International Journal of Computer Applications® (IJCA) (0975 – 8887)
Proceedings on National Conference on Emerging Trends in Information & Communication Technology (NCETICT 2013)

Hybrid Contrast Enhancement Approach for Medical Image

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ABSTRACT
Available methods for image contrast enhancement focus mainly on the properties of the image to be processed while excluding any consideration of the observer characteristics. In many applications, especially in the medically related images, effective contrast enhancement for diagnostic purposes can be achieved by including certain basic human visual properties. Available techniques for contrast enhancement pertaining to medical image depend on the image characteristics, hence a hybrid contrast enhancement techniques are preferentially considered for medical image to observe better result. Present work deals with above context for CT scan images with single seed based region growing adaptive enhancement techniques. Experimental result shows that the proposed work gives better performance when compared to the existing techniques.

Keywords
Region growing, Adaptive Histogram Equalization, CT scan image, Single seed pixel

1. INTRODUCTION
Recent advances in digital medical imaging techniques have led to an increased interest in digital image processing. Existing techniques give attention on enhancement of contrast are of particular interest in the areas of chest radiography, mammography and computer tomography. Enhancement techniques usually are problem oriented processing techniques in which a particular algorithm is applied to design for a specific application [1].Normally X-Ray images can be used to image the human internal body structure. Such type of images which is used to recognize the internal problems. It is a mostly used imaging modality to check the bone fractures and other related problems.[2]. Even though lot of advantages of X-Ray technology, but it can produce low contrast images. CT images are used to image the internal structure of human body and also important diagnostic tool in the field of medicine. It provides good contrast between the different soft tissues of the body which make it especially useful in imaging the brain, muscles and cancers compared with other medical imaging techniques increased on software and hardware level. With advancement of technology some CT machines have also been introduced which can increase the contrast at their own with the help of software and hardware. As the CT images are being used for diagnostic purposes, some software may also be designed to perform auto diagnosis. In general, the elucidation of CT image is being done manually by experienced interpreters of the medicine field. This work is time, manpower consuming .Additionally, human elucidation of CT images is very subjective, inconsistent and sometime predisposed. image enhancement is also a significant part for automated CT image inspection systems. For making the CT images more visual and explanatory some contrast enhancement techniques may be implemented in manual or auto intervening system. [3] Especially a hybrid approach can give better solution to the problems related with all types of medical images and this will be very useful for clinical diagnostic synthesis. (4)

2. EXISTING CONTRAST ENHANCEMENT TECHNIQUES
Due to above reason the medical image can be easily analyzed with the help of contrast enhancement. There are different techniques are already available for analyzing medical images based on contrast manipulation. The methods are as follows;

2.1 Contrast Adjustment
It is the simplest method done by scaling all the pixels of the image by a constant k

$$g(m,n) = f(m,n) \times k$$

Where f(m,n) is the input image

g(m,n) is the output image and k is the constant

2.2 Linear Stretch
It is a simple technique in which contrast of an image is enhanced Here all the pixels intensities can be uniformly enhanced. .

2.3 Unsharp masking
This is the technique used for edge enhancement. In this approach, a smoothened version of the image is subtracted from the original image, hence, tipping the image balance towards the sharper content of the image. [5]

2.4 Histogram Equalization
This is the technique that attempts to spread out the gray levels in an image so that they are evenly distributed across their image. It reassigns the brightness value of pixels based on the image histogram. It provides more visually pleasing results across a wider range of images. This is a global technique, where the enhancement can be implemented by means of applying equalization of the histogram of the whole image. However, it is well recognized that using only global information is often not enough to achieve good contrast enhancement. [6]

2.5 Adaptive Histogram Equalization:
This is a technique by using localized histogram equalization which considers a local window for each individual pixel and computes the new intensity value based on the local histogram defined in the local window. Adaptive characteristics can give better result, but it computation is hard enough even though there are some fast techniques for updating the local histograms. Moreover, adaptive histogram equalization is a

uniform local operator in the sense that all the pixels within the local window equally contribute to the determination of the new value of the center pixel being considered..

