Tomographic SAR Inversion by Generic Log-Barrier Algorithm – The Second Order Cone Programming Approach.

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***Abstract* – In Multi-Baseline SAR tomography, vertical resolution is directly proportional to the synthetic height aperture antenna. In order to avoid the problem of obtaining aliased inverted tomographic results is necessary to collect a sufficient number of observations that are distributed along the vertical synthetic aperture intervals according with the sampling theorem. In order to perform a successful SAR Tomography is so required to acquire a great number of repeat-pass radar tracks. A so done procedure increases all the problems due to the temporal decorrelation phenomena. Consequently, it's often necessary to design tomographic SAR acquisition geometries, using the fewest number of repeated active radar tracks. To adequately compensate the bad consequences due by the under-sampled configuration, it's therefore necessary to process the acquired data with evolved signal processing techniques. In order to process forest environments by the SAR Tomography technique, in the above described configuration, is necessary to implement algorithms that can well work for targets that have a coherent scattering nature and for targets that have a continuous scattering nature, or for both of them. In forests a foliage area target is characterized to have a continuous vertical reflectivity spectrum and man made objects, tree trunks or the flat earth, are characterized to have a discrete vertical reflectivity spectrum. Various Compressed Sensing (CS) signal processing techniques that base their principal computational core processing in minimizing the ℓ_1 norm, in most of the cases are unable in the continuous environmental condition to correctly estimate scattering targets parameters. The first order statistics CS signal processing techniques will maybe be excellent methods for processing only isolated coherent scatterers of a multi-baseline data-set. This paper considers the problem of Convex Optimization (CVX) in order to process tomographic data-sets in forested environments for a Fourier under-sampled configuration. The CVX problem, in the case of forested areas is solved by a Second Order Cone Programming Solution (SOCPs) using a generic log-barrier algorithm, trough a successfully computational bottleneck Newton calculation. This work is intended to be a reference paper in order to validate the SAR Tomography technique as a powerful utility, to perform a precise forest parameter estimation, in terms of radiometric accuracy and in the particular minimum-tracks number configuration. This technique is validated either processing synthetic or real tomographic radar data-sets. The contrasted results are obtained analyzing different spectral Fourier based estimators, like bamforming and Capon, that where been compared with the more advanced signal processing techniques based on the ℓ_1 minimization and SOCP log-barrier CS. Results demonstrate that the SOCP log-barrier CS technique is a far superior algorithm, if compared with both classical Fourier spectral estimator and with those based on the first order statistics CS. With SOCP log-barrier CS techniques it's possible to precisely estimate the targets position in height, preserving their forms, in a very strong back-scattering radiometric accuracy, over the worst under-sampled acquisition condition.**