A Novel Approach to Medical & Gray Scale Image Enhancement

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ABSTRACT

Image enhancement is a mean as the improvement of an image appearance by increasing dominance of some features or by decreasing ambiguity between different regions of the image. Image enhancement processes consist of a collection of techniques that seek to improve the visual appearance of an image or to convert the image to a form better suited for analysis by a human or machine. Many images such as medical images, remote sensing images, electron microscopy images and even real life photographic pictures, suffer from poor contrast. Therefore it is necessary to enhance the contrast. The purpose of image enhancement methods is to increase image visibility and details. Enhanced image provide clear image to eyes or assist feature extraction processing in computer vision system. Numerous enhancement methods have been proposed but the enhancement efficiency, computational requirements, noise amplification, user intervention, and application suitability are the common factors be considered when choosing from these different methods for specific image processing application

Keywords-*Image Enhancement, Image Negation, Histogram Equalization, DWT, BPHE.*

INTRODUCTION

Enhancement is simple and most appealing area among all the digital image processing techniques. The main purpose of image enhancement is to bring out detail that is hidden in an image or to increase contrast in a low contrast image. Whenever an image is converted from one form to other such as digitizing the image some form of degradation occurs at output. Image enhancement is among the simplest and most appealing areas of digital image processing. Basically, the idea behind enhancement techniques is to bring out detail that is obscured, or simply to highlight certain features of interest in an image. Enhanced images provide better contrast of the details that images contain. Image enhancement is applied in every field where images are ought to be understood and analyzed. For example, Medical Image Analysis, Analysis of images from satellites, etc. Image enhancement is among the simplest and most appealing areas of digital imageprocessing. Basically, the idea behind enhancement techniques is to bring out detail that is obscured, or simply to highlight certain features of interest in an image.

Why we are moving towards image enhancement?

Enhanced images provide better contrast of the details that images contain. Image enhancement is applied in every field where images are ought to be understood and analyzed. For example, Medical Image Analysis, Analysis of images from satellites, etc.

There are three types of image enhancement which are as follows:

a. Spatial domain

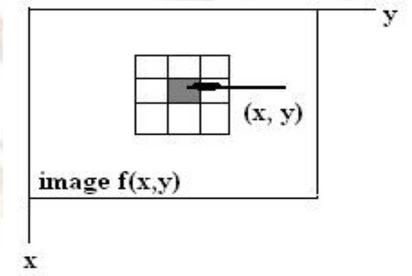

Fig 1: Spatial domain

Spatial domain approaches direct information of pixel in an image. The image processing function may be expressed as :

G(x,y)=T{f(x,y)}where f(x,y) is the input image & g(x,y) is the proposed image.

b. Frequency domain

In frequency domain the Fourier transform of an image is modified. Fourier series: Any function that periodically repeats itself can be expressed as the sum of sine's /cosines of different frequencies, each multiplied with a different coefficient. Fourier Transform: Functions that are not periodic, whose area under the curve is finite, can be expressed as the integral of sine's and/cosines multiplied by a weighting function.

c. Transform domain

Transforming image intensity data into specific domain includes altering high-frequency content of image. Using discrete cosine, Fourier, and wavelet transforms

I. MAIN METHODOLOGY

a. Image Negation Method

Now contrast and poor quality are main problems in the production of medical images.

Medical image enhancement technologies have attracted much attention since advanced medical equipment's were put into use in the medical field. Negation method is generally used to enhance the medical image. Negation of image is nothing but reversing the intensity levels of an image to produce the equivalent of photographic negative. This type of processing is particularly suited for enhancing white or gray details embedded in dark region of an image especially when the black areas are dominant in size. The negative point transformation function also known as contrast reverse. The negative transformation shown in fig. is obtained by following expression, s=L-1-r
Where's' is Output image after transformation
L-1 is Maximum Pixel value
r -is Input Image.

