HYBRID FRACTAL IMAGE COMPRESSION FOR SATELLITE IMAGES

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Abstract— In this paper, we present a hybrid fractal image compression method for satellite images. The proposed algorithm uses entropy and arithmetic coding. The satellite image is decomposed into low frequency sub-band and high frequency sub-band. The low frequency sub-band uses fractal coding, thus making the low-frequency information loss less which is sensitive to human visual system. The high frequency sub-band uses arithmetic coding. Affine transformation and iterative function system techniques have been applied for the compression and decompression of satellite images. The Matlab simulation results show significant improvement in the compression ratios, PSNR values and encoding time.

Index Terms— Affine Transformation, Arithmetic Coding, Fractal, Image Compression, Iterative function System, PSNR.

I. INTRODUCTION

Image compression is a specialized form of data compression. Various methods of data compression can be applied to image compression, since an image is just an array of numbers. One of the applications of wavelet has been to image compression. The JPEG 2000 standard designed to update and replace the current JPEG standard uses wavelets instead of discrete cosine transform (DCT) to perform decomposition of images. This overcomes the block effect of the DCT image compression algorithm.

Fractal image compression is one of the lossy compression method based on the concept of fractal. In the aspect of improving the image quality and reduce the decoding time, fractal image compression algorithm has natural advantages. This exploits similarities in different parts of the image. Fractal image compression is proposed by Barnsly in 1988 and implemented by Jacquin. This is based on the theory of affine transformation and iterative function system (IFS), which is developed by Barnsly and Hutchinson. This method is suitable for image with more self-similar parts. The advantages of fractal image compression are multi resolution property, high compression ratio and also fast decoding. This method is based on the collage theorem, which shows that, it is possible to code fractal images by means of contractive transformation defining an iterated function system. The advantage offered by fractal image compression are high decoding speed, resolution independent and high bit rate. But due to the short counting of the computational cost in the coding phase, fractal coding is incompetent against other techniques. The most important factor to be considered while developing fractal image compression is the computational time. The need to develop an algorithm with less coding phase and high compression ratio is still a challenging task in this field.

In fractal image compression method, the first step is to choose the type of image partition technique for the range block formation. Many partition techniques have been proposed by researches, such as horizontal vertical partition, adaptive quad-tree partitioning, fixed size square partitioning [1][3], Quad-tree partition technique [4], and delaunay triangulation [6]. Next step is the selection of domain pool, where the choice depends on the type of partition technique being use, domain blocks must be transformed to cover range blocks. There are wide varieties of domain pool techniques have been proposed, such as local domain pool method, global domain pool method, [1][4] synthetic code book, hybrid code book. The crucial step in the fractal image compression is selection of transforms. The affine transform [1] is applied on domain blocks to form range blocks and determine the convergence properties of decompression.

II. FRACTAL AND ITERATED FUNCTION SYSYTEM THEORY

The main goal of fractal image compression is to encode an image as the fixed point of a suitable contractive mapping, which must be constructed. Let us consider a gray scale image, T, of size $P \, x \, P$ pixels. The image may be partitioned into blocks of pixels called domain blocks and range blocks. The range blocks, R, are a set of non-overlapping blocks of size $N \, x \, N$. The domain blocks are the sub-blocks of the original image. They may be overlapping and larger in size than the range blocks. In order to compress the image T using fractal image compression, an affine transformation $w_1(T)$

$$w_1(\mathbf{x}) = w_1\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} a & b \\ c & d \end{pmatrix}\begin{pmatrix} x \\ y \end{pmatrix} + \begin{pmatrix} e \\ f \end{pmatrix} \qquad (1)$$

is introduced. The coefficients a, b, c, d, e, f are used in order to shrink, translate, rotate, and shear the new image $w_1(T)$.

The basis for fractal image compression is the construction of an iterated function system that approximates the original image. For a transformation f to be contractive, eq (1) must be satisfied, where $0 \le s < 1$.

$$d(f(x), f(y)) \le (s)(d(x, y)) \forall x, y \in \mathrm{X} \qquad (2)$$

Eq (2) states that, the distance $d(x, y)$ between any two points in a metric space X is reduced by applying the transformation $w\,(T)$ which maps X into itself.

III. PROPOSED ALGORITHM

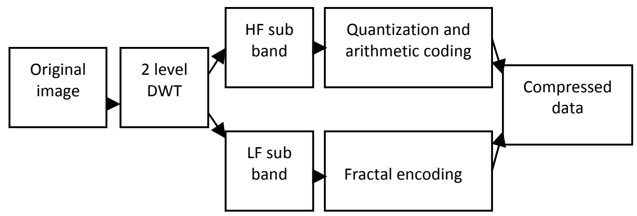


Fig 1: Hybrid Algorithm Coding

Fig.1 and Fig.2 shows the block diagram of hybrid fractal image compression. The original image is transformed using 2 level discrete wavelet transformations. All sub-bands at first level are ignored (HL, LH, HH are set to zero) and all sub-bands at second level (LH2, HL2, HH2) are quantized by a factor, except LL2 sub band. The quantized sub bands (LH2, HL2, and HH2) are arithmetic coded. The LL2 sub band is compressed using fractal encoding.

