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SURVEY ON IMAGE COMPRESSION TECHQNUIRES

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ABSTRACT

Data from multimedia systems, such as pictures, music, and training videos, require a large amount of storage and transmission bandwidth. Digital image compression is a method for reducing picture data rates in order to conserve storage space and decrease transmission rate needs. It is a solution for a variety of imaging applications that require a lot of data to represent digital images. In general, it may be described as a technique that entails finding ways to reduce the size of picture documents while retaining critical information.

Keywords: Image Compression; VQ; DCT;JPEG;

INTRODUCTION

Image compression is the process of compressing digital pictures using data compression techniques. In fact, the goal is to minimize picture data redundancy in order to store or transmit data in a more effective manner.

Uncompressed multimedia data (graphics, music, and video) requires a large amount of storage and transmission bandwidth. Despite significant advancements in mass storage density, processor speeds, and digital communication system performance, demand for data storage capacity and data transmission bandwidth continues to outpace existing technology. The recent development of data-intensive multimedia-based online services has not only maintained the need for more effective methods to encode signals and pictures, but it has also made signal compression a key component of storage and communication technology.

Image compression is thought as an application of a proper copy function to a graphic signal to be able to limit strong range or program of bandwidth restricting or bit-rate decrease to a graphic signal to be able to take it within the limits of a lesser capacity channel. In general conditions, it could be defined as a method that involves solutions to decrease the size of the image documents while keeping necessary important information[1].

DEPENDENCE ON COMPRESSION

Image compression addresses the condition of reducing the quantity of data necessary to present an electronic image with appropriate image quality. The actual basis of the decrease process is removing redundant data. Image compression is a method that has fascinated several researchers seeing back again to more than 40 years. The original give attention to research work in this field was in the development of analog options for reducing video transmitting bandwidth, an activity called bandwidth compression.

The introduction of the digital computer and following the development of advanced designed circuits, however, induced interest to alter from analog to digital compression solutions. Presently, image compression is regarded as an "enabling technology" and is recognized as a natural way of controlling the increased spatial resolutions of today's imaging receptors and innovating broadcast TV expectations. Furthermore, image compression takes on a significant role in many important and diverse applications. In a nutshell, an ever-expanding quantity of applications relies upon the useful manipulation, safe-keeping, and transmitting of binary, grayscale, and color images.

TABLE 1: evidently illustrates the necessity for sufficient space for storage, large transmitting bandwidth, and long transmitting time for image, music, and video tutorial data.

Multimedia data	Size/Duration	Bits/Pixels	Uncompressed size (B is bytes)	Transmission Bandwidth (b is bits)	Transmission time (for 28.8K Modem)
A Page of text	11"x8.5"	Varying resolution	4-8 KB	32-64 Kb/page	1.1-2.2 sec
Telephone quality speech	10 sec	8 bps	80 KB	64 Kb/page	22.2 sec
Gray scale image	512 x 512	8 bps	262 KB	2.1 Mb/image	1 min 13 sec
Color mage	512 x 512	24 bps	786 KB	6.29 Mb/image	3 min 39 sec
Medical image	2048 x 1680	12 bps	5.16 MB	41.3 Mb/image	23 min 54 sec

WHAT ARE THE PRINCIPLES BEHIND COMPRESSION?

The fact that adjacent pixels are linked and therefore contain duplicate information is a typical feature of most pictures. The first step is to discover a representation of the picture that is less correlated. Redundancy and irrelevancy reduction are two key components of compression. The goal of redundancy reduction is to get rid of duplicates in the signal source (image/video). Irrelevancy reduction removes portions of the signal that the receiver will not notice, such as the Human Visual System (HVS). In general, there are three kinds of redundancy:

WHAT ARE THE DIFFERENT CLASSES OF COMPRESSION TECHNIQUES?

a) Lossless vs. Lossy compression

In lossless compression methods, the reconstructed picture is quantitatively equal to the original image after compression. Lossless compression, on the other hand, can only accomplish a little degree of compression. An picture that has been rebuilt after lossy compression has degraded in comparison to the original. This is often due to the compression method entirely discarding unnecessary data. Lossy methods, on the other hand, may achieve considerably greater compression. There is no discernible loss under typical viewing circumstances (visually lossless).

b) Transform vs. Predictive Coding

In predictive coding, previously transmitted or accessible data is utilized to forecast future values, with the difference being coded. It is very easy to execute and adjust to local picture features since it is done in the image or spatial domain.

