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An Improved Hybrid Wavelet-Fractal Image Compression Using Gradient Based Method

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Abstract - Fractal Image Compression is one of the lossy image compression technique where we can obtain a large amount of compression by representing an image as a contractive affine transform. But the main drawback of FIC is its encoding complexity and lack of speed. At the same time it has several advantages such as we can zoom images without degrading the quality due to its resolution independent nature. Similarly DWT (Discrete Wavelet Transform) is one of the most commonly used compression scheme where we obtain best compression. But for a required PSNR the CR of DWT is lesser than the FIC. There are several researches going on in combining these two methods. Here we study the possible techniques to combine the fractal image compression with the wavelet and a new gradient based method for reducing the encoding time.

***Keywords* - Fractal Image Compression, Discrete Wavelet Transform, Compression Ratio, Peak Signal to Noise Ratio, Encoding Time.**

1. Introduction

The demand for multimedia applications has increased drastically over the years. Which results in image and video compression has become an important issue in reducing the cost of data storage and transmission. Image compression plays a very crucial role in applications like tele-video conferencing, medical Imaging, remote sensing document etc. Recently, a large amount of techniques has appeared in the literature for achieving high compression ratios and among them, the fractal approach becomes a significant compression technique.

The compression offers a means to reduce the storage cost and increase the transmission speed. Image compression is used to minimize the size in bytes of a graphics file without degrading the quality of image. Mainly there are two types of image compression, Lossy as well as Lossless. In lossless compression, the reconstructed image is numerically similar to the original image. Where as in lossy compression the reconstructed image have some degradation. But this provide greater compression ratios than lossless technique. The approaches for lossy compression include lossy predictive coding and transform coding. Most commonly used transform coding are DCT and DWT. FIC is also one among them. Fractal image coding has its base in the mathematical theory of iterated function systems (IFS) developed by Barnsley[1], whilst the first fully automated algorithm was developed by Jacquin [2].

Fractal image compression consists of finding a set of transformations that produces a fractal image which approximates the original image. Redundancy reduction can be achieved by describing the original image through smaller copies or parts of the image. The approach consists of expressing an image as the attractor of a contractive functions system, which can be recovered simply by iterating the set of functions starting from any initial arbitrary image. The form of redundancy exploited is named piece-wise self-transformability. This term refers to a property that each segment of an image can be properly expressed as a simple transformation of another part having higher resolution. IFS based still image compression techniques have very good performance at high compression ratios. The major problem of fractal-based compression techniques is the encoding complexity. However, the complexity of the decoding is less when compared with the encoding. Fractal-based techniques produce outstanding results in terms of compression in images, retains a high degree of self-similarity. Encoding time required is spent on the search for the best-match block in a large domain pool. Basically It works by partitioning an image into blocks called range and domain and using Contractive Mapping to map range blocks to domains. Several block partitioning algorithms such as block classification and quad tree partition are proposed [3] for effective partitioning. Due to the un symmetry in encoding and decoding this compression technique is not widely used. But now a days to reduce the encoding time and speed up the compression several methods are used mainly they are classified based on classification methods, search strategy and hybrid methods. Classification methods include domain-range pixel value difference [4] , FIC using soft computing techniques [5] etc . Based on search strategy there are particle swarm optimization [6], range exclusion and domain pool reduction [7]. And the hybrid methods include fractal coding with DCT [8] and fractal coding with DWT [9].

2. Hybrid Wavelet Fractal Coder

The Discrete wavelet transform (DWT), which utilizes the technique of sub band coding, is found to afford a fast computation of wavelet transform. It is easy to implement and also reduces the computation period and necessary resources. In wavelet transforms the signals are examined carefully using a set of basis functions which are related to each other by simple scaling and translation operations. The signals to be analyzed are passed through filters with different cutoff frequency at different scales. When a signal passes through a filter its splits into 2 bands, lower and higher frequency sub bands where these procedures are repeated for only the low frequency sub bands to obtain a multilevel wavelet decomposition of an image [10].The fundamental idea of fractal coding is to decompose an image into segments using the standard image processing techniques such as edge detection, color separation, and spectrum and texture analysis. Each such segment is then looked up in a library of fractals.

The library essentially contains codes called iterated function system (IFS) codes ,which are a compact set of numbers. A set of codes for a given image is determined using a systematic procedure. When the IFS codes are applied to a set of image blocks, an image which is a very close estimation of the primary is obtained. This scheme is highly effective for compressing images. Image adjustment is performed to boost the intensity of the image after which the image is resized to its original size. The sub band image is compressed by using fractal algorithm. During decoding fractal codes are iteratively applied to any absolute image of the assonant size. By using all the true details of the sub bands five wavelet sub trees are built. Non overlap range block $R_H(X,Y)$ and overlapping domain block D_H are built using equations (1) and (2). For each range block the assonant fractal algorithm is utilized to find the best matched domain block with a negligible MSE using equation (3). The performance analysis parameter (PSNR) can be find out by using (4).

