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Research Article

A Review of Medical Image Enhancement Techniques for Image Processing

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Abstract

Image Enhancement is one of the most important and complex techniques in image processing technology. The main aim of image enhancement is to improve the visual appearance of an image, or to offer a "better transform representation of the image. Various types of images like medical images, satellite images, aerial images and real life photographs suffer from different problems like poor contrast and noise. It is essential to enhance the contrast and remove the noise to increase image quality. Recently a lot of work has been done by different researchers and scientists in the field of image enhancement. Many techniques have already been proposed and devised for enhancing the digital images. Most of the techniques are based upon the concept of transform domain methods which can introduce the artifacts which further reduce the intensity of the input image. The main objective of this paper is to highlight the drawbacks of the existing techniques.

Keywords: *Enhancement, Medical Images, Histograms, CLAHE.*

1. Introduction

Image enhancement process consists of a collection of techniques that are used to improve the visual appearance of an image. Image enhancement is a process by which the visual quality and the overall appearance of an image are improved so as to extract the spatial features of the image. The photographs taken using cellular phones and smart phones are generally of poor contrast. So, this type of images needs enhancement algorithms to improve its contrast. The main function of image enhancement is to improve the interpretability or perception of information contained in the image for human viewers (Panett *et al*, 2011). It creates output image that subjectively looks better than the original image by changing the pixel's intensity of the input image. Image enhancement, which is one of the important techniques in digital image processing, plays an important roles in many fields, such as medical image processing, remote sensing, speech recognition, high definition television (HDTV), hyper spectral image processing, industrial X-ray image processing, microscopic imaging and many other image/video processing applications (Gorai *et al*, 2011). Most of these techniques require interactive procedures to obtain suitable results, and therefore are not suitable for routine application.

The work done by various scientists and researchers for Image Enhancement are discussed here

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Madhu *et al* 2011 proposed that the adaptive histogram equalization technique can produce a better result, but the image is still not free from fuzzy appearance.

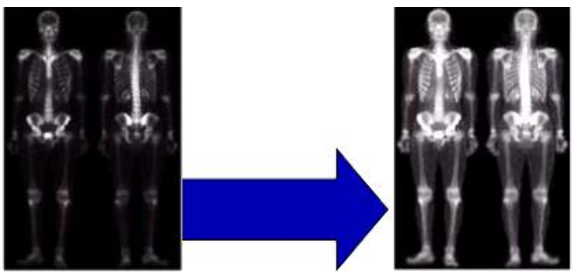

Fig.1: Showing the effect of Image Enhancement

Further modification in quality of image is proposed by Hasikin *et al* 2012 proposed that the fuzzy grayscale image enhancement technique is proposed by maximizing fuzzy measures contained in the image. The qualitative and quantitative performances of the proposed method are in contrast to another method. The proposed method produced better quality enhanced image and required minimum processing time compared to other methods. Selvi et at 2013 proposed a method for enhancing the fingerprint images. The major objective of this paper is to produce a noise free image. Firstly, the portion of the image affected by noise is analyzed and then the enhancement is performed on that portion using fuzzy

based filtering approach and adaptive thresholding. This methodology consists of four steps namely: Preprocessing, Fuzzy based filtering, Adaptive thresholding, and Morphological Operation. In Preprocessing, the original image is cropped to a particular size so that it can be preprocessed. The size of image is decreased to 256 pixels and then fuzzy based inference is applied on it. In fuzzy approach, the original image pixels are converted into membership values. In this process, the noisy portions of the image are identified. To further enhance the contrast, Adaptive thresholding and Morphological operation are applied. It produces better PSNR values than all these conventional methods.

From 2007 to 2013 lot of local image enhancement algorithms have been introduced to improve enhancement technique. Many kinds of images like medical images, satellite images, aerial images and still real life photographs suffer from poor contrast and noise. So, the principal objective of image enhancement is to modify attributes of an image, to make it more suitable for a given task and provide better picture detail of image. Digital Image enhancement techniques provide a large amount of choices for improving the visual quality of images.

This paper is organized as follows: Section 2 describes the Literature Survey, highlighting work done by different researchers in the field of image enhancement. Section 3 describes the Histogram Based Techniques which are to be used in the field of medical electronics. Section 4 highlights the Gaps in work done. Section 5 discussed the conclusion drawn from the paper.

