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Shadow Detection Technique of Satellite Image for Shadow Removal

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Abstract: According to the characteristics of urban high- resolution color image remote sensing, we can work considering the object oriented shadow detection and removal method. In this project, shadow affected portion are taken into consideration in image segmentation, and according to the statistical features the suspected shadows are extracted. After that, the dark objects which could be mistaken for shadows are taken out according to object properties and spatial relationship between the objects. For the object detection first we apply available Tsai method but we got very less accuracy in final result of this method. Then we apply new technique in which first we apply color image transformation then global thresholding, morphological erosion convolution filtering. Experimental result shows that the accuracy of the new method is more.

I. INTRODUCTION

In the last ten or more years, with the availability of high resolution satellites, the observation of Earth and the rapid development of some platforms such as airships and nonhuman-aerial vehicles, there is an increasing need of analyzing high-resolution images for different applications. If we consider the urban areas then we can easily get that, surface features are quite complex, with a great variety of objects and shadows formed by elevated objects like some tall buildings, bridges and trees. In one consideration shadows themselves can be useful for the information in 3-D reconstruction, building position, height estimation [1], [2], but it can also interfere with the processing and for high-resolution remote sensing images [3]–[5]. For example, shadows cause incorrect results during change detection. So, the detection and removal of shadows play an important role in applications of urban high-resolution sensing images such as object classification and recognition, change detection and image fusion.

There are number of algorithms for the detection shadow. Existing shadow detection methods can be generally categorized into two groups [6]: model-based methods and feature-based methods. In the first group it is based prior information such as scene, moving targets, and camera altitude to construct shadow models [7], [8]. These methods are often used in some specific scene conditions such as aerial image analysis and video monitoring. The second method identifies shadow areas with information of gray scale, brightness, saturation, and texture. By combining the two methods we can make improved algorithm [4]. At first, the shadow area estimation is done according to the space coordinates of buildings or objects calculated from digital surface models, the altitude and azimuth of the sun. Then, to accurately identify shadow, the threshold value is set which is calculated from the estimated grayscale value of the shadow areas. Generally most shadow algorithms for detection are based on shadow features. For example, the shadow region is appears like low grayscale value in the image, and for the threshold value is chosen between two peaks in the grayscale histogram of the image data to separate the shadow from the non shadow region [3], [9]. According to many theories, images are converted into different invariant color spaces like HSV, HCV, YIQ to obtain shadows with Otsu's algorithm [11]. This helps to prevent the false shadow created by vegetation in certain invariant spaces. According to that work, for the shadow detection a successive thresholding scheme was proposed. To remove the false shadows of dark objects such as moist soil, the normalized difference vegetation index, the normalized saturation–value difference index and the size and shape of the shadow area are considered. Recently, to detect shadows, a hierarchical supervised classification scheme was used.

For the detection by Tsai algorithm of color aerial image, the input image can be first transformed into hue, saturation and intensity (HSI) or other like luma, blue-difference chroma, red- difference chroma (YC_bC_r) or in hue, chrome and value (HCV) color model [5-6]. Under transformed invariant color model, ratio map is construct by calculation of ratio of hue over the intensity and then the global thresholding is used to identify the shadow. Tsai algorithm detection performance is more accurate for HSI model by comparing with previous work. In our new method at first we transform RGB color aerial image in to the gray image and then apply the global thresholding scheme using otsu's method to create a shadow map used for the classification of input color image into the shadow pixels and non-shadow pixels. By applying both the methods on same image, we observe that the accuracy of the new technique is more than the previously available Tsai method.

II. SHADOW DETECTION

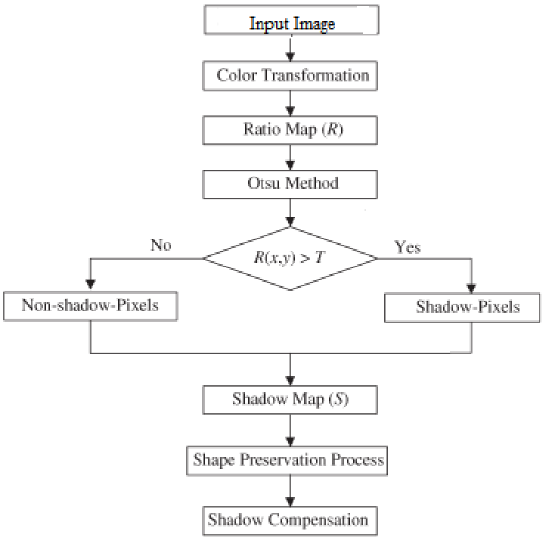

Fig. 1: Tsai algorithm

The flow chart of the Tsai method is shown in fig.1. In this algorithm color transformation is applied on the input RGB color image into invariant color model like HIS, HCV, YIQ, or YC_bC_r. to transform the RGB color image into his color model following formula is used:

