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Satellite Image Quality Improvement Using Wavelet Based Enhancement Method

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Abstract: In image processing there are many enhancement methods have been proposed earlier to improve quality of satellite images. Despite of having advance steps still those methods unable to give satisfied result. There are many issues related to the satellite images it included edge enhancement also, as edges plays important role in information preservation. Therefore this new method is focus on edge preservation and enhancement. In this new method uses the concept of wavelet and morphological filtering. As the Gabor filter is used for efficiently detects the edges from image, while these detected edges are sharpened by using morphological filters. Also the other intermediate steps are applied so that it works on other important aspects such as noise removal, color and useful information preservation etc. This method gives better qualitative and quantitative result compare to the well known state-of- the-art techniques.

Keywords: Image enhancement, wavelet transform, Gabor filter, morphological filtering, remote sensing.

I. INTRODUCTION

In image processing images are the most convenient and effective means of conveying information. Image processing where the input is an image, such as a photo-graph or video frame and the output of may be either an image or a set of parameters related to the image. In image processing it develops the application that could perform the operation related to the visual functions of all images like enhance the image to improve image quality, perform compression to reduce storage space and remove the noise etc. In today's world image processing is a fastest growing field in many areas of science and engineering. There are several important aspects in it, from which image enhancement is most appealing and simplest area among all. [1].

Image enhancement in which processing an image in such a way that the enhanced image is more useful than the original for the particular application. The basic idea related to the image enhancement is to bring out detail that is not visible clearly or highlight certain important features of an image. Also it is necessary to improve the visibility of the image by removing unwanted noise, to find more details and improve contrast etc. There are two main approaches of image enhancement i.e. spatial domain and frequency domain.

Spatial based domain image enhancement operations are performed in order to work on the image contrast, brightness. It directly operates on pixels; therefore the pixel value of the enhanced image will be varying as per the transformation methods applied on the input values.
One of the advantages of this domain method is that the complexity of these techniques is low and conceptually simple to understand so used in many real time implementations. However these methods lacks in imperceptibility requirements and providing sufficient robustness. This domain method contains bilateral filter it produce distortion and blur in image. [2].

The other frequency based domain method is used to describe the analysis of mathematical functions or signals with respect to frequency. This method operates directly on the transform coefficients of the image such as discrete cosine transform, Fourier transform and discrete wavelet transform. The idea behind this technique is to enhance the image by manipulating the transform coefficients. The advantages of frequency based image enhancement includes low complexity of computations, manipulating the frequency composition of the image, ease of viewing and the easy applicability of special transformed domain properties. [3]. Satellite images are used in many image processing applications such as cartography, geosciences studies, agriculture, weather forecasting, astronomy, landscape and geographical information systems etc. In our work the main effort on edge enhancement has been focused mainly for improving the visual perception of images which is unclear. In existing methods the popular edge enhancement filtering is perform by using traditional filters but it contains some drawbacks [4, 5].

II. PROPOSED METHOD

A new image enhancement technique is instigated for making satellite images more informative and helping to achieve the goal of image interpretation. Edge in the

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image helps to identify useful information, due to this reason edge enhancement focus mainly.

A. Select Input Image

Select satellite image as an input of different image format or size, next is decomposed the input image into R, G, B color component. Using matlab application separately shows these R, G, B value by using histogram.

B. Check for Quality

Here we can check the quality of input satellite image, by calculating the mean intensity of an image. After that we can it needed to enhance or not. It is nothing but the average of the intensities of all pixels in an image.

First find the value of, n = length(x) (1)
Next calculate the value of, mean = sum(x) / n (2)

By using above equations we can calculate the mean intensity, if is greater than 0.5 then it is consider as quality image which does not need to enhance otherwise it is need to.

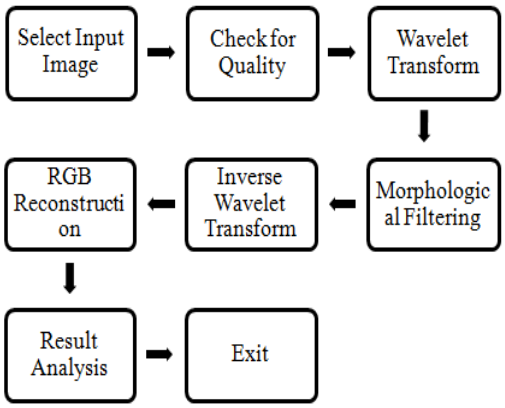

Fig 1. Block Diagram of Proposed Method

C. Wavelet Transform

Gabor filters are directly related to Gabor wavelets, since they can be designed for number of dilations and rotations. We cannot apply expansion for Gabor wavelets, because this requires computation of biorthogonal wavelets, therefore it is very time-consuming. For this created a filter bank consisting of Gabor filters with various scales and rotations. It has various transforms, frequencies, various features, operators and image properties which are used in detecting image segmentation. Gabor filter is used in many applications but mainly used for edge detection purpose. As the frequency and orientation representations of Gabor filters are similar to those of the human visual system so it is appropriate for texture representation and discrimination in image processing. In our work it perform important role for edge detection and enhancement.

