Image Watermarking using Fractal Based Neighborhood Search Method

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Abstract— The "Image watermarking is a kind of marker covertly embedded in a noise-tolerant signal such as an audio, video or image data". It is typically used to identify ownership of the copyright of such signal. "Watermarking" is the process of hiding digital information in a signal. The hidden information should, but does not need to, contain a relation to the carrier signal. Image Watermarking may be used to verify the authenticity or integrity of the carrier signal or to show the identity of its owners. We also define a fractal as a rough or fragmented geometric shape that can be subdivided in parts, each of which is (at least approximately) resize copy of the whole. "A Fractal is a natural phenomenon or mathematical set that exhibits a repeating pattern that displays at every scale".

Key words: Image Watermarking, Neighborhood Search Method

I. Introduction

In The Digital media are gaining wider popularity, and then security related issues are becoming greater concern. Progress in these has increases to massive scopes for develop and distribution of digital media theme. The "Image watermarking" was first emerged in 1993 are displed.this image watermarking is a technology that organizes and assigns security, data certification, publishing protection to the digital media theme. Watermarking is the embedding of allude, watermarks in to the digital media theme like as portrait, audio and film. The Image watermarking is a field of information on hiding which hide the crucial information in the original data for protection illegal publication and distribution of multimedia data. Image watermarking is a very developing field and used in various applications which have been proved to be successful. The way is realize this feature is to embed a layer of the authentication signature into the digital image using a image watermark. In the case of the image being tampered, it can easily be detected as the pixel values of the embedded data would change and do not match with the original pixel values. There are many spatial and frequency domain techniques available for image watermarking are used. Image Watermarking techniques are judged on the basis of their performance on a small set (or large set) of properties. These properties include robustness, transparency, watermarking capacity, blind detection and fragile security. Image Watermarking schemes are developed according to the requirements of the all application do not require each of these properties in their entirety i.e. Image watermarking requirements are all application dependent and some most desirable properties for these applications are in nature.

A. Watermarking Principle

Image watermarking is a very developing field and used in various applications which have been proved to be successful. The Image watermarking has been applied in a number of image processing techniques.

The aim of every application is to providing security of the digital content. The image watermarking applications are Broadcast Monitoring, digital Fingerprinting, Transaction Tracking, and Copyright protection, Temper Detection, Data Hiding and Content Authentication etc.

Every digital watermarking technique includes two algorithms: one as the embedding algorithm and other as the detecting algorithm. These two processes are same for all the typeof watermarking techniques.

Image Watermarking is a technique which is used in the digital signal processing of embedding hidden information into multimedia data. This information is not usually visible, only dedicated detector or extractor can see and extracts that information.

Image Watermarking use digital image for embedding the hidden information, after embedding the watermarked image is generated and the watermarked image is more robust against attacks.

Image watermarking system is usually divided into three distinct steps, embedding, attack and detection. In embedding, an algorithm accepts the host and the data to be embedded and produces a watermarked signal. Image watermarked signal is and then transmitted or stored, usually transmitted to another person. If this person makes a modification, this is called an attack. The embedding takes place by manipulating content of the image data, which means the information is not embedded in the frame around the data, it is carried with the signal itself. Figure 1 shows the basic block diagram of watermarking process [5].

The original image and the desired watermark are embedded using one of the various schemes that are currently available on image. The watermarked image is passed through a decoder in which usually a reverse process to that employed during the embedding stage is applied to retrieve the watermark image.

The different techniques in the way in which it embedding is differ the watermark on to the cover object. A secret key is used during the embedding and the extraction process in order to prevent access to the watermark image.

B. Basic Requirements

1) Transparency

The embedding watermark image should not degrade the original image. And then It visible distortions are introduced in the image, it creates suspicion and makes life ease for the attack. It also degrades the commercial value of the watermark image.

2) Robustness

This is dived too far the most important requirement of a watermark image. There are various attacks cropping, compression, scaling (unintentional) and intentional attacks which are aimed at destroying the watermark. So, the embedded watermark should be such that it is invariant tovarious such attacks.

3) Capacity

This watermarked quantity describes the maximum amount of data that can be embedded into the image to ensure proper retrieval of the watermark image during extraction & detection.

