Geophysical Research Abstracts
Vol. 18, EGU2016-15931, 2016
EGU General Assembly 2016

An automatic damage detection algorithm based on the Short Time Impulse Response Function

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Structural Health Monitoring together with all the dynamic identification techniques and damage detection techniques are increasing in popularity in both scientific and civil community in last years.
The basic idea arises from the observation that spectral properties, described in terms of the so-called modal parameters (eigenfrequencies, mode shapes, and modal damping), are functions of the physical properties of the structure (mass, energy dissipation mechanisms and stiffness). Damage detection techniques traditionally consist in visual inspection and/or non-destructive testing. A different approach consists in vibration based methods detecting changes of feature related to damage. Structural damage exhibits its main effects in terms of stiffness and damping variation. Damage detection approach based on dynamic monitoring of structural properties over time has received a considerable attention in recent scientific literature.
We focused the attention on the structural damage localization and detection after an earthquake, from the evaluation of the mode curvature difference. The methodology is based on the acquisition of the structural dynamic response through a three-directional accelerometer installed on the top floor of the structure. It is able to assess the presence of any damage on the structure providing also information about the related position and severity of the damage. The procedure is based on a Band-Variable Filter, (Ditommaso et al., 2012), used to extract the dynamic characteristics of systems that evolve over time by acting simultaneously in both time and frequency domain. In this paper using a combined approach based on the Fourier Transform and on the seismic interferometric analysis, an useful tool for the automatic fundamental frequency evaluation of nonlinear structures has been proposed. Moreover, using this kind of approach it is possible to improve some of the existing methods for the automatic damage detection providing stable results also during the strong motion phase. This approach helps to overcome the limitation derived from the use of techniques based on simple Fourier Transform that provide good results when the response of the monitored system is stationary, but fails when the system exhibits a non-stationary behaviour. The main advantage derived from the use of the proposed approach for Structural Health Monitoring is based on the simplicity of the interpretation of the nonlinear variations of the fundamental frequency. The proposed methodology has been tested on numerical models of reinforced concrete structures designed for only gravity loads without and with the presence of infill panels. In order to verify the effectiveness of the proposed approach for the automatic evaluation of the fundamental frequency over time, the results of an experimental campaign of shaking table tests conducted at the seismic laboratory of University of Basilicata (SISLAB) have been used.

Acknowledgements
This study was partially funded by the Italian Civil Protection Department within the project DPC-RELUIS 2015 - RS4 “Seismic observatory of structures and health monitoring”.

References
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