Effective Satellite Image Contrast Enhancement and Sharpness Enhancement

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Abstract – Satellite image processing is a potential need of human lifecycle because many satellites are launched to assist the human life in case of disaster management, weather prediction, etc. Satellite image processing and analyzing face the challenges due to the poor contrast and sharpness. This paper proposes a new methodology for contrast enhancement and sharpness enhancement on satellite imagery. The contourlet transform and Singular Value Decomposition are the core components of contrast enhancement. The sharpness enhancement is performed by the Discrete Wavelet Transform (DWT), Stationary Wavelet Transform (SWT) and the cluster based ranged distribution (CRD) methods. The proposed method enhances the satellite images significantly to a superior quality. The experimental result proves the efficient enhancement capability of the proposed method than the conventional algorithms.

1. Introduction

Satellite images are the key sources for analyzing the Atmosphere, Agriculture, Geology, Forestry, etc [1]. Satellite imagery can assist to estimate the geographical parameters of the Universe. Satellite images are acquired by satellite and transfer to earth station. The satellite image processing tasks are segmentation, classification, change detection, etc. Satellite image enhancement makes the visual quality improvement by a optimum way to best fit for the other image processing tasks related to satellite images.

Satellite image processing is suffered by poor contrast and inadequate sharpness, and hence there is a need of preprocessing schemes for the improvement of contrast distribution and image sharpness. This paper contributes a new work for satellite image enhancement which includes the solution for the drawback of existing systems.

The contrast enhancement can be reached by General Histogram Equalization (GHE) [3][4]. The Local Histogram Equalization (LHE) technique is also employed to enhance contrast level [5]. The Brightness Preserving Dynamic Histogram Equalization (BPDHE) method is also presented to improve contrast level [6]. The singular value based equalization is adapted for the contrast improvement of satellite images [7]. The author, Rande A. et al. design a low contrast satellite image improvement method using Discrete Cosine transform pyramid and Singular Value Decomposition [8].

An image sharpening method based on wavelet is described in [9]. A digital image interpolation based image sharpening method is published in [10]. Riesz potential oriented satellite image sharpening method is provided with detail in [11]. The local directional similarity vector is computed using the surrounded pixels to improve the image sharpness and that is referred in [12].

The existing methods are having limitations on performance of satellite image visual quality improvement, in cases of contrast distribution and satellite image sharpening. This paper proposes a new method for the satellite image enhancement which includes satellite image contrast enhancement and sharpness enhancement. The proposed method is enriched by the methodologies such as DWT, SWT, Contourlet transform, SVD and CRD.

The section 2 of this paper explains about the proposed methodology and the section 3 evaluates the analysis and section 4 concludes about the power of the proposed algorithm's performance.

III. Proposed Method

The proposed method enhances the satellite images by improving the contrast level and the sharpness level. The contrast improvement is lifted by Retinex, Single Value Decomposition (SVD) and Contourlet methods. The contrast output is given as input to the sharpness enhancement scheme. Then the DWT, SWT and CRD methods are employed to improve the satellite image's sharpness. The architecture diagram of the proposed satellite image enhancement method is depicted in Fig.1.

The input satellite images proposed by Retinex [16] algorithm to generate enhanced images and again both of these images are transferred by Contourlet [17] into four sub band images. The correction coefficient p is found from the Singular value matrix using equation 1.

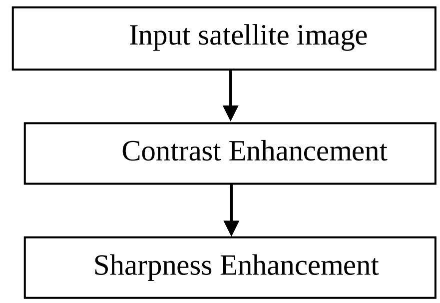

Fig.1. Architecture diagram of the proposed method.