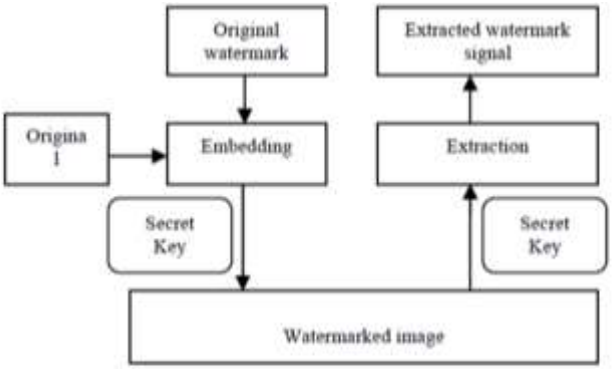

Fig.1: Block diagram of watermarking process [5]

II. FRACTAL

The French mathematician Benoit B. Mandelbrot first coined the term fractal in 1975. He derived the word from the Latin fractus, which means "broken", or "irregular and fragmented". In fact, the birth of fractal geometry is usually traced to Mandelbrot and the 1977 publication of his seminal book The Fractal Geometry of Nature. Mandelbrot claimed that classical Euclidean geometry was inadequate at describing many natural objects, such as clouds, mountains, coastlines and trees. So he conceived and developed fractal geometry &Fractal.

There are two main groups of Fractals: linear and nonlinear. The latter are typified by the popular Mandelbrot set and Julia sets, which are fractals of the complex plane. And Then, the fractals used in image Watermarking are linear, and of the real plane. So, the fractals used are not chaotic, in other words, they are not sensitive to initial conditions. They are fractals from Iterated Function Theory. An Iterated Function System (IFS) is simply a set of contractive affine transformations. IFSs may efficiently produce shapes such as ferns, leaves and trees.

Fractal: Generally, we can define a fractal as a rough or fragmented geometric shape that can be subdivided in parts, each of which is (at least approximately) a reduced-size copy of the whole.

A Fractal is a natural phenomenon or mathematical set that exhibits a repeating pattern that displays at every scale. Self-Similarity: In mathematics, a self-similar object is exactly or approximately similar object to a part of similar to a part of itself andthe whole has a same shape as one or more of the parts.

A. Characteristics of Fractal

- The construction of a Fractal is based on an iterative or Recursive Process.
- A Fractal is infinitely complex. It can be magnified infinitely.
- The magnification of a Fractal, you can find subsets of it that look like the whole figure. This Figure is called “self-similarity”.
- The Dimensions of a Fractal is typically non-integer and hence non-integer complexity

$$\mathbf{d} = \frac{\log c}{\log s} \qquad (2.1)$$

where s: Scaling factor, c: Number of Congruent Subset ,d: Dimension

B. Mathematics Behind Fractal

In Nature all objects are continuous and non-differentiable. There is complexity within complexity in all natural objects and that is why we cannot differentiate natural objects. Finally, Euclidean geometries are defined by algebraic formula. Fractals are normally the result of an iterative or recursive construction or algorithm so it cannot be defined using algebraic equations which we’ve studied till now. Most natural curves are of infinite length yet including finite area such as coast line of an island, Surface area of lungs, etc. So, we need different geometry so analyze these kind of objects. Cauchy Sequence, Contractive mapping theorem, Banach Fixed-Point Theorem, Affine Transformation, Iterated Function System, Collage Theorem are used for fractals mathematical.

III. FRACTAL IMAGE WATERMARKING BASED ON NEIGHBORHOOD SEARCH METHOD

The proposed technique of fast fractal image watermarking based on neighborhood search is developed in order to reduce the time of encoding without combining pure fractal encoding technique to other watermarking technique. The proposed method is a pure fractal Watermarking technique and so it provides PSNR but here selection of range block is performed based upon its variance value and after that selected range block will be encoded using neighboring domain blocks while other range blocks were encoded using mean value. The following sections explain the procedure of encoding and decoding with flow chart.