In general Gabor filter is a linear filter whose impulse response is represented by a harmonic function multiplied by a Gaussian function

$x_{smooth}(m,n)$ □ □ x(m,n)□ h(m,n) (3)

$x_{edge}(m,n)= x(m,n)- x_{smooth}(m,n)$ (4)

First calculate the value of x_{smooth} in equation 3, after that subtract x_{smooth} from original image gives the image edges x_{edge}, therefore we get the edges from the image. To enhance the detected edges more, another equation applied on it. By using K as a scaling constant, multiply the K with detected edges and added back into original image so get more sharpen image as shown in equation 5.

xsharp(m, n) =x(m, n) +k[xedge (m, n)] (5)

Initially value of k is user defines one, but in our work we have already assign value for it. It is apply on satellite images for find more important information and then used in many applications such as forestry, astronomy, geosciences studies and geographical information systems.

D. Morphological Filtering

To enhance the detected edges morphological filtering applies on it. A morphological filter is an important aspect of an image processing to solve numerous problems, also it is a non linear filter used to sharpen edges effectively. Most importantly morphological image processing is used for solving the image sharpening problem.

E. Inverse Wavelet Transform

When applying above processes the frequency components have been enhances that has to be reconstructed using inverse wavelet transform.

F. RGB Reconstruction

We have to reconstructed R, G, B value back in this step. To get accurate enhance image here created one loop, by using that we get different value. First we have to select one random value R for filtering, after that differentiates object pixels and background pixels. The pixel value which is greater than R is considering as object pixels, while others are background pixels. Next calculate the average of object pixels P1 and background pixels P2. Find new value of R by taking an average of P1 and P2. The new value of R use again for filtering pixels, continue execution until new value matches ones before it. Finally we get accurate value which gives enhance output image.

III. RESULT & DISCUSSION

This section presents the results obtained after implementing proposed method. In order to prove the effectiveness of the proposed algorithm over the other existing method we have calculated some results, here we are discussing it. First we can discuss about the entropy of image.

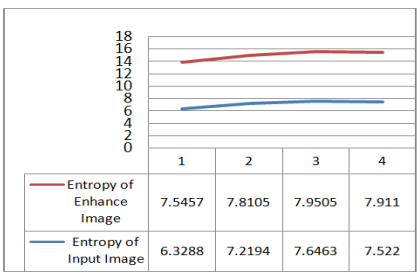

Fig 2: Comparison graph of entropy values of input and enhance image

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Entropy value shows the amount of information present in an image. If the entropy value increases this indicates that information in an image more visible than input image. Whereas low entropy value of enhance image than input image shows that it loss some information.

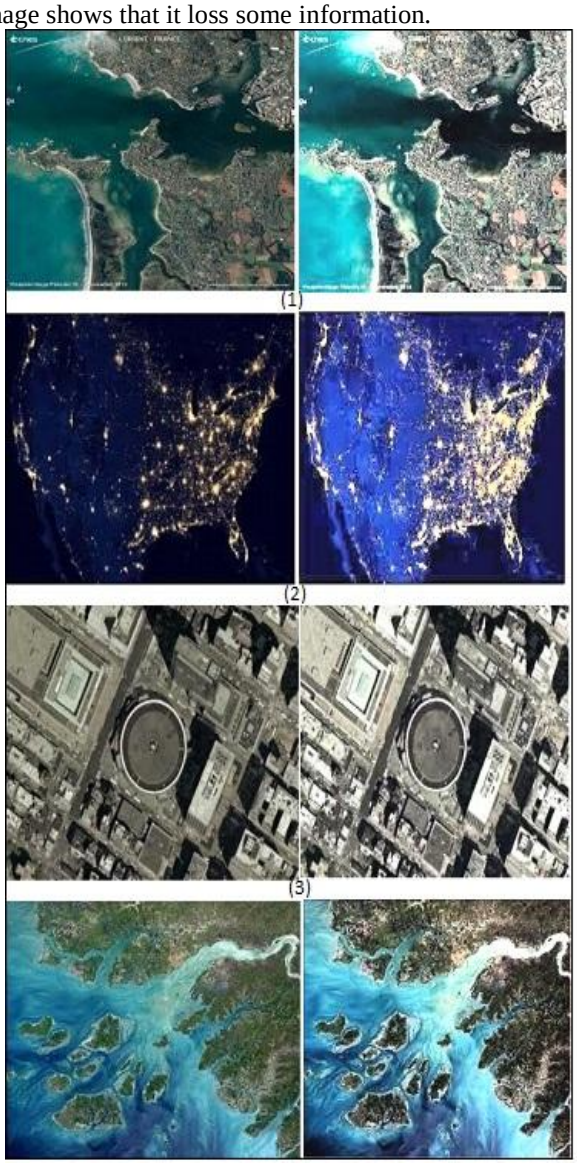

Figure 3: Left side images are input image and right side images are enhance images

For comparison of entropy values we have implemented it on different satellite images shows in figure 3. In the figure 2 we can see the comparison graph of entropy value, it shows that entropy value of enhance image by using our proposed method is increased than input image.
Peak signal to noise ratio is calculate by following formula;

$$PSNR = 10 \log_{10} \left(\frac{R^2}{MSE} \right)$$

Peak signal to noise ratio is used as a quality measurement between the original and enhance image. PSNR value indicates the quality of image if it is high in enhanced image means image quality improves in it than original image.

