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VARIOUS IMAGE COMPRESSION TECHNIQUES: A REVIEW

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ABSTRACT

Due to increasing demand for multimedia content such as digital images and video has led to interest in research into compression techniques. The development of higher quality and less expensive image acquisition devices has produced steady growth in both image size and resolution, which tends to greater consequent for the design of efficient compression systems. Therefore, one of the important factors for transmission or storage image data through a communication media is image compression. In this paper we discussed different compression techniques based on transform coding, fractal coding and vector quantization etc.

KEYWORDS: Compression Techniques, Redundancy, MSE, Lossless, Lossy, LZW coding, Arithmetic coding.

1. INTRODUCTION

An image is a visual representation of something, uses a huge number of bytes for storage. By minimizing the size of an image we use image compression techniques, without degrading the quality of the image. Compression [1] refers to avoid redundancy of the quantity of information used to represent a file, image or video content without reducing the quality of the original data. Image compression may be the application of data compression. The main aim of image compression is to reduce the redundancy and irrelevancy present in the image, so it can be easy to stored and transferred data efficiently. The compressed image is described by less number of bits compared to original. Hence, the desired storage size are reduced, consequently most pictures will be keep and it will transferred in quicker to save the time, transmission bandwidth.

In image compression, redundancies are classified into three type's viz., coding redundancy, inter-pixel redundancy and psycho visual redundancy. Coding redundancy is present when optimal code words are assigned to a set events (such as gray level values) have not been selected to take full advantage of the probabilities of the events, which results in coding redundancy. Inter pixel redundancy due to the correlations between the pixels of an image. Due to data, omitted by the Human Visual System (HVS) that is visually non-essential information is called psycho visual redundancy. From the compressed data we can obtain reconstructed image. This process is referred to as inverse process or decompression.

Mainly there are two types of image compression techniques: Lossless compression and Lossy compression.

1.1 Lossless compression

In this technique compressed data will be the same replica of actual data i.e., there is no loss present in the data. On the contrary, the images and also the music required not to be generated exactly. A resemblance of the actual image is adequate for the most objective, as far as the error or problems between the actual and compressed image is avoidable or tolerable. This compression includes: Huffman Encoding, Run Length Encoding, Arithmetic Coding, Entropy Encoding and Lempel–Ziv–Welch Coding.

1.2 Lossy compression

In this technique decreases the bits by recognizing the not required information and by eliminating it. The compressed image is exactly not same as the input image, there is few loss of the information is present in the image. But it is acceptable. Dropping non-essential information from the source of data can save the storage space. It includes predictive coding and transforms coding.

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1.3 Benefits of Image Compression

- It not only reduces storage needs but also its overall execution time.
- It provides less cost for sending data through communication network whereas the cost usually based on its duration of sending data.
- It can benefit users by loading data faster and web pages use less space on an online host.
- It does not reduce the physical size of an image but instead compresses the data that makes up the image into a smaller size.

2. MATERIALS AND METHODS

Various performances that are used to compare different image compression techniques. MSE, PSNR and CR are some of them. The MSE define as mean square error which is the cumulative squared error between the compressed and the original image. The peak signal to noise ratio (PSNR) is a measure of the peak error between the compressed and the original image [2]. To measure the ability of image compression by comparing the size of the image being compressed to the size of the original image called as compression ratio (CR). They are:

$$\text{Mean Square Error, MSE} = \frac{1}{MN}\sum_{y=1}^{M}\sum_{x=1}^{N}[I(x,y) - I'(x,y)]^2 \quad \text{(i)}$$

Where I(x, y) is the original image, I'(x, y) be the decompressed image and M, N be the dimensions of the images.

$$\text{Peak Signal to Noise Ratio, PSNR} = 10*\log_{10}(255^2/MSE) \quad \text{(ii)}$$

For a good compression contains less MSE i.e., lower value for MSE means lesser error and high PSNR value.

