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ORIGINAL ARTICLE

A Method of Spatial Unmixing Based on Possibilistic Similarity in Soft Pattern Classification

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Abstract This paper proposes an approach for pixel unmixing based on possibilistic similarity. The approach exploits possibilistic concepts to provide flexibility in the integration of both contextual information and a priori knowledge. Possibility distributions are first obtained using a priori knowledge given in the form of learning areas delimitated by an expert. These areas serve for the estimation of the probability density functions of different thematic classes also called endmembers. The resulting probability density functions are then transformed into possibility distributions using Dubois-Prade's probability-possibility transformation. The pixel unmixing is then performed based on the possibilistic similarity between a local possibility distribution estimated around the considered pixel and the obtained possibility distributions representing the predefined endmembers in the analyzed image. Several possibilistic similarity measures have been tested to improve the discrimination between endmembers. Results show that the proposed approach represents an efficient estimator of the proportion of each endmember present in the pixel (abundances) and achieves higher

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classification accuracy. Performance analysis has been conducted using synthetic and real images.

Keywords Spatial unmixing · Endmembers · Possibilistic similarity · Contextual information

1. Introduction

An accurate and reliable image classification is a crucial task in many applications such as content based image retrieval, medical and remote-sensing image analysis, computer vision and robotics, web image search, visual tracking, and scene interpretation. An important difficulty related to this task stems from the existence of mixed pixels usually called 'mixels'. These mixels contain a mixture of more than one class of different thematic classes also called endmembers contained in the analyzed scene. Endmembers, as illustrated in Fig.1, correspond to macroscopic objects in the scene, such as water, soil, metal, vegetation, etc. Unmixing is critical for image analysis. In [1], they describe unmixing in the following way: "Spectral unmixing is the procedure by which the measured spectrum of a mixed pixel is decomposed into a collection of constituent spectra, or endmembers, and a set of corresponding fractions, or abundances, that indicate the proportion of each endmember present in the pixel."

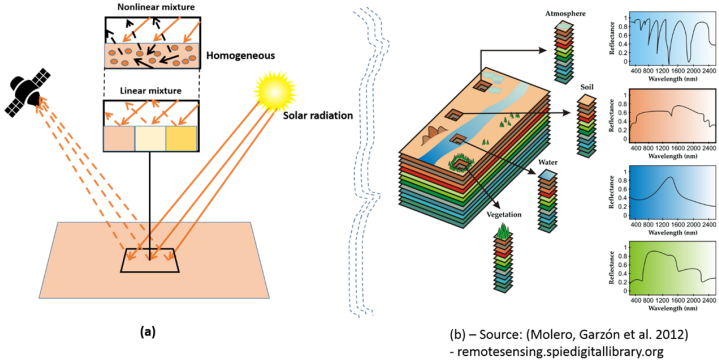

Fig. 1 a) Linear and non-linear pixel mixtures;
b) Concept of hyperspectral imaging [2]

Mixels arise mainly due to the limitation in spatial and spectral resolving capacity of the sensor being used. Spectral measurement might be the result of some composite of the individual spectra, a mixel, if the sensor spatial resolution is low enough that disparate materials can jointly occupy a single pixel, for instance, in remote sensing performing wide-area surveillance at high altitude. Mixels might also result from