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Implementation of Robust Water Marking Technique using SVD Algorithm with GUI Representation

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Abstract: Digital image watermarking is one such technology that has been developed to protect digital images from illegal manipulations. In this paper we propose a invisible digital watermarking scheme based on Singular Value Decomposition (SVD). In the proposed method, we first divide the host image into two partions such as upper and lower, and then SVD is applied to each block. The output image of SVD is embed with the watermark image.To retrive the original images (Host image and Watermarked image), we perform inverse SVD to each block to get watermarked image. Similarly in the detection we also divide the image into blocks, and then decomposed by SVD then retrieve the watermark bits. The proposed algorithm is shown to be robust to Resizing, Bit plane removal, Row column blanking attack, Cropping, Brightness, Row column copying attacks. This method changes all the singular values of the global SVD decomposed from the original image and the computing time is long. In this paper we also compared the results with PSNR for different techniques such as DCT, DWT and SVD.

Keywords: DCT, DWT, SVD, PSNR.

I. INTRODUCTION

With the rapid development of computer and network, more and more multimedia products are spreading on the Internet. How to prevent the copy or hostilely modify of the products is an austerity problem for the providers. Digital watermark is an effective method to protect the copyright and to check whether the product is modified. An effective watermarking scheme should contain these characteristics: robustness, security, adequate capacity of the information, invisibility etc. Generally, digital watermark can be classified into two categories according to the embedding domain: the spatial domain watermark and the transform domain watermark. In the spatial domain, the pixel values of the image are modified, such as the LSB [1]. But these methods are not very robust against image processing and the watermark may be erased easily. In the transform domain, the image is first translated using DCT (Discrete Cosine Transform) [2] or DWT (Discrete Wavelet Transform) [3] and then the watermark is embedded into these transform domains. Ju Liu et al proposed an ICA-based watermarking scheme, which is a method in another transform domain [4]. Singular value decomposition (SVD) is an effective numerical analysis tool used for matrices and is widely used in digital image processing. The singular values of the image are very stable, so even if great disturbances are added to images, the singular values will not change markedly. In [5], Liu and Tan proposed a digital watermark in SVD, which modify the global singular values (SVs) of the original image. This method changed all the singular values of the global SVD decomposed from the original image and the computing time is long. In [6], Zhou and Tang presented an improved method based on block SVD which was faster than the former method but the false positive probability is very high. In this paper, we embed the watermark into the singular values in another way, that is, instead of changing the values of the eigen matrix of the original image, we only modify the order of the SVs in each block. In the detection, whether the order is changed is used as the measurement of the existence of watermark. The proposed method not only reduces the false positive probability, but also is robust against common image processing.

II. Singular Value Decomposition

The SVD is employed in a variety of applications from least squares problems to solving systems of linear equations. Each of these applications exploits key properties of the SVD. Its relation to the rank of a matrix and its ability to approximate matrices of a given rank. Many fundamental aspects of linear algebra rely on determining the rank of a matrix. Making the SVD an important and widely used technique. Singular value decomposition takes a rectangular $m \times n$ matrix *A* and calculates three matrices *U*, *S*, and *V*. *S* is a diagonal $m \times n$ matrix (the same dimensions as *A*). *U* and *V* are *unitary* matrices with sizes $m \times m$ and $n \times n$ respectively. The matrices are related by the equation

$$A = USV^H \qquad \text{...(1)}$$

Calculating the SVD consists of finding the Eigen values and eigenvectors of AA^H and A^HA. The eigenvectors of A^HA make up the columns of *V;* the Eigen vectors of AA^H make up the columns of *U*. The Eigen values of A^HA or AA^H are the squares of the singular values for *A*. The singular values are the Diagonal entries of the *S* matrix and are arranged in descending order. The singular values are always real numbers. If the matrix *A* is a real matrix, then *U* and *V* are also real. Equation (1) can be expressed as

$$A = \sum_{i=1}^{\min\{m,n\}} U_i S_i V_i^H$$

Where U_i and V_i are the i^{th} column vectors of *U* and *V* respectively, and S_i are the singular values.

