SPECTRAL RULES AND GEOSTATISC FEATURES FOR CHARACTERIZING OLIVE GROVES IN QUIKBIRD IMAGES

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1. INTRODUCTION

In this work the algorithm proposed by Sanz in [1] for the extraction of class specific textures features has been implemented and evaluated for discriminating between forests and permanent crops, specifically olive groves, in VHR QuikBird images. The algorithm is based on the variogram-method which was applied in [1] on aerial imagery at 50-cm resolution. The algorithm can estimate arbitrarily shaped texture of regions with one or two orientations in multi-spectral images and then differentiate classes characterized by similar spectral features. It is based on the following characteristics: a) the period T is defined as the distance between texture elements named texton and it differs from zero if texture is oriented; b) the direction of the principal orientation texture θ_1; c) the direction of the secondary orientation texture θ_2. The algorithm has been introduced in a two-stage stratified hierarchical classification system of QuikBird images, as recently proposed in [2]. In this work in the first stage of the system the Maximum-Likelihood classifier adopted in [2] has been substituted by the Landsat-like image fully automated spectral rule-based per-pixel classifier (LSRC), properly down-scaled to deal with QuickBird images and recently proposed in the literature [3]. This down-scaled version of LSRC indicated as Quick Bird-like SRC, i.e. QSRC non-contextual visual properties exclusively to provide a preliminary spectral map of the image. The second stage, which is required to compensate for the reduced spectral resolution of QuikBird images, is composed by a battery of class-specific classification modules. The variogram- method is used in this second stage to discriminate classes according to their precise orientation characteristics, if present, and is applied to the panchromatic band of the image.

The results obtained in the analysis of a QuikBird image of an area characterized by intensive olive trees cultivation in Southern Italy reveals the effectiveness of the proposed approach. The automatic detection of both tree plantation directions and tilling practice orientation with respect to hill slope may have several applications, for instance in the development of soil loss prevention measurements or in precision farming.

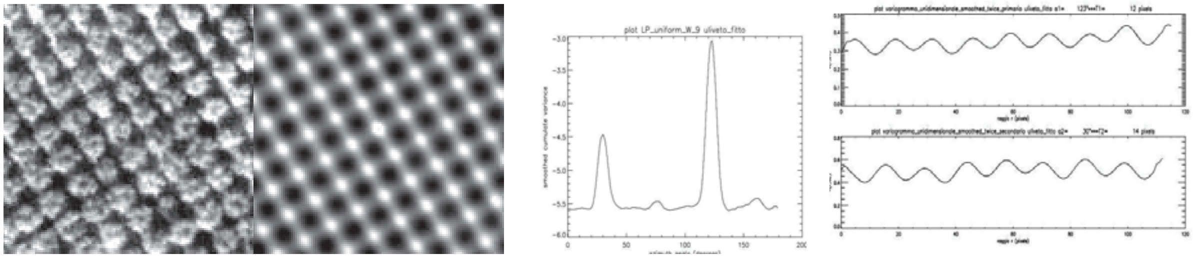
2. MATERIALS AND METHODS

Precise orientation characteristics are extracted by the variogram of the panchromatic QuikBird image band to differentiate between oriented (e.g olive trees, vineyards, tilled fields) and not oriented classes (e.g. forest, untilled fields). In addition, for oriented classes, e.g. olives trees, the normalized variogram reproduces the direction and inter-row spacing present in the original image. Consequently, it is possible to determine the number of orientations (e.g. two for olive trees and orchards, one for tilled fields and vineyards) and their specific periods, which depends on agricultural practices. A QuickBird image acquired in Southern Italy on January 16 2005 has been considered. The attention is focalized on the automatic detection of orientation and period estimation of young and old olive trees as class specific texture features to be used in the second stage of a hierarchical classification system. The image has been radiometrically calibrated before producing a Pan-Sharpened image (PS) according to [4]. A preliminary spectral map has been provided by QSRC from the PS image. The panchromatic band, properly masked by specific class spectral category has been used as input to the variogram based algorithm. The validation of orientations and period values automatically has been carried out against ground truth.

