COLOR-CODING OF SAR IMAGES USING MULTITEMPORAL

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Abstract

In this paper, we present an innovative, human-centered framework for color-coding of multitemporal SAR images. The objective is to provide ready-to-use images for applications and characterized by a high degree of interpretability, even for non-expert users, and the possibility to be processed with simple, end-user-oriented algorithms for information extraction.

Index Terms – image interpretation, synthetic aperture radar

I. INTRODUCTION

In order to favor the dissemination of SAR data, it is very important to take care of users' experience, both from the standpoint of visualization and processing [1]. In fact, despite the huge investments made by the international community to develop and launch new sensors, the use of SAR data in applications is still rather limited. Therefore, there is a strong necessity to design end-user-oriented frameworks putting users at the center of the processing chain [2].

In this paper, we present an innovative, human-centered framework for RGB composition of time-series SAR images. The aim is to provide ready-to-use images characterized by a high degree of interpretability (even for non-expert users) and the possibility to be processed with simple techniques/algorithms for the extraction of meaningful physical information [3]. In such way, the idea (widely diffused in among multidisciplinary users) that SAR images are too complicated to be understood and processed is overcame.

II. METHODS AND PRODUCTS

The MAP3 framework exploits a rigorous multitemporal processing for making explicit the semantic of SAR images using an end-user-oriented RGB presentation. The framework is composed by three major processing blocks aimed at:

- Radiometric calibration and geometric registration, in order to make images of the time series comparable each other. Despeckling is also a key activity in this phase to enhance image presentation and improve objects discrimination;

- Selection of the best variables involved in the fusion process. This choice will determine the output product;
- Data fusion,

The outputs of the MAP3 framework are two classes of RGB products we named as Level-1α [1] and Level-1β [4]. These products have different rationale:

- Level-1α products are bi-temporal images oriented to change-detection applications. In this case, we exploit two SAR images and their interferometric coherence to enhance changes with respect to a suitable reference situation.
- Level-1β products summarize in a unique RGB frame the information content of a SAR multitemporal series. In this case, the RGB channels are constituted by temporal variables (mean backscattering, mean interferometric coherence, saturation index, time-series variance) opportunely combined. These products are particularly well suited for classification applications, since objects' appearance in the RGB image depends on their characteristic dynamics.

The principal characteristic of both Level-1α and Level-1β products is that the association color-object, being physical-based, is stable. Moreover, the RGB composition is designed in such way to recall the natural color palette, at least for some image features.

In Fig. 1, we show a Level-1α product depicting a rural area of Burkina Faso. This area is characterized by a semi-arid climate. This means that, at the top of the dry season, the environment is completely bare. This represents a good reference situation for change-detection, i.e. to monitor the evolution of the scene by comparing the electromagnetic response of a test image with that of the reference one.

However, the characteristics of this product allow for easily recognize water bodies and vegetation without having any information about the product composition. This is possible because these features are rendered in natural colors, giving the possibility even to non-expert users the possibility to easily reconstruct the scene semantic. Obviously, this is a false-color image. Therefore, other features are rendered in a color which depends on their electromagnetic response during the acquisitions composing the product. As an example, trees all around the lake are rendered in cyan due to their temporal backscattering stability.

As stated above, the proposed RGB products, are characterized by a physical-based and stable color-object association. Therefore, the variation of the scene does not affect the rendering of image features. This can be clarified by considering Fig. 2. In this case, the Level-1α product depicts a scene acquired over the city of Castel Volturno (Italy), i.e. in a temperate Mediterranean climate. However, the features' colorimetric response is constant (vegetation-green, bare soil-prussian blue, shadows/permanent water-black, etc.).

In Fig.3a and Fig. 3b, two images extracted from a Level-1β product concerning the city of Dresden is shown. The considerations made above about Level-1α products hold. In fact, even in this case, the color-object association is stable varying the scene and the climatic condition. Obviously, this association is different, since in this kind of images the rendering depends on objects' temporal behavior rather than their change with respect to a reference situation.

