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The System of Shadow Detection and Removal Using Object Oriented Technique

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Abstract: From satellite like Quick Bird, IKONOS etc., very high resolution satellite images are available. There are usually affected with shadows. These shadows can reduce information from the images. In this paper, for the detection of shadow, an object oriented shadow detection of shadow an object oriented shadow detection method is used. In this technique, using segmentation process, each object in the input image is extracted. After that suspected shadows will be detected by comparing grayscale average of each object in segmented image and threshold obtained from original image. False shadows are eliminated by comparing grayscale average in different image bands. Then shadow removal will be done using boundary extraction and IOOPL matching. Homogeneous section will be attained through IOOPL matching. This is effective method for the detection and removal of shadow.

Keywords: Change detection, image segmentation, inner-outer outline profile line (IOOPL), object-oriented, shadow detection, shadow removal.

I. INTRODUCTION

In urban areas, because of the elevated objects such as high buildings, bridges and trees shadows may form. These shadows can become useful information in 3-D restoration, height estimation and building location recognition. They can cause errors in computer algorithms and image fusion. Also they can interfere with processing and application of high-resolution remote sensing images. So it is necessary to detect and remove the shadows present in images. There are mainly two approaches for shadows detection. First is model based approaches and second is shadow feature based approaches. In first method i.e. model based methods uses prior information such as scene, moving targets and camera altitude. It constructs shadow models. In second method i.e. shadow feature based methods, it identifies shadow areas as grayscale, brightness, saturation and texture. In image if there is shadow region, then it can appear as a low grayscale value. Also shadows cab be detected by converting RGB images into invariant colour spaces like HSV, HCV, etc. Mainly shadows are divided into two parts:- 1) Self shadow, 2) Cast shadow. The shadow on a subject on the side that is not directly facing the light source is known as self-shadow. The cast shadow is defined as the shadow of a subject falling on the source of another subject because the former subject has blocked the light source. The cost shadow is again divided into two parts:- 1)umbra, 2)penumbra. When light has been directly blocked by object then shadow created that shadow known as umbra, while penumbra shadow is created when something partly blocks the direct light. In most of the cases, the optical images are contaminated with shadow. In optical images cast shadows results from light source being blocked by objects. Therefore parts of image are not illuminated by direct light. These regions are mostly taken as darkest areas in an image and can be misclassified as dark objects for example water. So to avoid this type of errors and incorrect results detection and removal of shadows is necessary. It is effectively rule out false shadows created by vegetation in certain invariant spaces.

II. METHODOLOGY

The proposed work is divided into modules. The block Diagram of shadow detection and removal is shown in following figure 1.

Any image taken from satellite contains false and true shadow. Detection and removal of shadow is described into following modules:-

1] Segmentation

2] Detection of Suspected Shadow

3] Elimination of False Shadow

4] Boundary of False Shadow

5] IOOPL Matching

An input image may be colour image or grayscale image. If input image is colour image then it will be converted to grayscale image

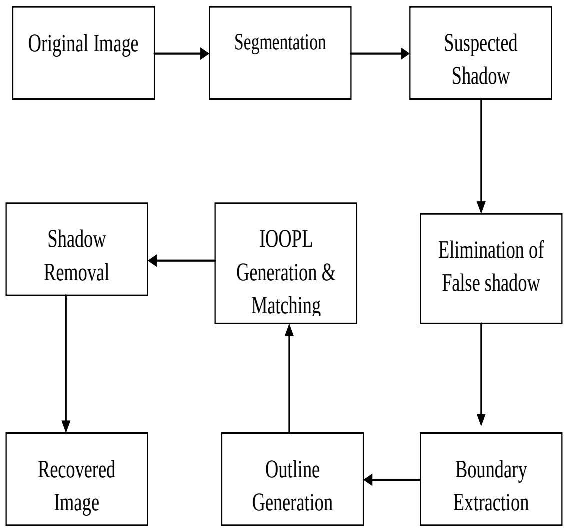

Fig. 1 Block Diagram of Proposed System

1] Segmentation:

For segmentation, traditional image segmentation gives insufficient result in segmentation. It makes it difficult to separate shadows from dark objects. So, here convexity model (CM) base segmentation along with colour factor and shape factor which distinguish between shadows and dark objects. The parameters of every object will be recorded including grayscale average, variance, area and perimeter.

