A Hybrid DCT, DWT and SVD Watermarking Scheme and Performance Analysis based on Different Kinds of Attacks in Medical Field

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Abstract— Now a days the use of digital data is increasing day by day. So it becomes very essential to protect multimedia information from piracy and also it is challenging. When it belongs to medical field, sensitive patient's data is to be exchanged through internet between different hospitals for diagnosis purpose. So privacy & protection of medical information of patient is very essential as it belongs to life of a human being. Hence authentication, copyright protection is obtained using digital watermarking technique. In this paper, a hybrid DCT, DWT & SVD watermarking scheme is proposed. The robustness & imperceptibility of watermarked image is analyzed by applying various kinds of attacks.

Key words: Image Watermarking, Discrete Wavelet Transform, Discrete Cosine Transform, Singular Value Decomposition, Robustness, Imperceptibility

I. INTRODUCTION

Commercialization of the multimedia content increases day by day due to the use of Internet at a rapid rate, so. To protect the contents of the owner, the technique named digital watermarking emerged. It hides secret information/image in such a way that it is imperceptible to human eye and also robust against common signal processing operations and attacks. At the same time it can positively identify the owner by comparing with the original content/key, if required. The watermarking system consists of two functions, viz. embedding function, and extracting/detecting function. The embedding function embeds the secret message called watermark into the original image and then the watermarked image is passed onto the internet where it may be passed through general processing functions or attacked by an attacker either to remove or destroy the watermark. The extracting/ detecting function is used to extract the watermark for verification. The general watermarking system is shown in Fig 1.

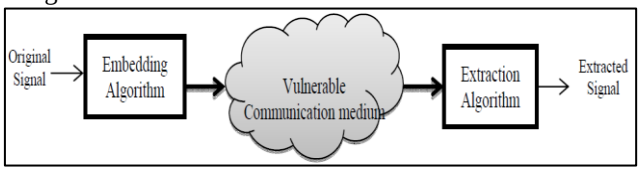


Fig. 1: General Watermarking System

The different watermarking algorithms have to fulfill different requirements as per the required applications. The three basic requirements as defined by Cox et al. [1] are:

A. *Transparency*

It means after insertion of watermark the original image should not be distorted i.e. the watermarked image and the original image should be perceptually same to human eye.

B. *Robustness*

Robustness is related to attacks. If watermark removal is difficult to various attacks like rotation, scaling, compression, noise then watermarking scheme is robust.

The rest of the paper is organized as follows. Section II provides brief details about hybrid DWT, DCT and SVD watermarking scheme. Performance analysis is done in section III. Experimental study and results are given in Section IV. Section V gives the conclusion & VI gives references.

II. METHODOLOGY

The proposed algorithm combines merits of three different techniques DCT, DWT and SVD. First one level DWT is applied to original cover image. To achieve imperceptibility HH band is selected & DCT is applied to HH band to get DCT resultant matrix. SVD is applied to this matrix and singular values are modified with singular values of watermark. Inverse SVD, inverse DCT and inverse DWT is performed to get watermarked image.

The procedure for embedding and extracting the watermark is given below.

A. *Watermark Embedding Process*

1) Let OI be the Original image of size N x N. Apply DWT to decompose it into four N/2 x N/2 sub-bands LL, HL, LH and HH.
2) Select HH band and apply DCT to it to get DCT coefficient matrix B.
3) Apply SVD to B, B=U*S*V, and obtain U, S and V matrices.
4) Let OW of size M x M to represent watermark. Apply DWT, DCT & SVD to it, OW=W_U*W_S*W_V' and obtain W_U, W_S and W_V.
5) Modify S1 with watermark such that S2=S + α* W_S.
6) Obtain B* using B*= U*S2*V^{-1}.
7) Apply inverse DCT to B* to produce HH*.
8) Apply inverse DWT to LL, HL, LH and HH* to get watermarked image WI.

B. *Watermark Extraction Process*

1) Apply DWT to WI to get LL, HL, LH and HH.
2) Apply DCT to HH band to get DCT matrix A.
3) Apply SVD to A, A= UW*SW*VW and obtain UW, SW & VW.
4) Obtain SW1=(S-SW) /α.
5) Obtain EW= W_U*SW1*W_V^{-1}
6) Apply inverse DCT & inverse DWT to get extracted or recovered watermark.

