International Journal of Computer Applications Technology and Research
Volume 2– Issue 5, 623 - 627, 2013, ISSN: 2319–8656

Survey on Image Enhancement Techniques

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Abstract: Enhancement is one of the challenging factors in image processing. The objective of enhancement is to improve the structural appearance of an image without any degradation in the input image. The enhancement techniques make the identification of key features easier by removing noise and other artifacts in an image. This paper analyzes the performance of various enhancement techniques based on noise ratio, time delay and quality. It also suggest suitable algorithm for remote sensing images based on the analysis.

Keywords: Image Enhancement, Histogram Equalization, Stochastic Resonance, Contrast Enhancement, Spatial domain, Frequency Domain and Noise ratio.

1. INTRODUCTION

Image Processing is a processing of image and takes image as an input, the output of image processing may be either an image or set of characteristics. This includes image enhancement, noise removal, restoration, feature detection, compression, etc. Digital images are always affected by noise, blurring, incorrect color balance and poor contrast. Most of digital images that can be produced through scanners, digital cameras, video cameras, Charged Coupled Devices (CCD cameras) and web-cam can be easily affected by the these problems. This will lead to low quality images. Image enhancement will be used to minimize the effects of these degradations. This can be done by using a number of image enhancement techniques. Specifically, an enhancement of color image is to process the luminance and color information to make an image has sharp details, rich in color and better visual effect without any distorting or shifting of color. The image enhancement is to process an image so that the result is more suitable than the original image for specific application. The enhancement technique applied for various applications such as medical images, remote sensing images and general images. The objective is to improve the characteristic of an image to get clear image [13]. The enhancement methods can be broadly categorized into following two methods:

1. Spatial Domain Method
2. Frequency Domain Method

The spatial domain techniques, directly operates on pixels of an image. The pixel values are manipulated to achieve desired enhancement. The gain of spatial based domain technique is that they conceptually simple to understand and the complexity of these techniques are low [15]. But these techniques have difficult to providing sufficient robustness and imperceptibility requirements.

In frequency domain methods, the image is transferred into frequency domain. It means that, the Fourier transform of the image is computed first. The result of Fourier transform is multiplied with a filter transfer function. And then the inverse Fourier transform is performed to get the resultant image. Frequency domain image enhancement is used to describe the analysis of mathematical functions and signals with respect to frequency and operate directly on the transform coefficients of the image, such as Fourier transform, discrete wavelet transform (DWT), and discrete cosine transform (DCT). The advantages of frequency domain are, less computational complexity, manipulating the frequency composition of the image [11]. The disadvantages are, it cannot simultaneously enhance all parts of image in good manner and it is also difficult to automate the image enhancement procedure. Image enhancement is applied in every field where images are ought to be understood and analyzed, this section briefly describe the various image enhancement techniques.

Image enhancement means, transforming an image *f* into image *g* using *T*. The values of pixels in images *f* and *g* are denoted by *r* and *s*, respectively. As said, the pixel values *r* and *s* are related by the expression,

$$s = T(r) \qquad (1)$$

Where *T* is a transformation that maps a pixel value *r* into a pixel value *s* [1]. The results of this transformation are mapped into the grey scale range. So, the results are mapped back into the range [0, L-1], where L=2k, k being the number of bits in the image being considered. So, for instance, for an 8-bit image the range of pixel values will be [0, 255].

2. IMAGE ENHANCEMENT TECHNIQUES

The enhancement doesn't increase the inherent information content of the data, but it increases the dynamic range of the chosen features so that they can be detected easily. Few enhancement techniques are to be described below for color and gray scale images:

2.1 Histogram Equalization

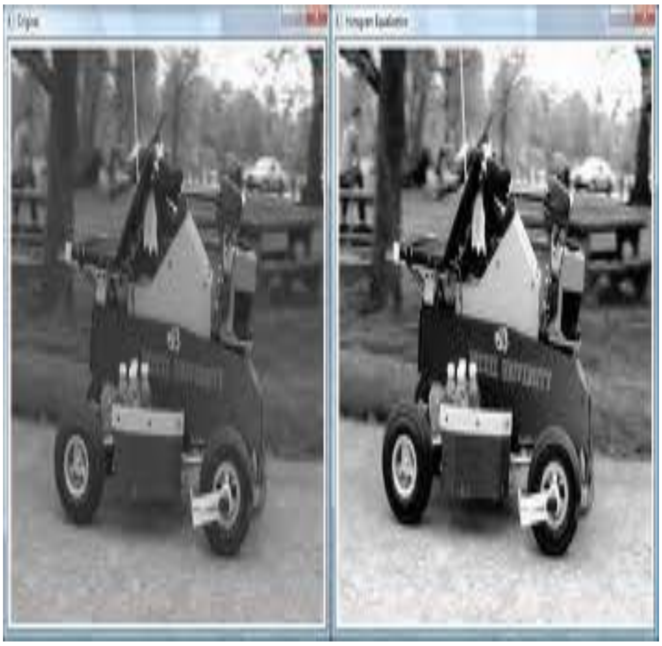
Histogram of an image is concerned with the gray levels. Using histogram to decide that given image is whether a dark image or light image or low contrast or high contrast image. It can be expressed using discrete function as,

$$P(r_k) = \frac{n_k}{n} \qquad (2)$$

Where r_k denotes kth gray level, n_k denotes number of pixels in the image, n denotes total number of pixels and $k=0, 1, 2 \ldots\ldots 255$. Histogram Equalization which stretches histogram to an image. It is used to improve the visual appearance of an image [10]. This technique involves,

1) Dividing image into segments.
2) Histogram is applied to find out the pixel intensity values for the gray levels and the image have gray levels or intensities in the range from 0 to 255.
3) Histogram Equalization is used to calculate the intensity values and make them uniform distribution of pixels to get an enhanced image.

Thus HE technique is used to increase the dynamic range of pixels for the appearance of an image.



(a) (b)

Figure. 1 (a) Original Image (b) Enhanced image for Histogram Equalization

2.2 Brightness Preserving Bi-Histogram Equalization (BBHE)

The overall BBHE technique is used for preserving of brightness of an image. Brightness preservation is one of the most important characteristics of an image. So this method splits the image's histogram into two independently equalized parts. So the intensities are arranged equal as well. One drawback of the histogram equalization can be found on the fact that the brightness of an image can be changed after the histogram equalization, which is mainly due to the flattening property of the histogram equalization [3]. Thus, it is rarely utilized in consumer electronic products such as TV where preserving the original input brightness may be necessary in order not to introduce unnecessary visual deterioration.

The BBHE is extension of histogram equalization to overcome such a drawback of histogram equalization [7]. The essence of the algorithm is to utilize independent histogram equalizations separately over two subimages obtained by decomposing the input image based on its mean with a constraint that the resulting equalized subimages are bounded by each other around the input mean. It is shown that the proposed algorithm preserves the mean brightness of a given image significantly well compared to typical histogram equalization while enhancing the contrast and provides a typical enhancement that can be utilized in consumer electronic products. The output is shown below:

(a) (b)

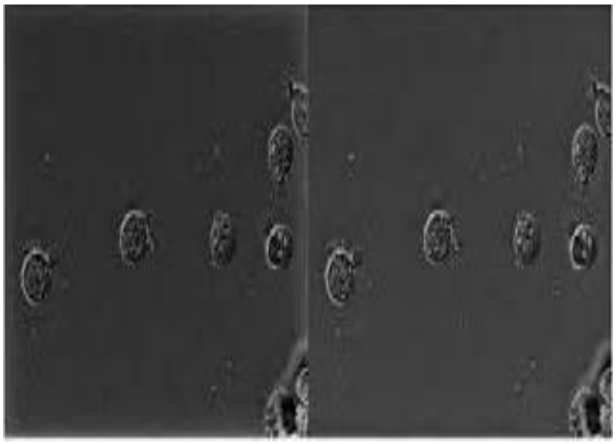
Figure. 2 (a) Original Image (b) Output Image for BBHE

2.3 Brightness Preserving Dynamic Histogram Equalization (BPDHE)

BPDHE is an extension of Histogram Equalization. In Dynamic Histogram Equalization (DHE) the input image's histogram is divided into partitions and so called sub-histograms. The DHE method is also used to provide mean brightness for an image and gives the intensities to have a new range [8]. It provides realistic images by look. In this method the intensities are equalized individually.

BPDHE is an extension to the DHE method. It shifts the mean brightness between the resultant histogram image and original image. So the mean brightness is preserved. And it produces the mean intensity of input and output images as equal.

