Fractal Image Compression & Algorithmic Techniques

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Abstract— *Fractal image compression is a very advantageous technique based on the representation of an image by a contractive transform. Based on fractals Fractal compression is a lossy compression method for digital images. The method is best suited for textures and natural images, relying on the fact that parts of an image often resemble other parts of the same image. In this paper we review and discuss about the Key issues of image compression, need of compression, its principles, and classes of compression and various compression algorithm of image. We review and discuss the advantages and disadvantages of these algorithms for compressing images for lossless and lossy Techniques.*

Keywords— *Fractal Image compression, Lossy, Algorithms, Fractals.*

I. INTRODUCTION

Visual information is very important for human beings to identify, recognize and understand the surrounding world. In common, an image file contains much more data than a text file. An image consists of a two dimensional array of numbers. The gray or color shade displayed for a given picture element (pixel) depends on the number stored in the array for the pixel. An image takes large amount of data requires much memory to store, takes longer to transfer, and is complex to process. For example, a grey scale image with 256×256 pixels requires about 65 Kilobytes of memory space and more than 18 seconds to transfer at 28.8kb/s. Image compression becomes necessary due to the limited communication bandwidth, CPU speed and storage size. In Image processing research image compression is most challenging fields. Fractal image compression is a relatively recent image compression method which exploits similarities in different parts of the image.

Fractal Image compression (FIC) is one among the compression techniques in the spatial domain which exploits similarities in different parts of the image. One can see the self similar regions in the image above. Fractal compression stores this type of information to achieve compression. To do Fractal compression, the image is divided into sub blocks. Then for each block, the most similar block if found in a half size version of image and stored. Then during decompression, the opposite is done iteratively to recover the original image. It is a block based image compression, detecting and coding the existing similarities between different regions in the image.

Time consuming is one the main drawback of Fractal image compression. In Fractal image compression encoding is take long time compared to decoding. Decoding is fast than encoding. In encoding the process is searching the appropriate domain for each range. In nowadays, Fractal image compression is very attractive.

Fractal image compression is developed by Hutchison and Barnsly.It is based on theory of IFS (Iterated Function System).In Image compression Jacquin and barnsly can first use of IFS.In ifs coding scheme the image will be partitioned into non overlapped range blocks. For each block, a similar domain block is found using IFS mapping. In IFS mapping coefficient will represent a data of block of the compressed image. Decoding proceed as follows. For reducing an encoding time, recently we have some improvements and modification have been studied.

For example: This is a Fern picture. We can see where these similarities lie. Each fern leaf resembles small portion of fern. This is known a famous Barnsely Fern. During more than two decades of development the IFS based compression algorithm stands outstanding performances for research and improvement .The basic idea is to represent an image by fractals and each of which is the fixed point of an IFS. An IFS consists of a group of affine transformations (Fisher 1995).Therefore, an input image can essentially be represented by a series of IFS codes. In this way, a compression ratio 10000:1 can be achieved (Barnsley & Sloan 1988). In short, for fractal image compression an image is represented by fractals rather than pixels. Each fractal is defined by unique IFS that consist of a group of affine transformations. Therefore the key point for this algorithm is to find fractals which can best describe the original image and then to represent them as affine transformations.

II. KEY ISSUES OF COMPRESSION

A. Principles Of Compression

A general feature of most images is correlated the neighbouring pixel also contain redundant information.

The main task is to find the less correlation representation of the image. Redundancy and Irrelevancy reduction is two fundamental components of compression.

Redundancy reduction aims at removing duplication from the signal source (image/video).Irrelevancy reduction omits part of the signal that will not be notices by the signal receiver namely HVS (Human Visual System).

There are three types of redundancy are coding redundancy, interpixel redundancy, psycho visual redundancy.

Coding Redundancy:

A code is a list of symbols (letters, numbers, and bits) used to signify a set of events. A code word is a sequence of symbols used to represent a piece of information or an event (eg.gray levels).A code word length is number of symbols in each code word. A code word length is a number of symbols in each code word.

