PARAMETRIC VERSUS NON-PARAMETRIC COMPLEX-VALUES IMAGE ANALYSIS

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The paper dwells into the comparison of parametric and non-parametric complex-valued 2D signal analysis, focusing the attention on complex-valued sub-meter SAR image data.
The work is based on the study carried out in [1][2], [3][4] and [5]. In [1][2] a parametric Gauss-Markov Random Field (GMRF) model has been proposed for texture analysis and in [3][4] a time-frequency analysis (TFA) method has been proposed as a non-parametric approach for classification scheme of different targets with different backscattering behaviors. In [5], the authors consider the source of the anisotropy, i.e. the geometric and volumetric scatterers, and present a general characterization of azimuthal anisotropy based on a sub-aperture pyramid which is a set of sub-apertures arranged in a pyramidal fashion: the collection of sub-apertures provides a multi resolution representation of SAR data.

The parametric complex-valued Gauss-Markov Random Field (GMRF) model can be used either as likelihood [1] or as prior model [2] in a Bayesian point of view. In [1] the complex-valued GMRF model is presented and applied on polarimetric data, while in [2] is mainly used for de-speckling purpose as prior model in Tikhonov regularization. We want to extend the analysis to targets in order to use the model parameters to characterize the backscattering behavior. We assume the data to be modeled by the GMRF likelihood. Although the data are not Gaussian where a strong scatterer is present, because the sinc SAR system response strongly modulates the target, a GMRF model gives vantages in term of simplicity.

The analysis of the spectrogram gives understanding of the scattering mechanism [3][4]. The TFA approach can be assumed as a generalization of the azimuth splitting method. In the latter, the cut of the spectrum allows the study of the phase responses of scatterers, which have been viewed by the antenna at different viewing angles. The principle exploits the holographic property of the spectrum at the cost of reducing resolution. The TFA approach gives encouraging results, but has been applied only on areas where groups of known targets are present. This does not allow a full exploitation of the method for practical application, thus the challenge is to extend the TFA method to analyze the image content in order to separate a broader class of targets.

The TFA is a linear model exploiting signal non-stationarity in the time-frequency domain, whereas the GMRF model with a quadratic energy function parameterizes the spectrogram of the signal. Parametric and non-parametric methods have been compared to understand, characterize and analyze complex-valued SAR images. Spot Light (SL) mode TerraSAR-X Single Look Complex (SLC) data have been used as test data building a database of scatterers with different phase behaviors.

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