The BPDHE technique uses different filters such as smoothing filter, Gaussian filter, etc. which smoothes the data by suppressing image noise for the clear image [9]. In addition to BBHE, DHE method provides better mean brightness for an image.

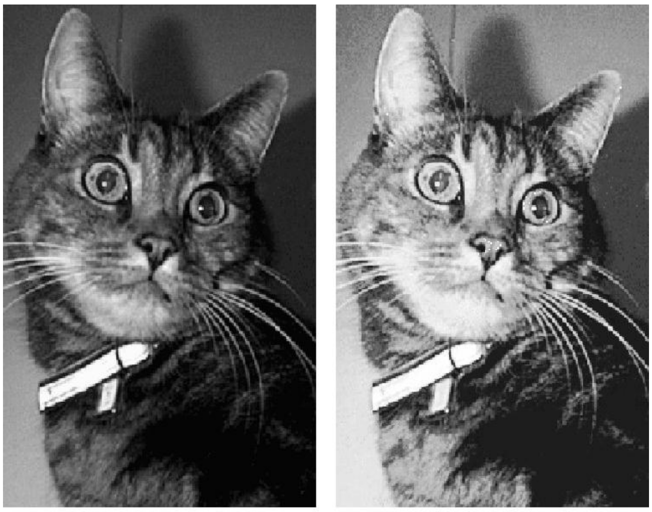


(a) (b)

Figure. 3 (a) Input image (b) Output Image for BPDHE

2.4 Adaptive Histogram Equalization (AHE)

Adaptive Histogram Equalization is used for improving contrast in images. It differs from Histogram Equalization by adaptive method that computes several histograms and each histogram corresponding to a distinct section of an image. The contrast of region for an image will not be sufficiently enhanced by Histogram Equalization. AHE improves this enhancement by transforming each pixel with a transformation function derived from a neighborhood region. It is used to overcome some limitations of global linear min-max windowing method. Thus it reduces the amount of noise in regions of the image. And also AHE have the ability for improving the contrast of grayscale and color image.



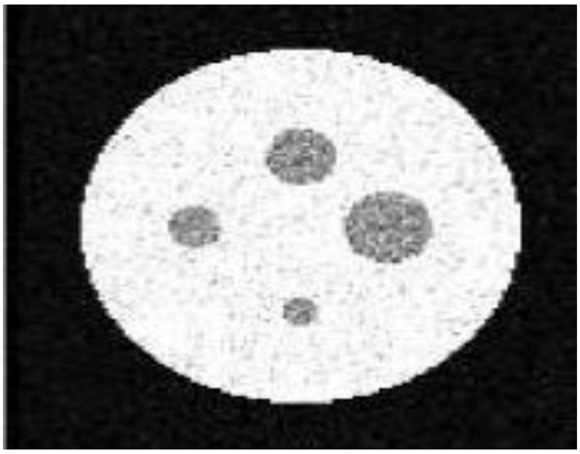
original — after adaptive histogram equalization

(a) (b)

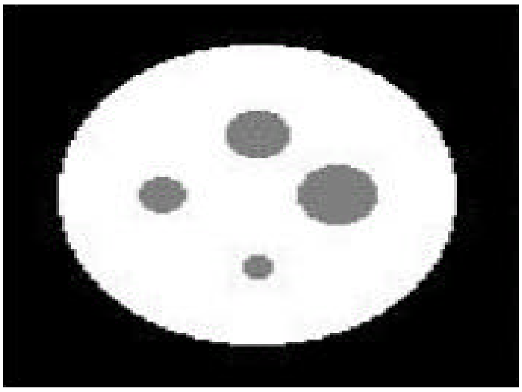
Figure .4 (a) Original image (b) Output Image for AHE

2.5 Stochastic Resonance(SR)

Stochastic resonance is broadly applied o describe any occurrence where the presence of noise in nonlinear system is beer for output signal quality then it absence [4]. To enhance the contrast of an image it utilizes external noise of an image.



(a)



(b)

Figure. 5 (a) Input (b) Output Image for SR

2.6 Contrast-Limited Adaptive Histogram Equalization (CLAHE)

To enhances the contrast of the grayscale image by transforming the values using contrast-limited adaptive histogram equalization (CLAHE).it operates on small regions in the image, called *tiles*, rather than the entire image [12]. Each tile's contrast is enhanced, so that the histogram of the output region approximately matches the histogram specified by the distribution parameter. The neighboring tiles are then combined using bilinear interpolation to eliminate artificially induced boundaries. The contrast, especially in homogeneous areas, can be limited to avoid amplifying any noise that might be present in the image.

