Contrast Enhancement with Background Brightness Preservation Using BBPHE in Medical Images

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Abstract

In Image Processing contrast enhancement plays an important role in various applications like biomedical, real life photography, satellite etc. The role of contrast enhancement is to improve the quality of image & produce an enhanced image as compare to original image. For improving the contrast various techniques has been developed like Histogram Equalization (HE), Automatic weighting mean separated histogram equalization(AWMHE), Brightness Preserving bi-histogram equalization (BBHE) etc. In order to reduce undesired artifacts & produces the natural image (especially in medical images) one of its solution is to preserve the mean brightness of input image inside output image. This paper presents the proposed technique of Background brightness preserving histogram equalization (BBPHE) with weighted median filter which decomposes the input image into sub-images based on background levels and non-background levels range and compare to other techniques like HE proves that BBPHE is better and can be verified experimentally by calculating the parameters of PSNR,MSE.

Keywords: *Image Processing, Image enhancement, histogram equalization, Brightness Preserving*

1.Introduction

Digital image processing often seem to be mathematically complex but central idea behind is quite simple. The main goal of image processing is understand, interpret the given data & give useful information at the output. For various applications like medical images, speech recognition, texture synthesis etc [10] where noise, poor quality of image, hue, brightness preservation are required image Enhancement plays an important role.

Image Enhancement means adjusting the brightness, changing the tone of the color, sharpening the image, reducing noise & improve the quality of an image by highlighting certain features of interest in image which can be perceived by human [1]. Image Enhancement is an essential pre-processing step for image segmentation. Image enhancement can be divided into two categories: Spatial domain & Transform domain. Spatial domain operate directly to change image pixels & used in sharp & smooth filtering images. Transform domain is based on convolution theorem, change the position of image, compute the image in fourier transform & decompose the image into high & low frequency signal [10][11]

1.1 Issues in Image Enhancement:

Beside improving the quality of image it suffers from various problems:
(i) Difficult task for automatic processes.
(ii)At low contrast, it is difficult to extract objects from dark background.
(iii)It gives false contours & changes in appearance of image due to its inefficient brightness Preservation.
(iv) For real time applications it require quite complex algorithms.

To overcome the issues various techniques have been developed are as:

Histogram equalization is widely used for contrast enhancement which remaps the intensity value of the image based on probability distribution in various areas like medical imaging, consumer electronics, speech recognition due to its higher efficiency & simplicity but suffers from a drawback by highlighting the edges, borders of the image it degrade the local details within the image & cannot preserve the original brightness of the image [6] [8]. To overcome the problem of HE other techniques are as Traditional Histogram equalization (THE), Automatic Weighting Mean separated Histogram Equalization (AWMSHE) ,BBHE (Brightness Preserving Bi-histogram Equalization), DSIHE (dualistic sub-image histogram equalization),RMSHE(Recursive mean separate Histogram Equalization), DHE(Dynamic Histogram Equalization),BPDHE(Brightness preserving dynamic histogram equalization), MCBHE(Multi level component based histogram equalization), WMSHE(Weighting mean-separated sub-histogram equalization) [5] which can be discussed in section iii.

As these techniques will increase the contrast but results in over enhancement so we proposed a new technique of Background Brightness preserving histogram Equalization (BBPHE) with post weighted median filter which decomposes the input image into sub-images based on background levels and non-background levels range. After that, each sub-image is equalized independently, and then combined into the final output image using filter, which replaces the value of a pixel by the median of the intensity values in the neighbourhood of that pixel [12] The remaining paper includes:Section II describe about the techniques used for image enhancement, Section III describes a proposed method, Section IV gives experimental results Section V concludes the paper.

2. Image Enhancement Techniques

2.1THE (Traditional Histogram Equalization): It is also called as Adaptive Histogram Equalization (AHE).It makes an adaptive selection of channels and thresholds based on the analysis of input image. It also reduces the processing time and noise. The contrast equalized image is generated by transforming the pixels' gray levels in each input interval to the appropriate output gray-level interval according to the dominant Gaussian component and the cumulative distribution function of the input interval [3] It cannot enhance the local details of the image. Its Drawback is over enhancement of image which results in unnatural image.