1.1 Applications

Image enhancement is used to enhance the quality of images. The main applications of image enhancement are Aerial imaging, Satellite imaging, Medical imaging, Digital camera application and in remote sensing. Image Enhancement techniques used in many areas such as forensics, Astrophotography and in Fingerprint matching, etc. Color contrast enhancement, sharpening and brightening are some of the useful techniques used to make the images clear. Medical imaging uses this for reducing noise and sharpening details to improve the visual representation of the image. This makes image enhancement a necessary aiding tool for reviewing atomic region in MRI, ultrasound. Images that are obtained from fingerprint recognition, security videos analysis and crime scene investigations are enhanced to help in identification of culprits and protection of victims.

2. Literature Survey

This section highlights the literature survey of various approaches used by different researchers in the field of image enhancement.

Henan, Wu *et al*. in 2011 presented an enhancement algorithm predicated on multi-scale Retinex to be able to improve the potency of remote sensing image enhancement. The principle and recognition types of multi-scale Retinex and wavelet were calculated. The research of panchromatic and multicolor remote sensing image enhancement were agreed out on the basis of the two methods, the end result showed that the mean valve of enhanced image by this algorithm is all about 125, the entropy and definition might be improved by 5% and 25% in contrast to wavel*et al*gorithm, and remote sensing images might acquire better enhancement quality, so multi-scale Retinex is a superior method for sensing image enhancement.

Juliastuti, E *et al*. in 2012 evaluated the contrast quality of digital image that scanned using both mode based on statistic image characteristic. The outcomes showed that the quality of digitized image using transmission mode is preferable to using reflection mode. However, if direct digital imaging is employed as a gold standard, image enhancement on digitized image continues to be necessary.

Hasikin, Khairunnisa *et al*. in 2012 presented a fuzzy grayscale enhancement technique for low contrast image. The humiliation of the low contrast image is normally caused by the insufficient lighting during image capturing and thus ultimately generates non-uniform illumination in the image. The majority of the developed contrast enhancement techniques enhance the image quality without thinking about the non-uniform lighting in the image. The fuzzy grayscale image enhancement method is proposed by maximizing fuzzy events contained in the image. The membership function is then adapted to improve the image by utilizing power-law transformation and saturation operator. The proposed method produced better quality enhanced image and required minimum processing time compared to other methods.

Mohommad F. K *et al*. in 2012 presented Bi histogram and Multi Histogram methods. Bi HE approach enhances the contrast preserving the brightness of the image but it spoil the natural display of image. On the contrary, Multi HE methods preserve the natural display but can't maintain the intensity or contrast. Firstly, the histogram of input image is divided into different sectors and then HE is applied on every sector. Each section is known as sub-histogram. It reduces the decomposition error of input histogram.

Wang, Lung-Jen *et al*. in 2012 showed that nonlinear image enhancement may be used to increase the quality of a fuzzy image. The aim of this paper is to build a successful image classification technique to determine the very best mix of clipping and scaling parameters by the chance cost method for image enhancement. Experimental results gives idea about the proposed opportunity cost method with image classification for the nonlinear image enhancement achieves a much better subjective and objective image quality performance compared to method utilizing the opportunity cost without image classification and other nonlinear image enhancement methods.

Peng, Zhang *et al*. in 2013 proposed a multi-scales nonlinear enhancement method of THz image. The THz image has lower contrast and bigger noise because the THz radiant power is small, for the purpose of improving the image definition. The detail coefficients are taken to de-noise and histogram equalization to be able to enhance this is of image edge and image detail. The approximation coefficients are taken to nonlinear transform to be able to suppress the background noise and improve target information. The proposed method could boost up the prospective information of THz image and take away the noise of THz image at the same time. Accordingly the brand new method could increase the THz image definition, and avoid the phenomenon that the histogram equalization not just enhances the prospective information but moreover enhances noise. Theory analysis and experiment shows that the brand new method is realistic and efficient, and the THz image enhancement effect is more matching the character of human eye.

