IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Volume-3, Issue-1 E-ISSN: 2347-2693

Chaos based Image Watermarking using IWT and SVD

A.Kala[1*] and K.Thaiyalnayaki[2]

[1]Assistant Professor, Department of IT, Sri Venkateswara College of Engineering, Chennai
www.ijcaonline.org

Received: Dec /26/2014 Revised: Jan/8/2015 Accepted: Jan/20/2015 Published: Jan/31/2015

Abstract- Copyright protection and rightful ownership is needed in the fast growing Internet environment. The watermarking offers a convenient way to hide specific information via an imaging system. In this paper, we proposed a IWT and SVD-based image watermarking scheme by embedding the watermark into the host image. The chaos encryption is applied to the watermark image before embedding into host image to provide robustness. The proposed watermarking algorithm is tested for different attacks. It shows very good robustness and also good quality of watermark is extracted by performing other common image processing operations like brightening, sharpening, contrast enhancement etc. The experimental results demonstrate that the proposed method overcomes the various attacks.

***Keywords*:** IWT, SVD, Chaos

I. INTRODUCION

The main goal of image watermarking is to hide some important information into a host image such that the presence of the watermark cannot be perceived by human vision. A good watermarking algorithm should be able to meet three criteria, i.e. the rightful ownership protection, robustness to image manipulations, and watermark imperceptibility. In the ideal situation, only the real owner can extract the watermark correctly from a watermarked image. Several methods have been addressed for developing or improving the image watermarking scheme. The SVD transformation is commonly employed in the image watermarking scheme because of stability property in its singular value matrix.

In the SVD watermarking approaches, the scaling factor plays an important role to control the robustness and imperceptibility of a watermark. By setting a higher value of the scaling factor, the watermarked image is more robust against several attacks. Yet, the image quality is dramatically degraded. In contrast, the transparency of the watermark is achieved by setting a lower scaling factor with a trade-off that the watermarked image is rather less robust against geometric and image processing attacks [1,5]. In this paper, the Chaotic Baker map is used for the encryption of the watermark image [7,8].

II. THEORY

A. Chaotic encryption

Chaotic encryption of the watermark image is performed using the chaotic Baker map. The Baker map is a chaotic map that generates a permuted version of a square matrix. In its discretized form, the Baker map is an efficient tool to randomize a square matrix of data. The discretized map can be represented for an N ×N matrix as follows:

$$B(x,y)=\left[\frac{N}{n_i}(x-N_i)+y \bmod\left(\frac{N}{n_i}\right), \frac{n_i}{N}\left(y-y \bmod\left(\frac{N}{n_i}\right)\right)+N_i\right]$$ where B(x, y) are the new indices of the data item at (x, y), $N_i \leq x < N_i + n_i$,
$0 < y < N$ and $N_i = n_1 + n_2 + \cdots + n_i$.

The chaotic encryption is performed as follows:
1. An $M \times M$ square matrix is divided into k rectangles of width n_i and number of elements N.
2. The elements in each rectangle are rearranged to a row in the permuted rectangle. Rectangles are taken from left to right beginning with upper rectangles then lower ones. Inside each rectangle, the scan begins from the bottom left corner towards upper elements.

B. Singular value decomposition (SVD)

The singular value decomposition, or SVD, is related to the theory of diagonalizing a symmetric matrix in linear algebra. It decomposes a rectangular matrix A into three matrices U, S and the transpose of V; U and V are orthogonal square matrices whose columns are called left and right singular vectors respectively, S is a rectangular diagonal matrix with diagonal entries in descending order that are called singular values. It may be considered as a method of transforming correlated data set into uncorrelated one that better explain the various relationships among the original data. SVD finds its significance in image processing as a digital image can be viewed as a matrix of nonnegative scalar entries.

Let A be a square matrix of order n, then according to SVD it can be represented mathematically as:

$$A = USV^T$$

where $UU^T = I_n$ and $VV^T = I_n$. The columns of U are orthonormal eigenvectors of AA^T, the columns of V are

© 2015, IJCSE All Rights Reserved

orthonormal vectors of A^TA and S is a diagonal matrix containing the square roots of the eigenvalues from U or V in descending order.

If r (r ≤ n) is the rank of the matrix A then the elements of the diagonal matrix S satisfy the relation and the matrix A can be written as

$$\sigma_1 \geq \sigma_2 \geq \ldots \geq \sigma_r > \sigma_{r+1} = \sigma_{r+2} \ldots = \sigma_n = 0$$

$$A = \sum_{i=1}^{r} \sigma_i u_i v_i^T$$

where u_i and v_i are the ith eigenvector of U and V and σ_i is the ith singular value.

