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A Robust Non Blind Hybrid Image Watermarking With Arnold Transform

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ABSTRACT: In recent years, digitization play big role in human life and become popular due to on line distribution of digital multimedia. This increases the possibility of large-scale unauthorized copying which may lead to undermine the music, film, book and software industries. These concerns over protecting copyright have triggered significant research to find ways to hide copyright messages and serial number into digital media. To achieve good imperceptibility and robustness, a robust non blind hybrid image watermarking with Arnold transform is proposed. Arnold transform are used to scrambling the watermark image prior to its embedding. The singular value of bands is going to embedded with watermark singular values making use of scaling factor (α). The experimental results show the effectiveness of proposed image watermarking scheme. Performance of methodology is evaluated using different fidelity parameters like as peak signal noise ratio (PSNR) and normalized cross correlation (NCC).

KEYWORDS: Digital Watermarking, stationary Wavelet Transform, singular value decomposition (SVD), Arnold transform, PSNR,NCC.

I.INTRODUCTION

In recent years, multimedia content like image and video etc. are available in digital form. Therefore, authentication, information security and other various issues are raised. Digital data can be stored efficiently and with a very high quality, and it can be manipulated very easily using Computers. Copying is simple with no loss of fidelity and a copy of a digital media is identical to the original [1-2]. Watermarking technology plays an important role in preventing copyright violation as it allows placing an imperceptible or perceptible watermark depending on the requirement in the multimedia data to identify the legitimate owner or detect malicious tampering of the document .Digital Watermarking is an authentication technique which permanently embeds a digital signal (watermark) in text, image, audio, video files (any Data) by slightly modifying the data but in such a way that there are no harmful effects on the data. The watermark embedded may contain information such as identification of the product's owner, user's license information etc.

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Generally, the image watermarking can be done in spatial domain or in transform domain [2-5].

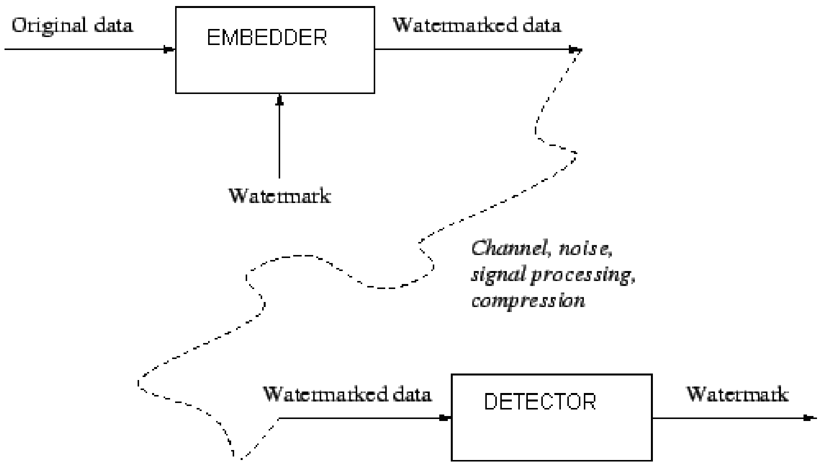

Figure 1. A generic diagram of digital watermarking

Compared to spatial domain techniques frequency-domain watermarking techniques proved to be more effective with respect to achieving the imperceptibility and robustness requirements of digital watermarking algorithms [6].Commonly used frequency-domain transforms include the Discrete Wavelet Transform (DWT), the Discrete Cosine Transform (DCT) and Discrete Fourier Transform (DFT) andstationary wavelet transform (SWT).

II.METHODOLOGY

A. Overview of stationary wavelet transform (SWT)

The new algorithm is designed which called stationary wavelet transform (SWT) because of its translation-invariance property due to which it is more efficient than other wavelet transforms like DWT etc. There is no much difference between SWT algorithm and DWT. In SWT, the output of each level of SWT contains the same number of samples as the input because of redundancy. So for a decomposition of N levels, there is a redundancy of N in the wavelet coefficients. The SWT is preferred as the wavelet transformation, since unlike the other wavelet transforms, the SWT procedures does not include any down sampling steps, instead, a null placing procedure is applied . In SWT domain LL (Approximation), HL (Vertical), LH (Horizontal), HH (Diagonal) sub-band information is present [7-8].