2.2 AWMSHE (Automatic Weighting Mean separated Histogram Equalization): Used for gray scale images. In this method an input image is separated into several sub images. It can be determined on the basis of local and global histogram. It involves the stages are as follows **(i)** Automatic histogram separation: Separate the input image on the basis of weighted mean function and automatic determine the recursion level [6]**(ii)**Piecewise Transform function: By equalizing sub histograms we achieve contrast enhancement. Drawback is that it cannot be applied to consumer electronic products that produce color images.

2.3 DSIHE (Dualistic sub-image histogram Equalization): It divides the image into sub images on the basis of median value. DSIHE is a term of preserving an image's brightness and entropy. It does not present a significant change in the brightness of the input image, especially for the large area of the image with the same gray-levels but preserve the original image luminance so used in video systems but some noise may be present in output enhanced image.

2.4 BBHE (Brightness Preserving Bi-histogram Equalization): It divide the image into two sub images on the basis of mean gray level. After separation these two sub images are equalized independently by using histogram equalization & the resultant image which contains the mean brightness between input mean & middle gray level but its drawback is that it cannot preserve the natural appearance of the image[2][7]

2.5 RMSHE (Recursive mean separate Histogram Equalization): It decompose the image recursively for generating 2r sub-image. Each sub images is independently enhanced by using HE method [7] As value of r is large it produces the output image exactly the copy of the input image and there is no enhancement at all. It is good brightness preservation technique but suffer from problem is that it decomposed the sub-histogram is the power of two.

2.6 MMBEBHE (Minimum mean brightness error bi-histogram equalization): It divides the image into sub images on the basis of threshold level & equalized by histogram equalization to produce output image. It preserves the mean brightness of the image & suitable for real time applications. It is superior brightness preserving method & has improved PSNR over BBHE, DSIHE, RMSHE.

2.7 DHE (Dynamic Histogram Equalization): It divides the image histogram based on local minima and a specific gray level is assign before equalization. It can be done on the basis of their dynamic range in input image and cumulative distribution (CDF) on histogram values. It cannot produce any side effects but cannot preserve the mean brightness of the image. It can be used for gray scale & color images, maintain the input brightness which overcomes the drawback of previous techniques but suffers from brightness preservation.

2.8 BPDHE (Brightness preserving dynamic histogram equalization): In this technique mean intensity of input image is equal output image mean intensity. It is based on the local maxima of the smoothed histogram. It overcomes the brightness preservation problem. In this method the input histogram is smoothed by a Gaussian filter, and then partitions on the basis of local maxima. Now each partition will assign a new dynamic range [2] Then equalization process is applied independently to these partitions. The changes in dynamic range and equalization process will change the mean brightness of the image. Finally normalize the output image to the input mean brightness. Its drawback is ignoring details results from the wide distribution of regions with detailed information in small regions.

2.9MCBHE (Multi level component based Histogram equalization): In this method it decompose the image into sub images as background & foreground sub images. Each is equalized by using histogram equalization and then processed the sub image using thresholding and connected component analysis [4] Used in image segmentation applications like tumor detection & handwriting recognition & also enhancing the local details of the image. It is simple & effective used for both local & global contrast enhancement but cannot used for background preservation.

3. Proposed Work

To overcome the over-enhancement by preserving the background a proposed work of new technique named as Background brightness preserving histogram equalization (BBPHE) with weighted median filter is used. For enhancing the contrast & useful in medical images such as tumor, cancer detection in lungs, brain etc. it can involve various steps as:-

1) First we decompose the input image into sub-images based on background levels and non-background levels range.

2) After that, each sub-image is equalized independently, and then combined into the final output image. Output image will go through weighted median filtering process to fine-tune the histogram of an image.

3) In this way, the background levels are only stretched within the original range, hence, the over enhancement can be avoided. Also, although other sub-images contain only comparatively low density grey levels, BBPHE is able to expand them into a wider range due to normalization. Hence, this will provide adequate enhancement on the image & easily detect the tumor, cancer in colored medical images.