Advantages of using SVD in the digital image processing field are as follows:

1. Singular values, SVs, represent algebraic image properties, where S represents the brightness of the image while U and V are the geometry properties of the image.
2. Singular values of each image have a good stability. It means that for a small perturbation added to an image, its SVs do not change fast.
3. SVD matrices can be square or rectangle.

C. Integer wavelet transform

The integer wavelet transform (IWT) provides the decomposition of the original image into a set of integer coefficients. Integer to integer wavelet transforms map an integer data set into another integer data set. These transform are perfectly invertible and yield exactly the original data set.

For transforming the image, the daubechies' 5/3 bioorthogonal wavelet for decomposition is given by an equation as follows:

$$d[n]=d0[n]-[1/2(s0[n+1]+s0[n])]$$
$$s[n]=s0[n]+[1/4(d[n]+d[n-1]+1/2)$$

Where d[n]is the high pass subband signal and s[n] is the low pass subband signal and s0[n]=x[2n] and d0[n]=x[2n+1]. Every wavelet or subband transform associated with finite length filters can be obtained as the Lazy wavelet followed by a finite number of primal and dual lifting steps and a scaling (the Lazy wavelet essentially splits the signal into its even and odd indexed samples). By combining the lifting constructions with rounding-off in a reversible way, a wavelet transform that maps integers to integers can be obtained.

The forward wavelet transform takes N elements in step *j* and calculates N/2 detail coefficients (shown as *d* above) and N/2 scaled values (shown as *s* above). The scaled values become the input for the next step of the wavelet transform (which is why these values are shown with the subscript *j+1*). In the next step, $N_{j+1} = N_j/2$. The inverse wavelet transform in step *j* rebuilds the $s_{j-1,i}$ and $s_{j-1,i+1}$ (even and odd elements) from the d_j and s_j values.

Advantages of IWT:

1. Low computational complexity
2. Efficient handling of lossless coding
3. Minimal memory usage
4. Performs best for images with greater amount of high frequency content.

III. PROPOSED METHOD

A. Watermark Embedding

Fig.3.1 represents the watermark embedding algorithm.

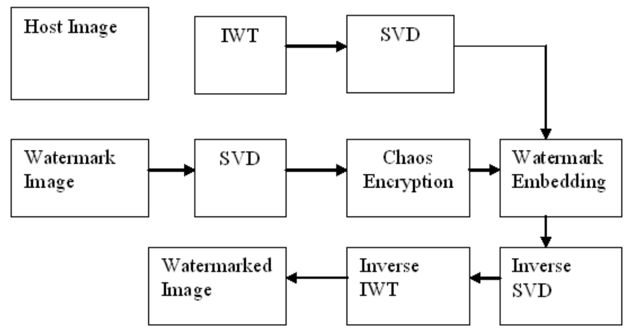


Fig 3.1 Watermark Embedding

Watermark image is embedded into host image using the following procedure:

- 1-level IWT is performed for a host image I with size L × K.
- The SVD is performed on the LL sub band of matrix A.
  - $A = U\,SV^T$
- The SVD is performed on the watermark image.
  - $D = Uw\,Sw\,V^Tw$
- The chaotic encryption is applied to an watermark image.
- Combine SVs of the chaotic encrypted watermark with the SVs of the selected sub-band using appropriate scaling factor α, as illustrated in Equation
  - $S_{wkd} = S_{org} + \alpha S_w$

  where α is the scale factor which controls the strength of each watermark bit to be embedded.
- Perform inverse SVD.
- Perform the inverse IWT to get the watermarked image Iw.

B. Watermark Extraction

Fig.3.2 represents the watermark extraction algorithm.

Embedded Watermark is extracted from the watermarked image by using the following steps.

1-level IWT is performed on a watermarked image I^w with size L × K.

© 2015, IJCSE All Rights Reserved

- Get all the subbands of the IWT image I^w.
- Apply SVD to LL subband of decomposed watermarked image to get three components U_{wkd}, S_{wkd}, and V_{wkd}.
- Apply SVD to original image to get three components U_{org}, S_{org}, and V_{org}.
- Subtract the SVs of the watermarked image with the SVs of the selected LL sub-band of original image and divide the result using the same scaling factor α, as illustrated in Equation.

$$S_{w'} = (S_{wkd} - S_{org}) / \alpha$$

- The chaotic decryption is applied to an encrypted watermark image.
- Perform the multiplication of U_w, $S_{w'}$ and V_w to get the watermark image.
- Output the extracted Watermark Image.

