

Digital Watermarking Scheme Based on SVD-DWT Technique with Different Noise Attacks

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ABSTRACT: In order to improve the robustness and imperceptibility of the algorithm, a new embedding and extracting method with DWT-SVD is proposed. The approximation matrix of the third level of image in DWT domain is modified with SVD to embed the singular value of watermark to the singular value of DWT coefficient. The proposed embedding and extracting method was employed to accelerate the hybrid DWT-SVD watermarking and to avoid the leak of watermark. This hybrid technique leads to optimize both the fundamentally conflicting requirements. The experimental results show both the good robustness under numerous attacks and the high fidelity. The time needed to perform the program is greatly decreased.

KEYWORDS: Discrete Wavelet Transform, SVD, PSNR, MSE

I. INTRODUCTION

Digital image watermarking can be done in both spatial domain and transform domain. In spatial domain the watermark bits directly added to the pixels of the cover image. Spatial domain methods can be easily modeled and analyzed mathematically. However the embedded watermark can be easily destroyed or removed by signal processing attacks such as filtering. The spatial domain technique makes use of human visual system, but sensitive to image scale so that same information must be embedded again and again in different locations of the host image. The least significant bit (LSB) method is an example of spatial domain method where the watermark is embedded into the least significant bits of the cover image. In this method, first the bit planes are extracted from the watermark and then shifted to the right. The shifted bit planes are added to the least significant bits of the cover image to get the watermarked image. The least significant bits are highly sensitive to noise, so that the watermark can easily be removed by image manipulations such as rotation and cropping. Thus, the LSB method provides high imperceptibility and less robustness. The correlation based method is another example of spatial domain techniques; in this method, the watermark is converted into Pseudo Noise sequence which is then weighted and added to the cover image bits. The watermarked image is compared with the cover image to detect the inserted watermark. The spatial domain methods are less complex compare to transform domain methods, however weak to different image attacks. The data hiding capacity of spatial domain techniques is higher than that of transform domain methods. Spatial domain techniques offer higher robustness to geometrical transformations.

The robustness and imperceptibility of the watermarked images can be improved by performing watermarking in frequency domain. Frequency domain techniques can provide better robustness against compression and filtering attacks, because the watermark coefficients spread throughout the cover image. In frequency domain, watermark embedding is done by modifying the image coefficients using image transforms. Masking techniques based on transform domain are more robust than least significant bit method with respect to cropping, compression and image processing. The main advantage of masking techniques is that they embed watermark coefficients in large areas of the host image. Many of the transform coefficients are small; hence even though they discarded during the process of compression the effect is negligible.

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II. DIGITAL IMAGE WATERMARKING USING WAVELETS

A wavelet is an oscillatory function of finite duration. The wavelet provides both spatial and frequency description details of the image. The temporal information is retained in this wavelet transformation process compared to other transforms like DCT and DFT. Haar, Daubechies, Complex, Balanced, Stationary, Morphological, Non-tensor, Berkley, Mexican- hat, Morlet, Shannon and Biorthogonal are the different wavelets used to perform image processing. The DWT is not effective to analyze non-stationary signals. Whereas short time Fourier Transform is an effective tool to do that operation, but the drawback is that it gives constant resolution at all frequencies. DWT provides both spatial and frequency description of an image with multiresolution. The multi-resolution property of the wavelet transform can be used to exploit the fact that the response of the human eye is different to high and low frequency components of the image. DWT can be applied to an entire image without using block structure as used by the DCT, thereby reducing the blocking artifact. Wavelet is an oscillatory function of time or space that is periodic and of finite duration with zero average value. A family of wavelets can be generated by dilating and translating mother wavelet. Wavelet provides time- frequency representation of a signal and is used to analyze non- stationary signals. Multi-resolution technique is used in wavelet transform where different frequencies are analyzed with different resolutions. Big wavelets give an approximate value of a signal, while the smaller wavelets boost up the smaller details. DWT is computed either by using convolution based or lifting based procedures. In both the methods, the output sequence decomposed into low-pass and high-pass sub bands, where each sub bands constituting of half the number of samples of the original sequence. The DWT represents an $N \times N$ image by N^2 coefficients. The DWT can be implemented through filter bank or lifting scheme. The DWT of an image is analyzed by allowing it to pass through an analysis filter bank followed by down sampling. The analysis filter bank consists of low-pass and highpass filters at decomposition stage. When an image passes through these filter banks, the image split into two sub bands. The low-pass filter performs averaging operation and extracts the coarse information of the image. Whereas the high-pass filter performs difference operation and extracts the details of the image. Then the output of the filtering operation is down sampled by two. This operation splits the image into four bands, namely, LL, LH, HL, and HH as shown in figure (1). The lowest resolution level LL consists of the approximation part of the original image and most of the energy is concentrated in this LL band. Hence modifications of this low frequency subband would cost severe and unacceptable image degradation. So the watermark is not embedded in LL subband. The good areas for watermark embedding are high and middle frequency coefficients (vertical, horizontal and diagonal coefficients). Human visual system is insensitive to these high and middle frequency subbands and effective watermark embedding is achieved without being perceived by human visual system.