4.Block diagram of proposed Method:

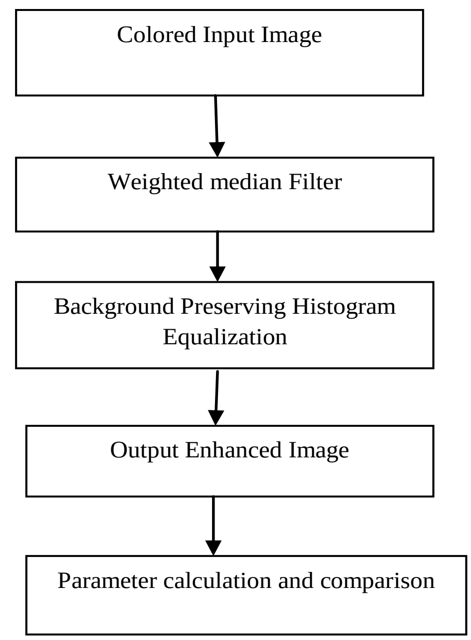

Figure 4.1 Proposed Algorithm Flow Chart

4. Experimental Results

In order to evaluate the performance of the Image enhancement techniques and its proposed model, the simulation is done with the help of Image processing tool in MATLAB software. The results of the simulation is shown as:

In order to detect liver cancer firstly take the original image of various patients. In this process we take one RGB image of a patient suffering from cancer . The input image is shown as:

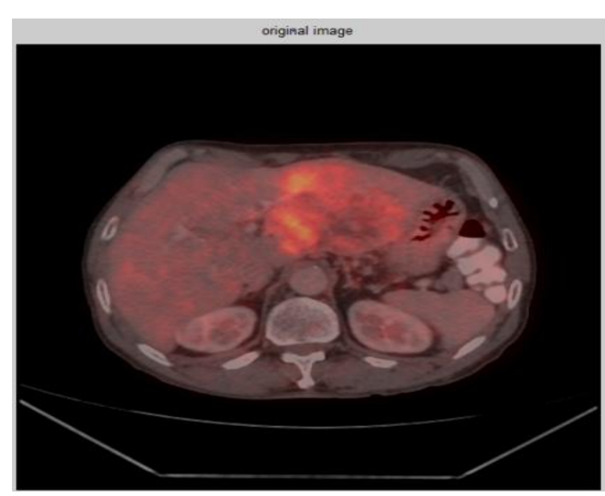

Figure 4.2 Liver cancer of original image

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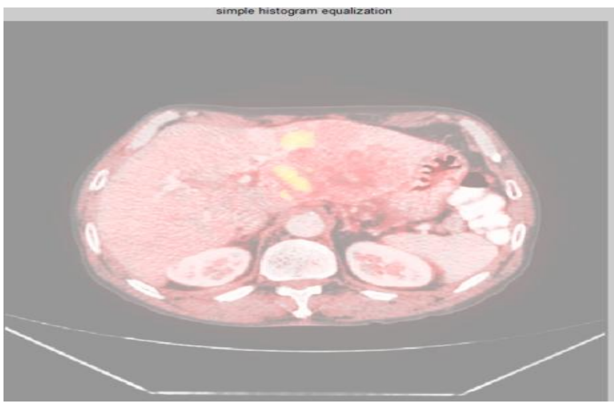
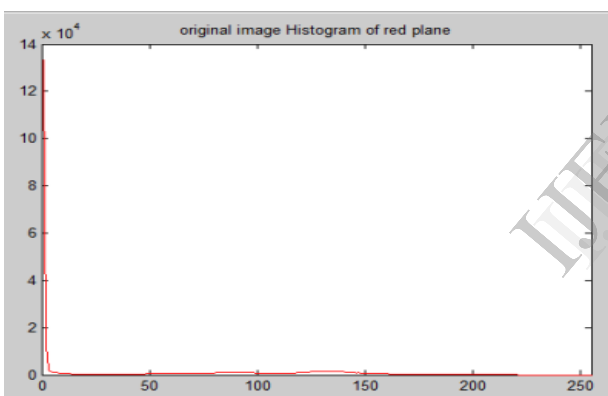
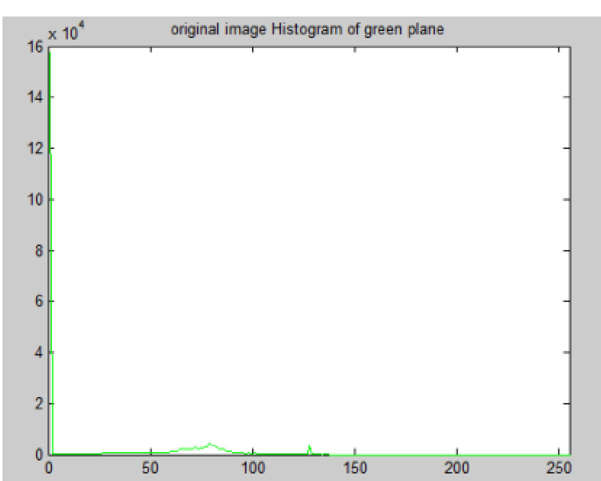
On applying simple histogram equalization approach results in enhancing the contrast of medical images i.e liver cancer. For the display of results the Histograms are plotted with the help of MATLAB.