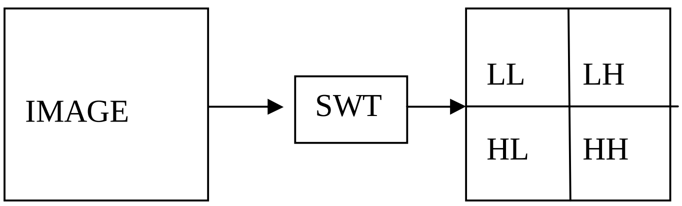

Figure 2: SWT decomposition of image at level-1

One of the most common methods used for watermarking is DWT, but one of the main drawbacks of this method is that because of the down-sampling of its bands, it does not provide shift invariance. This causes a major change in the wavelet coefficients of the image even for minor shifts in the input image. The shift variance of DWT causes inaccurate extraction of the cover and watermark image .since in watermarking; we need to know the exact locations of where the watermark information is embedded, to overcome this problem proposed using stationary wavelet transform [10-11].

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B. Overview of singular value decomposition (SVD)

The singular value decomposition of a matrix is a factorization of the matrix into a product of three matrices. Given an $m\times n$ matrix A, where m ≥ n, the SVD of A is defined as eq. (2.1)

$$A=U\Sigma V^T \quad (2.1)$$

Where, U is an $m\times n$ column-orthogonal matrix whose columns are referred to as left singular vectors; $\Sigma = \text{diag}(\sigma_1, \sigma_2, \ldots, \sigma_n)$ is an $n\times n$ diagonal matrix whose diagonal elements are nonnegative singular values arranged in descending order; V is an $n\times n$ orthogonal matrix whose columns are referred to as right singular vectors.
If rank (A) = r, then Σ satisfies $\sigma_1 \geq \sigma_2 \geq \ldots \geq \sigma_r \geq \sigma_{r+1} = \sigma_{r+2} = \ldots \sigma_n = 0$.
Here, SVD efficiently represents intrinsic algebraic properties of an image, where singular values correspond to brightness of the image and singular vectors reflect geometry characteristics of the image. Since slight variations of singular values of an image may not affect the visual perception, watermark embedding through slight variations of singular values in the segmented image has been introduced as a choice for robust watermarking [12-13].

C. Arnold Transform

The Arnold transform, also commonly known as cat-face transformation, or cat-face mapping, was introduced by Arnold. For an imageC with N *N, the Arnold transform operation on the position (x, y)pixel is given by

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

The Arnold transform, which changes the positions of the pixels, can be repeated many times in order to obtain a scrambled image. However, due to the periodicity of the Arnold transformation, the original image can be restored after a certain number of iterations [9].

D. Anti-Arnold Transform

Use of the Arnold transform periodicity on a scrambled image to recover the original image could be achieved at the expense of possibly a large computational complexity depending on how many iterations have already been used to obtain the scrambled image. The anti-Arnold transform is given by

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

If a scrambled image is obtained by using n iterations of the operation of the Arnold transform, it needs the same number of iterations to recover the original image using the anti-Arnold transform. Therefore, the use of anti-Arnold transform to recover the original image can provide significant savings in computation, if n<<Tn [9].

III.PROPOSED WATERMARKING ALGORITHM

Image watermarking process contains two different steps, one is embedding the watermark image into cover image and other is extracting the watermark image from watermarked image. Both the step is very important for any watermark system for generate watermarked image and retrieve back hidden data from water marked image.

A. Watermark Embedding

The watermark embedding process is described below as following:
Step.1: Load the cover image and watermark image.
Step.2: Decomposed cover the image into four sub-bands using SWT-SVD.
Step.3: Apply the Arnold transform on the watermark image to obtain scrambled watermark image using n iteration.

