A Composite Algorithm for Digital Image Watermarking

Shuchi Sirmour and Archana Tiwari

Abstract – **Digital watermarking is the technique to insert some kind of ownership information in any digital media like image, audio, video. Digital watermarking is one of the data hiding techniques. In this paper to improve the robustness, the hybrid DWT-SVD based algorithm is proposed for embedding and extracting process. The suggested method is performed by modification on singular value decomposition of images in Discrete Wavelet Transform (DWT) domain. Modification of the appropriate sub-bands leads to a watermarking scheme which favorably preserves the quality. The experimental result shows good robustness by using hybrid DWT-SVD method in comparison with DWT based watermarking algorithm using Haar wavelet and SVD based digital image watermarking.**

Keywords – Digital watermarking, Discrete wavelet transform (DWT), Singular value decomposition (SVD).

I. INTRODUCTION

Now a day's use of internet is increasing day by day. Digital data utilization along with the increased popularity of the internet has facilitated information sharing and distribution. In recent years, the accessing of multimedia or digital data has become very easy because of the fast development of the internet. In other words, this development makes unauthorized, illegal access and manipulation of multimedia files over internet. Watermarking is a branch of information hiding which is used to hide proprietary information in digital media like photographs, digital music, or digital video. The ease with which digital content can be exchanged over the internet has created copyright infringement issues. Copyrighted material can be easily exchanged over peer-to-peer networks and this has caused major concerns to those content providers who produce these digital contents [1].

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Digital watermark is a code that is embedded inside an image. It acts as a digital signature, giving the image a sense of ownership or authenticity. Digital watermarking stands for embedding a signal, called 'watermark' into a digital cover, in order to prove ownership, authenticity or integrity of the cover or it may relate to audio, images, video or even text. Digital watermarking provides copyright protection of data. For image watermarking, the algorithms can be categorized into one of the two domains: spatial domain or transform domain [2,3]. In spatial domain the data is embedded directly by modifying pixel values of the host image, while transform domain schemes embed data by modifying transform domain coefficients. Algorithm used for spatial domain are less robust for various attacks as the changes are made at Least Significant Substitution (LSB) of original data. While in the transform domain the watermark is embedded by changing the magnitude of coefficients in a transform domain with the help of discrete cosine transform (DCT), discrete Fourier transform (DFT), discrete wavelet transform (DWT), and singular value decomposition (SVD) techniques [4,5]. This provide most robust algorithm for many common attacks.

II. DWT AND SVD

A. Discrete Wavelet Transform(DWT)

The Discrete Wavelet Transform(DWT) is currently used in a wide variety of signal processing applications, such as in audio and video compression, removal of noise in audio and the simulation of wireless antenna distribution. Wavelets have their energy concentrated in time and are well suited for the analysis of transient, time-varying signals [6]. Wavelet transform use wavelet filters to transform the image. There are many available filters, although the most commonly used filters for watermarking are Haar Wavelet Filter, Daubechies Orthogonal Filters and Daubechies Bi- Orthogonal Filters. Each of these filters decomposes the image into several frequencies.

DWT involves decomposition of image into frequency channel of constant bandwidth. This causes the similarity of available decomposition is done in multistage transformation. At level 1: image is decomposed into four sub-bands: lower (LL), vertical (LH), horizontal (HL), and diagonal (HH) detail components. Where LL denotes the coarse level coefficient which is the low frequency part of the image. LH, HL, and HH denote the finest scale wavelet coefficient. The LL sub-band can be decomposed further to obtain higher level of decomposition. This decomposition can continues until the desired level of decomposition is achieved for the application. The watermark can also be embedded in the remaining three sub-bsnds to maintain the quality of image as the LL sub-band is more sensitive to human eye.

Advantages of DWT are: wavelet is superior in most situations in quality, wavelet transform has the advantage over fourier transform in that it represents both frequency and time. Fourier transform only shows which frequencies are used but not when the frequencies occur. Disadvantages of DWT are: still has ringing artifacts.

B. Singular Value Decomposition (SVD)

An image can be represented as a matrix of positive scalar values. Formally, SVD for any image say A of size m x m is a factorization of the form given by $A = USV_T$, where U and V are orthogonal matrices in which columns of U are left singular vectors and columns of V are right singular vectors of image A. S is a diagonal matrix of singular values in decreasing order. The basic idea behind SVD technique of watermarking is to find SVD of image and the altering the singular value to embed the watermark. In digital watermarking schemes, SVD is used due to its main properties: 1) A small agitation added in the image, does not cause large variation in its singular values. 2) The singular value represents intrinsic algebraic image properties [4].

