CLASSIFICATION IN NIR HYPERSPECTRAL IMAGING: THE IMPORTANCE OF USING BOTH SPECTRAL AND SPATIAL INFORMATION

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ABSTRACT: Chemometric methodologies have nowadays become fundamental assessment tools especially in the field of near-infrared (NIR) hyperspectral imaging, where instruments routinely yield massive amounts of spatial and spectral information for large varieties of samples. Nevertheless, a particular limitation can still hamper their application on a broader scale: when exploring data produced by devices for hyperspectral imaging (three-dimensional arrays), in fact, an unfolding step is generally required prior to any analysis operation. This leads to the complete loss of the aforementioned spatial information, and, thus, to an incomplete exploitation of the full potential that this type of technique could exhibit for the characterization of complex matrices. In this regard, several works on the importance of resorting to such spatial information, have lately been published. *Inter alia*, an interesting approach that was pointed out as a possible solution in this context is the wavelet transform *[1,2]*. When spatial details extracted by the use of wavelet transforms are fused with the information carried by the spectral profiles recorded for all the scanned pixels, indeed, new features of the image structure are detectable by means of multivariate statistical methods *[3]*. The main aim of this work is to explore the performance of this novel framework when addressing classification tasks in NIR hyperspectral imaging. More specifically, it will be shown that classification models built by Partial Least Squares Discriminant Analysis (PLS-DA), when trained taking into account also the spatial details returned by 2-D stationary wavelet transform (SWT 2-D), can lead to more accurate results.

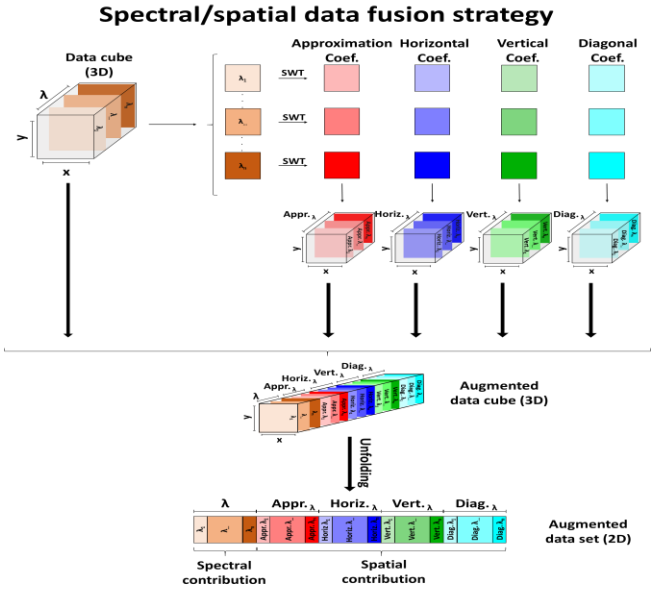

Figure 1 – Scheme of the proposed spectral/spatial strategy.

The proposed methodological strategy encompasses the following steps (see Figure 1 for a more detailed illustration): i) SWT 2-D is applied to the hyperspectral images under study so as to extract four distinct sets of wavelet coefficients (approximation features and horizontal, vertical and diagonal details, respectively) for every wavelength of the investigated spectral domain. This way, the whole spatial information encoded in the hyperspectral images at hand is captured and extracted; ii) the retrieved wavelet coefficients are pretreated and fused with the measured pixel profiles into an augmented data matrix containing, at this point, both spectral and spatial information and which is finally analyzed by means of PLS-DA. As a proof-of-concept, this approach has been tested on a NIR image provided by Prof. José Manuel Amigo Rubio *[4]*. Preliminary results have shown that when the spatial information is accounted for, a higher accuracy in the detection of the edges of the characterized objects can be achieved. These initial results represent only a starting point for a more comprehensive evaluation of this novel procedure: more studies are currently in progress to further explore its pros and cons.

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