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Performance Comparison of Image Compression Using Wavelets

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ABSTRACT

This paper describes how the Fractal image coding takes the long time in its computation. It is its block searching and matching which takes long time. So to overcome this, we use the combination of fractal and wavelet this reduces the computation time. Based on this, we proposed an improved fractal image algorithm based on the wavelet subtree. The algorithm proposed improved fractal image compression technique in wavelet domain with thresholding value. This reduces the encoding time effectively.

1. INTRODUCTION [4], [6]

When a digital image is transmitted through a communication channel, the cost of transmission depends on the size of the data. To reduce the transmission cost the data need to be compressed. There are many methods to compress an image like Joint Photographic Expert Group (JPEG) this method eliminates the high frequency components of the signal and storing the low frequency fourier coefficients but the drawback of this method its compression ratio is high. So fractal image compression method allows the images to be stored in computer in less memory. Fractals means broken or irregular fragements that describes family of complex shapes that possess an inherent self similarity or self affinity in their geometrical structure. Fracal image compression is also called as fractal image encoding because compressed images are represented by contractive transforms. These transforms are composed of collection of a number of affine mappings on the entire image, known as Iterated Function System(IFS). Contractive transformation is applied to the IFS's called Collage theorem. This theorem is the technique core of the fractal coding. For a certain image X, we choose a certain number of contractive mapping such as N, and we can get number N sets by transformed for N times in which every set is small image. If the reconstructed image collaged by these N small image then it is very similar to X image. Collage theorem provides a distance between the image to be encoded (target image) and the transformation of that image. If the error difference between the target image and the transformation of that image is less than a certain value of transform is an equivalent- representation of image this is also known as contractive transformation set or union of mapping from the image to itself.

It has big compression ratio and fast decoding but it is ts encoding that takes long time means searching and matching of block makes its long time. The usual approach is based on the collage theorem.

2. DESIGNING OF FRACTAL[7], [5]

2.1. Image Partitions

The square support S of The original image is partitioned into nonoverlapping square range cells of two different sizes, thus forming a two level square partitioned. This type of partitioned is closely related to quad-trees. The larger cells- of size B X B-are referred to as (domain) parents, the smaller ones –of size B/2 X B/2-as (range) children. A parent can be split into up to four non overlapping children. The whole process of fractal image encoding is shown in Fig. 1.

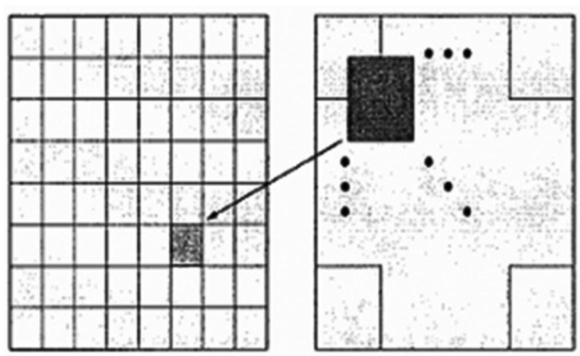

Fig.1: One of the Block Mappings in a PIFS Representation

Firstly, we have to select the image partition scheme for the formation of range blocks, secondly domain block must be selected from the domain pool in such a way domain blocks must be transformed to cover range blocks. Thirdly, the partition scheme used and the type of domain pool used affect the choice of transforms. Fourthly, Then a suitable candidate from all available domain blocks is searched to encode any particular range block. Fifthly, This step of fractal image compression is computationally very expensive. This computational requirement is the biggest limitation of fractal encoding. A wide variety of techniques have been proposed to fasten the process.

3. FRACTAL IMAGE CODING BASED ON WAVELET SUB-TREE[4]

Generally signals are processed in time domain, sometimes time and frequency both representations are required. Wavelet analysis is capable of providing the time and frequency information simultaneously, hence giving a time-frequency representation of the signal. Multi resolution is the beauty of the wavelet i.e. different parts of the signal are viewed through different resolutions.

