International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

IJIEMR Transactions, online available on 18th Aug 2017. Link :http://www.ijiemr.org/downloads.php?vol=Volume-6&issue=ISSUE-3

Title: **DIGITAL IMAGE WATERMARKING WITH SINGULAR VALUE DECOMPOSITION TRANSFORM & REDUNDANT DISCRETE WAVELET TRANSFORM**

Volume 06, Issue 07, Pages: 265 – 271.

Paper Authors

SK.MUNWAR ALI

Eswar College Of Engg, Narasaraopet, Guntur Dt.

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

DIGITAL IMAGE WATERMARKING WITH SINGULAR VALUE DECOMPOSITION TRANSFORM & REDUNDANT DISCRETE WAVELET TRANSFORM

SK.MUNWAR ALI

Asst Professor, Dept Of E.C.E, Eswar College Of Engg, Narasaraopet, Guntur Dt.

ABSTRACT— This paper mainly focus on digital data safety. The proposed work is based on the selection of scaling factor, instead of using constant and randomly computed values with the variation of an image is considered. The scaling depends on distribution of pixel values in the cover image. Before this, by using Redundant Discrete Wavelet Transform (RDWT) & Singular Value Decomposition(SVD) transform the image is converted in transform domain . Later on any one of coefficient singular value is embedded with above chosen scaling factor. The performance of proposed work had compared with Robust blind watermarking scheme based on RDWT–SVD. using MSE, PSNR, NC & BER.

Keywords— watermarking, Singular Value Decomposition, Redundant Discrete Wavelet Transform, imperceptibility

I.INTRODUCTION:

Digital watermarking technique, embed the image or any information i.e. watermark into the digital media like image, audio & video. The hiding techniques are categorized either spatial or transform domain. In spatial domain, the watermark values are embedded directly on data. In the transform domain, the watermark embedding is by altering the transform coefficients. For example the transforms are; Finite Ridgelet Transform (FRIT), Discrete Cosine Transform (DCT), Discrete Fourier Transform (DFT), Discrete Wavelet Transform (DWT), Redundant Discrete Wavelet Transform (RDWT) and the Singular Value Decomposition (SVD). To improve the robustness and achieve the high imperceptibility, the watermarking is done by using either two or three transform techniques. This type of watermarking is called hybrid watermarking. Zhang XP[1] gives a watermarking scheme for protecting the rightful ownership based on Singular Value Decomposition (SVD). It gives some good results. He uses only one transform technique.F.J[2] gives the RDWT technique. G.E[3] gives the watermarking technique by using DWT and SVD. Later on mohammad A[8] gives an improved watermarking scheme based on SVD. Lai CC[12] implemented the watermarking scheme by using two or more transform techniques. He uses Discrete Wavelet Transform (DWT) and SVD. Later on L.s [13], Nasrin [19] produces watermarking scheme based on Redundant Discrete Wavelet Transform (RDWT) and SVD to get the improved results. This method gets improvements in terms of robustness and imperceptibility. The balance of the paper managed as preliminaries, proposed method,

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

experimental results, and performance measures respectively

II.A.REDUNDANT DISCRETE WAVELET TRANSFORM (RDWT):

One of the disadvantages of DWT is its shift variance property. It occurs due to the presence of down sampler. This shift variant causes major changes in the wavelet coefficients even for minor shifts in it. This leads an inappropriate extraction of watermark from watermarked image.

The RDWT [19] is established to overcome this disadvantage. The RDWT is shift invariant. Various RDWTs are Overcomplete DWT (ODWT), Undecimated DWT (UDWTP), shift invariant DWT (SDWT). The RDWT is obtained by eliminating down sampling operator for the usual implementation of DWT. With RDWT the size of sub bands is same as transformed image. The RDWT to an image like f(i,j) can be implemented as below. Here h(-k), g(-k) are the low pass and high pass analysis filters, h(k), g(k) are low pass and high pass synthesis filters, and cj, dj are low band and high band output coefficients at level ‘j’.

