Secure Copyright Protection for Images Using Redundant DWT and SVD

Munazah Jamal[1], Saira Mudassar[2], Farkhand Shakeel[3], Nauman Shah[4], Hassaan Malik[5] and Hamza Bin Tahir[6]
[1-6]NCBAE, Multan, Pakistan
[1]munazahjamal@ymail.com,[2]sairamcs40@gmail.com,[3]farkhandshakeel@yahoo.com,
[4]naumanahmed@yahoo.com,[5]engr.hassaan88@gmail.com,[6]hamzabintahir0322@gmail.com

***Abstract*— Digital Image Watermarking (DIW) is such a technique designed specifically for the protection of the images or data from illicit transformations. One of the best suited techniques for copyright protection and owner authentication is watermarking. In this document, a non-blind Digital Image Watermarking technique was proposed that is the fusion of two different techniques i.e., Redundant Discrete Wavelet Transform (RDWT) and Singular Value Decomposition (SVD) in YCbCr color space. A reliable way of protection was introduced as it showed more resistance than that of different wavelet based techniques. The proposed scheme was tested against different geometrical transformations (median filtering, noise addition, cropping) and provided better extraction of the watermark. The performance increased the evaluation values of different parametric results i.e., Mean Square Error (MSE), Normalized Correlation (NC) and Peak Signal-to-noise Ratio (PSNR).**

***Keywords*— Singular Value Decomposition, Redundant Discrete Wavelet Transform, Non-Blind Technique, YCbCr Color Space, and HH Sub-band**

I. INTRODUCTION

Watermarking deals with copyright protection, security-oriented applications or other ownership verification, the survival of the watermark become effective in both cases i.e., having non-malicious as well as malicious manipulations. In the condition of secure watermarking, the loss of the secreted data that is hidden should be accessible only at the outflow of a considerable deprivation of the quality of the host data. As to non-malicious attacks, a vast range of digital and analog processing tools exist i.e., lossy compression [11], linear and non-linear filtering, cropping, editing, scaling, noise addition and many others that apply to check the authenticity of the watermark.

Thus, in the case of image, following techniques are considered i.e., zooming and shrinking, rotation, contrast, enhancement histogram manipulations, row/column removal or exchange In simple words, watermark infringement does not necessitate to be impossible (which probably will never be the case), but it should be difficult enough. Threshold value is used to check the scale factors that result in the measurements of best suited peak values (Fig. 1).

There are different kinds of watermarking: Visible & Transparent Watermarking, Visible watermarks are embedded in visual content and they remain visible when the content is viewed. Transparent watermarks are invisible that they cannot be detected by just screening of the digital content. Fig. 2 shows the difference visible and invisible watermarks. Similarly another kind is Public & Private Watermarking: In public watermarking, the authorization is given to the users of content so that the detection of the watermark is made applicable while in private watermarking, the users are not allowed to perceive the watermark.

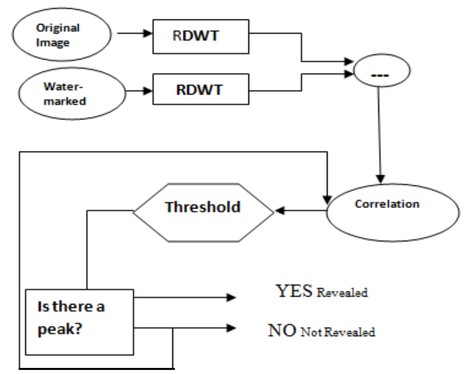

Fig. 1: Measuring Parametric Values

Fig. 2: Difference between invisible and visible watermark

II. LITERATURE REVIEW

Most commonly used techniques of watermarking are: Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT), Discrete Fourier Transform (DFT), and Singular Value Decomposition (SVD). Combination of two techniques is known as hybrid technique. There are two basic techniques that are used as hybrid, named as DWT-DCT and DWT-SVD. Wavelets are decomposed into four bands.

Discrete Wavelet Transform:

The image is first converted in two ways, high and low-pass and then it is filtered along the rows and the resultant for each filter is down- sampled by two. The high and low frequency components are corresponded by the two sub-signals along with the rows and hence, are represented each of size N by N/2. Again, both of these sub-signals are high and low-pass filtered, but now, at this time along with the column data. The results are again down-sampled by two:

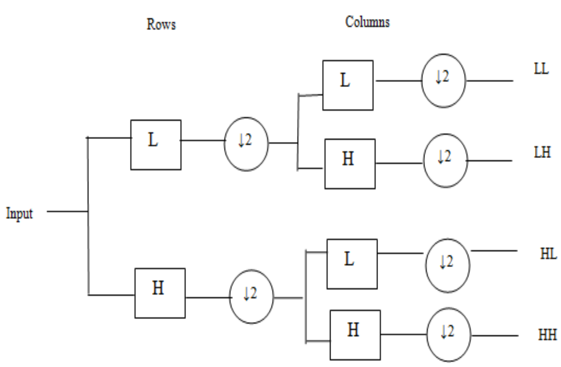

Fig. 3: One decomposition step of the two dimensional image

In this way, the original image is divided into four sub-images each of size N/2 by N/2 that contain information from different frequency components. Fig. 2 shows the one decomposition step of the two dimensional 2D grayscale image. Fig. 3 shows the four sub-bands in the distinctive arrangement.

