ELECTROMAGNETIC-BASED APPROACH FOR RGB REPRESENTATION OF SAR MULTITEMPORAL DATA

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Abstract

In this paper we present an innovative approach for interpretation, processing and representation of multi-temporal SAR images. The proposed approach includes three blocks of activities concerning data calibration, adaptive processing and user-based representation. The knowledge of electromagnetic models guides the production of RGB products, whose interpretation does not require specific expertise in remote sensing. The method is presented with the support of a case study concerning the production of land cover maps in a rural context.

Index Terms – Synthetic aperture radar, multitemporal processing, RGB representation.

I. INTRODUCTION

Despite the huge amount of available data and scheduled missions, the use of SAR data in applicative scenarios is still limited. The main constraints to a full exploitation of the potentiality of SAR are the lack of reliable interpretation models and the limited efficiency of methods that should present the retrieved information with universally recognized symbolism [1].

This paper presents a new approach for addressing these issues, shading light on the importance of electromagnetic models for both image interpretation and data representation. The proposed 3 steps multi-temporal adaptive processing (MAP3) define the processing needed for the production of new multi-temporal products. The proposed processing aim at obtaining a set of spatially, temporally and radiometrically comparable images, whose appropriate combination will provide user-friendly maps. In section II, the rationale of the proposed approach is discussed. In Section III, the obtained RGB products are presented. Discussion of the results and the concluding remarks are provided in Section IV.

II. RATIONALE

The block diagram of Fig. 1 describes the rationale of the proposed approach, made of three blocks of processing. The pre-processing chain includes data coregistration, despeckling and calibration, providing as output a set of comparable images. The obtained images are then combined in order to retrieve the physical information that is object of analysis. The last block involves the processing devoted to appropriately represent the estimated information, providing products that could be read and comprehended by users with no experience with SAR images.

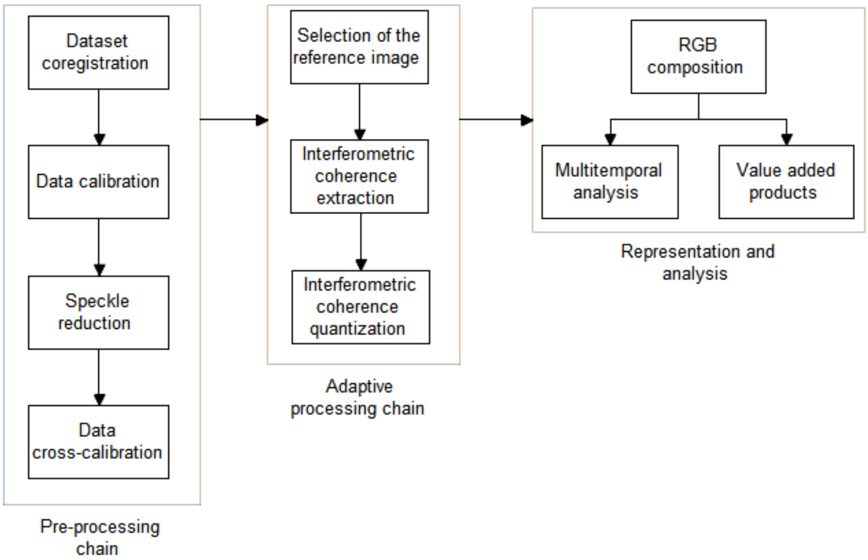

FIG. 1 – Block diagram of the proposed method.

The design of the blocks was guided by six properties: (i) reproducibility; (ii) automation: a minimum number of parameters to be set up by the users; (iii) adaptability: the processing should be suitable for a large number of applications; (iv) reversibility: the processing chain should preserve the electromagnetic and physics characteristics of the analyzed scene, giving rise to invertible models; (v) visualization: the output maps should be comfortable with human view and help the visual extraction of information; (vi) interpretation: the obtained maps and value added products should be easily interpreted by a large variety of scientists and researchers belonging to different disciplinary sectors.

Knowledge of the electromagnetic propagation and scattering models is needed in order to combine the images of the time series in a color composite view. In fact, the data should be expressed in a common scale with a number of levels (usually 256) suitable with human visual perception. Blind methods existing in literature tried to solve the problem with percentile-based histogram clipping and rescaling. But, in time-variant scenarios (for example, in monitoring agricultural cycles), this method could lead to alteration of the amplitude ratios between different images and to misclassification of the required features.

In our approach, in order to guarantee a reliable criterion of comparability between a series of images, we impose the conservation of the amplitude ratios, ensuring that the histogram clipping is performed at the same amplitude level for all the elements of the time series. Under the hypothesis that the calibration step provides perfectly calibrated images, the proposed method guarantees the balance of the channels involved in the RGB composition. The choice of the clip level is guided by electromagnetic backscattering models.

III. RGB PRODUCTS

The rationale described in Section II has been tested on a set of 15 COSMO-SkyMed stripmap images with 3 meters of spatial resolution acquired in the North of Burkina Faso, a semi-arid region where a 3 months wet and a 9 months dry seasons characterize the climate [2]. We loaded on red, green and blue bands the coherence map, the test image and a reference image acquired at the end of the dry season, respectively. The band-color association facilitates the association between the displayed colors and the physical characteristics of the scene. The clip level has been chosen in order to enhance the evolution of vegetation during the year. In Fig. 2 a full resolution detail of the intensity of a single SAR image, acquired in August (during the wet season) is compared with the corresponding MAP3 product.

