ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 13, March 2018

MEDICAL IMAGE ENHANCEMENT USING GAMMA CORRECTION BASED ON DWT-SVD TECHNIQUES

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ABSTRACT

Medical imaging technique plays a major role in the diagnosis and treatment of many diseases. In addition to this, the imaging technique help in diseases prevention, major disease prevention, major disease severity evaluation, treatment severity evaluation , one of the most important imaging technique for brain is CT scan image. CT scanning provides more detailed information on head injuries, stoke, brain tumors and other brain diseases than regular radiographs(X-rays).In the proposed method, The first step the technique decomposes the input medical images into four frequency sub-bands by using DWT and then estimates the singular value matrix of LL sub-band image. In the second step, an enhanced LL component is generated using an adequate correction factor and inverse SVD. In a third step, an adaptive gamma correction factor is calculated for each image Finally, the obtained LL sub-band image undergoes inverse DWT (IDWT) together with the unprocessed low-high (LH), high-low (HL) and high-high (HH) sub bands for enhanced image generation. In this method, metrics like Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR) and Absolute Mean Brightness Error (AMBE) are calculated.

Keyword - Contrast enhancement, DWT-SVD, Adaptive gamma correction ,Non-contrast CT image, Peak Signal to Noise Ratio(PSNR),Mean Square Error(MSE),Absolute Mean Brightness Error(AMBE).

INTRODUCTION

Medical images plays an essential role in patient's health condition and the impact of the picked treatments. Despite the increasing progress in the techniques of capturing these images, the generated images could not pose satisfactory quality for an accurate diagnosis. Environmental noises, patients' special conditions in photography, emergency situations, lighting conditions and technical constraints of imaging devices are amongst the reasons why images may have low quality. Therefore, miscellaneous kinds of artifact and noise in imaging modalities degrade the quality of such image. CT image obtains an important amount of information about the human body to generate its corresponding cross-sectional image that illustrate valuable medical information. CT images were widely used as an efficient medical imaging tool and it replaced many imaging techniques which have been inappropriate in illustrating pathology, anatomy and more truculent diagnostic checks. Nevertheless, CT scans for some parts of the body, like the liver, have low contrast which eventually results in an inaccurate diagnosis. Some contrast agents may be introduced for the purpose of enhancing the CT scans' contrast, although they are harmful or even deadly sometimes for some patients due to the occurrence of anaphylaxis. Image contrast and quality enhancement or image detail improvement algorithms are necessary to highlight the image details in different medical image processing applications, particularly non-contrast CT scans. A common purpose in these applications is to

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enhance the contrast and the quality of image while preserving the edge information. Indeed, degradations may have a crucial impression on the quality of the image and consequently, it affects the human interpretation as well as the performances of computer assisted methods in medical imaging.

Different techniques are proposed in literature to repair the damaged images and improve their quality, improve their contrast and brightness. In fact, contrast enhancement of dark medical images, like non-contrast CT images, is an important and crucial step in image processing, particularly when reimaging is not possible. In general there are two main categories of contrast enhancement methods: spatial and frequency domain methods. Spatial domain algorithms are considered for a direct processing of image's pixels. Histogram equalization (HE) methods are one of the most image enhancement techniques used in spatial domain. Nevertheless, HE does not always give acceptable performances since it could produce a contrast lost for less frequent gray levels and an over-enhancement for frequent ones. Singular Value Decomposition method is also considered for image equalization. This method preserves the general shape of the histogram and significantly reduce the loss of information contained in the histogram. Some other techniques, operating in the frequency domain, are also presented and are based on changing the transform domain of an image. In order to protect the edge information from possible degradation, SVD algorithm applied on LL sub-band image, obtained using DWT. Different contrast enhancement algorithms. based on gamma correction are also presented. Bhandari et al. proposed a simple approach for enhancement of dark image based on knee function and gamma correction using DWT-SVD. Gamma correction factors are set manually, which could not give a suitable enhancement for different types of images.