Interpixel redundancy:

Interpixel Redundancy implies that any pixel value can be reasonably predicated by its neighbours ie) correlated. To reduce Inter pixel Redundancy, the data must be transformed in another format ie) through a transformation Eg: Thresholding, different between adjacent pixel, DFT

Psycho visual Redundancy:

The human eye does not respond with equal sensitivity to all visual information. It is more sensitive to the lower frequencies than to the higher frequencies in the visual spectrum.

B. Need For Compression

The huge size of the data files, in uncompressed form. The storage device has relatively slow access. Only limited bandwidth of the common channel.

Bitmap images take up a lot of memory. Image compression reduces the amount of memory needed to store an image. For instance 2:1 megpixel,8bit RGB image(1600*3200)occupies 1600*1200*3 bytes=5760000 bytes=5.5 MB.This is the uncompressed size of the image.

Compression ratio is the ratio between the compressed image and uncompressed image, 512 KB jpeg file the compression ratio would be 0.5 mb: 5.5 mb=.11

C. Different Types Of Compression Techniques

There are two types of compression are lossless and lossy

Lossless Compression:

There is no information loss, and the image can be reconstructed exactly the same as the original.

Applications: Medical imagery, Archiving

Lossy compression

Lossy compression loses some of the original data.

Applications: commercial distribution (DVD) and rate constrained environment where lossless methods cannot provide enough compression ratio.

D. Methods

Lossy compression methods include Transform coding, Vector quantization, Fractal coding, Block truncation coding, Sub band coding

Lossless Compression methods include Run length encoding, Huffman encoding, LZW coding, Area coding

E. Advantages And Disadvantage Of Lossless And Lossy:

Lossless:

The quality of file is better than lossy. Information from file is still there, nothing is deleted. The drawback of lossless is although the quality of the file is better than loss file, it still takes up space.

Lossy:

The file has been compressed to the smaller byte, therefore mores data storage for other files on the hard drive. The drawback is all the information have been removed once it has been compressed and it hard to recover information that was original.

III. VARIOUS COMPRESSION ALGORITHMS FOR IMAGE

A. DCT

A DCT was first invented by 1974 for an important achievement for the research people working on image compression. A DCT (Discrete Cosine Transform) are used to change the pixels in the original image into frequency domain coefficients. The DCT is widely used in image compression algorithms. It can be regarded as a discrete-time version of the Fourier cosine series. It is similar to DFT. DFT is a technique for converting a single into elementary frequency components. Thus DCT can be computed with a Fast Fourier Transform (FFT) like algorithm in O (n log n) operations. We have chosen for the ability to decorrelate image pixels within the spatial domain, as well as being an orthogonal transform. A DCT is similar to DFT, but can provide a better approximation with fewer coefficients. The coefficients of DCT are real valued of complex valued in DFT.The DCT functions are each 8x8 block can be looked at as a weighted sum of these basis functions. The process of 2D DCT is also the process of finding those weights.

In 1942 JPEG had introduced the first international standard for still image Compression with DCT-based.

The DCT-based encoder is essentially compression of a stream of 8 x8 blocks of image samples. Each 8 x 8 block makes its way through each processing step, and yields output in compressed form into the data stream. Because adjacent image pixels are highly correlated the forward DCT (FDCT) processing step lays the foundation for achieving data

compression by Concentrating most of the signal in the lower spatial frequencies have zero or near –zero amplitude and need not be encoded.

B. Vector Quantization

The main idea is to develop a dictionary of fixed-size vectors, called code vectors. Normally vector is a block of pixel values. An image vector means given image is then partitioned into non-overlapping blocks (vectors). Each in the dictionary is determined and its index in the dictionary is used as the encoding of the original image vector. Thus, each image is represented by a sequence of indices that can be further entropy coded.

C. Fractal coding

The main idea is to decompose the image into segments by using standard image processing techniques such as color separation, edge detection, and spectrum and texture analysis. Then each segment is looked up in a library of fractals. The library really contains codes called iterated function system (IFS) codes, which are compact sets of numbers. A set of codes for a given image are determined, such that when the IFS codes are applied to a suitable set of image blocks yield an image that is a very close approximation of the original. This scheme is highly effective for compressing images that have good regularity and self-similarity.

