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Research paper

Enhanced Medical Image Watermarking Scheme with CLA-HE& DWT, SVD Transforms

Srinivasarao Gajula[1*], Rajesh.V[2]

[1]Research scholler, [2]Professor, [1,2]Department of ECE
K L University, Green Fields, Vaddeswaram, Guntur Dt., Andhra Pradesh. India.
**Corresponding Author Email: [1]gsrinivasarao443@gmail.com , [2]rajesh4444@kluniversity.in*

Abstract

In order to get clear information regarding patient it is necessary to enhance medical images like MRI, CT scan, ultrasound etc. For clinical diagnosis, we have to transmit it through the communication network. During this process information must be protected from malicious users. In this process these images are manipulated, so to protect these images we have to follow some security requirements. In this paper, we are increasing the quality of the image by using enhancement with clahe technique and that enhanced image is watermarked for security purpose by using DWT, SVD transforms with a scaling factor as uniform distribution function. The performance evaluation parameters will give better results for medical as well as under water images. The obtained results are very helpful for integrity of medical images. The technique will provide better response for medical images. This method will give good results in terms of improvement in output, Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE).

Index Terms: *Discrete Wavelet Transform (DWT), Singular Value Decomposition (SVD), Peak Signal to Noise Ratio (PSNR), Mean Square Error (MSE).*

1. Introduction

The recent technology is rapidly increasing with computer networks. Generally, there is lot of importance of medical images to store patient information in the form of MRI, CT scan etc. Medical images are used to observe tissues, body parts or organs of a person and these are helpful for diagnosis and treatment of the patient. Data security for storing and transmitting between different hospitals is an important task. Now the trend is going with the evolution of information and communication technology (ICT) in the fields of tele medical applications. The information can be transferred through communication network is becoming low cost without losing their quality. These images must be protected from malicious users [2]. Digital image watermarking is the process of hiding the original image in to watermark image and this it will be access by authorized persons only [3].The biomedical image can be placed in to cover image without changing the originality of image [4]. Like this we can embedded different types of images like codes, text files or numbers etc [5]. The Watermarking is best technique for security purpose [3]. The water marking methods can be categorized in different manners like transform and spatial domains. The spatial domain provides less complexity and good embedding process but week in terms of robustness. The important technique is LSB [7] and local binary pattern LBP [8]. The transform domain provides more robust images. The common techniques are DWT [9], DFT [10], and SVD [6]. It is a factorization of real or complex matrix. The factorization form is USV^I of real or complex value of A (mxn).The diagonal entries of ‘S’ are known as singular values of ‘A’= USV^I.
Contrast limited adaptive histogram equalization (CLAHE) has produced good results on medical images. Adaptive Histogram Equalization (AHE) gives the histogram of a local window at a given pixel [14].In this technique the image is divided in to several non overlapping regions with equal sizes. In the next step the histogram of each region is calculated. Depending on the limit histogram is obtained, and then it is redistributed.
In this paper, we are using CLAHE technique for image enhancement and DWT, SVD techniques for watermarking and uniform distribution function as a scaling factor. In Section I contains the introduction of Watermarking, Section II contain the related work of image watermarking and SVD, Section III contain the proposed work, Section IV contain the results and discussion, Section V contain the conclusion of research work with future directions.

2. Proposed Work

Here the original image in enhanced by using CLAHE method. Then we are applying one level DWT for both cover and original image. The proposed method is combination of techniques like DWT, and SVD. The main theme of DWT is compositing the watermark image into four bands called LL, LH, HL, and HH. LL sub band represent high scale low frequency coefficient set.