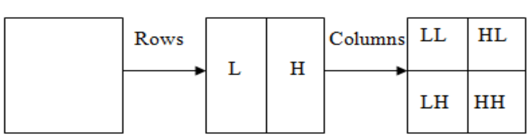

Fig. 4: One DWT decomposition step

Singular Value Decomposition:

Singular Value Decomposition is used for factorization of a real or complex matrix which has numerous applications in different fields of image processing. This transform is a linear algebra transform. A digital image can be expressed with all of the entries showing the intensity value of each pixel in the image in a matrix form. SVD of an image A can be represented by the dimension in $N*N$ is given

$$A=USV^T \qquad (1)$$

Where, S is known as singular matrix or a diagonal matrix carrying out nonnegative singular values of matrix A and U, V are orthogonal matrices.

III. PROPOSED TECHNIQUE FOR WATERMARKING

Watermark Embedding:

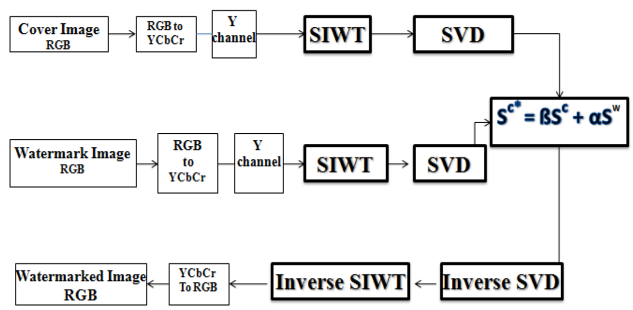

Fig. 5: Watermark Embedding Process Using RDWT-SVD

Watermark Extraction:

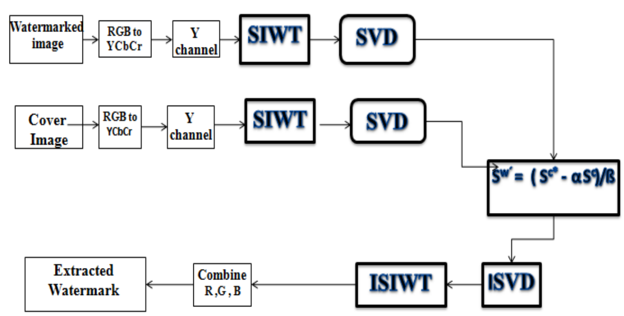

Fig. 6: Watermark Extracting Process Using RDWT-SVD

IV. SIMULATION RESULTS

Two experiments are performed to evaluate different parametric values for each technique, both experiments contain JPEG image using RGB color space with size 512×512 bit, depth 24 and resolution 96×96 dots per inch, cover image lena.jpg and the image used for watermark is peppers.jpg, and another experiment is done on same RGB color space having extension of JPEG with size 512×512, bit depth 24 and resolution 1×1 dots per inch. Host image NCBAE.jpg and watermark image baby.jpg are given in Fig. 2. By making comparisons to different state of art techniques, the proposed scheme will have the following extracted and embedded images as shown in Fig. 6. Table I and Table II show the evaluation matrices results (PSNR and NC) without attacks and algorithm CPU time for the proposed technique compared with the other state of art techniques. The NC for extracted watermark after attacks for the proposed technique compared with the other state of art techniques shown.

Fig. 7: Wallpaper.jpg (host) b) Art.jpg (watermark)

Table I: Values for Embedding Process using NCBAE.jpg as host and Baby.jpg as watermark

Embed Watermark Image	DWT	DWT-SVD	PROPOSED COLOR RDWT-SVD
PSNR-RED	24.0712	28.6238	46.9486
PSNR-GREEN	22.1091	27.5755	45.3983
PSNR-BLUE	27.9651	27.2327	47.3009
RED_NC	0.9724	0.9984	0.9999
GREEN_NC	0.9539	0.9980	0.9997
BLUE_NC	0.9738	0.9985	0.9986

Table II: Values for Extracting Process using NCBAE.jpg as host and Baby.jpg as watermark