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Step.3: Decomposed scrambled watermark image into four sub-bands using SWT-SVD.
Step.4: Compute new sigma matrix using fusion of both sigma matrix with scaling factor.
Step.5: Using new computed signal matrix Snew.
Step.5: Therefore, watermarked image obtained using inverse SWT based on LLnew band and remainingsub band of cover image.

B. Watermark Extraction

Step.1: Load the cover image, watermark image and watermarked image.
Step.2: Decomposed the images into sub-bands using SWT-SVDrespectively.
Step.3: Compute new sigma matrix using fusion of both sigma matrix using scaling factor work as key in watermark embedding process.
Step.4: Using new computed signal matrix Snew.
Step.5: Therefore, extracted watermark image obtained byusing inverse Arnold and SWT.

IV.SIMULATED RESULTS AND DISCUSSION

Over all analysis has done with gray scale image and evaluated with consider fidelity parameters. Here, images used are obtained from USC-SIPI image database [14] as a standard evaluation database for watermarking algorithms.

A. Evaluation Fidelity Parameters

The visual performance of watermarked images is determined by using peak signal-to-noise ratio (PSNR) and Normalized Correlation which are historically adopted in image processing in order to evaluate the performance of the output results.

$$MSE = \frac{1}{NM}\sum_{i=1}^{N}\sum_{j=1}^{M}(f(i,j) - g(i,j))$$

$$PSNR = 10\log_{10}\frac{L^2}{MSE} \qquad \text{eq. (1)}$$

From eq. (1), L shows the values of pixel range. As MSE is inversely proportional to PSNR, thus the small mean square error tends to high signal to noise ratio. The quality measurement for image is directly measure from the pixel values. For better image quality the PSNR must be high. The quality of the image is measured using normalized cross co-relation (NCC) and is obtained by using eq. (2)

$$NCC = \frac{\sum_{i=1}^{N}\sum_{j=1}^{M} g(i,j) * g'(i,j)}{\sqrt{\sum_{i=1}^{N}\sum_{j=1}^{M}(g(i,j))^2}\;\sqrt{\sum_{i=1}^{N}\sum_{j=1}^{M}(g'(i,j))^2}} \qquad \text{eq. (2)}$$

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B. Sample image

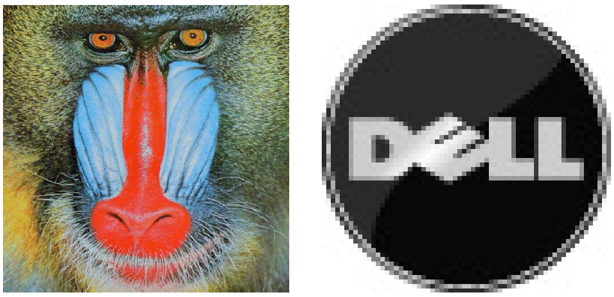

Fig.3 (a): Mandrill image   Fig. 3(b): Dell Logo image

Fig. 3(a) and Fig. 3(b) shows the cover image and watermark image for proposed work.

C. SIMULATED EXPERIMENTAL RESULTS

Here we used images mandrill as original image and the Dell-logo image as the watermark. Both the images are of equal size of 512X512. The value of visibility factor k is varied from 0.001 to 10 with Arnold transform at n=5 iteration.

Scaling factor(S.F)	PSNR	NCC
0.001	infinity	0.6432
0.01	45.81	0.9970
0.02	40.02	0.9993
0.03	36.53	0.9997
0.05	32.11	*0.9999*
0.1	26.10	0.9999
1	9.66	0.9619
10	6.37	0.7393

Table I shows the PSNR Value and NCC value for proposed image watermarking techniques at n=5 iteration of ARNOLD transform.

