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A REVIEW: SATELLITE IMAGE CONTRAST AND BRIGHTNESS ENHANCEMENT TECHNIQUES

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***ABSTRACT*- Satellite images have low contrast and are not of good quality. So in order to improve the contrast and brightness of image, contrast enhancement techniques are used. In this paper, overview of different techniques of image, contrast enhancements are being presented which can be used to improve the brightness and contrast of image. These techniques include HE, GHE, BBHE, DSIHE, DWT-SVD, DCT-SVD, CS-DWT-SVD. Even the comparison of techniques is also shown.**

***KEYWORDS*- contrast enhancement, HE, GHE, BBHE, DSIHE, DWT, SVD, DCT**

I. INTRODUCTION

Satellite image are useful in various applications. Some of the fields in which satellite images are used include education, weather forecast, agriculture, biodiversity conservation, geology etc. In general, raw images from satellite are not of good quality so contrast enhancement is performed for better image visualization and interpretation. [3]In image processing applications a fundamental role is being played by image enhancement. In image processing applications decisions rely upon the image information and these decisions are made by human beings (the experts). Techniques of image enhancement include edge enhancement, contrast enhancement and noise enhancement. Enhancement is applied to improve superiority of a digitally stored image. Enhancement can be done to make an image darker or lighter or to decrease or increase contrast. For human viewers, sensitivity of information that is carried in an image can be improved by image enhancement and it also provideinput that is enhanced for other regular techniques of image processing. At this procedure, one or more image attributes are customized. For a given task the option of attributes and the way they are customized are specific. For virtual interpretation when an image is processed, the viewer is the final person to tell how well a specific method. [1,2,4].Contrast enhancement tunes the intensity of each pixels magnitude based on its surrounding pixels. Contrastenhancement is classified into indirect and direct methods.Indirectmethods include Histogram equalization and histogram specification. In this image histogram is modified. As intensity global distribution is stretched, so indirect method is not useful and powerful. Contrast enhancement direct method is, contrast is measured and image is enhanced by measurement modification of contrast.[5]

Rest of the paper is systematized as follows: II portion gives the different techniques of contrast enhancement. III portion briefs about the literature survey, IV portion concludes the paper.

II. CONTRAST ENHANCEMENT TECHNIQUES

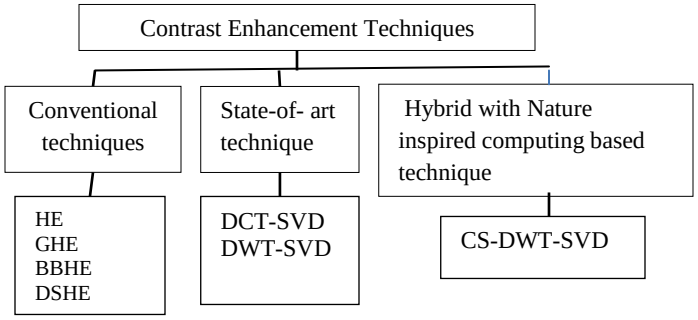

Figure 1: contrast enhancement techniques

A. Histogram Equalization

Normally for different images in this technique, global contrast is elevated and it specifically elevate when close contrast values of image are used to symbolize usable data. On histogram with this arrangement there is better scattering intensities with which higher contrast is attained by regions that have local contrast which is lower.

Advantage:

i. For images it is a fruitful strategy in which both the backgrounds and foregroundsareeither bright or dark.
ii. The recovery of original histogram is possible if the equalization function of the histogram is known.

Disadvantage:-

i. itincreasebackground noise contrast, while lowering the usable signal.
ii. in photographs unrealistic effects occur
iii. Also equalization ofhistogram can produce undesirable effects (like visible image gradient) when placed on images with low color depth. [12]

B. Global Histogram Equalization

Let digital image stand for Q = {Q (f,g)}, where at (f,g) place, pixel gray level is shown as Q(f,g). In image number of total pixels is given by o. There are H level of image to which

intensity is digitized, these level are {Q0, Q1, Q2…..Q_{H-1}}. Hence ∀Q(f,g)ϵ{Q0,Q1,Q2,….Q_{H-1}}. For image,Q_l is gray level and nl is number of total pixels having Q_l as gray level. So for Q_l, probability density is given as:-

$$P(Q_l) = \frac{o_l}{o}, l = 0,1,2,3 \dots \dots H-1 \quad \dots\dots\dots(1)$$

histogramis known to be as graphical appearance of PDF(probability density function) and PDF is the link in P(Q_l) and Q_l. Based on the PDF of image,the function of cumulative distribution function is given by

$$C(rQ_l) = \sum_{g=0}^{H-1} P(Q_g) = \sum_{g=0}^{H-1} \frac{o_l}{o} \quad \dots\dots\dots(2)$$

C(Q_{H-1})=1and l = 0, 1,2,3 ……., H-1. The original image meanbrightness is not consideredby the HE output mean.[8] Advantages:

i. image contrast is increased successfully by GHE

Disadvantages:

i. on mean brightness there is no constraint is put on preserving it.
ii. many unwanted effects occur like washed out appearance

C. BI-Histogram Equalization

By this strategy two subsections are created from the histogram that is input and these two subsections are separately equalized and for partitioning the subsections threshold is chosen by the factors. This threshold is shown as ϵ. Histogram of an image is divided into two parts in this method and the mean brightness value of input grants intensity of partition. The mean brightness value of image which is input, is average intensity of pixels that make input image. Output image mean brightness is in amidst of input mean and middle grey level [5].Advantages:

i. It overcome the drawback of HE.
ii. without producing unnecessary artifacts BBHE enhances image [18].