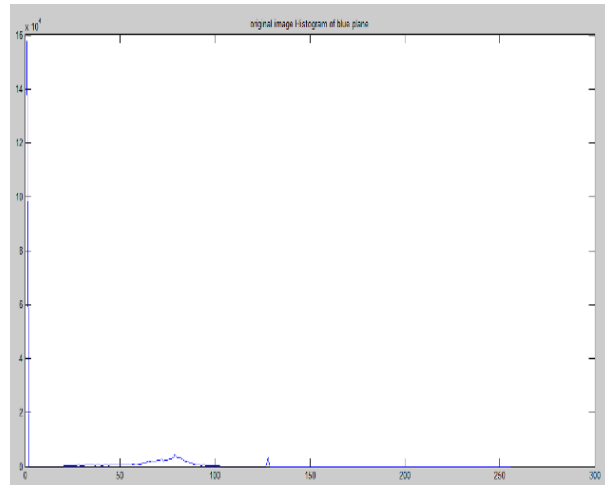


Figure 4.3 HE process on input image along with histograms

But it suffers from a drawback of preserving background brightness results in novel approach of BBPHE. This approach on applying on original image first split the image on the basis of pixel value less than mean and greater or equal to mean.

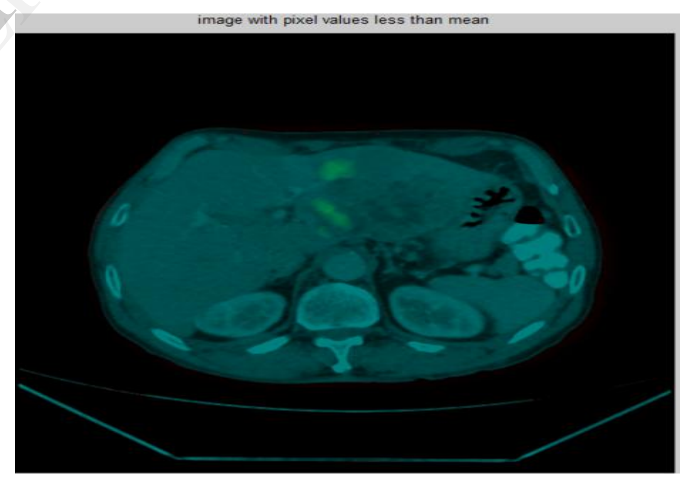


Figure 4.4 BBPHE approach with pixel value less than mean

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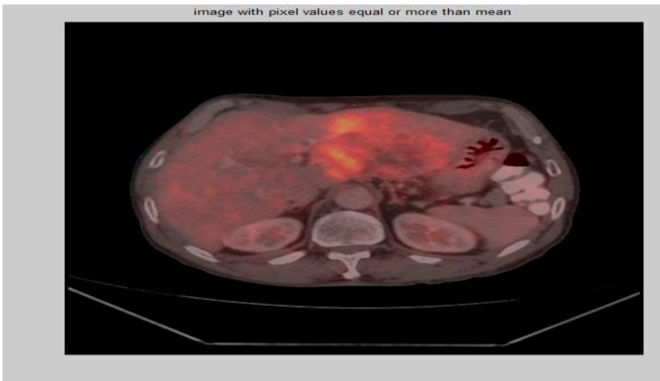
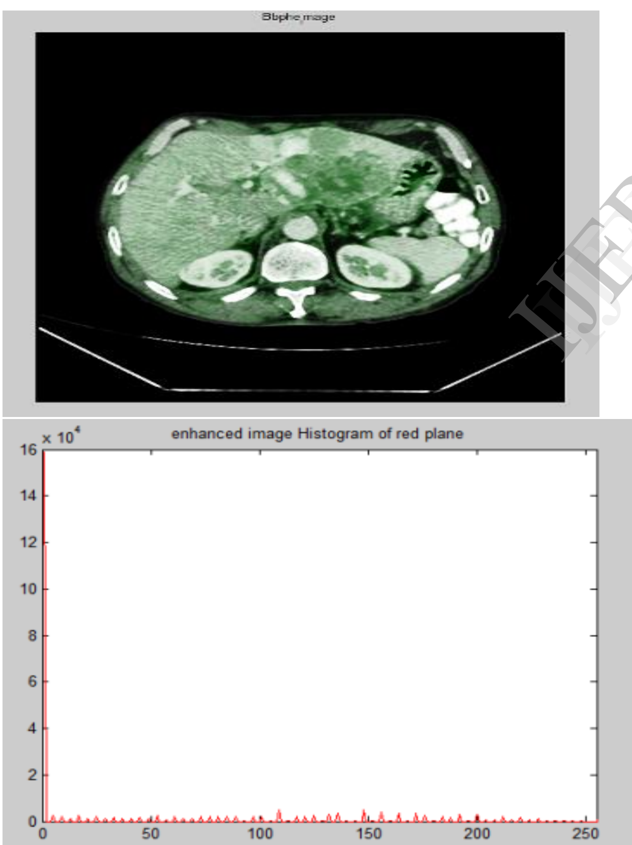


