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Dual Image Watermarking Based on DWT-SVD

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ABSTRACT

Image watermarking has become an important tool for intellectual property protection and authentication. In this paper a watermarking technique is suggested that incorporates two watermarks in a host image for improved protection and robustness. The watermarks are embedded in to the LH & HL sub band of the host image. The technique has been tested using Lena image as a host and the copyright logo and watermark image are watermarks. The proposed scheme has been simulated and analyzed with various geometric and non geometric attacks. The PSNR and correlation coefficient values are compared with these attacks. The preliminary results show that the proposed scheme performs better with additional robustness.

Keywords: *Dual image watermark, DWT,SVD*

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1. INTRODUCTION

In recent years, the interest for watermarking technologies has widely been increased with the ease of access for digital media. Digital watermarking plays an important role in multimedia information security [1]. It is a process of embedding some secret data in the host media such as images, videos, audios, etc. So far various digital image watermarking techniques have been presented in literatures. These schemes can be categorized according to different aspects .These aspects are based on perceptibility, robustness against attack, watermark embedding domain and whether the host image is required or not in the extraction. Based on perceptibility, they can be divided into visible and invisible. Based on robustness, they can be divided robust, semi-fragile and fragile approaches. Based on the watermark embedding domain, they can be divided into spatial domain and transform domain

based techniques. The Spatial-domain technologies refer to those embedding watermarks by directly changing pixel values of host images. Compared to spatial-domain watermark, watermark in frequency domain is more robust and compatible to popular image compression standards. Possible frequency image transformations include the Discrete Fourier Transform (DFT), Discrete Cosine Transform (DCT) and Discrete Wavelet Transform. The concept of dual watermarking, wherein, two watermarks are embedded instead of one for increased protection and security has been proposed earlier in both spatial and transform domains [2][3][4][5] .In this paper, Discrete Wavelet Transform (DWT) domain is used and the watermark is embedded in the mid-frequency region, in order to achieve perceptual invisibility as well as robustness to attacks. Based on whether the host image is required or not in watermark extraction, the available methods can be divided into blind, semi-blind and non-blind techniques.

This paper is organized as follows: related works in the field of image watermarking is summarized in section 2. Section 3 presents the proposed work on robust DWT SVD based dual image watermarking in mid frequency band. Section 4 examines the simulation and analysis. Section - 5 shows the conclusion with future work.

2. LITERATURE REVIEW

The concept of dual watermarking, wherein, two watermarks are embedded instead of one for increased protection and security has been proposed earlier in both spatial and transform domains [6-11].In this paper the watermark logo is added to the watermark image then this watermark is embedded in the cover image [12].In this paper, Discrete Wavelet Transform (DWT) domain is used and the watermark is embedded in the mid-frequency region, in order to achieve perceptual invisibility as well as robustness to attacks [13].

The dual image watermarking most commonly used to embed two watermarks in the host image. Primary Watermark is embedding into Secondary watermark, then it is embedding into the host image. But this paper original Image is partitioned into LL,LH,HL,HH subbands. Watermark image is embedding into LH band and watermark Logo is embedding into HL subband [14]. The high frequency coefficient sets HH include the edges and textures of the image and the human eye is not generally sensitive to changes in such coefficient sets. This allows the watermark to be embedded without being perceived by the human eye. The agreement adopted by many DWT-based watermarking methods, is

to embed the watermark in the middle frequency coefficient sets HL and LH is better in perspective of imperceptibility and robustness[15].

3.DUAL IMAGE WATERMARKING BASED ON DWT SVD

The dual image watermarking scheme, the embedding watermarks in mid frequency only .It is used to increase imperceptibility and robustness. In this paper works by embedding watermark image and watermark logo into LH and HL sub bands in the host image.

The DWT is applied to the host image. The host image is decomposed into LL LL, LH,HL,HH sub bands. Then apply the Singular Value Decomposition (SVD) into LH and HL sub bands of the host image[16]. The SVD is applied to the watermark image and watermark logo. The SVD value of watermark image is added to the SVD value of LH sub band of the host Image [17]. The SVD value of watermark Logo is added to the SVD value of HL sub band of the host Image, then we get the watermark embedding. Finally apply IDWT to the watermark embedding watermarked image is obtained. Fig. 1. Shows the block diagram of the proposed watermark embedding. Fig. 2. shows the block diagram of watermark extracting[18].