$$\begin{bmatrix} I \\ V1 \\ V2 \end{bmatrix} = \begin{bmatrix} \frac{1}{3} & \frac{1}{3} & \frac{1}{3} \\ \frac{-\sqrt{6}}{6} & \frac{-\sqrt{6}}{6} & \frac{-\sqrt{6}}{3} \\ \frac{1}{\sqrt{6}} & \frac{-2}{\sqrt{6}} & 0 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

(1)

$$H = \begin{cases} \tan^{-1}(\frac{V_2}{V_1}) & if\ V_1 \neq 1 \\ H & is\ undefined \end{cases}$$

After this we calculated the ratio map R by using formula no. (2), which is used to decide whether pixel is shadow pixel or non-shadow pixel by comparing with threshold 'T'.

(2) $$R(x,y)=\frac{H_e(x,y)+1}{I_e(x,y)+1}$$

Where R(x, y), H_e(x, y) and I_e(x, y) are pixel position at(x, y) of R, image H_e and image I_e respectively. In Tsai method the range of R(x, y) is [0-255].

For the calculation of threshold 'T', Otsu method is used. After calculation of T and comparing it with ratio map R, we take decision about shadow pixel like if the R is less than threshold then it is non shadow pixel and if it is greater than threshold then that pixel is shadow pixel.

$$S(x,y)=\begin{cases}1, & R(x,y)>T\\ 0, & Otherwise\end{cases}$$

The new technique of shadow detection algorithm for the color aerial image is as shown in fig.2.

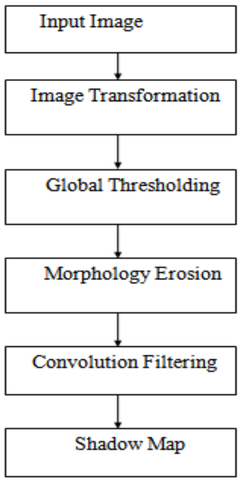

Fig. 2: New algorithm for the shadow detection

According to this method first we transform the input RGB image into gray image. After that using otsu's method we calculate threshold T for the gray image which is obtained by first step to obtain ratio map R. Then to refer more information about shadow to increase more accuracy, morphological erosion with 5×5 square structuring element is applied. In next step to alleviate the noise effect without blurring the boundaries between shadow and non-shadow region convolution filtering is used.

III. Experimental Result

To demonstrate the comparative result of both Tsai method and our new method we apply these algorithms on some images for detection of shadow.

Execution of both algorithms are done in MATLAB software.

(A) (B) (C)

Fig. 3: (a) Original image. (b) Shadow detection by Tsai's method. (c) Shadow detection by new algorithm.

If we observe the original image (a) where an object car is in shadow area, now by first applying Tsai's method (b), we can observe that car is not detected where as by applying new algorithm in image (c) we can detect car. And also many small non-shadow areas are considered as a shadow area in Tsai's method.

Now we can observe one more image in fig 4:

Fig. 4: (a) Original image. (b) Shadow detection by Tsai's method. (c) Shadow detection by new algorithm

In this image (a) dark object tar road is in non-shadow area but by applying the Tsai's method (b) we got that road is shadow area where as the new method consider it as a shadow area. That means it is also helpful to differentiate dark objects and shadow area.

By observing these two methods we can get that accuracy of our new method is more than that of other.

IV. CONCLUSION

For shadow detection in urban high-resolution remote sensing image we have put forward a systematic and effective method. Using the shadow detection method proposed in this paper it is possible to accurately identify shadows. Threshold selection and false shadow removal can be done in simple but effective ways to ensure shadow detection accuracy.

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