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# A Dwt-Svd Based Watermarking Techniques For Digital Images

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***ABSTRACT**:*

*Robustness geometric against distortion is one of the crucial important issues in watermarking. In this paper, a new discrete wavelet transform- singular value decomposition (DWT-SVD) image watermarking algorithm that is robust against affine transformation and ordinary image processing is presented. We use DWT transform to obtain four different frequency subbands. Watermarking is embedded in high frequency subbands by singular value decomposition (SVD). This is unlike traditional viewpoint that assumes watermarking should be embedded in low or middle frequency to have good robustness. Peak signal to Noise Ratio(PSNR) and Normal Cross Correlation are computed to measure image quality and template matching. In addition, the competency of the proposed scheme is verified under common image processing operations and a comparative study is made against our previous technique [6].*

***KEYWORDS:****DWT-SVD, Digital images, Robust watermarking*

## I. INTRODUCTION

The growth of high speed computer networks and that of Internet has explored means of new business, entertainment, scientific, and social opportunities in the form of electronic publishing and advertising. It also deals with product ordering, transaction processing, digital repositories, real time information delivery and web newspapers, libraries, and magazines, network audio and video etc.The new opportunities can be broadly labeled as 'electronic commerce'. The improvement of technology result in cost effectiveness of selling software, high quality art work in the form of digital images and video sequences by transmission over World Wide Web (www). Digital media offer several distinct advantages over analog media: the quality of digital audio, images and video signals are higher than that of their analog counter- parts. Editing is easy because one can access the exact discrete locations that should be changed. Copying is simple as it has no fidelity. The copy of a digital media is identical to the original. The ease by which digital information can be duplicated and distributed has led to the need for effective copyright protection tools. As a result various software products have been recently introduced in attempt to address these growing concerns. It should be possible to hide data (information) within digital images, audio images and video files. The information is hidden in the sense that it is perceptually and statistically undetectable. One way to protect multimedia data against illegal recording and retransmission is to embed a signal, called ownership digital signature or copyright label called watermark, which completely characterizes the person who applies it and therefore, marks it as being his intellectual property. Watermarking is the technique of embedding a secret imperceptible signal directly into the original data in such a way that always remains present.

Geometric attacks such as scaling, rotation and translation are very easy to apply and may lead many watermark detectors to total failure due to loss of synchronization between the embedded and the correlating watermarking. Several watermarking methods resistant to geometric attacks have been presented in literature [1,2]. In recently, a transform called Singular Value Decomposition (SVD) is used with Discrete Wavelet Transform (DWT) was explored for watermarking [3,4,5].

## II. BACKGROUND AND THEORY

Methods and techniques adopted by the watermarking schemes including DWT, Singular value decomposition(SVD) and watermark construction process adopted in our previous watermarking algorithm is as explained. .

**Discret wavelet Transform (DWT)**

An image is decomposed into four subbands denoted by LL,LH,HL and HH at level 1 in the DWT domain ,where LH,HL, and HH represents the finest scale wavelet coefficients and LL stands for the coarse-level coefficients .The lowest resolution level LL consists of the approximation part of the original image .The remaining three resolution levels consist of the detail parts and the LL subband can further be decomposed to obtain another level of decomposition. The decomposition process continues on the LL subband until the desired number of levels determined by the application is reached .LH,HL and HH are the finest scale wavelet coefficients. Since human eyes(HVS) are much more sensitive to the low-frequency part (the LL subband), the watermark can be embedded in the other three subbands to maintain better image quality. In the proposed algorithm, watermark is embedded into the host image by modifying the coefficients of high-frequency bands i.e.HH subband.

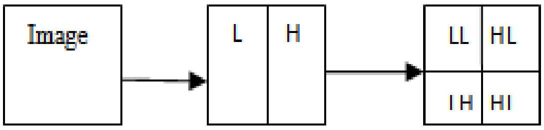


Figure 1:DWT decomposition of an image

**Singular value decomposition (SVD)**

Singular value decomposition is a mathematical tool used to decompose a matrix into two orthogonal matrices and one diagonal matrix consisting of the singular values of the matrix. From the point of image processing an image can be considered as a 2D matrix. Therefore, consider an image A to be an $m \times m$ matrix; the SVD of A can be given by

$A = USV^T$ , where U and V are orthogonal matrices, and

$S = \mathrm{diag}(\lambda)$, is a diagonal matrix of singular values $\lambda_i = 1, 2, \ldots m$ arranged in decreasing order. The columns of V are the right singular vectors, whereas the columns of U are left singular vectors of the image A. In case of SVD based watermarking, SVD of the cover image is taken and then singular values of the matrix are modified by introducing the watermark. SVD approach has found use in watermarking field because of the fact that singular values obtained after decomposition of the image matrix are very stable and do not change on introduction of small perturbations. Moreover, singular values represent intrinsic algebraic image.

