International Journal of Signal Processing, Image Processing and Pattern Recognition
Vol.8, No.6 (2015), pp.193-198
http://dx.doi.org/10.14257/ijsip.2015.8.6.20

DWT-SVD based New Watermarking Idea in RGB Color Space

Md. Atiqur Rahman[1] M.M. Fazle Rabbi[2]

Department of Computer Science & Engineering
Bangladesh University of Business & Technology, Mirpur-2, Dhaka-1216, Bangladesh
atick.rasel@gmail.com , rabbi102@gmail.com

Abstract

The growing demand of securing the online trade and digital content bought the digital watermarking as major tools for protecting copyright, preventing unauthorized distribution, track back the source, confirming the ownership, authentication and many more. This paper proposes a new algorithm which shows better resistance against some common attacks. The SVD-DWT technique is applied here for deconstructing and reconstructing the image. The secret watermark is embedded into the R band using a secret key after separating the host image into three respective bands namely R, G and B. The extracting process is performed by splitting the watermarked image into all the color channels and then applying further process into R plane. The experimental result shown in tabular form indicates the better robustness of the proposed algorithm against various attacks on image.

Keywords: *watermarking, key-matrix, SVD-DWT, digital image processing, embedding, extracting*

1. Introduction

Digital watermarking has many important applications in this time and age due to its vast spectrum of usages in the field of digital contents over online and offline. E-commerce and digital intellectual property become very lucrative for intruder and hacker. As a result copyright protection and authentication of digital contents also become a priority. Digital watermarking is a technology which is much discussed by the researchers in this current era of time due to its important security usages in the digital industry. Some watermark applications used in copyright protection, distribution tracing, authentication etc. After embedding the watermark in the original image, the perceptibility of the image should not be distorted. The secret watermark should be extracted from the modified image for authenticity. There are mainly two methods for adding a watermark into an image. In one of the method the secret image can be added into the spatial domain of the original image. In the other approach the transform domain is used for adding watermark. Though the former method is easy to be processed but has some limitation in terms of security [1]. The later method has some advantages over the previous one. The transform domain method is more robust than the spatial domain approach [2]. This is why the researchers have focused their interest on the transform domain schemes. In the process of spatial domain technique the pixel of the original image is modified to embed a watermark. On the other hand in the transform domain method the secret image is embedded into the transformed coefficients [5]. After embedding a watermark into an image few things should be present into the new image in order to be considered as a good watermarked image. The watermark should not be visible into the original image and the picture is expected to be robust under geometric and signal processing attack and finally the watermark must be recovered after being attacked [3]. The robustness of the image is still a major concern against modifications of

ISSN: 2005-4254 IJSIP

the original image. Many researchers have used various algorithms for embedding and extracting methods against different attacks on the image. The discrete wavelet transformation (DWT) based on singular value decomposition (SVD) is one of the effective method that widely used in watermarking process. There are few transform domains available for watermarking like DWT, DCT and DFT. In this paper we have chosen the DWT approach due to its strong resistance against some attacks, mostly high frequency filter attack and compression [6]. The singular values (SV) of the SVD matrix have trivial effect on it after some common attack [7]. Therefore due to its better resistance against some common attack, the SVD method is combined with the DWT in our proposed algorithm. The result is being measured by using the peak signal noise ratio (PSNR) and normalized correlation (NC) values with a set of threshold value. The PSNR is used to compare the similarity between original image and the watermarked image. The normalized correlation (NC) value is used to compare the original watermark with extracted watermark by measuring the cosine angle of the two vectors. This paper has been organized as follows: section I is the background theory of the recognized techniques used in this paper, section II is the review of related works, section III is the proposed method used here, section IV is the analysis of the result and section V is the conclusion.

2. Background Theory

A. Discrete Wavelet Transformation (DWT)

Discrete wavelet transformation (DWT) is an important tool for analyzing the frequency domain of an image. It transforms the data vector into four sub-bands (LL, HL, LH and HH). Each sub-band can be further decomposed using the DWT again until there is only one coefficient [3]. The watermark is embedded in one of the frequency. Embedding watermark in different frequency provides different features. For example embedding watermark in low frequency (LL) shows robustness against image compression attacks [14].

B. Singular Value Decomposition (SVD)

To extract the features of an image value as a matrix the SVD method is used [4]. The SVD decompose a matrix into three matrices. SVD provides robustness in the watermarking process [14].

$$A = USV^T$$

In the equation A is a matrix which is decomposed into three different matrixes. S is the diagonal matrix. Adding information into the diagonal matrix has insignificant effect on the image.