D. Dualistic Sub-Image Histogram Equalization (DSIHE)

It follow the main idea which is equivalent to the idea applied in BBHE. The idea of BBHE is that, the image which is input is broken down to sub images and so individually the sub images histogram are equalized and thus proposed the technique with equal area, known to be as DSIHE. Input image break down occur in DSIHE method with aim of output image shannon's entropy maximization, instead of breaking image by mean grey level. Resultant image shannon's entropy maximization is done by breaking the image which is first in sub images of two and separately for both sub image histograms are balanced. For this purpose, the two sub images formed by input image in which one is bright and one dark and it is presented that O is output image and its brightness is produced by DSIHE method is the image Z with equal area amount average and image middle grey amount ie. L/2.[6]Advantage:

i. enhance image effectively.
ii. Keep luminance of original image [18].

E. DWT-SVD

Satellite image enhancement is done in two parts. Given input signal is decomposed into four parts by DWT. Whereas SVD is technique used for reduction of data and also for detection of feature and for the purpose of enhancement. DWT come out to be a superior and useful tool of mathematics in the field of image processing and remote sensing. DWT fundamental concept is to break down the given signal which is input into four parts by using the dilation and translation property that is known to be as mother wavelet. For obtaining the coefficient of wavelet, suitable wavelet function need to be picked for wavelet break down of image. [15]

F. DCT-SVD

It consist of two parts, one is SVD and other is DCT. For the given input signal, discrete cosine transform is computed . DCT break the input image into two parts ie. DCT Lower frequency coefficient and DCT higher frequency coefficient. After this D and D^ variables are calculated. Then SVD is applied. U, Σ, V are calculated through SVD and max element in Σ is also found. Then finally IDCT is applied. And we get an enhanced image.
Signals are transformed to components of elementary frequency by discrete cosine transform and also it is applied for obtaining features.
For extraction of feature, low contrast image enhancement and data reduction method of SVD is used. Data points with high variable set and high dimension are taken and reduced to a space with low dimension so that original data substructure is exposed more clearly and ordering is done from most to least variation.
Advantage:

i. flexible
ii. Efficient
iii. Better contrast enhancement
iv. Provide brighter and sharper image
v. Obtained Histogram in dynamic range is stretched [17].

G. Cuckoo Search based DWT-SVD

In CS-DWT-SVD approach, firstly on given image apply histogram on it and then on GHE image apply DWT ie (a) image as well as apply DWT on original input imageie (b) image. the decomposition of wavelet for image is done on row by row as well as then by column by column basis. Hence because of the process of DWT image will be split into four bands. The four images obtained are referred to as LL, LH, HL, HH. On (a) image apply cuckoo search algorithm for optimization and then threshold DWT sub-bands.Now From the four images consider LL images and apply SVD on both image (a) (b). then the output is combined and IDWT is applied and finally an enhanced image is obtained.[3]

Advantages:

i. DWT is better than FFT and DCT as DWT provide more accuracy and efficiency in results [4].
ii. In comparison to above methods Better contrast and brightness

Table 1: comparison of different enhancement techniques

Sr. no.	Technique	brightness	contrast	Quality of enhanced image	MSE mean square error
1	GHE	Poor	Good	Poor	High
2	DWT-SVD	Good	Poor	Good	Low
3	DCT-SVD	Better	Better	Good	Comparatively high
4	CS-DWT-SVD	Comparati--vely better	Better than above	Better quality	Lowest

III. LITERATURE SURVEY

A.K. Bhandari et al. [3] presented an algorithm for improvement of low contrast image quality of satellite. For this a new Cuckoo Search (CS) algorithm and DWT-SVD approach is used for enhancement of contrast of images of satellite. By DWT, image that is input is broken down to frequency sub band of four, then for optimization CS algorithm is used for each subband of DWT and then for image sub band for low- low thresholdsingular value matrix is obtained, then by applying IDWT enhanced image is reconstructed. For particular image, intensity information are employed by the singular value matrix, if any changes are done in singular value then given image intensity also changes. Results of experiment shows supremacy ofperformance of the proposed method in terms of Standard Deviation , Mean, MSE and PSNR over techniques of conventional as well as state-of-the-art.