3. FIC using Soft Computing Techniques

This is one of the classification method used to reduce ET.

Here classifying the domain pool using Artificial neural network classifier. A domain range match produces long encoding time. In order to reduce this encoding time the best matching domains for each range can be selected from same class. This classification is based on back propagation algorithm and the input which is given to the classifier are two features, standard deviation and skewness both are extracted from the domain cells.

4. Proposed Method

Hybrid wavelet-fractal image compression techniques are the best to improve the encoding time of pure fractal image compression techniques. More than half of the encoding time required can be reduced by using this method and can able to maintain the un symmetry between encoding and decoding at a limit. But beyond a limit when it further reduces it can be seen that the quality of the image goes on degrading. Hence a new method is needed in order to keep the quality of the image in an acceptable range. Here comes the relevance of this Gradient based method. The method is applied while searching, for the best matching domain-range pair.

4.1 Gradient Based Searching

Gradient stands for the intensity variations in an image. In Hybrid wavelet-fractal image compression technique instead of taking the whole image for FIC we are taking only wavelet transformed images. So the number of bits required to represent an image decreases because only few number of coefficients is needed to represent a whole image. And the searching is carried out only that much of portions that is which is based on the sub band size on each levels of decomposition. Otherwise in BFIC we have to compare for each and every blocks of an image with the domain. But here only blocks belonging to the same same subband is taken for matching purpose. Hence ET and CR can be improved. At the same time this method results in the neglecting of even more best matches because they may lie in other sub bands also. So this can be find out by taking the gradient of all the blocks and search is carried out based on this gradient value.

For an image mainly there are three types of gradients, they are Horizontal gradient H(z), Vertical gradient V(z), and Diagonal gradient D(z). Horizontal gradient is the intensity variation in horizontal direction where as other two gradients are the intensity variation in vertical and diagonal directions.

Fig 1 and 2 shows the block diagrams of encoding and decoding parts of the proposed met

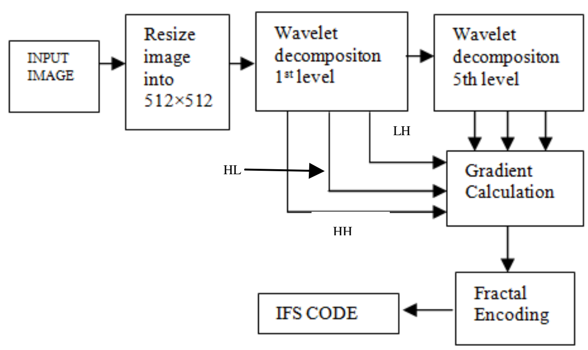

Fig 1 Block diagram of proposed method (Encoder)

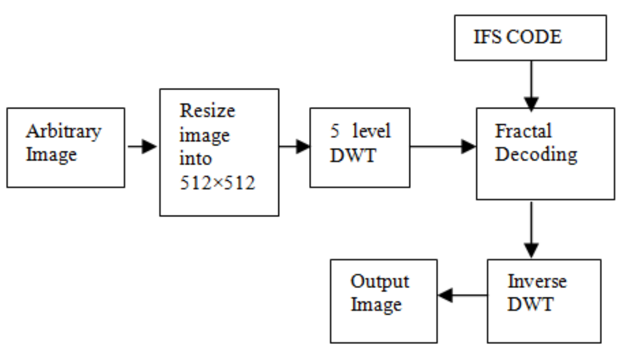

Fig 2 Block diagram of proposed method (Decoder)

4.2 Algorithm of Proposed Method

4.2.1 Encoding Phase

1. Read the input image
2. Resize the image into 512×512
3. Perform 5 level wavelet decomposition
4. Divide 4 sub bands into non overlapping range and domain blocks
5. Create 8 linear transformations of each domain blocks
6. Calculate H(Z) of each range blocks using [row n-row1] where n×n is the size of the block
7. Calculate V(Z) of each blocks using [column n-column 1]
8. Based on values of H(Z) and V(Z) setting a threshold value
9. If both H(Z) and V(Z) are greater than threshold it is taken as D(Z).
10. By comparing 3 gradient values and based on the predominant value among them find the best suiting affine transformation for each range blocks. And save it as IFS Code.

4.2.2 Decoding Phase

1. Choose an arbitrary Image
2. Resize the image into 512×512
3. Perform 5 level wavelet decomposition
4. Apply IFS Codes iteratively on each sub bands
5. Take inverse IDWT.

5. Results and Analysis

Haar wavelet is used for the wavelet decomposition. The results are compared with basic fractal image compression (BFIC) and Wavelet-Fractal image compression (WFC) and FIC using soft computing techniques.

5 images are used for this experiment fig 3 shows the original images and fig 4 shows reconstructed images.

Fig. 3 Original Images.

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Fig. 4 Reconstructed images using Proposed method.

