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Wavelet Based Digital Image Watermarking Algorithm Using Fractal Images

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ABSTRACT: With the rising development of data technology, electronic publishing is becoming more popular, therefore the need for copyright security has been increased. Digital watermarking is employed to preserve digital data from being changed. This paper gives an algorithm to embed fractal images within the wavelet domain using Lifting Wavelet Transform. Fractal image is formed from Quadtree decomposition is converted into a binary image. This binary image is employed as a watermark. The cover picture is converted into RGB components and then the binary watermark is inserted into mid-frequency bands of the cover image to guard data from attackers. Watermark is inserted in the blue component of the RGB image. The PSNR, SSIM, and NC values obtained during this analysis show that the method is invisible and robust against signal distortions like contrast enhancement, gamma correction, image sharpening, Gaussian filter, etc.

I.INTRODUCTION

Digital watermarking is an act of hiding information associated with a digital signal (i.e. an image, song, video) within the signal itself. The word “Digital Watermark” coined by Charles Osborne and AndrewTirkein December 1992. It's an idea closely related to steganography. Watermarking is the method of embedding data into digital multimedia content, while steganography is the practice of concealing a secret message behind a common message. Watermarking has been around for many ages, within the sort of watermarks, found originally in plain paper and afterward in paper bills. However, the area of digital watermarking was only developed during the last 15 years and it's now being employed for various applications. Digital image watermarking is classified based on embedding position as spatial and frequency domain watermarking. Spatial domain techniques modify image pixels of images and frequency domain techniques involve modifying transform coefficients rather than changing image pixels directly.

This paper presents an algorithm based on LWT for digital watermarking of RGB images taking fractal image as watermark. Original color image is separated into RGB channels. Binary fractal image is obtained from Quadtree decomposition of watermark image. So, instead of taking watermark as it is, substitute binary fractal image is used. Watermark is embedded into Blue channel. ILWT is applied to get the watermark embedded image. R channel, Green channel and watermarked Blue channel are concatenated to get the Final embedded image.

II.FRACTAL IMAGE AND QUADTREEDECOMPOSITION

A. *FRACTAL IMAGE:*

Fractals are fragmented and unique shapes. Mathematician Benoit Mandelbrot first used the word “Fractal” in 1975. The concept of self-similarity can be used where the number of similar parts is equal to the number of affine transformations if the image is with similar pattern large image compression can be obtained, the success depends on kind of self-similarity present in a particular image.

Collage theorem

Suppose there is a underlying space $R_2$and there is an object *L*, *L* is an element of hausdorff space (*h*) and there is(x,d) is acomplete matrix space, then affine transforms are w1,w2,w3, ………,wn.When w1 is applied on all the points on the set it will produce a subset of the original set, w2 gives another subset of the original set, w3 gives another subset so that theirunion gives back the whole originalset.

Starting from set '*L*' and applying certain affine transformationsonthesetl.*L*thedistancebetweentheoriginal set and transformed set is a small no '∈'.
∈

Given as

$$h(\ L \cup w_m\ (L)) = \in(1)$$

IFS (Iterated function system) which means affine transformations w1, w2, w3…..wn iterated a large no of times on any initial set will converge on an attractor 'A' thedistance betweentheinitialset'L'andtheattractor'A'willbe

$$h(L, A) = \in / (1 - \gamma) \qquad (2)$$

Where,is the contractivity factor of theIFS.

A. *QUADTREE DECOMPOSITION*

Quadtree division is technique used in fractal image compression method. It reduces computational complexities and memory requirements.

In Quadtree decomposition, the image is divided into identical square blocks and all blocks are searched for some homogeneity principle. If the principle is applicable for the block, the block is subdivided further and is iterated till each block meets the homogeneity criterion.In this paper, fractal image is binarized to get the binary watermark image used as substitute watermark Fig. (1) Shows Fractal of animage.