5. RESULTS AND CONCLUSIONS

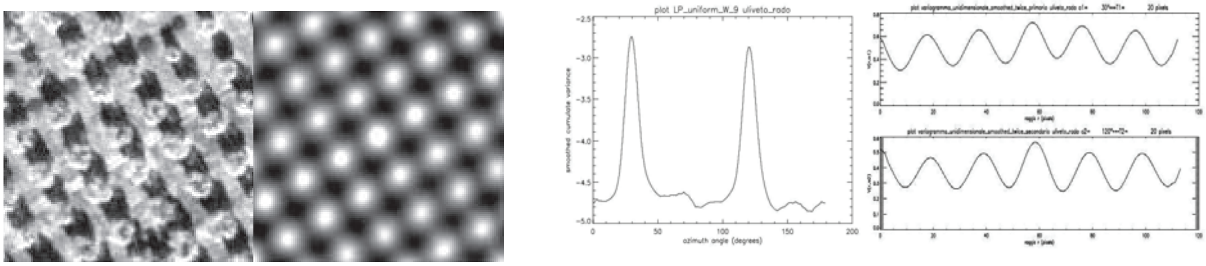
An experimentally determined threshold K_p (in this image K_p=0.65) is applied to variogram values to separate regions not having any directionality from regions with directionality. For latter regions direction and period estimation is carried out. In Figure 1 to 3 the normalized variogram for old and young olive trees are reported along with: the values of the dominant

Figure 1. *1.a)* Panchromatic moving window on a Dense (old) olive trees field; *1.b)* normalized variogram; *1.c)* variogram cumulative variance $A(\alpha)$; *1.d)* Variogram along two directions θ_1 and θ_2, where: θ_1=123° and period T_1=12 pixels; θ_2=30° and period T_2=14 pixels; θ_1 and θ_2 have been extracted from cumulate variance $A(\alpha)$.



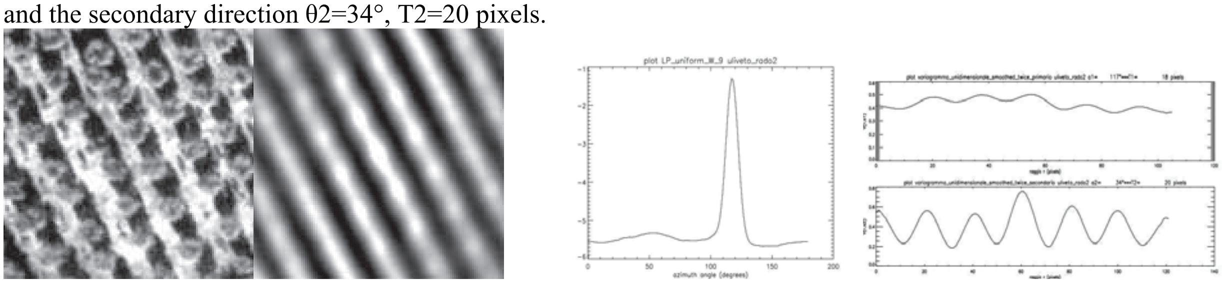
1.a) 1.b) 1.c) 1.d)

Figure 2. 2.a) Young olive trees; 2.b) normalized variogram; 2.c) variogram cumulative variance; 2.d) variogram along two directions: θ_1=30°, T_1=20 pixels, θ_2=120°, T_2=20 pixels; θ_1 and θ_2 output from cumulate variance $A(\alpha)$



2.a) 2.b) 2.c) 2.d)

Figure 3. 3.a) Young olive trees in a problematic condition, i.e. shadows and bright soil in background; 3.b) normalized variogram; 3.c) variogram cumulative variance; 3.d) variogram along two directions, i.e the dominant direction θ1=117°, and the secondary direction θ2=34°, T2=20 pixels.



3.a) 3.b) 3.c) 3.d)

orientation θ_1 and the secondary orientation θ_2; the corresponding period values obtained after filtering the variogram function along θ1 and θ_2. The focus of the paper is on the application of geostatistic variogram conceps to extract class specific features, with particular attention to olive groves, to be used in a multi-stage hierarchical classification system of QuikBird images.

11. REFERENCES

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