III. PERFORMANCE ANALYSIS

To check the quality of the watermarked image w.r.t the original image, PSNR (Peak Signal to Noise Ratio) is used. It can be calculated as:

$$PSNR = 10 \times log_{10} \frac{255^2 \times M \times N}{\sum_{i=1}^{M}\sum_{j=1}^{N}(G(i,j) - G'(i,j))^2)}$$

Where G is the original host image, and G′ is the watermarked image. M and N the width and height of the

original image. The higher the PSNR value means higher is the imperceptibility or transparency between original & watermarked image.

To find out the similarity between the original and extracted watermark, normalized correlation coefficient (NCC) is calculated. Its formula is:

$$NC = \left(\sum_{i=0}^{M-1}\sum_{j=0}^{N-1} OW * EW\right) / \left(\sum_{i=0}^{M-1}\sum_{j=0}^{N-1} OW * OW\right)$$

Where OW is original watermark and EW is extracted watermark. NCC is a value between 0 and 1. The larger the NCC value, the higher the watermark robustness.

IV. EXPERIMENTAL STUDY AND RESULTS

For experimental study, we have used ultrasonic medical images as host image in which watermark is embedded & patient's record is used as watermark image which is embedded into host image.

Fig. 2: Sample Medical Images used as Host Image

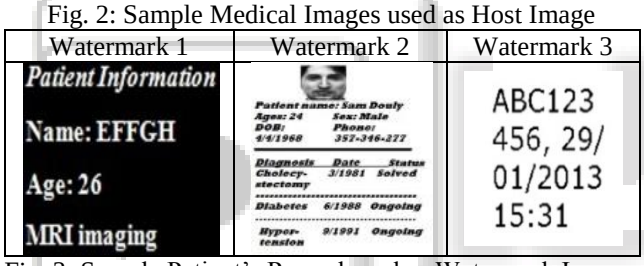


Fig. 3: Sample Patient's Record used as Watermark Images

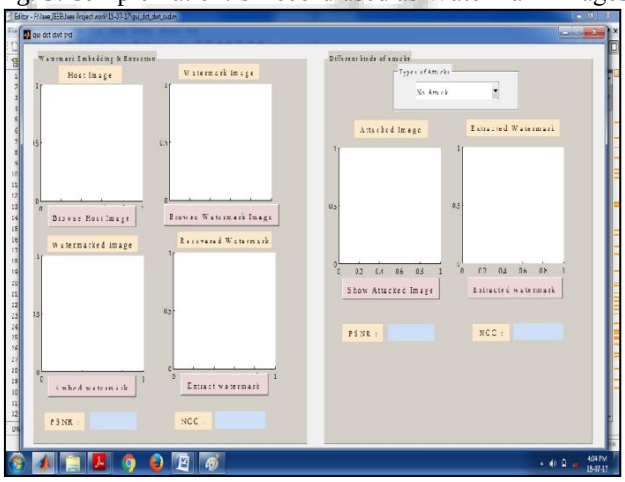


Fig. 4: GUI for Embedding & Extraction of Watermark

	DCT	DWT	SVD	DCT-DWT-SVD
For W1 watermark		Patient Information Name: EFFGH Age: 26 MRI imaging		
Sample 1	42.5111	50.6216	85.2107	32.4485
Sample 2	41.4253	49.3149	85.3499	32.4105
Sample 3	42.8391	51.0956	85.5777	32.9437
Sample 4	41.4085	49.9981	85.4431	32.5710
Sample 5	42.5786	50.7922	84.9854	32.6790