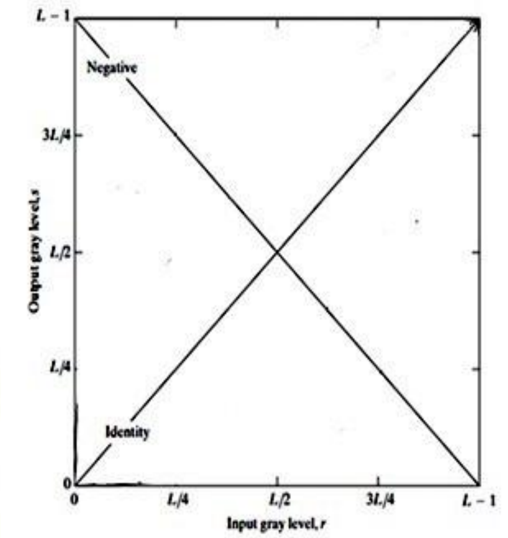

Fig 2: Negative Image graph

b. Histogram Equalization Method (HE)

Histogram equalization is a technique by which the gray-level distribution of an image is changed in such a way as to obtain a uniform (flat) resulting histogram, in which the percentage of pixels of every gray level is the same. To perform histogram equalization, it is necessary to use an auxiliary function, called the transformation function, $T(r)$. Such transformation function must satisfy two criteria

1. $T(r)$ must be a monotonically increasing function in the interval $0 \le r \le L - 1$.
2. $0 \le T(r) \le L - 1$ for $0 \le r \le L - 1$.

The most usual transformation function is the cumulative distribution function (cdf) of the original probability mass function, given by Histogram equalization is used for increasing contrast of an image. This can be achieved by using histogram stretching operation [3].

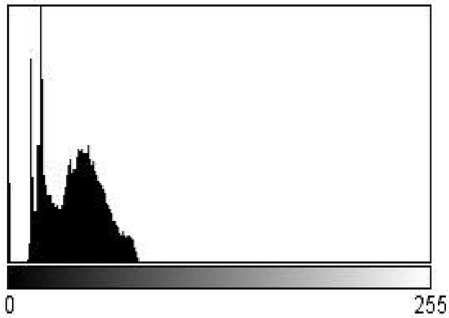

Fig 3: Histogram of Original Image

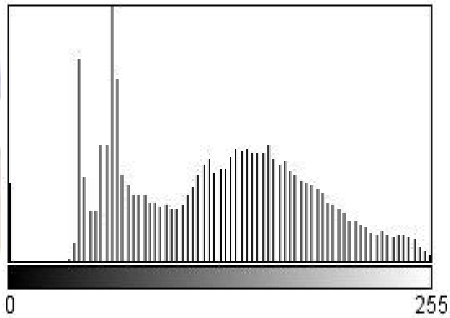

Fig 4: Histogram of Enhanced Image

Fig.3 shows histogram of original image, when we apply the Histogram Equalization method we get the enhanced image. Fig.4 shows stretched histogram of enhanced image.

C. DWT (Discrete Wavelet Transform) based Method

Aerial images captured from aircrafts, spacecraft's, or satellites usually suffer from lack of clarity, since the atmosphere enclosing Earth has effects upon the images such as turbidity caused by haze, fog, clouds or heavy rain. The visibility of such aerial images may decrease drastically and sometimes the conditions at which the images are taken may only lead to near zero visibility even for the human eyes. Even though human observers may not see much than smoke, there may exist useful information in those images taken under such poor conditions[1].

Recently we use a wavelet-based dynamic range compression algorithm to improve the visual quality of digital images captured in the high dynamic range scenes with no-uniform lighting conditions. The fast image enhancement algorithm which provides dynamic range compression preserving the local contrast and tonal rendition is a very good candidate in aerial imagery applications such as image interpretation for defense and In this paper the latest version of the proposed algorithm which is able to enhance aerial images so that the enhanced images are better than direct human observation, is presented. The results obtained by applying the algorithm to numerous aerial images show strong robustness and high image quality.
The proposed enhancement algorithm consists of three stages. The first and the third stage are applied

in the spatial domain and the second one in the discrete wavelet domain.