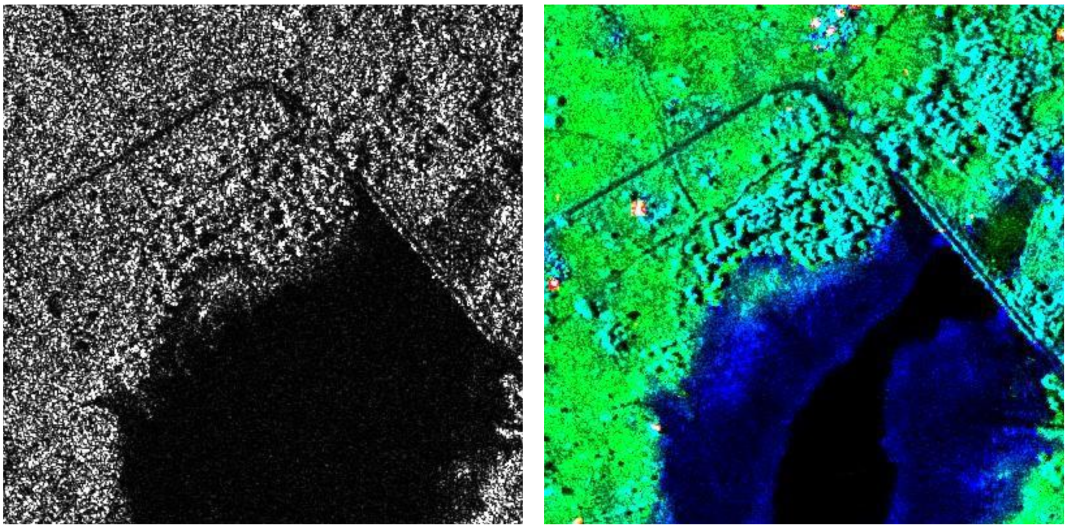

Fig. 2 – Single SAR image intensity (left) and MAP3 result (right).

The interpretation of Fig. 2b, where vegetation is mapped in green and water in blue, does not require any *a priori* knowledge of the electromagnetic mechanisms that govern the formation of the SAR image, despite they were essential for their construction.

An RGB image for each acquisition was provided, allowing a monitoring of the land cover on a 40 x 40 km^2 area. The proposed approach allows to show the growth of vegetation, because it determines an enhancement of the electromagnetic backscattering during the wet season, as shown in Fig. 3. In the dry season image, the cyan is the dominant color because the electromagnetic response of the two scenes is almost unchanged, except for the areas in which the counter-season agriculture is exercised.

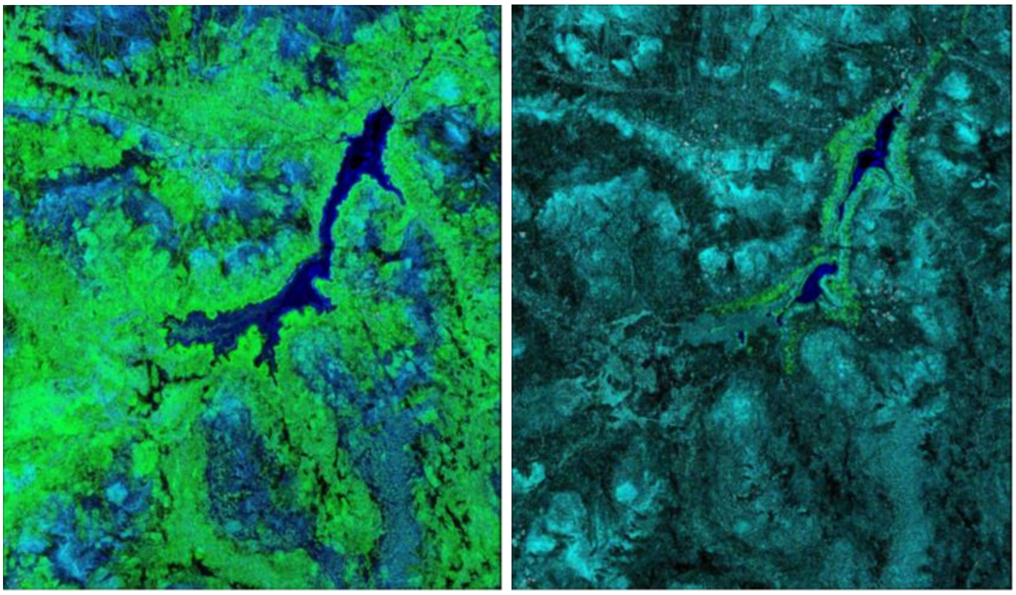

FIG. 3 – Comparison between MAP3 products relative to wet (left) and dry season (right) acquisitions.

IV. CONCLUSION

In this paper we presented a new approach for processing a set of multi-temporal SAR images and producing RGB products. The method is based on three blocks of processing and provides products that can be easily read by potential beneficiaries, with no expertise in electromagnetics or remote sensing. Appropriate electromagnetic models guide the choice of the tuning parameters that allow to adaot the processing to specific applications.

ACKNOWLEDGEMENT

The SAR images were provided by the Italian Space Agency (ASI) under the aegis of the 2007 COSMO-SkyMed AO Project 'Use of High-Resolution SAR Data for Water Resource Management in Semi-Arid Regions'.

REFERENCES

[1] V. Madhok and D. A. Landgrebe, "A Process Model for Remote Sensing Data Analysis," *IEEE Trans. Geosci. Remote Sens.*, vol. 40, no. 3, pp. 680–686, 2002.

[2] D. Amitrano, G. Di Martino, A. Iodice, G. Ruello, F. Ciervo, M. N. Papa, and Y. Koussoube, "Effectiveness of High-Resolution SAR for Water Resource Management in Low-Income Semi-Arid Countries," *Int. J. Remote Sens.*, vol. 35, no. 1, pp. 70–88, 2014.