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Short Time Impulse Response Function (STIRF) for automatic evaluation of the variation of the dynamic parameters of reinforced concrete framed structures during strong earthquakes.

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This study presents an innovative strategy for automatic evaluation of the variable fundamental frequency and related damping factor of nonlinear structures during strong motion phases. Most of methods for damage detection are based on the assessment of the variations of the dynamic parameters characterizing the monitored structure. A crucial aspect of these methods is the automatic and accurate estimation of both structural eigen-frequencies and related damping factors also during the nonlinear behaviour.
A new method, named STIRF (Short-Time Impulse Response Function - STIRF), based on the nonlinear interferometric analysis combined with the Fourier Transform (FT) here is proposed in order to allow scientists and engineers to characterize frequencies and damping variations of a monitored structure.
The STIRF approach helps to overcome some limitation derived from the use of techniques based on simple Fourier Transform. These latter techniques provide good results when the response of the monitored system is stationary, but fails when the system exhibits a non-stationary, time-varying behaviour: even non-stationary input, soil-foundation and/or adjacent structures interaction phenomena can show the inadequacy of classic techniques to analysing the nonlinear and/or non-stationary behaviour of structures. In fact, 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. Results are consistent with those expected if compared with other techniques. The main advantage derived from the use of the proposed approach (STIRF) for Structural Health Monitoring is based on the simplicity of the interpretation of the nonlinear variations of the fundamental frequency and the related equivalent viscous damping factor.
The proposed methodology has been tested on both numerical and experimental models also using data retrieved from shaking table tests. Based on the results provided in this study, the methodology seems to be able to evaluate fast variations (over time) of dynamic parameters of a generic reinforced concrete framed structure.
Further analyses are necessary to better calibrate the length of the moving time-window (in order to minimize the spurious frequency within each Interferometric Response Function evaluated on both weak and strong motion phases) and to verify the possibility to use the STIRF to analyse the nonlinear behaviour of general systems.

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References
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