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Spectral unmixing techniques for retrieving plant foliar information

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In this study two novel approaches for supervised and semi-supervised hyperspectral unmixing are applied in the unmixing of CHRIS/PROBA data, in order to monitor seasonal land cover changes – in particular plant foliar coverage. Foliar coverage variations are directly linked to seasonal changes of the ecophysiological status of a plant (i.e. growth status, pigment concentrations, LAI etc). The high potential of using hyperspectral satellite data in monitoring plant biochemical and structural characteristics is important in ecophysiological studies. A reliable and efficient method to extract leaf and/or canopy information from a mixed pixel significantly contributes towards this direction. In this study, the development of two efficient algorithms in spectral unmixing enables the detection and mapping of leaf contribution to the overall pixel spectra and its seasonal variations. For this purpose, leaf spectra measured in the field, simultaneously to satellite acquisitions, are included in the endmember data set. The proposed unmixing techniques are performed on ground reflectances, assuming knowledge of the number and spectral signatures of the objects present in the images. An efficient estimation for their corresponding fractions in the pixels of the image is developed, based on a recently proposed maximum a posteriori probability (MAP) method. By exploiting the constraints naturally imposed to the problem, closed form expressions are derived for the statistical parameters required by the MAP estimator. In the semi-supervised scenario, we assume that a spectral library is given, containing spectral signatures of multiple endmembers. The objective in the latter case, is (a) to determine how many and which endmembers are present in the mixed pixel under study and (b) to use the selected endmembers to estimate the corresponding abundance fractions - especially the abundance of foliar coverage. The approach is based on a properly modified weighted l1-regularized least squares algorithm. The motivation of using the sparsity promoting l1 norm is that in practice, only a small number of the available endmembers are present in each pixel. Based on this observation, a weighted version of the well-known least absolute shrinkage and selection operator (lasso) criterion is utilized, where weights are used for penalizing different coefficients in the l1-regularization scheme. To efficiently solve the l1 minimization problem, the Least Angle Regression (LARS) algorithm is used. The performance of the proposed methods is compared to the performance of existing unmixing algorithms, such as standard convex programming procedures and ENVI software unmixing routines.