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CONTRAST ENHANCEMENT WITH ENTROPY MINIMIZATION TECHNIQUE

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ABSTRACT

Almost every branch of medical imaging uses the concept of digital image processing for visualizing and extracting details from the data images. Thus, quality enhancement has become more important to be performed with the help of various techniques. The enhancement of an image is one of the most acceptable methods to get the deeper knowledge of any image. There are various contrast enhancement methodologies that are being used for the partitioning of any image. This paper extends the process of contrast enhancement using histogram equalization along with minimization of entropy on the ultrasound images, concentrating on the small and informative part of the image.

KEYWORDS: enhancement, histogram equalization, entropy, ultrasound images.

I. INTRODUCTION

Image enhancement techniques are being used in many applications of image processing, especially where the subjective quality of images has become an important parameter for human interpretation. Even if the noises are rare, but they disturb the images and also impacts the quality of many image processing algorithms. Contrast is an important factor for the evaluation of any image quality. The contrast resolves the visual properties that keep an object distinguishable from other similar objects and the rest background. In visual perception, contrast can be determined by finding out the difference between the color and the brightness of the object with other objects. Many algorithms for accomplishing contrast enhancement have been developed and applied to several problems in image processing. Various methods have been proposed in literatures for enhancing the images such as image histogram equalization, local region based enhancement, and transform domain methods. Here, Contrast limited adaptive Histogram equalization method is being used for image enhancement and further related entropy of the image has been calculated and thus compared.

II. CONTRAST ENHANCEMENT

The contrast enhancement is the basic need of any image that can be used for the enhancement of features of the data image and also such that the prepared enhanced image must become better than original image. Various contrast enhancement techniques are known both in spatial domain and transform domains. In spatial domain techniques, the intensity values of any image is modified whereas in transform domain techniques, transform domain coefficients are modified and scaled. Histogram equalization (HE) is one of the simple and effective contrast enhancement techniques to be known. The (HE) distributes various pixel values of the image uniformly such that the histograms of the enhanced image become linear cumulative histogram. The HE technique [1] is a global operation and therefore it cannot preserve the image brightness. To overcome this issue local-HE [2] and many brightness preserving local HE techniques have been proposed.

Histogram Equalization

Due to low quality images, contrast enhancement is commonly required for the captured medical images [5]. The Histogram equalization allows increasing the dynamic range of the histogram of an image. It flattens and stretches the dynamic range of the image's histogram and thus resulting in overall the contrast improvement [1] of the image. Histogram equalization tends to assign different intensity values to each pixel in the input image such that the output image brings up a uniform distribution of all the intensities. This improves the contrast of an

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image by obtaining a uniform histogram. This technique can either be used on the entire image or may be on a small part of any image.

Contrast Limited Adaptive Histogram Equalization

Adaptive Histogram Equalization is a technique in which the contrast of any data image is enhanced by transforming the intensity values in the data image. Histogram Equalization is one of the global technique in which the enhancement is based on the equalization of the histogram of the entire image [2]. Adaptive Histogram Equalization attempts to overcome the limitations of Histogram Equalization. Another popular method, Contrast Limited Adaptive Histogram Equalization (CLAHE) method that has been given by K. Zuiderveld and have proposed the further improvement of image contrast formany imaging areas including medical imaging applications to overcome the certainty of amplification of noise problem and thus improves the contrast. Contrast limited adaptive histogram equalization (CLAHE) method helps to improve the image quality at good scale. In last two decades various researchers have been using CLAHE method for pre processing of different images. This method produces the optimal equalization in terms of maximum entropy and also limits the contrast of an image[8]. The CLAHE method is a useful method for the brightness improvement as in geographical channels or underwater environments or true color images. In CLAHE, the equalization is implemented individually for all the three RGB color spaces[10]. These RGB components are merged together to result the color equalized image. CLAHE was originally developed by the researchers for successfully enhancing the low contrast medical images. The method partitions the input image into small related regions and finds the equalization to each region this flattens the distribution of all grey levels and thus the hidden features of the image become more visible. The CLAHE technique is described as:

Step 1: The Division of each input image into more than one non overlapping contextual regions, provided that they should be of equal size of the blocks, each corresponding to the surrounding neighborhood pixels.

Step 2: To calculate the intensity histogram of each region.