3. Review of Related Works

Mohamed and Pan proposed to embeds the watermark image into the low-frequency sub-band (LL3) [11]. They also applied the Error Correction Coding (ECC) techniques into their algorithm. Shumei et al proposed a technique for combing the space and transform domain together [12]. Some researchers used Arnold transform along with DWT-SVD to scramble the image [13].

4. Proposed Method

A. Algorithm for Embedding Formula

1. The R, G and B planes of original image are separated first. Then the R plane is used for embedding.
2. DWT-2 is applied on R planes of the host Image and decompose to 4 levels for finding HL4 band
3. Calculate decomposition error of original image (OIDE)
4. Create a watermark using the following procedure:

a) Set Watermark(1:r,1:c)=0, where r=c
b) Select key(number of non-zero square matrix) where key <=r and
c) Create two Key matrix using key

$$km^1=\begin{bmatrix}\alpha_{1,1} & \alpha_{1,2} & \alpha_{1,3} & \cdots\cdots\cdots\cdots & \alpha_{1,key}\\ \alpha_{2,1} & \alpha_{2,2} & \alpha_{2,3} & \cdots\cdots\cdots\cdots & \alpha_{2,key}\end{bmatrix}$$
$$km^2=\begin{bmatrix}\beta_{1,1} & \beta_{1,2} & \beta_{1,3} & \cdots\cdots\cdots\cdots & \beta_{1,key}\\ \beta_{2,1} & \beta_{2,2} & \beta_{2,3} & \cdots\cdots\cdots\cdots & \beta_{2,key}\end{bmatrix}$$

Where both matrixes follow the following conditions:

i. $km^1_{i,w}$ & $km^2_{i,w}$ <= r for w = 1 to key & i = 1 to 2
ii. $\alpha1,1 \le \alpha2,1 \le \alpha1,2 \le \alpha2,2 \le \alpha1,3 \le \alpha2,3 \le \cdots\cdots \le \alpha1,key\text{-}1 \le \alpha2,key\text{-}1 \le \alpha1,key \le \alpha2,key$
iii. $\beta1,1 \le \beta2,1 \le \beta1,2 \le \beta2,2 \le \beta1,3 \le \beta2,3 \le \cdots\cdots \le \beta1,key\text{-}1 \le \beta2,key\text{-}1 \le \beta1,key \le \beta2,key$

d) Repeat i =1 to size (km^1, 2)
Repeat j= $km^1_{1,i}$ to $km^1_{2,i}$
Repeat k= $km^2_{1,i}$ to $km^2_{2,i}$
Set $watermark_{j,k}$ = 1

5. SVD technique is applied on watermark image. The equation for embedding is:

$$HL4^{wmi} = HL4 + V$$

Where V is the diagonal matrix of watermark image and $HL4^{wmi}$ is watermarked image.

6. Apply inverse DWT-2 to obtain the modified band $R^{/}$. Then construct watermarked image I^{wmi} using the following equation:

$$I^{wmi} = R^{/}, \text{G, B bands} + OIDE$$

The embedding formula is demonstrated through the figure 1.

B. Algorithm for Extraction Formula

The Host Image and the watermark are extracted applying the following process on the watermarked image. The extraction procedure is described below:

1) Split R^{wmi}, G^{wmi} and B^{wmi} planes from the watermarked image I^{wmi}.
2) Decompose R^{wmi} planes four times to obtain $HL4^{awmi}$ band.
3) Calculate decomposition error of Attacked image (AIDE)
4) Apply the following equation to get the first pre process watermark (PP^w).

$$PP^w = HL4^{awmi} - HL4$$

5) Apply inverse SVD to get the second pre process watermark (W^{few}) using the following equation:

$$W^{few} = S * PP^w * D^{/}$$

6) Apply following threshold to get third pre process extracted watermark (W^{few})

$$W^{few} = \begin{cases} 1 & if\ W^{few} < Threshold \\ 0 & otherwise \end{cases}$$

7) Mapping W^{few} to get only square matrixes (number of square matrix in watermark is equal to key) which is final Extracted watermark.
8) Find $R^{extract}$ band using the following equation:

$$R^{extband} = HL4^{awmi} - W^{few}$$

9) Apply inverse DWT-2 and use the following equation to get $R^{extplan}$ plan:

$$R^{extplan} = R^{extplan} + AIDE$$

10) Reconstruct the extracted image using $R^{extplan}$, G and B bands. The extraction formula is exposed through figure 2.
11) Normalized Correlation is computed between watermark and derived watermark according to the below equation:

$$NC=\frac{\sum_{i=1}^{p}\sum_{j=1}^{q} Watermark_{i,j}\ \ W_{i,j}^{few}}{\sqrt{\sum_{i=1}^{p}\sum_{j=1}^{q} watermark_{i,j}}\ \sqrt{\sum_{i=1}^{p}\sum_{j=1}^{q} W_{i,j}^{few}}} \quad \ldots\ldots\ (1)$$

Where W is Watermark pattern and W^{few} is derived watermark pattern.

