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SHADOW DETECTION AND REMOVAL FROM VERY HIGH RESOLUTON SATELLITE IMAGE

Abstract: *Shadows cause hindrance to correct feature extraction of image features like buildings, towers etc. in urban areas it may also cause false color tone and shape distortion of objects, which degrades the quality of images. Hence, it is important to segment shadow regions and restore their information for image interpretation. This paper presents an efficient and simple approach for shadow detection and removal based on HSI color model in complex urban color remote sensing images for solving problems caused by shadows. In the proposed method shadows are detected and compensated using the infrared channel.*

Keywords: *satellite images, shadow, multichannel, high resolution, algorithm, detecting, compensating.*

Introduction

Many image processing and analysis techniques have been developed to aid the interpretation of remote sensing images and to extract as much information as possible from the images. The choice of specific techniques or algorithms to use depends on the goals of each individual project [1, 2]. Remote sensing data can be used in circumstances where it is impossible terrestrial research methods, such as fires and floods. One of the most common types of error encountered in remotely sensed data is shadow. This problem is a major source of confusion and misclassification in extracting land cover information from remote sensing data. The presence of shadow can also lead to misleading results if change detection is applied to a ground surface because of changes in the shadows, depending on the time and season. Space images of the town infrastructure, as a rule, contain many shadows cast by tall objects (buildings, bridges, towers, etc.) when the scene is lit by the sun. Shadows are a substantial obstacle in recognition of objects because they make it difficult to determine boundaries of those objects. On the other hand, a shadow is a deciphering feature making it possible to learn a lot about the shape, location and other properties of an object casting it. In object recognition, an important step is detection and compensation of shadows, as well as reconstruction of the scene in the shadowy area.

Paper overview

At the moment, there are classical algorithms of image processing for detection and selection of shadows, namely, contour, cluster, and frequency algorithms [3-5]. A variety of image enhancement methods have been proposed for shadow removal, such as histogram matching, gamma correction, linear correlation correction and restoration of the color invariance model [7,8]. The main shortcoming of these algorithms is formation of false outlines, which is caused by the substantial difference of brightness of the shadow and surrounding background and, subsequently, by a sharp change of brightness at the boundary of the shadow with the background and the object, which substantially complicates the stage of reconstruction of objects in the shadowy area [9].

Formulation the problem

There is a necessity to improve the algorithm of detection and compensation of shadows in the multichannel satellite images.

The basic material

In this work, an improvement of the algorithm for detection and compensation of shadows, the foundations of which include:

1. The preliminary processing stage, increase of the information capability on the base of ICA and Wavelet transforms [2].
2. Selection of the vegetation component.
3. Determination of the optimal binarization threshold.
4. Selection of the outlines of the objects.
5. Segmentation of the shadow area.
6. Compensation of the shadow area.

The structure chart of the improved algorithm is represented in Figure 1. The proposed method has been examined with variety of high resolution satellite images obtained under dissimilar illumination conditions in urban areas. The paper investigates satellite images from Worldview-2, the original size of the panchromatic image is 4600x4604 and 1150x1151 multichannel. The multichannel bands (Band1 = Coastal, Band2 = Blue, Band3 = Green, Band4 = Yellow, Band5 = Red, Band6 = Red Edge, Band7 = Near-Infrared 1, Band8 = Near-Infrared 2) cover the spectral range from 400 nm - 1050 nm at a spatial resolution of 1.84 m, while the panchromatic band covers the spectrum from 450 nm – 800 nm with spatial resolution 0.46 m. Figure 2 represents images obtained after each stage of work of the algorithm.

