AFFINE COMPENSATION OF ILLUMINATION IN HYPERSPECTRAL REMOTE SENSING IMAGES

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1. ABSTRACT

A problem when working with satellite or airborne images in the optical domain is the need to compensate for changes in the illumination conditions at the time of acquisition. This is particularly critical when working with time series of data, where the compensation for atmospheric and illumination changes is a requisite for the normalisation of the multi-temporal information. A common practice is to use external information about atmospheric aerosols or visibility to compensate these changes, but such information is usually not available at the appropriate spatial or temporal scales. Atmospheric correction strategies based on radiative transfer codes may provide a rigorous solution but it may not be the best solution for situations where a huge amount of hyperspectral images may need to be processed and computational time is a critical factor. The GMES ("Global Monitoring for Environment and Security") initiative by the European Commission [1] will allow to "enable decision-makers in Europe to acquire the capacity for global as well as regional monitoring". It has promoted the creation of a new generation of satellites (the SENTINEL series) with "ultra-high resolution" and "superspectral imaging" capabilities [2]. Operational data storage and processing will be even more demanding. Therefore, there is an urgent need to quickly and reliably compensate for changes in the atmospheric transmittance conditions and varying solar illumination/viewing angles.

In this paper three different forms of affine transformation models (general, particular and diagonal) are considered as candidates for rapid compensation of illumination variations. They are tested on a series of simulated multispectral images of Top-Of-Atmosphere (TOA) radiance, where the surface is a synthetic scene of a test site in Spain called Barrax, where reference data for validation is available. This synthetic image is created using a tool called H-COMP [3]. H-COMP is an IDL (Interactive Data Language)-based software toolkit which was originally designed to evaluate end-member extraction and spectral unmixing techniques for the analysis of hyperspectral imagery. With H-COMP the user can interactively draw regions on the generated image, and associate spectral signatures from available libraries to each region. The synthetic image is initially based on an atmospherically corrected image acquired by CHRIS-PROBA sensor of a test site in Barrax, 20 Km away from Albacete (Spain). The area is characterized by a flat morphology and large, uniform land-use units. Differences in elevation range up to 2m only.

For the comparison of the three models, the simulated TOA radiance images for different illumination conditions are obtained using the 6S code [4] with a range of changes in the Visibility parameter, for three different solar times (7AM, 12 and 16PM). In order to isolate these scattering-type changes from those related to absorption, a method by Clayton et al [5] to eliminate those absorptions is applied. Compensation ability is assessed using the Frobenius matrix norm. The results indicate that in 2 of the more moderate Sun positions, for all the Visibilities tested, the particular affine method is better than the other 2. We consider whether this is due to the effect of the path radiance on the 6S radiance images generated. The results also indicate that the proposed methodology is satisfactory for practical normalization of varying illumination and atmospheric conditions in remotely sensed images required for operational or time critical applications.

2. REFERENCES

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