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Editorial

Special Issue on Polarimetric SAR Techniques and Applications

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1. Introduction

Synthetic Aperture Radar (SAR) polarimetry is an active and fruitful field of research in Earth observation. Polarimetry provides sensitivity to the soil moisture, as well as to the structural and geometric properties of the targets under observation, allowing a more accurate identification and classification than with non-polarimetric data. Moreover, the increasing number of spaceborne SAR systems equipped with polarimetric capabilities, as well as future planned missions, enables the advance in this research field at all levels, from theory and physical modeling to final applications.

2. Polarimetric SAR: Techniques and Applications

This special issue was introduced to collect the latest research on relevant aspects of SAR polarimetry, to present state-of-the-art developments, and to show the current and futures challenges of SAR polarimetry with the availability of new sources of data. Therefore, this special issue also places an emphasis on studies for the exploitation of data provided by the new polarimetric spaceborne SAR sensors, which include additional frequency bands, interferometric capabilities, enlarged spatial coverage, high spatial resolution, and/or shorter revisit times. There were 17 papers submitted to this special issue, and nine papers were accepted (i.e., 50% acceptance rate). The published papers can be grouped into three main topics: polarimetric data classification, SAR polarimetry applications, and polarimetric SAR interferometry (PolInSAR).

From all the papers accepted in this special issue, three of them focused on polarimetric SAR data classification, covering different techniques, as well as different types of land surfaces. The first paper, authored by X. Wang, Z. Cao, Y. Ding, and J. Feng, introduces a composite kernel method, based on a Support Vector Machine classification approach [1]. The contribution of this paper is that data classification is based on a weighted combination of both polarimetric information and spatial characteristics derived from the Span image. As demonstrated by the authors, the introduction of this spatial information improves the overall classification accuracy. In the case of the Flevoland dataset, containing urban and agricultural areas, the overall accuracy increased from 95.7%, obtained with traditional methods, to 96.1%, whereas in the case of the San Francisco dataset, containing mainly urban areas, the overall accuracy increased from 92.6 to 94.4%. The second paper, authored by H. Zakeri, F. Yamazaki, and W. Liu, proposes the study of the city of Tehran, basically containing urban, bare, and semi-arid areas. The authors aim to classify this urban environment, whose population has increased dramatically, raising from 6 million inhabitants in 1986 to 12 million in 2011. In this case, the authors propose a Support Vector Machine classification scheme based on the use of polarimetric as well as texture information [2]. As in the previous paper, it is demonstrated that the use of spatial information, together with polarimetric information, helps to increase the overall classification accuracy. The third paper, authored by F. Gao, T. Huang, J. Wang, J. Sun, A. Hussain, and E. Yang, also addressed the problem of polarimetric SAR data classification considering spatial information. In this case, the authors propose a dual branch deep convolutional neural network, in which one of the branches considers the classification of the polarimetric information while the second considers the use of the spatial information, also derived from a combination of the original polarimetric images [3]. In this case, the authors also demonstrated that the use of spatial information, in combination with polarimetric information, helps to improve the overall accuracy of the classification approach. As it can be deduced from these interesting contributions, the classification of polarimetric SAR data improves classical classification approaches not based on polarimetric diversity. Nevertheless, the combination of this polarimetric information, together with spatial attributes, seems to offer clear improvement in classification accuracy, as demonstrated by all the authors.

A total of five papers were focused on the applications of SAR polarimetry; four papers were dedicated to land and vegetation, and one was dedicated to ocean. Two papers were devoted to studies on rice, as it is the main staple crop in the world. In the first one [4], Y. Izumi, S. Demirci, M. Z. bin Baharuddin, T. Watanabe, and J. T. Sri Sumantyo analyzed the temporal variations of polarimetric observables derived from full-circular and dual-circular polarimetric data acquired along the rice cultivation cycle with a ground-based sensor, and assessed several variables with regard to their effectiveness in phenology retrieval. O. Yuzugullu, E. Erten, and I. Hajnsek developed in a study [5] on the estimation of biophysical variables in rice fields by employing X-band copolar data and electromagnetic modeling of the scene. Also related to vegetation, but with a broader environmental scope, the paper coauthored by T. Ullmann, S. N. Banks, A. Schmitt, and T. Jagdhuber [6] describes the response of a large number of polarimetric observables, obtained at L-, C-, and X-bands in a tundra scene located in Canada. The use of shorter wavelength imagery (X and C) was beneficial for the characterization of wetland and tundra vegetation, while L-band data highlighted differences between the bare ground classes better. H. Omar, M. A. Misman, and A. R. Kassim [7] addressed the estimation of aboveground biomass in tropical forests by combining dual-pol data from two different sensors, Sentinel-1A and ALOS PALSAR-2, at two different frequency bands. As for the ocean application of polarimetry, Y. Zhang, Y. Li, X. S. Liang, and J. Tsou contributed in their study [8] with a comparison of quad-, compact-, and dual-polarimetry for oil spill classification, in which a new set of input features was proposed and tested.

Finally, one paper was published on polarimetric SAR interferometry, coauthored by D. Lin, J. Zhu, H. Fu, Q. Xie, and B. Zhang [9], in which a truncated singular value decomposition (TSVD)-based method is proposed for forest height inversion from single-baseline PolInSAR data. With such an approach, the assumption of null ground-to-volume ratio in one of the observed channels, common in most PolInSAR algorithms, is avoided.

3. Future Trends in Polarimetric SAR

Although this special issue has been closed, more advances in the processing and the exploitation of polarimetric SAR data are expected in the near future. Its usage in conjunction with other data sources (i.e., data fusion) and in a multi-temporal framework (i.e., time series) seems to be the most promising scenario for most final applications. Nonetheless, basic research and theoretical developments are still required to fully quantify the potentials of this remote sensing technology.

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