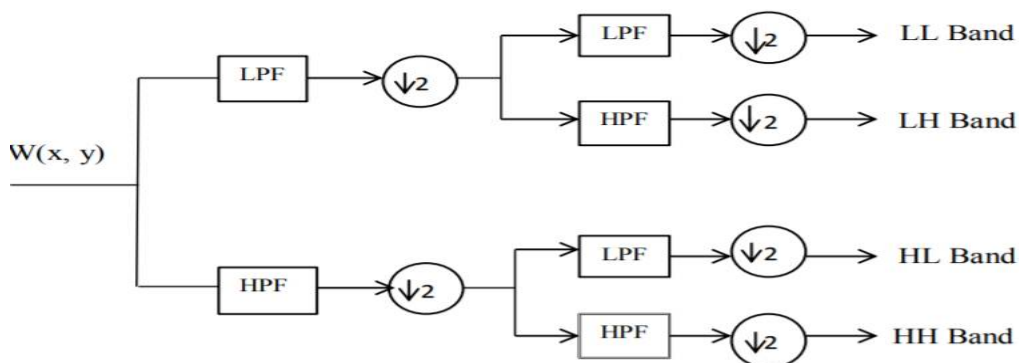


Figure 1: Wavelet Decomposition using Sub-band coding

III. PROPOSED METHODOLOGY

DWT involves decomposition of image into frequency channel of constant bandwidth. This causes the similarity of available decomposition at every level. DWT is implemented as multistage transformation. Level wise decomposition is done in multistage transformation.

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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.

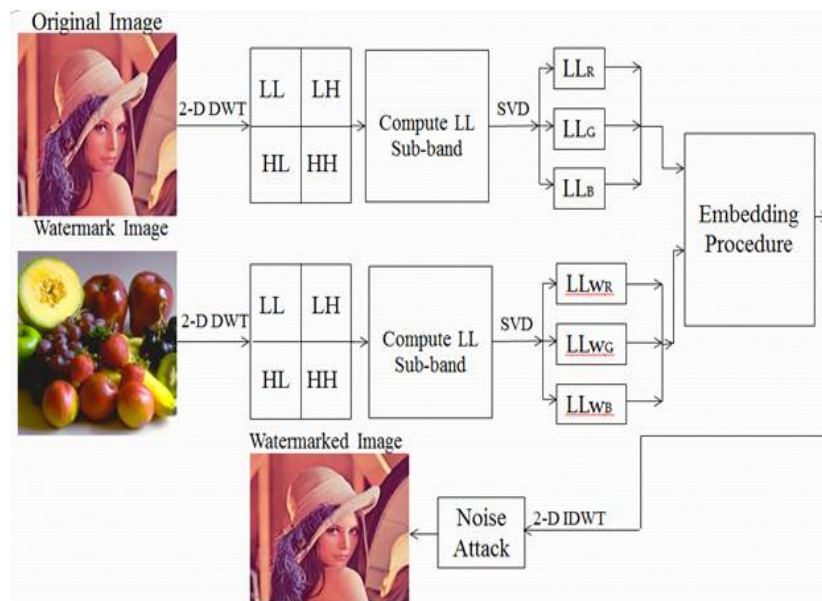


Figure 2: Flow Chart of Proposed Methodology

Algorithm for Watermark Embedding

- Step 1: Input Host image
- Step 2: Rearrange the host image (RI)
- Step 3: Apply 2-D DWT on rearranged image RI to decompose it into four sub-bands LL, HL, LH and HH.
- Step 4: Select sub-band LL of RI.
- Step 5: Then apply SVD to sub-bands LL to get SH1, SH2 and SH3.
- Step 6: Input watermark image Wi. Apply 2-D DWT to decompose it into four sub-bands LL1, HL1, LH1 and HH1.
- Step 7: Select sub-bands LL1 of Wi.
- Step 8: Then apply SVD to sub-bands LL1 to get SW1, SW2 and SW3.
- Step 9: Modify SH1, SH2 and SH3 by using equation

