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ROBUST AND BLIND WATERMARKING SCHEME BASED ON SHUFFLED SVD AND RDWT FOR COLOURED IMAGES

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ABSTRACT

Watermarking is the technique to solve the issue of copyright degradation, but this has to be resolved by keeping a steady check on the imperceptibility and robustness which incur to be its main objectives. In order to accomplish these objectives the usage of a hybrid transform is adopted in this paper, the idea behind using a hybrid transform is that the cover image is modified in its singular values rather than on the DWT sub- bands, therefore the watermark makes itself vulnerable to vivid attacks. Experimental results are available to support the study.

Keywords: Authentication; copyright protection; robustness; Discrete Wavelet Transform (DWT); Singular Value Decomposition (SVD)

1. INTRODUCTION

With the advent of Internet technologies and wide availability of computers and smart phones, the digital data acquisition, exchange and transmission are becoming simple. Many people are skeptical of uploading their content on the Internet due to lack of intellectual property protection available to them. The digital watermarking is one of the techniques that can provide the solution to protect their ownership. In digital watermarking techniques, a digital watermark can be visible or invisible to the human visual system. Visible watermark can be easily defeated and removed by replacing or cropping it from the digital media. Therefore, the watermark should be invisible to human eyes to ensure protection of data from unauthorized sources. A variety of invisible watermarking schemes have been reported in recent years [1]-[11]. Such techniques are broadly classified in two categories: spatial-domain and transformed domain based. The earlier watermarking techniques are spatial in nature with the simplest being least significant bit (LSB) substitution of the image pixel data [3].Improvement and variant of this techniques are proposed in [2],[6,7],[9,10]. These techniques are relatively robust against JPEG compression, filtering and scanning. As opposed to spatial domain techniques, transformed domain techniques provide

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better capacity that can embed a large number of data without incurring noticeable visual distortion. In addition, transformed domain schemes provide better robustness against common image processing attacks and geometrical attacks. The common examples of transformed domain techniques incorporates Discrete cosine transform (DCT) [11], Finite Ridgelet transform (FRIT)[12], Discrete Fourier transform (DFT)[13], Discrete wavelet transform (DWT)[14], Redundant discrete wavelet transform (RDWT)[15-18], and Singular value decomposition (SVD)[19-23]. Recently, some researchers suggested hybrid watermarking schemes that combines two or three transforms to provide better robustness and high imperceptibility [19]. Recently, we proposed two watermarking schemes that combine Chinese remainder theorem (CRT) with DCT and discrete tchebichef transform (DTT). But these schemes are not resilient to rotation, scaling and translation attacks [24, 25].

The SVD transform always shows a good performance while combine with transform domain techniques. Its primary advantages are (1) the size of the matrices from SVD transform is not fixed and can be a square or a rectangle. (2) Singular values in a digital image are less affected in general image processing operations and (3) Singular values contain intrinsic geometrical properties. Most literature [15, 19, 23] only embeds the watermark singular value into the host image. However, this embedding strategy has a potential situation of false positive problem. An adversary can easily obtain the correct watermark from an unauthorized image downloaded from the public source of Internet. A false positive problem occurs when the correct counterfeit extracted watermark is obtained from an arbitrary image in which the embedded watermark is totally different from the extracted watermark [16]. In other words, an attacker can easily find any reference image from an arbitrary image.

2. RELATED WORKS

Recently, a number of watermarking techniques based on RDWT and SVD have been proposed [15-18]. The scheme based on RDWT and SVD by Makbol-Khoo [17] is robust and blind. However, such a scheme could not address the problem of false positive detection. In their scheme, the cover image 'A' is decomposed into four subbands using RDWT, and watermark W is directly embedded into the singular values of each subband. The modified subbands are inversed SVD and then inverse RDWT to obtain the watermarkedimage. While the technique proposed by H.-C. Ling et al. [16] have addressed the problem of false positive detection by avoiding watermark's SVD orthogonal vectors U and V in embedding and extraction process. However, the extracted watermark quality was around 0.3364 for LL sub-band, and much worse, i.e. less than 0.08 for other subbands. Musrrat Ali and Chang Wook [22] suggested two methods as a

