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Compression Technique Using DCT & Fractal Compression – A Survey

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Abstract

Steganography differs from digital watermarking because both the information and the very existence of the information are hidden. In the beginning, the fractal image compression method is used to compress the secret image, and then we encrypt this compressed data by DES.The Existing Steganographic approaches are unable to handle the Subterfuge attack i.e, they cannot deal with the opponents not only detects a message ,but also render it useless, or even worse, modify it to opponent favor. The advantage of BCBS is the decoding can be operated without access to the cover image and it also detects if the message has been tampered without using any extra error correction. To improve the imperceptibility of the BCBS, DCT is used in combination to transfer stego-image from spatial domain to the frequency domain. The hiding capacity of the information is improved by introducing Fractal Compression and the security is enhanced using by encrypting stego-image using DES.

Keywords: Steganography, data hiding, fractal image compression, DCT.

1. Introduction

One of the important application of data compression is image processing on digital images. It reduces the redundancy of image data to store it efficiently Multimedia data which is uncompressed (graphics ,audio , video) need storage capacity & transmission bandwidth .Now a days there is rapid progress in mass storage density & digital communication system performance . The future of multimedia based web applications is data intensive , so we need to have efficient way to encode signal & images .Compression is achieved by the removal of one or more of three basic data redundancies: (1) Coding redundancy, which is present when less than optimal (i.e. the smallest length) code words are used(2) Interpixel redundancy, which results from correlations between the pixels of an image & (3) psycho visual redundancy which is due to data that is ignored by the human visual system (i.e. visually nonessential information).In this paper will mainly concentrate on the comparative study of compression techniques namely DCT (Discrete Cosine Transform) & Fractal Compression.

2. Review Of Compression Technique

2.1.DCT (Discrete Cosine Transform) : A discrete cosine transform (DCT) is a sequence of finitely many data points in terms of a sum of cosine functions oscillating at different frequencies. From lossy compression of audio and images to spectral methods for the numerical solution of partial differential equations , it turns out that cosine functions are much more efficient , whereas for differential equations the cosines express a particular choice of boundary conditions. Here is a block diagram explaining the same, followed by the decoding of the image.

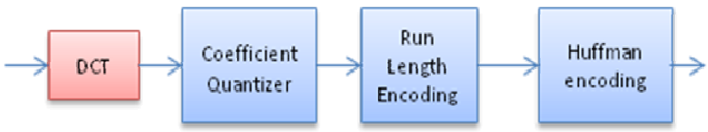

Fig 1 Encoding of DCT

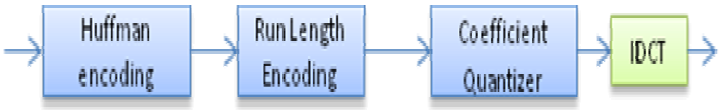

Fig 2 Decoding of DCT

2.2. Fractal Compression: The method relies on the fact that in a certain images, parts of the image resemble other parts of the same image (self-similarity). But the computation time required to encode an image might be very long due to an exhaustive search for the optimal code. It is lossy image compression technique ,achieve high level of compression preserves the quality as of the original image . Its working is as shown in the figure 3.