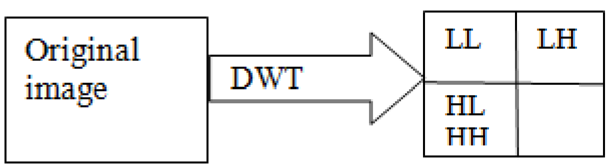

Fig. 1: DWT decomposition

Watermark Embedding

The steps to embed watermark are as below:
1) split the cover image into equal parts by using DWT

dwt(c) = {LL, LH, HL, HH} … ………………….. (1)

2) Apply Singular Value Decomposition technique to LL sub band of cover image

[U S V] =svd(LL) ………..………… ……...… (2)

3) Apply CLAHE technique to original image to improve the quality of the image and treat it as watermark image.
4) Apply DWT to watermark image.
5) Modify the Singular Values 'S' by embedding watermark 'W' with a scaling factor 'α'

$$Snew = S + \alpha W \quad …….……………… …… (3)$$

6) The scaling factor α is taken as uniform distribution function

$$\alpha = f(c/a,b) = \frac{1}{b-a} I_{(a,b)}(c) \quad ..… ….… (4)$$

7) SVD technique is applied on singular value of Snew sub band of the watermark image.

[U1 S1 V1] =svd(Snew) ………………..…. … (5)

8) Then inverse SVD is applied on transformed host image.

LLnew = U*S1*V^T………………………..… …. (6)

9) Modified coefficients of high frequency LL sub band are used to apply inverse DWT results in obtaining watermarked image.

wd =IDWT {LLnew, LH, HL, HH} ......……. … (7)

Watermark Extraction

1) Apply DWT to watermarked image.

Dwt(wd) = {LLwd, LHwd,HLwd,HHwd}….. … (8)

2) Apply SVD to LLwd of watermarked image.

[Uwd Swd Vwd] = svd(LLwd)…………..… …. (9)

3) Apply Inverse SVD with singular value Swd, U1, V1

A=U1*Swd*V1^T ………………………..… .… (10)

4) Extract water mark image as W= (A-S)/α …(11)

