Statistical Computation, Quantification and Analysis of Shadow Detection and Its Removal from Satellite Images

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Abstract

A Shadow is an effect which is generated by bright light source on an object. In this research paper, a new methodology for shadow removal based on color based method is proposed. The Entropy, Peak signal-to-noise ratio (PSNR) and Mean-squared error (MSE) results of earlier Tsai Method and proposed color based method are calculated and compared with each other. The results show that the proposed color space model is better than the previous Tsai.

Keywords: Shadow Removal, Entropy, PSNR, MSE

Introduction

As per science, Shadows played an important role in remote sensing. Over the past decade or more, with the availability of high-resolution satellite earth observation and the rapid development of a number of platforms such as airships and non-human air vehicles, there is a growing need for high resolution image for a variety of applications in urban areas. 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. [1]. The main problem caused by shadows is decline or exhaustion of object in satellite images. [2] In simple terms, Shadows can react negatively to HR in images. There are two moments present: the cast shadow (the piece of the object or not lit) and both have a different brightness value. The biggest problem of shadows is a name of either decrease or total loss of information. The process of and constructing arguments us called Argumentation. In other words, argumentation is the process whereby arguments are constructed, exchanged and evaluated in light of their interactions with other arguments.[2] Shadow removal is a serious problem in satellite image processing. The major problem is, if we delete or remove shadow from the satellite image so the resultant image will be with incomplete information.

Past Shadow Detection and Removal Work by Tsai[4]

The Tsai's (algorithm) method is shown by flowchart in Fig.1. To detect shadows in the color satellite image, the Tsai algorithm initial transforms the input image into an invariant color image or model, that is. HSI(Hue saturation intensity), HCV(Hue Chroma Value), HSV(Hue shaded Value), YIQ (Luma in-phase quadrature)color models. For every pixel, the ratio of color to intensity is obtained to determine if pixel is a shadow pixel or not. Of these invariant color models, Tsai's algorithm has the best shadow detection performance for the HSI model or image.

It follows following steps.

Step1: Firstly, satellite image can be transformed into hue, saturation and intensity.

Step2: Ratio map is constructing by calculation of ration of hue over the intensity and then the global thresholding is used to identify the shadow.

Step3: Satellite image will transform RGB color satellite image into gray image and then apply the global thresholding scheme using Otsu's method.

Step 4: After applying Otsu method, we can easily identify Non shadow pixel and shadow pixel.

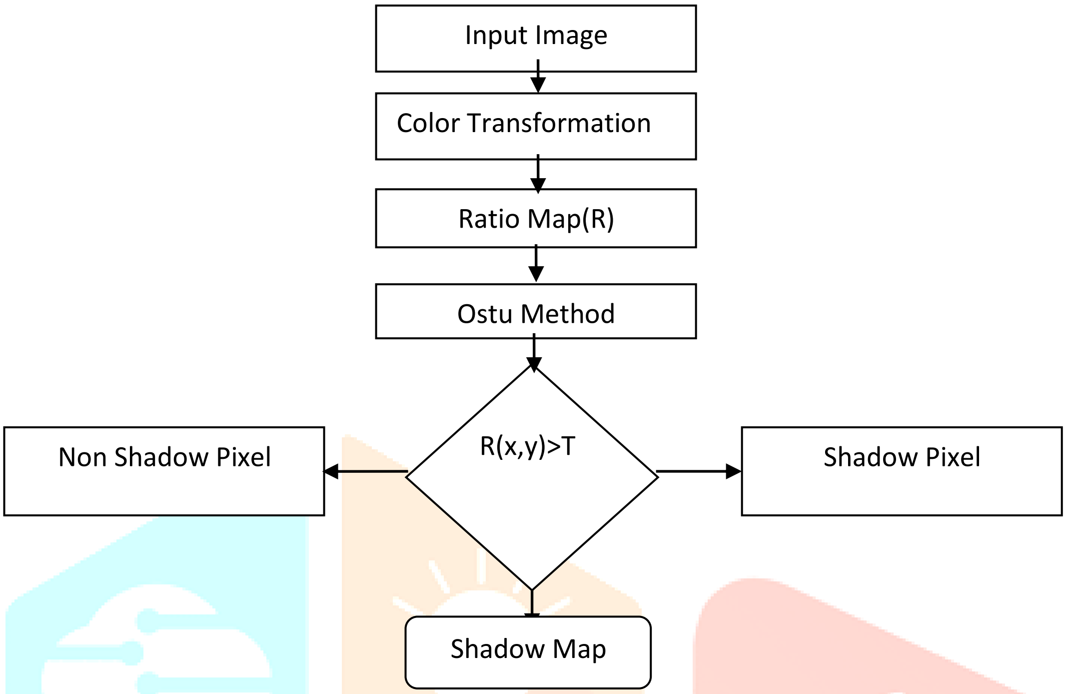
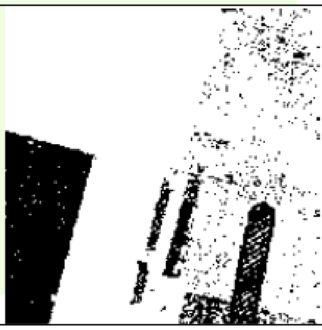
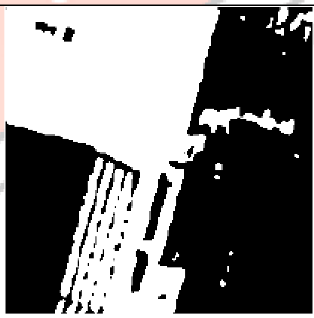