D. Block truncation coding

In this coding, the image is divided into non-overlapping blocks of pixels. The threshold and reconstruction values are determined in each block. In the block the threshold is usually the mean of the pixel values. Then a bitmap of the block is derived by replacing all pixels whose values are greater than or equal (less than) to the threshold by a 1 (0). Then for each segment (group of 1s and 0s) in the bitmap, the reconstruction value is determined. In the original block the average of the values of the corresponding pixels.

E. Subband Coding

Sub band coding is the image is analyzed to produce the components containing frequencies in well-defined bands, the sub bands. Subsequently, quantization and coding is applied to each of the bands. The quantization and coding well suited for each of the sub bands can be designed separately is a main advantage of this coding.

F. Run length encoding

Run-length encoding is simplest method of compression used for sequential. It is very useful in repetitive data. This technique replaces sequences of identical pixels, called runs by shorter symbols. A data made of any combination of symbols can be compressed by using this encoding. The data contain only 0 and 1.so it is very effective and need not to know the frequency of occurrence of symbols. To replace consecutive repeating occurrences of a symbol by one occurrence of the symbol followed by the number of occurrences is a basic idea for Run-length encoding. When compared to other method this method is even more efficient because the data use only two symbols (0 and 1).

G. Lempel Ziv (LZ) encoding

Ziv and Lempel can be developed in 1977 and 1978. Terry Welch improved the scheme in 1984 (called LZW compression).Lempel Ziv (LZ) encoding is an example of *dictionary-based* encoding. LZW (Lempel-Ziv–Welch) is a dictionary based coding. Dictionary based coding can be static or dynamic. In static dictionary coding,during the encoding dictionary is fixed and decoding processes. In dynamic dictionary coding, the dictionary is updated on fly. LZW is broadly used in computer industry and is implemented as compress command on UNIX.The main idea is to create a table (a dictionary) of strings used for transmission session. If both the sender and the receiver have a copy of the table, then previously occurred strings can be replaced by their index in the table to minimize the amount of information transmitted.

H. Huffman Coding

Huffman coding is a popular technique for removing coding redundancy. It produces the smallest possible number of code symbols per source symbol. A coding symbol based on their statistical occurrence frequencies. The image of the pixel are treated as symbols, In this Huffman coding the symbols that occur more frequently are assigned a smaller number of bits. Huffman coding is a prefix code[binary code].

Huffman coding was introduced by David Huffman. A most used method for data compression is Huffman coding. It is a basic for several popular programs. Huffman coding is similar to Shannon-Fano method. Huffman construct code tree from bottom up to top down (build the codes from right to left).

Huffman code procedure is based on the two observations.
a. More frequently occurred symbols will have shorter code words than symbol that occur less frequently.

b. The two symbols that occur least frequently will have the same length.

METHODS	ADVANTAGES	DISADVANTAGES
Discrete Cosine Transform	Real-valued Better energy compaction Coefficients are nearly uncorrelated	Undesirable blocking artifacts affect the reconstructed images or video frames. Impossible to completely decorrelate the blocks at their boundaries
Vector Quantization	Blindingly fast decompression Good quality at ~~excellent~~ compression ratios No coefficient Quantization	Slow codebook generation No Standard Slow decompression
Fractal coding	Good Mathematical Encoding-frame	Slow Encoding
Block Truncation coding	Simplicity Fault Tolerance High compression Efficiency	Relatively high bit rate Ragged Edges
Subband Coding	Operate on the whole image as one single block Avoiding blocking artifacts	Less Accurate
Run length encoding	Easy to implement Does not require much CPU power	High storage Requirements Only for Color image
Lempel Ziv (LZ) encoding	Simplicity Speed Very Efficient	Too many bits Everyone needs a dictionary Only works for English text.
Huffman Coding	Very Efficient Entropy	Length of the code could be very large

IV. CONCLUSIONS

This paper has surveyed most important advances in different steps of fractal image compression. In this paper we review and discuss about the Key issues of image compression, need of compression, its principles, and methods of compression and various compression algorithm of image. We review and discuss the advantages and disadvantages of these algorithms for compressing images for lossless and lossy Techniques.

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