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Performance Evaluation of a Hybrid SVD_DWT Watermarking Algorithm Using Arnold Transform

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Abstract— In todays fast pace world of internet, everyday there is some development in the information sharing tools and application. The information sharing tools helps coping and storing data, editing and generating multiple copies etc. The ease of these software tools has given us lots to facilities but on the other hand made the information over the network highly insecure. Huge amount of data, files and document are being transferred over the internet, which requires some mechanism to prevent the data from tampering and illegal manipulations. Identification of the actual owner of the data is also very essential. Digital data can be protected against illegal tampering and the actual owner of the data can be identified by embedding digital signature or watermark in the digital data. In this paper we have proposed an effective semi blind watermarking algorithm using hybrid DWT-SVD methods. Arnold transform is also used to increase the robustness of the algorithm. PSNR and NC are calculated to show the effectiveness of the proposed method

Keywords—Watermarking, DWT, SVD, PSNR, NC, Arnold transform

I. INTRODUCTION

Watermarking is a method to embedding visible or invisible digital signature or watermark in digital data to prevent it from illegal tampering and copyright protection. There are few requirements to develop a good watermarking technique such as robustness, security, capacity, imperceptibility etc, and for the past 2 decades research is going on to develop method that fulfill almost all the requirement. In this paper a robust watermarking method is proposed, where combination of discrete wavelet transform, singular value decomposition and Arnold transform are used. The rest of the paper is organized into the following sections: section II contains the proposed work section III the flow chat diagram section IV experiment and results section V conclusion and future scope .

II. PROPOSED WORK

In the proposed work we have used the combination of discrete wavelet transform and singular value decomposition. The discrete wavelet transform gives the multi resolution analysis and also different orientation like horizontal, vertical and diagonal, of digital image.[9,10] There are many type of wavelet transform like **Haar** and **Daubechies.** SVD helps in decomposing and reducing the large dimensional image matrix into lower dimensional space.SVD decomposes the image I into three sub matrix USV^T [3,5]

Arnold transform also known as cat face transform is suitable for image of size N*N where

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 1 & 1 \\ 1 & 2 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} \bmod N$$

where x, y are the coordinates of the original image, x' and y' are the coordinates of the transformed image and N is the size of the image. Arnold transform changes the position of the pixel and if done several times scramble image is obtained. Transformed image is obtained after number of iteration, this iteration number is used as encryption key and also as secrt key during extraction [4,8].

This section contains the algorithm or the steps followed in the proposed work.

A. Embedding Process

1. Take the cover image of size (N*N) and apply discrete wavelet transform (DWT) on it.DWT will divide the image into LL,HL,LH,HH band

LL	HL
HL	HH

Fig.1 DWT Level -1 decomposition

2. Take the LL band (I^L) of size (N/2*N/2) and apply SVD on each sub matrix of size 2*2.

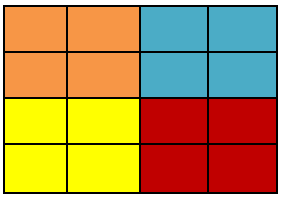

Fig.2 2*2 sub matrix of transformed LL band

3. Take the watermark W of size (M*M) and apply DWT to get LL, HL, LH, HH band.
4. Take the LL band and apply Arnold transform to get the transformed LL band W^L of size (M/2*M/2)[4,8].
5. Embed each pixel of the scrambled watermark W^L into S value obtained after applying SVD on 2*2 sub matrix of I^L to get new S' such that:

$$S': S=\alpha W^L$$

6. Reassemble the USV values of each 2*2 sub matrix and apply inverse DWT on the LL band to get the watermarked image.

B. Extraction Process

1. Take the watermarked image, apply 1-level DWT.
2. Take the LL band of the watermarked image (I^L) and apply SVD on 2*2 sub matrix of I^L image.
3. As we know that the scrambled LL value of the watermark or W^L is in the S value of the I^L.

$$S': S= \alpha W^L$$
$$W^L=S'/ \alpha$$

4. Apply Arnold transform reverse the scrambled image W^L [6,7]
5. Compare the W^L value obtained after extraction with the original value, and apply inverse DWT to get the watermark.

