ETSIP011 Variational Textured Dirichlet Process Mixture Model with Pairwise Constraint for Unsupervised Classification of Polarimetric SAR Images

Abstract

This paper proposes an unsupervised classification method for multilook polarimetric synthetic aperture radar (PolSAR) data. The proposed method simultaneously deals with the heterogeneity and incorporates the local correlation in PolSAR images. Specifically, within the probabilistic framework of the Dirichlet process mixture model (DPMM), an observed PolSAR data point is described by the multiplication of a Wishartdistributed component and a class-dependent random variable (i.e., the textual variable). This modeling scheme leads to the proposed textured DPMM (tDPMM), which possesses more flexibility in characterizing PolSAR data in heterogeneous areas and from high-resolution images due to the introduction of the classdependent texture variable. The proposed tDPMM is learned by solving an optimization problem to achieve its Bayesian inference. With the knowledge of this optimization-based learning, the local correlation is incorporated through the pairwise constraint, which integrates an appropriate penalty term into the objective function so as to encourage the neighboring pixels to fall into the same category and to alleviate the “salt-and-pepper” classification appearance. We develop the learning algorithm with all the closed-form updates. The performance of the proposed method is evaluated with both low-resolution and high-resolution PolSAR images, which involve homogeneous, heterogeneous, and extremely heterogeneous areas. The experimental results reveal that the class-dependent texture variable is beneficial to PolSAR image classification and the pairwise constraint can effectively incorporate the local correlation in PolSAR images. Index Terms—Polarimetric synthetic aperture radar (PolSAR); unsupervised classification; Dirichlet process; variational inference and remote sensing.