Radar Permanent Scatterers Identification in Urban Areas: Target Characterization and Sub-Pixel Analysis

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The Permanent Scatterers (PS) technique, developed by the authors during the last three years, allows the identification of radar targets particularly suitable for SAR interferometric measurements. In fact, despite its remarkable potential, spaceborne SAR Differential Interferometry (DInSAR) has not been fully exploited as a reference tool for ground deformation monitoring, due to the presence of atmospheric artifacts as well as geometrical and temporal phase decorrelation. Both drawbacks are overcome by using a multi-image framework of interferometric data (>30 images) in order to properly identify and exploit the subset of image pixels corresponding to coherent reflectors (PS).
Whenever the sparse grid of PS is dense enough (more than 3-4 PS/Km2, constraint always satisfied in urban areas), accurate phase measurements carried out on the sparse PS grid allow one to compensate data for the atmospheric phase contributions.
Average ground deformation rate as well as full displacement time series (both along the satellite Line Of Sight, LOS) are estimated with millimetric accuracy on individual PS locations, fully exploiting the long temporal series of SAR data available in the ESA ERS-1/2 archive. Therefore, the PS subset of image pixels can be seen as a high-density (100-300 PS/Km2, in urban areas) "natural" geodetic network.
In this paper, we present some new results concerning the statistical characterization of the PS, both in terms of amplitude and phase returns. Moreover, it is shown how PS density can be significantly increased, in urban areas, by adopting a second-order model. Here, two individual scatterers per resolution cell are considered. Available data are then used to recover their reflectivity, elevation and LOS velocity. Problems related to over-fitting and model parameters estimation will be addressed. Results obtained processing 64 SAR images (ESA-ERS archive) acquired over Milan will be shown.
Finally, we present how PS can be exploited to carry out interferometric measurements using ERS-2 images acquired when the sensor was in Emergency Back-up Mode (EBM). Both theoretical (signal processing) and practical issues will be considered. First results obtained over Paris will be discussed.

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