Watermark extracting is the reverse process of watermark embedding. The DWT is applied to the embedded image. After the decomposition of the embedded image, SVD is applied to that. Finally the extracting watermark image and watermark logo is obtained [19].

In this proposed dual image watermarking only embedding two watermarks separately in LH and HL sub bands. Other dual image watermarking, one primary watermark is embedding into secondary watermark. Then this secondary watermark is embedded into the host image. In this proposed scheme provides better imperceptibility and robustness.

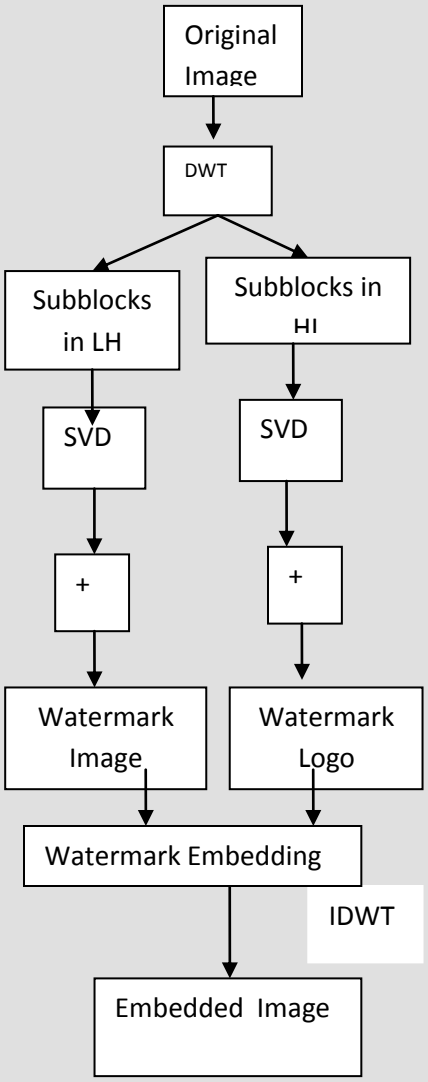

Fig 1 Block Diagram of Proposed watermark Embedding

A.WATERMARK EMBEDDING

Step 1:

Define the host image for embedding watermark and specify its size.

Step 2:

Using DWT, decompose the host image into 4 sub bands: LL, HL, LH, and HH.

Step 3:

Apply SVD to LH,HL sub band of the host Image: $I^H=U^H*S^H*V^H$

Step 4:

Apply SVD to LH,HL sub band of the watermark image W and watermark Logo: $W=U^{W}*S^{W}*V^{W.}$

Step 5:

Modify the singuar values of the LH and HL subbands of the host image with the singular values of the LH and HL subbands of the watermaaark:

$$S^{WM}=S^{H}+\alpha S^{W}$$

Step 6:

Obtain the modified DWT coefficients

$$I^{WM}=U^{H}*S^{WM}*V^{H}.$$

Apply the inverse DWT using modified DWT coefficients to produce the watermarked image.

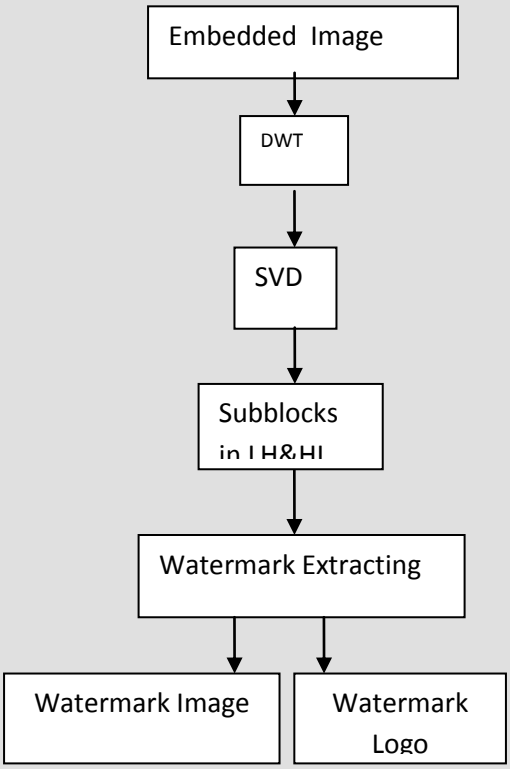

Fig 2 Block Diagram of Proposed watermark Extracting

B.WATERMARK EXTRACTING

Step 1:

Using DWT,decompose the watermarked image I^{wm} into four subbands:LL,HL,LH and HH.