A. Selection of Range Blocks

In the proposed technique of new fast fractal image watermarking based on neighborhood search image is first divided in to overlapping domain blocks and non-overlapping range blocks. The selection of the range block is performed based upon its variance value. Variance is a crucial parameter to measure the variation in a set of numbers. In order to obtain the pixel value in a particular range block, we have to find its variance value. Variance is always non-negative number and variance of zero indicates that all data values are identical. Similarly small variance indicates that the data set is very close to its mean value while high variance value indicates that the data set is spread out around its mean and with each other. So, variance is very important descriptor to analyze data set of numbers. The variance of a random variable x can be considered as the expected value of the squared deviation from the mean $\mu = [x]$:

$$\mathbf{Va(X) = E[(X-\mu)^2]} \qquad \mathbf{(3.1)}$$

The equation (3.1) can be simplified in to equation (3.2) which is given below.

$$\boldsymbol{Va(X) = E[X^2] - (E[X])^2} \qquad (3.2)$$

Using equation (3.3) the variance of the range block is computed. If the variance of the range block is less than the predefined threshold value than the range block is encoded by its mean value of pixels. The mean value of all pixels is stored for the given range block and that value will be placed at the time of decoding process in order to generate that particular range block. Here the crucial parameter is the threshold value to select range block for further processing. If the predefined threshold value is higher than most of the range blocks will be encoded by its mean value as explained. So, image having higher uniformity in pixel values needs higher threshold value while image having higher variation needs lower threshold value to simplify range blocks. Here the threshold value is chosen manually which is not so lower or so higher and it gives optimum results for the various images.

B. Searching of Neighbor Domain Blocks

The image is first divided into non-overlapping range blocks and overlapping domain blocks. Then the range block is selected based upon its variance value. Hence the variance of the range block is lower than the predefined threshold value than the range block is encoded through its mean value. The rest of the range blocks are encoded as a pure fractal encoding technique through matching range block with the domain blocks and finding scaling parameter s, offset parameter o and suitable affine transformation. But searching from all the possible domain blocks will consume lots of time and therefore will increase encoding time. In order to reduce the encoding time we have to reduce the search and so in this proposed technique the domain blocks which are in neighborhood of the range blocks will be considered to encode the given range block. The distance between a range block R, and a domain block D, both n pixels is defined as follows:

$$\mathbf{E(R,D)} = \sum_{\mathbf{i=1}}^{\mathbf{n}} (\mathbf{Sdi + o - r_i})^{\mathbf{2}} \quad (\mathbf{3.3})$$

Here the best coefficient S and O Parameter are given by following equations.

$$\boldsymbol{s} = \frac{\langle \mathbf{R-\bar{R}.1, D-\bar{D}.1} \rangle}{\|\mathbf{D-\bar{D}.1}\|^{\mathbf{2}}}, \boldsymbol{o} = \overline{\boldsymbol{R}} - \boldsymbol{s}\overline{\boldsymbol{D}} \qquad (3.4)$$

Where <, >, R, D,$\bar{R}$,$\bar{D}$are inner product, range block, domain block, mean of R and mean of D respectively. Here in the proposed method the best domain block is found from the neighborhood of the range block. After selecting the best domain block from the neighborhood related to that domain block, three new domain blocks are created by clockwise rotating it 90°,180°and 270°, also and then three and the original domain block all are mirrored. Here, and then in addition to the original domain block, we have seven new domain blocks. These new by seven domain blocks are added to the domain pool and now we have to find an affine transformation that maps the selected domain block to range bock with minimum distance. At the end of encoding we have to store location of the domain block, affine transformation, scaling parameter s and offset parameter o.

C. Scaling Parameter Modified

Scaling parameter is modified are used for vector. Store the S parameter at given range block. And then compute the new S parameter by adding the value of “1” value according to the place value of vector and adding the “0” to the remaining data.

D. Encoding & Decoding process

First of choice of two images. First input image second is logo image (secret image). Then read the input image &logo image (secret image). This Second secret image And find to vector. This image is divisible. This images are not divisible to convert images into square size. Then convert images into square size is used. This input image divides into overlapping domain blocks. And then reduced the size of domain blocks by averaging four neighborhoods pixels. Input images are divide the non-overlapping range blocks. This rang blocks is find out the variance. And then variance of the range block are computed. If the variance of the range block is less than the predefined threshold value the range block is encoded by its mean values of pixels. The mean value of all pixels is stored for the given range block and that value will be placed at the time of decoding process in order to generate the particular range block. Then increment count2 and find out particular domain block from neighborhood domain blocks of range block and which has less error(higher similarity).domain block apply in affine transformations and find out the best matched transformations domain blocks with given range block. And then store the location, transformations for the given range block. Increment count 1 store the average value of the pixels of range block. All range block are covered and otherwise not covered and find the new S parameter adding the value “1”to the place value of vector and adding “0”to the remaining data.. Last simulations results is stored the all values and hide the secret image.

