Presenting and Corresponding author: Mario Costantini
Affiliation: Telespazio S.p.A.
Address: Via Tiburtina, 965 - 00156 Roma, Italy
Email: mario.costantini@telespazio.com, mario.costantini@gmail.com

A New Method for Identification and Analysis of Persistent Scatterers in Series of SAR Images

Mario Costantini, Salvatore Falco, Fabio Malvarosa, Federico Minati
Telespazio S.p.A.
Via Tiburtina, 965 - 00156 Roma, Italy

Abstract

Synthetic aperture radar (SAR) interferometry allows measuring slow terrain movements. The extraction of this information is a complex task, because the phase is measured only modulo 2π. Moreover, the phase is affected by noise (due to the decorrelation between the signals of different acquisitions), and systematic terms (due to the limited accuracy of the orbital data and digital elevation model used in the processing, and to the different atmospheric conditions at the various acquisition dates). The points characterized by too high noise must be discarded, while the systematic terms must be determined, using statistical or deterministic models for the disturbances to be eliminated and the signals to be determined.

The persistent scatterer approach [1], [2], with the ideas of minimizing the amplitude and phase dispersions in long series of full resolution SAR images, brought important advances in the respect of the problem above. In this approach, a key step is the removal of orbital and atmospheric phase artefacts, necessary not only for the analysis but for the identification of all possible persistent scatterers. Typically, the atmosphere phase delay in any point of the full resolution image is estimated by means of local (linear) or global (model based) interpolations or fits, starting from the phase delays estimated on a preliminary set of points selected by analyzing amplitude dispersions [1], [2], [3]. An alternative possibility is to start from a low resolution model of the atmosphere obtained on multi-looked data [4], [5].

In this work, we present a new algorithm for the identification and the analysis of persistent scatterers in series of full resolution SAR images. Orbital and atmosphere phase artefacts are effectively eliminated by exploiting their spatial correlation, but without using model based interpolations to remove orbital and atmospheric phase artefacts. In addition, a modified definition of the so-called temporal coherence is proposed, which is more effective, in particular with not very long series of acquisitions. This approach allows us to efficiently identify all possible persistent scatterers, and to retrieve the corresponding terrain height and displacement velocity.

The method have been tested and compared with other techniques on simulated and real SAR data. The obtained results show that the proposed approach is very promising. In particular, it is expected to obtain a higher density of persistent scatterer measurements than previous techniques, at least in the cases where the atmospheric artefacts are not very well described by the models used in standard approaches.

References

[1] A. Ferretti, C. Prati, F. Rocca, “Permanent scatterers in SAR interferometry,” *IEEE Trans. Geosci. Remote Sensing*, vol. 39, pp. 8-20, Jan. 2001.

[2] A. Ferretti, C. Prati, and F. Rocca, “Non-linear subsidence rate estimation using permanent scatterers in differential SAR interferometry,” *IEEE Trans. Geosci. Remote Sensing*, vol. 38, pp. 2202–2212, Sept. 2000.

[3] A. Hooper, H. Zebker, P. Segall, and B. Kampes, “A new method for measuring deformation on volcanoes and other natural terrains using InSAR persistent scatterers,” *Geophys. Res. Lett.*, vol. 31, 2004.

[4] R. Lanari, O. Mora, J.J. Mallorqui, P. Berardino, and E. Sansosti, “A small-baseline approach for investigating deformations on full resolution differential SAR interferograms,” *IEEE Trans. Geosci. Remote Sensing*, vol. 42, no. 7, pp. 1377–1386, July 2004.

[5] G. Fornaro, F. Lombardini, F. Serafino, “Three-dimensional multipass SAR focusing: Experiments with long-term spaceborne data,” *IEEE Trans. Geosci. Remote Sensing*, vol. 43, no. 4, pp. 702–714, April 2005.