The matrix *A* can be approximated by matrix Â with rank *k* by

$$\hat{A} = \sum_{i=1}^{k} U_i S_i V_i^H$$

The 2-norm of a matrix may be calculated from the singular values. Therefore the 2-norm of the error matrix (*A*, *Â*) is the equal to the next singular value not used in Â. As the singular values are in descending order, it can be seen that the error decreases towards zero in the 2-norm sense.

Singular value decomposition takes a rectangular matrix of gene expression data (defined as A, where A is a n x p matrix) in which the n rows represents the genes, and the p columns represents the experimental conditions. The SVD theorem states:

$$A_{n\times p} = U_{n\times n} S_{n\times p} V^T{}_{p\times p}$$

Where

$U^TU = I_{nxn}$

$V^TV = I_{pxp}$ (i.e. U and V are orthogonal)

Where the columns of U are the left singular vectors (gene coefficient vectors); S (the same dimensions as A) has singular values and is diagonal (mode amplitudes); and V^T has rows that are the right singular vectors (expression level vectors). The SVD represents an expansion of the original data in a coordinate system where the covariance matrix is diagonal.

Calculating the SVD consists of finding the eigenvalues and eigenvectors of AA^T and A^TA. The eigenvectors of A^TA make up the columns of V, the eigenvectors of AA^T make up the columns of U. Also, the singular values in S are square roots of eigenvalues from AA^T or A^TA. The singular values are the diagonal entries of the S matrix and are arranged in descending order. The singular values are always real numbers. If the matrix A is a real matrix, then U and V are also real.

III. Robust Image Watermarking Scheme using Singular Value Decomposition (SVD)

In this paper we propose a invisible digital watermarking scheme based on Singular Value Decomposition (SVD). In the proposed method, we first divide the image into 8*8 sub blocks, and then each block is decomposed by SVD. We embed the watermark image bits into the D-matrix. Finally we perform inverse SVD to each block to get watermarked image. Similarly in the detection we also divide the image into 8*8 sub blocks, and then decomposed by SVD then retrieve the watermark bits. The experimental results show that the proposed scheme is robust against common image processing operations, such as JPEG compression, additive Gaussian noise, and median filter, Singular value decomposition(SVD) is an effective numerical analysis tool used for matrices and is widely used in digital image processing. The singular values of the image are very stable, so even if great disturbances are added to images, the singular values will not change markedly. In the proposed scheme diagonal matrix (D) is used for watermark embedding. The diagonal matrix formed by applying powerful mathematical tool named as SVD (Singular Value Decomposition). In the proposed method, the cover images is divided into 8x8 sub blocks and then apply the SVD to each sub block. After SVD calculation it results two orthogonal matrices and one diagonal matrix formed. In this method we modify the diagonal matrix for watermark embedding and extraction processes.

