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A Robust, Secure and Imperceptible Image Watermarking Using DWT-SVD and Encryption

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Abstract

Digital Watermarking is one of the techniques to hinder the unauthorized use of digital media. This technique can help the protection of proprietorship rights toward ensuring the copyright information and authentication in a networked environment. Inspired by combining Discrete Wavelet Transform (DWT) with modification of Singular Value Decomposition (SVD). Digital image watermarking technique based on the encryption algorithm is proposed in the present work in order to improve the robustness, security and the imperceptibility. The watermark image is encrypted by using Advanced Encryption Standard (AES) encryption technique with a secret key and then transformed the original (host) and watermark images using DWT and modified SVD for embedding the encrypted watermark in the high frequency sub band (HH) of the original (host) image. The experimental results show that the proposed method is superior from where robustness, imperceptible and security as compared with some related methods.

Keywords: Digital watermarking, DWT, SVD, Encryption technique

1. Introduction

Recently with rife growth of internet and the developing rapidly of communication technologies, which provide users with easy access to digital assets such as images, videos, sounds, etc. and used illegally.Therefore, the security of the multimedia information is truly imperative.The objective of digital image watermarking systems task is to copyright protection and authentication of digital image.

Digital watermarking, which be a processing for embedding data into digital, while embedding should be ended in such a approach so that,perceptual degradation is nothing,in the same time non-eliminate by unauthorized gatherings and must sturdy against different intentional and non-intentional offensives [1].We can be divided watermarking techniques according to the embedding domain into two main denominations : spatial and transform domain.Watermark is embedded in a specific pixel of the host

image in the spatial area. As for transform domain, at first a host image is transformed to a frequency domain and then watermark is inserted into the frequency coefficients [2,3].

Despite of thespatial domainhas low computational cost and it is faster but not efficient, that's led for using the transform domain watermarking techniques is more considerably.The prime interest of transform domain technique is their unrivaled robustness to common image deformations [4,5]. Commonly the transform domain watermarking techniques used a two major transform methods, which are Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT).After wavelet decomposition of host and/or watermark image, it can be embeddedthe watermark in various sub-bands (either low frequency or high ones).

Generally, watermarking using the DWT and DCT displayed a good performance in both invisibility and robustness.Due to the multi-resolution capability in time and frequency of DWT, that makes it is well-known transform for image processing [6].Currently, singular value decomposition (SVD) is one of the most robust numeric analysis techniques with widely of applications especially watermarking.The aim of SVD-based image watermarking is stability of individual values and considered a main feature for it [7].

In addition, the combining of Encryption and digital watermarking techniques together is an important scheme in digital right management to realize high security.The importance of these two techniques is that they are complimenting each other in order the increased security of the digital artifacts, it can be achieved by using benefits of the both.Encryption transforms the original digital contain intohuman unreadable format[8]. Along with that, the four essential properties that determine quality of watermarking technique are Robustness, imperceptibility, embedding capacity and security.That's mean, there is a major challenge in watermark digital image, which is achieving these standards simultaneously since they contradict each other for achieving multiple level security [9, 10].

The main contributions of this paper is building an watermarking algorithm with a robustness as well as a highly imperceptibly and security, through the combining DWT with modification of SVD, and digital image watermarking technique based on the encryption algorithm.The remainder of this paper is organized as follows. Section 2reviews some related works, and the proposed watermarking scheme is carried out in Section 3.Experimentation and results are given in Section 4, followed by the conclusions of this paper as given in Section5.

2. Related Work

In this section, we will introduce a brief review of some research, most have focused on improving the robustness of watermarking algorithms against attacks.In [11], The authors have been proposed a robust and secure DWT-SVD digital image watermarking using encrypted watermark of cheque image to provide identification of watermark which is relevant to bank system perception .

In the same context in [12] the Hybrid multiple watermarking technique using fusion of DWT, DCT, and SVD, simultaneous embedding of multiple watermarks (text and image) into the same multimedia object in order a security with acceptable performance in terms of robustness and imperceptibility. In addition, security of the text watermark by using encryption.The grafting quantization index modulation (QIM) onto relative modulation (RM), to process the quality degradation problem because of the excessive coefficient modulation in DCT-based image watermarking, was presented in [13].