Tsai et al. classified the input image into six parts and therefore processing each part with the adequate enhancement technique. In fact, this classification is accomplished considering manual defined thresholds which could not always fit an adequate contrast improvement of different types of images. To mitigate this problem, Rahman et al. proposed an adaptive gamma correction (AGC) method suitable for the enhancement of a huge type of images.Gamma correction factor is calculated dynamically for each image according to its statistical information. However, this method based contrast enhancement cannot conserve the boundary or edge details of original image.

In this paper, a new approach is proposed for low contrast CT scans enhancement based on adaptive gamma correction and using DWT-SVD (DWT-SVD-AGC) technique. The main advantage of such a dynamic method is that it could be applied to large types of images for contrast enhancement with simultaneously preserving the edge information of the original image. In fact, the SVD technique is applied in a first step for contrast enhancement of LL sub-band image obtained using DWT. In a second step, for a further contrast improvement, the obtained LL sub-band image is processed using a modified transfer function based on adaptive gamma correction transformation. Parameters of gamma transformation are dynamically and automatically calculated depending on the statistical information of the processed LL sub-band image. then DWT-SVD technique can be applied.This paper includes the performance metrics like Mean square error (MSE),Peak signal to noise ratio(PSNR) and Absolute mean brightness error (AMBE) are calculated. The rest of this paper is organized as follows. In section III the proposed algorithm is described with the flowchart. The experimental results are given in section 4, in this several metrics is found and the conclusion is drawn in section V.

III. Proposed Work

The general method of the proposed algorithm for medical image enhancement is concerted in different parts described as follows. The dark input medical image '*Ii* 'is firstly processed by GHE algorithm in order to compute '*Ii*^ '. Both images are decomposed by DWT into *LL, LH, HL*, and *HH* for '*Ii*', and , *Ii*' , and for'*Ii* ∧ enlightenment information is surrounded in *LL* sub-band but the edges are concerted in other sub-bands (i.e., *LH, HL*, and *HH*). Hence, separating the high-frequency sub-bands and applying a contrast enhancement on only *LL* sub-band will protect the edge information from possible degradation. In a first enhancement step, SVD method is applied over both low frequency components *LL* and LL^ to generate respectively *UL, ΣL, VL*, and *UL∧, ΣL∧, VL∧*. The maximum element in *UL* and *VL*, from *LL* and the maximum element in *UL*^ and *VL*^ from *LL*^ are respectively calculated to determine the correction factor ξ. The correction factor ξ, the enhanced

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singular value matrix *ΣL^*, and the enhanced *LL* sub-band SVD are respectively calculated.

$$§ = \frac{\max(\hat{U}_L)+\max(\hat{V}_L)}{\max(UL)+\max(VL)} \quad ......(1)$$

$$\bar{\Sigma}_L = § \times \hat{\Sigma}_L \quad ......(2)$$

$$\hat{LL}_{SVD} = \hat{U}_L \ \bar{\Sigma}_L \ \hat{V}_L^{T} \quad ....(3)$$

After that, the enhanced *LL* sub-band using SVD approach, SVD, is classified according to equation (8) into either low-contrast class *C1* or moderate contrast class *C2* depending on the available contrast of this sub-band image (μ and σ represent respectively the mean and the standard deviation of the enhanced sub-band image in this case). An adaptive gamma factor correction is calculated dynamically according to the obtained class is considered for *LL* sub-band images with low contrast for *LL* sub-band images with moderate SVD LL contrast. In a second enhancement step, an adaptive intensity transformation using gamma correction is applied on *SVD* sub-band to generate the final enhanced , sub-band image.