Fig.1. Fractal of an image using Quadtree Decomposition

B.LIFTING WAVELET TRANSFORM

Second generation wavelets are produced using lifting scheme of Lifting LWT. Phases involved in this scheme are split, predict and update. Splitting phase involves splitting data into even and oddsets. Inprediction even sets predicts oddsets and in update phase modernized even sets are obtained using wavelet coefficients [11]. LWT is faster, reduces memory requirements & removes weakness of quantization errors if compared with classical method [12]. In LWT there are split and merge processes used in replacement of up sampling and down sampling in DWT. Because of this computational complexity in LWT is reduced to 50%. Original image can be decomposed into sub bands of frequency such as LL, LH, HL and HH. LH sub band is used here to embed binary watermark image.

III.PROPOSEDSYSTEM

A. *WATERMARK CONSTRUCTION*

1. Cameraman image of size 256*256 is our watermark image which will be implanted in the cover image. Image is resized to size128*128.

2. Quadtree decomposition of watermark is taken. Image is decomposed into 2 sub blocks of size 64*64 and tested for homogeneity criterion, and subdivided further until it gets the homogeneitycriterion.

3. Output of the Quadtree decomposition is a sparse matrix of size128*128.

4. This matrix is converted to binary image. Instead of using watermark image as it is, fractal binary image obtained using Quadtree decomposition is inserted into the blue channel of the hostimage.

B. EMBEDDING WATERMARK

1. Cover image is converted to its Red, Green, Blue channels, two level LWT is performed on Blue component, which gives LL1,HL1,LH1,HH1 subbands.

2. Binary watermark is embedded into the HL1 band of second level decomposition of the Blue component of host image.

$$w' = \alpha * w_m \qquad (3)$$

w' =water marke dimage

w_m = watermark

α = scalingfactor

3. Two level ILWT is performed to get the Blue

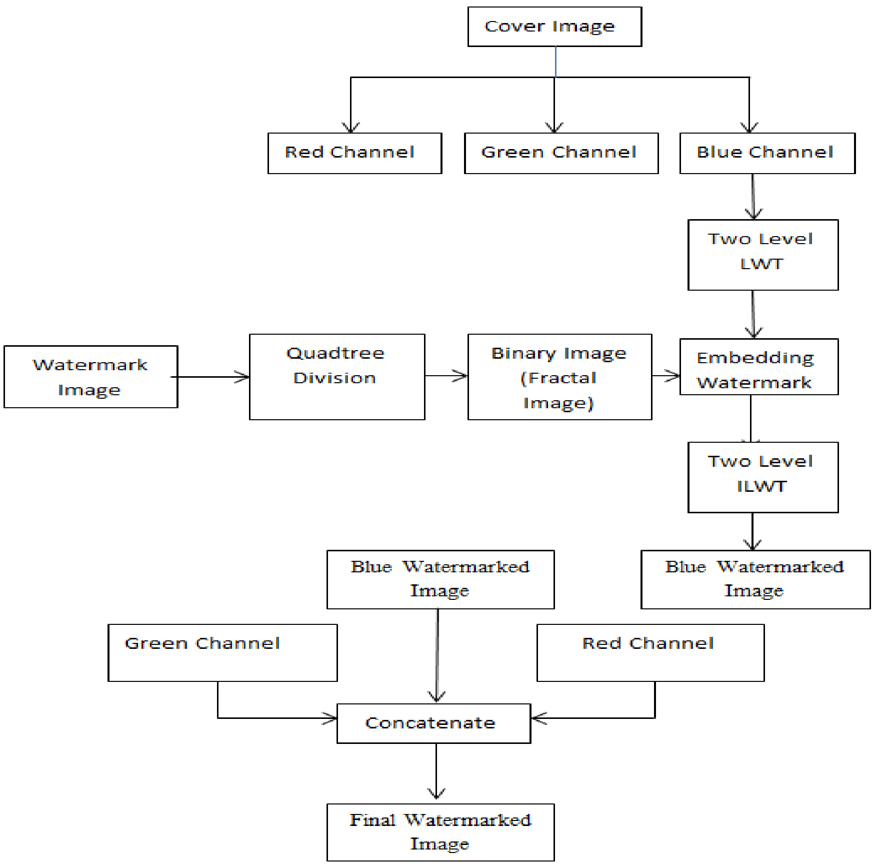

Fig.2 Watermark Embedding

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C.EXTRACTION OF WATERMARK

1. Final watermarked image is separated into RGB channels.
2. Blue component is taken to extract embedded watermark.
3. Two level LWT is applied and watermark is extracted from blue channel using equation.