Fig-1 Tsai Algorithm flowchart

Experimental Results with Tsai Algorithm

		
(a)	(b)	(C)
		
(d)	(e)	(f)

In above figure (a) Original image(b) Shadow detection by Tsai's algorithm.(c) Shadow detection by our new analysis based algorithm.(d) Shadow removal(Enhanced shadow image) using adaptive histogram equalization. (e) Shadow removal (Enhanced shadow image) using image adjustment.(f) final shadow removal for image

Proposed Shadow Detection and Removal Algorithm

The proposed (algorithm) method is shown by flowchart in Fig.3. To detect shadows in the color satellite image, the proposed algorithm initial remove the noise in to the input image and it follows following steps to detect and remove shadow from satellite images.

Step1: Firstly, identify and remove the noise from the satellite image.

Step2: For reading every pixel image converted into the binary image and if it is dark, convert it to 0, and if it is clear, convert it to 1(or invert 1 and 0).

Step3: For image segmentation threshold is apply on satellite images.

Step4: As a smoothing operator Gaussian filter is apply on satellite images and it is also use to minimize the noise.

Step5: The basic idea is to probe the satellite image with a template shape, which is called structuring element, to quantify the manner in which the structuring element researcher will use morphology.

Step6: To reconstruct the edges of satellite image smooth masking is applied.

Step7: Apply proposed algorithm to remove shadow from the satellite image.

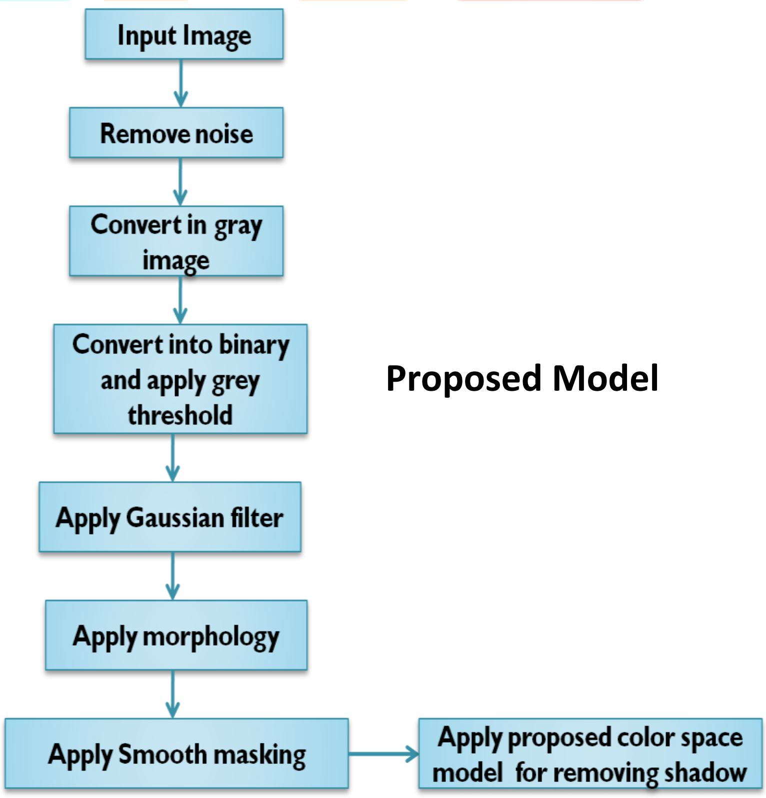
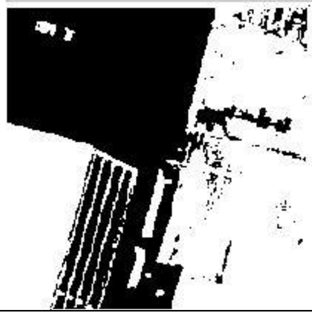
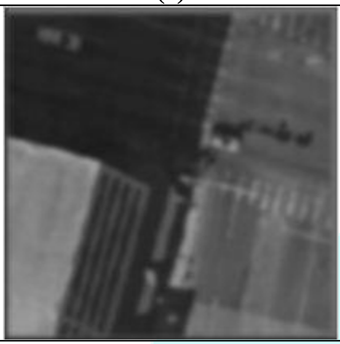
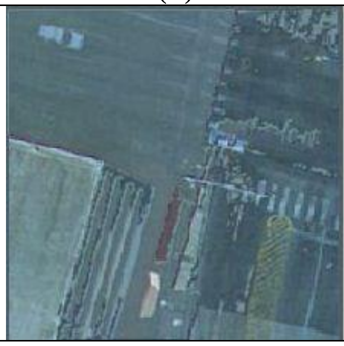


