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# Application of an Automated System for the Processing of VLF signals to Detect, Analyze and Classify Seismic-Ionospheric Precursor Phenomena

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This paper studies the development and application of an automated system based on Predictive Modular Neural Networks (PREMONNs) and Self Organizing Maps (SOMs) along with the necessary backend development of database classification required to provide a fully integrated system for detecting disturbances that can be attributed to seismic-ionospheric precursor phenomena using VLF radio signals. The aforementioned system can analyze all the relevant data and bring forth and adaptively discriminate different characteristics in the received signals, in real time in order to provide data segments of interest that can be correlated to subsequent seismic phenomena and can be classified with respect to pre-recorded samples of previous points of interest (POIs).
PREMONNs as it was demonstrated in previous studies can be used for time-series switching detection and can be applied to the detection of POIs , whereas SOMs have been extensively used in unsupervised pattern recognition and classification of datasets.
For the purpose of this paper, data acquired in Thessaloniki (40.59N, 22,78E) from the VLF station in Tavolara, Italy (ICV station Lat 40.923, Lon. 9.731) for over two years (December 2010 - December 2012) are used. The receiver was developed by Elettronika Srl, and is part of the International Network for Frontier Research on Earthquake Precursors (INFREP).
The received VLF signal is normalized and then processed using the Empirical Mode Decomposition Method (EMD). The resulting data are passed to an Artificial Neural Network (ANN) based on PREMONNs trained specifically for this purpose and the output from that stage is passed onto a classifier based on SOMs to compare and classify points of interest based on a current database of received signals and identifying and storing new ones for future reference. The efficacy of the detection and the results of the aforementioned process is then discussed and results are presented.
Therefore, based on the results it may be concluded that an automated system developed with time series detection, pattern recognition and database classification can significantly improve the current method of analyzing data produced by Seismic-Ionospheric Precursor phenomena and can provide a real-time method for correlating seismic activity with the observed disturbances.