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REVIEW ARTICLE

A REVIEW ON IMAGE COMPRESSION TECHNIQUES

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Abstract- The availability of images in many applications are augmented owing to the technological advancement which cannot impacts on several image operation, on availability of sophisticated software tools that influence the image and on image management. Although the technological advances in storage and transmission, the demand placed on the storage capacities and on bandwidth of communication exceeds the availability. Hence, image compression has proved to be a valuable method as one solution. This paper attempts to give a recipe for selecting one of the popular image compression algorithms based on Wavelet, DCT, VQ, and Fractal approaches.

Keywords- Image Compression techniques JPEG, wavelet, DCT

I. INTRODUCTION

Image compression is very significant for efficient transmission and storage of images. Requirement for communication of multimedia data through the telecommunications network and accessing the multimedia data through Internet is increasing explosively. With the apply of digital cameras, requirements for storage, manipulation, and transfer of digital images, has grown explosively.

From last few decays, the rising demand of storage and transmission of digital images, image compression is now become a necessary application for storage and transmission. Demand for communication of multimedia data through the telecommunications network and accessing the multimedia data through Internet is growing explosively. With the use of digital cameras, requirements for storage, manipulation, and transfer of digital images, has grown explosively. There are many image compression techniques existing, but still there is need to develop faster, and more strong and healthy method to compress images. Because, main difficulties in developing compression algorithms for image is the need for preserving the minutiae i.e. ridges endings and bifurcations, which are subsequently used in identifications. There are two different types of redundancy relevant to images spatial redundancy and spectral redundancy [1].

By using data compression techniques, it is possible to remove some quantity of redundant information. The will save some amount of file size and allows more images to be stored in a certain amount of disk or memory space.

II. NEED OF COMPRESSION

In a raw state, images can occupy a large amount of memory both in RAM and in storage. Image compression reduces the storage space required by an Image and the bandwidth needed when streaming that image across a network. It is clearly the need for adequate storage space, large transmission bandwidth and long transmission time for image. At the present state of art in technology, the only answer is to compress image[3].

III. PRINCIPLE OF COMPRESSION

A common characteristic of most of the images is that the neighbouring pixels are correlated and therefore contain redundant information. The foremost task is to find less correlated representation of the image. Two elementary components of compression are redundancy and irrelevancy reduction. Redundancy decrease aims at removing duplication from the signal source (image). Irrelevancy reduction omits parts of the signal that will not be noticed by the signal receiver, namely the Human Visual System (HVS)[2]. In general, three types of redundancy can be identified:

- Spatial Redundancy or correlation between neighboring pixel values.
- Spectral Redundancy or correlation between different color planes or spectral bands.
- Temporal Redundancy or correlation between adjacent frames in a sequence of images (in video applications).

Since, we focus only on still images. Image compression techniques are explored in this paper. For image compression there are three types of redundancies,

- Coding Redundancy
- Interpixel Redundancy
- Psychovisual Redundancy

Coding redundancy is present when less than best possible code words are used. Interpixel redundancy results from correlations between the pixels of an image.

IV. DIFFERENT CLASSES OF COMPRESSION TECHNIQUES

Two ways of classifying compression techniques are mentioned here.

1. Lossless vs. Lossy compression

Lossless compression schemes, the reconstructed image, after compression, is numerically equal to the original image. However lossless compression can only accomplish a modest amount of compression. An image reconstructed following lossy compression contains degradation comparative to the original. Often this is because the compression scheme completely discards redundant information. However, lossy schemes are able of achieving much higher compression. Under normal viewing conditions, no visible loss is perceived (visually lossless)[2].

2. Predictive vs. Transform coding

In predictive coding, information already sent or existing is used to predict future values, and the difference is coded. Since this is done in the image or spatial domain, it is relatively simple to apply and is readily modified to local image characteristics. Differential Pulse Code Modulation (DPCM) is one particular example of predictive coding. Transform coding, on the other hand, first transforms the image from its spatial domain demonstration to a different type of representation using some familiar transform and then codes the transformed values (coefficients). This method provides better data compression compared to predictive methods, although at the expense of better computation[3].

V. VARIOUS COMPRESSION ALGORITHMS

1. JPEG : DCT-Based Image Coding Standard

The JPEG/DCT still image compression has become a standard recently. JPEG is designed for compressing full-color or grayscale images of normal, real-world scenes[2]. To exploit this technique, an image is first divided into nonoverlapped 8×8 blocks. A discrete Cosine transform is applied to each block to interpret the gray levels of pixels in the spatial domain into coefficients in the frequency domain. The coefficients are normalized by different scales according to the quantization table provided by the JPEG standard conducted by some psycho visual facts. The quantized coefficients are rearranged in a zigzag scan order to be more compressed by an well-organized lossless coding approach such as run length coding, arithmetic coding, or Huffman coding. The decoding is simply the inverse procedure of encoding[3,4]. So, the JPEG compression takes about the same time for both encoding and decoding. The encoding/ decoding algorithms provided by an autonomous JPEG group are existing for testing real world images. The information loss occurs only in the method of coefficient quantization. The JPEG standard defines a standard 8×8 quantization table for all images which may not be appropriate. To achieve a better decoding quality of various images with the same compression by using the DCT approach, an adaptive quantization table may be used instead of using the standard quantization table.