$$\text{Compression Ratio, CR} = \frac{Orginal\ image\ size}{compressed\ image\ size} \quad \text{(iii)}$$

There are different types of compression methods in terms of lossy and lossless compression standards are:-

2.1 Run Length Encoding

One of the simplest image compression techniques is Run length coding in which sequence of identical symbols (run) are replaced with a pair containing the symbol and the number of repetitions of that symbol [3]. This technique is used in the primary compression technique in the 1-D CCITT Group 3 fax standard in BMP file format. The first step of this method is to read the files and then it scans for finding the repeating character strings. This algorithm is effective in the case of long run of characters but it is not much effective when data files have less repetition of characters.

2.2 Huffman Encoding

Huffman coding is one of the entropy encoding algorithms used for lossless data compression. It uses a specific method for assigning variable length codes to input characters [4]. The length of code is depending on the estimated probability of occurrences of characters. The most common characters using shorter strings of bits and least frequently character assigns larger strings. Then the codes are stored in a codebook which was constructed for each image and set of images. To enable decoding, codebook plus encoded data must be transmitted.

2.3 Predictive Coding

Predictive Coding Technique represents another example of exploration of interpixel redundancy in which only the new information in each pixel to be encoded. This new information is generally defined as the difference between the actual and the predicted value of the pixel. The predictors output is rounded to the nearest integer and calculate the prediction error i.e., the difference between the actual value and predicted value. The prediction error can be encoded by using variable length code (VLC).

2.4 Transform Coding

This algorithm begins with the partitioning of the original image into sub images of small size (usually 8x8)[5]. Then the transform coefficients are calculated on each block and converting the original array pixel into an array coefficients. The resulting coefficients are then quantized and the output of the quantizer produces the bit stream

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representing the encoded image by using a symbol encoding technique. The reverse process takes place at the decoder side.

2.5 Vector Quantization

Vector quantization (VQ) techniques are the extension of scalar quantization principles to multiple dimensions. These techniques contain code vector and image vectors. Code vector is a dictionary of fixed size vector and image vectors are non- overlapping blocks of given image. First this algorithm determines the nearest matching vector in the index of dictionary for each image vector. Then this index is used for encoding the original image vector. It is particularly attractive to multimedia applications.

2.6 Lempel-Ziv Welch Coding

Lempel-Ziv Welch Coding is the one of the dictionary technique [4]. It maps a variable number of symbols into a fixed code and places longer repeated entries in a dictionary. In the case of a dictionary method a symbol or a string of an alphabet is represented with an index to the dictionary created from source alphabet. If a new symbol is occurred, then it is coded with the index contained in the dictionary. Otherwise coding cannot be efficient. Initially the dictionary contains single character string for all the possible characters and this algorithm is performed by scanning through the input strings, until it found that there is no string present in the dictionary. If a string is not contained in the dictionary then send the string without the last character and stored as a new symbol in the dictionary. The avoided last string character is used for scanning of further substrings. These way subsequent longer strings are stored in the dictionary, and then made further processing of these strings as single output. Better compression performance is achieved in case of data containing repeated strings. Higher compression ratio is achieved for longer sequences.

Table2.1 Comparison between some compression techniques

Methods	Merits	Demerits
Vector Quantization	Simple decoder No Coefficient quantization	Codebook generation is slow
Fractal	Good mathematical encoding frame	Slow encoding
Genetic algorithm	Capable of handling Complexity and irregular solution space	Repeated fitness function evaluation for complex problem
DCT	High quality and small degree of compression	Bit allocation Coefficient quantization
Wavelets	High compression ratio It produces no blocking artifacts	Less coefficient, bit allocation and coefficient quantization
Huffman coding	Easy to implement, Produces optimal and compact code	Relatively slow, decoding is difficult
LZW	Dictionary based technique and to implement easily	Management of string table is difficult
Arithmetic coding	Represents frequently occurring sequences of pixels values with fewer bits.	It is a paid algorithm
Run length coding	Simple to implement and high execution speed	Compression ratio is low as compared to other algorithms

3 LITERATURE REVIEW

Image compression plays a crucial role in many important applications, including tele-videoconferencing, remote sensing, document & medical imaging and facsimile transmission. The goal of image compression is to reduce the space required for storing images, while preserving the visual quality of the reconstructed image close to the original image. In this section, we are going to present reviews about this field.