$$SH1 = SH1 + (0.10 * SW1);$$

$$SH2 = SH2 + (0.10 * SW2);$$

$$SH3 = SH3 + (0.10 * SW3);$$
- Step 10: Construct modified SVD matrix SH1, SH2 and SH3.
- Step 11: Apply inverse DWT and finally get watermarked image WI.

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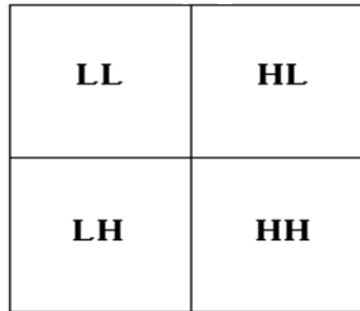


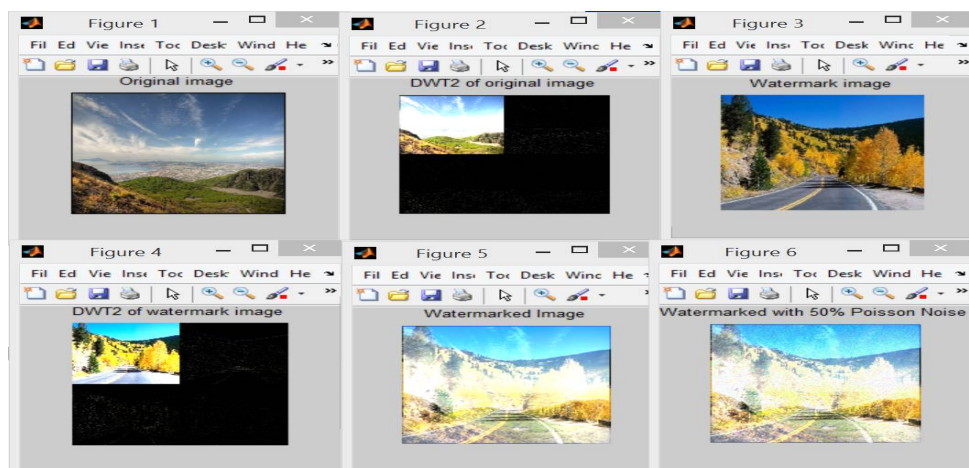
Figure 3: 2-D Discrete Wavelet Transform

IV. SIMULATION RESULT

Discrete Wavelet Transform (DWT): The digital wavelet transform are scalable in nature. DWT more frequently used in digital image watermarking because of its excellent spatial localization and multi resolution techniques. The excellent spatial localization property is very convenient to recognize the area in the cover image in which the watermark is embedded efficiently.

Singular value decomposition (SVD): Singular value decomposition is a linear algebra technique used to solve many mathematical problems. Any image can be considered as a square matrix without loss of generality. So SVD technique can be applied to any kind of images. The SVD belongs to orthogonal transform which decompose the given matrix into three matrices of same size.

Figure 4; show the original Sky image of 512×512 pixel value. The random image of the original image is resized 512×512 image, resize image is shown in figure 4 (a). The original resize image is passing through 2-D DWT and 2-D DWT original resize image is shown in figure 4 (b).



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Figure 4: Experiment Image Poisson Noise Attack

The watermark image is 512×512 pixel value is shown in figure 4 (c) and watermark image is passing through 2-D DWT and 2-D DWT watermark resize image is shown in figure 4 (d). Both images are passing through the embedding processing and original image add with watermark image is shown in figure 4 (e). Embedding processing image attack with 50% Poisson noise is shown in figure 4 (f). Applied median filter for Poisson noise image and get output image is shown in figure 4 (g).

As shown in table 4.1 the PSNR, MSE, NAE and computation time result are obtained for the proposed DWT-SVD technique. From the analysis of the results, it is found that the proposed DWT-SVD technique gives superior performances.