Predictive coding is shown by Differential Pulse Code Modulation (DPCM). Transform coding; on the other hand, converts the picture from its spatial domain representation to another kind of representation using a well-known transform before coding the changed values (coefficients). When compared to predictive techniques, this method compresses data more efficiently, but at the cost of more processing.

COMPRESSION MODEL

A model of an average compression system is defined using the block diagram shown in figure 1.1. A graphic compression system mainly includes four major steps, particularly, color space change, removal or decrease in redundancy, a decrease in entropy and entropy encoding. Inside the above

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block diagram, color space change is the procedure of changing the RGB color to YUV model to split up power from color. The second step uses change techniques, like Discrete Cosine Transformation (DCT) or Discrete Wavelet Transform (DWT), to recognize the redundant data, where quantization can be used for minimizing the changed data. Quantization process leads to decrease in entropy of data, attained by dropping non-significant information in the changed data while keeping significant icons of the image. The 3rd step's the reason for the lossiness in image data after decompression. The past step is encoding the effect to reduce the storage requirements.

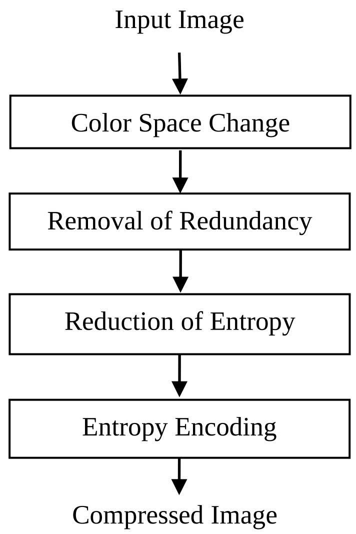

Figure 1.1: Image Compression Model

VARIOUS COMPRESSION ALGORITHMS

a) A. JPEG : DCT-Based Image Coding Standard

JPEG stands for "Joint Photographic Experts Group" and is a DCT-based image coding standard. JPEG/DCT still picture compression has lately become a standard. JPEG is a format for compressing pictures of genuine, real-world situations in full color or grayscale. An picture is first partitioned into no overlapping 8x8 pieces to use this technique. Each block is subjected to a discrete Cosine transform (DCT) [10, 14], which converts the grey levels of pixels in the spatial domain into frequency domain coefficients. The coefficients are adjusted using various scales based on a quantization table supplied by the JPEG standard and some psycho visual data. The quantized coefficients are reordered in a zigzag scan order before being compressed further using a lossless coding technique such run length coding, arithmetic coding, or Huffman coding. The decoding process is just the inverse of the encoding procedure. As a result, both encoding and decoding take approximately the same amount of time using JPEG compression. For real-world picture testing, an independent JPEG group has supplied encoding/decoding methods. Only during the coefficient quantization procedure does information become lost. For all pictures that may not be suitable, the JPEG standard provides a standard 88% quantization table. Instead of utilizing the conventional quantization table, an adaptive quantization table may be used to improve the decoding quality of different pictures with the same compression when employing the DCT method.

b) Image Compression by Wavelet Transform

What is a Wavelet Transform?

Wavelets are functions with a zero average value that are defined over a limited interval. The wavelet transform is based on the concept of representing any arbitrary function (t) as a superposition of a collection of wavelets or basis functions. These basis functions, also known as baby wavelets, are created by dilations or contractions (scaling) and translations of a single prototype wavelet known as the mother wavelet (shifts). An N x N matrix is used to represent the Discrete Wavelet Transform of a finite length signal x(n) with N components, for example. See [3] for a straightforward and good introduction to wavelets.

Why Wavelet-based Compression?

Despite the many benefits of JPEG compression methods based on DCT, such as their simplicity, acceptable performance, and availability of special purpose hardware for implementation, these schemes are not without flaws. Due to the fact that the input picture must be blocked, correlation across block borders is not removed. This results in visible and obnoxious "blocking artifacts", which are especially evident at low bit rates, as shown in Fig.1. By using smoothly overlapping blocks, Lapped Orthogonal Transforms (LOT) [5] try to address this issue.

While blocking effects are minimized in LOT compressed pictures, the additional computational cost of these techniques does not justify their widespread use in lieu of DCT.

The wavelet transform has acquired broad acceptance in signal processing research in general, and in picture compression research in particular, during the last few years. In many situations, wavelet-based schemes (also known as sub band coding) outperform other types of coding schemes, such as DCT-based systems.

