Color Image Watermarking Scheme in RGB Space Using DWT-SVD

Rajesh Kumar Mishra[1] Kanchan cecil[2]
(DoET)Jabalpur engineering college

Abstract--- To overcome the problem of color image this paper proposes a watermarking scheme in B domain of color image DWT-SVD. The singular values of B channel are modified by singular value of watermark. Low frequency sub-band coefficients are less robust to geometrical distortion and histogram equalization while High frequency sub-bands are resistant to another attacks. Hence embedding the same watermark in all bands will make it difficult to remove the watermark from all frequency sub-bands. So here we embed watermark in all four sub-bands (LL, HL, LH, HH) to increase robustness. Set of image processing attacks are applied to watermarked image to check the scheme performance.
Key words: Watermarking, DWT, SVD.

I. INTRODUCTION

Image watermarking is one of the widely used techniques to protect the copyright of digital images. It is technique to embed information in original image so that later can be extracted for ownership verification. Important application of the watermark technique is copyright protection [3], ownership verification, finger printing, medical application, broadcast monitoring etc. Efficiency, security, Robustness is the major requirements for the watermark system. The common signal processing attacks are JPEG, compression, filtering, cropping, rotation, resizing and additive noise. Generally Imperceptions and Robustness are contradictory to each other. Hence the improvement of imperceptions often causes the loss of robustness and vice versa, so the watermarking designers have to compromise between these two. According to the domain in which watermark embedded, watermarking techniques can be classified into spatial and frequency domain techniques [2]. In spatial domain techniques watermark is embedded by directly modifying pixel values of cover image. These algorithms are simple and efficient but less robust and secure to image processing attacks [9]. In the frequency domain techniques the watermarks inserted into transformed coefficients of image and spread out to entire part of image for making more robustness against watermarking attack [4]. For this transformation any techniques [9][10] can be used from Discrete Fourier transform (DFT) , Discrete cosine transform (DST) and Discrete wavelet transform (DWT)[5][6][11] . Peak signal to noise ratio (PSNR) and Normalize correlation (NC) are major parameters used to check the performance of watermarking techniques. Color image watermarking can be implemented in RGB, YUV and YIQ color spaces. In the transform domain watermarking the common method is to modify the coefficients obtained from singular value decomposition of image. The SVD [1] embed the singular values of the watermark into the singular values [8][9]. Quality degradation is the most important drawback in SVD based algorithm. Also the extracted watermark is not enough robust in SVD based algorithm .In this paper a new watermarking algorithm for color images in B color space is proposed by using DWT and SVD method. The schemes improve the visual quality of extracted watermark under image processing attacks and also improve the Normalized correlation and Peak signal to noise ratio.

II. BACKGROUND AND THEORY

A. *Discrete Wavelet Transform (DWT)*

DWT has developed as a new time and frequency analysis method in recent years. At level 1, DWT decomposes image into four non overlapping sub bands: LL1 (Approximate sub band), HL1 (Horizontal sub band), LH1 (Vertical sub band) and HH (Diagonal Sub band). Here, LL1 is low frequency component whereas HL, LH and HH are high frequency (detail) components. By decomposing the approximated image at each level into four sub images forms the pyramidal image tree Mathematically the wavelet transform is convolution operation, which is equivalent to pass the pixel values of an image through a low pass and high pass filters. Figure 1.shows 2-D wavelet decomposition.

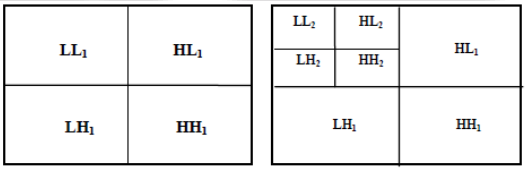

Fig. 1: 2-D Wavelet Decomposition Sketch Map

B. *Singular Value Decomposition (SVD)*

For traditional algorithm, Singular value decomposition is a numerical algorithm of matrix diagonalization . Given a real m x m A, this matrix can be transformed into three components
U, S and V, respectively,

$$A = USV^T \qquad (1)$$

Where U and V components are m x m real unitary matrices, and S is diagonal matrix, the superscript T denotes matrix transposition. The diagonal elements of S, denoted byσ_i, are called the singular values of A. The columns of U denoted by u_i, are called the left singular vectors of A while V denoted by v_i, are called the right singular vectors of A,

III. A WATERMARKING ALGORITHM COMBINING SVD WITH DWT

A. *Watermark embedding procedures*

(1) Denote the original color image as I, and then extract the blue component, named B.

