Blind Watermarking Technique for Copyright Protection of Image Based on DCT, DWT, SVD, BFO and PBFO Domain

Sonam Naidu[1] Gouri Upadhyay[2] Rahul Chawda[3]
[1]Research Scholar [2]Assistant Professor [3]Head of Department
[1,2,3]Department of Computer Science & Engineering
[1,2,3]Kalinga University, Raipur, C.G., India

Abstract— Watermarking is the process of inserting predefined patterns into multimedia data in a way that the degradation of quality is minimized and remain at an imperceptible level. Many digital watermarking algorithms have been proposed in special and transform domains. The techniques in the spatial domain still have relatively low-bit capacity and are not resistant enough to lossy image compression and other image processing operations. For instance, a simple noise in the image may eliminate the watermark. On the other hand, frequency domain-based techniques can embed more bits for watermark and are more robust to attack. Some transforms such as Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT) are used for watermarking in the frequency domain. In this thesis, we compare the DCT watermarking algorithms and especially the DWT watermarking algorithms based on robustness criteria. In other words, the robustness of different transform watermark algorithms is evaluated by applying different attacks. One main reason to consider the DWT watermarking algorithms is that several multimedia standards such as the JPEG2000 and MPEG-4 are based on the DWT. These new standards brought new requirements such as progressive, low bit rate transmission, and region-of-interest coding. This paper presents a digital watermarking technique which is based on DWT, DCT and SVD. DWT has excellent spatial localization, frequency spread and multi resolution characteristics. DCT & SVD based watermarking techniques offer compression. These desirable properties are used in this combined watermarking technique. Compared with DWT-DCT, DCT SVD, DWT-SVD based watermarking techniques; experimental results show that this algorithm is robust to various attacks such as JPEG compression, cropping, rotation, and noise which are checked by the invovlement of Bacterial Foraging Optimisation (BFO) and Parallel Bacterial Foraging Optimisation (PBFO).

Keywords: Watermarking, DWT, DCT, SVD, BFO, PBFO

I. INTRODUCTION

The Internet is an excellent sales and distribution channel for digital assets, but copyright compliance and content management can be a challenge. These days, digital images can be used everywhere – with or without consent. Images that are leaked or misused can hurt marketing efforts, brand image and, ultimately, sales. The possible implications of this situation include the unauthorized distribution of such material with the purpose of making illegal profit or otherwise damaging the legal owner. Inevitably the business world and the authorities have expressed great concern over this issue, and as a result, the scientific community has become extremely active trying to provide techniques for copyright protection of digital material. One way to address this problem is Image Watermarking. It is the process of inserting hidden information in an image by introducing modifications of minimum perceptual disturbance. Robustness, perceptual transparency, capacity and blind watermarking are four essential factors to determine quality of watermarking scheme. Image watermarking techniques can be divided into two groups in accordance with processing domain of host image. One is to modify the intensity value of the luminance in the spatial domain and the other is to change the image coefficient in a frequency domain. In recently, a transform called Singular Value Decomposition (SVD) was explored for watermarking. Frequency domain techniques are used commonly because of their robustness to various types of attacks like JPEG compression, cropping, rotation, noise, blur etc. SVD-based watermarking algorithms are also very robust against these attacks. DWT has excellent spatial localization and multi-resolution characteristics, which are similar to the theoretical models of the human visual system. DCT and SVD based watermarking techniques offer compression. Further Performance improvements in DWT-based digital image watermarking algorithms, DCT-based watermarking algorithms and SVD-based watermarking algorithms could be obtained by combining DWT, DCT and SVD. The idea of combining these transforms is based on the fact that combined transforms could compensate for the drawbacks of each other, resulting in effective watermarking.