$$hj[k]=hj+1[k]\uparrow 2 \quad (1)$$

$$gj[k]=gj+1[k]\uparrow \quad (2)$$

1. RDWT analysis:

$$cj(k)=(cj+1[k]*hj[-k]) \quad (3)$$

and

$$dj(k)=(cj+1[k]*gj[-k]) \quad (4)$$

2. RDWT synthesis:

$$cj+1(k)=12\,(cj\,[k]*hj\,[k]+[k]*gj\,[k]) \quad (5)$$

II.B. Singular Value Decomposition (SVD)

SVD [19] is a technique developed for a wide variety of applications. It is mainly used in image processing applications such as image hiding, image compression, noise reduction and image watermarking. Several watermarking approaches have been proposed based on the SVD. Due to the extensive computations when SVD is applying alone on an image, some hybrid SVD-based algorithms have been developed such as DWT-SVD, and RDWT– SVD. SVD is a numerical analysis tool used to analyze matrices and it will be decomposed into three matrices. If A is an image, it is indicated as

A∈Rnm, , R represents the real number domain. Then, the SVD of A is defined as follows

$$A = USV^T \quad (6)$$

U and V are orthogonal matrices where U, V ∈
Rnm, S represents the diagonal matrix S ∈ Rnm
as shown below

$$S = \begin{bmatrix} \sigma_{1,1} & & \\ & \ddots & \\ & & \sigma_{n,n} \end{bmatrix} \quad (7)$$

Singular values are the diagonal elements (σ1,,,,,,, σn) of the matrix S.They satisfy: σ1,1 ≥σ2,2≥……≥σr,r……≥σn,nOut of three
matrices (U, V&S) the singular values ‘S‘tellsabout brightness and stability of an image

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

III.THE RDWT–SVD WATERMARKING PROCESS:

In this techniqe, RDWT is used together with SVD. The watermark embedding and watermark extraction are as follows and the flow of process is shows in figure 1&2:

III.A watermark embedding algorithm

Perform 1-level RDWT on cover image 'C' to decompose into four sub-bands, which are LL, LH, HL and HH:

- Apply SVD to LH:

$$[U\ S\ V] = svd(LH) \quad (9)$$

- Modify the Singular Values 'S' by embedding watermark 'W' with a scaling factor 'α':

$$S_{new} = S + \alpha W \quad (10)$$

the scaling factor 'α' taken as the uniform distribution pdf of the cover image

$$\propto = f(c!\,a,b) = \frac{1}{b-a} I_{[a,b]}(c) \quad (11)$$

'a' and 'b' are min and max pixel values of cover image

- Apply SVD to the modified singular value S_{new}

$$[U1\ S1\ V1] = SVD(S_{new}) \quad (12)$$

- Perform Inverse SVD to get new sub band LH_{new}

$$LH_{new} = U * S1 * VT \quad (13)$$

- Perform IRDWT with new LH and original LL, HL, HH of cover image to acquire watermarked image 'C''

$$C' = idwt\{LL, LH_{new}, HL, HH\} \quad (14)$$

III.B watermark extraction algorithm

- Apply RDWT on the watermarked image (C') to decompose into four sub-bands LLw, LHw, HLw, HHw

$$dwt(C') = \{\ LLw, LHw, HLw, HHw\ \} \quad (15)$$

- Apply SVD to sub band LH_w

$$[Uw\ Sw\ Vw] = SVD(LHw) \quad (16)$$

- Apply Inverse SVD with singular value 'Sw', U1, V1 to get D as follows:

$D = U1 * Sw * V1T$ (17)

- Extracted watermark image:

$W = (D - S)/\alpha$ (18)