Due to the lack of a requirement to block the input picture and the variable length of its basis functions, wavelet coding methods with greater compression avoid blocking artifacts. Wavelet-based coding [2] is more resilient to transmission and decoding faults and also allows for progressive picture transmission.

Additionally, they are more closely related to the HVS features.

Wavelet coding methods are particularly well-suited for applications requiring scalability and acceptable deterioration because to their inherent multi-resolution nature [6].

c) VQ Compression

Two operations comprise a vector quantize. The encoder is the first component, while the decoder is the second. The encoder accepts a vector as input and produces the index of the codeword with the least distortion. In this instance, the least distortion is determined by comparing the input vector to each codeword in the codebook using the Euclidean distance. Once the nearest codeword is located, its index is sent through a channel (the channel may be a computer storage device, a communications channel, or something similar). When the encoder gets the codeword's index, it replaces it with the codeword's related codeword.

VQ concept for image compression is to create a codebook of code vectors such that each code vector may represent a set of picture blocks of size m X m (m=4 is usually used). A single picture or a collection of images is first partitioned into m X m non-overlapping blocks represented by m2-tuple vectors dubbed training vectors. Training vectors may be very vast in size. A 512X512 picture, for example, provides 16,384 training vectors.

The purpose of codebook design is to create a small number of representative vectors, referred known as code vectors of size 256 or 512, from a collection of training vectors. The encoding process begins by searching the codebook for the nearest code vector for each non-overlapping 4X4 block of an image to be encoded. The most critical task is to create a flexible codebook. Nasrabadi and King [11] provide an unbiased assessment of VQ. Chen's study [16] shows that despite the method's lengthy off-line training, a codebook produced using the LBG [12] approach usually has better PSNR values than certain other systems. In this work, we use the LBG method to train a 256X256-byte codebook to achieve a 0.5 bpp compression ratio.

CLASSIFICATION OF COMPRESSION TECHNIQUES

Several researchers have done extensive picture compressing research. This section provides a short overview of a few key contributions from the current literature. The wavelet transform's power has recently been studied and improved in the picture compression community. When methods to

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decompose discrete temporal signals were developed in 1976, the foundations of Discrete Wavelet Transform (DWT) were laid. Similar work was done in the field of sub band coding, which is a kind of signal coding. Pyramidal coding, which is comparable to sub band coding, was invented in 1983. Many refinements to these coding methods were developed afterwards, resulting in effective multi-resolution analysis systems. Various image coding algorithms have been created based on DCT and DWT. This section discusses a few of them that are relevant to this study[3].

d) Fractal Compression

The late 1980s and early 1990s saw the introduction of fractal image coding [20]. It is used in Encarta/Encyclopedia to encode/decode images [15]. Fractal coding is based on the Collage and fixed point theorems for a locally iterated function system composed of a collection of contraction affine transformations [15, 19]. A fractal compression method divides an image into non-overlapping 88 blocks called range blocks and then creates a domain pool containing all possible overlapped 1616 chunks called domain blocks that are related with eight isometrics from reflections and rotations. It searches exhaustively in a domain pool for the best-matched domain block with the smallest square error for each range block after applying a contractive affine transform on the domain=block.

A fractal compressed code for a range block is composed of quantized contractively coefficients in the affine transform, an offset determined by the mean of the range block's pixel grey levels, the location of the best-matched domain block, and its isometric type. Decoding is the process of determining the fixed point, the decoded picture, from any original image. Until all decoded range blocks are received, the method applies a compressed local affine transform to the domain block corresponding to the location of a range block. The process is performed repeatedly until convergence is achieved (which typically takes no more than eight iterations).

Two significant issues that arise in fractal encoding are processing requirements and the availability of optimal range-domain matching [19]. The most desirable feature is that decoding is resolution-independent. One may expand a picture by decoding a smaller encoded image, increasing the compression ratio exponentially [15,18].

A comparison method based on [20] is developed and utilized in this work [17]. It utilizes range and domain block matches of defined sizes.

VARIOUS COMPRESSION ALGORITHMS

TABLE 2 : Experimental Comparison

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

CONCLUSION

We have reviewed and summarized the characteristics of image compression, need of compression, principles behind compression, different classes of compression techniques and various image compression algorithms based on Wavelet, JPEG/ DCT, VQ, and Fractal approaches.

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