Multispectral subpixel detection using least square unmixing

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Abstract

Subpixel target detection is designed for small target with size less than a pixel. Many approaches have been developed for this problem, and in which, least square unmixing is one of the most widely used methods. It can detect subpixel target by estimating its abundance fraction resident in each pixel. This method has been successfully applied in hyperspectral remotely sensed images, but it encountered a constraint for multispectral images. In order for the this approach to be effective, the number of bands must be larger than or equal to that of signatures to be classified, i.e., the number of equations should be no less than the number of unknowns. This ensures that there are sufficient dimensions to accommodate orthogonal projections resulting from the individual signatures. This constraint is known as Band Number Constraint (BNC). Such inherent constraint is not an issue for hyperspectral images since they generally have hundreds of bands, which is more than the number of signatures resident within images. However, this may not be true for multispectral images where the number of signatures to be classified is greater than the number of bands. The phenomenon of the BNC was first witnessed when the Orthogonal Subspace Projection (OSP) was applied to 3-band SPOT (Satellite Pour l'Observation de la Terra) data where four signatures were used for classification. It was found that the OSP performed poorly in discriminating four signatures using 3-band SPOT data, particularly those with similar spectra. More precisely, if we want to classify objects effectively using OSP or least square approaches, each object requires a separate dimension. If there is a dimension used to accommodate two or more objects, it is

impossible to discriminate these objects using a single dimension. Two directions can be considered to relax this constraint, one is to increase the number of bands; and another is to decrease the number of signatures. The previously proposed Generalized Orthogonal Subspace Projection (GOSP) belongs to the first category. Since linearly generated images do not provide more information in simultaneous equations, it generates additional bands by nonlinear functions from original bands, which include auto-correlation, cross-correlation, square root function and logarithm function. Although it relaxed the BNC, the detection results did not perform well when target spectrum has low reflectance. In this paper we take another approach. Instead of increasing the number of bands, the proposed method decreases the number of signatures by selecting part of materials applied to least square approach, and then those detection results are nonlinearly combined for endmember detection. It can be viewed as an extension of the least square approach and the experimental results showed it can successfully detect all endmembers.

Index Terms — Hyperspectral, Multispectral, Least Square, Band Number Constraint (BNC), Orthogonal Subspace Projection (OSP), Generalized Orthogonal Subspace Projection (GOSP).

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