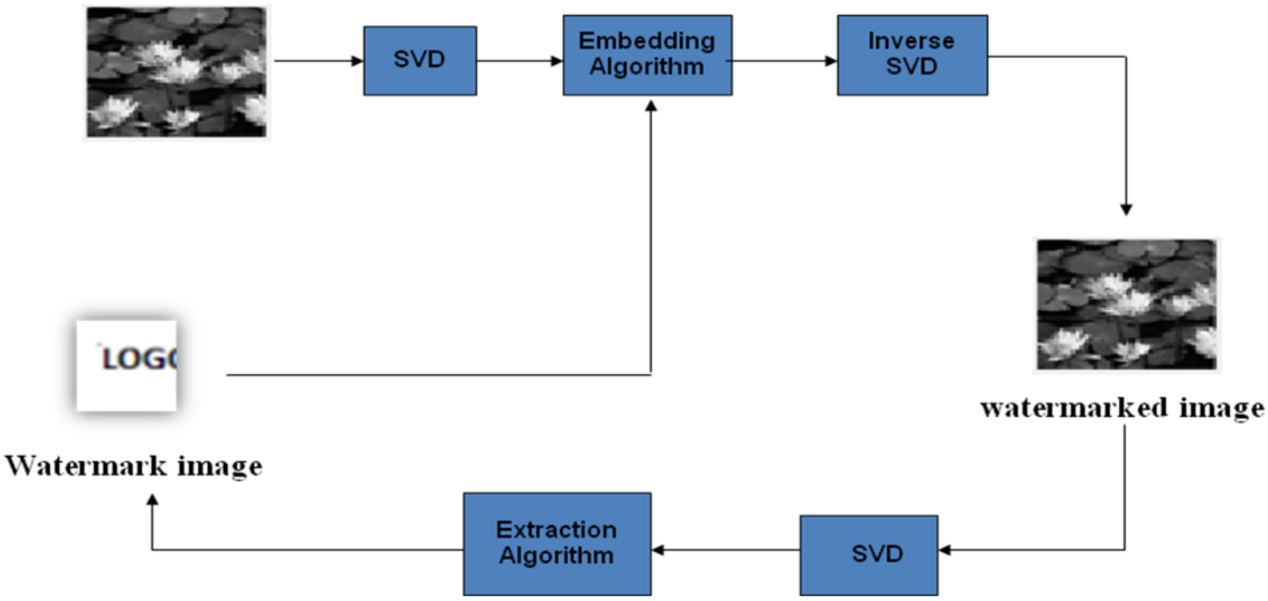


Fig. 1 Flowchart for Proposed Model

A. The watermark embedding algorithm:

1. Taking the host image of size 512x512.
2. Host image is divided into top left and right bottom parts. In this we select the top left is selected for hiding the watermark image.
3. The host image is sub divided into 8x8 sub blocks SVD transformation is applied on each individual selected block
