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DUAL DIGITAL SIGNATURE USING STATIONARY WAVELET TRANSFORM-SINGULAR VALUE DECOMPOSITION

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ABSTRACT

Digital signature or watermarking mainly used for copyright protection. Sometimes, the digital information is copied in transmission, to overcome this drawback which is used to different watermarking techniques and different transforms. These watermarking and transform techniques protect the digital information. In this paper, Frequency domain techniques that are Stationary Wavelet Transform (SWT) and Singular Value Decomposition (SVD) are used to embed the two watermark images into selected image blocks. The proposed scheme performance measuring parameters are PSNR (Peak-Signal-to-Noise -Ratio), SSIM (Structural Similarity Index Measure) and NCC (Normalized Cross-Correlation). The experimental result exposes high robustness. To check the strength of the proposed algorithm, various attacks has been applied to the final watermarked images.

Keywords: *Digital Signature, Stationary Wavelet Transform (SWT), Singular Value Decomposition (SVD), Copyright Protection, Robustness.*

I. INTRODUCTION

Multimedia data distributed over the internet became very popular. This data can be transmitted in a digital format. Any digital information has audio, video or images format. Sometimes the digital related information could be easily copied in transmission, so the digital signature or watermarking is an emerging technology, which is used to protect the digital information. The digital watermarking method is used to embed the secret image to form a cover image and display the resulting watermarked image is same as the cover image. In end, extraction technique was used to retrieve the watermark images. Digital watermarking has various applications such as copyright protection, broadcast monitoring, content archiving, image verification, tampering, fingerprinting, annotation and control the privacy [1].

The properties of any watermarking scheme consist fidelity, robustness, integrity, security, imperceptibility, and capacity [1].Digital signatures were classified into two types' visible digital signature and invisible digital signature. The visible digital signature will be visible to the humans and invisible digital signatures are not visible. There are two embedding areas are available in the digital signature scheme that is spatial area and transforms/frequency area [2]. Coming to the spatial area embedding as well and extraction of the digital signature is done while changing the intensity and color values of the variously selected pixels. One of the spatial domain algorithm is Least Significant Bit (LSB), but a disadvantage of the spatial domain is less robust. Various transform domain algorithms are spread spectrum, Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT), Singular Value Decomposition (SVD), Stationary Wavelet Transform (SWT) etc. The Stationary Wavelet Transform has more advantage when compared to all other transforms because it designs to avoid the lagging of translation invariance of the Discrete Wavelet Transform.

II. LITERATURE REVIEW

The dual watermarking technique is used for multipurpose image protection using different signatures. Gaurav et al. [3] introduced DWT-SVD Dual Watermarking Scheme, which was used to improve robustness and protection. In this scheme, easily detected second watermark image in all the cases but first watermark detection sometimes difficult. Sagar et al. [4] presented a Dual Watermarking for High Protective Copyright system. A dual watermarking technique is developed by the BPCS and Alpha channel masking algorithm. Embed the data into bitmap files by using BPCS Technique. The main focus of this project is embedding the possible data into a cover image but impossible to detect by the human view. Just noticeable distortion (JND) technique is developed by the Lin et al. [5] for copyright protection. In this scheme, were used to embed the visible and invisible watermarks. The dual robust watermarking scheme is introduced by the Lusson et al. [6] two color spaces are used here that is RGB and YCbCr, one watermark image is inserted into RGB color space and another binary watermark inserted into color space YCbCr of a cover image. It is a non-blind watermarking technique. These two schemes focus only on copyright protection of dual watermarking; Liu et al [7] worked on a blind dual watermarking for color images which is used for authentication and copyright protection. In this scheme, two watermarks are used for copyright purpose invisible robust watermarks embedded into DWT in YCbCr color space, and authentication purpose fragile watermark is used, but Fragile watermarks are destroyed easily and very sensitive due to slight modification of watermarked images but one of the negative aspects is lack of translation- invariant in the DWT. This paper presents a dual digital signature using frequency domain techniques.

III. METHODOLOGY

Wavelet gives a time-frequency representation of the signal, wavelets are categorized into two types, first is continuous wavelet transform and it operates over possible and translation. The second one is Discrete Wavelet Transform. It uses a specific subset of scale. Due to the down-sampling process the DWT is not a translation-invariant, to overcome this drawback SWT is used.