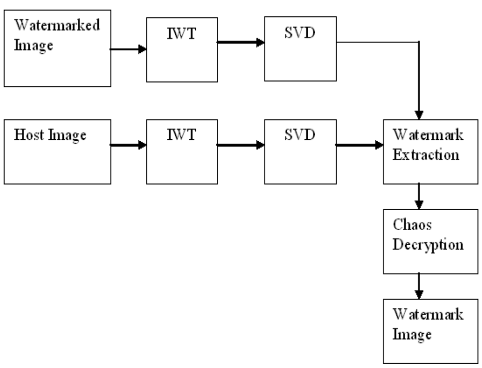


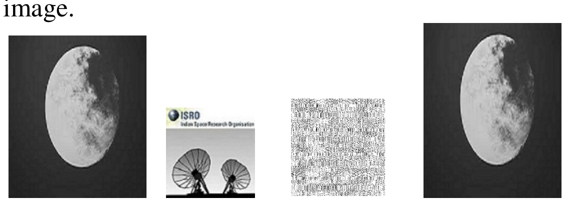
Fig 3.2 Watermark Extraction

IV. EXPERIMENTAL RESULTS

The watermarking is developed in JAVA with NetBeans environment. SVD is developed using Java Matrix (JAMA) package. In JAMA package, Singular value decomposition class is used to get three matrices from single input matrix.

Watermark Embedding

Fig 4.1 shows the host image, watermark image, encrypted watermark image and watermarked images. The images used in experiments are of size 512 × 512 for host image and of size 256 × 256 for the watermark image.



Host Image Watermark Image Encrypted Watermark Watermarked Image

4.1 Watermark Embedding

Watermark Extraction

Fig 4.2 shows the watermarked image, extracted watermark image and decrypted watermark image. The images used in experiments are of size 512 × 512 for host image and of size 256 × 256 for the watermark image.

Watermarked Image Extracted Watermark Decrypted Watermark

4.2 Watermark Extraction

V.CONCLUSION

In this proposed approach, we use a chaos method for image encryption. It is secured because it uses encryption technique to encrypt the watermark image. After extraction of the watermark, the quality of the image is good. Thus, we conclude that the proposed approach is effective for watermarking scheme, which is resistant to the common attacks.

VI. REFERENCES

[1] C.-C. Chang, P. Tsai, C.-C. Lin," SVD-based digital image watermarking scheme", Pattern Recognition Letters 26 (10) (2005) 1577–1586.

[2] Chesta Jain, Vijay Chaudhary,"Performance Analysis of Integer Wavelet Transform for Image Compression " IEEE conference 2011.

[3] Chin-Chin Lai ,"Digital Image Watermarking Using Discrete Wavelet Transform and Singular Value Decomposition", IEEE Transaction on Instrumentation and measurement Vol.59, No 11, November 2010.

[4] Li-bao Zhang Xian-chuan Yu, "An Efficient Image Coding Using Multiple Subbands Integer Wavelet Decomposition", International Symposium on Intelligent Signal Processing and Communication Systems Nov.28-Dec.1, 2007 Xiamen, China

[5] R. Liu, T. Tan, "An SVD-based watermarking scheme for protecting rightful ownership", IEEE Transactions on Multimedia 4 (1) (2002) 121–128.

6] Ms.K.Thaiyalnayaki, Ms A.Kala, " Dual robust watermarking using Integer wavelet Transform and Singular value decomposition", International Journal of

 © 2015, IJCSE All Rights Reserved

Remote Sensing & Geoscience ISSN No: 2319-3484 ,Volume 2, Issue 6, Nov. 2013

[7] Waleed Al-Nuaimy Mohsen A.M, "An SVD audio watermarking approach using chaotic encrypted images", Digital Signal Processing 21 (2011) 764–779

[8] F. Han, X. Yu, S. Han, Improved Baker map for image encryption, in: Proceedings of the First International Symposium on Systems and Control in Aerospace and Astronautics, ISSCAA 2006, pp. 1273–1276.

[9] A.Kala, K.Thaiyalnayaki ,"Robust Lossless Image watermarking in Integer Wavelet Domain using SVD", International Journal of Computer Science Engineering,Volume 2,issue 2 ,March 2013.

 © 2015, IJCSE All Rights Reserved