In this paper [6] vector quantization based image compression technique proposed by Jau-Ji Shen. Vector quantization (VQ) can adjust the encoding of the difference map between the original and restored compressed version images. Its experimental result shows to improve the quality of VQ compressed images during the

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transmission process of encoding and further be depending on the difference map from lossy to lossless compression.

In this paper [7] a novel method i.e., called as five module method (FMM) for image compression. In this paper presents converting each pixel value in 8x8 blocks which is the multiple of 5 for each of RGB array. For reducing storage space, after getting the value could be divided by 5 to get new values which are bit length for each pixel contain 8 bits. The advantage of this method is to provide high PSNR (peak signal to noise ratio) although it is low CR (compression ratio). This method is used for bi-level like black and white medical images where the pixel in such images is presented by one byte (8 bit). As a suggestion, a variable modulus method (X) MM, where X can be any number, may be constructed in later research.

In this paper [8] presents a researcher about new image compression method called as discrete wavelet transformation(DWT).The redundancy of data can be reduced and provide easy for transmission and store the data in an efficient form. First decompose the images into sub bands, and then the resulting coefficients are compared with a threshold. Coefficients below the threshold are set to zero and above the threshold value as encoded with less compression technique. It is noted as wavelet are better suited to time-limited data and wavelet based compression technique maintains better image quality by reducing errors.

In this paper [9] presents bi-level image compression techniques using neural networks by S.Sahami. This is a lossy image compression technique. Lossy compression implies leads to loss some information i.e., compressed image is same as that the original uncompressed image but not just like the previous as in the process of compression. In the bi-level compression method the locations of pixels of image are applied to the inputs of a multilayer perceptron neural-network. The output of the neural network denotes the pixel intensity 0 or 1. The final weights of the trained network are quantized represented as a few bits, Huffman encoded and then stored as the compressed image. In the reconstruction phase, by applying the pixels locations to the trained network, the output determines the intensity. High compression ratios as well as high PSNRs have obtained using the proposed method. The results of experiments on more than 4000 different images indicate higher compression rate of the proposed structure compared with the commonly used methods like (CCITT)G4 Comite Consultatif International de Telegraphique et Telephonique and joint bi-level image expert group (JBIG2) standards. The proposed structure of neural-network has the capability to compress binary image. In the future they will use activity, pattern based criteria and some complexity measures to obtain high compression rate.

In this paper [10] presents image compression technique based on utilizing reference points coding with threshold values by Yi-Fei Tan. This paper explains an image compression method which is used to perform both lossy and lossless compression. To define threshold values in the compression process can achieve different compression ratios by varying the threshold values. During the compression process this method determines the quality of decompressed image. If the threshold value of a parameter in the proposed method is set to 0, then lossless compression is performed and lossy compression can be achieved by when the threshold value of a parameter assumes positive values. To calculate the optimal threshold value T that should be used for performing further study.

In this paper [11] presents a novel technique for encryption and compression of an image using stream cipher and SPIHT by C Rengarajaswamy. Stream cipher used for encryption and SPIHT for image compression. This method is experimented with an image was first encrypted by using stream cipher. Then undergoes compression. In this paper the key generated by stream cipher converting the original image into small number of bit streams and also generate a secret key pseudo randomly, these are XOR-ed. In this paper stream cipher encryption is carried out to provide better encryption and SPIHT compression provides better compression as in the case larger size images can be chosen. Also decompressed with the minimal or loss in the original image. Thus high confidential encryption and the best compression rate have been energized to provide better security.