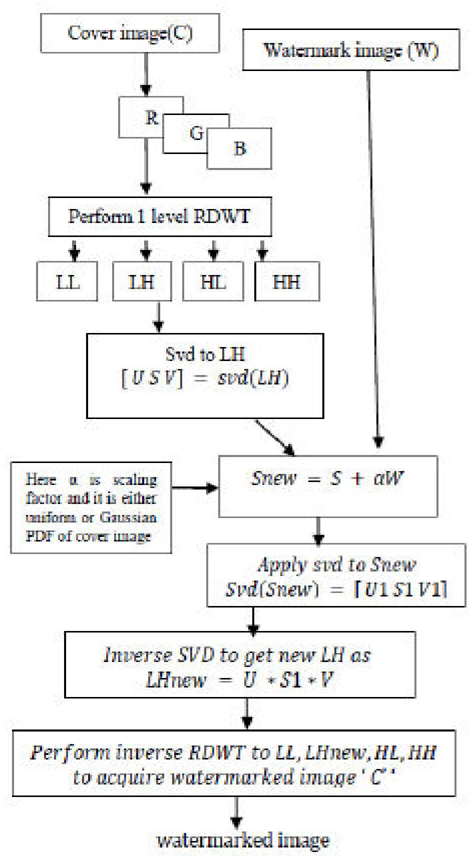


Fig1: watermark embedding process

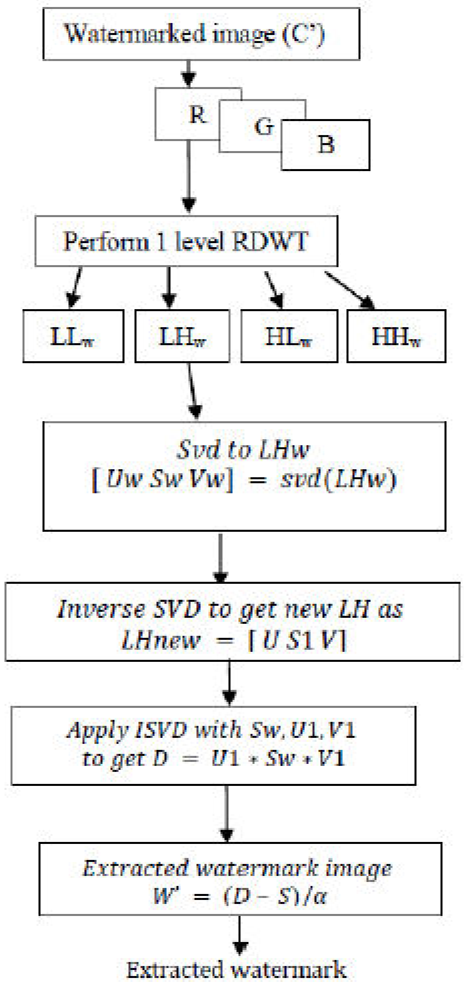


Fig2: watermark extraction process

IV. SIMULATION RESULTS

The proposed work is executed on MATLAB software with various images. They are gray scale images of size 512×512, identified as: Cameraman, lena, baboon, peppers. The watermark image is a gray-scale image of size 512×512. It is identified as Rice. Here the scaling factor (which is used for embedding watermark in host image) is taken as either uniform or Gaussian distribution pdf of host image, but inmy work uniform distribution pdf is computed. The resultant images (host, watermark, watermarked, extracted watermark) of proposed work are shown in figures 3&4. The objective and subjective criteria to measure the quality of the watermarked image, and both should be good. One of the objective criteria is peak signal-to-noise ratio (PSNR).

$$PSNR = 10\log_{10}\left[\frac{\max(C(i,j))^2}{MSE}\right] \quad (19)$$

Where the Mean Square Error (MSE) between the host image 'C' and the watermarked image 'W' is defined as

$$MSE = \frac{1}{m*n}\sum_{i=1}^{m}\sum_{j=1}^{n}[C(i,j)-W(i,j)]^2 \quad (20)$$

The robustness can be also evaluated by calculating the Normalized Cross-Correlation (NC), which indicates the similarity between the original watermark and the extracted watermark after attack. The NC is defined as:

$$NC(w,\bar{w}) = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}[w(i,j)-\mu_w][\bar{w}(i,j)-\mu_{\bar{w}}]}{\sqrt{\sum_{i=1}^{M}\sum_{j=1}^{N}[w(i,j)-\mu_w]}\sqrt{\sum_{i=1}^{M}\sum_{j=1}^{N}[\bar{w}(i,j)-\mu_{\bar{w}}]}} \quad (21)$$