$$w_m = \frac{w'}{\alpha} \quad \textbf{(4)}$$

=watermark w_m

=watermarked w'

=scalingfactor α

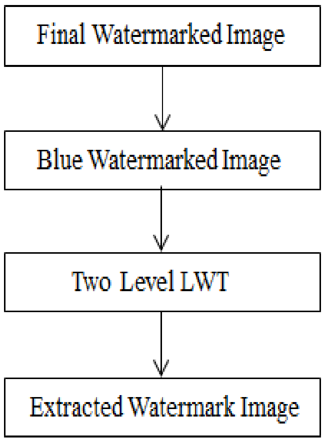

Fig.3 Watermark Extraction

IV.EXPERIMENTAL RESULTS

For experimentation, code is implemented in MATLAB 2018a. Four RGB images are used for this study. They are taken from sipi.usc.edu. RGB image (512*512) in TIFFformat is used as cover image. Watermark used is Gray scale image(256*256). Fig4 shows images used in the experimentation.

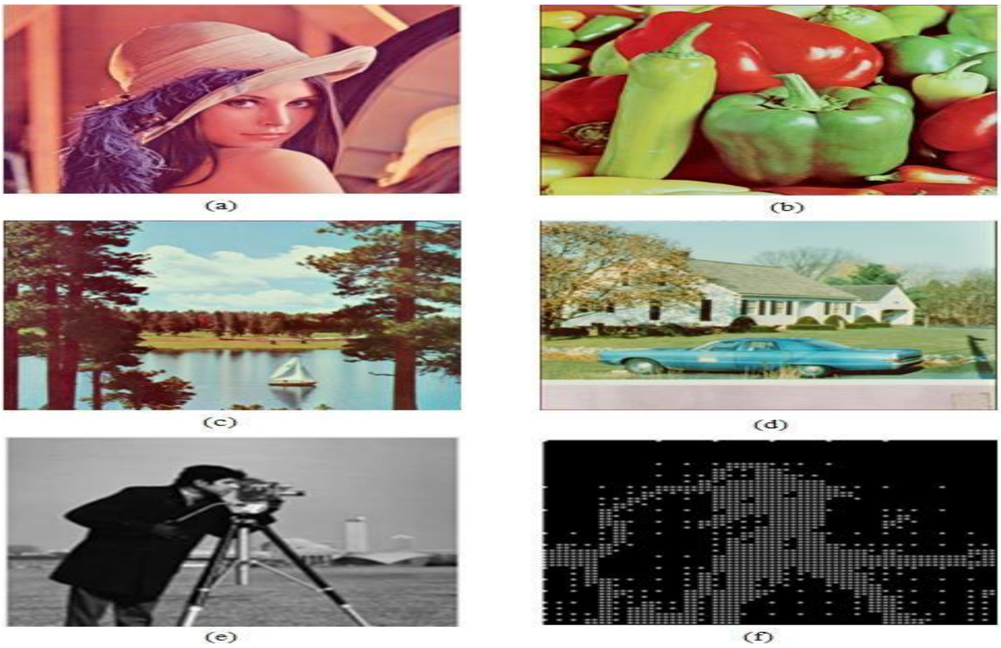

Fig 5 showstradeoffbetween and PSNR. As the value of increases value of PSNRdecreases,forα=0.01 PSNR value obtained is67.8378,forα=0.18PSNR.