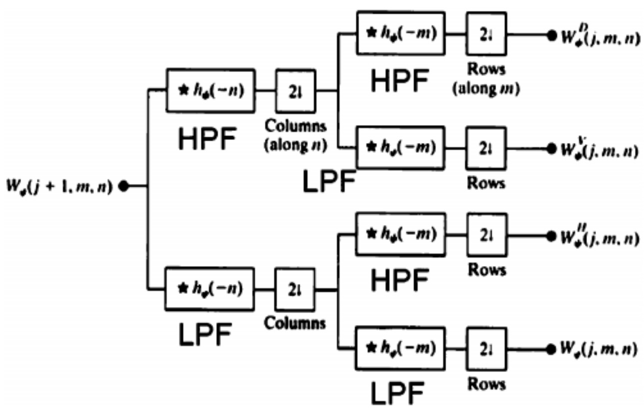

Fig.2: DWT in 2D One Stage 2D Analysis Bank

Filter $h_\varnothing(-n)$ is a low-pass (half-band) filter, whose output $w^H(j,m,n)$ is an *approximation* of the input $h_\varnothing(-n)$; $h_\varnothing(-n)$ is a high-pass (half-band) filter, whose output $w_\varnothing^D(j,m,n)$ and $w_\varnothing^V(j,m,n)$is a high-frequency or *detail* part of the input $h(-n)$. Synthesis filters $h(n)$ and $h(n)$ combine two subband signals to produce $w_\varnothing(j+1, m, n)$, which is the original signal.

In wavelet domain a square in the image is split up into four equal sized subsquares. Below fig.3 gives an idea how an image can be decomposed into four subimages.

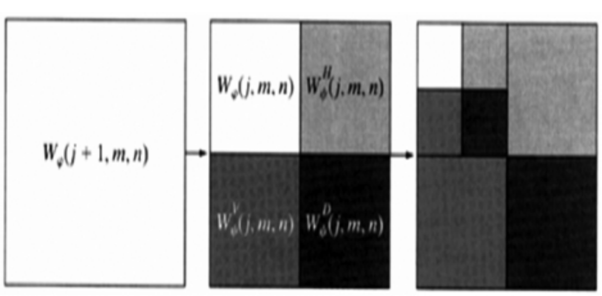

Fig. 3: Two Stage Decomposition

The oriented wavelet sub-tree is a kind of structure with tree shape, it is composed by wavelet coefficients with different resolution same direction and same relative space position. The wavelet coefficients of image after wavelet transform can compose three kinds of oriented wavelet sub-trees: the horizontal direction wavelet sub-tree which has low frequency in horizontal direction and high frequency in vertical direction; the vertical direction wavelet sub-tree which has high frequency in horizontal direction and low frequency in vertical direction; the diagonal direction wavelet sub-tree which has both high frequency in horizontal and vertical direction, shown in Fig.3.

3.1. Wavelet based Fractal Image Coding Algorithm

3.1.1. Encoding Process

1. Take an image as input of size 512 x 512.
2. Calculate (DWT) Haar wavelet up to i = 1, 2,3…….N. levels.
3. For all N levels, divide the H,V,D components of the ith level in to domain blocks of size 2Bx2B and that of (i+1)th level in to range blocks of size BxB.
4. For domain block, find the best matching range block.
5. Save the mapping information i.e. scaling factor and position of the best matched block into a text file.
6. Also save the Nth level approximation component in to the same text file.
7. Transmit this text file as encoded as message.

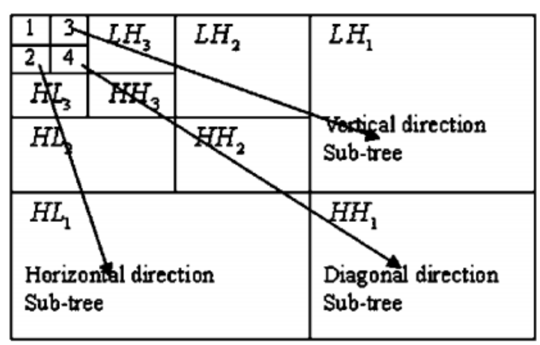

Fig.4 Wavelet Subtree

3.1.2. Decoding Process

1. Read the encoded message file.
2. Take a bitmap image of size 512x512.
3. For all N levels compute (DWT) Haar wavelet of the image and process the H,V,D components with the help of the data in the encoded message file.

4. Take Inverse Discrete Wavelet Transform (Haar) for all N levels and get the reconstructed image. Repeat the process for k iterations.