4. A matrix D_{large} is formed with largest singular values of each block. The size of the D_{large} is 32x32
5. The maximum and minimum values of D_{large} are represented as d_{max} and d_{min} respectively.
6. Taking the watermark image of size 32x32, then converted into binary image
7. If the watermark bit =1 then modify the D_{large} as

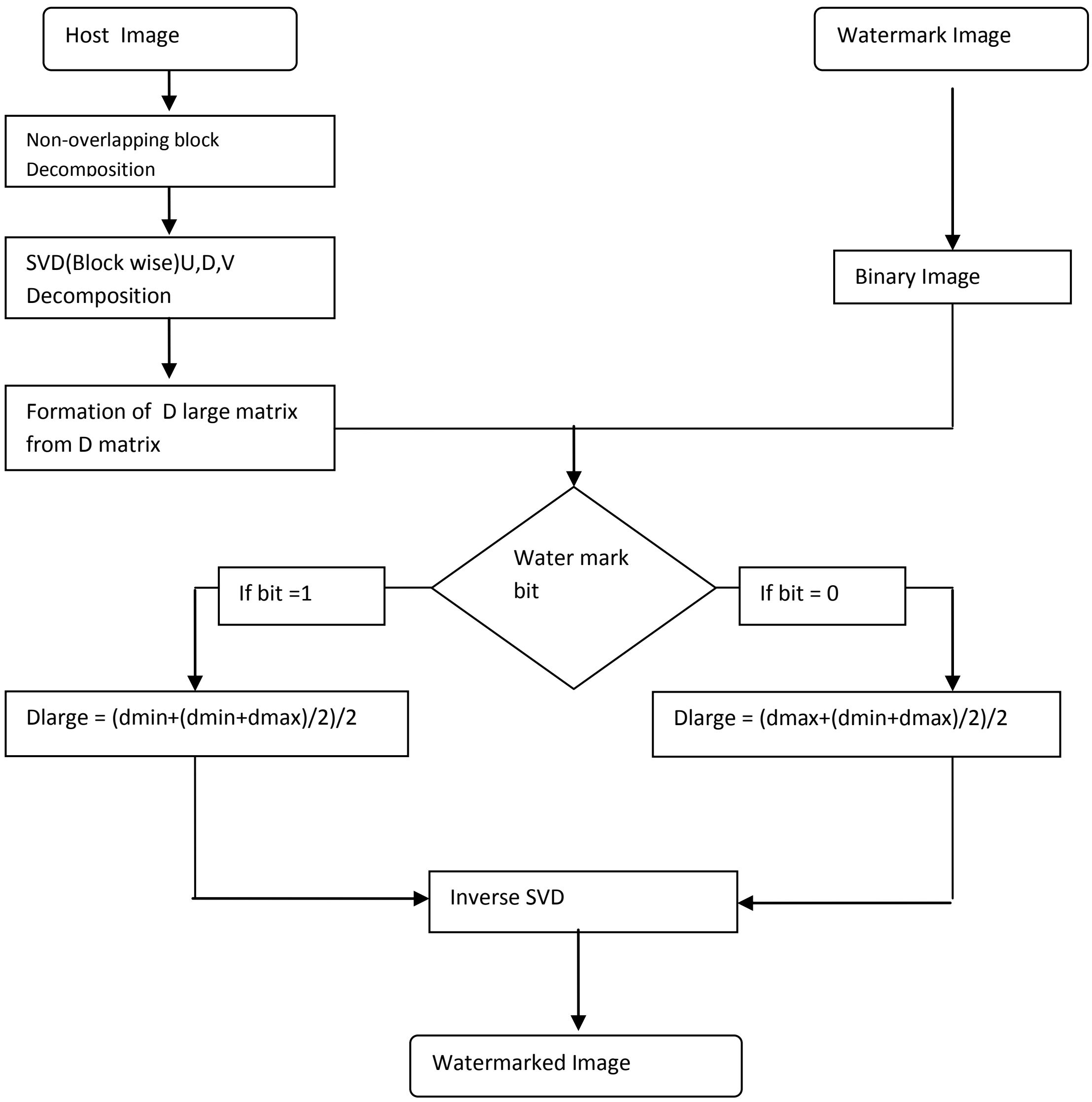
$D_{large} = (d_{min}+(d_{min}+d_{max})/2)/2$