3. PROPOSED ALGORITHM

Normally an image has varying characteristics and hence existing type algorithm cannot adapt to it. Sometimes for a given image, global transform or a fixed operator yield worst result in some parts of image. [7]. This can be compensated and can be improved by means of region dependent algorithm. Suppose that we start with a single pixel p and wish to expand from that *seed pixel* to fill a coherent region. Let's define a similarity of $S(i, j)$ such that it produces a high result if pixels i and j are similar and a low one otherwise. Initially, consider a pixel q adjacent to pixel p. Then add pixel q to pixel p's region if $S(p, q) > T$ for some threshold . The fixing of threshold value generally taken low fixed gray level value and then criteria is evaluated. Instead of fixing low gray level value the threshold can be automatically selected based on the different gray level of the low contrast images After that proceed to the other neighbors of p and do likewise. Suppose that $S(p, q) > T$ and add pixel q to pixel p's region. Now similarly consider the neighbors of q and add them likewise if they are similar enough. If continue this recursively, an algorithm analogous to a "flood fill" but which works not on binary data but on similar grayscale data The proposed algorithm is based on the adaptive region growing technique with the single seed point to overcome the drawbacks of the existing techniques.

The algorithm is carried out by the following way:

Step 1: Seed point of an image is selected based upon single pixel from group of pixels and include in an empty buffer.

Step 2:. Eight connected neighbors are first found for each unprocessed pixels from the top of the buffer. From each neighbor point ,their pixel gray level is checked whether it is in within the deviation of seed pixel gray level value. The criteria for deviation is given below

$$(f\ (m, n)\text{-seed})\ /\ \text{seed} <= £ \qquad (1)$$

Where f(m,n) is the gray level value of the current pixel and the threshold £ = 0.5 [7] and may fix automatically based on low gray level of the original image .

If the deviation is satisfied then that pixel is included in foreground buffer otherwise to background buffer.

Step 3*:* Similarly all the unprocessed pixels in the buffer are implemented for the step 2 procedure. If already pixels occupied in foreground buffer then it can be ignored and subsequent pixels are check for criteria...

Step 4: Now apply adaptive histogram equalization to modify the gray level values of group of pixels in foreground buffer. .

Step 5: Enhanced image is obtained by making combination of foreground and background buffer.

Step 6: To acquire sharp. Edges the gradient of original image is formulated and then added to step-5

Step 7: Finally resultant enhanced image is displayed.