Table 1: Result for Different Image in Without Noise Attack

Image	PSNR (dB)	MSE	NAE	Computation Time (ns)
Lena Image	35.289	77.561	18.652	4.674
Flower Image	44.206	12.334	2.376	4.682
Home Image	34.069	28.519	10.005	4.093
Sky Image	34.436	94.581	25.512	4.532

The proposed DWT-SVD technique gives a highest PSNR 35.289 dB for Lena image and lower PSNR 33.862 dB for Sky image.

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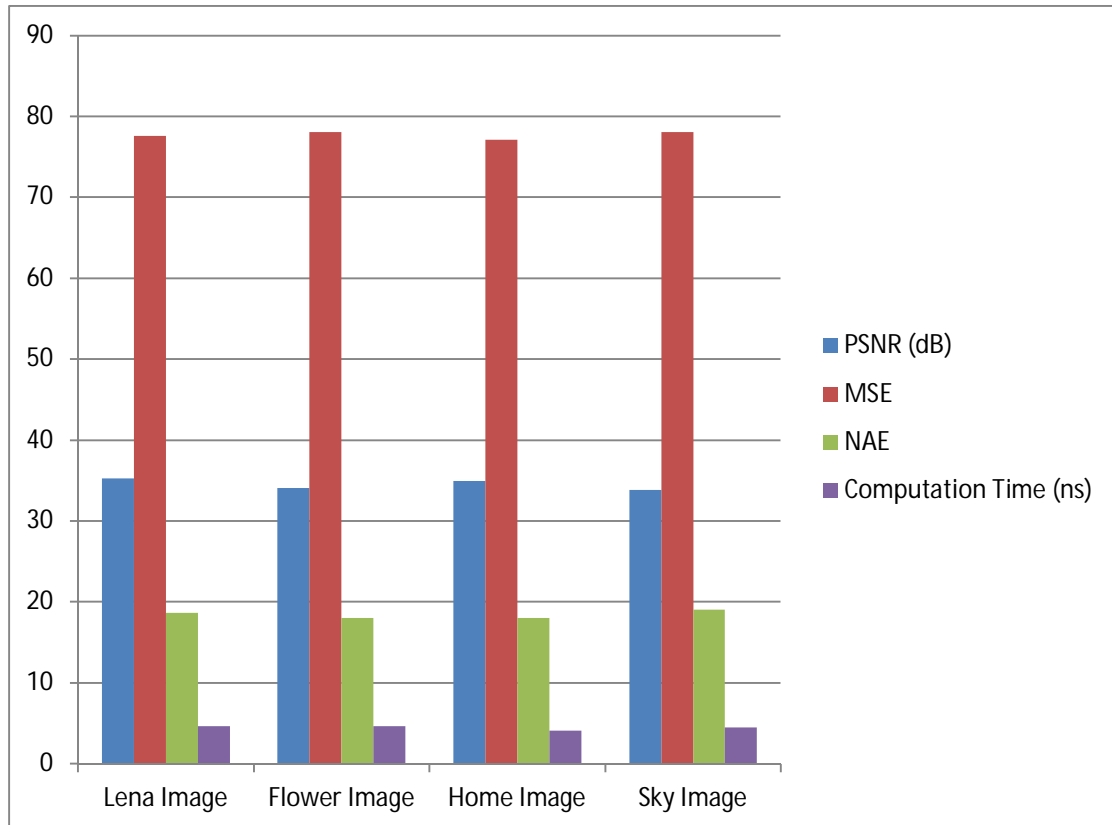


Figure 5: Bar Diagram of the Different Image with Different Parameter in Without Noise Attack

Figure 5 shows the graphical illustration of the performance of DWT-SVD technique discussed in this research work in term of different parameter. From the above graphical representation it can be inferred that the proposed DWT-SVD technique gives the best performance for Lena image.

V. CONCLUSION

In this dissertation, we studied the different watermarking algorithm such as spatial domain and frequency domain. In contrast to the spatial-domain-based watermarking, frequency domain-based techniques can embed more bits of watermark and are more robust to attack. Online application of watermarking for video in the spatial domain becomes cumbersome due to associated high computational complexities involved. In this thesis we embed DWT-SVD and low boost filter technique to watermark the digital image efficiently. Watermarking algorithms have varied requirements according to the application, the algorithm aims to target.

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