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countermeasure to the false positive problem. Firstly, the principal component of the watermark is embedded into the host image instead of singular values of the watermark. The other singular vector matrix is stored as side information which can be used later in watermarking extraction process. Secondly, insertion of entire watermark into the host image instead of singular values to reduce the dependence of SVD vectors U and V. These ideas are limited for DWT-SVD based schemes. However, their ideas are not extensively studied in the literature for RDWT-SVD based schemes. Khaled L. et al. [18] have claimed that the combination of RDWT and SVD cannot be used to overcome false positive problem. In order to counter the above schemes, our work not only addresses the solution to the false positive problem but also shows that the quality of the extractedwatermark is much better than most of the RDWT-SVD based schemes. The paper is organized as follows: The proposed RDWT and Shuffled SVD (SSVD) scheme is presented in Section-2. A comparative analysis of our scheme with other schemes is demonstrated in Section 3. Finally, conclusions and future works are presented in Section 4.

3. PROPOSED ALGORITHMS

This work is based on embedding watermark image on the cover image using redundant discrete wavelet transform (RDWT), and Shuffled singular value decomposition (SSVD). SSVD improves the reconstructed image quality by breaking an image I into a set of ensemble images $I = \{I_1, I_2 ..... I_n^2\}$. The SSVD can be computed by permuting the watermark image and then applying standard SVD algorithm. The SSVD can be defined as

$$I \xrightarrow{SSVD} S\{I\} \xrightarrow{SVD} USV^T \quad (1)$$

Where $S\{I\}$ denotes the shuffled or scrambled operator. It is proved that the reconstructed image using SSVD are of better visual quality compared to a standard SVD operator under the same image rank [20]. The RDWT-SVD watermark embedding and extraction procedure is shown in Figure 1 (a) and (b) respectively.

3.1 Watermark Embedding algorithm:

The steps are as follows:

1. Apply RDWT to the cover image. The image I will be decomposed into four subbands, which are $\{LL, HL, LH, HH\}$
2. Take SVD on each subband. $Z_i = SVD(I_i)$, where I_i can be any of the subband $\{LL, HL, LH, HH\}$. Thus,
$$Z_i = U_i S_i V_i^T \quad (2)$$
3. Let W be the watermark image. Appl ing SVD on W, it decompose to $uw1, sw1$ and $vw1$. $uw1$ and $vw1$ are left and right singular vectors and $sw1$ is diagonal matrix (a.k.a. singular value). Modify the singular values of Z_i by embedding the watermark like as follows:

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$$S_i^c = S_i + \beta(uw1 \times sw1)$$

(3)

$\beta = 0.08$ for LL and 0.05 for HL, LH and HH subbands.

Note: $vw1$ is used as the key for water mark extraction.

4. Take SVD of each subband with the modified coefficients

$$S_i^c \; I_i^m = SVD(S_i^c) = U_i^m S_i^m V_i^{mT}$$

(4)

where I_i^m indicate the modified subbands of $\{LL, HL, LH, HH\}$

5. Take inverse SVD using the singular value S_i^m with U_i and V_i of the original image as left and right singular vector matrices.

$$I_i^w = U_i S_i^m V_i^T$$

(5)

6. Finally apply inverse RDWT to the coefficients of modified subbands to obtain watermarked image I^w.

3.2. Watermark Extraction Algorithm

1. Apply RDWT to the possibly distorted watermarked image I^{w*}. Now I^{w*} is decomposed to $\{LL^*, HL^*, LH^*, HH^*\}$ subbands. Apply SVD on each distorted subband as follows:

$$I_i^{w*} = U_i^{w*} S_i^{w*} V_i^{wT*}$$

(6)

2. Apply inverse SVD to each subband using singular value S_i^{w*}, keeping U_i^m and V_i^m obtained in Equ (4) as the keys.

$$I_i^{m*} = U_i^m S_i^{w*} V_i^m$$

(7)

3. Find parameter

$$W_p = \frac{I_i^{m*} - S_i}{\beta}$$

(8)

where β=0.08 for LL and 0.05 for $\{HL, LH, HH\}$ subbands, and S_i is the singular values obtained in Equ (2) of embedding algorithm.

4. Extract the watermark using the formula

$$W_i^* = W_p \times vw1^T$$

(9)

where $vw1^T$ is the right singular vector of watermark W, which is used as Key for watermark extraction.