Step 2:

Apply SVD to LH and HL subbands of the image: $I^{WM}=U^{WM}*S^{WM}*V^{WM}$

Step 3:

Apply SVD to LH and HL subbands of the watermark image W: $W=U^{W}*S^{WM}*V^{W}$.

Step 4:

Extracts the singular values of watermarking: $S^{W1}=(S^{WM}-S^{H})/\alpha$

Step 5:

Construct the watermarking $W^{1}=U^{W}*S^{W1}*V^{W.}$

4. Experimental Results and Analysis

In order to test our proposed algorithm, the simulation is made in MATLAB 7 environment. The host image used is 512x512 grayscale 'Lena' and the logo1 is a 256x256 grayscale image of 'copyright'. The logo2 is a 256x256 watermark image. The cover image which is watermarked with the signed-logo, is subjected to attacks like cropping, rotation, JPEG compression, scaling and noising. For each type of attack the results are computed for the maximum extent that can be tolerated [20]. The simulation is carried out to analyze the imperceptibility and the robustness of the watermark image. Digital watermarking techniques must satisfy the following properties.

A. Evaluation of the effectiveness

The proposed algorithm is simulated on standard test image lena with size 512×512. The logo1 is a 256x256 grayscale image of 'copyright'. The logo2 is a 256x256 watermark image. The simulation is carried out to analyze the imperceptibility and the robustness of the watermark image [21]. The metric used for evaluating the quality of extracted watermark and watermarked image is PSNR (Peak Signal to Noise Ratio).The performance analysis is carried out to perform by as follows:

- *Peak signal Noise Ratio*

  The peak signal-to-noise ratio (PSNR) is used to evaluate the quality between the attacked image and the original image. The PSNR formula is defined as follows:

$$PSNR = 10*\log_{10}\frac{255*255}{{}^{1}\!/_{H*W}\sum_{x=0}^{H-1}\sum_{y=0}^{w-1}[f(x,y)-g(x,y)]^{2}}\,db$$

- *Correlation coefficient*

The Correlation Coefficient is used to find the reliability of the extracted watermark through this formula:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{n\sum x^2 - (\sum x)^2)(\sum y^2 - (\sum y)^2}}$$

Where, r is the number of erroneously detected bits, and M×N is the extracted watermark image dimensions. Therefore, there is no obvious perceptual distortion between the watermarked image and the original one.

B. Robustness to attacks

To evaluate the robustness of the proposed method, several attacks have been applied to the watermarked image. In the experiments, both geometric and non geometric attacks were used[22].

- Cropping:

Cropping refers to the removal of any part of the image to improve framing. In MATLAB incrop function is used to crop the image.

- Gaussian noise

Gaussian noise is a process that adds a noise signal to an image in order to deliberately corrupt the image hence reducing its visual quality [10]. In MATLAB controlling the distribution width is achieved by adjusting the third input parameter (denoted here as r) of the imnoise function[23].

Table I.watermarked image under Gaussian noise attack

Variance (mean μ=0)	PSNR value of attacked watermarked Image	PSNR Value of Extracted Watermark Logo1	PSNR Value of Extracted Watermark Logo2
0.0001	88.3452	52.4535	40.8723
0.0002	80.6521	46.8710	27.9022
0.0004	75.9023	38.2178	17.7510
0.0006	72.4009	34.8214	14.6216
0.0008	71.8563	33.3422	12.3577
0.001	67.3654	30.3271	11.4480
0.003	56.8956	29.6234	8.7626
0.005	53.7562	28.8632	7.9534
0.01	48.2187	27.3346	7.3451

II. Watermarked image under salt and pepper noise attack

Noise Density D	PSNR value of attacked watermarked Image	PSNR Value of Extracted Watermark Logo1	PSNR Value of Extracted Watermark Logo2
0.01	59.6523	67.9432	53.1643
0.02	58.9745	46.8710	27.9022
0.0004	75.9023	38.2178	17.7510
0.0006	72.4009	34.8214	14.6216
0.0008	71.8563	33.3422	12.3577
0.001	67.3654	30.3271	11.4480
0.003	56.8956	29.6234	8.7626
0.005	53.7562	28.8632	7.9534
0.01	48.2187	27.3346	7.3451