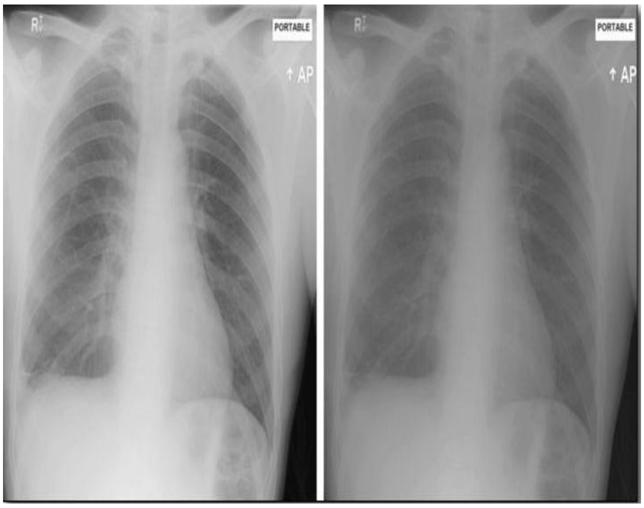
Figure 6. Original Image and Enhanced Image for CLAHE

2.7 Contrast Enhancement

This technique automatically brightens images that appear dark or unclear. Apply appropriate tone correction to deliver improved quality and clarity [2]. This play an important role in medical applications. This because of visual quality is very important to diagnosis diseases. X-Ray used to capture the internal structure of human body. It especially useful for check bone fracture. There are many advantages but X-Ray technology but it generates low contrast image due to presence of bulk amount of water in human body.

Image enhancement also perform automated X-Ray check system for making X-Ray images with more visual and contrast by using some contrast enhancement technique .Zooming an image an important task in many application .while zooming an image the pixels are inserted to enlarge the size of image.

The main task is interpolation of new pixel form surrounding the original pixel [6]. In weighted median used for edge preservation and less blocky look to edges. The Cathode Ray (CR) image of a patient's chest displayed with contrast enhancement on the left and unprocessed on the right for Contrast Enhancement is shown below using MATLAB.



(a) (b)

Figure. 7 (a). Original Image (b).Enhanced Image

2.8 Adaptive DWT based DSR

The DWT technique is used to produce high frequency content images. The DWT which decomposes the input image into sub bands. They are Low-Low (LL), Low-High (LH), High-Low (HL), and High-High (HH). The process of image using DWT is carried out by interpolating high-frequency sub band images and the low-resolution input images to produce the enhanced image [5]. The Adaptive DWT based DSR technique presented for perform enhancement of very dark images. It using inter noise to improve the performance of input image. It gives better enhancement for very dark images. It leads to less computational complexity [14]. This Technique is applied for enhancement of very dark images.

In Dynamic Stochastic Resonance (DSR) an external noise of an image is considered for an image. And the Adaptive DWT based Dynamic Stochastic Resonance uses internal noise for improving performance of an input image. It produces output without artifacts, ringing, blocking of the image. The adding of noise to the input image is useful for non-linear systems using this technique. By using lower noise intensities in SR mechanism the signal cannot be able to reach the threshold value. In this technique the noise allows the signal to reach the threshold value. Thus Adaptive DWT based Dynamic Stochastic Resonance is suitable for enhance both the grayscale and colored image.

3. PERFORMANCE ANALSIS

This paper collected various image enhancement techniques. In this section the performance of various image enhancement techniques have been specified in the below Table 1.

Table 1. Comparison of Enhancement Techniques

Enhancement Techniques	**Advantage / Dis Advantage**	**Noise ratio**	**Time delay (ms)**
Histogram Equalization	Preserves the background brightness / Not much suitable for color images.	24.3442	2.0
BBHE	Maintains the mean brightness / Takes more computational time.	25.1157	1.8
BPDHE	Produces intensity range of input and output images as equal / Does not give clear contrast.	24.4065	1.9
AHE	Contains low contrast with dark regions of image / Creates some unwanted blurring in edges.	30.2665	1.2
SR	Provides better signal quality for output image / Technique used for very low contrast image.	23.5472	1.6
CLAHE	Avoids amplifying noise that might present in image	30.7692	1.0
Contrast Enhancement	Gives clear contrast for X-Ray images / More computational requirement.	29.5928	2.0