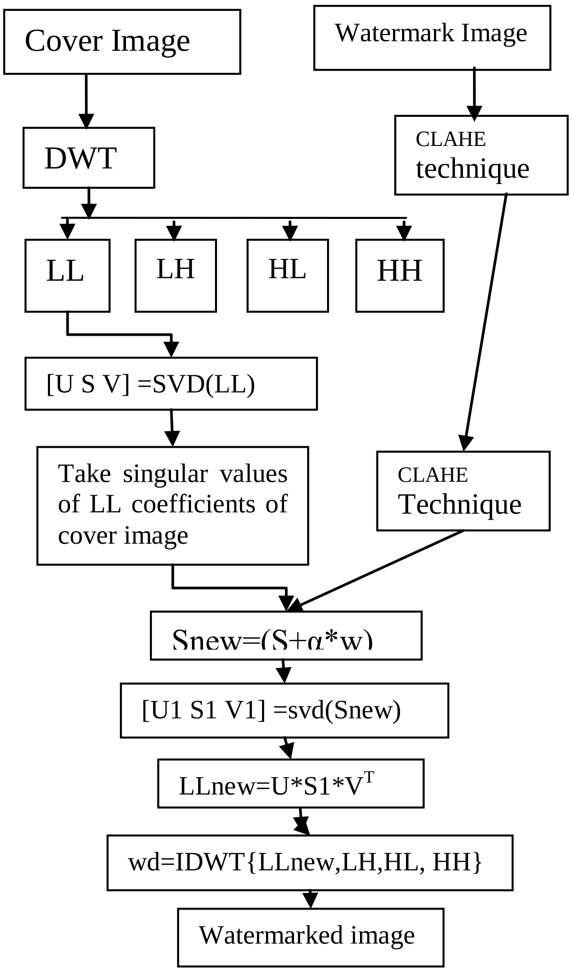

Fig. 2: Watermark embedding block diagram

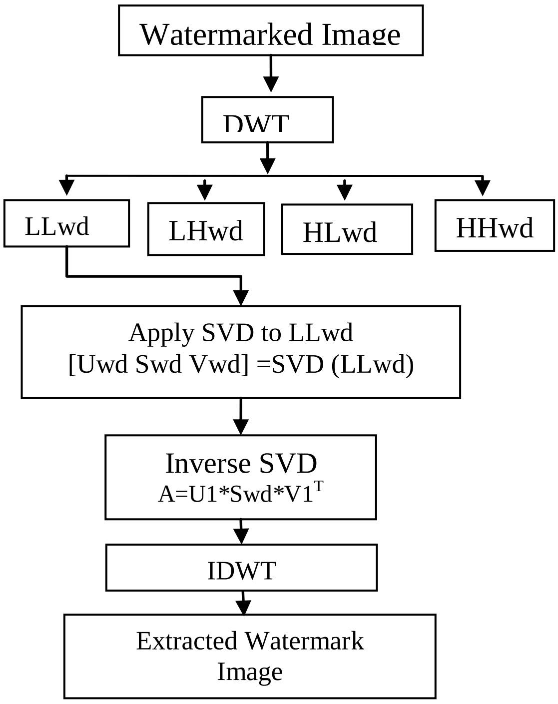

Fig. 3: Watermark extraction block diagram

3. Results and Discussion

Mainly there are two types of quality metrics used to determine the performance of techniques those are Mean Square Error (MSE) and the Peak Signal to Noise Ratio (PSNR). The existence of MSE and PSNR is as follows.

Mean Square Error

$$MSE = \frac{1}{m \times n} \sum_{i=1}^{m} \sum_{j=1}^{n} [x(i,j) - y(i,j)]^2 \quad \ldots\ldots\ldots \quad \ldots\ldots\ (12)$$

Peak Signal to Noise Ratio

$$PSNR(dB) = 10 * \log_{10}\left[\frac{(255)^2}{MSE}\right] \quad \ldots\ldots \quad \ldots\ldots\ (13)$$