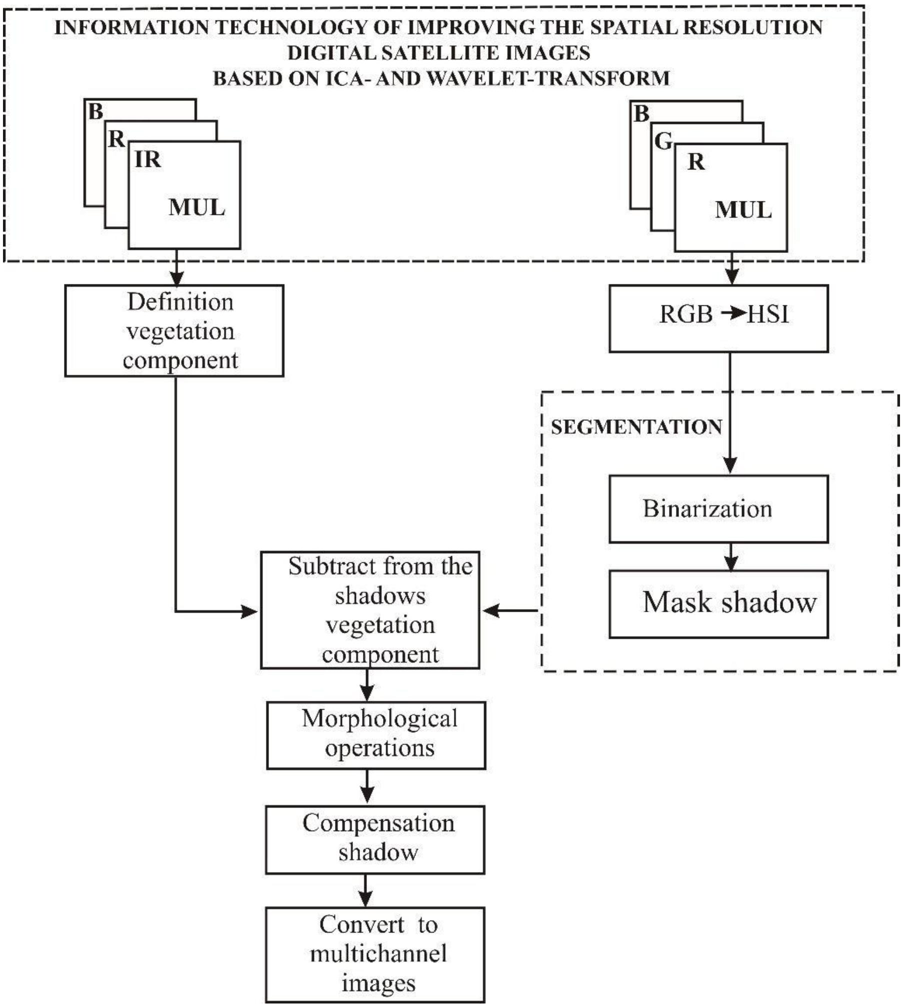

Figure 1. Algorithm scheme

We proposed to select the vegetation component with the use of the infrared channel. As the R channel, we select the IR, second and third (G and B, respectively). This operation is represented by this expression:

$$NDI = \frac{IR - R}{IR + R} \tag{1}$$

where IR - infrared channel, R - red channel.

Suppose R, G, and B are the red, green, and blue values of a color. The HSI intensity is given by the equation:

$$I = (R + G + B)/3. \tag{2}$$

Now let m be the minimum value among R, G, and B. The HSI saturation value of a color is given by the equation:

$$S = 1 - m / I \; if \; I > 0, \; or \qquad S = 0 \; if \; I = 0 \tag{3}$$

To convert a color's overall hue, H, to an angle measure, use the following equations:

$$H = cos^{-1}\left[\frac{(R - ½G - ½B)}{\sqrt{R^2 + G^2 + B^2 - G - RB - GB}}\right], \; if \; G \geq B, \; or \tag{4}$$

$$H = 360 - cos^{-1}\left[\frac{(R - ½G - ½B)}{\sqrt{R^2 + G^2 + B^2 - RG - RB - GB}}\right], \; if \; B > G, \tag{5}$$

where the inverse cosine output is in degrees.

