A ROBUST DIGITAL WATERMARKING FOR GRAY SCALE IMAGE

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Abstract: Digital image watermarking is a process of embedding a piece of digital content (image) into the original cover image and also it protects digital content from illegal manipulations. This paper describes the robust digital watermarking for gray scale image based on algorithms discrete wavelet transform (DWT), discrete cosine transform (DCT) and singular value decomposition (SVD). The aim of this paper is to increase robustness and imperceptibility of the image for different attacks like compression, rotation and cropping etc., And also evaluates parameter values to know performance metrics of the image.
Keywords: DWT; DCT; SVD; Embedding; Extraction

I. INTRODUCTION

In a recent years developing effective watermarking techniques to avoid the unauthorized duplication of multimedia content. One approach is to avoid this problem is digital watermarking (i,e audio ,video, images, text).Embedding watermarks [3]-[6] in both signals and images can cause distortion in them so it mainly depends on the some requirements like imperceptibility or transparency, robustness and capacity. Transparency high means after embedding watermark there is no distortion in the cover image. If removal of watermark from watermarked image is more difficult to the attackers then it is more robust one. Capacity depends on how much data should be embedded as a watermark, and is high means one can hide more information. A digital watermarking property depends on security, capacity and watermark recovery with or without the original image. In our paper we are developing for non blind technique so it totally depends on watermark as well as cover image during embedding and extraction. In watermarking according to domain of watermark insertion two techniques comes into picture i.e. spatial domain and frequency or transforms domain. In spatial domain information can be spread out to entire image, after insertion of watermark into the cover image it reduces characteristics of the image and modified the whole content of the image. In spatial domain we don't have any choice because of this it is least significant one. So in our implementation we used transform domain techniques and explained one by one bellow:

A. Discrete Wavelet Transform (DWT)

DWT decomposes an image into set of band limited components such as LL, LH, HL, HH bands and is reassembled to get back original image without error. The concept behind DWT is that the multi-resolution and it contains both low and high frequency bands with constant bandwidth on logarithmic scale. The magnitude is high for low component and is more significant for embedding and extraction process [1].We can see in the figure low band is more transparent one and we are using this component for embedding and extraction will get good results. As we increases the resolution level, less no of frequency bands are involved so watermark extraction at lower resolutions is computationally more effective. Single level resolution shown below

Fig 1: 1st level decomposition

B. Discrete Cosine Transform (DCT)

It transforms a signal into elementary frequency component with varying magnitudes and frequency. In DCT two processes are available for embedding and extraction. In global DCT applying it to all part of image and separating the spectral regions according to their energy. It is less significant one for this, we referring to block based DCT and is divides image into non-overlapping blocks. Apply forward DCT to each of these blocks, it contains set of ac and dc coefficients. Left top corner of the matrix represents the lowest frequency coefficients are called ac coefficients while the right bottom most corner represents highest frequency coefficients are called dc coefficients. Apply any selection criteria to embed watermark by modifying the selected coefficients.

C. Singular value decomposition (SVD)

It represents the algebraic properties of an image. In SVD decomposed into three matrices that are of the same size as

the original matrix. Then SVD of original matrix A is defined as A=USV' where U and V are orthogonal matrices and S is diagonal elements are called singular values we used these S values to embed and extract the image.

II. RELATED WORK

The following works were carried out by specific persons in the area of digital watermarking search: Authors proposed watermarking algorithms based on DCT DWT SVD. They apply single level DWT and select the middle frequency bands LH and HL to embed watermark and applied 8*8 DCT square block process to select dc coefficients to achieve good image quality of watermarked [2]. Divide wavelet coefficients into blocks in each block they got first, second and third maximum coefficients. Then quantize first and second maximum coefficients according to binary watermark bits. Using DWT they can extract watermark without using original image or watermark and it provides quite robust against non-geometry or geometry attacks [7]. Sixteen low frequency band coefficients of the DCT sub-blocks used for embedding watermark information. The embedding process is based on changing the selected DCT coefficients of the host image to odd or even values. It maintains excellent invisibility qualities [8]. Host image is decomposed up to 3-levels and applied DCT block process to select coefficients and applied random sequences to the middle coefficients of DCT during embedding. The implementation of this paper shows good imperceptibility and higher robustness against common signal processing attacks [9]. A scrambled version of watermark is obtained with the help of Arnold transform. The embedding and extraction done in the high frequency domain of DWT and the small modification is not perceived by human eye. And it provides robustness against attacks such as image adjustment, blurring etc… [10]. Cover image is modified (zigzag) and divided to number of blocks of size n*n. To form reference image find the spatial frequency of each block and kept a threshold on this spatial frequency. Then applied DCT to HF band of DWT and modified the singular values of watermark and reference image to hide the watermark [11]. Original image is rearranged using zigzag sequence then apply DCT and SVD on all high bands LH, HL and HH of DWT. Watermark is then embedded by modifying the singular values of these bands to achieve robustness against different attacks [12]. Authors applied DCT to 3-levels high frequency band of wavelet transform. It is more efficient in terms of PSNR and correlation with original watermark and provides robustness against to the many image processing attacks [13]. Author uses SVD, non fixed orthogonal bases U and V for embedding. A result of SVD gives good accuracy, robustness and good imperceptibility in resolving rightful ownership of watermarked image [14]. Author performs 2-levels decomposition of original image and watermark image is embedded in LL band of cover image. And DCT changes image into blocks of M bits and compared watermarking using DWT and DWT-DCT methods performance analysis on the bases of PSNR, similarity factor of watermark and recovered watermark [15].