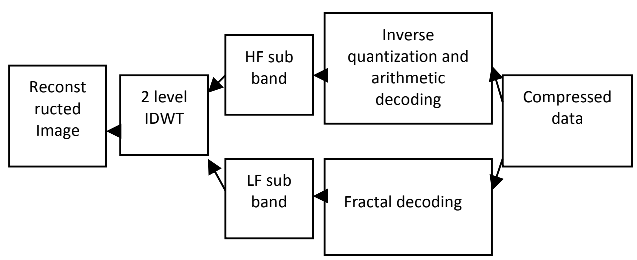


Fig 2 Hybrid Algorithm Decoding

Fig.3 shows the block diagram of fractal image compression and decompression using affine transformation and iterative function system. First we divide the LL2 sub band into non overlapping blocks called range blocks of size 1x1 and the overlapping blocks called domain blocks of size 2x2. The domain block of size 2x2 is averaged over each distinct block of 2x2 pixels called scaled domain blocks of size 1x1 blocks. Now we create the domain pool which has six dimensional matrixes, which includes original domain block, 90, 180, -90 degree rotation, horizontal flip and vertical flip of the LL2 sub band domain blocks. During the encoding an offset value is recorded by calculating the mean value of each range blocks. Now, we can compare the range blocks and domain blocks and also the recorded the offsets value of the range blocks. Next we test with each domain blocks, which is in domain pool along with two gray scales for the best transformation. When the best transformation is found, the corresponding location, symmetry of domain block and gray scale value are recorded in matrix.

LL2 sub band is decompressed using the concepts called iterative function system. First the domain block of the seed image is created and rescaled to range block size of 1x1. Iteratively, the domain blocks are transformed and mapped to range block using recorded matrix. After five iteration of transformation and mapping, the attractor is generated. The final generated attractor is decompressed LL2 sub band. The sub bands (LH2, HL2, and HH2) are arithmetic decoded, finally the image is reconstructed using two level inverses DWT.

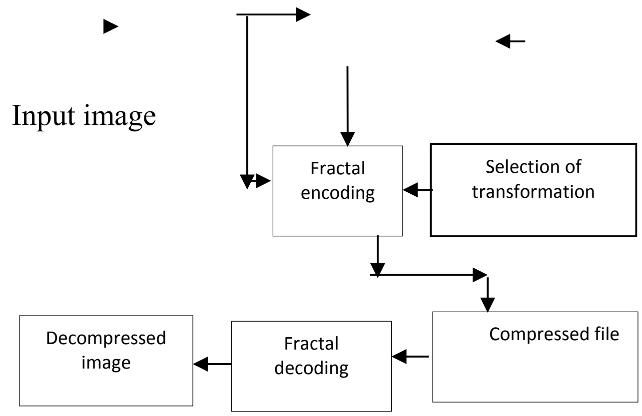
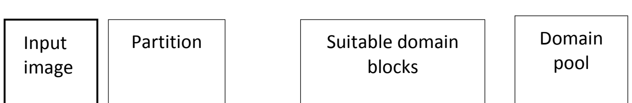


Fig 3: Fractal Image Compression and Decompression

IV. RESULTS AND DISCUSSION

The hybrid fractal image compression algorithm is implemented in Matlab. For encoding and decoding the satellite images of size 720 X 720, are captured at different time instant are used. The satellite images are resized to 256 X 256. All these images have very high self-similar parts. Experimental results are listed for range block of size is 1 X 1, domain block of size 2 X 2 for hybrid fractal image compression technique and range block of size 2 x 2, domain block of size 4 x 4 for pure fractal image compression technique. The MSE, Compression Ratio, PSNR values and Encoding time are obtained for the different satellite images, are tabulated in Table 1 and Table 2. The original satellite images and the reconstructed satellite images are shown in Fig 4 and Fig 5.