Fig-3 Proposed Algorithm flowchart

Experimental Results With Proposed Algorithm

		
(a)	(b)	(C)
		
(d)	(e)	(f)

In above figure (a) Original image(b)Remove noise and convert in gray.(c) Shadow detection by our new analysis based algorithm and apply threshold .(d) Apply Gaussian filter and morphology. (e)Apply smooth masking.(f) final shadow removal for image by our new analysis based algorithm.

Result Parameters [3]

1. Entropy

Image entropy is a value used to explode for a satellite image, which means that it contains the measure for information to be encoded via a robust algorithm.

The satellite images with lower entropy value have very little contrast and the images contain a lot of black air.

On the other hand, the satellite images with higher entropy value have a greater contrast, like the satellite images with heavy crater areas on the moon and the higher entropy images cannot be compressed as far as low entropy images.

Following define formula is used to calculate the entropy of any satellite image:

$$\text{Entropy} = -\sum_{i} Pi \log_2 Pi$$

In the above formula, Pi is the probability that the difference between two adjacent pixels is equal to i, and $\log_2$ is the base 2 logarithm. In Table 1 comparisons between the entropy value of satellite images by using proposed method and earlier method Tsai is shown.

2. Mean Square Error (MSE)

It stands for Mean square error. The average square error indicates how close a regression line is to a set of points. To do this, you take distances from the points to the regression line (these distances are the "errors") and square them. Squaring is required to remove any negative characters. It also gives greater importance to larger differences. This is called the average square error when you find the average of a series of errors.

3. Peak Signal to Noise Ratio (PSNR)

PSNR stands for Peak signal-to-noise ratio is a technical name used for the relationship between the highest achievable power of the signal and the effect of corrupting noise that affects the reliability of the display. The higher value of PSNR represents the better quality of the compressed or reconstructed image.

PSNR is the peak signal-to-noise ratio measure in decibels (dB).

The following equation describes the PSNR:

$$\text{PSNR}=\frac{20\log_{10}{}^{2^k}}{\sqrt{MSE}}$$

Here MSE indicates the mean square error and K describes the bits per pixel.

Table 1. Comparisons of Entropy, MSE and PSNR: Earlier(Tsai) V/S Proposed Methods

Sr.No	Parameter	Earlier Method	Proposed Method
1	Entropy	7.1551	6.5777
2	MSE	872.17370	839.92717
3	PSNR	18.75877	18.92238

Conclude

Based on the parameters as given in the table above, we can declare that the projected method is clearly better than the earlier method. Although we cannot mark the distinction between the images as obtained from both the methodology with bare eyes, we can most correctly see the value of entropy, MSE, PSNR of each of the image as obtained after the use of earlier and proposed technique. For future work, we can test the proposed methodology with different variables (other than above parameters).

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