EXPLOITATION OF THE ADDITIVE COMPONENT OF THE POLARIMETRIC NOISE MODEL FOR SPECKLE FILTERING

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Speckle suppression in Single Look Complex (SLC) polarimetric images is still a challenge because of the difficulty to separate a highly dimensional noise from the signal with little useful information that can be derived from rank-1 covariance/coherency matrices. It has been demonstrated in [1] that for SLC data, the observed Hermitian matrix $\mathbf{Z}$ is affected by two noise components:

$$\mathbf{Z} = \mathbf{C} + \mathbf{N}_m + \mathbf{N}_a$$

where $\mathbf{N}_m$ is the multiplicative noise component that will dominate in image regions with strong coherence values whereas $\mathbf{N}_a$ is the additive noise component dominant within low coherence areas. In [2], a turbo-filtering approach has been proposed for the filtering of speckle noise in SLC images. This approach combines two orthogonal filters: the first one is a conventional adaptive filter in the image domain and the second one is a filter in the noise domain. In our initial implementation, only the multiplicative term $\mathbf{N}_m$ was used in the turbo-filter feedback loop. In this paper, we look at the possibility to use the additive noise component in order to further improve the extraction of the image structure from the off-diagonal terms of the coherency/covariance matrix. The goal here is to improve the feedback from the filter working in the noise space in order to correct for eventual restoration deficiencies by a conventional adaptive filter (e.g. Lee filter or MBPolSAR [3]).

The additive noise space is more challenging to handle because it is a complex and zero centered noise with a coherence dependent variance. A simple way to tackle the problem is to work on the amplitude of the additive noise. First, we investigate the statistical properties of the additive noise component in particular the high order moments. Then, we propose to retrieve the image structure from the estimated noise image using a wavelet transform. The resulting image structure mask is then combined with the one derived from the analysis of $\mathbf{N}_m$ only.

Filtering performances are evaluated on artificial PolSAR images as well as real SLC datasets. Performance metrics are focusing on speckle suppression (ENL), edge preservation, bias reduction on polarimetric parameters (Cloude-Pottier parameters), point target preservation and classification performance.

[1] López-Martínez, C.; and Fàbregas, X., "Polarimetric SAR Speckle Noise Model" IEEE Transactions on Geoscience and Remote Sensing , vol.41, no.10, pp.2232-2242, Oct. 2003.

[2] Farage, G.; Foucher, S.; Benie, G.B., "Turbo Speckle Filtering Applied on PolSAR Images," IGARSS 2008, vol., no., pp.2648-2652, 23-28 July 2007.

[3] López-Martínez, C.; and Fàbregas, X., "Model-Based Polarimetric SAR Speckle Filter," IEEE Transactions on Geoscience and Remote Sensing , vol.46, no.11, pp.3894-3907, Nov. 2008.