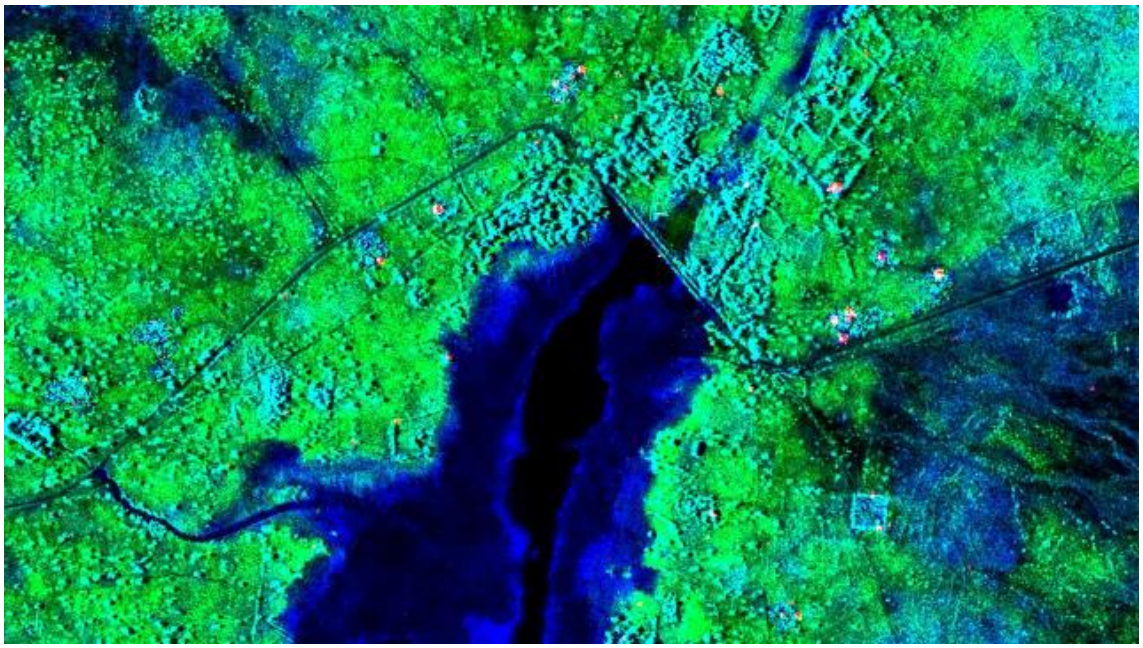


Figure 1. Burkina Faso, change-detection-oriented Level-1α product.