Wu, Pei-Chen et al. [13] proposed a novel method of HE, which is made up of separating histogram module which is automatic and transformation of intensity module.Result of Experiment shows that method suggested keeps original histogram features of shape and contrast is efficiently improved.

Chauhan, Ritu, and Sarita Singh Bhadoria [14] showed that image visualization is improved and brightness is preserved by HE preserving brightness and clustering weight, it is even better than method of HE.By changing the pixel level of intensity, image contrast is increased by HE for input image through distribution of intensity. However, there are some disadvantages of Histogram equalization.

Bhandari, A. K. et al. [15] presented image enhancement of multispectral remotely sensed image by using SVD and wavelet filter.Decomposition by discrete wavelet transform of input image and estimated matrix of singular value and finally improved image is made by inverse DWT. So this approach is good for extracting features of satellite images of INSAT, LANDSAT. Results of Meyer Wavelet and SVD methodie.proposed method reveals that there is increase in efficiency, flexibility and edge sharpness in comparisons to already present GHE and various wavelet filters technique.Results of proposed method shows that, this method is better than other conventional methods.

Ahirwar, Vaishali et al. [16] designed a hybrid model through DCT, DWT and joined the output of both techniques with image fusion. Algorithm proposed removes noise and enhances features by decomposition of image using DWT and DCT, a very important part in this algorithm for smooth image is adaptive histogram equalization. The results of test of different images are checked with previous method, different parameters are used to get the result for image quality improvement, less mean square error and high PSNR. This paper presented a hybrid model used various parameter for enhance images .

Kotkar, Vijay A., and Sanjay S. Gharde [12] introduced two methods for image enhancement,(WLBSHS) and (LBSHS). WLBSHS uses local as well as global enhancement in weighted approach. For global enhancement, Bidirectional Smooth Histogram Stretching (BSHS) method is used. They divided the histogram in two parts and use forward and backward gamma transform on these parts, with bin interval control mechanism. They developed the hybrid method which is applied for enhancing the image contrast with its brightness preserving by making the mixture of global and local enhancement. For enhanced image evaluation this research has examined parameters PSNR EME, AMBE, BR, E. It is found that this hybrid method is better thanAGCID,VHA and AWIE.

Lee, Eunsung et al. [11] presented a technique on remotely sensed image enhancement of the contrast by transformation of adaptive intensity with dominant brightness level analysis.they first performed DWT on the images which are input and then decompose using the log-average luminance the LL sub-band into intensity layers of low, middle, high. Based on each layer dominant brightness level, estimation of function of intensity transfer is done by using the knee transfer and the gamma adjustment function. Resulting enhanced image is obtained after the intensity transformation, by using the inverse DWT. The proposed algorithm uses the intensity transfer function that is adaptive. Results of experiment shows that the algorithm suggested improves thelocal details by improving overall contrast as well as visibility. The suggested method can improve any image of low contrast that is get by satellite camera and this method is also good for other devices of imaging.

Priyadarshini et al. [10] proposed a new satellite image resolutionand contrast enhancement technique based on DWT, Stationary Wavelet Transform and Dynamic HE brightness preserving. The wavelet transform being used to make the high resolution image. BPDHE enhances the image contrast . The low resolution and contrast image is break down by using Stationary Wavelet Transform and DWT. By Lanczos interpolation the subbands are interpolated. To

produce high resolution low contrast image.The intermediate process is carried out. By using BPDHE the contrast is enhanced. With Wavelet Transform breaking of Output of BPDHE isdone and by using SVD the new LL is constructed. By using inverse wavelet transform the sub-bands are recombined. Images with low contrast and resolution are enhanced by proposed method. To show that the projected method is good than the conventional method, quantitative metrics are measured.

Shakeri, Mohsen et al. [9] proposed a new histogram modification method that contains a combination of brightness level transferring partand histogram division part. In histogram division part, histogram of image will be divide into smaller optimum subunits according to standard deviation and mean value. By using PSNR criterion this division is controlled automatically. In the second part, by using local cumulative probability distribution function for each of subunits of histogram, they would reach the image which is enhanced. Results of experiment shows that this method will enhance contrast of image as well as keep histogram visual details.

Ji, Xiaoqiang et al. [8] analyzed the fuzzy mechanism of image in hazeand image degradation reason. From the point of view of image enhancement and imagerestoration , an image haze removal approach that is efficient and real-time in view of the global dark-channel prior theory and image contract extending was proposed. Firstly, for the removal of haze and fog they used the global dark-channel prior method, and then for enhancing image brightness and contrast, HE approach is applied. The results of experiment showed that a haze-free image is obtained.

IV. CONCLUSION

From the literature survey, we have studied different techniques for contrast enhancement. Satellite images are not of good quality so there is a need to enhance the raw satellite images. CS-DWT-SVD based contrast and brightness enhancement for satellite images provide superior result as compared to the other techniquesie state-of-art as well as conventional techniques. CS-DWT-SVD technique provide better contrast and brightness. In future, to get optimized results other nature inspired computing algorithm can be used for enhancement of satellite images.

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