III. FLOW CHART DIAGRAM

A. Embedding Process

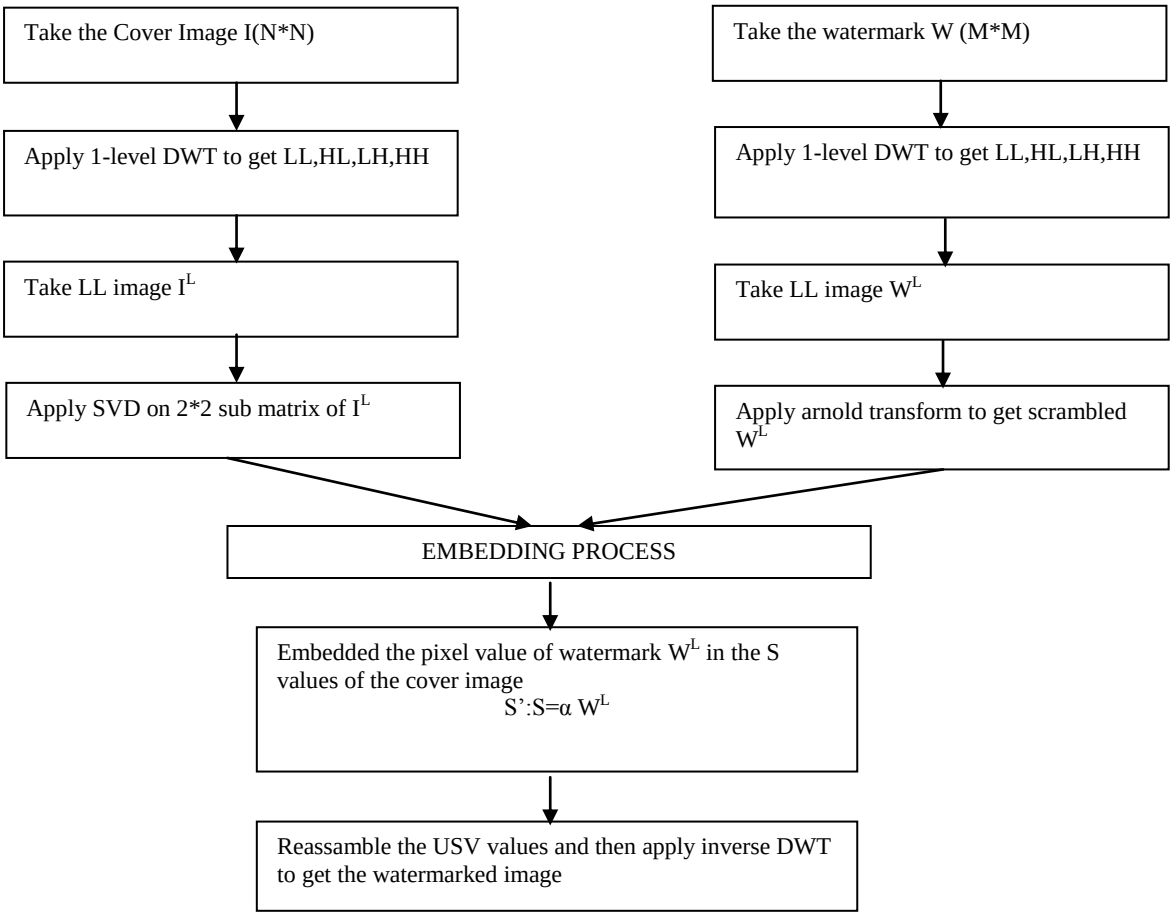

Fig.3 Flow diagram of watermark embedding process

B. Extraction Process

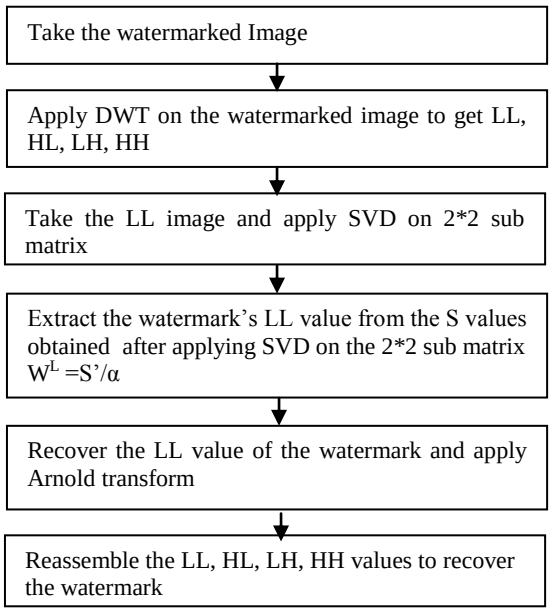

Fig.4 Flow diagram of watermark embedding process

IV. EXPERIMENT AND RESULT

The proposed work is tested on the grey scale images. The size of cover image is 128*128 and the size of watermark is 64*64[1]

A. Performance Evaluation

The performance of the proposed work is measured on the basis of PSNR and NC[10].

1. Peak Signal to noise ratio

   It is the measure of the visual quality of the watermark image in comparison to the original image or the degradation of the watermark image with respect to the image before watermarking.

   $$PSNR=10\log10(((\text{peak signal strength})^2\text{-}1)/MSE)$$

   Where peak signal strength is max pixel value or the peak value of the image which is 255 for grey scale images, and MSE is the mean square ratio that is equal to the average squared difference between two images[11,12].

2. Normalization Coefficient(NC)

   NC determines the similarity between two images. It value varies in between 0 and 1[13].

B. Results

The algorithm is tested on various grey scale images. Results mentioned below uses cameraman as cover image and airplane as watermark. The algorithm is also tested for real time situation or attacks that can destroy important information in the image[2].

(a)

(b)

(c)

