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Haar Wavelet Based Joint Compression Method Using Adaptive Fractal Image Compression

Ali Ibrahim Khaleel[1], N.Anupama[2]
[1,2]*(College of Engineering & Technology, Acharya Nagarjuna University ,AP ,India,)*

Abstract: *We are introducing the discrete wavelet transform based joint methodology with the existing Adaptive Fractal Image Compression technique. By developing this method we will get the better quality of the image w.r.t peak signal to noise ratio and improvement in the compression ratio. As we have previous FIC methods in usage we are going to compare our results with them sequentially by applying image metrics to show quality of the decompressed image after reconstruction. In this thesis, five methods have been proposed to: reduce the long time of the FIC and Haar waveletincrease the compression ratio and keep the reconstructed image quality. The five methods are:1- Discrete Wavelet Transform Adaptive Fractal Image Compression DWT+AFIC, 2- The Adaptive Fractal Image Compression AFIC method.3- The ZM-RDE method, 4- Reducing the Domain Image Size (RDIZ) method, 5- The Range Exclusion (RE) method.*

Keywords*: Fractal, range block, Discrete Wavelet Transform, image compression, Peak Signal to noise ratio and compression ratio*

I. Introduction

The people communicate ways are quickly modifying. The conventional wired voice call is no longer the only reasonable and reliable method for communications and information transferring. Rather, many methods ranging from voice calls over wireless networks to video calls over the telephone network have been found, as well as the transmission of arbitrary images or through a computer network (distributed multi-media systems) [1]. Furthermore, the multimedia market is also growing rapidly, and the World Wide Web (WWW) makes the internet easily accessible for everyone. So the digital images are widely used now in many different applications, including entertainment, advertising, journalism, security and law enforcement, medical imaging, and satellite imaging[2]. For that, the amount of digital information and computer graphics applications was grown and increased [3]. These applications, especially those treating with digital photographs and other complex color images can generate very large file sizes thus the digital image compression is needed for the storage and the transmission requirements.Data compression provides an efficient way to represent information by using techniques that can exploit the different kinds of structures that may be present in the data.

Since ancient times, the data compression has been a practice of humankind. The ancient Chinese used special concise character syntax (Wen-Yan) to record daily spoken language in a short form, while the essence of meaning was kept. In this way, they discarded the redundant characters that not affect the essential meaning; therefore, the precise meaning can be saved. In the 18th century, to save the time in the communication between London and important ports in the shutter telegraph, the British Admiralty uses a compressed language format. Over than 200 words for different descriptions of snow have been used by the Eskimo therefore, a single word is enough to describe the exact type of snow precisely [4].

The data compression can be defined as the process of compacting data files into smaller files to enhance the efficiency of transmission and storage, in other words, compression is the process of representing information compactly. At the revolutionary technology of multimedia, it would be practical to put images, audio, and video in a compressed form on websites [5].

If the image contains a large amount of data, that's mean much storage space, large transmission bandwidth and long transmission time will be needed; therefore, it is better to store only the essential information needed to reconstruct the image and that's what the image compression can make [6].

II. System Design Model

1- Discrete Wavelet Transform Adaptive Fractal Image Compression DWT+AFIC method, which made on developing the haar based DWT method by adopting the AFIC in which we are going to do the DWT as preprocessing to AFIC method.

2- The Adaptive Fractal Image Compression AFIC method, which made on developing the ZM-RDE method by adopting the Adaptive Quadtree Partitioning Technique (AQPT) and the Domain Block Selection Technique (DBST). The AQPT is an adaptive partitioning technique which depends on the uniformity of the blocks as a partitioning criterion. It is independent of the fractal mapping

3- The ZM-RDE method, which is the development of the RD-RE method. The development comes from combining the RD-RE with the Zero Mean Intensity Level (ZMIL) method. The ZMIL method introduces the transforms of the full search problem using a more convenient form by adopting an unconventional affine parameter (i.e. The range mean r) which has better properties than the conventional offset parameter and a new search algorithm has been developed. Using ZMIL will lead to: Reducing the complexity of matching operations which can speed up the encoding operation; Increase both of the compression ratio and the reconstructed image quality. The results showed that ZM-RDE can achieve a better performance in terms of the CR, ET and the PSNR than the RD-RE.

4- Reducing the Domain Image Size (RDIZ) method, which reduced the domain pool by minimizing the Domain Image Size to only $1/16^{th}$ of the original image size? This in turn will affect the encoding time, compression ratio and the image quality. The RE and RDIZ were coupled to work under one algorithm called the RD-RE. The experimental results show that RD-RE can achieve a higher compression ratio and a significant reduction in the encoding time but with some decay in the reconstructed image quality.

5- The Range Exclusion (RE) method, which is responsible for reducing the number of the ranges blocks that needed in the matching process. RE used a variance factor as a criterion to indicate and exclude the homogenous ranges from the matching process which lead to increase the compression ratio and decrease the encoding time.

The goal of Fractal Image Compression FIC or encoding is to be able to store an image as a set of IFS transformations instead of storing individual pixel data [8]. So, the FIC is a data compression technique which exploits the affine redundancy that is commonly present in all natural images and most artificial objects, this redundancy is related to the similarity of an image with itself [96].

