AN IMPROVED DARK OBJECT SUBTRACTION METHOD FOR ATMOSPHERIC CORRECTION OF REMOTE SENSING IMAGES

*Yu Wang *, Hongyan He, Wei Tan, Wenwen Qi*

Beijing Institute of Space Mechanics & Electricity, Beijing 100094, China

Beijng Key Laboratory of Advanced Optical Remote Sensing Technology, Beijing 100094, China

**93031@163.com*

Background

The radiation collected from remote sensors taken from space must transit through the earth's atmosphere. The reflectance of the ground is significantly impacted at some level by light wave scattering and absorption from atmospheric conditions such as aerosols, water vapor and particulates. For generating high-quality scientific remote sensing data, atmospheric correction is required to remove atmospheric effects and to convert digital number (DN) values to surface reflectance (SR).

Dark Object Subtraction(DOS) is a widely used and well-known simple image-based absolute atmospheric correction method. This approach assumes that there are at least a few pixels of dark objects throughout a satellite image scene, and they should have zero value, along with a horizontally homogeneous atmosphere. Thus, the minimum DN value in the histogram considered as dark objects from the scene which is known as the atmospheric effects (mostly from haze), which accordingly is subtracted from all pixels. Atmospheric transmittance and path radiation are the key determinants of DOS atmospheric correction accuracy. In four factors (atmospheric molecule, ozone content, aerosol and water vapor content) that affect atmospheric transmittance and path radiation, atmospheric molecules and ozone content are relatively stable with little difference in space, while aerosols and water vapor are larger temporal and spatial variation, which are the main factors restricting the accuracy of atmospheric correction. The variation makes it significantly harder to obtain the aerosol optical thickness and the water vapor optical thickness with high precision. However, the common practice is to ignore these two factors or make use of the weather station data, which seriously limits the atmospheric correction accuracy of the DOS.

Method

Aiming to improve the estimates of surface reflectance through traditional image-based DOS method, this paper investigates to achieve the simultaneous acquisition of atmospheric radiation parameters based on the multi-spectral information. An Improved Dark Object Subtraction (IDOS) method which tends to correct the haze in terms of atmospheric scattering and path radiance for optical remote sensing image is presented. The new method retrieves the ancillary information on the aerosol optical depth (AOD) and total water vapor (TWV) from the multi-spectral information. AOD is retrieved using the Dense Dark Vegetation (DDV) algorithm. TWV retrieval over land is performed with the Atmospheric Pre-corrected. Differential Absorption algorithm. The AOD and TWV obtained from the retrieval are used to optimize the DOS model.

Data

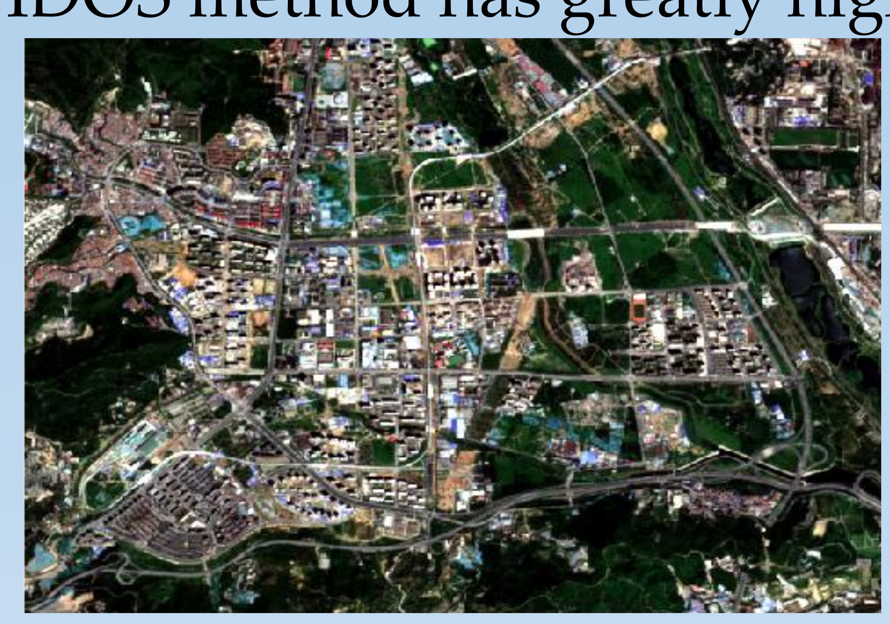
The experimentation is carried out using data of Sentinel-2, which carries a Multispectral Instrument (MSI), recording in 13 spectral bands, covering a wide range of wavelengths from 440 up to 2200 nm. The look up table is established to retrieve the AOD by using the band B12 (SWIR) and correlates its reflectance with band B04 (red) and band B02 (blue). Band B08A (atmospheric window region) and band B09(absorption region) are applied to calculate the atmospheric transmittance, and then retrieve the total water vapor content. After atmospheric correction, the reflectance image, the histogram of reflectance and the typical object spectral information are analyzed to evaluate the correction accuracy of IDOS.