8. If the watermark bit = 0 then modify the D_{large} as

   $D_{large} = (d_{max}+(d_{min}+d_{max})/2)/2$

9. After the modification of D_{large} values, inverse SVD is applied on each selected block to get the watermarked image.

Embedding Methodology



Flow chart of Embedding Methodology

B. **Extraction process:**

The watermark extraction algorithm is as follows:

1. Taking watermarked image of size 512x512.
2. Watermarked image is divided into top left and right bottom parts. In this we select the top left image for extracting the watermark image.
3. The watermarked image is sub divided into 8x8 sub blocks
4. SVD transformation is applied on each individual selected block
5. A matrix D_{large} is formed with largest singular values of each block. The size of the D_{large} is 32x32

6. The watermark bit is '1' if D_{large} lies in the interval d_{min} to $(d_{min} + d_{max})/2$.

7. The watermark bit is '0' if D_{large} lies in the interval $(d_{min} + d_{max})/2$ to d_{max}

IV. RESULTS

A. HOST IMAGE- WINTER

In the following fig.2 LOG image is watermarked into the winter host image from that we calculated the PSNR for different techniques(DCT, DWT, SVD) by considering image Resizing

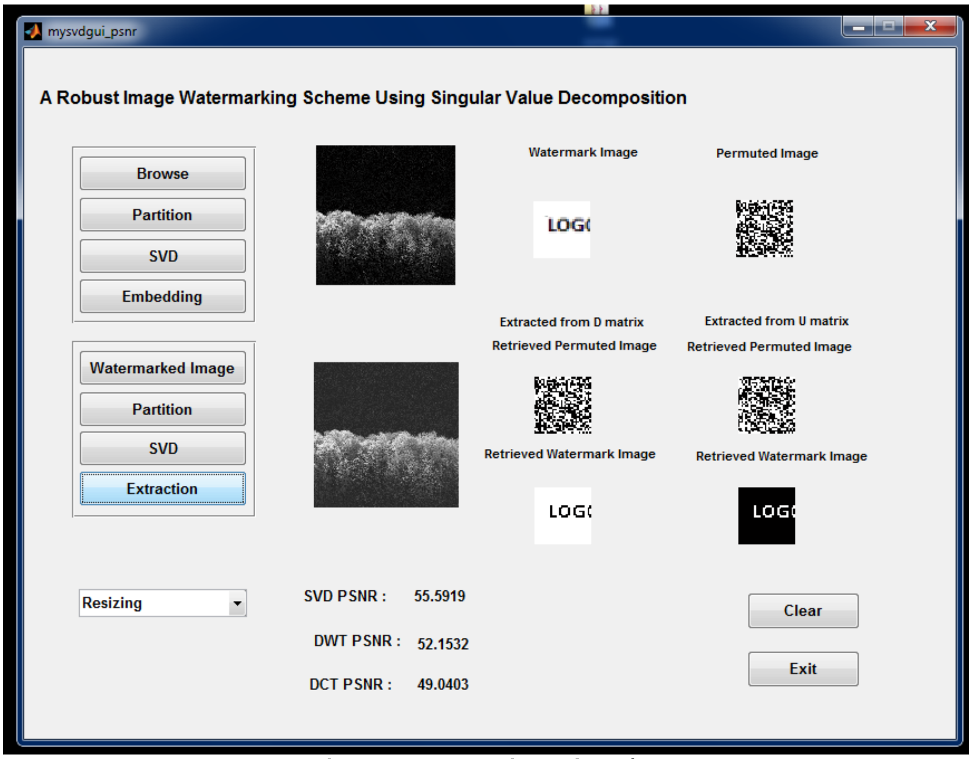


Fig. 2 A Robust image Watermarking Scheme for winter

B. HOST IMAGE- WATER LILLIES

C. In the following fig.3 LOG image is watermarked into the winter host image from that we calculated the PSNR for different techniques(DCT, DWT, SVD) by considering median filtering

Table 1 Comparision table of PSNR for different host images

S. No	Cover Image	DCT	DWT	SVD
1	winter	49.04	52.15	55.59
2	water lillies	48.06	47.44	59.73

In the table1 we compared the different techniques i.e DCT, DWT, SVD with PSNR.

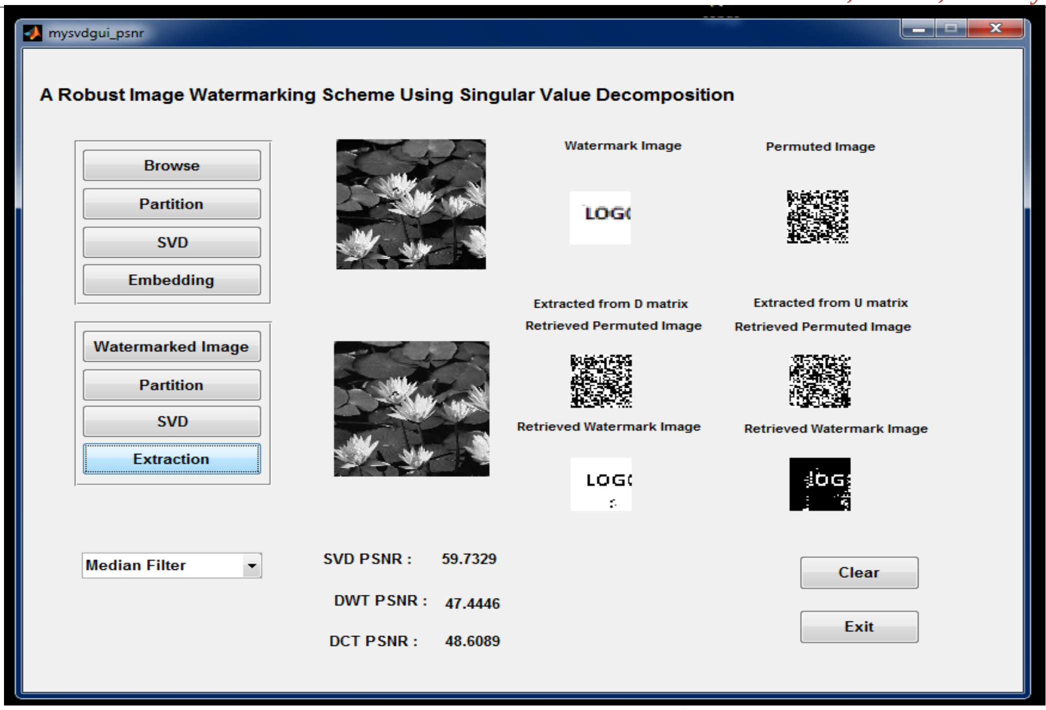


Fig. 3 A Robust image Watermarking Scheme for Winter

V. CONCLUSION

In this paper, a watermarking scheme based on Singular Value Decomposition, is proposed. The proposed method is highly robust and can survive many image processing attacks. The quality of the watermarked image is good in terms of perceptibility and PSNR.

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