Table III.Watermarked image under Speckle Noise attack

A. Variance (Mean=0)	*B. PSNR value of attacked watermarked Image*	*C. PSNR Value of Extracted Watermark Logo1*	*D. PSNR Value of Extracted Watermark Logo2*
0.0001	92.3412	62.2142	∞
0.0003	88.8211	56.3240	40.3123
0.0005	85.5823	47.3428	27.8370
0.001	81.6419	43.9674	22.54626
0.002	74.54234	37.9834	16.95835
0.004	68.78636	34.7632	13.6880
0.006	64.3286	32.9866	11.3452
0.008	63.9123	32.7828	10.7984
0.01	38.6357	30.6723	7.8551

- Salt and pepper noise: Salt and pepper noise is a form of noise typically seen on images. It represents itself as randomly occurring white and black pixels.

- Speckle noise: Speckle noise is a granular noise that inherent exists in and degrades the quality of the active radar and synthetic aperture radar images.

Table IV. Watermarked image under cropping attack

Cropped Area	Proposed Method (Correlation Factors)	Reference[10] (Correlation Factors)	Reference [9] in DWT Domain (Correlation Factors)
128*128	0.9908	0.9847	0.4172
120*120	0.9923	0.9852	0.4185
80*80	0.9937	0.9889	0.4270
64*64	0.9945	0.9905	0.4299
32*32	0.9964	0.9946	0.4355

Table V. Watermarked image under jpeg compression attack

Compression Ratio	Proposed Method (Correlation Factors)	Reference[10] (Correlation Factors)	Reference [9] in DWT Domain (Correlation Factors)
10%	0.8994	0.8015	0.4172
20%	0.9623	0.9586	0.4180
30%	0.9937	0.9798	0.4195
40%	0.9945	0.9909	0.4210
50%	0.9975	0.9953	0.4250
60%	0.9986	0.9979	0.4310
70%	0.9986	0.9979	0.4330
No Compression Ratio	1	1	0.4172

Table VI. Watermarked image under Rotation attack

Scaling Factor	Proposed Method (Correlation Factors)	Reference[10] (Correlation Factors)	Reference [9] in DWT Domain (Correlation Factors)
0.6	0.4894	0.3981	0.3930
0.8	0.5432	0.5665	0.4155
1.0	0.9987	0.9993	0.4172
1.2	0.8564	0.7218	0.4310
1.4	0.8794	0.7028	0.4410

Table VII. Watermarked image under Scaling attack

Angle (in degrees)	Proposed Method(Correlation Factor)	Reference[10] (Correlation Factors)	Reference[9]in DWT Domain (Correlation Factors)
350	0.8432	0.7478	0.4392
355	0.8627	0.7527	----
0	1	1	0.4172
5	0.8432	0.7496	0.4192
350	0.8332	0.7387	0.4242

From the results in Table 1-7, we observe that this watermarking scheme is robust to compression and other common image processing operations like cropping, rotation, scaling and noising. We also evaluate the quality by computing their corresponding Correlation Factor. The extracted cover image and watermark logos have good PSNR & the watermark is imperceptible in the watermarked image.

C. The performance of the new algorithm

To evaluate the performance of the new algorithms the PSNR and CC have been computed and compared with some famous benchmarks. From the results in Table 1-7, we observe that this watermarking scheme is robust to compression and other common image processing operations like cropping, rotation, scaling and noising. We also evaluate the quality by computing their corresponding Correlation Factor [24]. The extracted cover image and watermark logos have good PSNR & the watermark is imperceptible in the watermarked image. The implementation of the new algorithm on Lena the result indicates, the proposed watermarking scheme improves the quality of the watermarking as well as increasing the security of images.

5. CONCLUSION

The past research work, dual image watermarking is performed by one watermark logo is embedding another watermark image, then it is embedding into the host image. But our new proposed algorithm uses two watermark images, each one is separately embedding into LH and HL sub-band of the host image. In this paper DWT SVD based dual image watermarking scheme in mid frequency is proposed. In our proposed system is used to increase the security level and also provide higher PSNR value. In DWT is used to increase imperceptibility and robustness. It also provides high security to the watermarked Image.

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