Extract Watermark	DWT	DWT-SVD	PROPOSED COLOR RDWT-SVD
PSNR-RED	21.9473	24.2229	39.2776
PSNR-GREEN	21.3326	31.3539	41.1172
PSNR-BLUE	24.7136	29.0073	37.7964
RED_NC	0.9522	0.9970	0.9986
GREEN_ NC	0.9946	0.9975	0.9988
BLUE_ NC	0.9758	0.9957	0.9970

Table III: R, G, and B channel values to measure robustness of Watermarked Image (Wallpaper.jpg and Art.jpg 512×512)

Watermarked (sym4)	MSE	PSNR	RMSE	CC
RED	1.3129	46.9486	1.1458	0.9999
GREEN	1.8761	45.3983	1.3697	0.9997
BLUE	1.2106	47.3009	1.1003	0.9986

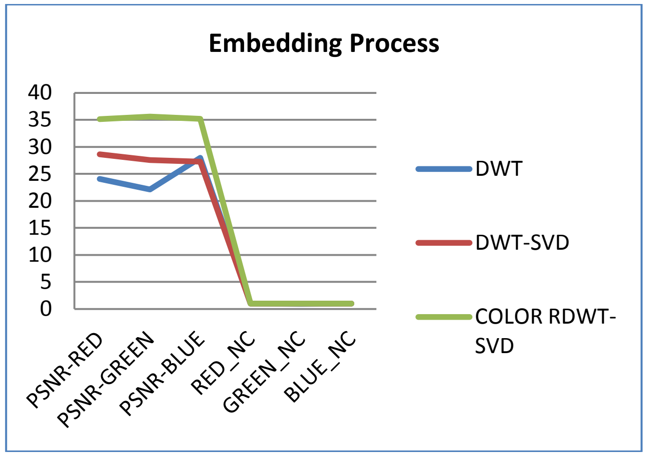

Fig. 8: Graphical Representation for Embedding

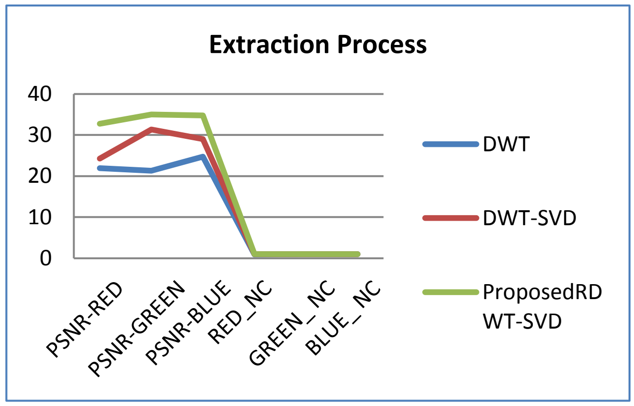

Fig. 9: Graphical Representation for Extraction

Table IV: R, G, and B channel values to measure robustness of Extracted Watermark Image (Wallpaper.jpg and Art.jpg 512×512)

EWatermark (sym4)	MSE	PSNR	RMSE	CC
RED	7.6793	39.2776	2.7711	0.9986
GREEN	5.0276	41.1172	2.2422	0.9988
BLUE	10.8003	37.7964	3.2864	0.9970

Table V: Comparison for both Host and Watermarked Image, Watermark and Extracted Watermark Image (Wallpaper.jpg and Art.jpg 512×512)

sym4	MSE	PSNR	RMSE	NC
Host and Watermarked Image	1.4665	46.4680	1.2110	0.9998
Watermark Image and Extracted Watermark	7.8357	39.1900	1.2110	0.9982

512×512	Watermarked Image	Extracted Watermark Image
RDWT-SVD		
0.005		
35		
75-75		
0.001-0.02		
Median Filter 3×3		
Gaussian Filter 3×3		

Fig. 10: Visualization Test after applying Attacks on Embedded and Extracted Image

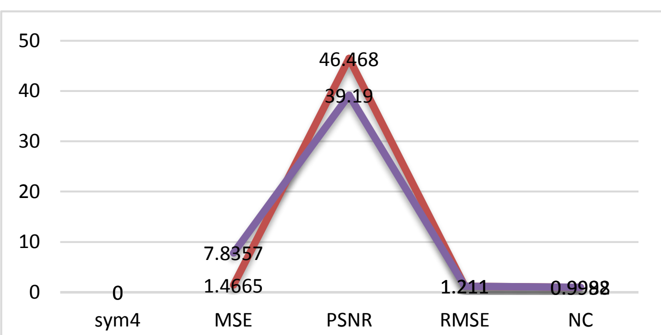

Fig. 11: Graph for both Host and Watermarked Image, Watermark and Extracted Watermark Image

IV. CONCLUSION

The scheme is tested for dimension of 512×512 RGB images with varying scale factor values i.e., α = 0.1 and ß=0.5, bit depth to be noted is 24 and resolution is same for both host image and watermark image i.e., 92×92. Robustness of both the watermarked image and the extracted watermark image was increased in above defined dimensional images. The proposed scheme was proved to show more fidelity for security purposes than previous techniques. Hence, image quality remained the same after applying different solidity attacks to both watermark embedding and extraction processes.