The diagram of the contrast enhancement process is described in Fig.2

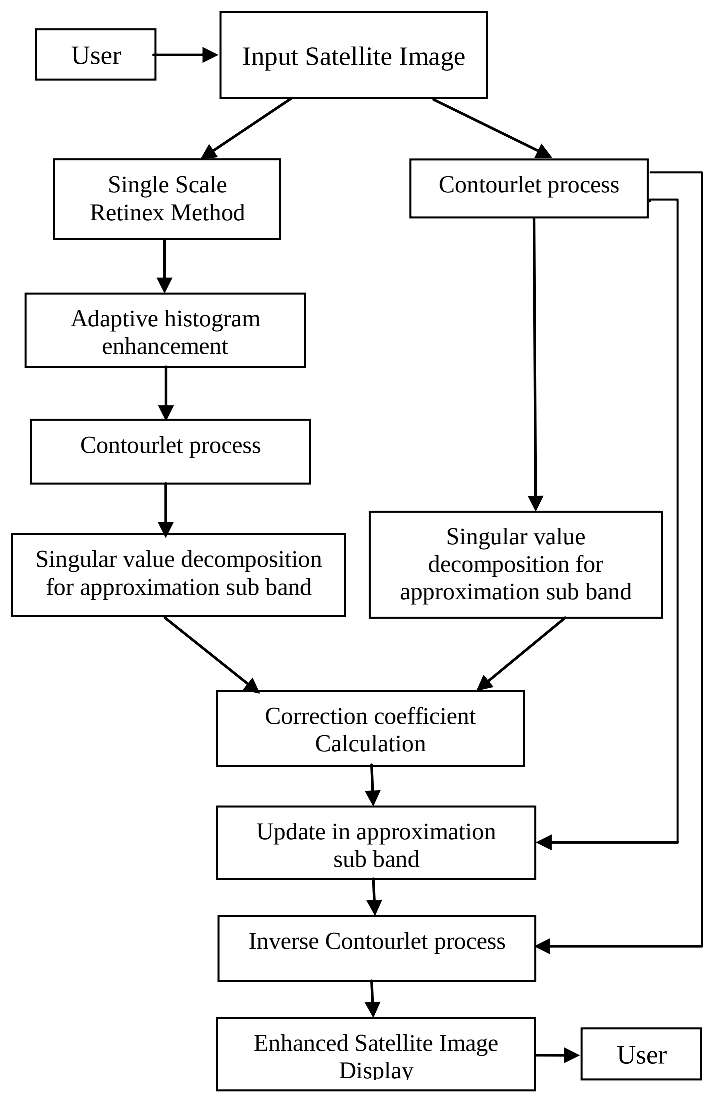

Fig.2. Block diagram of the proposed method's contrast enhancement.

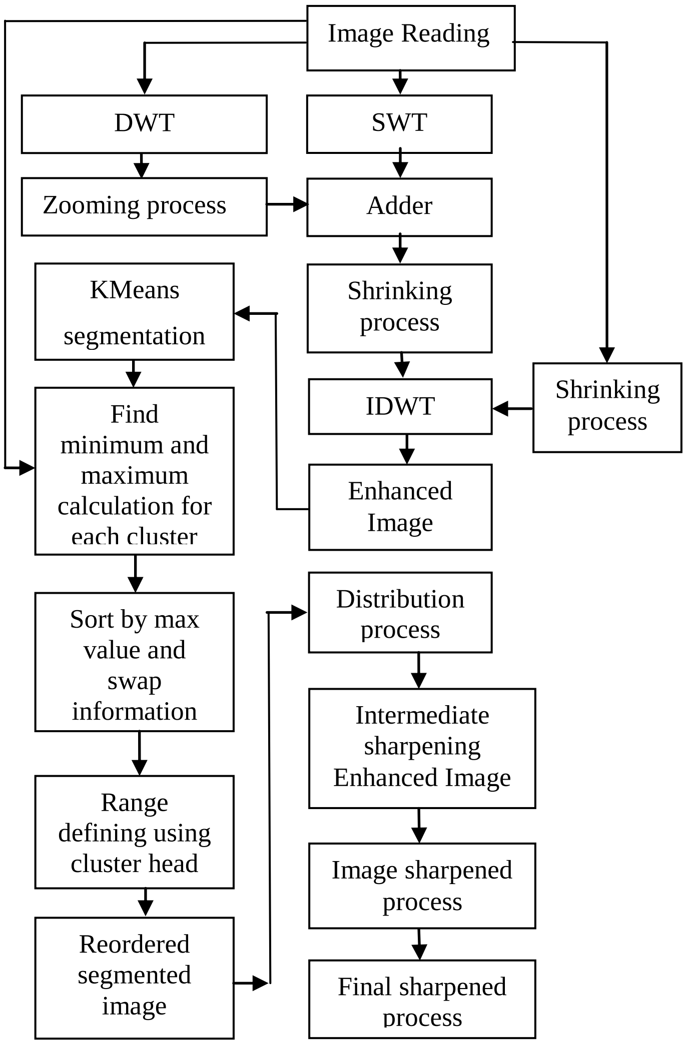

Fig.3. Block diagram of the proposed method's sharpness enhancement scheme.

$$p = \frac{\text{Max (LL value matrix of input image)}}{\text{Max(LL value of equalized image}} \quad (1)$$

The correction term p is used to modify the LL image. The new LL image and the other three sub band images are integrated to perform the inverse Contourlet process which provides the contrast improved image.

