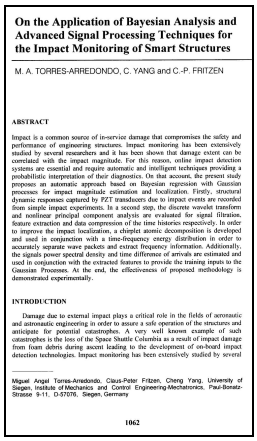

On the Application of Bayesian Analysis and Advanced Signal Processing Techniques for the Impact Monitoring of Smart Structures

M. A. TORRES-ARREDONDO, C. YANG and C.-P. FRITZEN

ABSTRACT

Impact is a common source of in-service damage that compromises the safety and performance of engineering structures. Impact monitoring has been extensively studied by several researchers and it has been shown that damage extent can be correlated with the impact magnitude. For this reason, online impact detection systems are essential and require automatic and intelligent techniques providing a probabilistic interpretation of their diagnostics. On that account, the present study proposes an automatic approach based on Bayesian regression with Gaussian processes for impact magnitude estimation and localization. Firstly, structural dynamic responses captured by PZT transducers due to impact events are recorded from simple impact experiments. In a second step, the discrete wavelet transform and nonlinear principal component analysis are evaluated for signal filtration, feature extraction and data compression of the time histories respectively. In order to improve the impact localization, a chirplet atomic decomposition is developed and used in conjunction with a time-frequency energy distribution in order to accurately separate wave packets and extract frequency information. Additionally, the signals power spectral density and time difference of arrivals are estimated and used in conjunction with the extracted features to provide the training inputs to the Gaussian Processes. At the end, the effectiveness of proposed methodology is demonstrated experimentally.

INTRODUCTION

Damage due to external impact plays a critical role in the fields of aeronautic and astronautic engineering in order to assure a safe operation of the structures and anticipate for potential catastrophes. A very well known example of such catastrophes is the loss of the Space Shuttle Columbia as a result of impact damage from foam debris during ascent leading to the development of on-board impact detection technologies. Impact monitoring has been extensively studied by several

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Ключевые слова:

Содержание.