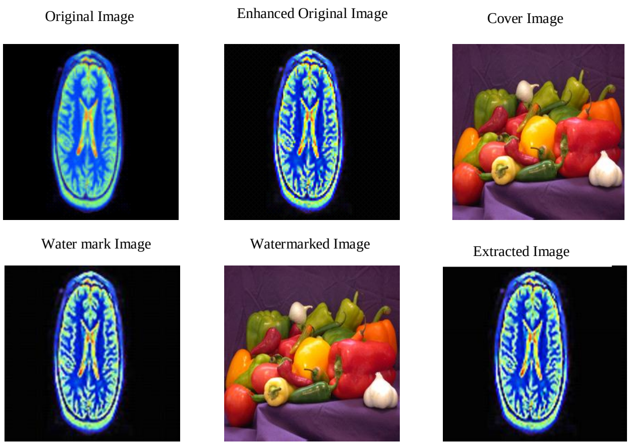

Fig. 4: Output results for img2

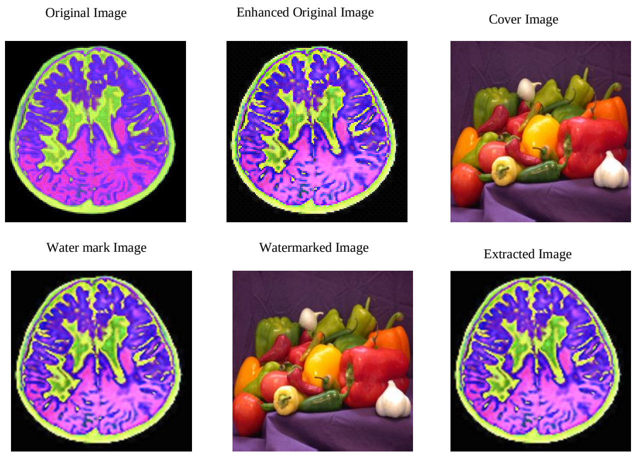

Fig. 5: Output results for img4

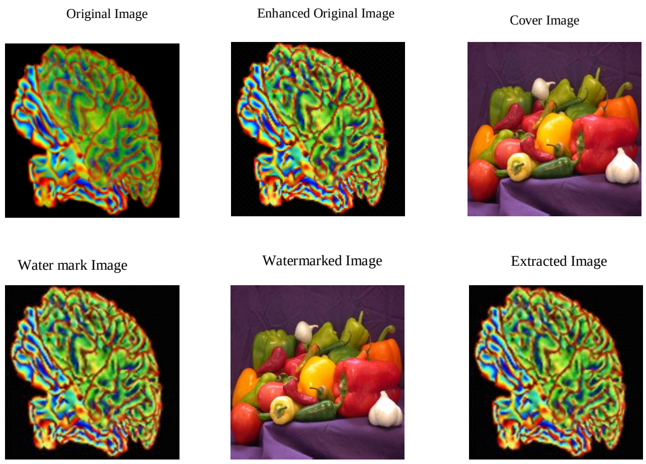

Fig. 6: Output results for img5

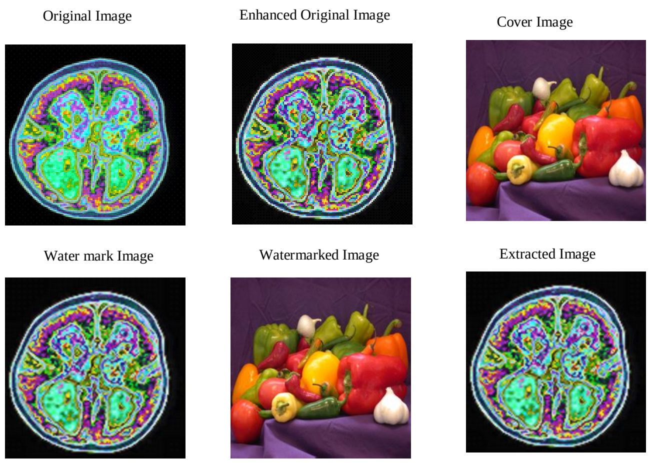

Fig. 7: Output results for img6

Table 1: The Image watermarking performance evaluation parameters PSNR & MSE, ME, STD,NCC

Figures	Parameters	PSNR (db's)	MSE	ME	STD	NCC
Img2	Existed method	40.240	6.152	116.81	60.955	**1.000**
	Proposed method	81.**244**	**0.000**	**81.606**	**60.712**	**1.000**
Img4	Existed method	40.173	6.248	117.02	60.950	**1.000**
	Proposed method	**74.707**	**0.002**	**81.607**	**60.714**	**1.000**
Img5	Existed method	39.754	6.880	116.90	60.849	1.000
	Proposed method	**77.636**	**0.001**	**81.607**	**60.714**	1.000
Img6	Existed method	39.768	6.858	116.55	61.076	**1.000**
	Proposed method	**77.78**	**0.0011**	**81.607**	**60.713**	**1.000**