Here N and M represent the number of pixels in watermark image 'W'. Here □, □̅ are indicate to the original watermark and the extracted watermark, and μ□μ□̅ are indicate mean of the original watermark and extracted watermark respectively. The correlation coefficient between w and □̅, can be between −1 and 1. One of important parameter which gives the watermarking quality is structural similarity (SSIM). Which checks the similarity between original watermark (w) and extracted watermark (□̅). The below is formula of SSIM.

$$SSIM(w,\bar{w}) = \frac{w.\bar{w}}{\sqrt{w.\bar{w}}} \quad (22)$$

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

The results shown in tables I & II are compared with Robust blind watermarking scheme based on RDWT–SVD.IN THIS TECHNIQUE scaling factor as a constant value for embedding watermark into the singular values of cover image

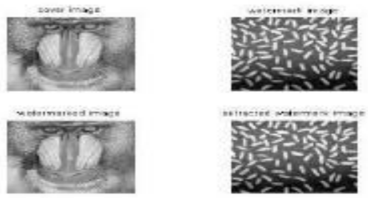


Fig 3: result of proposed work on baboon image

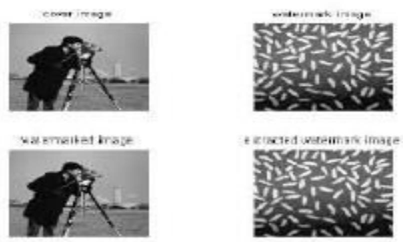
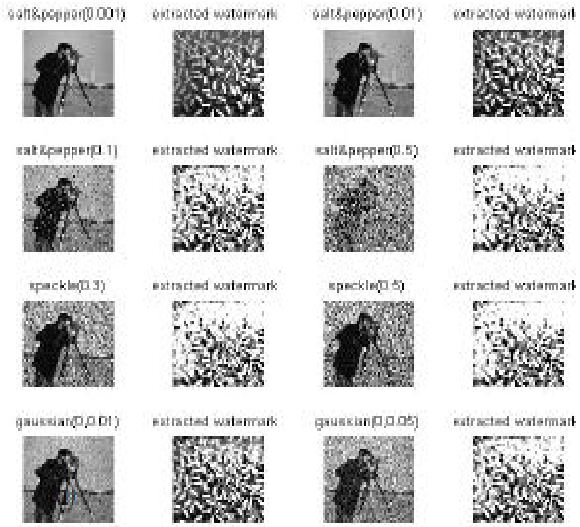
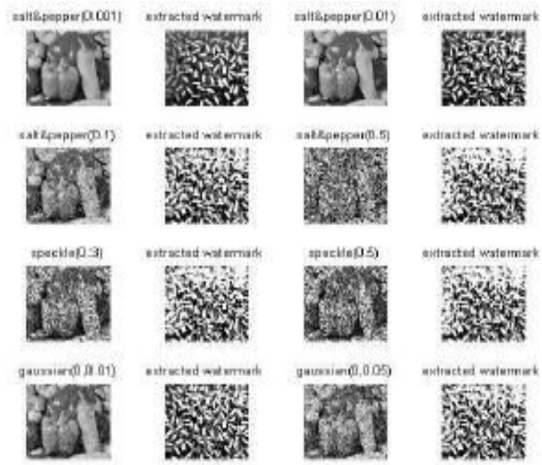


Fig 4: result of proposed work on cameraman image

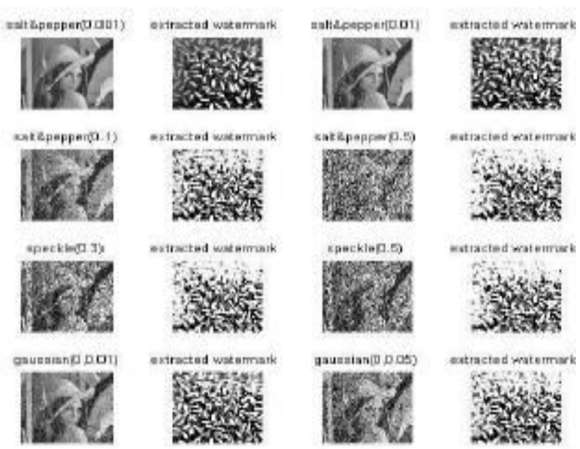
Table I: comparison table on Experimental results of proposed work and [19] in terms of MSE, PSNR, NC, BER, SSIM without attacks.