2] Detection of Suspected Shadow:

For the detection of suspected shadow, threshold value will be calculated. To find out the threshold, binomial histogram splitting is feasible way. Threshold is the mean of two peaks of histogram. This threshold will be attained according to histogram of original image. Then by comparing threshold and grayscale average of each object which is obtained in segmentation, suspected shadow will be detected. Suspected shadow can be detected by comparing grayscale value estimation of each object and threshold by using following equation (1) and (2)

$$Gq = \frac{1}{2}(Gm + Gs) \quad (1)$$

$$h(T) = \text{Min}\ \{h(Gq-\varepsilon),\ h(Gq+\varepsilon)\} \quad (2)$$

Where Gm- Average grayscale value of an image

Gs - Left peak of the shadow in the histogram

T - Threshold, where $T \in [Gq-\varepsilon,\ Gq+\varepsilon]$

ε - Neighborhood of T

$h(I)$- Frequency of I , where $I = 0, 1, \ldots, 255$.

3] Elimination of False Shadow:

In the suspected shadows, dark objects may be included. So for the accuracy in the shadow detection, elimination of dark objects in important. Rayleigh scattering is used for elimination of false shadow. Rayleigh scattering gives result in smaller grayscale difference between shadow and nonshadow area in the blue (B) waveband than in red (R) and green (G) waveband. Consequently, for the majority of shadows, grayscale average at blue waveband is slightly greater than grayscale average at green waveband. Also, properties of green vegetation itself make green waveband significantly greater than blue waveband. So, false shadow from vegetation can be eliminated by comparing blue waveband and green waveband of all suspected shadows.

4] Boundary Extraction:

There will be large probability of both shadow and non-shadow areas in close range on both sides of shadow boundary belong to same type of object. By contracting the shadow boundary inward and outward gives the inner and outer outline of shadow image. To determine the radiation features of same type of object on both sides of shadow boundary, the inner and outer outline profile lines (IOOPL) are generated along inner outer outline lines. In shadow detection we will get vector line of shadow detection. Nonshadow area will be expanded outward from vector line from shadow boundary. Shadow area will be contracted inward from shadow boundary from vector line. There is one-to-one correspondence between nodes along inner and outer outline. It gives the extracted boundary of shadow image.

5] IOOPL matching:

Shadow removal method is based on inner-outer outline profile line (IOOPL) matching. When the correlation between both inner and outer outlines is close enough, there is large probability that this location belongs to same type of object. The grayscale value of corresponding nodes along inner and outer outline at each waveband will be collected to obtain inner outer outline profile line (IOOPL). IOOPL matching will be used to recover shadow areas in an image. IOOPL will divide into average sections with same standard to rule out nonhomogeneous sections. IOOPL will divide into average sections with same standard to rule out non-homogeneous sections. Then similarity of each line pair will be calculated section by section using equation (3). In this equation similarity of set A and set B is expressed.

Similarity,

$$(A, B) = \frac{\sum_{i=1}^{n}(c_i^A - \overline{c^A})(c_i^B - \overline{c^B})}{\sqrt{\sum_{i=1}^{n}(c_i^A - \overline{c^A})^2 \cdot \sum_{i=1}^{n}(c_i^B - \overline{c^B})^2}} \quad (3)$$

Where A= Curve representing one set

B= Curve representing another set

c_i^x = Grayscale of node i on curve X

$\overline{c^x}$ = Grayscale average of all nodes on curve X

In IOOPL matching, if the correlation coefficient is large, then IOOPL line pair belongs to same type of object, and thus considered to be matching. And if correlation coefficient is small, then some different types of objects exists in this section. So these parts will be ruled out. Relative radiation correction i.e. RRN (Relative Radiometric Normalization) is used to remove which calculates the radiation parameter according to homogeneous points to each object. From this shadow free image will be obtained as output image.

III. Results And Discussion

The results of this methodology are shown through images. For this process input image has taken shown in figure 2. This image cab be any color image or grayscale image. If color image is taken as an input image then it can be converted into grayscale image as shown in figure 3.