2. Image Compression by Wavelet Transform

Wavelets are functions defined over a restricted interval and having an standard value of zero. The basic idea of the wavelet transform is to distinguish any arbitrary function (t) as a superposition of a set of such wavelets or basis functions. These basis functions or baby wavelets are provided by a single prototype wavelet called the mother wavelet, by dilations or contractions (scaling) and translations (shifts). The Discrete Wavelet Transform of a finite length signal x(n) having N components, for example, is expressed by an N x N matrix. For a simple and excellent introduction to wavelets[2].

Despite all the advantages of JPEG compression techniques based on DCT namely straightforwardness, satisfactory performance, and availability of special purpose hardware for implementation; these are not without their shortcomings. Since the input image needs to be ``blocked," correlation across the block boundaries is not eliminated. This results in noticeable and annoying ``blocking artifacts" mostly at low bit rates. Lapped Orthogonal Transforms (LOT) try to solve this problem by using smoothly overlapping blocks. Although blocking effects are compact in LOT compressed images, enlarged computational complexity of such algorithms do not justify wide substitution of DCT by LOT[11].

Over the past several years, the wavelet transform has gained widespread acceptance in signal processing in common and in image compression research in particular. In many applications wavelet-based methods (also referred as sub band coding) outperform other coding methods like the one based on DCT. Since there is no need to block the input image and its basis functions have variable length, wavelet coding schemes at higher compression avoid blocking artifacts. Wavelet-based coding is additional robust under transmission and decoding errors, and also facilitates progressive transmission of images. In addition, they are better matched to the HVS characteristics. Because of their inherent multi-resolution nature, wavelet coding schemes are especially appropriate for applications where scalability and average degradation are necessary[4].

3. VQ Compression

A vector quantizer is composed of two operations. The first is the encoder, and the second is the decoder. The encoder takes an input vector and outputs the index of the codeword that offers the lowest deformation. In this case the lowest distortion is found by evaluating the Euclidean distance between the input vector and each codeword in the codebook. Once the nearest codeword is available, the index of that codeword is sent by a channel (the channel could be computer storage, communications channel, and so on). When the encoder obtain the index of the codeword, it replaces the index with the connected codeword. The fundamental idea of VQ for image compression is to set up a codebook consisting of code vectors such that each code vector can represent a group of image blocks of size m × m, (m=4 is always used). An image or a set of images is first divided into m × m non overlapping blocks which are represented as m2-tuple vectors, called training vectors. The size of training vectors can be very big. For example, a 512 × 512 image contributes 16,384 training vectors. The goal of codebook design is to establish a few representative vectors, called code vectors of size 256 or 512, from a set of training vectors. The encoding method is to look for a nearest code vector in the codebook for each non overlapped 4 × 4 block of an image to be encoded. The most important work is to design a multipurpose codebook. Nasrabadi and King give a good review of VQ[8]. Chen's comparison indicates that a codebook developed based on LBG algorithm generally has higher PSNR values over some other schemes despite its slow off-line training. In this paper, we adopt LBG algorithm for training a codebook of size 256×256 to meet a desired 0.5 bpp compression ratio[8].

4. Fractal Compression

Fractal image coding was introduced in the late 1980s and early 1990s. It is used for encoding/ decoding images in Encarta/Encyclopedia. Fractal coding is based on the Collage theorem and the fixed point theorem for a local iterated function system consisting of a set of contraction affine transformations. A fractal compression algorithm first divides an image into non overlapping 8×8 blocks, called range blocks and forms a domain pool containing all of probably overlapped 16×16 blocks, related with 8 isometries from reflections and rotations, called domain blocks. For each range block, it exhaustively searches, in a domain pool, for a best matched domain block with the minimum square error after a contractive affine transform is applied to the domain=block. A fractal compressed code for a range block consists of quantized contractively coefficients in the affine transform, an offset which is the mean of pixel gray levels in the range block, the location of the best matched domain block and its type of isometry[10]. The decoding is to find the fixed point, the decoded image, by starting with any initial image. The procedure applies a compressed local affine transform on the domain block corresponding to the position of a range block until all of the decoded range blocks are obtained. The procedure is repeated iteratively until it converges (usually in no more than 8 iterations)[7]. Two serious problems that occur in fractal encoding are the computational demands and the existence problem of best range-domain matches. The most attractive property is the resolution-independent decoding property. One can enlarge an image by decoding an encoded image of smaller size so that the compression ratio may increase exponentially. An algorithm based on using range and domain block matches of fixed sizes is written and is used for a comparison in this paper.

VI. CONCLUSION

In this paper we discuss about the importance of image compression and we can achieve image compression by adjusting data redundancy for practical applications, 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, Fractal approach should utilize its resolution-free decoding property for a low bit rate compression.

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