$$\bar{I}_i = IDWT(\bar{LL}_\gamma \text{ ,LH,HL,HH}) ....(4)$$

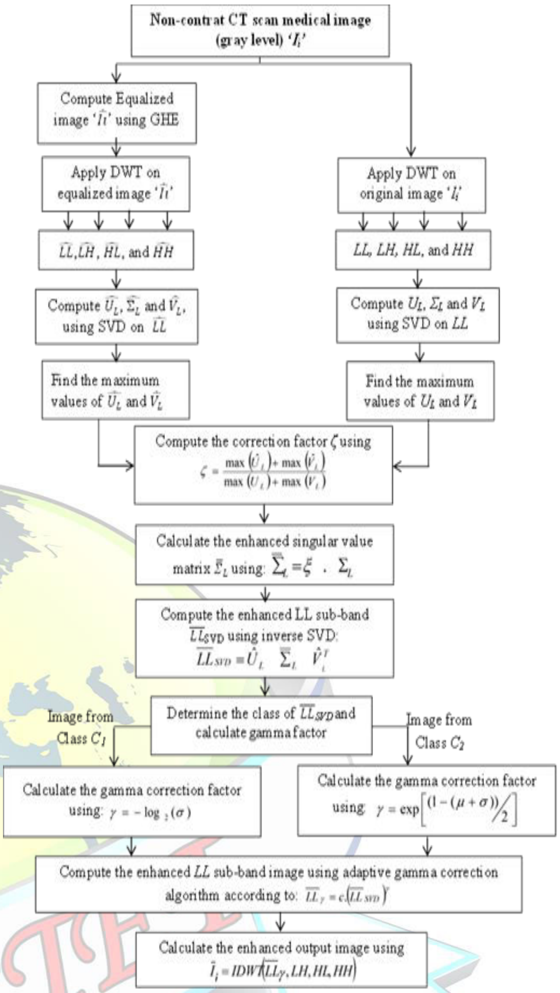

Fig1: FLOW CHART

NON CONTRAST CT IMAGES

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Fig2: Original image

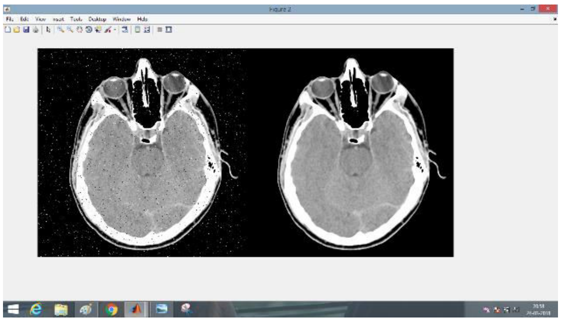

Fig3: Median filter image

Fig4: Histogram image

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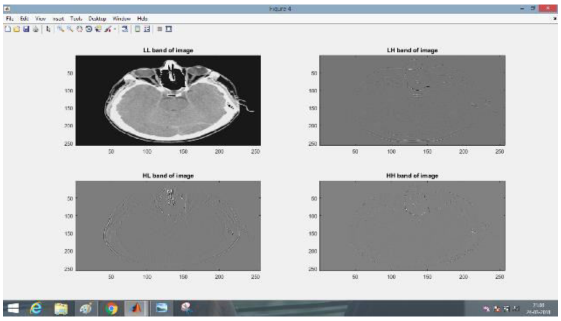

Fig5: Sub-band image

Fig6: DWT-SVD image

Fig7:Enhanced image

IV EXPERIMENTAL RESULTS

The proposed method is tested on many gray level images. The result thus obtained is compared with two other methods, namely histogram equalization(HE) and (CLAHE).The parameters like peak signal to noise ratio (PSNR), mean square error (MSE) and (AMBE) are calculated for all the three methods and the results are tabulated.

Table 1: Performance metrics for various images

Non contrast CT images	MSE	PSNR	AMBE
IMAGE 1	21.8551	34.7353	4.2393
IMAGE 2	34.3441	32.7723	4.2393
IMAGE 3	32.0203	33.0766	4.2393
IMAGE 4	42.0081	31.8975	4.2393
IMAGE 5	33.6874	32.8563	4.2393

V. CONCLUSION

This paper proposed a new contrast enhancement technique based on adaptive gamma correction using DWT-SVD method. This algorithm is dedicated for contrast enhancement of CT images. DWT algorithm is considered to decompose the dark original image into different sub-band images. In order to obtain an improved image characterized by higher contrast with edges preservation, only LL sub-band images are processed using SVD method and adaptive intensity transformation using gamma adjustment function.the performance metrics like Mean Square Error (MSE),Peak Signal to Noise Ratio (PSNR)

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and Absolute Mean Brightness Error (AMBE) are calculated.

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