Table 1: Comparison on ET,PSNR,CR of BFIC and Proposed

	BFIC			**Proposed**		
Images	ET	PSNR	CR	ET	PSNR	CR
Camera man	353.25	33.38	34.1	154.53	32.05	43.5
Lena	368.36	32.67	34.1	153.64	30.72	43.5
Baboon	353.62	30.29	34.1	160.39	30.44	43.5
Chilli	348.09	32.20	34.1	154.61	29.84	43.5
Pepper	336.48	32.57	34.1	160.48	30.47	43.5

Table 2: Comparison on ET,PSNR,CR of WFC and Proposed

	WFC			**Proposed**		
Images	ET	PSNR	CR	ET	PSNR	CR
Camera man	156.67	30.52	43.5	154.53	32.05	43.5
Lena	154.82	29.58	43.5	153.64	30.72	43.5
Baboon	158.35	29.73	43.5	160.39	30.44	43.5
Chilli	161.16	29.23	43.5	154.61	29.84	43.5
Pepper	159.75	29.35	43.5	160.48	30.47	43.5

Table 3: Comparison with FIC using soft computing technique

	FIC with HGANN		**FIC with GA**		**Proposed method**	
	Lena	Baboon	Lena	Baboon	Lena	Baboon
PSNR	30.0	24.98	28.34	28.22	30.7	30.4
E.T	2978	7590	4470	4230	154.8	158.3

Table 4: Performance Analysis

Parameters	**Performance of proposed over BFIC**	**Performance of proposed over WFC**
Encoding Time	57.2%	1.8%
PSNR	-4.4%	3.7%
Compression Ratio	27.65%	Remains the same

5.1 Equations

$$E(R_{Hi}, D_{Hi}) = \frac{1}{n}\sum_{i=1}^{n}(s.d_{hi} - r_{hi})^2 \quad v=n\varepsilon N \qquad (1)$$

$$S = \frac{\sum_{i=1}^{n} d_{hi} r_{hi}}{\sum_{i=1}^{n} d_{hi}^{2}} \qquad (2)$$

MSE is the cumulative difference between the compressed and original image. Image quality improves with smaller value of MSE.

$$MSE = \frac{\sum_{M,N}[I_1(m,n) - I_2(m,n)]}{M*N} \qquad (3)$$

PSNR is a measure of peak error between the original and compressed image. Higher the PSNR value, better the image quality. Where R is the maximum pixel value of the image

$$PSNR = 10 \log_{10}\left[\frac{R^2}{MSE}\right] \qquad (4)$$

6. Conclusion

A new gradient based hybrid wavelet-fractal image compression technique is presented here. WFC alone can reduce the encoding time required but by comparing with BFIC image quality is also reduces. The proposed method used here increases the image quality into an acceptable range also maintain other two parameters. Also by comparing the proposed method with FIC using soft computing techniques the proposed method can reduce the encoding time required with an acceptable PSNR.

References

[1] M.F Barnsley, and J.H.Elton, "Recurrent iterated function systems", Springer-Verlag,1989

[2] Arnaud E. Jacquin, "Image Coding Based on a Fractal Theory of Iterated Contractive Image

Transformations", IEEE Transactions on image Processing. Vol.I.no.I. January 1992.

[3] Feng-qing Qin, and Jun Min, Hong-rong Guo,"A Fractal Image Compression Method Based on Block Classification and Quadtree Partition", World Congress on Computer Science and Information Engineering. 2009

[4] Venkata Rama Prasad Vaddella, and Ramesh Babu,**"**Fast Fractal Image Compression Based on Domain-Range Pixel Value Difference", Global Journal of Computer science and TechnologyVol.10, Issue 4Ver.1.0 June 2010

[5] D. SophinSeelil, and Dr M.K Jeyakumar, "A Study on Fractal Image Compression Using Soft Computing Techniques", IJCSI International Journal of Computer Science Issues, Vol.9,Issue 6,No 2. November 2012.

[6] Yin-Lon Lin and Wen-Lin Chen, "Fast Search Strategies for Fractal Image Compression", Journal of Information Science and Engineering. 2012.

[7] Taha Mohammed Hasan, Xiangqian Wu**,** "An Adaptive Algorithm for Improving the FractalImage Compression (FIC)", Journal of multimedia, Vol. 6, No. 2. December 2011.

[8] G Farhadi "A Hybrid Image Compression Scheme Using Block-based Fractal Coding" Conference focused on Video *I* Image Processing and Multimedia Communications.*5* Julv 2003.

[9] R.E Chaudari "Wavelet Transformed based Fast Fractal Image Compression", International Conference on Circuits, Systems, Communication and Information Technology Applications (CSCITA)2014.

[10] Prashanth N and Arun Vikas " Fractal Image compression for HD images with Noise using wavelet transforms", International Conference on Advances in Computing, Communications and Informatics (ICACCI) 2015.