Object Shadow Detection From Remote Sensing Images

Atul A. Kolge  
Dept. of Electronics & Telecommunication Engineering  
Yeshwantrao Chavan College of Engineering  
Nagpur, India  
atulkolge21@gmail.com

Yogita K. Dubey  
Dept. of Electronics & Telecommunication Engineering  
Yeshwantrao Chavan College of Engineering  
Nagpur, India  
yogeetakdubey@yahoo.co.in

Abstract— In accordance with the characteristics of urban high-resolution color remote sensing images, we put forward an object shadow detection method. In this method, during image segmentation, shadow features are taken into consideration and after that using statistical feature of the images, suspected shadows are extracted. According to shadow properties and spatial relationship between objects, some dark objects could be ruled out. In our method, first color image is transform to gray image, after that global thresholding process is performed to detect the shadow region. Next to that morphology erosion process is performed. Then convolution filtering to construct coarse-shadow map, to classify the input color image into the candidate shadow pixels and the nonshadow pixels. Experiments show that the new method can accurately detect shadows from urban remote sensing images.

Index Terms- Color aerial images, convolution filtering, Shadow detection.

I. INTRODUCTION

There are various high spatial resolution satellites like QuickBird, IKONOS, Resource 3 and GeoEye for the observation of Earth and the speedy development of aerial platforms like airships and unmanned aerial vehicles. In urban areas, surface features are more complex, with a variety of objects and shadows formed by elevated objects such as bridges, high buildings, and trees. This shadow may cause faulty results in the change detection.

Detection of shadow is very important in the applications of urban remote sensing images like object recognition, image fusion, object classification and change detection. So, it is an important research issue to detect shadows for urban aerial images[1]. Based on the three features, which are geometrical properties, intensity values, and light directions. However, for color aerial images, the shadow detection accuracy can be improved by using both the intensity and the color information. Because the chromaticity information is not affected by the change of illumination for some cases, a shadow region can be detected by selecting the region which is darker than its neighboring regions but remainder that it has similar chromaticity information [3]. Using this illumination invariant property of chromaticity, many efficient methods have been developed to detect shadows for color images efficiently.

They not work well For color aerial images since few shadow properties in color aerial images have not been considered . To detect shadows of color aerial images, Polidorio et al. [9] considered two properties of shadows, first is low luminance and second one is highly saturated blue/violet wavelength. Using two shadow properties, the red, green, and blue (RGB) color aerial image is first transformed into the hue, saturation, and intensity (HSI) color image or model, and then after that segmentation process is applied to the saturation component and the intensity component to identify shadows [4],[7]. Later, Huang et al. [10] observed that the pixels in a shadow region have large hue value, small difference between green and blue color values, and low blue color value.

Using this observation, three experimental thresholds are determined to detect shadows in the HSI color image or model [8]. After that Tsai [2] presented an efficient algorithm to detect shadows for color aerial images. The input image can be first transformed into the hue, saturation, and intensity (HSI); luma, blue-difference chroma, and red-difference chroma (Y Cb/Cr); hue, saturation, and value (HSV); hue, chroma, and value (HCV); or luminance, hue, and saturation (YIQ) color models [5-6]. Under the transformed invariant color model, Tsai construct the ratio map by calculated the ratio of the hue over the intensity for each pixel and after that global threshold of the constructed ratio map is determined to identify shadows. Experimental results show that Tsai’s algorithm has better shadow detection accuracy when compared to the previous works. Also among these invariant color models, Tsai’s algorithm has the best shadow detection performance for the HSI color model. In this paper, a new analysis (algorithm) method is given to detect shadows for color aerial images. First RGB color aerial image is transform to gray image and then applies a global thresholding process using Otsu’s method to create a coarse-shadow map which is used for classifying the input color aerial image into the candidate shadow pixels and the non-shadow pixels. Under testing images, experimental results show that, the shadow detection accuracy of our new analysis (algorithm) method has better shadow detection accuracy when compared with the Tsai’s (algorithm) method.

In Section II, we survey Tsai’s shadow detection (algorithm) method. In Section III, our (algorithm) method is presented. Section IV, performance comparison between our proposed algorithm and Tsai’s algorithm. section V, over all conclusion for this paper.

II. PAST SHADOW DETECTION WORK BY TSAI

In this section, we survey the method (algorithm) proposed by Tsai [2]. The flowchart of Tsai’s (algorithm) method is shown in Fig. 1. To detect shadows in the color aerial image, first Tsai transforms the input RGB image into an invariant color model or image, i.e., HSI, HCV, HSV, YIQ, or Y Cb/Cr color models. For each pixel, the ratio of the hue over the intensity is used to determine whether the pixel is a shadow...
pixel or not. Among these invariant color models, Tsai’s algorithm has the best shadow detection performance for the HSI model.

