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Generation of Multiple Earthquake Accelerograms Compatible with Spectrum Via the Wavelet Packet Transform and Stochastic Neural Networks

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The principal purpose of this article is to present a novel methodology based on wavelet packet transform techniques and stochastic neural networks to generate more artificial earthquake accelerograms from available data, which are compatible with specified response spectra or the design spectra. The proposed method uses the decomposing capabilities of wavelet packet transform on earthquake accelerograms, and the learning abilities of stochastic neural network to expand the knowledge of the inverse mapping from response spectrum to coefficients of wavelet packet transform of earthquake accelerogram. This methodology results in a stochastic ensemble of wavelet packet transform coefficients of earthquake accelerograms and, they are used to the generate accelerograms applying the inverse wavelet packet transform. Finally, an interpretive example is presented which uses an ensemble of recorded accelerograms to train and test the neural network, aiming at the demonstration of the method effectiveness.

Keywords Earthquake Accelerogram Generation; Spectrum; Wavelet Packet Transform; Stochastic Neural Networks

1. Introduction

Earthquake response spectra are often used in the analysis and seismic design of the structures. The major weakness of response spectrum analysis in seismic design of structures lies in its debility to provide temporal information of the structural responses. Such information is often necessary to achieve a satisfactory design. In some cases, it is desirable to develop an artificial earthquake accelerogram compatible with a given design spectrum. The more the performance of the nonlinear dynamic analysis, the more the need for developing accelerograms from design spectra. Therefore, the methods to generate realistic accelerograms become more important.

If it is considered the spectrum calculation from an accelerogram a direct problem, determining an accelerogram from its spectrum is an inverse problem. Mathematical methods are not suitable for solving these inverse problems, particularly due to the lack of unique solution. However, biologically inspired soft computing methods, such as neural networks, can imitate the robust problem-solving strategies applied in nature while dealing with these inverse problems. The imprecision tolerant learning capabilities of neural networks offer opportunities to solve non-unique inverse problems [Ghaboussi, 1999].

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