**Overview of Previous method [6]**

This section briefly describes the watermarking generating algorithm of our previous work [6].The watermark is generated from the content information of host image. It includes the following steps:

- The original image P of size MxM ,is partitioned into non overlapping blocks of size 2x2.
- Perform 1-level DWT on the original image and acquire the LL1 component, which is of size M/2xM/2. Let this matrix be A.
- A reduced size (M/2xN/2) image B is obtained from original image.
- Compute one feature value from each block using equation (1).

$$B(x,y)= \{ \sum_{i=1}^{2} \sum_{j=1}^{2} P(x*2+I,y*2+j)\}/4, \qquad (1)$$

*Where* $0 \le x \le M/2$ *and* $0 \le y \le N/2$.

- Find the difference between A and B. Let it be C.
- A binary sequence named W can be obtained by applying the following constraint.
- W (x,y) ={0 if C(x,y) is even and 1 otherwise}
- Disorder the matrix W with the help of Arnold Transform, the resultant is the required watermark pattern to be embedded into the host image. In this method, watermark is generated from original image. This watermark is embedded in the HH subband of the original image. This embedded watermark is extracted in detection phase and is compared with the derived watermark to decide authenticity.

**Proposed Algorithm**

In this section we have discussed a scheme for embedding watermark. We have used DWT and SVD for developing an algorithm. Let A be the cover image and W be the watermark. The cover image and watermark are gray scale images of size MxN and M/2xM/2.The main idea of our proposed method is as follows.

**Watermark Embedding**

1. One-level Haar DWT is used to decompose the cover image A into four subbands

(i.e., LL, LH, HL, and HH).

2. SVD applied to LH and HL subbands, i.e.

$$A^k = U^k S^k V^{kT}, \qquad k = 1, 2$$

where k represents one of the subbands.

3. The watermark is divided into two parts:

$$W = W^1 + W^2,$$

Where $W^k$ denotes half of the watermark.

4. The singular values are modified in HL and HH subbands with half of the watermark image and then SVD is applied to them, respectively,i.e.

$$S^k + \alpha W^k = U_w^k S_w^k V_w^k$$ where $\alpha$ denotes the scale factor.

The scale factor is used to control the strength of the watermark to be inserted.

5. Two sets of modified DWT coefficients are obtained, i.e.,

$$A^{*k} = U^k S_w^k V^{kT}, \qquad k = 1, 2$$

6. The watermarked image $A_w$ is obtained by performing the inverse DWT using two sets of modified DWT coefficients and two sets of non-modified DWT coefficients.

**Watermark Extraction**

1. One-level Haar DWT is used to decompose the watermarked (possibly distorted) image $A_w$* into four subbands: LL, LH, HL, and HH.

2. Apply SVD to the HH and HL subbands, i.e

$$A_w{}^{*k} = U^{*k} S_W{}^{*k} V^{*kT}, \qquad k = 1, 2$$

3. Computation of

$$D^{*k} = U_w{}^k S_w{}^{*k} V_w{}^{*kT}, \qquad k = 1, 2$$

4. Half of the watermark image from each subband is extracted, i.e.

$$W^{*k} = (D^{*k} - S^k)/\alpha, \qquad k = 1,2$$

5. Results of Step 4 are combined to obtain the embedded watermark

$$W^* = W^{*1} + W^{*2}$$

## III. EXPERIMENTAL RESULTS

The proposed watermarking method is software implemented in MATLAB. We test the proposed scheme on gray scale image with the size 256x256 and watermarking image with the size 128x128. The cover image, the watermarking image, the watermarked image and extracted watermark image are shown in Figure1.We used the scaling factor 0.01.Scaling factor is used to control the watermark strength.