Michael Barnsley proposed FIC as a technique to store images in a small amount of space. His idea was based on his work with fractal mathematics, and his observation that most natural scenes contain Affine Redundancy, or sub-sections that look very similar [95, 97]. Therefore, FIC can work to find the similar patterns that exist on different scales and at different places in an image, and then eliminate as much redundancy as possible.

Any fractal compression system involves a process that looks for these repetitions across scale and position. Then, instead of saving information about every similar part of an image, the system merely saves the common representation and how it is used on different scales and in different places [49], that when applied these representations iteratively to an arbitrary initial image will converge to the desired image. However, the trick in fractal compression is in finding the necessary transformations for a given image. Much of the initial knowledge of fractal based compression is due to Barnsely and Sloan [70]. But the idea of Barnsely is suitable only for the artificial images like the Fern or the Sierpinski triangle where the whole image is self-similar to all of its parts. But what about the natural images? Where there is no such whole self-similarity, for that several researchers have taken up the challenge to design an automated algorithm to implement an image compression using the basic IFS method and its generalizations. In a way, the work by Jacquin and his subsequent papers broke the ice for FIC providing a starting point for further research and extensions in many possible directions.

But still FIC has a disadvantage, since fractal image compression usually involves a large amount of matching and geometric operations. The coding process is so asymmetrical that encoding of an image takes much longer time than decoding. Thus, the computational complexity of it is still the greatest burden of its use in practice, and many studies attempt to reduce this complexity.

III. Simulation Results

Figure 3.1 shows about the comparison of reconstructed images of different methods on lena image

Figure 3.1 lena image comparison

Method	MSE	PSNR	CR
RE	342.22	22.79	6.84
RDIZ	11.40	26.29	6.67
ZM-RDE	2236.01	14.64	9.10
AFIC	131.66	26.94	8.98
DWT+AFIC	28.54	33.58	9.84

Figure 3.2 lena table comparison

Figure 3.2 comparison of above table we are considering the mean square error (MSE), peak signal to noise ratio (PSNR) and compression ratio (CR) for all the respective methods. For lena image DWT+AFIC method reaches above 28 dB than other methods where compression ratio is above 9.8 than others

Figure 3.3shows about the comparison of reconstructed images of different methods on fruits image

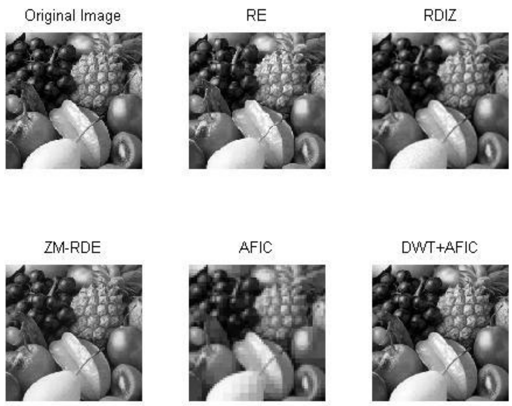

Figure 3.3 fruits image comparison

Method	MSE	PSNR	CR
RE	484.38	21.28	7.58
RDIZ	10.06	26.67	6.67
ZM-RDE	4760.86	11.35	9.10
AFIC	170.41	25.82	6.12
DWT+AFIC	0.79	49.18	9.84

Figure 34fruits table comparison

Figure 3.4 comparison of above table we are considering the mean square error (MSE), peak signal to noise ratio (PSNR) and compression ratio (CR) for all the respective methods. For fruits image DWT+AFIC method reaches above 49 dB than other methods where compression ratio is above 9.8 than others

Figure 3.5shows about the comparison of reconstructed images of different methods on lena image

Figure 3.5barbara image comparison

Method	MSE	PSNR	CR
RE	403.87	22.07	7.09
RDIZ	10.03	26.68	6.67
ZM-RDE	2255.83	14.60	9.10
AFIC	119.64	27.35	7.81
DWT+AFIC	42.01	31.90	9.84

Figure 3.6barbara table comparison

Figure 3.6 comparison of above table we are considering the mean square error (MSE), peak signal to noise ratio (PSNR) and compression ratio (CR) for all the respective methods. For barbara image DWT+AFIC method reaches above 30 dB than other methods where compression ratio is above 9.8 than others

IV. Conclusion

The proposed *DWT+AFIC* worked on; decreasing the encoding time and increasing the compression ratio at the same time. In addition, it made to keep the reconstructed image quality as much as possible. For that, *DWT+AFIC* adopted the *AFIC*, *AQPT*, *ZMIL*, *RE*, *RDIZ* and *DBST* techniques, all these techniques worked together to achieve the aim of *DWT+AFIC* and to minimize the trade-off among the ET, CR and the PSNR. *DWT+AFIC* has many control parameters, these parameters give the *DWT+AFIC* a high flexibility to get different performing results in term of CR, ET and PSNR so we can get a higher PSNR on the account of the ET and CR and vice versa to accomplish the requirements of different applications. The comparison results show that the *DWT+AFIC* has better performance than BFIC, Duh's method,

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