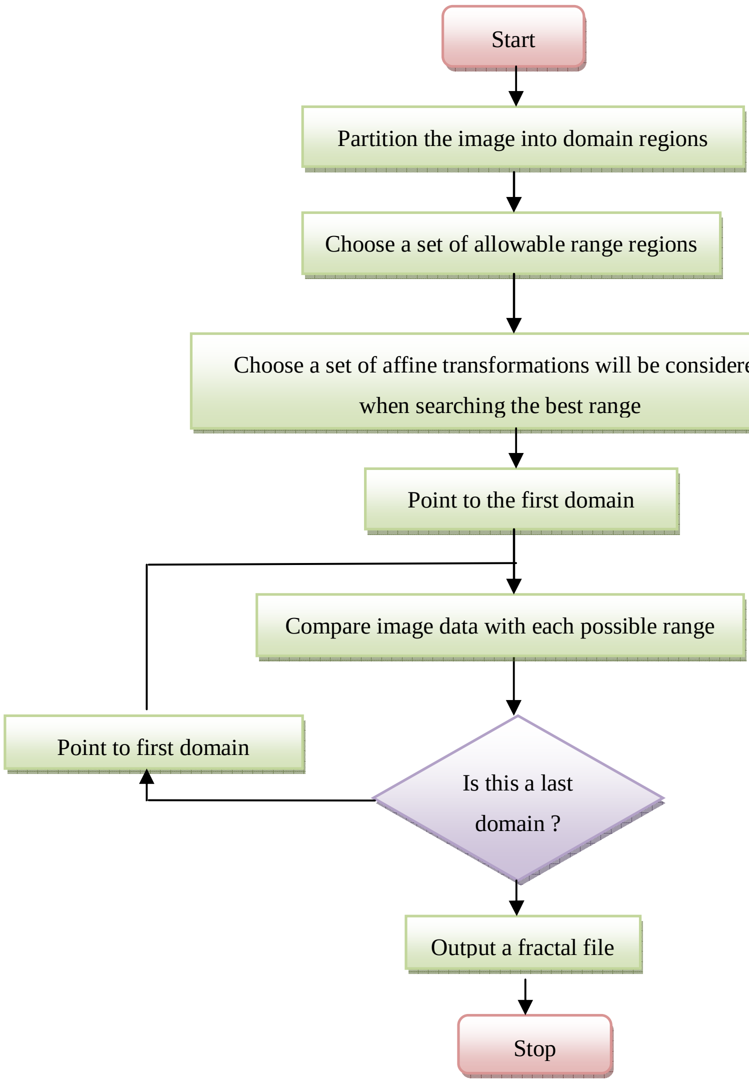

Fig 3 Algorithm for fractal compression

3.Review of Compression Algorithms

The techniques used to compress/decompress a single gray level image are expected to be easily modified to encode/ decode color images and image sequences . The goal of image compression is to save storage space and to reduce transmission time for image data. It aims at achieving a high compression ratio (CR) while preserving good fidelity of decoded images.. Recent compression methods can be briefly classified into four categories: (a) Wavelet, (b) JPEG/DCT, (c) VQ, and (d) Fractal methods, which are discussed by various people are briefly reviewed below.

Chin-Chen Chang discussed [3] that proposed model does the data embedding into the cover image by changing the coefficients of a transform of an image such as discrete cosine transform. The high compression rate is one of the advantages of fractal image compression. Main advantage is the good image quality, after enough iteration for decompression. But the computation time required to encode an image might be very long due to an exhaustive search for the optimal code. And DES encryption is used to provide the security to the data, but it is unable to protect the Stego-Image from subterfuge attack. Which is nothing but , the attacker not only detect a message, but also render it useless or even worse, modify it to the opponent's favor.

K.B.Raja [4] has proposed a model which uses LSB ,but LSB provides poor security ,and DCT for converting objects in spatial domain to frequency domain. This model uses only raw Images because of subterfuge attack. The JPEG, BMP and GIF image formats, the header contains most of the image information. This leads to the problem of insecurity and therefore the payloads from such images can be easily identified.

Hairong Qi discussed in [2] that in the proposed model the technique BCBS(Blind Consistency Based Steganography)is used .The advantage of the BCBS approach is that the decoding process can be operated blindly without access to the cover image, which enhances the imperceptibility. And that it not only decodes the message exactly, it also detects if the message has been tampered without using any extra error correction. The main drawback is the amount of data to hide is very less because he is selected only one row / Column to hide with one bit per pixel. And also the security is provided only for the Stego-Image not for the data that can be improved by using DES.

Niels Provos [6] has found PSNR(Peak Signal To Noise Ratio) to be a good indicator of finger and face recognition matching scores in the case of JPEG2000 and SPIHT. Both wavelet-based algorithms perform exceptionally well in terms of rate-distortion performance and matching scores of all recognition systems considered. While PSNR exactly predicts the poor matching scores of fractal compression the case of fingerprint images, the relatively high PSNR results for face images suggest fractal compression to perform superior to JPEG for this biometric modality. The opposite is true – despite the low PSNR results, JPEG performs quite well in face recognition applications for high and medium bit rate applications

Chin-Chen Chang [3] He has proposed a scheme to embed an image compressed via fractal image compression into the DCT domain of the cover image. Due to the high compression rate of fractal compression, also it can embed a secret image larger than the cover image itself. Moreover, the more decompression iterations will be done, the better decompressed secret image quality will get. Also, these compression codes of fractal compression must not be lost, or the embedded message cannot be extracted. Thus some modification on the bit streams of the modified coefficients to prevent the information loss caused by discrete cosine transformation. As for security, encrypt the compressed data via DES so that it can be prevent the eavesdroppers from getting the secret image.

Chaur-Chin Chen [25] has only reviewed and summarized the characteristics of four up-to-date image coding algorithms based on Wavelet, JPEG/DCT, VQ, and Fractal approaches[5]. Experimental comparisons on four 256×256 commonly used images, Jet, Lenna, Mandrill, Peppers, and one 400×400 fingerprint image suggest a recipe described as follows. Any of the four approaches is satisfactory when the 0.5 bits per pixel (bpp) is requested. Hence for practical applications, he concluded that wavelet based compression algorithms are strongly recommended.