Figure 4.5 BBPHE approach with pixel value equal or more than mean

After applying this approach the resultant BBPHE output is



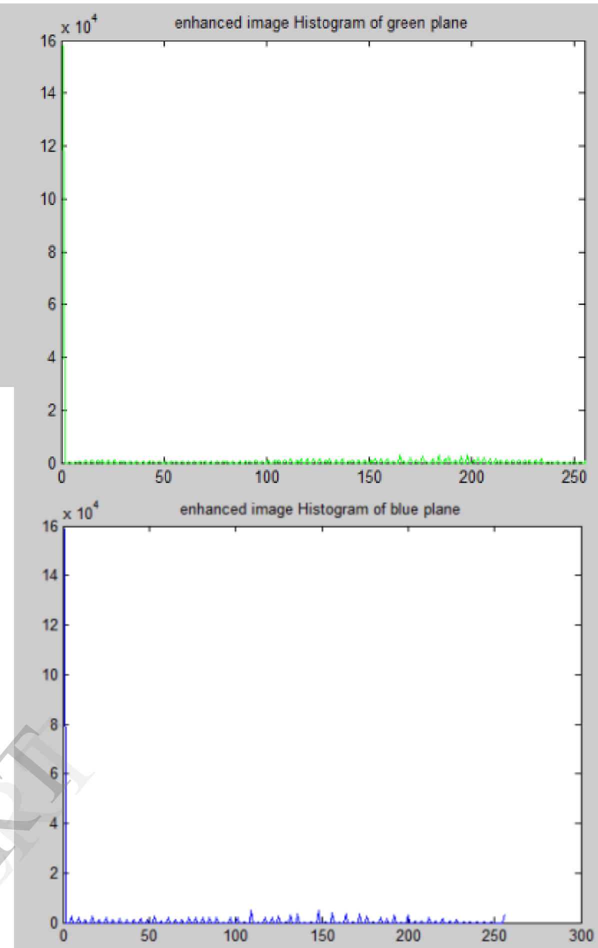


Figure 4.6 Resultant liver cancer image of BBPHE along with its histograms

This technique will not only enhance the contrast but also preserve the background brightness which produce more improved results with respect to simple histogram equalization by calculating the parameters PSNR, MSE.It can also be better by calculating other parameter like euclidean distance and elapsed time.

(iii) The elapsed time to complete whole process is 17.426805 seconds.

Table 4.1: Comparison of Different Measuring Parameters for an image

SNo.	Technique	PSNR	MSE
1.	Simple Histogram Equalization	5.0819	142.6077
2.	Background Brightness Preserving Histogram Equalization	15.4437	43.2569

Table4.2: Calculation of Different Parameters of Proposed technique

SNo.	Parameter	Value
1.	Euclidean distance	2.5449e+04
2.	Percentage Distance	58.

After observing the results and calculating the result we can conclude that BBPHE is much better than Histogram equalization.

5. Conclusion

In this paper we focused on medical images i.e liver cancer so a proposed BBPHE approach of image enhancement for colored images which analyzes that it prevents the over enhancement & enhances the quality of medical images without artifacts while preserving the input brightness as compare to various image enhancement techniques. By calculating the various parameters like PSNR, mean square error it may be prove that BBPHE can be the best method from simple histogram equalization especially in medical images.

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