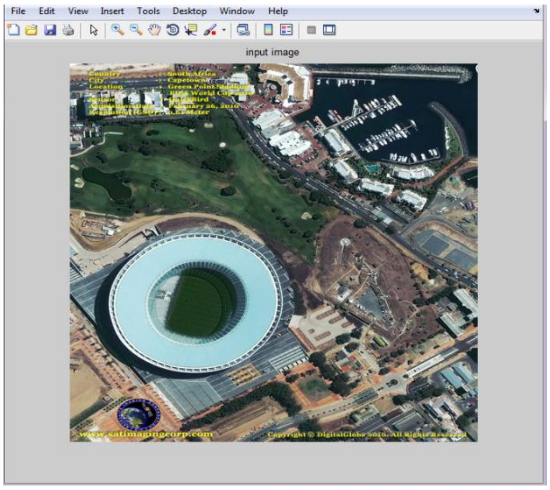

Fig. 2 Input Image

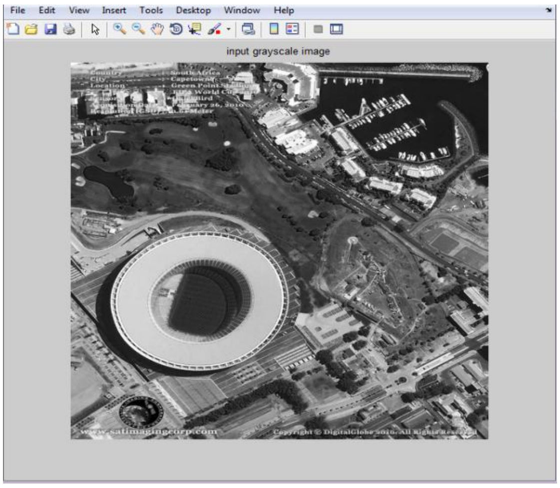

Fig. 3 Grayscale Image

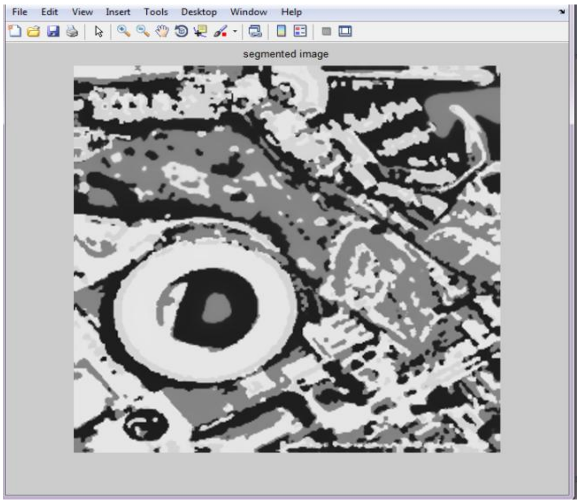

Fig. 4 Segmented Image

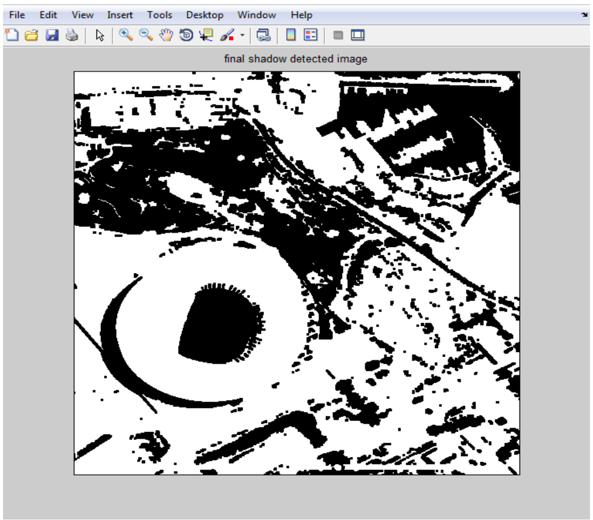

Fig. 5 Shadow Detected

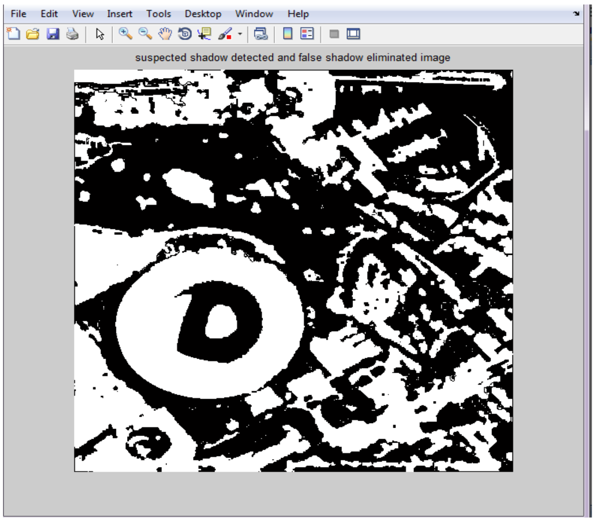

Fig. 6 Suspected Shadows Detected and False Eliminated Image

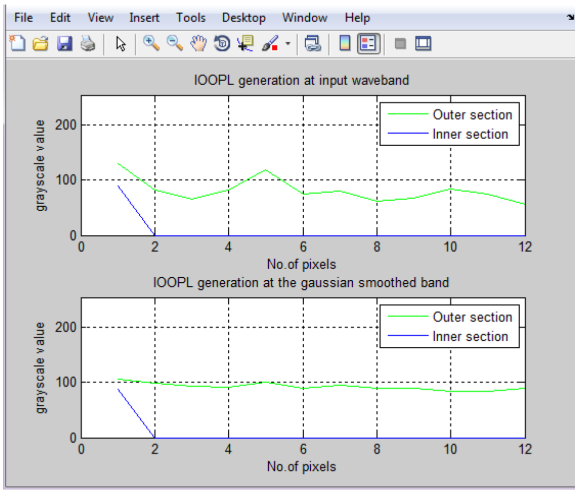

Fig. 7 IOOPL Graph Generation

From the segmentation result shown in figure 4, it can be seen that segmentation that considers shadow and dark objects. Then shadow area is detected through threshold method shown in figure 5. After that suspected shadow is detected and false shadow is eliminated from image as shown in figure 6. After elimination false shadow, inner and outer line generation for shadow removal. The inner outer outline profile line (IOOPL) graph generation is shown in figure 7. With the help of RRN (Relative Radiometric Normalization) shadow is removed. The output image i.e. recovered image is shown in figure 8.