Two image watermarking techniques based on the Homomorphic transformand singular value decomposition (SVD) introduced in [14], they are denoted as Homomorphic-Based SVD image watermarking and Homomorphic Block-Based SVD image watermarking.Further, performance improvement of the watermarking method based on combination of discrete Shearlet transform (DST) and Bidiagonal SVD (BSVD) has been suggested in [15].

3. Proposed watermarking approach

In this section we describe the secure and robust watermarking scheme that is constructed by incorporating DWTwith modification of SVD based on the encryption algorithm for digital image watermarking, in order to improve the robustness, security and the imperceptibility.In our method, after the watermark is encrypted by using AES with secret key, the DWT has been applied for the original image (host) and modified SVD for it to embedding the watermark in HH1.

Additionally, our method generates signatures by create key that ensure the security for the watermark in the embedding and the extraction process. The watermark embedding and extraction algorithmsare as follows,

The embedding algorithm

Step 1: The original N*N RGB image (host) is transformed into sub-bands [LL,LH, HL, HH] using DWT.

Step 2: SVD is performed on LL sub-band (on RGB components) of decomposed RGB original image.

Step 3: The watermark of size M*M RGB image is encrypted with (AES) encryption technique and then transformed into sub-bands [LL, LH, HL, HH] using DWT.

Step 4:SVD is performed on LL sub-band (on RGB components) of decomposed RGB encrypted watermark image.

Step 5: After performing SVD on both original and watermark images, the resultant watermark image is then embedded with the original image.

Step 6: Inverse SVD is performed on embedded image.

Step 7: Finally, inverse DWT is performed to produce the watermarked image.

The extraction algorithm

Step 1: The original N*N RGB image is transformed into sub-bands using DWT.

Step 2: SVD is performed on LL sub-band (on RGB components) of decomposed RGB original image.

Step 3: The watermark of size M*M RGB image is transformed into sub-bands using DWT.

Step 4: SVD is performed on LL sub-band (on RGB components) of decomposed RGB watermark image.

Step 5: The watermarked image (output of embedding) is transformed into sub-bands using DWT.

Step 6: SVD is performed on LL sub-band (on RGB components) of decomposed RGB watermarked image.

Step 7: Then the extraction is applied to the resultant SVD image.

Step 8: Inverse SVD is applied on resultant image after extraction.

Step 9: Finally, inverse DWT is performed to get the extracted watermark image.

Step 10: decrypted the encryption watermark to get final watermark.

4. Performance evaluation and experimentation results

In this section we evaluate capabilities of the proposed approach of the watermarking algorithm on the basis of its robustness and imperceptibility. A larger Peak Signal to Noise Ratio (PSNR) refers that the watermarked image exceedingly resembles the original image meaning that the watermark is more imperceptible. The $PSNR$ is defined as

$$PSNR = 10log\frac{(Pmax)^2}{MSE} (1)$$

where $Pmax$ is maximum pixel value of the image, the Mean Square Error (MSE) isdefined as

$$MSE = \frac{1}{X \times Y} \sum_{i=1}^{X} \sum_{j=1}^{Y} (I_{ij} - W_{ij})^2 (2)$$

where I_{ij} and $W_{ij}$are a pixel ofthe original image and the watermarked image, both are of size $X \times Y$. By the correlation factor, that is determined the robustness of the algorithm and similarity and differences between original and extracted watermark is measured by the Normalized Correlation (NC). Its value is generally 0 to 1. Ideally it should be 1 but the value 0.7 is acceptable [16].

$$NC = \sum_{i=1}^{X} \sum_{j=1}^{Y} (W_{originalij} - W_{recoveredij}) / \sum_{i=1}^{X} \sum_{j=1}^{Y} W_{originalij}^2 (3)$$

Where $W_{originalij}$ is a pixel of the original watermark of size $X \times Y$ and $W_{recoveredij}$is a pixel of the recovered watermark of size $X \times Y$.