The contrast enhancement image is given as input to the sharpness enhancement process. The input contrast improved image is undergone DWT process [13] and SWT process. The DWT process's LL sub band is zoomed to the original image size and that output is used for the replacement of LL sub band of SWT. A Shrinking process is applied over the resultant LL sub band. Then the inverse DWT process reconstructs the image which is known as intermediately enhanced image. The K Means [14] clustering method is applied over the enhanced image for finding the minimum and maximum calculation for each cluster and the values are distributed based on each cluster. The distributed image is further sharpened by Gaussian sharpening method [15]. The enhanced image is improved in case of contrast and sharpness.

III. Experimental Results and Analysis

The proposed method is analyzed against the following two existing methods.

- Jang et al. method [16]
- Rui et al. method [10]

Fig.4. Ilustration of the output of proposed method. a) Original image b) Enhanced image.

The Fig.4.a. shows the original image whereas the Fig.4.b. shows the enhanced image of the proposed method.

Table 1: Average MSSIM analysis

Sl. No	Enhancement method	Proposed method
1	61.72623	120.3896
2	91.18675	138.4005
3	41.816528	137.8501

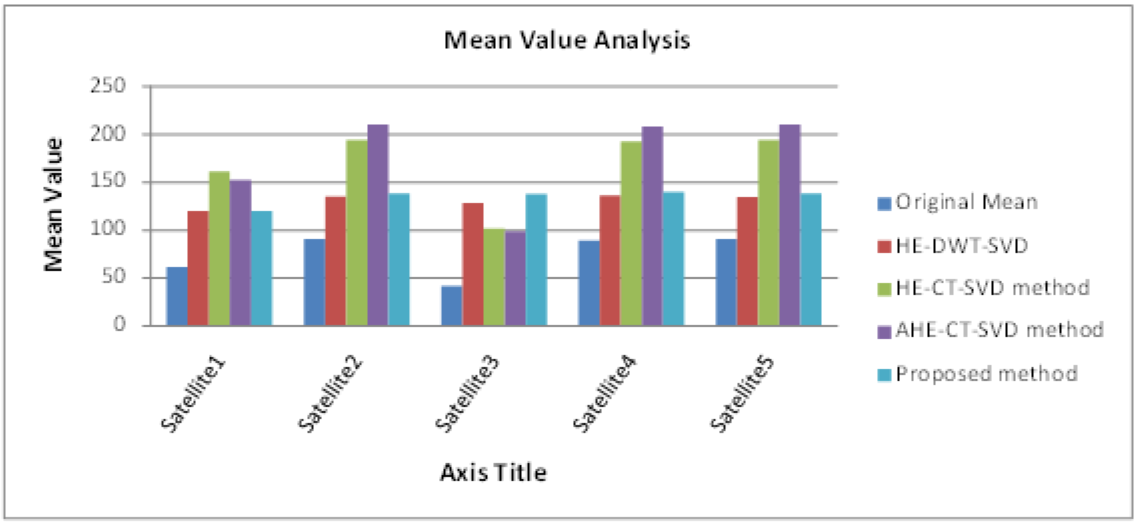

Fig.5. Average MSSIM analysis chart.

The Table1 and Fig.5 show the average MSSIM analysis for the 3 methods. The higher MSSIM means better enhancement in visual quality and based on this doctrin the proposed method is the leading method than the existing methods, which means the proposed method is the best one among the others.

Table 2: Average time cost for image enhancement

Sl.No	Satellite Image Enhancement method	Arage time taken (in secs)
1	Jang et al.	15.11
2	Rui et al.	17.13
3	proposed	32.16

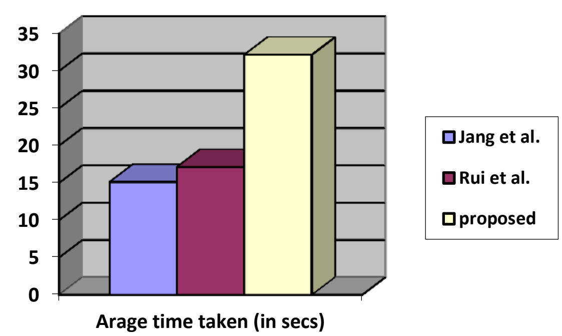

Fig. 6. Average time cat analysis chart.

Conclusion

This paper designs a satellite enhance method to lift the visual quality of remote sensing images in terms of contrast enhancement and sharpness enhancement. The proposed method is working without any error and accomplishes its target accurately. The experimental results proves that the MSSIM of the proposed method is higher than the others, which means the pre-eminents of the proposed method is assured. According with time cost analysis the proposed method also takes a reasonable time taken. By considering the overall benefits of the proposed method, this paper concludes the superiority of the proposed method towards the satellite image enhancement.

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