4. SIMULATION RESULTS AND DISCUSSION

In this section, several simulations are conducted to examine the robustness and imperceptibility of the proposed RDWT-SVD algorithm. Simulations are carried out using three images, Lena, Baboon and Pepper images as cover/host images. Cameraman and Chinese character are used as watermark image. All the standard test images are shown in Figure 2. The sizes of the host images are 512×512. The size of cameraman image (watermark) is 512×512. The objective quality (i.e., imperceptibility) of the watermarked image and extracted watermark are measured in terms of

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peak-signal-to-noise-ratio (PSNR) and normalized correlation (NC) respectively. The PSNR value in decibels (dB) indicates similarity between the host image and watermarked image, while NC verifies the presence of watermark. These are given below:

$$\text{PSNR}=10\log_{10}\frac{I_{Peak}^{2}}{MSE} \quad (10)$$

Where MSE is the mean square error between the watermarked image, I^{w} and its original image, I.

$$\text{MSE}=\frac{\sum_{i=1}^{N}\sum_{j=1}^{N}[I(i,j)-I^{w}(i,j)]^{2}}{N^{2}} \quad (11)$$

The NC value between original watermark (W) and extracted watermark (W^{*}) is defined as:

$$\text{NC}=\frac{\sum_{i=0}^{M}\sum_{j=0}^{M}[W(i,j)W^{*}(i,j)]}{\sum_{i=0}^{M}\sum_{j=0}^{M}[W(i,j)]^{2}} \quad (12)$$

Table 1 The comparison of imperceptibility (db) of our scheme, Makbol & Khoo[17], Li etal.[14], Rastger et al.[19], Lagzian et al.[15].

Image (512x512)	Proposed	Makbol & Khoo[17]	Li et al.[14]	Rastger et al.[a]	Rastger et al.[b]	Lagzian et al.[15]
Lena	54.3157	54.0353	50.89	43.3506	45.9337	38.52
Pepper	54.0472	54.1556	-	43.3586	45.9543	-
Baboon	58.3684	55.9768	-	43.3653	45.9228	-

Table 1 shows the comparison of PSNR values of the watermarked image between the proposed scheme and with other schemes. It shows that higher quality of the watermark image is obtained using our proposed scheme. The high PSNR of the proposed RDWT SVD based scheme implies that the presence of watermark cannot be perceived by human eye.

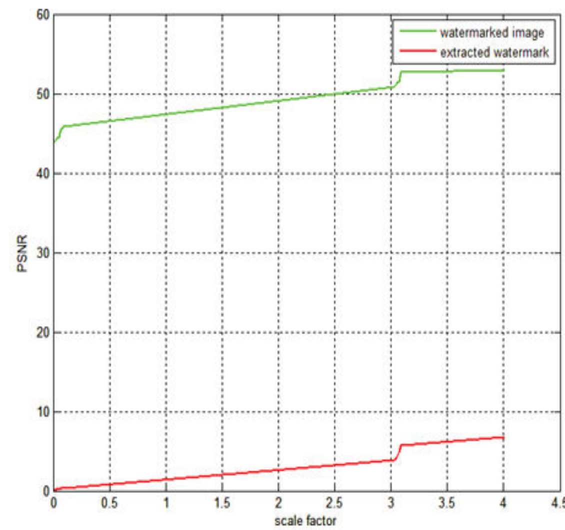

Fig. 1. (c) Watermarked Image (d) Extracted Watermark(PSNR = 5)

Fig. 1. (a) Cover Image (b) Watermark

5. COMPUTATIONAL TIME

The experiments are conducted using Intel i5 processor 2.6 GHz with 6 GB RAM. The two watermarking schemes are simulated in MATLAB 15a with an un-optimized program code to make a fair comparison. From Table 2 we can see that our proposed scheme offers similar computation in both embedding

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and extraction stages compared with that of Makbol and Khoo method.