Table 1: Comparison of PSNR Values

For W2 watermark				
Sample 1	42.5076	43.5796	58.3290	23.5028
Sample 2	41.4251	43.2617	57.8562	23.6143
Sample 3	42.8420	43.7401	59.0953	24.6364
Sample 4	41.4090	43.4541	59.8161	23.6156
Sample 5	42.5761	43.6133	59.7478	24.2977
For W3 watermark				
Sample 1	42.5072	43.1546	58.0302	32.0141
Sample 2	41.4252	42.9122	57.4720	31.9799
Sample 3	42.8420	43.2509	58.8008	32.5224
Sample 4	41.4090	43.0558	59.6341	32.1127
Sample 5	42.5767	43.1519	59.4573	32.2647

Table 2: Comparison of NCC Values

Watermark Image	DCT	DWT	SVD	DCT-DWT-SVD
W1	0.7775	0.8549	0.9275	0.9999
W2	0.4987	0.7266	0.4405	0.9994
W3	0.4919	0.7060	0.3385	0.9998

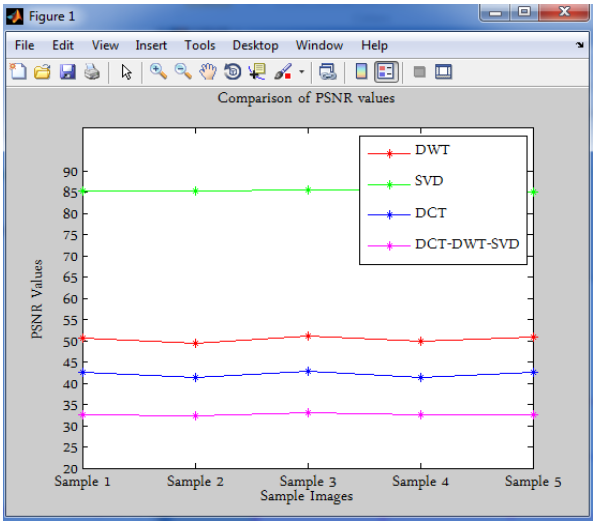


Fig. 5: Graph of Sample Images against PSNR Values

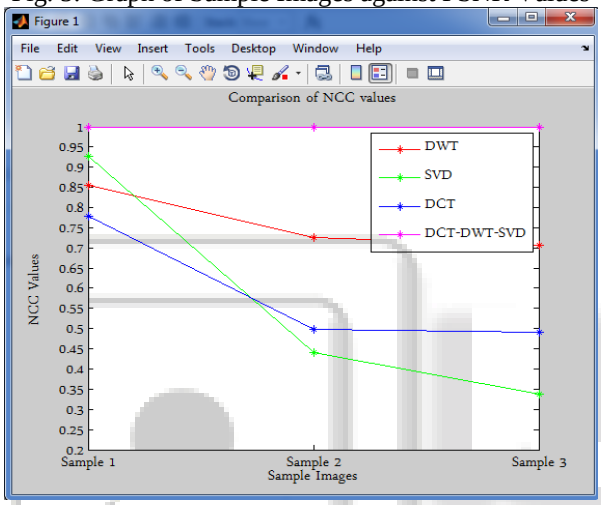


Fig. 6: Graph of Sample Images against NCC Values

Different kinds of attacks are performed on the watermarked images; watermarks are then extracted from them. Some attacks are shown in Table III below.