II. PROPOSED METHODOLOGY

The proposed algorithm uses DWT, DCT and SVD. So before discussing the proposed algorithm. In Singular Value Decomposition, singular values correspond to the luminance of the image (i.e, image brightness) and the corresponding singular vector specifies the intrinsic geometry properties of the image. Many singular values have small values compared to the first singular value. If these small singular values are ignored in the reconstruction of the image, the quality of the reconstructed image will degrade only slightly. Slight variations of the singular values do not affect the visual perception of the image, i.e., singular values do have a good stability. Based on these properties of SVD, diagonal matrix containing singular values is mainly used to embed watermark. The DCT has special property that most of the visually significant information of the image is concentrated in low frequency coefficient of the DCT. In the literature various hybrid techniques are proposed by the researchers such as DCT-SVD, DWT-SVD and DWT-DCT. In our proposed method, watermark is embedded into the singular values of the low frequency band of the DCT block of selected DWT sub band. We compare our proposed method with DWT-SVD, DCT-SVD based techniques. Also

DCT-DWT-BFO and DCT-DWT-PBFO techniques are seen altogether in the input image.

A. Singular Value Decomposition:

From the viewpoint of linear algebra, the discrete image is non-negative real matrix. The SVD of a matrix is a kind of orthogonal transforms used for matrix diagonalization.

Let I be an image, and its size be M×N. The SVD of I can be described as follows:

$$I = USV^T \quad (1)$$

Where U and V are two M×N and N×N unitary orthogonal matrices, and S is an N×N diagonal matrix.

The elements of S are nonnegative values on diagonal representing singular values of I.

The diagonal elements of matrix

$S = \mathrm{diag}(s1, s2, \ldots, sn)$ satisfy the order: $s1 \geq s2 \geq \ldots \geq sn$.

It is important to note that

- The nonnegative components of S represent the luminance value of the image.
- Changing them slightly does not affect the image quality and they also don't change much after attacks, watermarking algorithms make use of these two properties.

B. Discrete Cosine Transform:

The DCT is similar to the discrete Fourier transform: it transforms a signal or image from the spatial domain to the frequency domain. It has been widely used because of its energy compaction property. DCT is faster than DFT because its transform kernel is real cosine function while it is complex exponential in DFT. The DCT has special property that most of the visually significant information of the image is concentrated in low frequency coefficient of the DCT.

C. Discrete Wavelet Transform:

DWT has excellent spatial localization and multi-resolution characteristics, which are similar to the theoretical models of the human visual system. The original image is decomposed into four sub-band images by DWT: three high frequency parts (HL, LH and HH, named detail sub images) and one low frequency part (LL, named approximate sub-image). The detail sub-images contain the fringe information while the approximate sub-image is the convergence of strength of original image. Relative to the detail sub-images, approximate sub image is much more stable, since the majority of image energy concentrates here. Therefore, watermark is embedded into approximate sub-image to gain a better robustness.

D. Bacterial Foraging Optimisation:

BfO is an optimization algorithm since it is efficient in solving real world optimiztion plroblems in different application domains. Researchers are trying to hybridize BFOA with different other algorithms in order to explore its local and global search propertoes separately. It has already been applied to many real world problems and proved its effectiveness.

E. Parallel Bacterial Foraging Optimization:

PBFO is associated with almost every problem of engineering. The underlying principle in optimization is to enforce constraints that must be satisfied while exploring as many options as possible within tradeoff space. There exists numerous optimization techniques for the noise removal.

III. EXPERIMENTS AND RESULTS

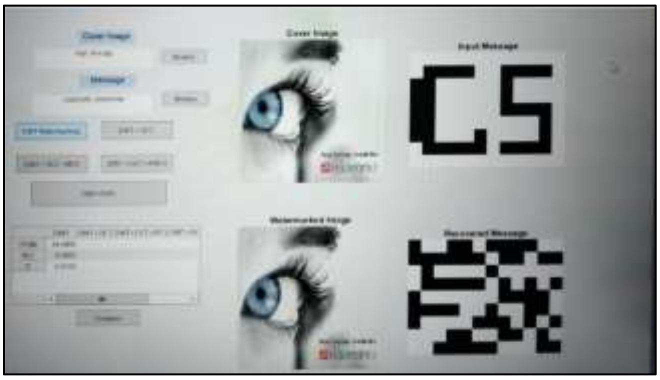

Fig. 3.1: Applying DWT technique to the input image

On applying discrete wavelet transform to the input image we found that recovered image is distorted and not clear at all.

