An Improved Technique for Enhancement of Satellite Image

Lavanya Sharma¹, Sudhriti Sengupta¹*, Birender Kumar²
¹Amity University, Noida, Uttar Pradesh, India
²ABES Engineering College, Ghaziabad and Noida International University, Greater Noida, Uttar Pradesh, India
shm.lavanya@gmail.com, ssgupta@amity.edu, bk.uptu@gmail.com

Abstract: Satellite Images are important source of data through images captured from artificial satellites revolving around orbit of the Earth. These images are susceptible to noise, irregular illumination which effects the quality of image. An improved enhancement technique is proposed in this paper that will increase the visual perception in the image while preserving the details. The effectiveness of the proposed technique is tested by using Entropy and histogram Analysis.

1. Introduction

Images of different locations in earth taken by artificial satellite are called Satellite Images. Satellite Image Processing is important as they provide information about the surface. If effective processing is done the images are widely used to inform and monitor the physical conditions, Infrastructure and detection of any animals etc. [1].

Satellite Images is a type of remote sensing which is utilized to collect coherent information about earth surface. These images play and vital role in many fields like astronomy, remote sensing, GPS, Disaster management etc. These images are very complex and inculcate processing criteria is required in analysis of the images. Researchers are developing techniques to use the satellite image data and making the processing easy and timely. One of the important techniques in satellite image processing is image enhancement [2]. Image enhancement is used to make the visual perception in the image clear and easily understandable. This method emphasis on different features of image such as edges boundaries or patterns. This is important for perceiving the details in the image. In this paper we have proposed an improved contrast enhancement technique which will improvise on the contrast of the image to certain limits by saturating 1% of the upper and lower pixel values. This process produces better quality images as compared to the conventional contrast enhancement technique and the ground truth of the original image.

Satellite images are used in a lots of applications. One of the issues with satellite images is low resolution of these images as they are effected by factors such as absorption, scattering etc. Researchers are interested in enhancing the quality of these images and many methodologies are proposed by the same [3]. Fourier Transformation and adaptive wavelength is used for preserving high frequency details in image [4-5]. To de-noise high resolution image cycle spinning method is used [6-7]. Other
popular enhancement techniques are Discrete Wavelet Transform, adaptive contrast modification, beta differential evolution algorithm etc. [9]. The field of satellite image processing is very vast and enhancement of these images are very useful for carrying out tasks like classification, clustering and visual inspection. Latitha et al. (2018) has used a technique based on neural network to enhance a particular place on earth surface automatically [10]. Thriveni and Ramashri (2010) has proposed a method in which the input image is based on Discrete Wavelet Technique. It is a tool used mainly in nonlinear image analysis. In this method, threshold decomposition is used for detecting edge position and morphological filters are used to sharpen these images [8]. Attachoo and Pattansethonon (2009) used a two stage filtering process for enhancing the details. It uses Laplacian merged Convolution resulting in clearer coloured satellite image [11-17]. A technique to enhance satellite image having poor contrast was developed using DWT and Singular value decomposition (SVD) methods by Sharma and Verma [12]. A novel method for remote image enhancement based on Principal Component Analysis and Intensity, Hue and Saturation (HIS) transformation proposed by Lu et al. in 2011 [13]. Jadhaya (2011) used Dyadic Integer coefficient based wave filters for enhancement of satellite image [14]. In 2020, Giri and Sengupta used general histogram Equalization to create True Color composite of input Satellite Image. It results in optimized result in producing clear satellite images while preserving hue value [15]. In this paper we have proposed an improved technique which will enhance the quality of image while preserving the details.

2. Proposed Model

The type of enhancement process depends on the nature of the image. One of the widely used technique in the frequency domain method. Fourier analysis, wavelength transfer etc. are the types of frequency domain method. The issue with high pass filter is that it tends to insert noise and thereby decreases quality. Smoothing of images is done in low space filling. Another popular technique of contrast enhancement is the linear contrast stretch. Histogram Equalization is used to increase brightness of the color zone and make it more interpretable. Gaussian stretch is also used as contrast enhancement technique. HIS (Hue, saturation and Intensity) transformation also sustainably improve the quality of image and is also widely used. Any image which contrast is well adjusted has a sharp dispersion between light and dark pixels. Contrast enhancement remains the intensity of image to a wide range of data type. In this method we have map the intensity value of the original image to new intensity value it uses 1% of the top and bottom pixel value for saturation. It tends to remap the value to fill the entire range [0-255].

The range can be adjusted to decrease the contrast to perceive the details in darker region. In this method, the range is adjusted by considering the bottom 1% at 0.01 and top 1% at 0.99 by applying this at both ends dynamic range for the remaining intensity is adjusted. The outcomes of the proposed work and conventional method are displayed in the fig.1. We have shown the actual implementation of the proposed technique in seven satellite images which have been taken from open source portal. The original image is shown in Fig1 (a). Enhanced Image obtained by applying proposed methodology is given in Fig.2 (b). To compare the efficiency of the proposed method we have taken the help of filtering technique which automatically adjust image intensity value.

3. Implementation

For validating the efficiency of the proposed methodology, seven test images have been accessed from open access web portal. The required experiments are done using Matlab 2018a
on Intel Core i3 7th Gen 3.60 Ghz having 8 GB RAM and 1 TB Hardisk. The operating system used is Windows 10 Professional, 64-bit system.

4. **Results and Discussions**

The result of the proposed method is compared with the enhanced images obtained by applying conventional enhancement method. To check the efficiency of the method we have used entropy of the image. Entropy of an image is a statistical value used for evaluating the image quality. The amount of distinct characteristics or variations in an image is given by entropy of image. If the image quality is high, then entropy is larger than the image having less quality [16]. The entropy of the original image, enhanced image obtained by proposed method and enhanced image obtained by conventional method is shown in Table 1.