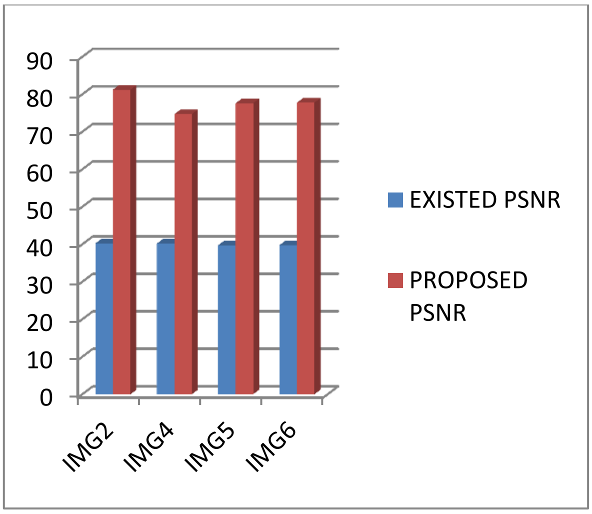

Fig. 8: Comparison between existed and proposed PSNR

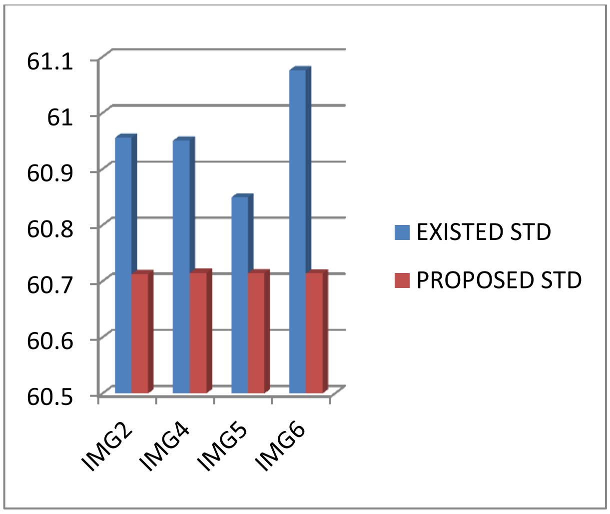

Fig. 11: Comparison between existed and proposed STD

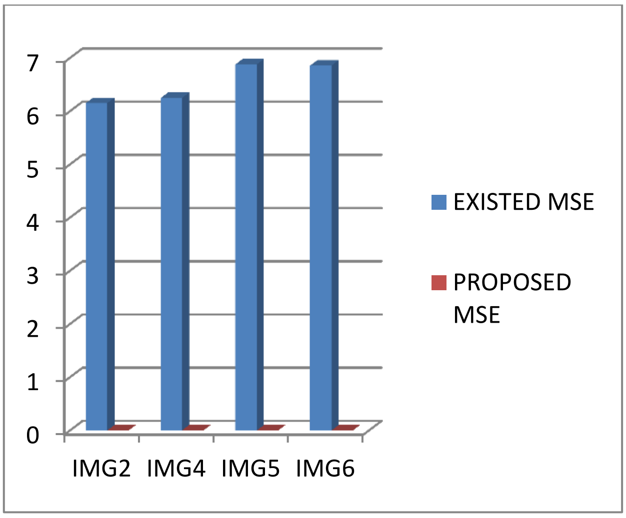

Fig. 9: Comparison between existed and proposed MSE

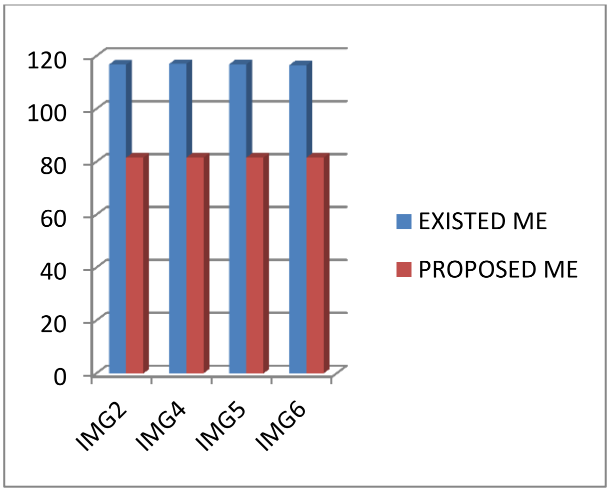

Fig. 10: Comparison between existed and proposed ME

4. Conclusion

In this paper we are discussing about Enhanced image watermarking scheme with DWT & SVD techniques by using uniform distribution function as a scaling factor. Here the original image is enhanced by using CLAHE method and watermarking is applied to that enhanced image. The results will gives better response for enhancement and as well as security purpose. This method is also used for underwater images to observe clearly the existence of the underwater images. Future work will focus on extending the proposed algorithm using advanced transformation techniques.

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