Recovered Watermark

(d)

Fig.5 (a) Cover image(cameramen.tif) (b)Watermark(airplane.tiff) (c)Watermarked Image (d)Recovered Watermark

TABLE I PSNR AND NC OF THE RECOVERED WATERMARK W.R.T THE ORIGINAL WATERMARK FOR DIFFERENT ATTACKS

Attack	**Results**		
	Recoverd Watermark	**PSNR**	**NC**
No Attack	Recovered Watermark 	48.1307	1.000
Gaussian	Recovered Watermark 	23.4248	0.9656
Salt and pepper	Recovered Watermark 	23.0857	0.9657
Poisson	Recovered Watermark 	23.6902	0.9648
Speckle	Recovered Watermark 	23.3377	0.96766
Image Rotation (15,'bilinear','crop')	Recovered Watermark 	23.2090	0.9680
Histogram Equalization	Recovered Watermark 	23.7680	0.9660
Image Adjust [0.4,1]	Recovered Watermark 	23.0413	0.9637
Median Filter [5,5]	Recovered Watermark 	23.8167	0.9673

JPEG Compression	Recovered Watermark 	23.6042	0.9714

V. CONCLUSION AND FUTURE SCOPE

After analyzing the result it is clear that the proposed work is robust and easy to implement. We have also used the scrambling technique called Arnold transform and the key to enhance the performance and security. The results obtained have proved satisfactory when compared with the standard set for a good watermarking algorithm (PSNR and NC). The algorithm is implemented on various grey scale images. The watermark is successfully embedded and recovered after extraction.

In the future this algorithm can be extended for various colored images

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