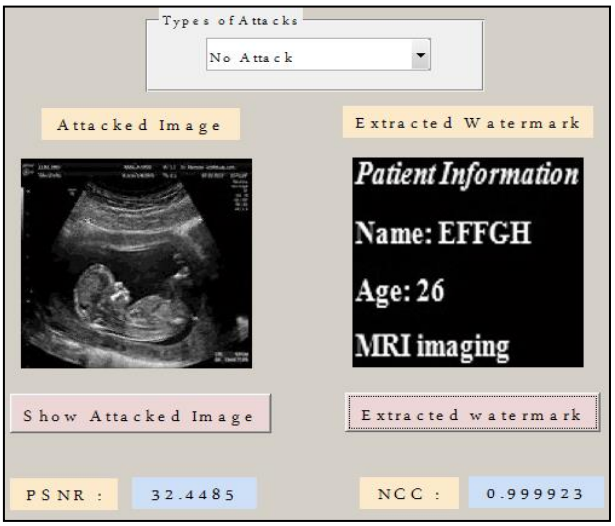


Fig. 7: No Attack

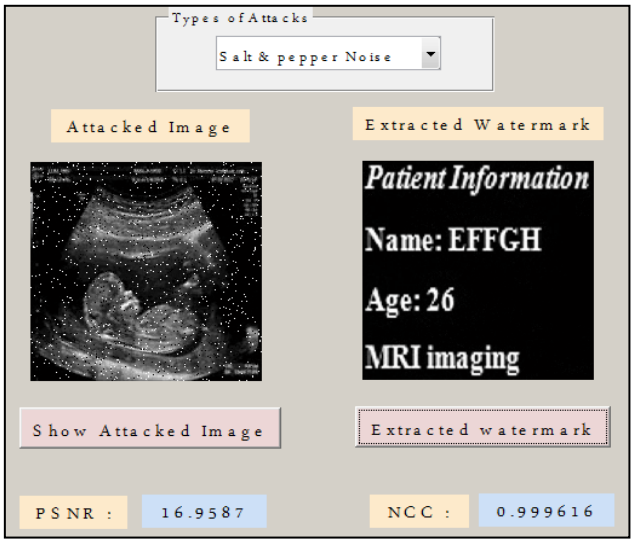


Fig. 8: Salt & Pepper Noise Attack

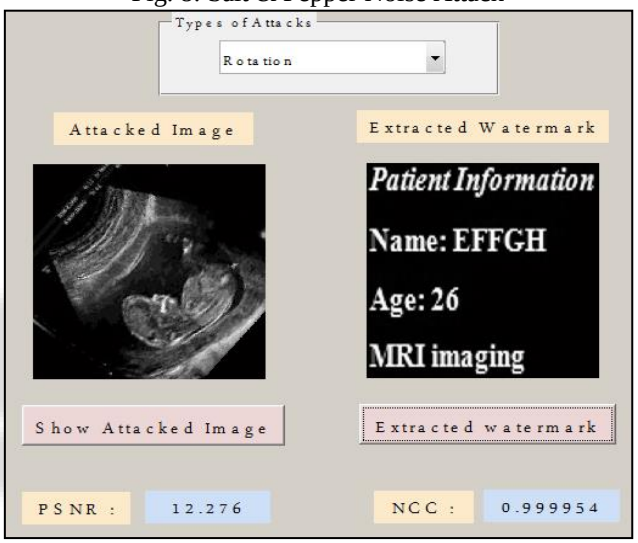


Fig. 9: Rotation attack

Attacked Watermarked Image	Extracted Watermark
 No Attack (PSNR=32.4485)	 NCC=0.999923
 Mean (PSNR=33.9523)	 NCC=0.999961

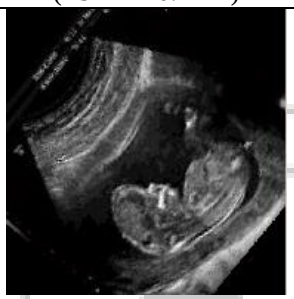
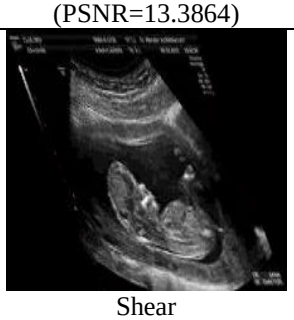
 Salt & Pepper noise (PSNR=17.0238)	 NCC=0.999621
 Gaussian noise (PSNR=10.2121)	 NCC=0.999849
 Rotation (PSNR=12.2760)	 NCC=0.999954
 Crop (PSNR=13.3864)	 NCC=0.999961
 Shear (PSNR=14.3344)	 NCC=0.999961
 Blurring (PSNR=26.8524)	 NCC=0.99996

Table 3: Attacked Watermarked Images & Extracted Watermark Using Hybrid DCT-DWT-SVD Method

V. CONCLUSION

We have studied hybrid watermarking technique using DCT, DWT & SVD on the basis of their perceptuality and robustness against attacks. These techniques can be used for copyright protection, authentication applications etc. From experimental results it shows that NCC values for hybrid method are nearly equal to 1 which indicates robustness against various attacks.

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