3.2. Fractal Image Compression Technique in Wavelet Domain using Threshold

Encoding Process can be speeded up if a suitable threshold value for MSE is chosen. This speeds up the encoding process because after getting the suitable value it will stop finding the matches for range blocks and domain blocks.

3.2.1. Encoding Algorithm

1. Take an image as input of size 512x512.
2. Calculate (DWT) Haar wavelet up to i=1, 2, 3…….N. levels.
3. For all N levels, divide the H, V, D components of the i^{th} level in to domain blocks of size 2Bx2B and that of $(i+1)^{th}$ level in to range blocks of size BxB.
4. Choose suitable value for threshold.
5. For every domain block find the matching of range block (depending on threshold value)
6. When the error value is less than the defined threshold value then save the mapping information i.e. scaling factor and position of the best matched block in to a text file.
7. Also save the N^{th} level approximation component in to the same text file.
8. Transmit this text file encoded as message.

3.2.2. Decoding Algorithm

The process for decoding the image is the same as that used for wavelet based Fractal Image Compression.

4. RESULTS

Fig. 5: Original Image

Using fractal image compression technique in wavelet domain without threshold. Fig. 5 shows an image lenna.tif of size 512x512. This image is compressed and decompressed using Fractal Image Compression Technique in Wavelet Domain.The encoding time is 124 seconds and the size of the encoded text file is 351KB. Fig. 6 shows the reconstructed image.

Fig. 6 Reconstructed image

The same original image Lenna.tif (Fig.6) is compressed and decompressed using Fractal Image Compression Technique in Wavelet domain with Threshold. The encoding time is 15 seconds and the size of the encoded text file is 344KB. Fig.8 shows the reconstructed images.

Fig. 7: Original Image

Fig. 8: Reconstructed Image Using Threshold

4.1. Comparison between Fractal Image Compression in Wavelet Domain Without Threshold and with Threshold

Table 1
Shows the PSNR, Decoding Time for Different Iteration using Fractal Image in Wavelet Domain Without Threshold

Iteration No.	*PSNR*	*Decoding Time (Seconds)*
1	19.9637	1.3360
2	22.5996	1.9310
3	25.5867	2.1380
4	27.5050	2.6200
5	27.9747	2.9330
6	27.9747	3.3880
7	27.9747	3.9130
8	27.9747	4.3370

Table 2
PSNR and Decoding Time for Iterations using Fractal Image Compression in Wavelet Domain with Threshold for Lenna.tif

Iteration No.	*PSNR (dB)*	*Decoding Time (Seconds)*
1	19.9637	1.4230
2	22.5996	1.8160
3	23.0121	2.1800
4	23.0319	2.5700
5	23.0327	3.0050
6	23.0327	3.4560
7	23.0327	3.8470
8	23.0327	4.3040

Compression Ratio Achieved is 85.5469

Fig.9 shows comparison of PSNR obtained, using Fractal Image Compression technique in wavelet domain, and wavelet domain with threshold, for an image Lenna.tif of 512x512 size.

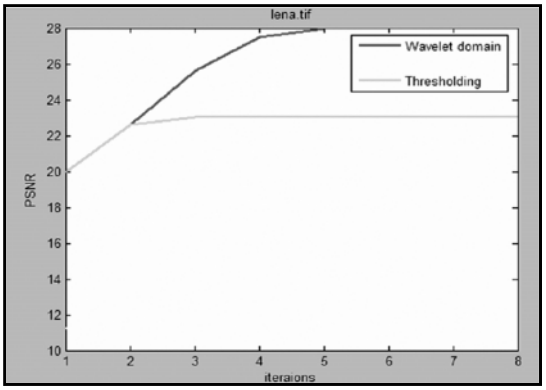

Fig. 9: Graph Showing Comparison

5. CONCLUSION

Wavelet based Fractal Image compression is a lossy image compression technique. This hybrid technique is much successful than pure fractal image compression technique. Use of the wavelet accelerates the matching process and reduces the encoding time and up to some extent it tries to overcome one of the major disadvantages of the pure fractal compression technique.

Fractal image compression in wavelet domain has large encoding time (which is much smaller than the pure fractal image compression technique) and very small decoding time with good value of Peak Signal to Noise Ratio (PSNR).

In wavelet domain with threshold encoding time and decoding time are less but with a little compromise with PSNR.

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