To investigate the effectiveness of the proposed method in consideration of various sizes of files, we performed experiments for the proposed hybrid watermarking method by applying encryption on an image before embedding into the cover has been investigated. In our experiment used the cover image of size(512×512) and the watermark of sizes $(256x256)$, $(128x128)$for testing and the robustness of the watermark was evaluated by determining Normalized Correlation (NC).The visual quality of the watermarked is evaluated by Peak Signal to Noise Ratio ($PSNR$) and Mean Square Error(MSE). Table (1) shows the performance of embedding and extracting in terms of (MSE), ($PSNR$) and (NC) against various attacks (Salt-paper (density 0.01), Gaussian noise $m = 0$, $v = 0.001$, Poisson Noise, Compression Q.F. 60%, Rotation by 10 (Clockwise) and Shifting Attack Translation [5 5]), where that's attacks are an attempts to remove or destroy the watermark image.MSE and $PSNR$ are calculated between the original file and stego file. Whereas NC is measured between the original and extractedfiles.

Table 1: Extraction of secret file

Size	Parameter	Without attack	Salt-paper (density 0.01)	Gaussian noise $m = 0$, $v = 0.001$	Poisson Noise	Compression Q.F.60%	Rotation by 10 (Clockwise)	Shifting Attack Translation [5 5]
64 KB	MSE	0.9746	1.8897	3.9943	4.1284	1.8943	66.9987	17.7843
	PSNR	58.2423	51.2371	44.3291	43.9932	51.9893	35.9879	41.2321
	Retrieved Secret file NC	0.9639	0.9348	0.9462	0.9498	0.9539	0.4313	0.9192

When facing various malicious attacks, it is found that our system shows stronger anti-interference performance and higher stability. Whereas Table (2) shows the efficiency in terms of computation time for embedding and extraction in unit seconds.Table (3) shows the PSNR performance comparison of the proposed method with other reportedtechniques [7, 17].

Table 2: Embedding and extraction time in unit seconds

Size	Embedding time in unit seconds	Extraction time in unit seconds
128 KB	0.798423	1.538391
256 KB	1.1532941	1.495923

Table 3: Compression of PSNR

Technique	Shahet al. [7]	Narulaal. [17]	Proposed method
PSNR	26.90	35.87	58.2423

5. Conclusion

In this paper, we presented an watermarking method Based DWT-SVD with encryption. Multidirectional properties of DWT and SVD make our method applicable for images with various texture. Result of tests on proposed method showed good robustness and high imperceptibility.That's results are a high motivation for using this approach for copyright protection. As a future work, the algorithm can be using full band DWT-DCT-SVD and further can be extended to video processing.

References

1. Singh, Satish Kumar, and Shishir Kumar. "Novel adaptive color space transform and application to image compression." Signal Processing: Image Communication 26, no. 10 (2011): 662-672.

2. Danyali, Habibollah, MortezaMakhloghi, and FardinAkhlagian Tab. "Robust blind DWT based digital image watermarking using singular value decomposition." International Journal of Innovative Computing, Information and Control 8, no. 7 (2012).

3. Furqan, Asna, and Munish Kumar. "Study and analysis of robust DWT-SVD domain based digital image watermarking technique using MATLAB." In Computational Intelligence & Communication Technology (CICT), 2015 IEEE International Conference on, pp. 638-644. IEEE, 2015.

4. Saxena, Praful, ShanonGarg, and ArpitaSrivastava. "Dwt-svd semi-blind image watermarking using high frequency band." In 2nd International Conference on Computer Science and Information Technology (ICCSIT'2012) Singapore April, vol. 28, p. 29. 2012.

5. Lai, Chih-Chin, and Cheng-Chih Tsai. "Digital image watermarking using discrete wavelet transform and singular value decomposition." IEEE Transactions on instrumentation and measurement 59, no. 11 (2010): 3060-3063.

6. Hu, Hwai-Tsu, and Ling-Yuan Hsu. "Exploring DWT–SVD–DCT feature parameters for robust multiple watermarking against JPEG and JPEG2000 compression." Computers & Electrical Engineering 41 (2015): 52-63.

7. Shah, Prasanna, ToshanlalMeenpal, Ankit Sharma, Vivek Gupta, and AmitKotecha. "A DWT-SVD based digital watermarking technique for copyright protection." In Electrical, Electronics, Signals, Communication and Optimization (EESCO), 2015 International Conference on, pp. 1-5. IEEE, 2015.

