IMPROVEMENT OF SITE RESPONSE USING CEEMD METHOD AND COMPARED WITH EMD AND FOURIER ANALYSIS

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Hilbert-Huang transform (HHT) has increasingly been enjoyed for dealing with non-stationary and non-linearity features of natural signals. Inherently, this method integrates empirical modal decomposition (EMD) and Hilbert Spectral Analysis in the unitary framework promulgated within engineering and seismological applications as an appropriate alternative of Fourier analysis. Particularly, Fourier transform is unable to extract transient phenomena effectively and this deficiency stems mostly from corresponding Complex Exponential Functions which employed for expanding. These functions decentralized in both time and frequency domain and regarding this drawback, EMD adaptively invokes a robust way to treat these local variations. Its underlying assumption is a time series could be divided into several intrinsic oscillating mode functions (imf) conveying parts of entire information of signal. Ensemble empirical mode decomposition (EEMD) is a noise-assisted method and also a significant improvement on empirical mode decomposition (EMD) in fact EMD methods have evolved from EMD to ensemble EMD (Wu and Huang, 2009) and recently to complete ensemble EMD (CEEMD) (Torres et al., 2011). To this end, we introduced these novel methods through examining theirs capability by merging their with well-known H/V ratio method. In this study, we used from Koujor earthquake record have been recorded by one of the stations in strong motion network of Tehran, and analysis of the H / V ratio to improve site response by method of Fourier transform, Hilbert – Huang transform and CEEMD and the accuracy of the data analysis by removing any unwanted transient increase, we finally have compared the accuracy of these three methods.

Thus, we achieve a decomposition of the data into n IMF modes, and a residue, r_n, which can be a constant, a monotonic mean trend, or a curve having only one extremum.

Thus it can be claimed that the primary signal is reconstructed by using the following equation:

$$x(t) = \mathrm{Re}\sum_{j=1}^{n} a_j(t) e^{i\int w_j(t)}$$

Studies on the effects of the site is very important and applied from the perspective of earth sciences and engineering seismology and so in terms of reservoir studies (Lambert et al., 2007.). In the meantime the H/V method is widely used to assess the dominant frequency of soil and site amplification factor. (Parolai et al., 2002; Chen et al., 2008; Okada, 2003; Bodin and Horton, 1999). This method was founded for the first time by Nakamura (1989) engineering practices has shown in many parts of the world, strength and practicality of it (Atakan et al., 2004). Because of the IMF1 is more dominant at the high frequencies (Figure 1), It can be concluded that the IMF1 has a local source. High frequency components of the record are mainly due to local and transient noise. Therefore appears with removing the IMF1, maximum point slightly displaced and in addition, it also takes a smaller amount.

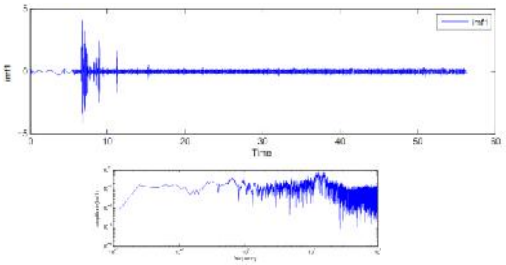

Figure 1. Imf1 from record (Upper) and Fourier spectrum in the frequency domain (Below)

But it is possible the original signal to be lost, therefore using the new method is recommended that will be described in details in the paper. We decompose the signal (Figure 2). The results differ from the previous case after removal first IMF that is investigated in details in the text.

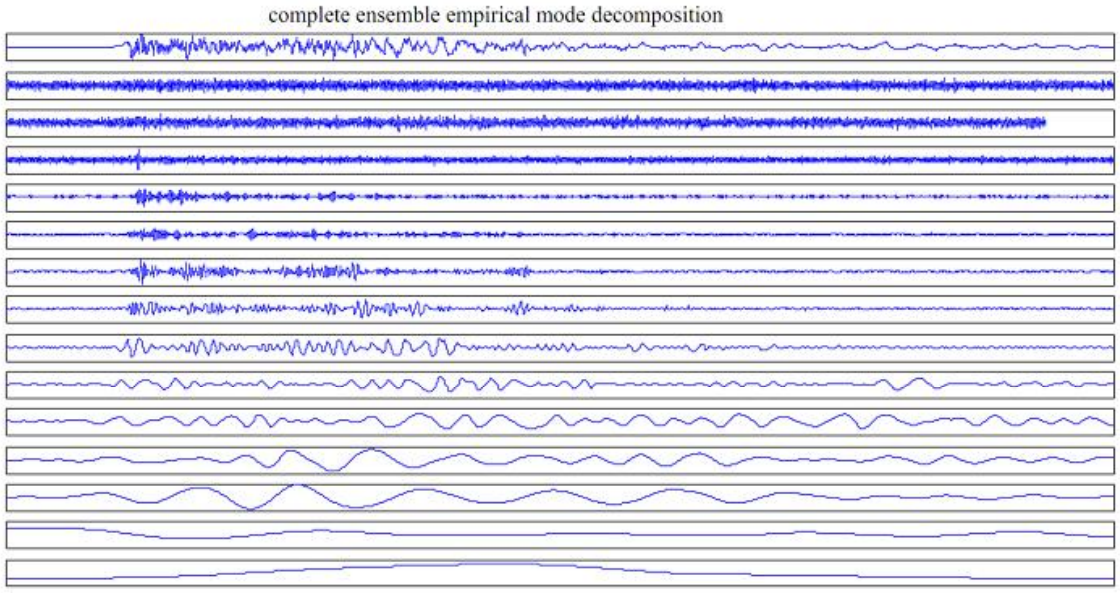

Figure 2. Conversion the record of Kojour earthquake in Tehran station to the intrinsic mode functions with CEEMD method

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