AN EFFICIENT METHODOLOGY TO SIMULATE MIXED SPECTRAL SIGNATURES OF LAND COVERS THROUGH FIELD RADIOMETRY DATA

The mapping of land cover and land use is a key application of remotely sensed data. A thematic map shows the spatial distribution of identifiable earth surface features; it provides an informational description over a given area, rather than a data description. Image classification is the process used to produce thematic maps from imagery.

Traditionally, the production of maps from satellite imagery assumes that each pixel of the image can be assigned to a single land cover class. In the remote sensing imagery, the measured spectral radiance of a pixel is the integration of the radiance reflected from all the objects within the Ground Instantaneous Field Of View, GIFOV, also called Ground Sample Distance, GSD (Schowengerdt 2007). Mixed pixels are generated if the size of the pixel includes more than one type of land cover. Obviously, spectral mixing is inherent in any finite-resolution digital imagery of a heterogeneous surface. Solving the spectral mixture problem is, therefore involved in image classification, referring to the technique of spectral unmixing.

Spectral unmixing has been used as a technique for analyzing the mixture of components in remotely sensed images. The technique is based on the assumptions that several primitive classes of interest can be selected, that each of these primitive classes has a pure spectral signature, which can be identified and the mixing between these classes can be adequately modelled as a linear combination (Small 2004) of the spectral signatures.

Spectral mixture analysis (SMA) techniques have overcome some of the weaknesses of full pixel approaches by using linear statistical modelling and signal processing techniques (Keshava 2002) (Rand 2001) (Tu 1999). The key task in linear SMA is to find an appropriate set of pure spectral components which are then used to estimate the fractional abundances of each mixed pixel from its spectrum and the endmember spectra by using a linear mixture model (Heinz 2000). The identification of the pure pixel value is often difficult. Because of sensor noise and within-class signature variability, endmembers only exist as a conceptual convenience and as idealization in real images.

In this investigation, it is proposed a methodology to simulate mixed spectral signatures of land covers, from endmember data obtained through Field Radiometry, using linear statistical modelling. Previously, the authors have experience to collect a optimal set of endmembers by measurements in situ with a field spectroradiometer (Vazquez 2004, 2008). They propose the use of new sub-pixel methods based on statistics and certain “units of sampling” to apply to the landscapes. The resultant point estimations for these new units will be the “observations” that will be crucial later to simulate signature spectral models. Good results about correlation remote and near spectral response have been obtained.

An efficient methodology to simulate mixed spectral signatures of land covers, from endmember data, using linear statistical modeling based on the least squares estimation approach, is proposed. The optimal set of endmember has been obtained by measurements in situ with a field spectroradiometer GER 1500. Also, it is proposed the use of new sub-pixel methods based on statistics and certain “units of sampling” to apply to the landscapes. The resultant point estimations for these new units will be the “observations” and all of them will carry out an special role to simulate the final spectral signature. This methodology is used to simulate spectral signatures of a Mediterranean forest landscape near to Madrid (Spain). Furthermore the spectral signature model obtained through Field Radiometry data will be correlated with the image data of the same zone provided by the Landsat 7 Enhanced Thematic Mapper Plus (ETM+) sensor once corrected. The results obtained in correlation studies seem to conclude its efficiency. At the same time, the results open new research guidelines.

METHODOLOGY

IDENTIFICATION OF THE LANDSCAPE UNITS TO BE ANALYSED

The Global Unit (G) has equal dimension of the pixel of remote sensor. This one will be submitted to a process of successive subdivisions, in order to get smaller units or Intermediate Units, Iu

From the sampling information of these Iu, it will be possible to model the mixed spectral response of G. For that, the size of each Iu must be such that behaves as a “homogeneous spectral unit” its spectral content must be as close as possible to the endmember in order to represent optimally the cover itself. High land covers variability will involve the existence of a large number of very small ones.

SAMPLING METHODS

The criteria to design the more representative statistics for Iu could be based on a strategy of “considering” more or less the information belonging to the different Elementary Units. In this sense, we propose the “balanced statistic” and the “unbalanced statistic”. The first one consists in assigning to each Elementary Unit, Eu, its same “weights”. So, each of them equally will contribute to the total spectral response of the Iu. The second one considers weighing different the information contained in the centre than the contained in the peripheral.

The Global Unit sampling method could be as simple as possible. We suggest a new method for picking up samples: the so-called “double-diagonal”. This model reflects with acceptable accuracy the spectral response of the Global Unit.

The regression models for each band (mixed hyperplanes) are obtained by linear least squares techniques through balanced and unbalanced statistics.

RESULTS

REFERENCES

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DATA

The study zone is situated in the Mountgancedo near Madrid (Spain). This site is located to the south-west of Community of Madrid, and it has a surface area of 125 hectares. The study area selected is located at 40º 24’30” N, and 3º49’50” W (4473/4474 N, 429/430 W UTM). Several mediterranean species of vegetation can be easily found, such as oaks Quercus ilex, spanish lavender Lavandula pedunculata and the crimson spot rockrose Cistus ladanifer. The surface is also covered by grass and abundant meadows as well as the soils, and rocks and stones outcrops. The land cover spectral samples have been obtained in the summer by Field Radiometry with the GER 1500, agreement with the date of Landsat ETM+ remote data register. Sampling in situ has been carried out according to a methodology that optimizes the number of samples to pick-up.

Even though the remote sensor (ETM+) has a spatial resolution of three bands, whereas in the fourth band this value is slightly lesser. The use of unbalanced statistic proves values closest to the satellite sensor.

To sum up, it has been proposed a methodology to simulate spectral mixed signatures. The methodology derives from the use of new sub-pixel methods based on statistics and certain “units of sampling”. Furthermore the spectral model obtained through Field Radiometry data will be correlated with the image data of the same zone provided by the Landsat 7 Enhanced Thematic Mapper Plus (ETM+) sensor once corrected. The results obtained in correlation studies seem to conclude its efficiency. At the same time, the results open new research guidelines.

The simulated mixed signatures will feed a Library Spectral of Land Cover Spectral Responses

CONCLUSIONS

Mixed hyperplanes for each band have been obtained by linear least squares techniques through balanced and unbalanced statistics.

The modeled spectral signatures are very similar that the one provided by the sensor satellite; once atmospheric correction has been made. Simulation, forecasts fits on line. As an example, the model predicts satellite corrected data for the Global Unit.