DETECTION OF MULTIPLE SCATTERERS IN SAR TOMOGRAPHY

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Abstract

Due to the capability to provide direct physical measurements, interferometry is among the remote sensing techniques that have most pushed the applications of SAR to a wide range of scientific areas and have provided direct returns for our society in terms of improved security. Repeat pass DInSAR and, more specifically, its evolution to Persistent Scatterers Interferometry (PSI), which allows the accurate localization of ground targets and the monitoring of possible displacements up to a mm/year order accuracy, has been the breakthrough for the application of SAR in the risk monitoring. Multipass/multiview SAR data are today available for most of the Earth surface by means of existing sensor acquisitions carried out over repeated orbits. Such amount of data demands for the development of new processing techniques aimed, similarly to multiple pass DInSAR and PSI, at jointly processing, in a coherent way, the available information lying in the complex data cube (associated to the Single Look Complex (SLC) image stack) to produce accurate physical measures. SAR tomography, also referred to as 3D SAR imaging, is a further example along this line. It is based on the principle that the acquisitions, corresponding to different passes, can be assimilated to the data collected at the different elements of an antenna array parallel to the elevation direction. Hence, as in the classic azimuth antenna synthesis process, digitally performed offline on the acquired signal, an (synthetic) aperture in elevation direction can be synthesized to profile the scattering distribution along that direction and, hence, to image the scene in full 3D. DInSAR and SAR tomography have been recently fused to identify a new framework, i.e. the differential SAR tomography processing, also known as 4D (space velocity) SAR imaging [1], [2]. Such technique has shown the potentiality to overcome the spatial resolution limits of the classic PSI, allowing the separation of multiple interfering scatterers within the same pixel.

The analysis of long-term multiview/multitemporal data requires the development of techniques able to distinguish the useful signal from noise and clutter in order to identify, locate, and monitor the huge number of ground structures. At the same time, it is also necessary to keep as low as possible the occurrence of signal misinterpretation, even in relatively low Signal-to-Noise Ratio (SNR) conditions. Standard PSI techniques carry out the detection of single scatterers via a threshold comparison of a decision variable, obtained by matching the observed phase values to a multibaseline/multitemporal linear model. On the contrary, 3D/4D based analysis detects single targets by comparing the focused scattering distribution along the elevation/elevation-velocity directions and the ideal response of a scatterer located at the given elevation/elevation velocity position. In [3], the problem of detecting single and stationary scatterers in multidimensional SAR imaging has been investigated, resorting to detection schemes based on the Generalized Likelihood Ratio Test (GLRT); however, such a detector is unable to accommodate multiple signal models, that can be describe a situation with multiple scatterers.

In this work we follow an alternative approach, proposed in [4], based on the multifamily likelihood ratio test; such approach extends the GLRT and alleviates its limitation in the detection of multiple scatterers within the same pixel.

[1] F. Lombardini, "Differential Tomography: a New Framework for SAR Interferometry", *IEEE Trans. Geosci. Remote Sens.*, Vol.43, pp.~7-44, 2005.

[2] G. Fornaro, F. Lombardini, and F. Serafino, "Multidimensional Imaging with ERS Data", *Fringe 2005 Workshop*, Frascati (Italy), 28 November - 2 December 2005, (http://earth.esa.int/workshops /fringe2005/ programme.html).

[3] A. De Maio, G. Fornaro, A. Pauciullo, "Detection of Single Scatterers in Multi-Dimensional SAR Imaging", in print on *IEEE Trans. on Geosci. and Remote Sens*.
[4] S. M. Kay, "The Multifamily Likelihood Ratio Test for Multiple Signal Model Detection", *IEEE Signal Processing Letters*, Vol. 12, No. 5, May 2005.