8. Makbol, Nasrin M., Bee EeKhoo, and Taha H. Rassem. "Block-based discrete wavelet transform-singular value decomposition image watermarking scheme using human visual system characteristics." IET Image Processing 10, no. 1 (2016): 34-52.

9. Urvoy, Matthieu, DalilaGoudia, and FlorentAutrusseau. "Perceptual DFT watermarking with improved detection and robustness to geometrical distortions." IEEE Transactions on Information Forensics and Security 9, no. 7 (2014): 1108-1119.

10. Gunjal, Baisa L., and Suresh N. Mali. "MEO based secured, robust, high capacity and perceptual quality image watermarking in DWT-SVD domain." SpringerPlus 4, no. 1 (2015): 126.

11. Gonge, SudhanshuSuhas, and Ashok Ghatol. "A Robust and Secure DWT-SVD Digital Image Watermarking Using Encrypted

Watermark for Copyright Protection of Cheque Image." In International Symposium on Security in Computing and Communication, pp. 290-303. Springer, Cham, 2015.

12. Singh, Amit Kumar. "Improved hybrid algorithm for robust and imperceptible multiple watermarking using digital images." Multimedia Tools and Applications 76, no. 6 (2017): 8881-8900.

13. Hu, Hwai-Tsu, and Ling-Yuan Hsu. "A mixed modulation scheme for blind image watermarking." AEU-International Journal of Electronics and Communications 70, no. 2 (2016): 172-178.

14. Abdallah, Hanaa A., Osama S. Faragallah, Hala S. Elsayed, Abdalhameed A. Shaalan, and Fathi E. Abd El-samie. "Robust image watermarking method using homomorphic block-based KLT." Optik-International Journal for Light and Electron Optics 127, no. 4 (2016): 2374-2381.

15. Mardanpour, Malihe, and Mohammad Ali ZareChahooki. "Robust transparent image watermarking with Shearlet transform and bidiagonal singular value decomposition." AEU-International Journal of Electronics and Communications 70, no. 6 (2016): 790-798.

16. Singh, Amit Kumar, Mayank Dave, and Anand Mohan. "Hybrid technique for robust and imperceptible multiple watermarking using medical images." Multimedia Tools and Applications 75, no. 14 (2016): 8381-8401.

17. Narula, Neha, Deepak Sethi, and ParthaPratim Bhattacharya. "Comparative analysis of DWT and DWT-SVD watermarking techniques in RGB images." International journal of Signal Processing, Image processing and Pattern Recognition 8, no. 4 (2015): 339-348.

تحسين متانة وأمن وعدم قابلية تقادم صورة العلامات المائية الرقمية باستخدام التشفير والجمع بين تحويل المويجات المنفصلة (DWT) مع تعديل التحلل للقيمة المفردة (SVD)

روكان خاجي

قسم الرياضيات/ كلية العلوم/ جامعة ديالى

المستخلص:

تعد العلامات المائية الرقمية أحدي التقنيات التي تعيق الاستخدام غير المصرح به للوسائط الرقمية. ويمكن لهذه التقنية ان تساعد في حماية حقوق الملكية نحو ضمان المعلومات الخاصة بحق المؤلف والتوثيق في بيئة مترابطة. مستوحاة من الجمع بين تحويل المويجات المنفصلة (DWT) مع تعديل التحلل للقيمة المفردة (SVD). تقنية العلامة المائية الرقمية القائمة على خوارزميه التشفير تقترح في العمل الحالي من أجل تحسين المتانة والأمن وعدم القابلية للتقادم. يتم تشفير صوره العلامة المائية باستخدام خوارزمية (AES)مع المفتاح السري ومن ثم تحويل الصور الأصلية (المضيفة) والعلامة المائية باستخدام (DWT) وتعديل (SVD) لتضمين العلامة المائية المشفرة في النطاق الفرعيعالي التردد (HH) للصورة الأصلية وأظهرت النتائج التجريبية للمخطط المقترح مزيدا من المتانة والأمن العالي.