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NEW FREQUENCY-BASED REAL-TIME MAGNITUDE PROXY FOR EARTHQUAKE EARLY WARNING IN IRAN

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Earthquake Early Warning System is a methodology for providing warning of forthcoming ground shaking during earthquakes. The approach uses a network of seismic instruments to detect the first-arriving energy at the surface, the P-waves, and translate the information contained in these low amplitude waves into a prediction of the peak ground shaking that follows. The instruments closest to the epicenter are the first to detect the seismic energy, and by using a seismic network this information can be integrated to produce a map of future ground shaking everywhere (Colombelli et al., 2015).

The frequency-based magnitude proxy employed in this paper is the predominant periods. This proxy, obtained using simple expressions that are valid for noise-free monochromatic signals, yield erroneous result. The τ_p, introduced in this study, is calculated directly from the actual velocity spectrum of the first few seconds of the seismic record. Using data from Iran earthquakes whose magnitudes range between 3 and 7.3, it is demonstrated that τ_p is correlated with the catalog magnitude and provides better magnitude assessment than the characteristic period for small magnitudes (M<4). The average prediction error is reduced with increasing the input interval up to 6 s.

A new strategy for a P wave-based, on-site earthquake early warning system has been developed and tested on Iranian strong motion data. The key elements are the real-time, continuous measurement of three peak amplitude parameters and their empirical combination to predict the ensuing peak ground velocity. The observed parameters are compared to threshold values and converted into a single, dimensionless variable. A local alert level is issued as soon as the empirical combination exceeds a given threshold.

The performance of the method has been evaluated by applying the approach to the catalog of Iranian earthquake records and counting the relative percentage of successful, missed, and false alarms. We show that the joint use of three peak amplitude parameters improves the performance of the system as compared to the use of a single parameter, with a relative increase of successful alarms. The proposed methodology provides a more reliable prediction of the expected ground shaking and improves the robustness of a single-station, threshold-based earthquake early warning system.

Allen and Kanamori (2003) introduced predominant period parameter (τ_p^{max}) based on the first four seconds of P-wave as well as records of earthquakes occurred in South California. The linear relations between τ_p and magnitude are used.

$$M_s=3.7 \log \tau_p+5.3\pm0.4$$

Ziv (2014) defined log-average period (τ_{mlog}) method by using records of Japan and California earthquakes with magnitude between 3.5 and 7.3 and a hypocentral distance of less than 30 kilometers. He showed that τ_{log} is more correlated with the magnitude and shows more reliable results compared to τ_p^{max} and τ_c parameters. τ_{log} is determined based on frequency power spectrum of records of the initial part of velocity seismogram.

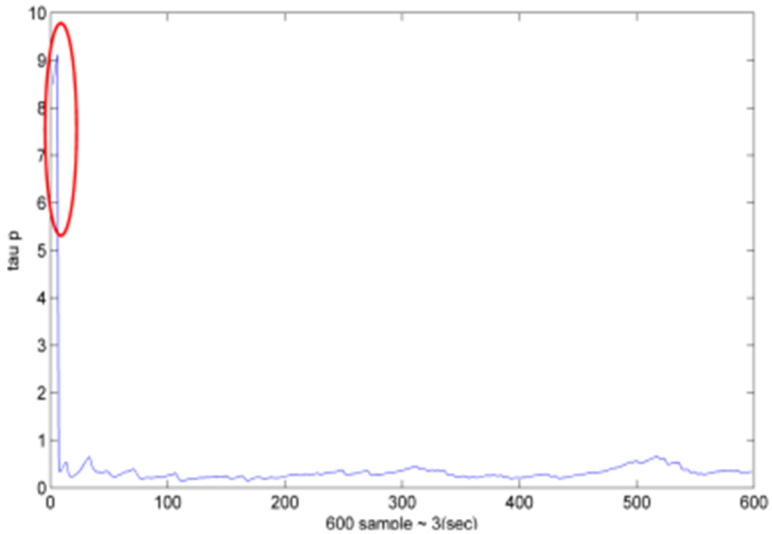

Figure 1. The Estimated value of τ_p calculation for time series of a singel record.

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