Selvi M. *et al*. in 2013 have provided a method for enhancing the fingerprint images. The first and foremost step in fingerprint recognition is enhancement. Fingerprint recognition is used for authentication purpose. The major objective is to produce a noise free image. Firstly, the portion of the image affected by noise is analyzed and then the enhancement is performed on that portion using fuzzy based filtering approach and adaptive thresholding. This methodology consists of four steps namely: Preprocessing, Fuzzy based filtering, Adaptive thresholding, and Morphological Operation. In Preprocessing, the original image is cropped to a particular size so that it can be preprocessed. The size of image is decreased to 256 pixels and then fuzzy based inference is applied on it. In fuzzy approach, the original image pixels are converted into membership values. In this process, the noisy portions of the image are identified. To further enhance the contrast, Adaptive thresholding and Morphological operation are applied. This approach is compared with existing approaches such as Gabor filtering, Histogram Equalization Wiener filtering and Anisotropic Filtering. It produces better PSNR values than all these conventional methods.

Khairunnisa H. *et al*. in 2013 have presented a fuzzy based technique for low contrast and non uniform images. The fuzzy method differentiates the dark and bright parts of the image. The fuzzy based technique outperforms the other conventional enhancement techniques such as power law transformation. Also, it produces brighter images and takes less time to implement as compared to other techniques. It has been proved that the processing time of the Fuzzy approach is 100ms.

Bhattacharya. S *et al*. in 2014 have proposed a fast method called singular value decomposition (SVD) to improve the contrast of an image locally. The image enhancement is used to increase the visual information of an image using various steps such as contrast enhancement, debluring, denoising etc. Contrast Enhancement is the most vital part of image enhancement because human eye is more sensitive to luminance than the chromatic information of an image. Mostly, the contrast enhancement techniques focus on the global enhancement of images but such global methods lead to loss of information in images. Thus, a technique is required to carry out localized image enhancement.

G. Raju *et al*. in 2014 have presented a new fuzzy and histogram based method to enhance low contrast color images. The given method is fast as compared to other enhancement techniques. In Fuzzy method, firstly the RGB image is converted into HSV color space so as to preserve the H and S components in the image. Only V component is stretched on the basis of control parameters M and K. The main objective of the method is to convert the histogram of original image into a uniform histogram. The Fuzzy based method has shown better results than the traditional methods such as Histogram Equalization, Adaptive Histogram Equalization, Bi-Histogram Equalization and Gray Level Grouping on the basis of visual quality. However, it can only be applied to low contrast and low bright color images.

3. Histogram based Techniques

3.1 Histogram Equalization

The goal of histogram equalization is to distribute the gray levels within an image so that every gray level is equally likely to occur. Histogram equalization will increase the brightness and contrast of dark and low contrast images.

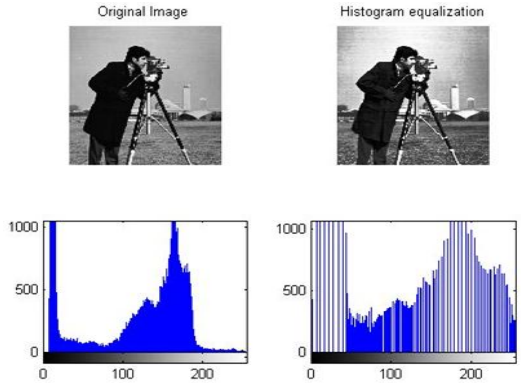

Fig 2: Histogram Equalization

Histogram equalization is used to enhance contrast. It is not necessary that contrast will always be increase in this. There may be some cases were histogram equalization can be worse. In those cases the contrast is decreased.

3.2 Adaptive Histogram Equalization

Adaptive histogram equalization (AHE) is a computer image processing technique used to recover contrast in

images. It may differ from normal histogram equalization in the respect that the adaptive method covers number of histograms, each equivalent to a different section of the image, and used them to rearrange the lightness values of the image. It is suitable for improving the local contrast of an image and bringing out more picture detail. However, AHE technique has drawback that it results in amplify noise in comparatively homogeneous regions of an image This problem in adaptive histogram equalization technique can be solved by using the modified technique called contrast limited adaptive histogram equalization (CLAHE) which prevents the amplification of noise by limiting the amplification process. Ordinary histogram equalization uses the same transformation derived from the image histogram to change all pixels. It works well when the division of pixel values is similar throughout the image.