(2) Use DWT and decompose B in to four sub bands LL, HL, LH & HH. Apply SVD to HL component of B to get U, S & V.
(3) Denote grayscale watermark by W, and then apply SVD on watermark.
(4) Multiply singular value of watermark by scaling factor K and add with singular value of color image, named Ss.
(5) Apply inverse SVD on Ss, U & V to get H1 component.
(6) Apply Inverse DWT by taking component LL, HL (H1), LH & HH to get B1 component of watermarked image. And combine R, G & B1 component to get Watermarked image I1.

The color image is transformed into R, G and B channels of size m x n. Human eyes are less sensitive to change in the intensity of the B channel. On the B channel the one-level DWT is applied to generate

Sub-band coefficients LL, LH, H L, H H of size m/2 x n/2.The SVD decomposition is applied on all sub-band coefficients and watermark.

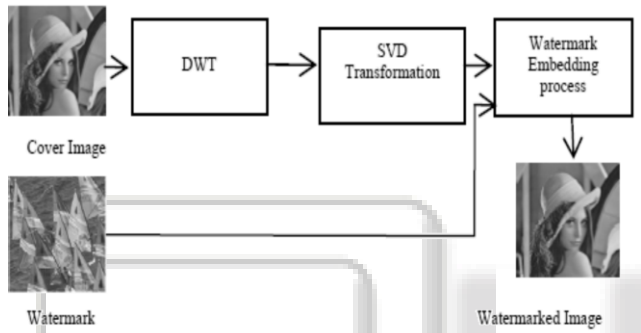

Fig. 2: Process of Imbedding Watermark in an Image

B. Watermark extracting procedures

(1) Separate B component from watermarked image.
(2) Apply DWT on B component of watermarked image.
(3) Apply SVD on HC component to get singular value S1.
(4) Apply SVD on watermark and get singular value S2.
(5) Support S2 from S1 and divide by scale factor K to get S3.
(6) Apply inverse SVD on S3 and U and V component of watermark named W1, this is the extracted watermark.

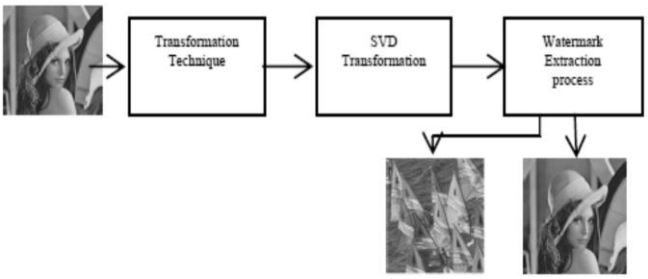

Fig. 3: Process of extracting watermark from image

In these experiments the color image of size 568 x 560 (Lena image) and monochrome watermark (cameraman) of size 284 x 280 are considered.

We test the proposed method under many attacks such as Gaussian noise, Speckle noise, Image sharpening, rotation etc. Peak signal to Noise ratio (PSNR) and Normalized Correlation (NC) are used to measure the performance of watermarking algorithm. Suppose $r(i,j), g(i,j), b(i,j), r'(i,j), r'(i,j), g'(i,j), b'(i,j)$ are image pixels of original image I $(M \times N \times 3)$ and watermarked image $I'(M \times N \times 3)$. Then PSNR is-

IV. EXPERIMENTAL RESULTS

The series of experiments are conducted to analyze the effect of embedding and extraction algorithm on the color image. The effect of different image processing attacks on color image is analyzed considering the watermarked Lena color image.

$$PSNR(dB) = 10log\frac{Max_I^2}{MSE/3}$$

Where Max_I is the maximal pixel value of image and $MSE = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}\left[\left(r(i,j) - r'(i,j)\right)^2 + (g(i,j) - g'(i,j))^2 + (b(i,j) - b'(i,j))^2\right]$

MSE =Mean Square Error

$$NC = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N} I(i,j)I'(i,j)}{\sqrt{\sum_{i=1}^{M}\sum_{j=1}^{N} I(i,j)^2}\sqrt{\sum_{i=1}^{M}\sum_{j=1}^{N} I'(i,j)^2}}$$

NC measures the similarity between original and extracted image & its maximum value is 1.Acceptable values of PSNR are considered to be 20 dB to 25 dB. Higher the PSNR value better it is.

