

Methods and Algorithms for Feature Extraction and Semantic Analysis of Very High Resolution Polarimetric Synthetic Aperture Radar Images

Abstract - In recent history we experienced an exponential growth of the remote sensing data volume, which was caused by our need of understanding and solving critical problems in various fields. Moreover, due to the continuous development of technological means, the quality of the delivered data is also improving, better and better spatial resolution being available with each new remote sensing system. This improvement in spatial resolution requires new methods and algorithms for processing and analyzing remote sensing data. With respect to low resolution polarimetric synthetic aperture radar data, parametric methods have been widely used in the state-of-the-art literature. These methods rely on data's stationarity hypothesis, and in order to extract some parameters one has to assume an a-priori probability density model. Therefore, the results of different operations are strongly dependent on the validity of the stationarity hypothesis and on the goodness-of-fit of the applied pdf model. In the new context of high resolution data, the stationarity hypothesis does not hold anymore, so nonparametric methods have to be employed. In PolSAR data processing, the most common approach is applying coherent and incoherent target decompositions of the polarimetric representations (the scattering matrix or the covariance matrix), which would represent each backscattering mechanism as the sum of some simpler, canonical mechanisms. However, with the continuous decrease of the resolution cell, the spatial context of the recorded objects has become very important in detecting semantically meaningful categories. Polarimetric decompositions can be successfully applied to individual pixels or to small neighborhoods, but they are not suitable to large image patches, because the use of an averaging operator would cause a significant loss of information. The goal of this dissertation is to provide solutions to overcome these issues. Therefore, a number of methods and algorithms are proposed. These methods and algorithms are nonparametric, they are not biased by the data's stationarity hypothesis or by the goodness-of-fit of an applied pdf model, and they take into consideration the spatial context of the recorded objects, being able to detect semantically meaningful categories. All these characteristics recommend the proposed methods for processing and analyzing high and very high resolution polarimetric synthetic aperture radar images.