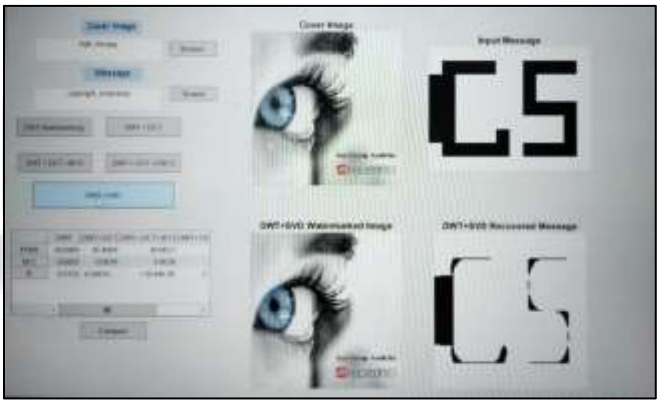

Fig. 3.2: Applying DWT and SVD technique to the input image

On applying discrete wavelet transform and singular value decomposition to the input image we found that recovered image is clear than earlier extracted image but not exact.

Fig. 3.3: Applying DWT and DCT technique to the input image

On applying discrete wavelet transform and discrete cosine transform to the input image we found that recovered image is much clear and similar to the input image.

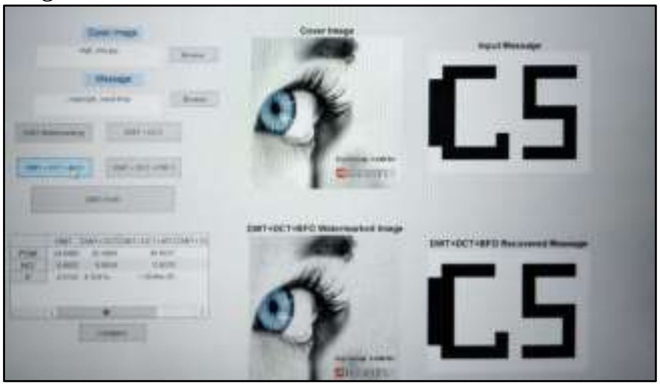

Fig. 3.4: Applying DWT, DCT and BFO technique to the input image

On applying discrete wavelet transform, discrete cosine transform along with bacterial foraging optimization to the input image we found that recovered image is much clear and similar to the input image.

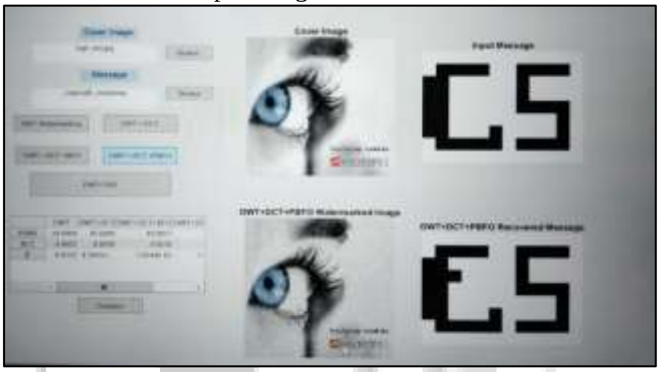

Fig. 3.5: Applying DWT, DCT and PBFO technique to the input image

On applying discrete wavelet transform, discrete cosine transform along with parallel bacterial foraging optimization to the input image we found that recovered image is clear and similar with some extra information to the input image.

IV. CONCLUSION

Parameters	DWT	DWT+DCT	DWT+DCT+BFO	DWT+DCT+PBFO	DWT+SVD
PSNR	24.6969	45.4089	49.0657	54.6036	21.7355
NCC	0.0022	0.0039	0.0039	0.0039	0.0038
IF	-0.0152	-4.3041e-06	-1.8544e-05	-5.1808e-06	-0.0100

Table 1: Comparison table

DCT-DWT-SVD based watermarking scheme is gives best performance in the presence of recovery of watermark image used to indicates the recovered data of images. The results are verified analytically in terms of PSNR, NCC and IF .Normalization coefficients and both are high for novel DCT-DWTSVD watermarking scheme.