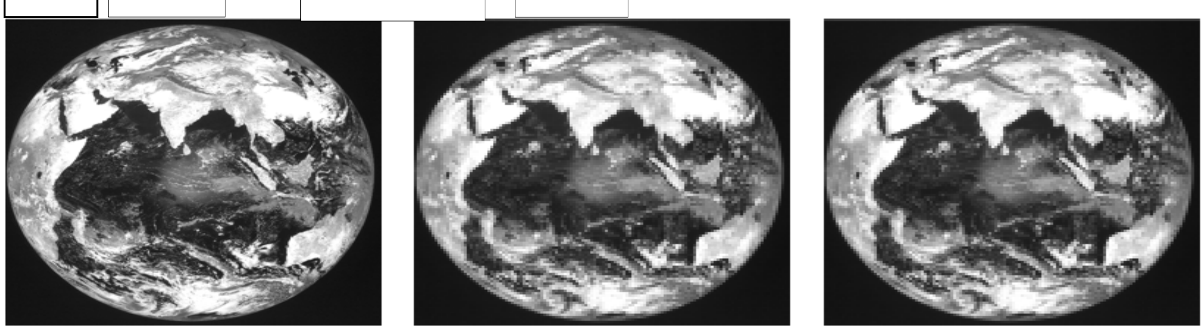


Fig 4(a) Original Satellite Image of Globe Image1

Fig 4(b) Reconstructed Image using Pure Fractal

Fig 4(c) Reconstructed Image using Hybrid Fractal

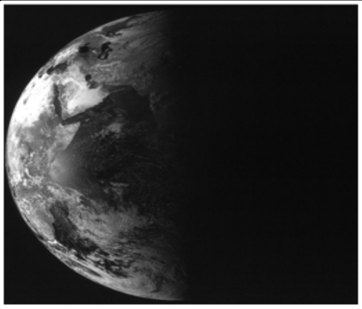


Fig 5(a) Original Satellite Image of Globe Image1

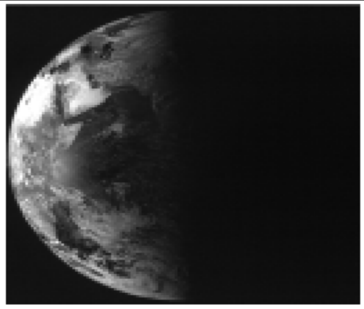


Fig 5(b) Reconstructed Image using Pure Fractal

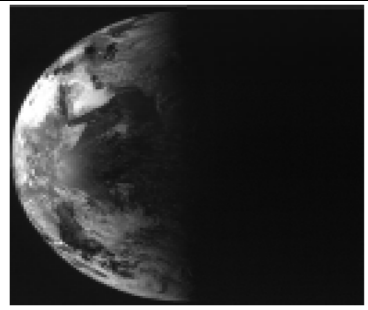


Fig 5(c) Reconstructed Image using Hybrid Fractal

	Methods	MSE	PSNR	Compression Ratio	Encoding Time in second
Globe Image 1	Pure fractal image compression	40.20	32.08	1.8	140.70
	Hybrid fractal image compression	40.58	32.04	2.8	2.93

Table 1 Values of MSE, PSNR, Compression ratio and Encoding time for satellite globe images 1.

	Methods	MSE	PSNR	Compression Ratio	Encoding Time in second
Globe Image 2	Pure fractal image compression	12.43	37.18	1.8	264
	Hybrid fractal image compression	12.6	37.09	3.4	3.12

Table 2 Values of MSE, PSNR, Compression ratio and Encoding time for satellite globe images 2.

It can be observed that, the encoding time in proposed hybrid fractal image compression is much less than the pure fractal image compression. The results suggest that the hybrid fractal coding techniques is better suited for the compression of satellite image with high self-similarity.

V. CONCLUSIONS

This paper presents a hybrid fractal image compression technique. The algorithm is based on arithmetic coding and fractal image compression. One of the techniques to reduce the encoding time is by reducing the domain pool size, by decomposing the image into low frequency sub-band and high frequency sub-band. Experimental results show that the hybrid fractal image compression algorithm increases the coding efficiency and reconstructed image with good quality.

VI. ACKNOWLEDGEMENT

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REFERENCES

[1] Chunlei Jiang, Shuxin Yin "A Hybrid Image Compression Algorithm Based on Human Visual System", IEEE International Conference on Computer Application and System Modeling (ICCASM) 2010.

[2] Y. Fisher, Fractal Image Compression: Theory and Application 1995.

[3] VeenaDevi.S.Y, A.G.Ananth "Fractal Image Compression of Satellite Imageries Using Variable Size of Range Block", IEEE International Conference on Signal and Image Processing Applications (lCSIPA) 2013.

[4] Bohong Liu and Ying Yan "An Improved Fractal Image Coding Based on the Quadtree", IEEE 3rd International Congress on Image and Signal Processing 2010.

[5] T.K. Truong, J.H. Jeng, I.S. Reed, P.C. Lee and A.Q. Li, "A fast encodind algorithm for fractal image compression using the DCT inner product", IEEE Transactions on Image Processing, vol. 9, April 2000.

[6] F. Davoine, M. Antonini, J.M. Chassery and M. Barlaud, "Fractal image compression based on Delaunay triangulation and vector quantization", IEEE Transactions on Image Processing, vol. 5 February.1996.

[7] Yuzo Iano, Fernando Silvestre da Silva, and Ana Lucia Mendes Cruz "A Fast and Efficient Hybrid Fractal Wavelet Image Coder", IEEE Transactions on Image Processing, vol. 15, January 2006.