Decoding for generated watermarked image. First of all take a initial zero matrix of image. And then load the saved variables of encoding. Range block is encoding its means and otherwise not means values. Range block is encoded by means in assign the stored average pixel value to the range block. Then find out the domain block as per the stored location. Apply the affine transformations on domain block as per stored value during encoding.S,O parameter is apply for domain block and find out the value of range block. And then all range block are covered. And take to the next range block and range block is encoding means values. Decrement the variables of iterations and variables for the iterations is may be zero. And find the MSE & PSNR value. Then last simulations results is watermarked image.

IV. SIMULATION RESULT

Fig. 2: Original Input Image

Fig. 3: Secret Image (logo image)

Fig. 4: Image of a lotus on pound (Img1)

This image is lotus of pound of image. This image size of 320x274.this image is original input image. Second image is secret image (logo image).this secret image size is 32x32. This input image is divisible and converts into divisible square size. The input image is divide the non-overlapping range block & overlapping domain block. And Then covariance variance, many variable are used. Last implement &simulation result watermarked image.

Fig. 5: Image of a Fabric (Img2)

This image is fabric of image. This image size of 320x274.this image is original input image. Second image is secret image (logo image).this secret image size is 32x32. This input image is divisible and converts into divisible square size. The input image is divide the non-overlapping range block & overlapping domain block. And Then covariance variance, many variable are used. Last implement &simulation result watermarked image.

Fig. 6: Image of a leafs (Img3)

This image is leafs of image. This image size of 320x274.this image is original input image. Second image is secret image (logo image).this secret image size is 32x32. This input image is divisible and converts into divisible square size. The input image is divide the non-overlapping range block & overlapping domain block. And Then covariance variance, many variable are used. Last implement &simulation result watermarked image.

Fig. 7: Image of a Flower (Img4)

This image is Flower of image. This image size of 320x274.this image is original input image. Second image is secret image (logo image).this secret image size is 32x32. This input image is divisible and converts into divisible square size. The input image is divide the non-overlapping range block & overlapping domain block. And Then covariance variance, many variable are used. Last implement &simulation result watermarked image.

Fig. 8: Image of a Nature (Img5)

This image is Nature of image. This image size of 320x274.this image is original input image. Second image is secret image (logo image).this secret image size is 32x32. This input image is divisible and converts into divisible square size. The input image is divide the non-overlapping range block & overlapping domain block. And Then covariance variance, many variable are used. Last implement &simulation result watermarked image.

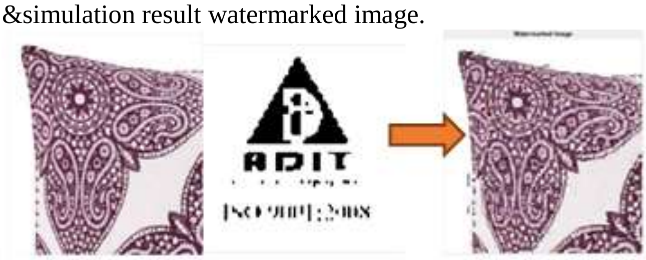

Fig. 9: Image of a Fabric (Img6)

This image is Fabric of image. This image size of 320x274.this image is original input image. Second image is secret image (logo image).this secret image size is 32x32. This input image is divisible and converts into divisible square size. The input image is divide the non-overlapping range block & overlapping domain block. And Then covariance variance, many variable are used. Last implement &simulation result watermarked image.

Sr No.	Input image of resolution:(320x274)	Pure Fractal (Neighborhood Search)	
		PSNR	MSE
1	IMG1	29.76	19.24
2	IMG2	22.20	15.66
3	IMG3	33.78	19.67
4	IMG4	24.33	13.43
5	IMG5	20.49	11.28
6	IMG6	34.79	23.72
7	IMG7	27.78	20.26
8	IMG8	30.95	18.54
9	IMG9	34.19	26.67
10	IMG10	32.75	23.55
11	IMG11	29.72	18.43
12	IMG12	25.80	12.34

Table 1:

V. CONCLUSION

High encoding time for the fractal image watermarking can be reduced using various algorithms for searching the domain block or range block by combining it to other watermarking technique. The New fractal image coding scheme presented here used Neighborhood Search instead of MSE & PSNR to compare the similarity of image blocks and compute the coefficients of linear expressions. The Image processing and fractal based image watermarking algorithm successfully implemented for 12 images. Different types of attacks for checking the performance of image watermarking algorithms was applied and found that the watermark was not be visible. The theoretical analysis and experiment results prove it is consistent of blocks choice in Neighborhood Search algorithm and then coding images of Neighborhood Search are more appropriate for HVS for its different coefficients with MSE & PSNR scheme.