Various Attacks	Proposed(DWT-SVD) Algorithm		SVD Algorithm [ref]	
	PSNR(in dB)	NC	PSNR(in dB)	NC
Without Attack	34.2165	0.9996	29.7182	0.7427
Gaussian Noise	33.4149	0.9995	27.2134	0.6434
Rotation	32.1941	0.9986	28.0008	0.5342
Image Sharpening	30.6618	0.9975	27.6531	0.7121
Speckle Noise	33.1320	0.9989	26.2165	0.5112
JPEG compression	33.3215	0.9995	28.4431	0.8315

Table 1: PSNR & NC comparison under various Attacks

Table1 show the PSNR & NC value comparison of proposed algorithm and ref [1].

Fig.4: Watermarked image and extracted watermark

The result clearly shows that the proposed DWT-SVD algorithm gives better PSNR & NC compared to SVD algorithm under various attacks. Since it combine advantage of DWT with SVD. Table2 show the extracted watermark of both algorithms under various attacks. The visual quality of extracted watermark from proposed algorithm is better than extracted watermark from SVD algorithm. So, overall performance of DWT-SVD method is better than SVD algorithm.

V. CONCLUSIONS

In this paper a new color image watermarking Based on DWT-SVD algorithm is proposed. The B component of color image is used for watermark embedding. The proposed algorithm combines the advantages of DWT and SVD so it performs better under different image processing attacks than only SVD algorithm. So the proposed method improves security and robustness.

REFERENCES

[1] Soo-Chang Pei, Hsin-Hua Liu, Tsung-Jung Liu, Kuan-Hsien Liu "Color Image Watermarking using SVD," IEEE International Conference on Multimedia and Expo(ICME), pp. 122-126, 2010.
[2] P. Vidyasagar, H. Song and C. Elizabeth., "A survey of digital image watermarking techniques", IEEE 3rd International Conference on Industrial Informatics, Frontier Technologies for the Future of Industry and Business, pp.709-716, 2005.
[3] I.J. Cox, M.L. Miller, 1. A. Bloom, 1. Fridrich, T. Kalker, "Digital Watermarking and Steganography", Second edition, Morgan Kaufmann Publishers, 2008.
[4] B. L. Gunjal and R. R. Manthalkar, "Discrete Wavelet Transform Based Strongly Robust Watermarking Scheme for Information Hiding in Digital Images," Third International Conference- Emerging Trends in Engineering and Technology,19-21 Nov 2010Goa,India, ISBN 978-0-7695-4246-1.
[5] Ali Al-Haj,"A Hybrid Digital Image Watermarking Algorithm", 4th International Conference on Innovations in Information Technology. pp: 690 - 694 Nov. 2007.
[6] Jung-Chun Liu, Chu-Hsing Lin, and Li-Ching Kuo" A Robust full band image watermarking scheme" Proceedings on IEEE.2006.
[7] R.Liu, and T.Tan, "An SVD-based watermarking scheme for protecting rightful ownership," IEEE Transactions on Multimedia vol. 4, PP. 121-128, 2002.
[8] D.S. Chandra, "Digital image watermarking using singular value decomposition," Proceedings of the 45th IEEE Midwest Symposium on Circuits and Systems (MWSCAS'02), vol. 3, pp.264–267, 2002.
[9] P. Meerwald, A. Ubi, "A survey on wavelet domain watermarking algorithms", Proceedings of SPIE, Electronic Imaging, Security and Watermarking of Multimedia Contents III, vol. 4314, pp. 505-516, 2001.
[10] D. Kundur, D. Hatzinakos, "Towards robust logo watermarking using multiresolution image fusion", IEEE Transcations on Multimedia, vol.6, pp. l 85-197, 2004.
[11] Nagaraj V. Dharwadkar, B. B. Amberker, "An Efficient Non-blind Watermarking Scheme for Color Images using Discrete Wavelet Transformation", International Journal of Computer Applications, vol.2, issue 3, pp.60-66, 2010.
[12] V.Santhi and Dr. Arunkumar Thangavelu, "DWT-SVD Combined Full Band Robust Watermarking Technique for Color Images in YUV Color Space,"International Journal of Computer Theory and Engineering,Vol. 1, No. 4,October20091793-8201.