IV. STATIONARY WAVELET TRANSFORM (SWT)

SWT is a translation-invariant, without down sampling process. The stationary wavelet transforms consists of four sub-bands, three detailed sub-band coefficients are (LH, HL, HH) and remaining one estimation sub-band coefficient (LL). This coefficient sub-bands size is same as the input image [8]. The 2-D stationary wavelet transforms decomposition method is shown in Figure 1. The stationary wavelet transform is also called as undecimated wavelet transforms [9].

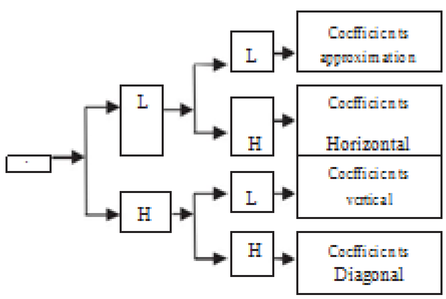

Figure 1. SWT Decomposition Scheme

B. Singular Value Decomposition (SVD)

The disintegration form of the SVD is a rectangular matrix M and it can be written as

$$M = Y\theta \quad (1)$$

Where M is a x b matrix; Y, Q are orthogonal matrices and diagonal matrix is indicated by the . The singular value decomposition transform depends on the concept of Eigen values and Eigenvectors [10]. To represent the image brightness which is called as energy compaction; Eigen values and Eigen vectors gets decomposed by the singular values whereas the geometrical properties of the image is represented by the singular vectors. Hence, the visual effect of the image is could not be disappointed due to small variations of the singular values, and it is stable. When inserting the watermark image into a cover image than SVD leads to good robustness.

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V. PROPOSED ALGORITHM

The proposed scheme consists of three steps one is reference image formation, the second one is image embedding, and another one is extracting. Figure 2 shows the reference image formation

A. Formation of the Reference Image

Step 1: The RGB cover image of size M x M is changed into YCbCr matrix format. Equation (2) is used to convert RGB image into YCbCr matrix.

$$Y = 0.299R + 0.587G + 0.114B$$
$$Cb = -0.172R - 0.339G + 0.511B + 128 \quad (2)$$
$$Cr = 0.511R - 0.428G - 0.083B + 128$$

Step 2: Take Y matrix is segmented into blocks, size n x n.

Step 3: Find edges of those blocks by using edge detection Technique.

Step 4: Each block of edges are arranged in descending order. In each block, a threshold is created on edges. Based on the edges, the necessary blocks are considered which are considerably higher than or equal to a threshold. Those blocks are called significant blocks which are used for making the reference image.

Step 5: Formation of the reference image is denoted as

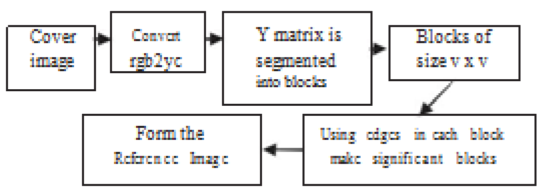

Figure 2. Formation of Reference Image

B. Signature Embedding Procedure

□. That reference image is divided into four bands these are called as HH, HL, LH, and LL. The dual watermarked image embedding procedure is shown in Figure 3.

□ , which is denoted as

□ * □ □ □ (3)

Step 3: Consider one watermark image of size is p x p that watermark image is denoted as 'w1'. Apply SVD on watermark image which is denoted as

□ =** □ (4)

Step 4: By means of singular values of the signature image, the singular values of the reference image are altered using equation (3).this can be written as

□ + ⌉ * here ⌉ is the watermark depth (5)

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Step 5: Inverse Stationary Wavelet Transform is applied to construct the watermarked reference image, of size is v x v and mapped into their standard position, the first watermarked image is formed.

Step 6: Again the first watermarked image forms the reference image by using reference image formation procedure .