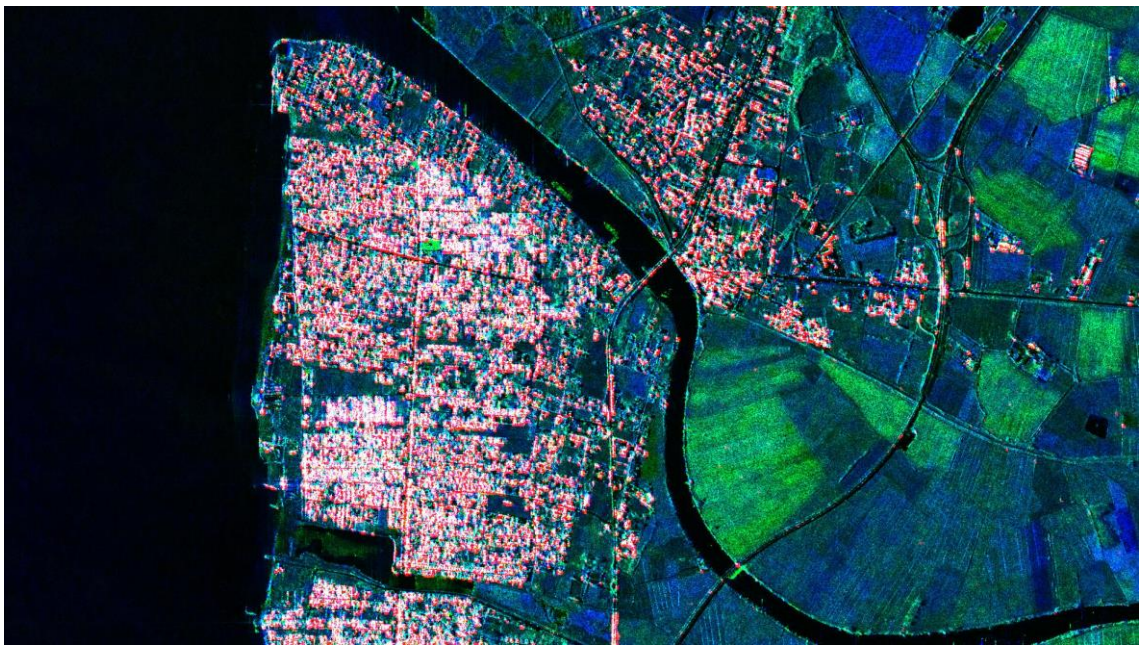
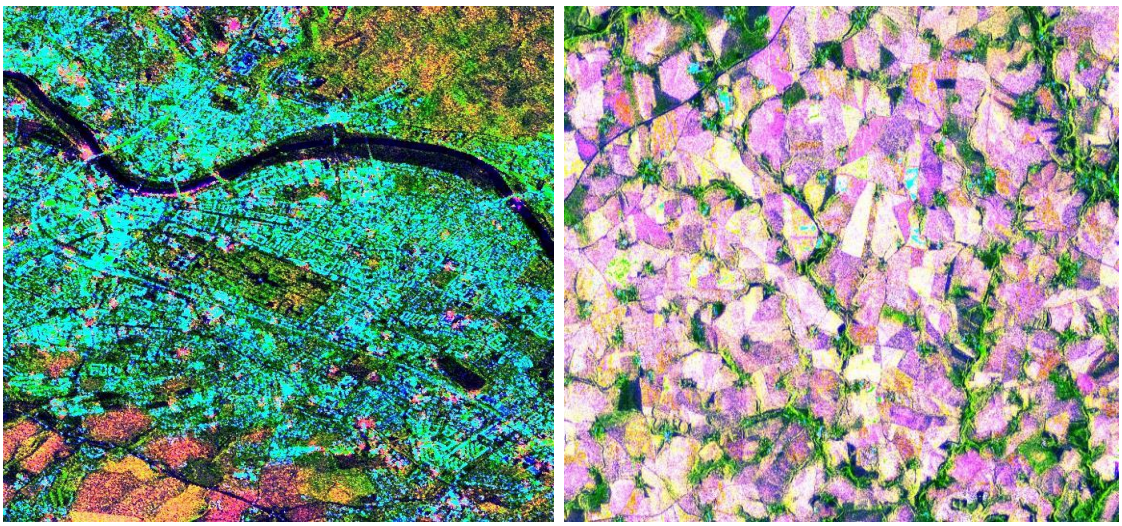


Figure 2. Castel Volturno (Italy), change-detection-oriented Level-1α product.

Both Level-1α and Level-β products demonstrated their suitability in applicative contexts, as illustrated, as in example, in [5] and [4].



(a) (b)

Figure 3. Dresden (Germany), Level-1β product: (a) urban area, and (b) growing crops.

III. Conclusions

In this paper, we presented an innovative framework for RGB composition of multitemporal SAR images. The aim is to provide ready-to-use images characterized by a high degree of interpretability and the possibility to be processed with simple algorithms for information extraction. The framework is particularly oriented toward end-users with the objective to improve their experience with SAR data.

References

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