Image Name	work	PARAMETER				
		MSE	PSNR	NC	BER	SSIM
Camera man	Proposed work	1.25e-04	86.1375	1	5.14e-05	1
	[19]	0.173	55.7388	0.9942	1.43e-05	1
Baboon	Proposed work	1.38e-04	86.7296	1	3.91e-05	1
	[19]	0.155	56.2279	0.9897	1.00e-05	0.99
Lena	Proposed work	1.45e-04	86.4902	1	6.11e-05	1
	[19]	0.219	54.7264	0.9929	8.09e-06	1
Peppers	Proposed work	1.48e-04	86.411	1	7.04e-05	1
	[19]	0.2437	54.2627	0.9934	6.06e-05	1



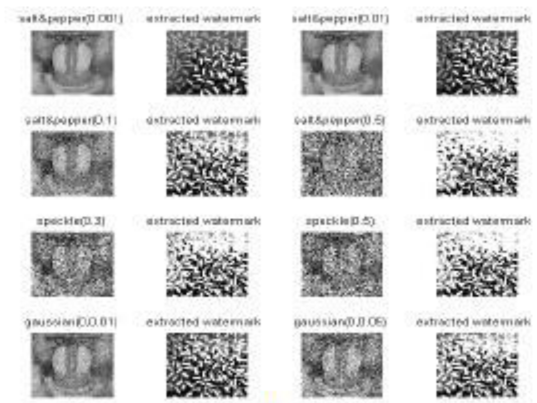


(b)



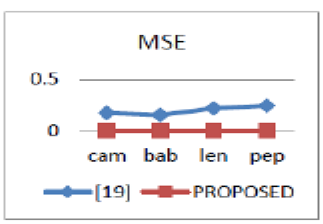
(c)

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

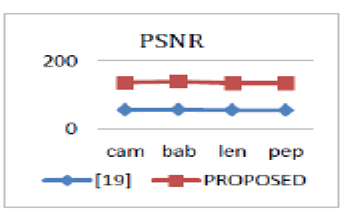


(d)

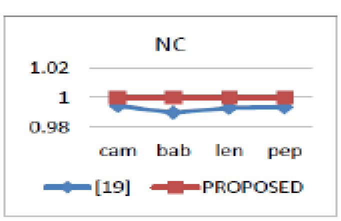
Fig 5: Noise attacks and extracted images under salt & pepper(0.001), salt & pepper(0.01), salt & pepper(0.1), salt & pepper(0.5),speckle(0.3), speckle(0.5),m Gaussian(0,0.01), Gaussian(0,05) for (a) cameraman, (b) peppers, (c) lena, (d) baboon respectively



(a)



(b)



(c)

Fig 6: comparative result graphs b/w proposed work and [19] (MSE, PSNR, NC) with noise attacks

Table II: MSE & PSNR values of cameraman, lena, baboon, peppers images under different noise attacks

Image type	Salt&pepper (0.001)		Salt&peppers (0.01)		Speckle (0.3)		Speckle (0.5)		Gaussian (0,0.01)		Gaussian (0,0.05	
	MSE	PSNR	MSE	PSNR	MSE	PSNR	MSE	PSNR	MSE	PSNR	MSE	PSNR
cameraman	17.812	35.62	202.15	25.074	4.42e+4	11.67	6.304e+3	10.134	593.55	20.39	2.652e+3	13.8947
Lena	17.666	35.6892	188.055	25.388	4.40e+4	11.69	6.395e+3	10.072	637.75	20.0842	2.817e+3	13.63
baboon	19.49	35.2322	171	25.7837	4.76e+4	11.34	6.953e+3	9.0709	648.51	20.0116	2.918e+3	13.47
peppers	18.74	35.40	196.28	25.20	4.17e+4	11.92	6.05e+3	10.307	631.19	20.12	2.763e+3	13.71