By observing all the paper s, we proposed a new robust digital watermarking technique for gray scale image as cover and watermark using advantages of three algorithms discrete wavelet transform, discrete cosine transform and singular value decomposition. To achieve robustness against different attacks watermark is embedded in lower band and modification is done singular values to get good transparency.

III. PROPOSED WORK FOR EMBEDDING AND EXTRACTION

First one level DWT applied to original cover image. LL band is selected for second level to achieve imperceptivity and HH band is selected. HH band is divided into 4*4 sub blocks. DCT is applied to each block and select first DC coefficients and form a matrix. SVD is applied to this matrix use the singular values to modified the original with singular values of watermark.

The procedure for embedding and extracting of watermark given step by step below:

A. Embedding process

1. Take original image of size N*N and apply DWT to get four sub bands LL, LH, HL and HH with size N/2*N/2.
2. Select LL band and apply 2-level DWT to decompose it into N/4*N/4 sub bands LL2, LH2, HL2, and HH2.
3. Take HH2 band , apply DCT 4*4 block process to select dc coefficients of each block and get DC coefficient matrix B
4. Then apply SVD to B, B= U*S*V', where U and V orthogonal matrixes and S is diagonal matrix are called singular values.
5. Take secrete or watermark image of size N/16*N/16. Apply SVD to it. B1= Us*Ss*Vs' and obtain Us, Ss and Vs
6. Modify S with Ss using tuned factor alpha with range 0 to 1
7. S1= S+(alpha * Ss)
8. Got Dct_val1= U*S1*V' i,e nothing but inverse SVD and place these values into positions of B
9. Apply inverse DCT (IDCT), to get LL_HH band
10. Apply inverse DWT (IDWT) to LL2, LH2, HL2 and LL_HH to get LL1 sub band
11. Apply inverse DWT to LL1, LH, HL and HH to get watermarked image

B. Extraction process

1. Take watermarked image and apply DWT to it to get ll, lh, hl and hh.
2. Then apply DWT to ll band to get ll2, lh2, hl2 and hh2
3. Then select hh2 band and apply DCT 4*4 square block process to select dc coefficients from each block to form matrix C
4. Apply SVD to C, C= u*ss*v' and obtain u, ss and v
5. To get back watermark, take temp = (ss-S)/alpha; EW = Us*temp*Vs'

6. EW is the recovered watermark image
7. To get back original cover image, take temp1= ss-alpha*Ss; EC = U*temp1*V'
8. Then apply inverse DCT to EC to get back ll_hh1
9. Apply inverse DWT to ll_hh1 to get back LL1
10. Apply inverse DWT to LL1 to recover the original image

IV. PARAMETER MATRICES

In our paper to evaluate parameter value used MSE, PSNR and NCC parameters.

Peak signal to noise ratio (PSNR): in this case is the ratio between maximum possible power of a original and the power of the watermarked that affects the fidelity of its representation.

Let consider original image as A and watermarked image as B with size M*N then MSE and PSNR value will be

$$MSE = \frac{1}{MN}\left(\sum_{i=0}^{M-1}\sum_{j=0}^{N-1}(|A-B|)\right)^2 \quad (1)$$

$$PSNR = 10.\log_{10}\left(MAX^2 A / MSE\right) \quad (2)$$

Normalized cross correlation (NCC):is calculated to know the robustness of algorithm. NCC is defined as follows using original watermark image (OW) and extracted watermark (EW)

$$NC = \left(\sum_{i=0}^{M-1}\sum_{j=0}^{N-1} OW * EW\right) / \left(\sum_{i=0}^{M-1}\sum_{j=0}^{N-1} OW * OW\right) \quad (3)$$

V. RESULTS AND TABULATION

Experimental set ups tested using MATLAB R2014b (8.4.0.150421), 64 bit (win 64). Here results are calculated using 256*256 cover image CAMERA MAN with 16*16 watermark image ANTENNA SIGNAL.