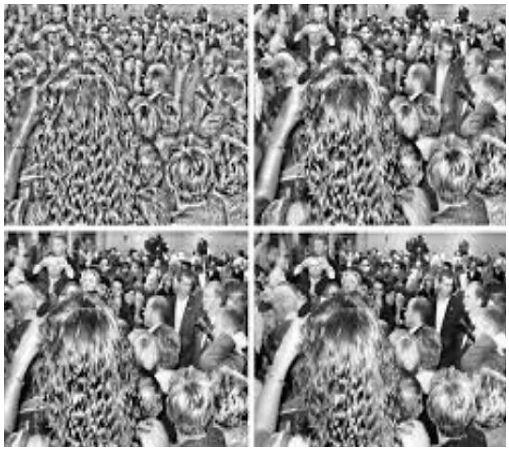

Fig 3: Adaptive Histogram Equalization

However, when the image contains regions that are extensively lighter or darker than most of the image, the contrast in those type of regions will not be correctly enhanced. Adaptive histogram equalization (AHE) technique improves this phenomenon by changing each pixel with a transformation function derived from a neighborhood region.

3.3 BI- Histogram Equalization

Brightness Preserving Bi-Histogram Equalization (BBHE) method divides the image histogram into two parts. In this method, the partition intensity is represented by the input mean brightness value, which is the average intensity of all pixels that construct the input image. Then the BBHE equalizes the sub-images independently based on their relevant histograms with the constraint that the samples in the proper 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 of the maximum gray level. Thus, the resultant equalized sub-images are surrounded by each other around the input mean, which has an outcome of preserving mean brightness.

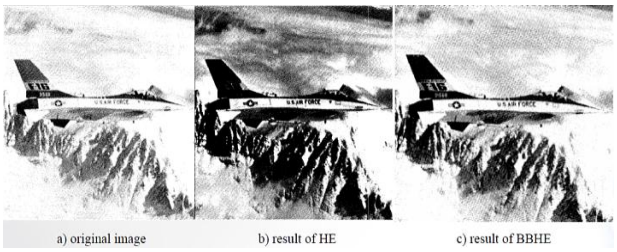

Fig 4: Bi- Histogram Equalization

3.4 Gray Level Grouping (GLG)

The basic principle involved in this technique is as follows. Firstly, we group the histogram components into a proper number of gray level bins according to their amplitudes in order to initially reduce the number of gray bins. The main objective of this technique is to get a uniform histogram for a low contrast color image. Conventional histogram equalization results in under or over contrast image since it leaves too much empty space on the grayscale. The drawback of GLG is that it is not computationally efficient compared to fuzzy-based methods. The quantitative analysis represent that fuzzy-based methods are superior to GLG.

3.5 CLAHE

CLAHE represents the Contrast limited adaptive histogram equalization. This method does not need any predicted weather information for the processing of fogged image. Firstly, the image captured by the camera in foggy condition is converted from RGB (red, green and blue) color space is converted to HSV (hue, saturation and value) color space. The images are transformed because the human sense colors similarly as HSV represent colors. Secondly value component is processed by CLAHE without effecting hue and saturation. This technique use histogram equalization to a contextual region. The original histogram is cropped and the cropped pixels are redistributed to each gray-level. In this each pixel value is reduced to maxima of user selectable. Finally, the image processed in HSV color space is converted back to RGB color space.

Fig 5: CLAHE (a) input image (b) output image

4. Gaps in Literature Work

Following are the different gaps in earlier research on image enhancement techniques.

- **Artifacts:** The majority of the image enhancement methods are transform domain so may come up with certain artifacts in output image so require some special aid to overcome illuminate artifacts.
- **Pixel lost:** As a result of transform domain methods certain pixels may get lost during conversion either original to transform or transformed signal to original pixel values.
- **Illuminate misbalancing:** Most of the methods depends upon certain predefined rules no concentrate on the objects or regions in the given image; so may imbalance the illuminate of the output image.
- **Edge degradation:** Edges plays significant role in vision processing but image enhancement technique may change the edges too. So can lead to degraded edges.

Conclusions

This paper highlights the various image enhancement techniques which can be used particularly for medical image enhancement which enable medical professional. The paper briefly reiterated the facts that, there still much improvements are required in existing techniques to get better results. In order to overcome the limitations of the earlier techniques a hybrid algorithm will be introduced in near future. The newest approach could have the ability to boost the contrast in digital images in efficient manner by utilizing the edge preserving fuzzy filter hypothesis. As edge preserving fuzzy has ability to reduce the effectuation of noise and yes it preserves the edges in efficient manner so provides better results. Additionally the proposed technique will use illuminate normalization based on the gray world hypothesis to reduce the illuminate artifacts.

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