N. F. Johnson [22] brought the Tree Structured VQ techniques in order to decrease the table storage needed for en-coding and decoding along with unstructured vector quantization (UVQ) or Tree-Structured Vector Quantization (TSVQ). Particularly, a low-storage Secondary Quantizer is employed to squeeze the code vectors of the primary quantizer. The absolute benefits of uniform and non-uniform Secondary Quantization are examined. Quantization levels are put up on a binary or Quad tree structure (sub-optimal). It is to set vectors in different quadrant. Signs of vectors are only needed to be evaluated. This will reduce the number of links by 2^L for L-d vector problem. It will work fine for symmetric distribution

According to **Sachin Dhawan.,** [24] the hybrid VQ algorithm is explained as follows, first the correlation in the test image is taken away by wavelet transform. Wavelet transform is employed in the course of lifting scheme. The wavelet employed during lifting scheme is HAAR wavelet. Then it will lead with the primary level of decomposition gives way four components namely LL, LH, HL and HH correspondingly. Multistage VQ is implemented to LL band. The pointed coefficients in the sub band LH, HL and HH are pyramidal vector quantized by capturing vectors of stated measurement. Finally an entropy coding algorithm like Huffman coding is implemented as the final stage of the compression system to code the indices. He has proposed an algorithm groups the benefit of lessening of codebook searches and storage complexity which is intrinsic to MSVQ .Additionally pyramid vector quantization may not need great codebook storage having simple encoding and decoding algorithm. Hence high compression ratio can be accomplished by including PVQ along with MSVQ.

4. Measuring Compression Performances

There are different criterion for measuring the performance of the compression also it depends on the nature of the application .When measuring the performance the main concern would be the space efficiency. The time efficiency is another factor. Since the compression behavior depends on the redundancy of symbols in the source file, it is difficulty to measure performance of a compression algorithm in general. The performance depends on the type and the structure of the input source. Additionally the compression behavior depends on the category of the compression algorithm: lossy or lossless. If a lossy compression algorithm is used to compress a particular source file, the space efficiency and time efficiency would be higher than that of the lossless compression algorithm. Thus measuring a general performance is difficult and there should be different measurements to evaluate the performances of those compression families.

4.1 Following are some measurements used to evaluate the performances of lossless algorithms.

1.Compression Ratio is the ratio between the size of the compressed file and the size of the source file. Compression Factor is the inverse of the compression ratio. That is the ratio between the size of the source file and the size of the compressed file. Saving Percentage calculates the shrinkage of the source file as a percentage. % size before compression saving percentage size before compression size after compression

All the above methods evaluate the effectiveness of compression algorithms using file sizes. There are some other methods to evaluate the performance of compression algorithms. Compression time, computational complexity and probability distribution are also used to measure the effectiveness.

2.Entropy This can be used, if the compression algorithm is based on statistical information of the source file. Self Information is the amount of one's surprise evoked by an event. In another words, there can be two events: first one is an event which frequently happens and the other one is an event which rarely happens. If a message says that the second event happens, then it will generate more surprise in receivers mind than the first message.

3.Code Efficiency Average code length is the average number of bits required to represent a single code word. If the source and the lengths of the code words are known, the average code length can be calculated .

4. Bit Error Rate (BER): Here we compute the BER for two equal size images that is cover image and stego-image. BER is more accurate for error analysis when compared to MSE, because in BER we compute the actual number of bit positions which are replaced in the stego image , which is calculated by

$$H(e) = -\sum_{i=0}^{m-1} p(e_i)\log_2 p(e_i)$$

5. Mean square error (MSE): The MSE is computed by performing byte by byte comparisons of the two images, since a pixel is represented by 8 bits and hence 256 levels are available to represent the various gray levels. The MSE will result in a meaningful value only when each byte of an image is compared with the corresponding byte of another image. Let c and s be the cover image and stego-image respectively. Let n*n be the total number of pixels. The computation of MSE can be performed as follows,

$$MSE = 1 \div n \times n \sum_{i,j=0}^{n-1} (c(i,j) - s(i,j))^2$$

Method	Advantages	Disadvantages
Wavelet High Compression	-High Compression Ratio -State-Of-The-Art	-Coefficient quantization -Bit allocation
JPEG	-Current Standard	-Coefficient(dct) quantization -Bit allocation
VQ	-Simple decoder -No-coefficient quantization	-Slow codebook generation -Small bpp
Fractal	-Good mathematical -Encoding-frame	-Slow Encoding

Table 1 Comparisons of methods[24]

5. Conclusion

Here after reviewed & summarizing the techniques of image compression ie, Wavelet, JPEG/ DCT,VQ, and Fractal approaches with the help of their experimental outcomes given by respective authors, so for practical approach we conclude that (1) Wavelet based compression algorithms are strongly recommended (2) DCT based approach might use an adaptive quantization table (3) VQ approach is not appropriate for a low bit rate compression although it is simple (4) Fractal approach should utilize its resolution-free decoding property for a low bit rate compression.

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