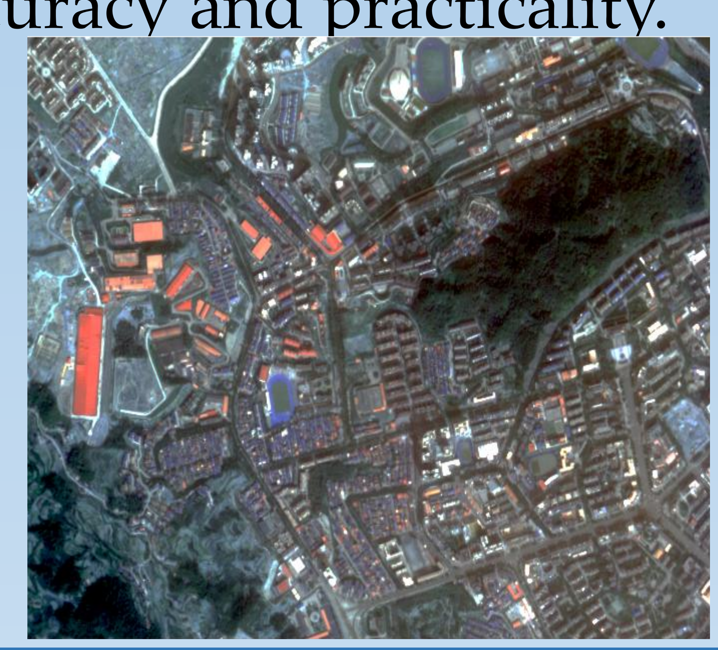
Results and Conclusions

1). The visual effects and reflectance of the remote sensing images have obvious changes. The uncorrected image is hazed by the absorption and scattering of the atmosphere, and the contrast is low. The corrected image is clearer, image contrast enhancement and restores the original appearance of the object. Atmospheric correction using this method is conducive to information extraction and thematic interpretation from remote sensing data.

2). Histograms can reflect the amount of information and distribution characteristics of the images. The histograms of blue, green and red bands are extracted respectively from the images before and after atmospheric correction. The histogram comparisons illustrate that the range of the corrected image histogram becomes wider, and the reflectance curve of each band is smoother. The visible bands of shorter wavelength are highly affected by atmospheric scattering especially of molecules and aerosol scattering, the difference of the images between before correction and after is large, while the influence of the red band is relatively small.

3). In order to quantitatively verify the accuracy of atmospheric correction, the retrieved reflectance is compared to apparent reflectance curve, the comparisons show that atmospheric corrected reflectance curve is closer to measured typical objects reflectance curve in the terms of both spectral shape and reflectance value, indicating that the effect of atmosphere have been successfully removed by using the proposed algorithm. Compared with the traditional DOS technique the IDOS method has greatly higher accuracy and practicality.





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