4. FLOWCHART FOR HYBRID CONTRAST ENHANCEMENT TECHNIQUE

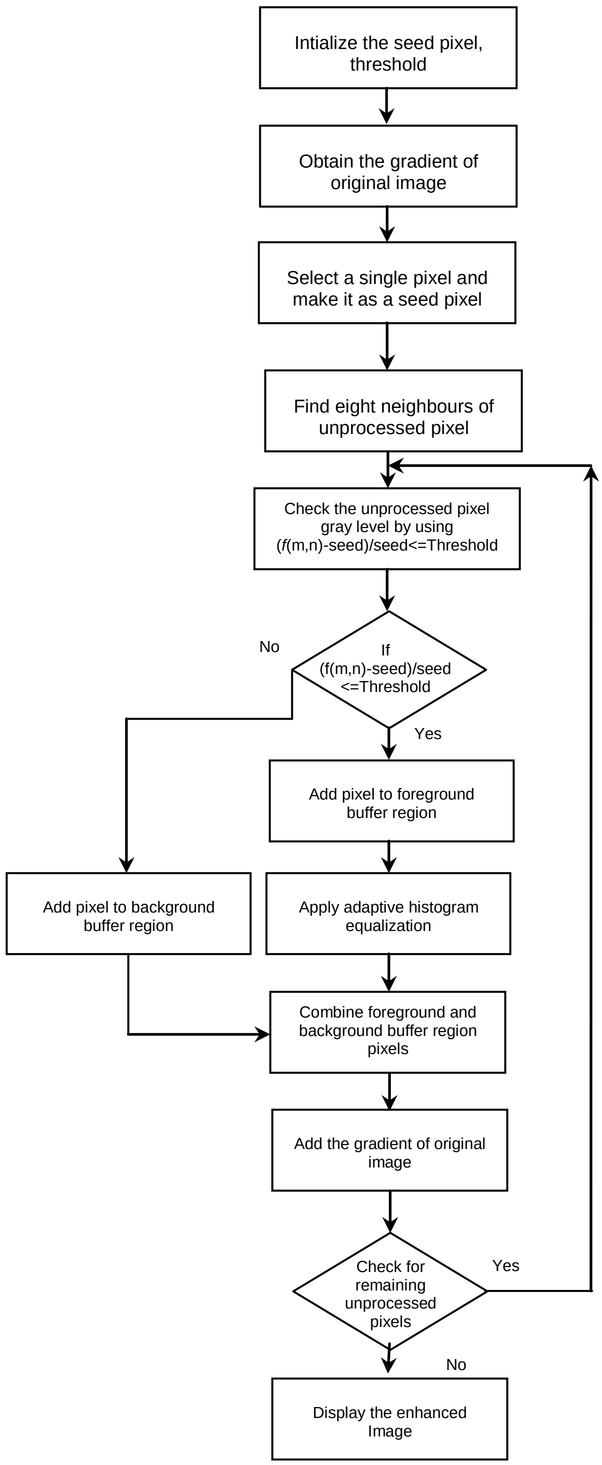


Figure 1 : Flowchart for Hybrid Enhancement technique

The above flowchart describes that a pixel has been as seed pixel in a original image then based on threshold the neighbor pixels are compared with seed pixel. The group of pixels which are satisfied criteria are allotted in foreground buffer and the group of pixels which are not satisfied criteria are allotted in background buffer. This procedure is repeated for other unprocessed pixels. Finally pixels in the foreground buffer are applied with adaptive histogram equalization resulting enhanced image is displayed in output.

5. PERFORMANCE EVALUATION

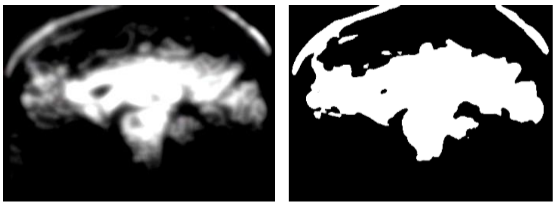
Performance evaluation of this algorithm was conducted on several CT-scan images. Two low contrast CT-scan images have been taken as sample for implementing this proposed algorithm. Evaluation has been done on the basis of (a) Signal-to-Noise Ratio (b) Contrast-to-Noise Ratio (c) Tenangrad measurement. Results for the proposed algorithm are hereby compared against the Adaptive Histogram Equalization & Linear Stretch algorithms based upon the above said quality metrics.

Table1: Quality Parameters Calculation Formulas

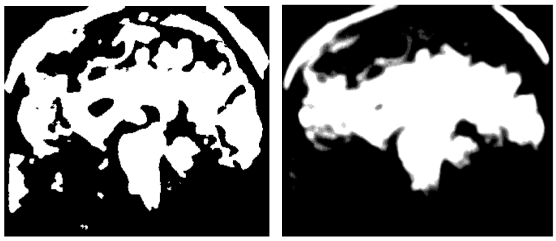
	Quality Factor	Implementation
1.	**Signal-to-Noise Ratio (SNR)**	$\left\| \frac{\mu_{signal} - \mu_{noise}}{\sqrt{2}\sigma_{noise}} \right\|$
2.	**Contrast –to –Noise ratio(CNR)**	$\frac{(\mu_{signal} - \mu_{noise})^2}{\sigma_{noise}^2}$
3.	**Tenangrad Measurement (TEN)**	$\sum_y \sum_x [s(x,y)]^2$ for $s(x,y) > t$