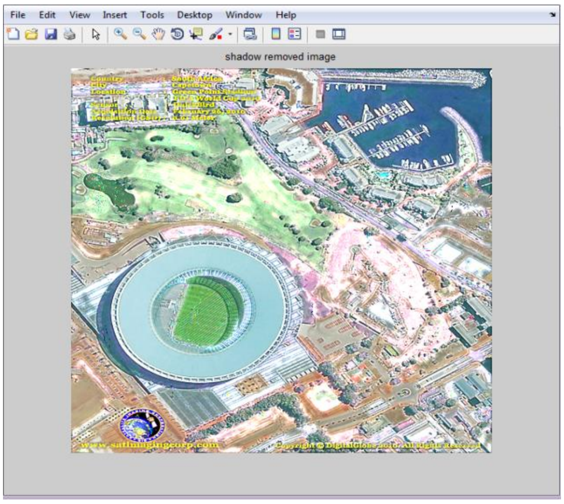

Fig. 8 Output Image

IV. Conclusion

This is a novel method which is object oriented shadow detection and removal for high resolution images of remote sensed urban areas. This overcomes the drawbacks of earlier methods. An image of any object contains false and true shadow. Here segmentation of image is done into different regions by convexity module. Next the Shadows are detected by Histogram based Threshold selection. The False Shadows are removed by colour space variation of wavebands. The Original content of the shadows regions are retrieved by inner-outer outline profile line (IOOPL). IOOPL is based on the outer surface of the regions. True shadows are removed by IOOPL matching. So the original contents retrieved well. This concept is mostly used for surveillance applications.

V. References

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