V. CONCLUSION

In this work transform domain techniques are used to embed the watermark into the digital data image. the novelty of work concentrated for the computation of scaling factor ‘α’. In this work uniform distribution pdf is used as one of methods for generation of ‘α’ value. By using this proposed method the PSNR, MSE and NC values are improved. The values are (86.1375, 0.00012& 1 for cameraman), (86.7296, 0.00013 & 1 for baboon) and (86.4902, 0.00014 & 1 for lena). It is concluded that the embedding and extraction of the proposed method shows the improvement over the existing method based on PSNR, MSE and NC values.

REFERENCES

[1] Zhang XP, Li K. Comments on “an SVDbased watermarking scheme for protecting rightful ownership”. IEEE Trans Multimedia 2005;7(3):593–4.

[2] Fowler J. The redundant discrete wavelet transform and additive noise. IEEE Signal Process Lett 2005;12(9):629–32.

[3] Ganic E, Eskicioglu AM. Robust embedding of visual watermarks using discrete wavelet transform and singular value decomposition. J Electron Imaging 2005;14(4):43004–9.
[4] Cui S, Wang Y. Redundant wavelet transform in video signal processing. In:International conference on image processing, computer vision, pattern recognition. 2006.p191–6.
[5] Hien TD, Nakao Z, Chen YW. Robust multilogo watermarking by RDWT and ICA. Signal Process 2006;86(10):2981–93.
[6] Cox I, Miller M, Bloom J, Fridrich J, Kalker T. Digital watermarking and steganography.2nd ed. San Francisco, CA, USA: Morgan Kaufmann Publishers Inc.;2007.
[7] Al-Haj A. Combined DWT-DCT digital image watermarking. J Comput Sci 2007;3(11):740–6.
[8] Mohammad A, Alhaj A, Shaltaf S. An improved SVD-based watermarking scheme for protecting rightful ownership. Signal Process 2008;88(9):2158–80.
[9] Haque SR. Singular value decomposition and discretee cosine transform based image watermarking. Master's thesis. Sweden: Department of Interaction and System Design,School of Engineering, Blekinge Institute of Technology;2008
[10] Li Z, Ping-ping Z, Gong-bin Q, Zhen J. Image watermarking with optimum capacity. In: 5th international conference on visual information engineering. 2008. p. 117–23.
[11] Wu HT, Cheung YM. Reversible watermarking by modulation and security enhancement. IEEE Trans Instrum Meas 2010;59(1):221–8.
[12] Lai CC, Tsai CC. Digital imagem watermarking using discrete wavelet transform and singular value decomposition. IEEE Trans Instrum Meas 2010;59(11):3060–3.
[13] Lagzian S, Soryani M, Fathy M. A new robust watermarking scheme based on RDWT–SVD. IJIIP Int J Intell Inform Process 2011;2(1):22–9.
[14] Rastegar S, Namazi F, Yaghmaie K, Aliabadian A. Hybrid watermarking algorithm based on singular value decomposition and radon transform. Int J Electron Commun (AEU) 2011;65(7):658–63.
[15] Lai CC. An improved SVD-based watermarking scheme using human visual characteristics. Opt Commun 2011;284(4):938–44.
[16] Ling HC, Phan RCW, Heng SH. On the security of a hybrid watermarking algorithm based on singular value decomposition and radon transform. Int J Electron Commun (AEU) 2011;65(11):958–60.
[17] Bhatnagar G. A new facet in robust digital watermarking framework. Int J Electron Commun (AEU) 2012;66(4):275–85.
[18] Lagzian S, Soryani M, Fathy M. Robust watermarking scheme based on RDWT–SVD: embedding data in all subbands. In: International symposium on artificial intelligence and signal processing (AISP). 2011. p. 48–52.
[19]N M Makbol. Robust blind watermarking scheme based on RDWT–SVD. J Electron Commun (AEU) 2013;67(11):102–112