The following equation is given to transform the RGB color model into the HSI color model:

\[
\begin{bmatrix}
I \\
V_1 \\
V_2
\end{bmatrix} = \begin{bmatrix}
\frac{1}{3} & \frac{1}{3} & \frac{1}{3} \\
-\frac{1}{\sqrt{6}} & -\frac{1}{\sqrt{6}} & \frac{1}{\sqrt{6}} \\
\frac{1}{6} & \frac{1}{6} & 0
\end{bmatrix}
\begin{bmatrix}
R \\
G \\
B
\end{bmatrix}
\]

\[
H = \begin{cases}
\tan^{-1}\left(\frac{V_2}{V_1}\right) & \text{if } V_1 \neq 0 \\
H \text{ is undefined}
\end{cases}
\]  

(1)

In the HSI model, I and H components called intensity and hue-equivalent components, respectively. By scaling I and H components to the range in [0, 1], we can obtain the intensity-equivalent image \(I_e\) and hue-equivalent image \(H_e\), respectively. The ratio map \(R\) is given by

\[
R(x, y) = \frac{H_e(x, y) + 1}{I_e(x, y) + 1}
\]  

(2)

Where \(R(x, y), H_e(x, y)\) and \(I_e(x, y)\) denote the pixel at position \(x, y\) of \(R\), the image \(H_e\), and the image \(I_e\), respectively. In Tsai’s algorithm method, the value of \(R(x, y)\) is scaled to the range [0, 255] for shadow detection.

Then Otsu’s thresholding method is applied on ratio map \(R\) to determine the threshold \(T\) which can be used for separating all the pixels of \(R\) into two classes. Based on threshold \(T\), a shadow map \(S\) can be obtained by

\[
S(x, y) = \begin{cases}
1, & R(x, y) > T \\
0, & \text{otherwise}
\end{cases}
\]  

(3)

Where \(S(x,y) = 1\) denotes the shadow pixel at position \((x,y)\). Next Tsai presented a shape preservation process to preserve shape information of objects casting shadow.

III. OUR SHADOW DETECTION ALGORITHM

In this section, our new analysis (algorithm) method is presented to detect shadows for color aerial images. The flowchart of our (algorithm) method is shown in Fig. 2.

![Fig.1-Tsai’s algorithm flowchart](image)

![Fig.2-our new analysis based algorithm flowchart](image)
IV. EXPERIMENTAL RESULTS

In this section, some experimental results are demonstrated to show the shadow detection accuracy comparison between Tsai’s algorithm and our new analysis algorithm. Both algorithm for shadow detection is executed using MATLAB.

![Shadow map (in white)](image1)

(a) Original image. (b) Shadow detection by Tsai’s algorithm. (c) Shadow detection by our new analysis based algorithm.

Fig. 3. (a) Original image. (b) Shadow detection by Tsai’s algorithm. (c) Shadow detection by our new analysis based algorithm.

Car in the shadow region in original image shown in fig 3(a) is considered as shadow by Tsai’s algorithm method shown in fig.3(b). and other non shadow region from original image also consider as shadow by tsai’s algorithm shown in fig.3(b). By using our method car is consider as non shadow region shown in fig. 3(c).

![Shadow map (in white)](image2)

(a) Original image. (b) Shadow detection by Tsai’s algorithm. (c) Shadow detection by our new analysis based algorithm.

Fig. 4. (a) Original image. (b) Shadow detection by Tsai’s algorithm. (c) Shadow detection by our new analysis based algorithm.

Many region of road in original image shown in fig 4(a) is considered as shadow by Tsai’s algorithm method shown in fig. 4(b). by our method road is consider as non shadow region shown in fig. 4(c).

More portion of building shown as shadow region by tsai’s algorithm in fig.4(b) which is nothing but non shadow portion in the original image shown in fig.4(a). By using our method building is consider as non shadow region shown in fig.4(c).

![Shadow map (in white)](image3)

(a) Original image. (b) Shadow detection by Tsai’s algorithm. (c) Shadow detection by our new analysis based algorithm.

Fig. 5. The original image. (b) Shadow detection by Tsai’s algorithm. (c) Shadow detection by our new analysis based algorithm.

Fig. 3(a)-5(a) show three testing images, which is nothing but original images. Fig. 3(b)-5(b) show shadow map (detection) using Tsai’s algorithm and fig. 3(c)-5(c) show shadow map (detection) using our proposed algorithm.

It can be seen from the shadow detection result that our new analysis algorithm gives better accuracy for shadow detection than Tsai’s algorithm.

V. CONCLUSION

In this paper, our new analysis algorithm has been presented for detecting shadows of color aerial images. RGB color image transform into the gray image and then Otsu’s method is used to determine a global threshold T for gray image to constructing the coarse-shadow map. Experimental results demonstrated that our new analysis algorithm has better shadow detection accuracy when compared with the Tsai’s algorithm.

REFERENCES


