



PROJET D'ACCEUIL D'UN DOCTORANT EN SITUATION DE HANDICAP

Very high-resolution polarimetric SAR image characterization through Blind Sources Separation techniques

Séparation aveugle des sources polarimétriques en télédétection RSO satellitaire à très haute résolution spatiale

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1. CONTEXT

The Grenoble-Image-speech-Signal-Automatics Lab is a joint Research Unit (UMR 5216) of the CNRS and the Grenoble INP. GIPSA-lab was created in 2007 by federating all the Image and Signal research activities in Grenoble. At present time, GIPSA-lab represents 137 fulltime researchers and professors (including 35% CNRS researchers) and 140 PhD students. Among the research themes developed in the SIGNAL-IMAGE-PHYSICS (SIGMAPHY) team of the GIPSA-lab Image and Signal department (DIS), active remote sensing for geophysical applications has been investigated as part of the OSUG (Observatoire des Sciences de la Terre, de l'Univers et de l'Environnement de Grenoble) through various projects: MEGATOR, EFIDIR, PERMANET...

2. DESCRIPTION

Appropriate backscattered signal stochastic models are essential for correctly segmenting high-resolution Polarimetric SAR (POLSAR) images. Modelling using multivariate, centered, circular Gaussian random process is no longer acceptable for the new high quality images, since the reduced dimensions of the resolution cells increase the heterogeneity of the observed scene and obsoletes the Gaussian polarimetric model. Examples of advanced, non-Gaussian polarimetric stochastic models are the SIRV (Spherically Invariant Random Vectors) model and various submodels (e.g. the K or KummerU model).

During classification of POLSAR images, each pixel receives the label of a class. The segmentation algorithm essentially relies on the underlying stochastic model assumed for the backscattered radar signal (e.g. Gaussian, SIRV/KummerU, etc.). As such, homogeneity of determined classes is based on the statistical distribution of POLSAR image pixels, and the physical characteristics of the objects in the image are not considered at this stage.

In order to complement the stochastically based pixel classification, physical characterization may be also used. Since the backscattered signal is intrinsically linked with the physical characteristics of the objects in the image, valuable information may be extracted therefrom. Efforts have been made in direction of characterizing the physical structure of the objects observed by the radar from their polarimetric echoes. Several such decompositions have been proposed: Huynen, H/alpha/A, TSVM. The fundamental idea is that each elementary reflector (surface, sphere, dihedral) has a particular backscattering mechanism and that each target may be described as a superposition of such elementary reflectors.

An alternative to the physical decompositions based on the covariance matrix is to use the techniques dedicated for blind source separation (BSS). In its simplest form, the latter assumes that a number of sensor record different linear combinations of an equal number of sources. Making use of relative weak hypothesis on the original sources (e.g. the statistical independence of the random sources), the BSS techniques attempt to retrieve

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the coefficients of the linear combinations (e.g. the mixing matrices) and, correspondingly, the signals transmitted by the sources.

Recent methodological advances developed in the GIPSA-lab, the SIGnal-iMAge-PHYsics team, proposed optimal unsupervised classification in non-Gaussian POLSAR clutter [1] and blind source separation applied to multi-spectral images [2]. The key idea of this thesis is to propose a new physical characterization of the scattering target, inspired by the Blind Sources Separation techniques and to compare it to the conventional Principal Component Analysis inspired techniques existing in the literature.

[1]. *Coherency Matrix Estimation of Heterogeneous Clutter in High-Resolution Polarimetric SAR Images*, **G. Vasile**, J.P. Ovarlez, F. Pascal, C. Tison, IEEE Transactions on Geoscience and Remote Sensing, accepted, 2010

[2]. *Multivariate Image Processing*, C. Collet, **J. Chanussot** and K. Chehdi, ISTE Ltd, UK and Wiley & Sons, USA, 2010

Collaborations: Jean-Philippe OVARLEZ (ONERA) et Irena Hajnsek (DLR)

Funding : CNRS – campagne doctorants en situation de handicap 2010

3. CANDIDATE PROFILE

Technical skills: signal and image processing

Informatics skills: Linux, C, MATLAB/IDL, Makefile

Location: GIPSA-LAB DIS/SIGMAPHY – CNRS UMR 5216

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