12) Pick signal to noise ratio is calculated using the following equation:

$$PSNR=10\ log_{10}\ \frac{Max^2}{\frac{1}{p*q}\ \sum_{i=1}^{p}\sum_{j=1}^{q}(f_{i,j}\ -\ f_{i,j}^{/})} \quad \ldots\ldots\ (2)$$

Where f is original image and $f^{/}$ is extracted image.

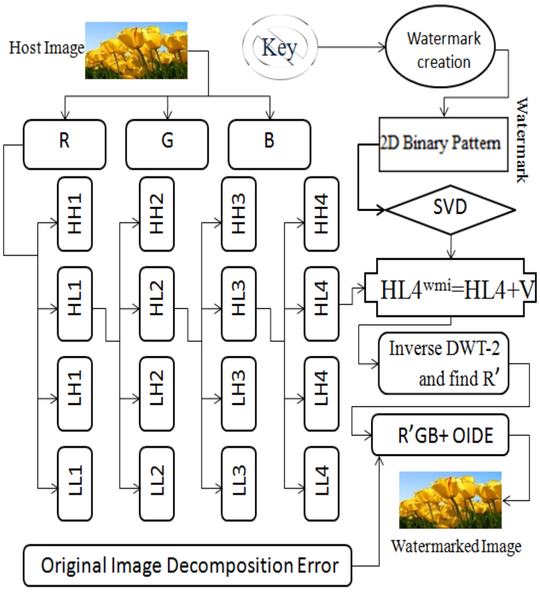

Figure 1. Embedding Procedure

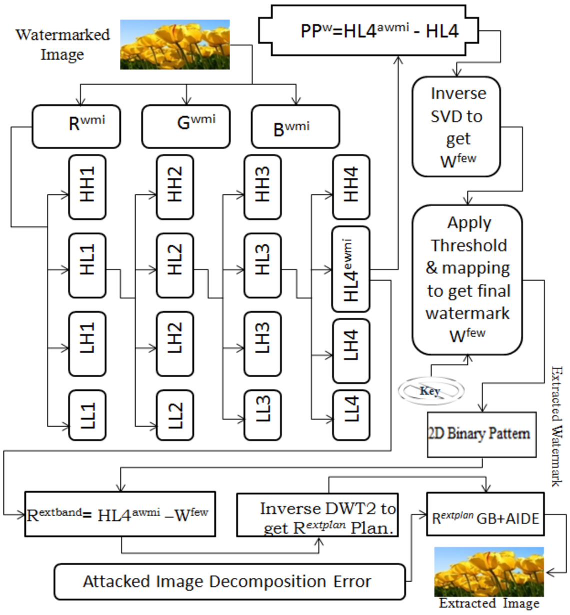

Figure 2. Extraction Procedure

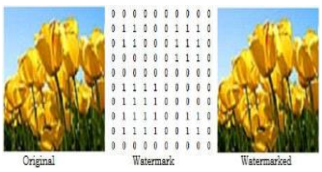

Figure 3. Host, Watermark & Watermarked Image

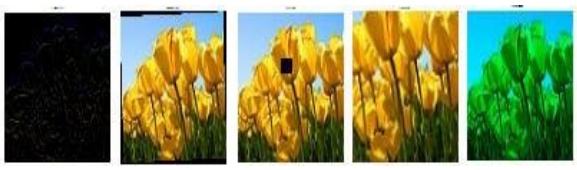

Figure 4. (a) Prewitt, (b) Rotation, (c) Pulling out, (d) Cropping, (e) High pass

5. Experiment Result

Performance Evaluation		
Noise	**PSNR**	**NC**
Gaussian(.01)	59.0014	1.0
Gaussian(.02)	54.2381	1.0
Gaussian(.03)	39.9823	0.9998
Motion	39.4771	.9999
Sobel	22.0345	0.9987
Pulling out	26.9062	0.9834
Rotation (1 degree)	29.9801	0.9965
JPEG Compression 95 percent	36.1672	0.9003
Average	53.6721	1.0
Prewitt	16.0129	.9960
Gaussian High pass	20.9821	0.9998
Cropping	42.6572	0.9961

In our research we use PSNR and NC estimate the excellence of watermarked image and extracted the correlation between extracted watermark and original watermark where larger normalized correlation value represent the better robustness of the watermark. We use 512*512 RGB image as a cover image and use 64*64 matrixes as a watermark image. We use a key (number of non-zero square matrix) in the watermark. We have seen, after decomposition some value is increase that we have indicated as decomposition error. Set threshold values and mapping matrix are very challenging part in the extraction procedure. In paper , we add watermark into the cover image in the frequency domain .the table-1 gives PSNR and NC on Gaussian, motion, sobel , pulling out, rotation, JPEG compression, average, prewitt, Gaussian high pass and cropping attack. After some attacks (Gaussian, motion and cropping) the watermark has been derived acceptably .For Gaussian, average and motion attacks, our algorithm has given very good result with very less visual alteration. The figure-4 exhibit attacked image after various attacks.