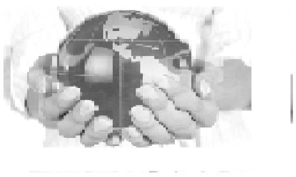

Fig1:a)Cover Image

b)Watermarking Image

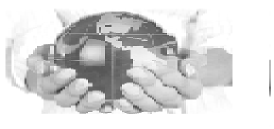

Fig1: c)Watermarked Image

d)Extracted Watermark Image

PSNR can be calculated as

$$PSNR = 10 \cdot \log_{10}\left(\frac{MAX_I^2}{MSE}\right) = 20 \cdot \log_{10}\left(\frac{MAX_I}{\sqrt{MSE}}\right) = 20 \cdot \log_{10}(MAX_I) - 10 \cdot \log_{10}(MSE) \quad (2)$$

Where MSE is defined as Mean Squared Error between original and distorted images, which is defined in equation (3).

$$MSE = \frac{1}{m\,n}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2 \quad (3)$$

where I is the original image and K is the distorted image. In the proposed as well the previous watermarking techniques, the watermarked image has been subjected to several types of image manipulations including Gaussian noises, median filtering image adjustment, histogram equalization ,cropping and rotation. So we evaluated the robustness of the proposed scheme by applying these attacks. The imperceptibility of watermark in the proposed method has been evaluated against incidental attacks by using the metric PSNR and compared with [6].A comparative study on Table 2 reveals the fact that the quality of watermarked image in the proposed scheme has improved a lot.

Table 2: Assessment of PSNR

| Attacks | PSNR | |
|---|---|---|
| | Method[6] | Proposed |
| ------ | 59.1168 | 80.0631 |
| Gaussian noise | 38.3272 | 56.9593 |
| Median filt. | 29.5727 | 56.9593 |
| Hist.equal. | 19.0944 | 56.9593 |

Robustness of the proposed method under the common image processing operations has been identified with the help of Normal cross correlation. Table 3 shows the experimental results. Normal cross Correlation (NCC) is calculated between watermarked image and extracted image. The watermarked image is attacked with cropping, Gaussian noise, histogram equalization, Median filtering and rotation. The NCC values are calculated and variation of PSNR and NCC values can be seen in the table.

Table:3 NCC values of extracted watermark subjected to various attacks.

| SF | GN | RO | CR | MF | HE | CA |
|---|---|---|---|---|---|---|
| .01 | .982795 | .982473 | .869641 | .937598 | .965637 | .92497 |
| .03 | .990369 | .990231 | .922314 | .964371 | .980901 | .93925 |
| .05 | .989351 | .992362 | .935861 | .968731 | .978567 | .94190 |

Experimental results shown in Table:3 describe the resilient nature of the watermarking scheme for aforementioned attacks. As the scaling (SF) is gradually increased from .01 to .05 ,we can observe an increase in the normalized cross correlation values of the extracted watermarks, also signifying degradation in the watermarked image quality. We carry out cropping of the watermarked image and extract corresponding watermark, which results in no significant degradation in the extracted watermark quality even in the presence of Gaussian noise. This proves robustness of the scheme. The watermarked image with different attacks and the recover watermark are shown in the figures1 to 5 below.

Fig1:a)Cont.adjust.

b)Recover Watermark

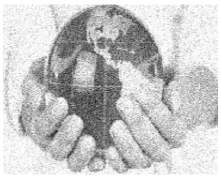

Fig2:a)Gaussian Noise

b)Recover Watermark

Fig3:a)Histogram Equalization

b)Recover Watermark

Fig4:a)Median Filtering

b)Recover Watermarking

Fig5:a)Rotation $45^0$

b)Recover Watermark

## IV. CONCLUSION

A new watermarking scheme is proposed in this paper. The watermark is embedded in the high frequency subbands and successfully extracted. The watermark embedding process does not degrade the visual quality of the image. Moreover the authentication process provides qualities like imperceptibility, robustness and security. The algorithm was tested with several standard test images and the experimental results demonstrated that it created high quality images and it was robust versus different attacks. Moreover the results of proposed scheme are compared with that of previous method [6], the results obtained show that the proposed technique is highly robust against attacks. Future work aim at making suitable enhancements to identify malicious attacks.

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