TABLE 1: PSNR value comparison for Washington DC image

Method	PSNR (dB)
SWT-RE	10.33
DWT-RE	11.74
DT-CWT	24.06
Proposed system	36.83

For comparing value of PSNR by using different method on Washington DC image. The results of this comparison are mentioned in table 1. As proposed system PSNR value is greater than other existing methods which show that the image quality is good. The PSNR value is measure in decibels (dB). The different wavelet transform methods apply on Washington DC image shows in figure 4. Figure 5 shows the PSNR results comparison graph with existing methods. [8]

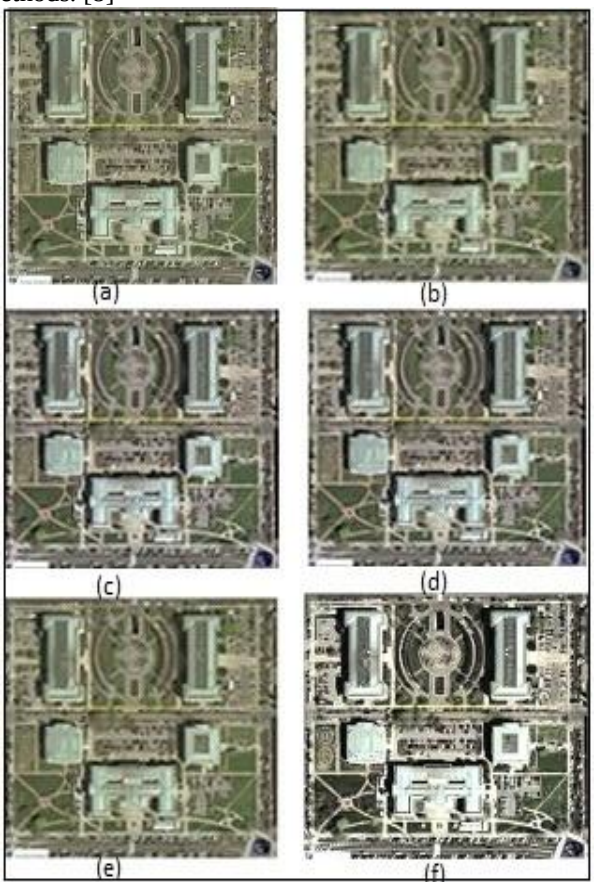

Fig 4: a. Original Washington DC image, b. Input image, c. SWT-RE, d. DWT-RE, e. DT-CWT-RE, f. Proposed method

After analysing the PSNR values of our implemented method, we can say that the main goal of satellite image quality improvement is achieved.

Also we can compare the intermediate results between the implemented steps by using parameters like entropy, average difference, structure content, MSE etc. So that we can understand the changes occurs in each next step.

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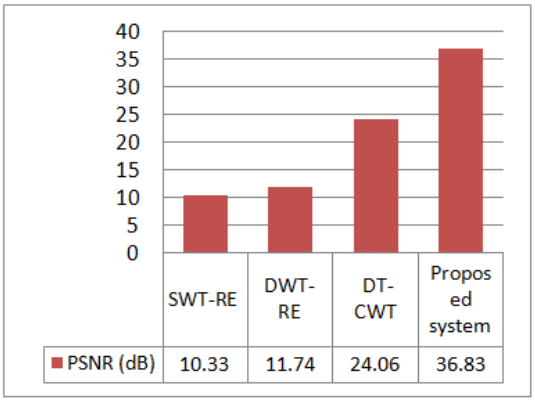

Fig 5. PSNR (Decibels) results of proposed technique compared with conventional and some state-of-art techniques.

IV. CONCLUSION

We have implemented this new method to improve the quality of satellite images and results have mentioned in the result analysis chapter. The gabor filter is very effective in detecting the edges from low contrast satellite images and detected edges is sharpen by using morphological filtering process. The visual examples shown in above chapters, have demonstrated that the implemented method was significantly better than many other well-known methods in respect of edge enhancement and useful detail restoration. This thesis will helpful to study the effective method for satellite image enhancement. This method is verified by both quantitative and qualitative parameter. In the result analysis chapter it shows that the PSNR, computational time and entropy value of an image is better than other well known state-of-art methods.

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