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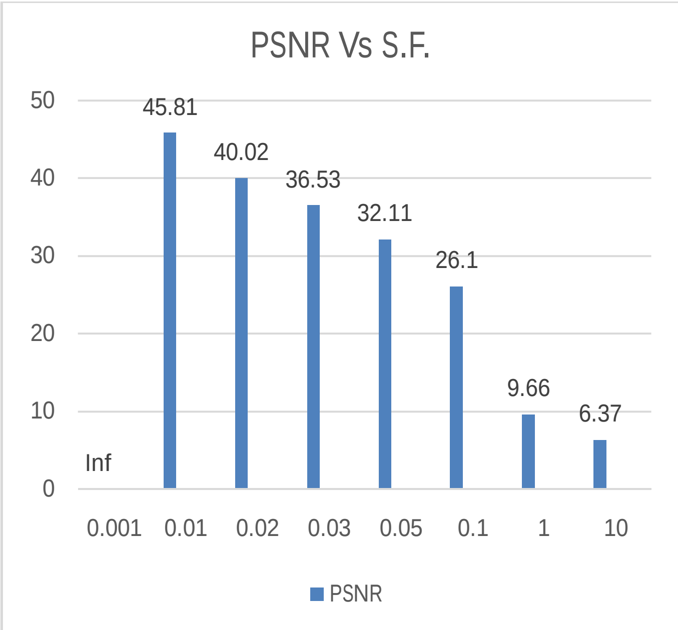

Fig.4 Bar chart for PSNR at different value of S.F

Fig: 4 show Bar chart of PSNR at different value of scaling factor for proposed method.
As seen in simulated results, watermarking algorithm is efficient as shown in Table I. It is also observed that as we decrease the value of visibility factor, the value of PSNR increases but the same time the value of CC decreases hence to get the best result we set the value of visibility factor at 0.02 with n=5 iteration using Arnold transform.

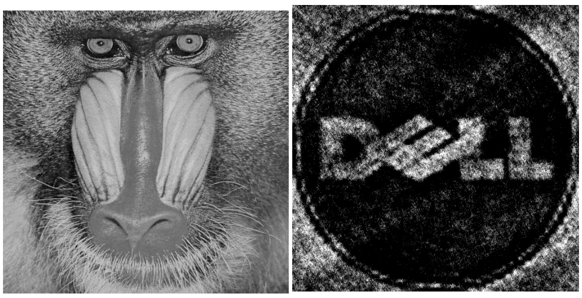

Fig 5(a) Watermarked image&recovered water mark image at SF=0.001 .

Fig 5(b) Watermarked image &recovered water mark image at SF=0.01

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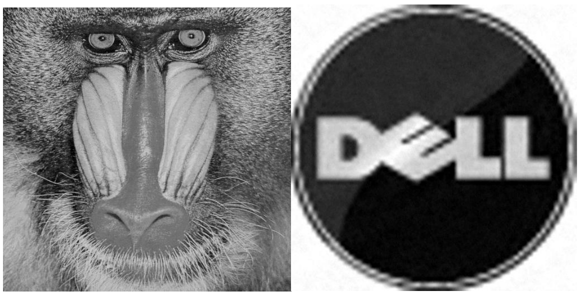

Fig 5(c) Watermarked image &recoveredwater mark image at SF=0.02

Fig 5(d) Watermarked image & recovered water mark image at SF=1.0

Fig. 5(e) Watermarked image & recover water mark image at SF= 10

Fig. 5(a-e) shows the visual representation of watermarked and recovered watermark image at different value of SF. The simulated experimental results also evaluated with visual representation of watermarked and extracted watermark image for human vision system (HVS).

V.CONCLUSION

Digital watermarking based on transform domain is at the focus of current research because of their robustness and imperceptibility.In this paper, a non-blind hybrid watermarking scheme with ARNOLD transform is implemented. Modifying Singular Values of the host image in SWT-SVD provides high robustness and simultaneously increase the value of transparency. This technique can embed the watermark into salient features of the image using different scaling factor. Experiment results shows that the quality of the watermarked image and the recovered watermark are dependent only on the scaling factors. Results are clearly seen that the proposed methodology having robust efficiency of watermarking with data hiding ability.

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