6. CONCLUSION

In this paper we have used two dimensional matrixes as a watermark. This paper proposes DWT and SVD based watermarking algorithm with decomposition error. The result of this paper shows that the algorithm is good for Gaussian, average and motion attacks attack with very less distortion. In future experiment we will concentrate on the new technique to improve the perceptibility of the cover image.

References

[1] N. Bi, Q. Sun, D. Huang, Z. Yang and J. Huang, "Robust Image Watermarking Based on Empirical Mode Decomposition," IEEE Transactions on Image Processing, vol.16, no. 8, (**2007**) August.

[2] D. Minghui and Z. Jingbo, "Robust Image Wtermarking Algorithm against Geometric Attack Based on BEMD", IEEE International Conference on Computer and Communications Security, (**2009**).

[3] L. Sumalatha, V. V. Krishna and M. R. Kumar, "A Robust Image Watermarking Scheme Using Simplified Significant Wavelet Tree Quantization," IEEE, (**2013**).

[4] C. Wenjuan and Y. Hongmei, "Watermarking Algorithm Against Geometrical Attacks Based on DWT-SVD", IEEE, (**2010**).

[5] Y. Xueyi, D. Meng, W. Yunlu and Z. Jing, "A Robust DWT-SVD Blind Watermarking Algorithm based on Zernike Moments," IEEE, (**2014**), p.1-6.

[6] Y. Tianyu, "Perfectly Blind Self-embedding Robust Quantization based watermarking scheme in DWT-SVD Domain", Journal of Image and Graphics, (**2012**).

[7] V. Santhi and A. Thangavelu, "DWT-SVD Combined Full Band Robust watermarking technique for color images in YUV color space".
[8] S. Voloshynovskiy, S. Pereira, V. Iquise and T. Pun, "Attack modeling Towards a second generation watermarking benchmark", Signal Processing, Special Issue on Information Theoretic Issues in Digital Watermarking, (**2001**).
[9] B. Gunjal and S. Mali, "Strongly Robust and Highly Secured DWTSVD Based Color Imane Watermarking: Embedding Data in All Y, U, V Color Spaces", Information Technology and Computer Science, (**2012**).
[10] B. L. Gunjal and S. N. Mali, "Comparative performance analysis of DWT-SVD based color image watermarking technique in YUV, RGB and YIQ color spaces", Internation journal of computer theory and engineering, vol. 3, no. 6, (**2011**) December.
[11] M. S. Yasein and P. Agatlzoklis,"A wavelet-based blind and readable image watermarking algorithm", 2002 IEEE,
[12] S. Wang, W. Zhao and Z. Wang, "A Gray Scale Watermarking Algorithm Based on LU Factorization", 2008 International Symposiums on Information Processing, (**2008**) IEEE.
[13] C. Wenjuan and Y. Hongmei,"Watermarking Algorithm against Geometrical Attacks Based on DWT-SVD", (**2010**) IEEE.
[14] C. W. H. Fung and W. G. Jr., "A novel DWT-SVD video watermarking scheme using side view", 2011 IEEE.,

Authors

Md. Atiqur Rahman, he obtained his B.Sc. and M.Sc. degree in Computer Science and Engineering from University of Rajshahi, Rajshahi-6205, Bangladesh in the year of 2008 (held on 2009) and 2009(held on 2011) respectively. He is now working as a Lecturer in the department of Computer Science and Engineering, Bangladesh University of Business and Technology, Dhaka-1216, Bangladesh. His research interests include Image processing, Pattern recognition, Parallel processing, Robotics, Computer Vision and signal processing.

M. M. Fazle Rabbi, he obtained his B.Sc. degree from University of Windsor, Windsor, Ontario, Canada and M.Sc. in Computer Science from University of Bedfordshire, Luton, Beds, UK in the year of 2004 and 2011 respectively. He is now working as a Lecturer in the department of Computer Science and Engineering, Bangladesh University of Business and Technology, Dhaka-1216, Bangladesh. His research interests include Image processing, Pattern recognition, Parallel processing, Robotics, Computer Vision and signal processing and Grid computing.

