc.edu.

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M.T.H. Sultan, K. Worden, W.J. Staszewski

Impact Damage Characterisation Using a Statistical Approach

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Many of the materials utilised in current technologies, especially those used in the aerospace industry, require an unusual combination of properties that cannot be met by conventional metallic, ceramic or polymeric materials alone. Therefore, aerospace structural engineers are constantly searching for alternative materials, such as composites. Composite materials consist of two or more constituents with varying properties, that when used together, form a new material. These can be tailored to have low densities, high strength and stiffness, and have good corrosion resistance. These materials improve structural efficiency, and can reduce the structural mass without compromising structural stiffness and strength.

The ultimate objective of the research work, described in this paper, was to conduct an experimental investigation to detect and quantify impact damage in structures made from composite plates. Two different approaches were used to record acceleration response signals resulting from impact excitation. The first used a standard impulse hammer in order to acquire time data and produce spectra for a number of non-damaging impacts. The second approach used a drop-test to perform a number of potentially damaging impacts. The impact energies for the drop tests ranged from 0.37 J to 41.72 J. Following a systematic series of experiments on the induction of impact damage in composite specimens, two different techniques were used to examine the impacted samples. X-ray radiography was used to evaluate the damage area whilst Scanning Electron Microscopy (SEM) was used to inspect the topographies of the specimens at high magnifications. The motivation behind this research work was based on the idea of using statistical or machine-learning methods to identify and categorise impacts (damaging or non-damaging and also types of failure modes) using only structural response data. The discussion here will be focused on outlier analysis on higher-dimensional multivariate data, the features are from binned spectra which leads to an 8-dimensional feature.

Ключевые слова:

Содержание.