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REFERENCES

[1] SoheilaKiani, Mohsen Ebrahimimoghaddam.,"A Fractal Based Image Watermarking For Authentication And Verification", IEEE Shahid Beheshti University; GC 2009.
[2] MIAO Xi-kui, SUN Jin-guang, ZHANG Yu-han.,"A New Fractal Watermarking Scheme Based on Image Normalization", IEEE International Conference on Multimedia Information Networking and Security 2009.
[3] Pedro Aaron Hernandez-Avalos, Claudia Feregrino-Uribe, Rene Cumplido., "Watermarking using similarities based on fractal codification", Elsevier 2011.
[4] FatemehDaraee, Saeed Mozaffari.,"Watermarking in binary document images using fractal codes", Elsevier,Vol-35,Pg no-120-129, 10 May 2014.
[5] Preetiparashar ,Rajeev Kumar singh., " A Survey: Digital Image Watermarking Techniques", International Journal of Signal Processing, Image Processing, and Pattern Recognition,vol.7.No.6.pp.111-124(2014).
[6] B. Sridhar and C. Arun, "A Wavelet based Image Watermarking Technique using Image Sharing Method", IEEE Trans image Processing vol,5.no 15 2013.
[7] I. Cox, J. Killian, F. Leighton, and T. Shamoon, "Secure spread spectrum watermarking for multimedia", IEEE Trans. Image Process., vol. 6, no. 12, pp. 1673–1687, 1997.
[8] J. Puate and F. Jordan, "Using fractal compression scheme to embed a digital signature into image", in Proc. SPIE Photonics East Symp., Boston, MA, Nov. 18–22, 1996.
[9] C. Lin, M. Wu, J. A. Bloom, I. J. Cox, M. L. Miller, and Y. M. Lui, "Rotation, scale, and translation resilient watermarking for images", IEEE Trans. Image Process., vol. 10, no. 5, pp. 767–782, May 2001.
[10] C. S. Tong and M. Pi, "Fast fractal image compression using adaptive search", IEEE Trans. Image Process., vol. 10, pp. 1269–1277, Sep. 2001.
[11] M. Pi, A. Basu, M. Mandal, and H. Li, "Comparison of non-orthogonal and orthogonal fractal decoding", in Proc. IEEE Int. Conf. Image Processing (ICIP), Singapore, Oct 24–27, 2004, pp. 505–508.
[12] A. E. Jacquin, "Fractal image coding: A review", Proc. IEEE, vol. 81, pp.1451-1465, 1993.
[13] B.Wohlberg, G.Jager, "A Review of the Fractal Image Coding Literature", IEEE Trans. on IP, vol. 8, pp.1716-1729, 1999.
[14] T. K. Truong, J .H. Jeng, I. S. Reed, P. C. Lee and A. Q. Li, "A Fast Encoding Algorithm for Fractal Image Compression Using the DCT Inner Product", IEEE Trans. on IP, vol. 9,pp.529-535, 2000.
[15] C. Tong, M. Pi, "Fast Fractal Image compression using Adaptive Search", IEEE Trans. on IP, vol.10, no.9, pp.1269- 1277, 2001.
[16] M. H. Pi, C. H. Li, H. Li, "A Novel Fractal Image Watermarking ",IEEE transactions on multimedia, vol. 8, pp. 488-499, 2006.
[17] Z. Yao, "Fixed Point In Fractal Image Compression As Watermarking", Proceedings of International Conference on Image Processing (ICIP), vol. 2, pp. 14-17, 2003.
[18] S. Pereira, T. Pun.,"Robust Template Matching for Affine Resistant Image Watermarks", IEEE Trans. on Image Processing, 2000,pp.1123-1129.
[19] C. Y. Lin, M.Wu, I. J. Cox, "Rotation, Scale, and Translation Resistent Public watermarking for images", IEEE transactions on image processing, vol.10, 2001, pp.767-782.
[20] P. Dong, N.P. Galatsanos, "Affine Transformation Resistant Watermarking Based on Image Normalization", IEEE Trans. On image processing, Vol. 8, 2002, pp.865-882.