SNR is the ratio of the mean of intensity difference between the signal (foreground) and the noise (background) to the standard deviation of the noise [8].Contrast Resolution is much related to SNR. A higher value is always desired for SNR. CNR is the squared ratio of the difference in the mean intensity of the foreground and the background to the standard deviation of the background. TEN involves computing gradient magnitude at every location in image and sums all magnitudes greater than a threshold T [8]. While comparing results for images, higher value of TEN and CNR represent better edges and contrast respectively.

5.1. RESULTS AND DISCUSSION

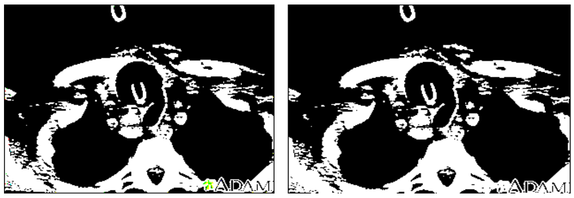


a) Original Image **b) Linear Stretch Image**

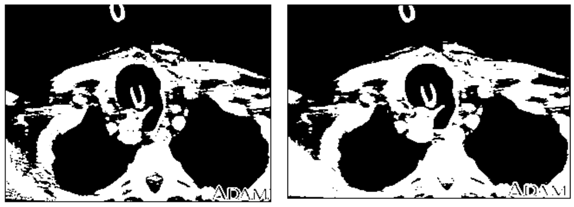


c) AHE Image **d) Proposed Image**

Figure 2 : Scul as a Test Image 1



a) Original Image **b) Linear Stretch Image**



c) AHE Image **d) Proposed Image**

Figure 3: Upper Chest Thorax as a Test Image 2

Table 2: Performance Evaluation for Figure 2

Algorithm / Quality parameters	Linear stretch	Adaptive Histogram Equalization	Proposed Hybrid algorithm
SNR	100.6124	112.633	166.0351
CNR	2.0246	2.53772	5.5135
TEN	7130530	8630217	11820574

Table 3: Performance Evaluation for Figure 3

Algorithm / Quality parameters	Linear stretch	Adaptive Histogram Equalization	Proposed Hybrid algorithm
SNR	77.6725	66.8048	366.6840
CNR	1.2066	0.8926	26.8914
TEN	3757641	4733227	4910953

The above performance evaluation parameters for test images such as Signal to Noise Ratio, Contrast to Noise Ratio and Tenangrad measurement shows that the low contrast image can be effectively processed by the hybrid enhancement techniques and also higher values show that this method is comparatively better than other existing methods like linear stretching. adaptive histogram equalization. Furthermore, the proposed method results such as higher values of Signal to Noise Ratio(SNR) predominantly removes noise factors, higher values of Contrast to Noise Ratio(CNR) and Tenangrad measurement(TEN)exhibits the sharp edges of an image thereby it is very useful to analyze for diagnostic problem for medical experts.

6. CONCLUSION

In this present work, a seed dependent Adaptive Region Growing approach for contrast enhancement has been proposed for CT-scan images. On comparing this approach with the existing popular approaches such as adaptive enhancement and linear stretching, it is revealed that the proposed technique gives much better results than the existing ones. CT-scan image has been used for justifying the visual results. Further, the technique is seed dependent so selection of seed is very important in this algorithm. A seed chosen in darker region will give better result than the seed chosen in brighter region. The reason for selecting the seed pixel in the darker region is normally an area to be enhanced due to low contrast factors. The work will be extended in future by selecting multiple seed point based multiple objective clustering technique. Further, the Medical Images may be differentiated for normal and abnormal portions of different organs of human body using Enhanced Image Segmentation technique. The work may further extended using different hybrid Image Enhancement techniques.

7. REFERENCES

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