Fig.4. (a) Lena, (b) Peppers, (c) Sailboat on lake, (d) House, (e) Watermark, (f) Binary Fractal image

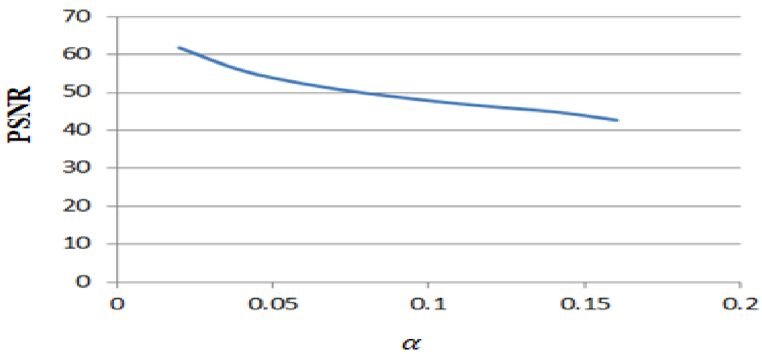

Fig.5 Trade-off between α and PSNR

Obtained is 42.7323,is set to 0.1 for tradeoff between transparency and robustness which gives value of PSNR 47.8378, this value of gives better values of NC. Different measuring instruments are used for measuring quality of the image they are PSNR, SSIM, and NC. The equation (5) is used to calculate the PSNRvalues.

$$PSNR = 20log10\left(\frac{MAX_i}{\frac{1}{M*N*O}\sum_{i=1}^{M}\sum_{j=1}^{N}\sum_{k}^{O}(w(i,j,k)-w\prime(i,j,k))^2}\right) \quad (5)$$

MAX_i**=Maximum pixel value of theimage**

PSNR is used to check transparency and concealing capability of the watermarking algorithm. Image with PSNR greater than 30 dB has acceptable image quality. Qualityassessment index SSIM i.e. Structural Similarity Index is computed using Luminance, Contrast and Structural terms. Overall index is multiplication of these three terms. Similarity of two images is measured using SSIM. It is good to have the value of SSIM in between 0 to 1. SSIM value is calculated using equation (6).

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Cover images	PSNR	SSIM	NC
Lena	47.8378	0.9994	1
peppers	47.8378	0.9995	1
Sailboat on lake	47.8378	0.9978	1
House	47.8378	0.9975	1

$$SSIM(i,j,k) = [l(i,j,k)]^{\alpha}[c(i,j,k)]^{\beta}[s(i,j,k)]^{\gamma} \quad (6)$$

Evaluation of robustness of watermarking can be measured by calculating values of NC (Normalized Correlation) after applying different attacks. If the value of NC is between 0.65 to 1.0 quality of extracted watermark is preserved. Value of NC is calculated using equation (7)

$$NC = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}\sum_{k=1}^{o} w(i,j,k) * w\prime(i,j,k)}{\sum_{i=1}^{M}\sum_{j=1}^{N}\sum_{k=1}^{o} w(i,j,k)^2} \quad (7)$$

w (i, j, k) = Watermark image, w'(i, j, k) = Extracted watermark image Table I shows the results before applying attacks.

This watermarking method using LWT is tested on four different RGB images. PSNR obtained is 47.8378 and SSIM values obtained are above 0.99.NC values obtained are 1. Average NC values obtained for contrast attack is 0.99, for Gaussian filter attack it is 0.89, 0.76 for Adaptive Histogram Equalization Attack, 0.96 for Image Sharpening and 0.94 for Gamma Correction Values of NC obtained in this experimentation prove that method is strong against contrast attack and weak against Adaptive histogram equalization attack. Fig 5 shows watermarked images with attacks and extracted watermarks from different attacks. Five different attacks are applied to test the strength of watermark. The attacks applied are Contrast Enhancement (CE), Gaussian Filter (GF), Adaptive Histogram Equalization (AHE), Image sharpening (IS), and Gamma Correction (GC).After applying attacks on watermarked images PSNR values are calculated. Poor values obtained means error introduced to the image is more and higher values obtained means error introduced is less. Table II shows PSNR values after applying attacks while Table III shows the SSIM values after applying attacks.

