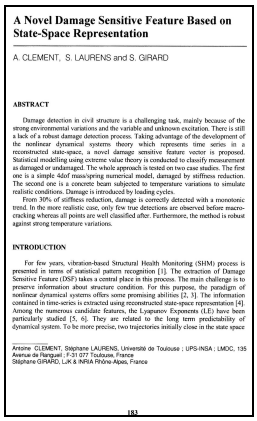

A Novel Damage Sensitive Feature Based on State-Space Representation

A. CLEMENT, S. LAURENS and S. GIRARD

ABSTRACT

Damage detection in civil structure is a challenging task, mainly because of the strong environmental variations and the variable and unknown excitation. There is still a lack of a robust damage detection process. Taking advantage of the development of the nonlinear dynamical systems theory which represents time series in a reconstructed state-space, a novel damage sensitive feature vector is proposed. Statistical modelling using extreme value theory is conducted to classify measurement as damaged or undamaged. The whole approach is tested on two case studies. The first one is a simple 4dof mass/spring numerical model, damaged by stiffness reduction. The second one is a concrete beam subjected to temperature variations to simulate realistic conditions. Damage is introduced by loading cycles.

From 30% of stiffness reduction, damage is correctly detected with a monotonic trend. In the more realistic case, only few true detections are observed before macro-cracking whereas all points are well classified after. Furthermore, the method is robust against strong temperature variations.

INTRODUCTION

For few years, vibration-based Structural Health Monitoring (SHM) process is presented in terms of statistical pattern recognition [1]. The extraction of Damage Sensitive Feature (DSF) takes a central place in this process. The main challenge is to preserve information about structure condition. For this purpose, the paradigm of nonlinear dynamical systems offers some promising abilities [2, 3]. The information contained in time-series is extracted using reconstructed state-space representation [4]. Among the numerous candidate features, the Lyapunov Exponents (LE) have been particularly studied [5, 6]. They are related to the long term predictability of dynamical system. To be more precise, two trajectories initially close in the state space

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Ключевые слова:

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