Fig2: original cover image

Fig3: watermark image

Fig4: watermarked image

Fig5: extracted watermark

Fig6: extracted cover image

TABLE 1:

	MSE	PSNR	NCC
Without attack	0.9707	48.2939	1

TABLE 2:

Attacks	NCC	PSNR	MSE
JPEG compression 60	0.9024	36.3960	15.0272
Median filter	0.2063	35.8902	16.8835
Wiener filter	0.3227	36.5085	14.6430
Gaussian filter	0.4958	37.4462	11.7994
Salt and pepper noise	0.9730	46.1413	1.5935
Image rotation	1	48.2939	0.9707
Image resize	-0.0346	34.5589	22.9396

Table 1 and Table 2 shows the results of proposed algorithm for watermark embedding PSNR, MSE and NCC

VI. CONCLUSIONS

In this paper, the proposed algorithm gives NCC value 1for no attacks and good PSNR and NCC values. So as per experimental result, the imperceptibility is high in the proposed scheme for watermarked image. It is robust against attacks like compression, salt and pepper noise and image rotation and it gives better results for filter attacks using advantages of three algorithms DWT, DCT and SVD.

REFERENCES

[1] Vaishali S. Jabade and Dr. Sachin R. Gengaje, "Literature Review of Wavelet Based Digital Image Watermarking Techniques,'' International Journal of Computer Applications (0975 – 8887) Volume 31– No.1, October 2011.

[2] MdSaiful Islam and UiPil Chong, " A Digital Image Watermarking Algorithm Based on DWT DCT and SVD,"International Journal of Computer and Communication Engineering, Vol. 3, No. 5, September 2014

[3] C. Rey and J. L. Dugelay, "A survey of watermarking algorithms for image authentication," Journal on Applied Signal Processing, vol. 2002, issue 6, pp. 613-621, 2002.

[4] G. Voyatzis, N. Nikolaidis, and I. Pitas, "Digital watermarking: an overview,"in Proc. Ninth European Signal Processing Conference, Rhodes, Greece, September 8–11, 1998, pp. 9–12.

[5] V. Potdar, S. Han, and E. Chang, "A survey of digital image watermarking techniques," in Proc. 3rd IEEE-International Conference on Industrial Informatics, Frontier Technologies for the Future of Industry and Business, Perth, WA, August 10, 2005, pp. 709-716.

[6] N. J. Harish, B. B. S. Kumar, and A. Kusagur, "Hybrid robust watermarking technique based on DWT, DCT and SVD," International Journal of Advanced Electrical and Electronics Engineering, vol. 2, issue 5, 2013

[7] M. J. Sahraee and S. Ghofrani, "A robust blind watermarking method using quantization of distance between wavelet coefficients," 20 October 2011© Springer-Verlag London Limited 2011

[8] Ahmed N. Al-Gindy, Ayman Tawfik, Hussian Al Ahmad, Rami A. Qahwaji, "A new blind image watermarking techniques for Dual watermarks using low-frequency band DCT coefficients," 1-4244-1378-8/07/$25.00 ©2007 IEEE

[9] Vijaya K. Ahire and VivekKshirsagar, "Robust Watermarking Scheme Based on Discrete Wavelet Transform (DWT) and Discrete Cosine Transform (DCT) for Copyright Protection of Digital Images," IJCSNS International Journal of Computer Science and Network Security, VOL.11 No.8, August 2011

[10] DasuVaman Ravi Prasad, "An Improved Invisible Watermarking Technique for Image Authentication," International Journal of Advanced Research in Computer Science and Software Engineering 3(9), September - 2013, pp. 284-291

[11] SatyanarayanaMurty. P, M.UdayBhaskar and P. Rajesh Kumar, "A Semi-Blind Reference Watermarking Scheme Using DWT-DCT-SVD for Copyright Protection," International Journal of Computer Science & Information Technology (IJCSIT) Vol 4, No 2, April 2012

[12] Md. Maklachur Rahman, "A DWT, DCT AND SVD based Watermarking Technique toProtect the Image Piracy," International Journal of Managing Public Sector Information and Communication Technologies (IJMPICT) Vol. 4, No. 2, June 2013

[13] Reena Anju and Vandana, "Modified Algorithm for Digital Image Watermarking Using Combined DCT and DWT,"International Journal of Information and Computation Technology. ISSN 0974-2239 Volume 3, Number 7 (2013), pp. 691-700

[14] Deepa Mathew K, "SVD based Image Watermarking Scheme," IJCA Special Issue on Evolutionary Computation for Optimization Techniques ECOT, 2010

[15] NavnidhiChaturvedi and Dr.S.J.Basha, "Comparison of Digital Image watermarking Methods DWT & DWT-DCT on the Basis of PSNR," International Journal of Innovative Research in Science, Engineering and Technology Vol. 1, Issue 2, December 2012