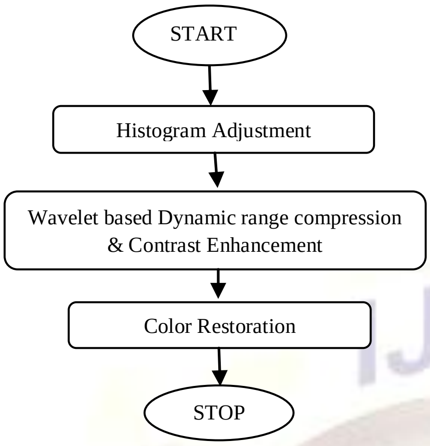

Fig 5: Flow chart of DWT

D. BPHE Method (Brightness Preserving Bi Histogram Equalization):

The Brightness preserving bi histogram equalization firstly decomposes an input image into two sub images based on the mean of the input image. One of the sub image is set of samples less than or equal to the mean whereas the other one is the set of samples greater than the mean. Then the BBHE equalizes the sub images independently based on their respective histograms with the constraint that the samples in the formal set are mapped into the range from the minimum gray level to the input mean and the samples in the latter set are mapped into the range from the mean t the maximum gray level. Means one of the sub images is equalized over the range up to the mean and the other sub image is equalized over the range. From the mean based on the respective histograms .Thus, the resulting equalized sub images are bounded by each other around the input mean, which has an effect of preserving mean brightness[2].

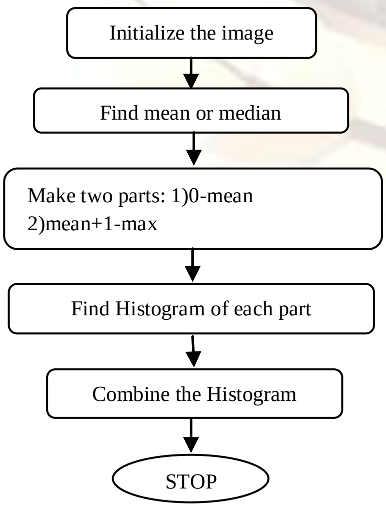

Fig 6. Flow chart of BPHE

II. QUALITY PARAMETERS

Depending on the parameter value we can determine in what extent an image is enhanced.

1. The MSE between two images f and g is denoted by,

$$MSE = \frac{1}{MN}\sum_{j,k}(f(j,k) - g(j,k))^2$$

Where the sum over j; k denotes the sum over all pixels in the images, and m is the number of rows, n is the number of column of each image.

2. The PSNR between two (8 bpp) images is, in decibels,

$$PSNR = 10\log_{10}\left(\frac{255^2}{MSE}\right)$$

PSNR tends to be cited more often, since it is a logarithmic measure, and our brains seem to respond logarithmically to intensity. Increasing PSNR represents increasing fidelity of compression. Generally, when the PSNR is 40 dB or larger, then the two images are virtually indistinguishable by human observers.

3. Structural Content (SC)

Structural Content is defined as,

$$SC = \frac{\sum M,N[I_1(m,n).*I_1(m,n)]}{\sum M,N[I_2(m,n).*I_2(m,n)]}$$

The large value of Structural Content (SC) means that image is of poor quality.

4. Average Difference (AD)

Average Difference (AD) is defined as:

$$AD = \frac{\sum M,N[I_1(m,n) - I_1(m,n)]}{M*N}$$

The large value of AD means that the pixel values in the reconstructed image are more deviated from actual pixelvalue. Larger value of AD indicates image is of poor quality.

5. Absolute means brightness error (AMBE):

It is the Difference between original and enhanced image and is given as

AMBE=E(x)-E(y)

Where E(x)= average intensity of input image E(y)=average intensity of enhanced image

6. Contrast:

Contrast defines the difference between lowest and highest intensity level. Higher the value of contrast means more difference between lowest and highest intensity level.