4. CONCLUSION & FUTURE WORK

This paper have discussed about various enhancement techniques with their performance analysis using MATLAB tool with appropriate output shown in the above table. The output of each technique showed that improved image quality and better structural appearance of an image. And also increased dynamic range of pixels with better contrast, keeps the overall brightness level and the edges are preserved without any degradation. Even though all the techniques gave better result, the combination of Adaptive Histogram Equalization (AHE) and Contrast-Limited Adaptive Histogram Equalization (CLAHE) yields good performance for remote sensing applications. Because the AHE is contains low contrast with dark regions. The CLAHE technique better in contrast, especially in homogeneous areas, can be limited to avoid amplifying any noise that might be present in the image.

In future work, these enhancement techniques are to be applied for video images and 3D images.

5. REFERENCES

[1] Rafael C Gonzalez and Richard E Woods, “Digital Image Processing”, third edition, Pearson Education, 2007.

[2] S.S. Bedi, Rati Khandelwal,” Various Image Enhancement Techniques- A Critical Review”, International Journal of Advanced Research in Computer and Communication Engineering, Vol. 2, Issue 3, March 2013.

[3] Chao Wang and Zhongfu Ye “Brightness Preserving Histogram Equalization with Maximum Entropy: A Variational Perspective”, Vol. 51, No. 4, November 2005.

[4] P. Hanggi, P. Jung, and F. Marchesoni, “Stochastic resonance”, Rev. Mod. Phys., vol. 70, 223–270, 1998.

[5] Hasan Demirel and Gholamreza Anbarjafari, “Discrete Wavelet Transform-Based Satellite Image Resolution Enhancement” VOL. 49, NO. 6, JUNE 2011.

[6] Hassan, N. Y. and Aakamatsu, N., ”Contrast Enhancement technique of dark blurred Image”, International Journal of Computer Science and Network Security (IJCSNS), Vol. 6, No. 2, 2006, pp. 223- 226.

[7] Kim’s, Min Chung, “Recursively Separate and Weighted Histogram Equalization for Brightness Preservation and Contrast Enhancement”, IEEE Transaction on Communication, Networking and Broadcasting, Page: 1389-1397, Publication year: 2008.

[8] Kong.N.S.P, Ibrahim .H, “Color Image Enhancement using Brightness Preserving Dynamic Histogram Equalization”, IEEE Transaction on Communication, Networking and Broadcasting, Page: 1962-1968, Publication year: 2008.

[9] Kuo-Liang Chung, Yu-Ren Lai, Chyou-Hwa Chen, Wei-Jen Yang, and Guei-Yin Lin, “Local Brightness Preservation for Dynamic Histogram Equalization”, 2011.

[10] MandeepKaur, K iran Jain, Virender Lather International Journal of Advanced Research in Computer Science and Software Engineering “Study of Image Enhancement Techniques : A Review” Volume 3, Issue 4, April 2013.

[11] Nancy, Er. Sumandeep Kaur,” Image Enhancement Techniques: A Selected Review”, IOSR Journal of Computer Engineering (IOSR-JCE) e-ISSN: 2278-0661, p- ISSN: 2278-8727Volume 9, Issue 6 (Mar. - Apr. 2013), PP 84-88.

[12] Papiya Chakraborty, “Histogram Equalization by Cumulative Frequency Distribution”, International Journal of Scientific and Research Publications, Volume 2, Issue 7, July 2012.

[13] Parth Bhatt, Sachin Patel”, Image Enhancement Using Various Interpolation Methods”, International Journal of Computer Science and Information Technology & Security (IJCSITS), ISSN: 2249-9555, Vol. 2, No.4, August 2012.

[14] Rajlaxmi Chouhan, C. Pradeep Kumar, Rawnak Kumar, and Rajib Kumar Jha, “Contrast Enhancement of Dark Images using Stochastic Resonance in Wavelet Domain”, International Journal of Machine Learning and Computing, Vol. 2, No. 5, October 2012.

[15] Ramkumar.M, Karthikeyan.B,” A Survey on Image Enhancement Methods”, International Journal of Engineering and Technology (IJET), ISSN: 0975-4024 Vol 5 No 2 Apr-May 2013, 960.