It can be observed from Table 1 that entropy of the images obtained by applying the proposed image enhancement technique is higher as compared to the original image and enhanced image obtained by conventional method.
Figure 1. Comparative analysis of satellite images: (a) Original image (b) Enhanced image by proposed technique and (c) Enhanced image by conventional technique.
### Table 1. Quantitative Comparison of the proposed Method

| Serial no. | Original Image | Proposed Technique | Conventional Technique |
|------------|----------------|-------------------|-----------------------|
| **Test Image 1** | 7.3772 | 7.5941 | 7.1483 |
| **Test Image 2** | 7.4584 | 7.6746 | 7.2991 |
| **Test Image 3** | 7.5909 | 7.5013 | 7.3359 |
| **Test Image 4** | 7.0577 | 7.3146 | 6.8717 |
| **Test Image 5** | 7.3672 | 7.4367 | 7.1544 |
| **Test Image 6** | 6.9324 | 7.3034 | 6.6437 |
| **Test Image 7** | 6.9633 | 7.2096 | 6.3555 |

Further, the pictorial representation of quantitative comparison is shown in figure 2. Figure 2. depicts a chart which shows that the efficiency measuring parameter is optimal in the proposed scheme as compared to the original image and conventional image enhancement scheme.

![Comparative Analysis of the Proposed Method with Conventional Enhancement and Original Image](image_url)

**Figure 2.** Comparative Analysis of the Proposed Method with Conventional Enhancement and Original Image
Figure 3. Comparison of Histogram of Original image and Enhanced Image by Proposed Technique

In Figure 3. Histograms of the original image and the enhanced image are shown to check the efficiency of the proposed contrast enhancement scheme. Histogram depicts the distribution of tonal and intensity value of each pixel. The histograms of the enhanced
images are spread out widely meaning that the images are exposed in proper contrasting environment. Also, good contrast in the enhanced image can be seen by large difference between maximum and minimal intensity value in the histogram. Thus by observing the histograms of the original images and enhanced images, it can be concluded that the proposed technique is efficient in enhancing the contrast of the image.

5. Conclusion

Satellite Images are very resourceful source of information pertaining to various domain. However, interference in communication signal due to various factors affect the standard of these images. Contrast enhancement process assist in adjusting these images by generating effective contrast between pixels of distinct hues. In this paper, an effective and efficient enhancement technique which uses mapping of intensity value in the output enhanced image is used. This method implies the limit in both lower and upper pixel range. The test is carried out by using seven images. The result comparison is done by using entropy of image. In all the seven images, the proposed method shows better results as compared to conventional methods.

References

[1] Stuti N and Seema B 2018 A Survey of Satellite Image Enhancement Techniques. International Journal of Advanced and Innovative Research. 2 131.

[2] Kriti B and Rishi S 2017 Analysis of Image Enhancement Techniques Used in Remote Sensing Satellite Imagery. International Journal of Computer Applications. 169 1.

[3] Jadhav B and Patil P 2015 An effective method for satellite image enhancement. International Conference on Computing, Communication & Automation. 1 1171-1175.

[4] Chae E, Lee E, Kang W, Cheong H and Paik J 2013. Spatially adaptive antialiasing for enhancement of mobile imaging system using combined wavelet-fourier transform IEEE Transactions on Consumer Electronics 59 862.

[5] Kundeti N, Kalluri H, Krishna S 2013. Image Enhancement Using DTCWT Based Cycle Spinning Methodology IEEE Conference On Computational Intelligence and Computing Research, 2013.1 13

[6] Demirel H and G Anbarjafari, 2010 Satellite image resolution enhancement using complex wavelet transform,” IEEE Transactions on Geoscience and Remote Sensing Letters 7 123.

[7] Temizel A and Vlachos T 2005 Wavelet Domain Image Resolution Enhancement Using Cycle Spinning, Electronics Letters. 41 119

[8] Thriveni R and Ramashri, 2013 Satellite image enhancement using discrete wavelet transform and threshold decomposition driven morphological filter International Conference on Computer Communication and Informatics, Coimbatore 1 1-4.

[9] Kenneth A and Dhanaseelan, F 2018. An Extensive Survey on Satellite Image Enhancement International Conference on Smart Systems and Inventive Technology (ICSSIT) 1 425.

[10] Demirel H and Anbarjafari G 2011 Discrete Wavelet Transform-Based Satellite Image Resolution Enhancement IEEE Transactions on Geoscience and Remote Sensing 49 1997

[11] Attachoo B and Pattanasethanon P 2009.A new approach for colored satellite image enhancement. IEEE International Conference on Robotics and Biomimetics, Bangkok 1 1365.
[12] Sharma N and Verma O 2014. Gamma correction based satellite image enhancement using singular value decomposition and discrete wavelet transform. *IEEE International Conference on Advanced Communications, Control and Computing Technologies* 1 1286

[13] Lu, S., Zou, L., Shen, X. et al. 2011 Multi-spectral remote sensing image enhancement method based on PCA and IHS transformations. *J. Zhejiang Univ. Sci. A* 12 453

[14] Jadhava B and Patilb M 2015 Satellite Image Resolution Enhancement Using Dyadic-integer Coefficients Based Bi-orthogonal Wavelet Filters *Procedia Computer Science* 49 17

[15] Giri, V and Sengupta S 2020. Satellite Image Enhancement and Restoration. *Proceeding of the International Conference on Computer Networks, Big Data and IoT* 49 252

[16] Du-Yih Tsai, Yongbum Lee, and Eri Matsuyama 2008 Information Entropy Measure for Evaluation of Image Quality 3 338.

[17] Sharma L 2021 *Towards Smart World*. (New York: Chapman and Hall/CRC)