TABLE I RESULTS BEFORE APPLYING ATTACKS

Cover Images	Attacks				
	CE	GF	AHE	IS	GC
Lena	18.7863	29.6558	17.1523	35.1228	12.9845
Peppers	22.1777	27.8940	17.1304	34.1240	13.1256
Sailboat on lake	21.2589	32.2019	16.7623	31.0457	13.2829
House	21.8767	33.0776	18.9719	31.4291	14.5025

TABLEII PSNR VALUES AFTER APPLYING ATTACKS

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Sailboat on lake	21.2589	32.2019	16.7623	31.0457	13.2829
House	21.8767	33.0776	18.9719	31.4291	14.5025

TABLE III.SSIM VALUES AFTER APPLYING ATTACKS

Cover Images	Attacks				
	CE	GF	AHE	IS	GC
Lena	0.7521	0.9753	0.6855	0.9934	0.8322
Peppers	0.9523	0.9703	0.7107	0.9929	0.8212
Sailboat on lake	0.8001	0.9720	0.6791	0.9762	0.8117
House	0.9104	0.9769	0.7638	0.9778	0.8524

TABLE IV.NC VALUES AFTER APPLYINGATTACKS

Cover Images	Attacks				
	CE	GF	AHE	IS	GC
Lena	0.9779	0.9470	0.7238	0.9975	0.9941
Peppers	0.9966	0.9194	0.7284	0.9559	0.8895
Sailboat on lake	0.9975	0.7115	0.6376	0.9381	0.9111
House	0.9992	0.9950	0.9610	0.9868	0.9971

Extraction process is tested against different attacks and watermark is extracted. Extracted watermark is correlated with watermark image. Normalized correlated values show that whether image quality is preserved or not. NC values are calculated after attacks being applied shown in Table IV.

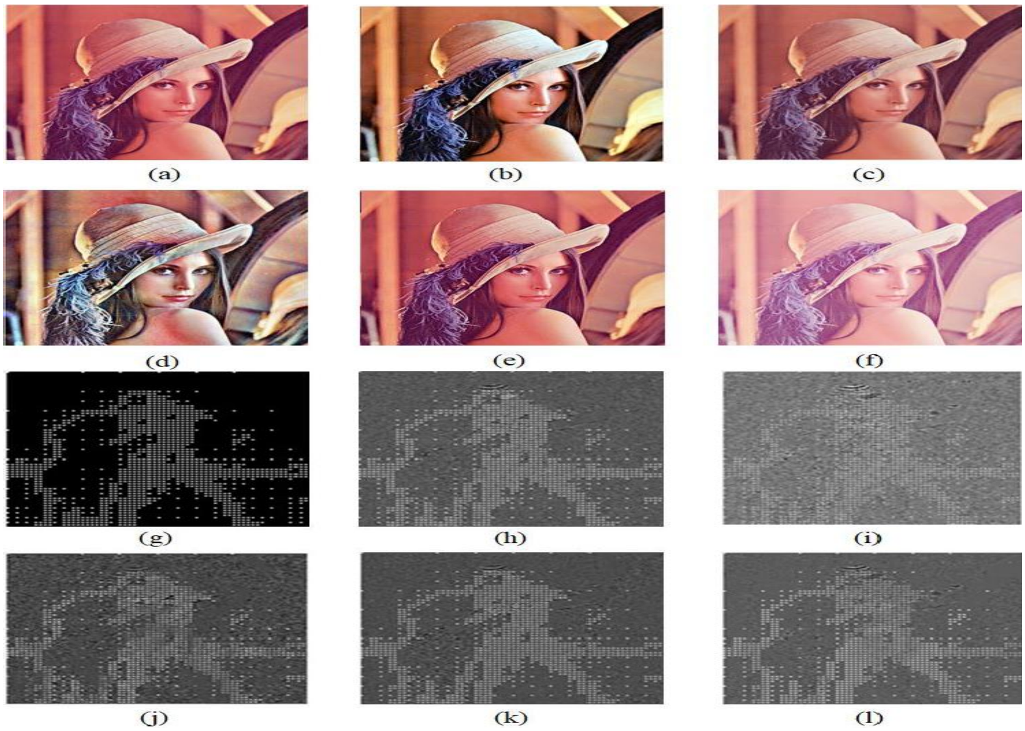

Fig.5 watermarked images and extracted watermarks (a) Without attack (b) Contrast enhancement (c) Gaussian filter (d) Adaptive histogram equalization

