USE OF NEURAL NETWORKS AND SAR INTERFEROMETRY FOR THE AUTOMATIC RETRIEVAL OF TECTONIC PARAMETERS

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ABSTRACT

From its first application in 1992 to detect the displacement field originated from the Landers earthquake [1], SAR Interferometry (InSAR) has been successfully applied to analyse a number of strong (Kobe, 1997 [2]; Izmit, 1999 [3]; Hector Mine, 2000 [4]; Denali, 2002 [5]; Bam, 2003 [6,7]) and moderate (Colfiorito, 1997 [8]) earthquakes. By mapping strain accumulation globally, InSAR is gradually breaking seismology's monopoly in the study of earthquakes, in many cases providing information not otherwise available. The centimetric accuracy of InSAR allows reconstructing the co-seismic surface displacement field by comparing pre- and post-event SAR data and calculating the interferometric phase [1]. It can also show pre- and post- event movements, whenever present.

In the recent years InSAR capabilities, together with classic seismological and geophysical data such as strong motion records and GPS, have also been used by geophysicists for the assessment of normal fault models [8], generally stemming from the Okada formulation [9]. In particular, for modelling radar interferometric data the RaNGe CHaNge (RNGCHN) software [10] calculates the displacement components, expression at the surface of the seismic source in an elastic half-space. Of great interest and usefulness in this context is the solution of the inverse problem, which means to recover the source parameters from the knowledge of InSAR surface displacement field. In particular the surface displacement field obtained by InSAR application contains useful information to define the fault geometry (dip and strike angle; width and length), the extension of the rupture, the distribution of slip on the fault plain. To this aim, some significant results have been achieved by means of the simulated annealing technique [11-13]. However, due to the intrinsic ill-posedeness of the problem, some issues remain still open and more investigation is needed.

Neural networks have already been recognized as being a powerful tool for inversion procedure in remote sensing applications [14,15]. They are composed of many nonlinear computational elements (called neurons) operating in parallel and connected by the so called synapses, each characterized by a synaptic weight. The use of neural networks is often effective because they can simultaneously address nonlinear dependencies and complex physical behaviour.

In this study we propose an innovative approach for the seismic source classification and the fault parameter quantitative retrieval. The originality of such an approach consists in exploiting at the same time the capabilities of neural networks and of InSAR measurements in the described context. The network is trained by using a data set generated by the RNGCHN software and then tested on real measured data. The input of the net consists of a set of features calculated from the interferometric image while the output vector contains the parameters characterizing the fault. Two problems have been analysed. The first one is the identification of the seismic source mechanism. The second one addresses the fault plane parameters estimation. The paper illustrates such a methodology and its validation on a set of experimental data. The experimental set up was composed by three case studies covering different types of faults: normal, strike slip, reverse.

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