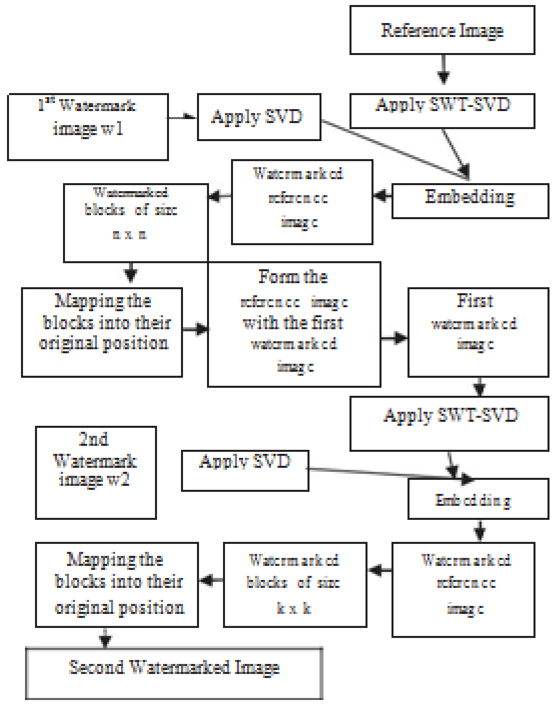

Figure 3. Dual Watermarked Image Embedding Procedure

. That reference image is classified into four bands those are HH (High-High), HL (High-Low), LH (Low-High), and LL (Low-Low).

, which is represented as

Step 9: Consider second watermark image of size is p x p that watermark image is denoted as ‘w^2’, Apply SVD on watermark image which is denoted as

(6)

Step 10: By means of singular values of the signature image, the singular values of the reference image gets modified using equation (6)\

here watermark depth (8)

Step 11: Inverse SWT is performed to construct the referenced watermark image, of size k x k and mapped these blocks into the original position to form the dual signature image.

C. Procedure for Signature Extraction

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The procedure for signature extraction is slightly different to the procedure of embedding. Below steps are used to extract the watermark images.

Step 1: Read final signature image, after divided into blocks of size is c x c.

Step 2: Edge detection technique is used to find the edges of each block.

Step 3: Each block of edges arranged in descending order, and for each block a threshold is created. Based on the threshold, essential blocks are chosen. These blocks are called significant blocks to form the reference image.

Step 4: Apply SWT on the reference image, which is divided into four bands that is LL1, LH1, HL1, and HH1.

Step 5: SVD transform is performed on

= * * (9)

Step 6: The below equation is used to watermark image singular values are extracted

=- / (10)

Step 7: Obtained the first extracted watermark image, which is in the form of equation (11).

= * * (11)

Step 8: Again the above extraction steps are followed to obtain the second extracted watermark image. Two watermark images are cameraman and copy. Then the extracted watermark images quality is measured by Normalized Cross-Correlation (NCC). The normalized cross-correlation finds the comparison of the initial signature image and extracted signature image.

VI. EXPERIMENTAL RESULT

In this paper, used to Lena, Baboon, Airplane, Lake, Tiffany, Splash, and House and pepper images are coverimages of size are 512 x 512.Those cover images are perceived in Figure 4 whereas the watermark images are observed in Figure 5 of size is 256 x 256. The proposed Dual watermarking technique is tested by the Structural Similarity Index Measure (SSIM), Peak- Signal- to- Noise Ratio (PSNR) function. These measures the undetectable performance of the dual signature mechanism. These two functions are Image quality measuring functions. The SSIM is always in the range of 0 to 1.The PSNR value is high than the high-quality image is obtained. The PSNR will be calculating the following equation (13).

MSE = σ σ (12)

PSNR = 10 (13)

The above equation (12) shows the host image's mean square error and the final Signature image. Here g(i,j) is the host .image and g'(i,j) is the final Signature image. In equation maximum possible pixel values of the grayscale images are indicated by the 255.The result has indicated by the image quality assessment (IQA) techniques. The proposed scheme simulation results are taken on MATLAB R2016a.

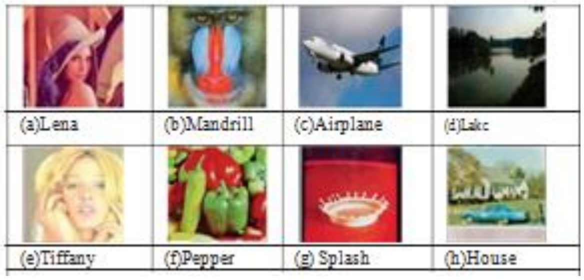

Figure 4. Eight Cover Images

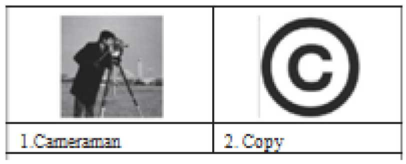

Figure 5. Watermark Images

The dual Signature technique protects the images in various fields. In this SWT – SVD methods are used to developing the algorithm. The advantages of both SWT and SVD are robustness and watermark capacity. The extracted watermark image quality is measured by the NCC. In this case, high NCC value provides the high robustness. The below equation (14) is used for measuring the robustness.