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(e) Image sharpening (f) Gamma correction (g) Watermark without attack. (h) Watermark with Contrast enhancement (i) Watermark with Gaussian filter (j) Watermark with adaptive histogram equalization (k) watermark with Image sharpening (l) Watermark with Gamma correction

V. CONCLUSION

Higher values of PSNR, SSIM & NC demonstrates watermark transparency, high resemblance and robustness of the algorithm. NC values obtained without attacks are 1. It shows extraction algorithm is running perfectly. Average NC value obtained with the attacks is 0.9132 shows watermark can survive against various attacks, especially against contrast enhancement.

REFERENCES

[1] LI, Cheng-Hao & WANG, Shuenn-Shyang (2000). “digital watermarking using fractal image coding,”IEICE Trans.E83-A.
[2] SoheilaKiani, Mohsen Ebrahimi Moghaddam, “A Multi-purpose Digital Image Watermarking Using Fractal Block Coding,”Journal of Systems and Software,Volume 84, Issue 9,2011,Pages1550-1562,
[3] Cao-Xiaoli, Xu-Haiyan and Tang-Huikang, "Study of Digital Image Watermarking Algorithm Using Fractal," 2012 IEEE Symposium on Electrical & Electronics Engineering (EEESYM), Kuala Lumpur, 2012, pp.611-614.
[4] Arun, K. K. Kabi, B. J.Saha and C. Pradhan, "Blind Digital Watermarking Algorithm Based on DCT Domain and Fractal Images," 2014 Conference on IT in Business, Industry and Government (CSIBIG), Indore, 2014, pp.1-7.
[5] Arun, K. K. Kabi, B. J. Saha and C.Pradhan,"Enhanced Digital Watermarking Scheme Using Fractal ImagesinWavelets," Fifth International Conference on Computing, Communications and Networking Technologies (ICCCNT), Hefei, 2014, pp.1-6.

[6] K. Ghaderi, F. Akhlaghian and P. Moradi, "A New Robust Semi-Blind Digital Image Watermarking Approach Based On LWT-SVD and Fractal Images," 2013 21st Iranian Conference on Electrical Engineering (ICEE), Mashhad, 2013, pp.1-5.
[7]S. Liu, Z. Pan and H. Song, "Digital Image Watermarking Method Based onDCT and Fractal Encoding," in IET Image Processing, vol. 11, no. 10, pp. 815-821, 102017.
[8]Mandelbrot, Benoît B. Fractals and Chaos. Berlin:Springer 2004.pp.38.
[9]Xing-Yuan Wang, Fan-Ping Li and Zhifeng Chen “Improved Fractal Image Coding Method” Fractals, World Scientific Publishing Company Vol. 17, No. 4 (2009)451–457
[10] Ching-Hung Yuen and Kwok-Wo Wong "Cryptanalysis on Secure Fractal Image Coding Based on Fractal Parameter Encryption" Fractals,World Scientific Publishing Company, Vol. 20, No. 1 (2012) 41–51.
[11] R. G. Kabra and S. S. Agrawal, "Robust Embeddingof Image Watermark Using LWT and SVD," 2016 International Conference on Communication and Signal Processing (ICCSP), Melmaruvathur, 2016, pp.1968-1972.
[12] V. Tomar, A. Kumar and A. Choudhary, "Conception & Implementation of a Novel Digital Image Watermarking Algorithm Using Cascading of DCT and LWT," 2014 International Conference on Reliability Optimization and Information Technology (ICROIT), Faridabad, 2014, pp.501-505.