III. RESULT ANALYSIS

Following figures shows original images and their enhanced images.

Fig 7. Original Lena Image

Fig 8. Image Negation of Lena Image

Fig 9. Enhanced Lena Image using HE

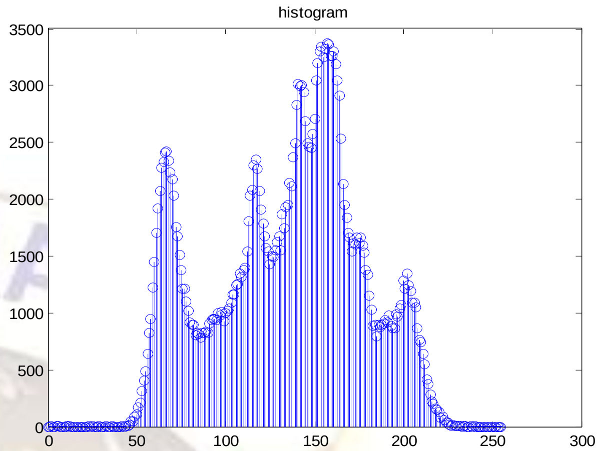

Fig 10. Histogram of Original Lena

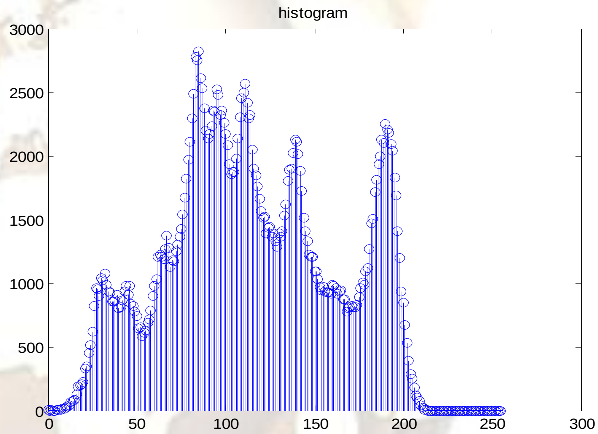

Fig 11. Histogram of Negative Lena Image

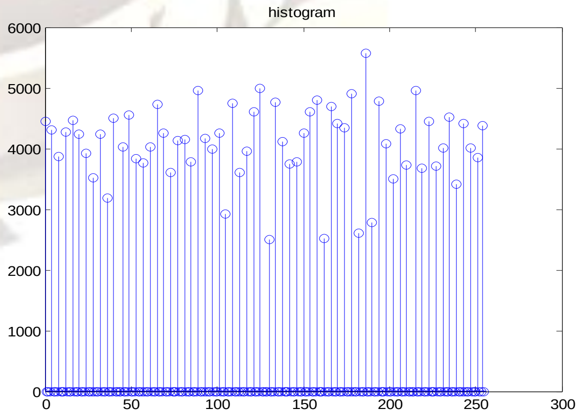

Fig 12. Histogram of Enhanced Image

Fig 13. Blurred Color Port Image

Fig 14. Enhanced Port Image using DWT method

The performances of these techniques are evaluated in terms of PSNR, AMBE, CONTRAST,MSE, SC and AD.

Table 1: Analysis of Different methods with various parameters

Methods Parameters	MSE	PSNR	SC	AD	AMBE	Contrast
Negative	7856	8.277	255	0	28.44	0
HE	1130	16.70	255	0	1.668	9
DWT	3484	12.21	255	0	17.92	20
BPHE	1056	16.99	255	0.7	0.712	25

IV. CONCLUSIONS

In this paper different image enhancement techniques are used to enhance the images from different area. Such as Negative image enhancement is used to enhance the images in medical field. HE is used to enhance the images which are captured from digital camera. DWT is used to enhance the Ariel images, e.g. Images captured through satellite or spacecraft .It is used to enhance the color images. BPHE technique is advanced version of HE. It increases the contrast of an image better than HE.

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