Step 3: Setting up of the clip limits in order to clip the histogram, (for example c=0.002). The clip limit is also defined as a threshold parameter, which can effectively alter the contrast of an image. The higher is the clip limit, thus it increases the contrast of local image regions.

Step 4: Modify each histogram by selecting transformation functions.

Step 5: Every histogram is then transformed according to the selected clip limit.

The mathematical expression for transformed gray levels for standard CLAHE method with Uniform Distribution can be given as

$$g = [g(max) - g(min)] * P(f) + g(min) \qquad (1)$$

where, g(max) is a Maximum pixel value
g(min) is a Minimum pixel value
P(f) is a cumulative distribution function
And g is a computed pixel value

And for exponential distribution grey level can be calculated as

$$G = g(min) - 1/\alpha \; * \; \ln[1- P(f)] \qquad (2)$$

Where α is the clip parameter

Step 6: The neighboring tiles were then combined using bilinear interpolation technique, then the image grayscale values were altered on the basis of modified histograms.

III. ENTROPY CALCULATION AND MINIMIZATION APPROACH

The entropy of a system, which was defined by Shannon**,** gives a measure of uncertainty. The Shannon's function produces the concept of information gain of an event and it is inversely related to the probability of its occurrence. Several authors have been using Shannon's concept for the purpose of image processing and pattern recognition problems. The Shannon's concept then defines the entropy of an image assuming that an image is entirely represented by its gray level histogram. After then, segmentation algorithms uses Shannon's function resulting into in an unappealing result, viz, same entropy and threshold values for different images with identical histogram.' The entropy is defined for a single random variable, and for various independent variables, the

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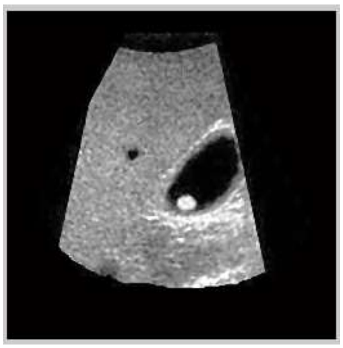
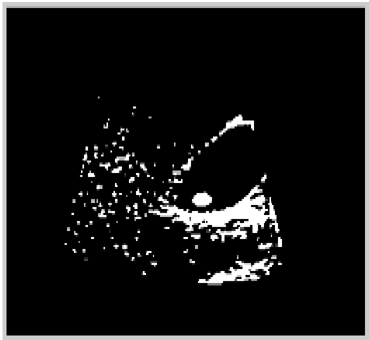
entropy of the set of these variables as the collected sum of the individual entropies. As the image is composed of several regions each region has its own random variable.

IV. RESULTS AND DISCUSSION

The medical ultrasound images of patients were taken for respective subjective and objective assessment. The subjective quality assessment of an image is done on the basis of the quality of the image that can be perceived by the visualization while the objective quality assessment of an image is a quantitative measure that can perceive the image quality automatically. The below shown figures explains the approach towards the objective assessment of the ultrasound image of a patient having gallbladder polyp.

Original Image ***Contrast Enhanced Image*** ***Entropy Based Segmentation***

Table1. Showing the parameters at each level of performance.

Parameters for original image	Parameters for contrast enhanced image	Parameters for entropy based segmentation
Standard deviation : 0.250043 Entropy :5.779766 Threshold : 0.254902 Contrast : 0.306594 Energy : 0.282883 Homogeneity : 0.913145	Standard deviation : 60.621958 Entropy :4.112694 Threshold : 0.247059 Contrast : 0.334031 Energy : 0.435472 Homogeneity : 0.909363	Standard deviation : 71.106964 Entropy :4.022758 Threshold : 0.296078 Contrast : 0.167630 Energy : 0.456189 Homogeneity : 0.950316

The original image shows the direct picture that has been taken from the medical equipment, which has been undergone with enhancement through CLAHE and finally the approach towards minimization of the entropy has been done so as to decrease the amount of information in the image and thus leaving a portion of interest.

V. CONCLUSION

In this paper the result of experimental study for entropy minimization for the ultrasound image is done. The study shows that the original image requires digital image processing and the performance of histogram equalization gives a good result. However when the entropy is calculated and compared of the original and processed image, it has been decreased leading to the object of interest.

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