V. ACKNOWLEDGEMENT

The completion of this undertaking would not be possible without participation and inspiration of so many people whose names all may not be enumerated. Their contributions are greatly appreciated and sincerely acknowledged. However, we would like to express our deep appreciation to the Directorate of Research Centre of Natıonal College of Busıness and Economıcs, Multan, for their endless support i.e., technical and financial support.

REFERENCES

[1] M. Jamal, F. S. Mahmood, and S. Mudassar, (2016) Quantization based IMAGE CONTENT Watermarking Using DWT Domain, Proc. ICCS-14, Multan, Pakistan December 12-15, 2016, Vol. 30, pp. 231-240.

[2] S. Mudassar, M. Jamal, F. S. Mahmood, ROBUSTNESS OF IMAGE CONTENT USING NON-BLIND DWT-SVD BASED WATERMARKING TECHNIQUE, Proc. ICCS-14, Multan, Pakistan December 12-15, Vol. 30, pp. 241-246, 2016.

[3] M. Jamal, F. S. Mahmood, and S. Mudassar ,Improved Robustness of RGB Image Content Watermarking Using RDWT-SVD Domain, Proc. 15th International Conference on Statistical Sciences Khairpur, Pakistan – March 9-11, 2017, Vol. 31, pp. 73-82.

[4] S. Mudassar, M. Jamal and F. S. Mahmood, Robustness of Image content using LWT-SVD based Watermarking Technique, Proc. 15th International Conference on Statistical Sciences Khairpur, Pakistan – March 9-11, 2017, Vol. 31, pp. 83-90.

[5] Khalid A. Al-Afandy, EL-Sayed M. EL-Rabaie, Fathi E. Abd El-Samie, Osama S. Faragallah, Ahmed ELmhalaway, A. M. Shehata, "Robust Color Image Watermarking Technique Using DWT and Homomorphic based SVD" , ISSN 1687-398X, Volume 16, Iss*ue 3, ICGST LLC, Delaware, USA.2016.*

[6] P. Mangaiyarkarasi, S. Arulselvi, Robust Color Image Watermarking Technique based on DWT and ICA 2014.

[7] Khalid A. Al-Afandy, Osama S. Faragallah, Efficient Color Image Watermarking Using Homomorphic based SVD in DWT Domain. Fourth International Japan-Egypt Conference on Electronic Communication and Computers (JEC-ECC) 2016.

[8] B. Arun, Wavelet Based Image Watermarking , Int. Journal of Engineering Research and Applications ISSN : 2248-9622, Vol. 4, Issue 7(Version 5), July 2014, pp.38-42, 2014.

[9] B. Shen, Iihwar K. Sethi and V. Bhaskaran, DCT Domain Alpha Blending, IEEE 1998.

[10] Munazah J., Saira. M, Improved Robustness of RGB Image Content Watermarking Using RDWT-SVD Domain**.** ISOSS Journal 2017.

[11] T. Rassem, N. M. Makbol and B. E. Khoo, Performance evaluation of RDWT-SVD and DWT-SVD watermarking schemes, 1774, 050021, 2016.

[12] Saira. M, Munazah J., Robustness of RGB Image Content Using LWT-SVD Based Watermarking Technique. ISOSS Journal 2017

[13] D. Bhowmik and C. Abhayaratne "Scalable watermark extraction for real-time authentication of JPEG 2000 images," Real-Time Image Process., vol. 8, no. 3, pp. 307–325, Sep 2013

[14] D. Bhowmik and C. Abhayaratne "Distortion constrained robustness scalable watermarking," in Proc. IET Conf. Image Process., Jul, pp. 1–6, 2012.

[15] D. Bhowmik and C. Abhayaratne "Robust watermarking for scalable image coding-based content adaptation," in Proc. IET Conf. Image Process., Jul, pp. 1–6, 2012.

[16] D. Bhowmik and C. Abhayaratne "2D+t wavelet domain video watermarking," Adv. Multimedia, vol. 2012, Art. no. 973418,2012.

[17] Houng-Jyh Wang and C.-C. Jay Kuo "High fidelity image compression with multithreshold wavelet coding (MTWC)," SPIE's Annual Meeting - Application of Digital Image Processing XX, San Diego, CA, 1997.

[18] A. Said and W. A. Pearlman "A new, fast, and efficient image codec based on set partitioning in hierarchical trees," IEEE Trans. on Circuits and Systems for Video Technology, pp. 243-250, June 1996.