In this paper [12] presents a technique for image compression using different embedded Wavelet based image coding with Huffman-encoder by S. Srikanth. They implemented the algorithms like SPIHT and EZW with Huffman encoding using different wavelet families. After that they compare the PSNRs and bit rates of these families. Different images are used for testing these algorithms, and it is seen that the result will be good quality and it provides high compression ratio as compared to the existing lossless image compression techniques.

In this paper [13] presents the principles of Pixel Size Reduction (PSR) image compression loss-less image compression algorithm by Pralhadrao V Shantagiri. This paper proposes a new spatial domain of lossless image compression algorithm for synthetic color image of 24 bits. This algorithm has been experimented on thousands of images and performing better when high occurring unique pixels are more. They also show the compression and decompression of their proposed algorithm. This paper uses the other tree based lossless image compression algorithm for future works.

In this paper [14] B. Gupta describes the Image Compression Technique under JPEG by Wavelets Transformation. Image compression is to minimize the size in bytes of a file without degrading the quality of the image and reduction in file size allows more images to be stored. JPEG and JPEG 2000 are two important image compression techniques. Mainly DCT is used for JPEG image compression standards. Here we use wavelets transform instead of DCT, which is widely used and robust method for image compression. It provides excellent energy compaction for highly correlated data.

In this paper [15] presents "An improvement or modification to the block based EZW" by Ch. Naveen. This modifications based on EZW suggested further improve the compression ratio. This method forces the maximum value in each block to the least maximum value of all the blocks in the image. At the encoder section first all the blocks are scaled down to the same maximum value and then it is encoded using EZW technique. Then reconstruct the original image the scaled down values of all the blocks are scaled up to the original maximum values at the receiver. Therefore the number of passes applied on each block will be equal to the lowest number of passes taken by one of the blocks in image. This downside approach will minimize the number of bits used for encoding the image which successively increase the compression ratio.

In this paper [16] A. Nashat presents "Image compression based upon wavelet transform and a stastical threshold". Here in this paper we use haar wavelets on the basis of transformation functions. This transformation consists of a sequence of low pass and high pass filters called as filter bank. The main advantage of the proposed algorithm is that the threshold level is calculated is based upon the mean and the standard deviation of the DWT coefficients. This algorithm provides sufficient high compression ratio without the degradation of image quality.

In this paper [17] Narmatha C presents "a novel lossless compression scheme for grayscale images using pixel based techniques". This paper describes compression scheme of pixel based technique has classified into two different types of processes one is compression and other is decompression. The main aim of this scheme is to improve the algorithm complexity, therefore it leads less chance is to reconstruct the original data by third parties or intruders. The main advantage of this algorithm has achieved the high complexity, less execution time for compression and good reconstructed quality of the image, no error rate and high compression ratio. The same algorithm with some modifications will apply in telemedicine for fast and efficient transmission for future.

In this paper [18] presents a new coding technique for loss-less imaging data compression by Atiqur Rahman. This method presents the probability of image data has been assigned by binary sequence with less number of bits which provides a better result than other art techniques in terms of compression ratio and average code length. There are many coding techniques used to compress data such as Huffman coding. Here this method uses a binary sequence instead of Huffman binary tree for coding the image data. Binary sequence means a number of binary combinations for 1 bit, 2 bits, 3 bits, 4 bits and so on. To encode an image data depends on the number of different probabilities combinations of the image. This proposed algorithm use linear for encoding which so provides better compression ratio and use less execution time than Huffman coding for the same images.

4 CONCLUSION

In this paper represent the concept of various image compression techniques. There are mainly two types of image compression: Lossy and Lossless techniques. A lossy compression method provides more compression ratio than lossless techniques. All the image compression is useful in their own related fields and some of those techniques are obtained good for certain applications like security technologies. Nowadays new compression techniques are developing by researcher's which gives better compression ratio.

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