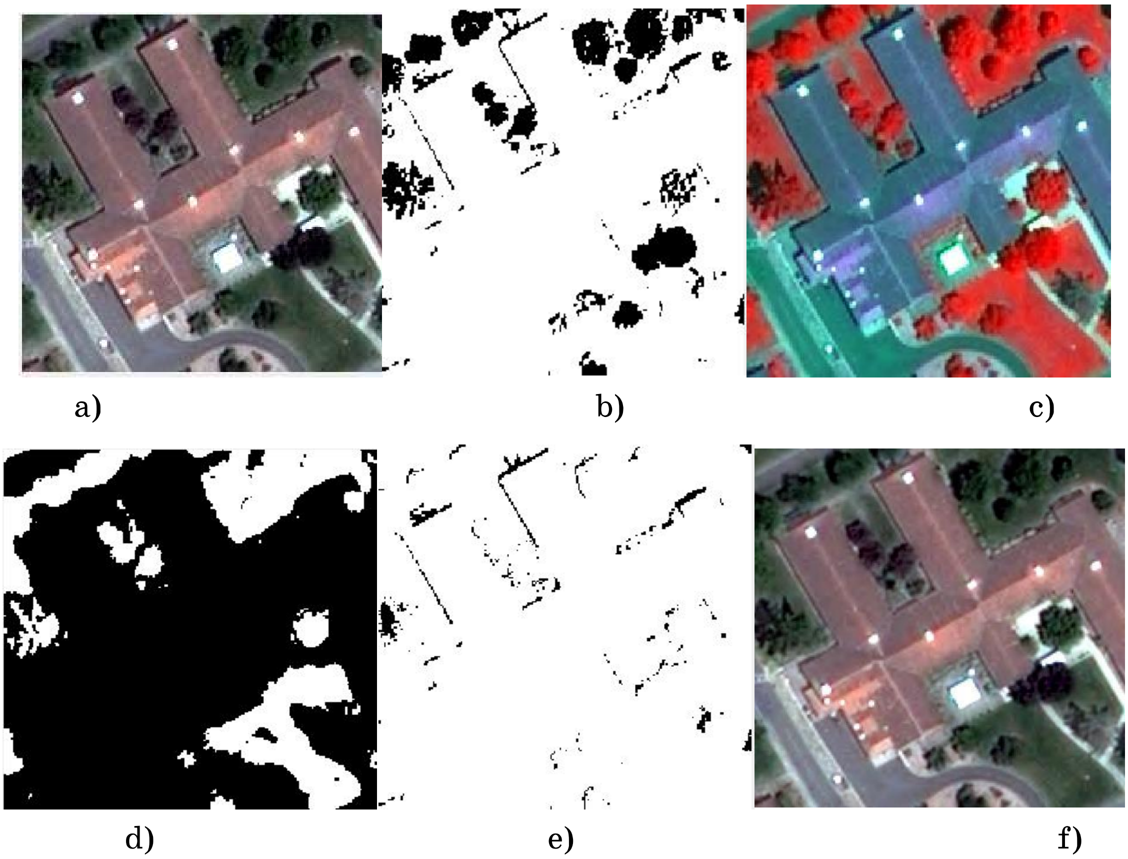

Figure 2. Algorithm scheme:

a) original image (R G B); b) binary image showing shadows; c) original image (IR R B); d) binary image showing vegetation; e) subtraction of vegetation component from shadow; f) result image

The task of segmentation of the image is implemented on the base of the two-level hierarchical pyramidal algorithm, which allows us to use various color and texture difference of areas. As the criterion of homogeneity, the evaluation of closeness of the elements and areas of the image in the combined texture and color space of features. In the process of segmenting, the image transformed into HSI color model underwent binarization with selection of the optimal threshold. As a result of binarization, shadow areas were set to 1, and areas without shadows were set to 0 (Figure 2 (e)). Then the mask is applied to the obtained image, and we get segmented of shadow areas.

On the next stage of the algorithm, we carry out the operation of subtraction of the vegetation component out of the shadow one, which allows us to leave out only shadowy areas in the image. Compensation of shadow pixels is done owing to the increase of the brightness component for those pixels, the brightness component of which is below the threshold value [8].Then we convert the obtained image from the HSI color space back into RGB. To convert hue, saturation, and intensity to a set of red, green, and blue values, you must first note the value of H .

Conclusion

In the paper, an improved algorithm is proposed for detection and compensation of shadows in multichannel satellite images with increased information capacity on the base of ICA- and wavelet transforms. As the source, a multichannel image with an IR channel is used, which makes it possible to reliably determine the vegetation component, as well as shadows cast by the vegetation. In order to get a shadow detection result, image segmentation considering shadows is applied. The shadow removal method based on brightness component matching can effectively restore the information in a shadow area. The parameters calculated by using the radiation difference between inner and outer homogeneous sections can retrieve a shadow very effectively. In the future, we will explore more feature information to estimate more accurate the shadow coefficient, and obtain better result of shadow removal.

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