Table 2 Computational time comparison between proposed method and Makbol and Khoo method

Method	Proposed method	Makbol and Khoo[17]
Watermark embedding	0.785 s	0.673 s
Watermark extraction	0.219 s	0.288 s

6. REFERENCE

1. Cox IJ, Kilian J, Leighton T, Shamoon T, "Secure spread spectrum watermarking for images, audio and video," IEEE Int. Conf. Image Processing 3: 243-246.
2. Bender WR, Gruhl D, Morimoto N, "Techniques for data hiding," Proceedings of SPIE Storage and Retrieval of Image and Video Databases, 2420: 164-173.
3. Van Schyndel RG, Tirkel AZ, Osborne CF, "A digital watermark," Proceedings of IEEE Int. Conf. Image Processing, Austin, TX, USA, II: 86-90.
4. Zhao J, Koch E, "Embedding robust labels into images for copyright protection," Proc. of the Int. Cong. on Intell. Property Rights for Special. Info. Knowledge and new Tech., Vienna, pp. 241-251.
5. Ruandaidh JJKO, Dautzenberg C, Boland FM, "Watermarking digital images for copyright protection," IEE Proceedings-Vision, Image and Signal Processing 144: 250-256
6. Nikolaidis N, Pitas I, "Copyright protection of images using robust digital signatures," Proc. IEEE Int. Conf. on Acoustics, Speech and Signal Processing, Atlanta, USA, 4, pp. 2168-2171
7. Barni M, Bartolini F, Cappellini V, Piva A, "Copyright protection of digital images by embedded unperceivable marks," Image and vision computing 16: 897-906
8. Swanson M, Zhu B, Tewfik A, "Transparent robust image watermarking," Proc. Int. Conf. on Image Processing. 3, pp. 211-214
9. Wolfgang R, Delp E, "A watermark for digital images," Proc. Int. Conf. on Image Processing, 3, pp. 219-222.
10. Cox IJ, Miller ML "Review of watermarking and the importance of perceptual modeling," Proceedings SPIE Human Vision and Elect. Imaging II, 3016, 92-99.
11. Lin S, Chen CF, "A robust DCT-based watermarking for copyright protection," IEEE Trans. Consumer Electron 46:415-421.
12. Campisi P, Kundur D, Neri A, "Robust digital watermarking in the ridgelet domain," IEEE Signal Process Letter 11: 826-830.
13. Premaratne P, Ko C, "A novel watermark embedding and detection scheme for images in DFT domain ," 7th international conference on image processing and its applications, Manchester, UK, pp. 780-783.
14. Lai CC, Tsai CC, "Digital image watermarking using discrete wavelet transform and singular value decomposition," IEEE Trans. Instrum. Meas., 59:3060-3063.
15. Lagzian S, Soryani M, Fathy M, "A new robust watermarking scheme based on RDWT-SVD," IJIIP Int. J Intel. Inform. Process., 2:22-29.
16. Ling H-C, Raphael Phan C-W, Heng S-H, "Comment on Robust blind image

watermarking scheme based on redundant discrete wavelet transform and singular value decomposition," Int. J. Electron. Commun. 67:894-897.
17. Makbol NM, Khoo BE, "Robust blind image watermarking scheme based on Redundant discrete wavelet transform and singular value decomposition," Int. J. Electron. Commun. 67:102-112.
18. Khaled L, Ahmed R, Khalil Z, "Ambiguity attacks on robust blind image watermarking schemebased on redundant discrete wavelet transform and singular value decomposition," J. Electr. Syst. Inform. Technol, 4:359-368.
19. Rastegar S, Namazi F, Yaghmaie K, Aliabadian A, "Hybrid watermarking algorithm based on singular value decomposition and randon transform," Int. J. of Electron Commun 65:275-285.
20. Guo J-M, Prasetyo H, "False-positive-free SVD-based image watermarking," J Vis. Commun. Image R. 25: 1149-1163.
21. Ranade A, Mahabalarao SS, Kale S, "A variation on SVD based image compression," Image Vision Comput. 25: 771-777.
22. Ali M, Ahn CW, "Comments on optimized gray-scale image watermarking using DWT-SVD and Firefly algorithm," Expert Systems with Applications, 42: 2392-2394.
23. Ganic E, Eskicioglu AM, "Robust embedding of visual watermarks using discrete wavelet transform and singular value decomposition," J Electronic Imaging, 14:1-1
24. Divya Shivani JL, Senapati RK, "Robust image watermarking using DTT and Listless SPIHT," Future Internet, 9:33.
25. JL Divya Shivani, RK Senapati, "A CRT based watermarking scheme using DTT," ARPN J. of Engg. and Applied Sciences, 12(11), 3600-3607,