$$NCC = \frac{\sum_i \sum_j w(i,j)\, w'(i,j)}{\sum_i \sum_j w(i,j)^2} \qquad (14)$$

Here w (i,j) original image pixel values and pixel values extracted from the Signature image denoted as w'(i,j).

A. Robust watermarking results

The watermarked image will be protected against the attacks. The watermark images are taken from the attacked image. In proposed technique, different attacks applied to the Lena (dual Signature image) to prove the Strength of the proposed signature scheme. The attacks in signal processing are, salt and pepper, darken, resizing, brighten, Gaussian noise, cropping, blurring, JPEG compression, median filter [11] etc...

Figure 6. Test the Four Cover Images

The above Figure 6 checks the imperceptibility and robustness of the four cover images, which are Lena, Mandrill, Airplane, and Lake.

As shown in table I the proposed scheme give good PSNR and NCC values when compared to the existing method.

Table I.psnr and ncc comparison results of the related robust watermarking scheme

Attack type and parameter		Existing method PSNR=40.85 SSIM=0.9814 NCC	Proposed Method PSNR=48.5056 SSIM=0.9996 NCC1	NCC2
JPEG Compression	90	0.9967	0.9978	0.9983
	80	0.9842	0.9981	0.9984
	70	0.9711	0.9975	0.9983
	60	0.8687	0.9968	0.9981
Gaussian noise	0.1	0.9664	0.9247	0.9810
	0.3	0.9171	0.8886	0.9709
	0.5	0.8735	0.8687	0.9653
Blurring	0.1	0.9997	0.9984	0.9985
	0.2	0.9514	0.9984	0.9985
	0.3	0.8735	0.9984	0.9985
Salt and pepper	0.01	0.9990	0.9906	0.9971

noise	0.02	0.9981	0.9792	0.9946
	0.04	0.9959	0.9661	0.9900
	0.08	0.9893	0.9570	0.9873

Table II shows the different attacks applied to the watermarked image and extracts the watermarks from attacked images. The proposed scheme has a high robustness because the NCC value is high.

Table II. attacked images and extracted images

Attacked images	Extracted images NCC1	NCC2
JPEG Q(80)	0.9981	0.9984
		
Salt&pepper(0.02)	0.9948	0.9982
		
Gaussian(0.1)	0.9835	0.9938
		
Blurring(0.2)	0.9984	0.9985
		
Contrast(+50)	0.9957	0.9978
		

B. Assessments among the dual Signature methods

Table III shows the performance of the proposed dual Signature method is compared with the other related dual Signature methods [5, 6 and 7] with different functionalities.

Table III. comparison of the proposed technique and related signature methods

Functionality	Lin et al. [5]	Lusson et al. [6]	Xiao LongLiu [7]	proposed scheme
Dual watermark	Robust Robust	Robust Robust	Fragile Robust	Robust Robust
Embedding domain	Spatial DCT	Spatial Spatial	Spatial DWT	Frequency Frequency

Visibility	Visible Invisible	Invisible Invisible	Invisible Invisible	Invisible Invisible
Blind extraction	Yes+Yes	Yes+No	Yes+Yes	No+No
Target Image	Gray	Color	Color	Color
PSNR	~30dB	~39dB	~40dB	~49dB
Copyright	Yes	Yes	Yes	Yes
Authentication	No	No	Yes	No

VII. CONCLUSION

Due to the purpose of copyright protection and robustness, in this paper dual digital signature mechanism for color images has been proposed. This scheme embeds the two invisible robust watermarks into frequency domain HH band of the reference image. The proposed technique gives the better results and the good quality watermarked Image is displayed. Coming to the experimental outcomes, the dual digital signature scheme can resist the different signal processing attacks, which provides a more imperceptibility and robustness. The proposed mechanism is well-known dual watermarking mechanism when compared to other mechanisms.

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