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An electromagnetic signals monitoring and analysis wireless platform employing personal digital assistants and pattern analysis techniques

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Abstract

This study presents the design and development of a mobile wireless platform to be used for monitoring and analysis of seismic events and related electromagnetic (EM) signals, employing Personal Digital Assistants (PDAs). A prototype custom-developed application was deployed on a 3G enabled PDA that could connect to the FTP server of the Institute of Geodynamics of the National Observatory of Athens and receive and display EM signals at 4 receiver frequencies (3 KHz (E-W, N-S), 10 KHz (E-W, N-S), 41 MHz and 46 MHz). Signals may originate from any one of the 16 field-stations located around the Greek territory.

Employing continuous recordings of EM signals gathered from January 2003 till December 2007, a Support Vector Machines (SVM)-based classification system was designed to distinguish EM precursor signals within noisy background. EM-signals corresponding to recordings preceding major seismic events (Ms$\geq$5R) were segmented, by an experienced scientist, and five features (mean, variance, skewness, kurtosis, and a wavelet based feature), derived from the EM-signals were calculated. These features were used to train the SVM-based classification scheme. The performance of the system was evaluated by the exhaustive search and leave-one-out methods giving 87.2% overall classification accuracy, in correctly identifying EM precursor signals within noisy background employing all calculated features. Due to the insufficient processing power of the PDAs, this task was performed on a typical desktop computer. This optimal trained context of the SVM classifier was then integrated in the PDA based application rendering the platform capable to discriminate between EM precursor signals and noise.

System's efficiency was evaluated by an expert who reviewed 1/ multiple EM-signals, up to 18 days prior to corresponding past seismic events, and 2/ the possible EM-activity of a specific region employing the trained SVM classifier. Additionally, the proposed architecture can form a base platform for a future integrated system that will incorporate services such as notifications for field station power failures, disruption of data flow, occurring SEs, and even other types of measurement and analysis processes such as the integration of a special analysis algorithm based on the ratio of short term to long term signal average.