EVALUATION OF THE INFLUENCE OF THE POLARIMETRIC CALIBRATION PROCESS ON THE H/A/ALPHA DECOMPOSITION

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1. INTRODUCTION

The different internal and external distortions sources to a polarimetric synthetic aperture radar (PolSAR) insert into the amplitude and phase synthesized by the SAR system, information that does not come from the ground targets, thus altering the information of the target backscatter measured by the radar. The process of minimizing these distortions, using different calibration procedures will depend on the internal characteristics of the SAR system, the illumination geometry, the propagation medium, the topography of the region imaged and the application of PolSAR images. Among these applications, the classification of digital images is of great importance. Several methods of complex PolSAR image classification have been developed in recent years, based on the entropy, anisotropy and the α-angle Target Decomposition Theory [1], [2], [3], [4], [5], [6]. The objective of this article is to evaluate the influence of the cross-talk and channel imbalance calibration on the estimation of the entropy and the α-angle parameters derived from this decomposition. Few studies can be found in SAR literature concerning the influence of the polarimetric image calibration process on the target decomposition methods and their consequences on the characterization and discrimination of different ground targets. The great advantage of using polarimetric data, represented by the scattering matrix [S], is the possibility of a physical interpretation of the scattering of a random media. For such, we can decompose the scattering matrix [S] into a sum of independent contributions, which are associated to certain basic scattering mechanisms. The methods employed to accomplish this decomposition are called Target

Decomposition Theorems. An important class of these decompositions theorems is called the eigenvector decomposition [7], which provides a physical interpretation of scattering mechanisms, through the concept of entropy (H), anisotropy (A) and the α-angle [8].

2. METHODOLOGY

The influence of the polarimetric calibration over the H and α-angle images is illustrated here by using a methodology divided into five steps based on an L-band fully polarimetric SAR data acquired by the SIPAM (Amazon Protection System) airborne R99-SAR over two areas of study, located in the Brazilian Amazon Forest and urban area regions. In the first step, several trihedral corner reflectors were distributed in the field over the imaged areas and they are used for calibrating the acquired images. In the second step, a system for radiometric and polarimetric calibration of PolSAR images has been implemented. This system, developed into the ENVI/IDL environment, consists of several well-known tools found in the literature, not available so far in a single SAR processing environment, with some additional interactive and user friendly graphic features. In the third step, the original Quegan´s algorithms [9] is used, with the modifications proposed by Kimura *et al*. [10], and the polarimetric information about the corners reflectors to calibrate the single-look complex PolSAR images. In this stage, the process of correcting the cross-talk, channel imbalance and symmetrization of cross-polarization components were combined to obtain different complex PolSAR calibrated images. In the fourth step, based on the entropy and α-angle images obtained from these calibrated images, samples of different classes of interest were selected, representing natural and artificial targets in the images, which provided an adequate characterization of various scattering mechanisms represented by the eight valid zones into the H/α-angle plan [1]. The last step was undertaken to evaluate the spread of the pixels within each cluster and the displacement of the centers of gravity of the classes of interest in the H/α-angle plan, when different polarimetric calibration procedures we applied.

3. CONCLUSION

The appropriate minimization of the cross-talk and channel imbalance distortions contributes to the displacement of the classes of interest towards the areas of the H/α-angle plan that proper characterize the scattering mechanisms of each of these classes. The results confirm the findings presented in Kimura *et al.* [10], where it is described that the α-angle is more sensitive to the calibration of co-polarized

channels, when there is a low level of cross-talk. The results described above suggest that, even with low levels of cross-talk and channel imbalance, according to the values obtained in this work for the R99B SAR sensor system, the use of the polarimetric calibration, especially the channel imbalance correction, is essential for a proper image classification. In case of using non-calibrated images, the results of PolSAR image classification based on the decomposition of entropy and α-angle may be affected by inaccurate characterization of scattering mechanisms in the H/α-angle plan, which will result in a grouping of different classes of interest representing these mechanisms. This shows that the effort for calibration is essential to ensure an accurate characterization of the polarimetric information from the ground targets, giving greater reliability in applications based on polarimetric SAR images.

4. REFERENCES

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