Advantages of SVD are: compression speed in SVD is high, small change in the input results in small change in the singular matrix so it is more stable. Disadvantage of SVD are: U and V will have to store together with the singular values.

III. PROPOSED ALGORITHM

The image decomposition is done with “Haar” which is symmetric, simple and orthogonal wavelet. The SVD is then applied to a selected sub-band. This result in three matrices U, S and V. We assume the dimension of the cover image I is N x N.

A. Embedding Watermark

- Read the cover image of size and the watermark of the same size.
- Use Haar DWT to decompose the image into four sub bands i.e. (LL, LH, HL, HH)
- Apply SVD to HH sub-band i.e.

  $I_o = U_o S_o V_o^T$

  Where I_o = HH
- Insert the watermark image into the middle component of the SVD applied cover image as in above equation:

  $W = U_w S_w V_w^T$

  Where W = watermark
- Apply inverse SVD (ISVD) to the HH sub-band by multiplying the modified matrix S_{ow} with the orthogonal matrices.
- Apply inverse DWT (IDWT) to get the watermarked image.

B. Watermark Extraction

- Read the watermarked image.
- Apply Haar DWT to decompose the watermarked image into four sub-bands i.e. (LL, LH, HL, HH)
- Apply SVD to HH sub-band i.e.

  $I_{ow} = U_{ow} S_{ow} V_{ow}^T$

  Where I_{ow} = HH
- The matrix as the middle component of the SVD that includes the watermark is computed and the watermark is extracted using the original image as it is a non-blind watermarking method.
- Apply inverse SVD to the HH sub-band.
- Perform inverse DWT method.
- The extracted watermark is recovered.

IV. Performance Evaluation

The designed system will be tested using following parameters:

A. Imperceptibility

Imperceptibility is the perceived quality of the host image that should not be distorted by the presence of the watermark. For quantitative evaluation of a watermarked image, the Peak Signal-to-Noise Ratio (PSNR) is typically used to evaluate the performance of the proposed scheme, which is defined as:

$$PSNR = 10 \log_{10} (2^N - 1/MSE)^2 \ dB$$

$$MSE = \sum_{i=0}^{n-1} \sum_{j=0}^{m-1} \frac{(a_{ij} - b_{ij})^2}{n * m}$$

Where m x n is the image size, a_{ij} and b_{ij} are the corresponding pixel values of two images [8].

V. EXPERIMENTAL RESULTS

To demonstrate the proposed approach, Lena’s image is used as an original image and copy-right image is used as the watermark. Figure:1 shows the cover image of size 512 x 512. Figure:2 shows the watermark image of size 340 x 340. Figure:3 shows the watermarked image. Figure:4 shows the recovered watermark image.

The peak signal-to-noise ratio (PSNR) was used as a measure of the quality of a watermarked image.

Figure: 1 Original Image

Figure: 2 Watermark Image

Figure: 3 Watermarked Image

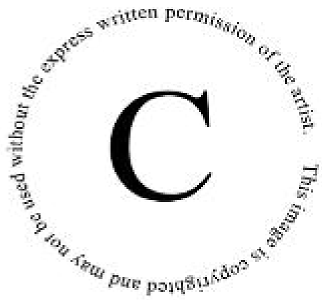

Figure: 4 Recovered Watermark Image

Table 1 : Experimental Data

Image	MSE	PSNR
Lena 1	0.00141	76.631
Mandril	0.01291	67.901
Pepper	0.00264	73.901
Lena 2	0.00916	68.507

Table 1 shows the peak signal to noise ratio of performance of our proposed method of original image with various watermark image, where our watermarked images PSNR has a better performance than DWT and SVD.

VI. CONCLUSION

In our simulation, the numerous tests on original image with size 512 x 512. Watermarking is an information hiding technique where a secret message is concealed in the digital content. In order to make this hidden information secure, imperceptible and robust, the watermark should be embedded in some proper locations. In our proposed method, PSNR of watermark images values are high as compare to other papers. Less the value of PSNR more will be the degradation in the quality of the original image. This shows that after watermarking, the quality of image degrades more when DWT technique is used for embedding the watermark in comparison with hybrid technique. The experimental results have confirmed that this new technique has two properties high fidelity and robustness. Improving the security aspect of the watermarking system, without any cost of imperceptibility and robustness, is one of the challenges of today's research in watermarking.

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