REFERENCES

[1] C. T. Hsu and J. L. Wu, “Multiresolution Watermarking for Digital Images,” IEEE Transaction on Circuits and System II, Vol. 45, No. 8, pp. 1097-1101, August 2015.

[2] K. Deb, M. S. A. Seraj et. al., “Combined DWT-DCT based digital image watermarking technique for copyright protection,” Seventh International Conference on Electrical & Computer Engineering, Vol.1, pp 458 – 461, December 2012.

[3] Kurniawan Wira Handito, Zulfikar Fauzi, Firda Aminy Ma’ruf, Tanti Widyaningrum, Kemas Muslim Lhaksmana, “The comparison between SVD-DCT and SVD-DWT digital image watermarking”, International Conference on Data and Information Science, International Conference on Data and Information Science IOP Publishing IOP Conf. Series: Journal of Physics: Conf. Series 971 (2018).

[4] M. Shahrezaee, Navid Razmjooy, “Image Watermarking Based on DWT-SVD”, Proceedings of the 2nd International Conference on Combinatorics, Cryptography and Computation I4C2017.

[5] Md. Maklachur Rahman, Md. Shale Ahammed, Md. Rishad Ahmed, “A Semi Blind Watermarking Technique for Copyright Protection of Image Based on DCT and SVD Domain”, Global Journal of Researches in Engineering: F Electrical and Electronics En Volume 16 Issue 7 Version 1.0 Year 2016.

[6] M. S. Hsieh, “Perceptual Copyright Protection using multiresolution Wavelet Based Watermarking and Fuzzy Logic,” International Journal of Artificial Intelligence & Applications, Vol.1, No.3, July 2010.

[7] N.Nikolaidis and I.Pitas, “Robust image watermarking in the spatial domain,” Signal Processing, Vol.1, No.66, pp.385-403, 2015.

[8] R. Sun, H. Sun, “A SVD and quantization based semi-fragile watermarking technique for image authentication,” International Conference on Signal Processing, Vol.2, pp 1952–1955, 2012.

[9] R. Liu and T. Tan, “A SVD-Based watermarking scheme for protecting rightful ownership,” IEEE Transaction on Multimedia, Vol. 4,No.1, pp 121128, March 2012.

[10] Sachin Gaur, Vinay Kumar Srivastava, “A RDWT and Block-SVD based Dual Watermarking Scheme for Digital Images”, International Journal of Advanced Computer Science and Applications, Vol. 8, No. 4, 2017.

[11] S. K. Bhagyashri, M.Y. Joshi, “Robust image watermarking based on singular value decomposition and discrete wavelet transform,” Third IEEE International Conference on Computer Science and Information Technology, Vol. 5, pp 337 – 341, July 2016.

[12] Soo-Chang Pei, Hsin-Hua Liu, Tsung-Jung Liu, Kuan-Hsien Liu, “Color Image Watermarking using SVD”, 978-1-4244-7493-6/10/$26.00 ©2010 IEEE ICME 2010.

[13] Soumitra Roy and Arup Kumar, “An indirect watermark hiding in discrete cosine transform–singular value decomposition domain for copyright protection”,

rsos.royalsocietypublishing.org, Received: 10 April 2017 Accepted: 19 May 2017.

[14] W. C. Chu, "DCT-Based ImageWatermarking Using Subsampling," IEEE Transaction on Multimedia, Vol. 5, No. 1, March 2013.

[15] Z. M. Lu, H. Y. Zheng et. al., "A Digital Watermarking Scheme Based on DCT and SVD," Third International Conference on Intelligent Information Hiding and Multimedia Signal Processing, Vol.1, pp 241 – 244, November 2017