Volume 4, Issue 7, July 2014 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

A Review of Various Image Compression Techniques

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Abstract— Images are an important form of data and are used in almost every application. Some applications cannot use images directly due to the large amount of memory space needed to store these images. There are various techniques that can be used to compress these images. These compression techniques can be lossy or lossless. Different applications use different types of compression techniques. This paper is an analysis of various compression techniques can be applied to different types of images. By analyzing the advantages and disadvantages of different techniques, we can choose the correct technique that can be used for image compression.

Keywords— Image Compression, Quantization, Optimization, Entropy, Compression Ratio, Image Quality

I. INTRODUCTION

By image compression we mean to reduce the storage space required to store the digital images. Digital images are used in various applications and sometimes they needed to be compressed for use. Image compression techniques are used according to the requirement of application. The objective of compression is to reduce the number of bits as much as possible, while keeping the visual quality of the reconstructed image as close to the original image as possible. Image compression systems are composed of two distinct structural blocks: an encoder and a decoder.

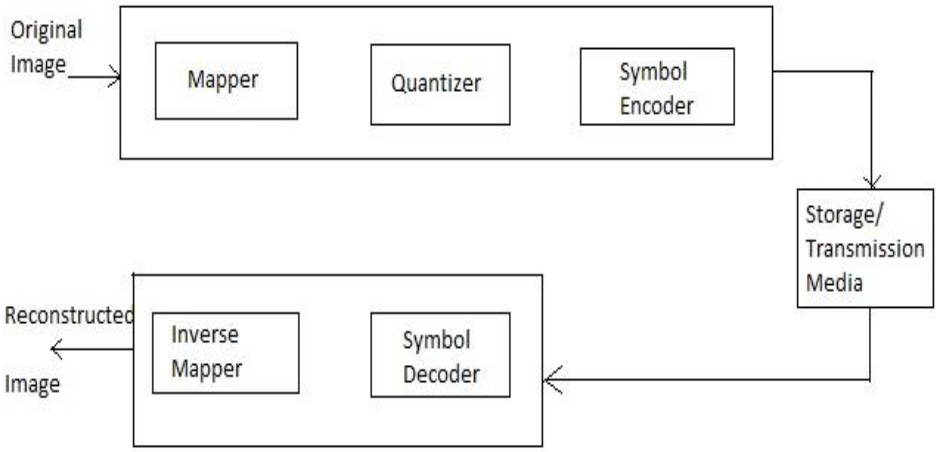

Fig. 1 Image Compression System

II. TYPES OF IMAGE COMPRESSION TECHNIQUES

There are mainly two types of image compression techniques discussed below:

A. Lossy Image Compression

In this type of image compression there is a loss of information. If the compressed image is decompressed then it will not be identical to original image but close to it. Various lossy compression techniques are listed below:

1) Transformation coding
2) Vector quantization
3) Fractal coding
4) Block Truncation Coding

i) Transformation coding: In this coding scheme, transforms such as DFT (Discrete Fourier Transform) and DCT (Discrete Cosine Transform) are used to change the pixels in the original image into frequency domain coefficients (called transform coefficients).[2]

ii) Vector Quantization: The basic idea in this technique is to develop a dictionary of fixed-size vectors, called code vectors. A vector is usually a block of pixel values. A given image is then partitioned into non-overlapping blocks (vectors) called image vectors. Then for 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.[2]

iii) Fractal Coding: The essential idea here 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 actually contains codes called iterated function system (IFS) codes, which are compact sets of numbers.[2]

iv) Block Truncation Coding: In this scheme, the image is divided into non overlapping blocks of pixels. For each block, threshold and reconstruction values are determined. The threshold is usually the mean of the pixel values in the block. 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.[2]

B. Lossless Image Compression

In this type of image compression there is no loss of information. If the compressed image is decompressed then it will be identical to the original image. There are various lossless image compression techniques listed below:

1) Run length encoding
2) Huffman encoding
3) Area coding
4) Data folding

III. QUANTIZATION TECHNIQUES

Quantization refers to the process of converting the continuous pixel values (such as decimal values) to discrete values (such as integers). The quantizer performs a lossy image compression. The input to a quantizer is the original data, and the output is always one among a finite number of levels. The quantizer is a function whose set of output values are discrete, and usually finite. This is a process of approximation, and a good quantizer is one which represents the original signal with minimum loss or distortion. There are two types of quantization -Scalar Quantization and Vector Quantization.[7]

A. Scalar Quantization

In scalar quantization, each input symbol is treated separately in producing the output. If the input range is divided into levels of equal spacing, then the quantizer is termed as a Uniform Quantizer, and if not, it is termed as a Non-Uniform Quantizer.[7]

B. Vector Quantization

In vector quantization the input symbols are clubbed together in groups called vectors, and processed to give the output. This clubbing of data and treating them as a single unit increases the optimality of the vector quantizer, but at the cost of increased computational complexity.[7]

IV. ENTROPY CODING TECHNIQUES

After the quantization has been applied to the image, a symbol encoding technique is applied to the image. Entropy is the amount of information present in the data, and an entropy coder encodes the given set of symbols with the minimum number of bits required to represent them.[7] Entropy Coding techniques mostly provide lossless compression.

A. Arithmetic Coding

The main idea behind Arithmetic coding is to assign each symbol an interval. Starting with the interval [0...1), each interval is divided in several subinterval, which its sizes are proportional to the current probability of the corresponding symbols. The subinterval from the coded symbol is then taken as the interval for the next symbol. The output is the interval of the last symbol . [4]

B. Huffman Coding

This is also a lossless image compression technique. Huffman coding is based on frequency of occurrence of a data item.[4] This technique maintains a table according to frequency of occurrence of data symbols. Then a variable-length bit code is assigned to each data symbol.

C. Run Length Coding

It is a simple entropy coding technique. The sequence of same consecutive pixel values are replaced by a token whose first part consists of the pixel value and the second part consists of the number of consecutive same values. For example 112222233345667 can be replaced as (1,2)(2,5)(3,3)45(6,2)7

D. Data Folding

Data folding is an iterative procedure, column folding followed by row folding, that is repeated at every image level. Original image (i.e. input image) must be square.[1]

V. OPTIMIZATION TECHNIQUES

The optimization techniques can effectively reduce the encoding time while retaining the quality of the retrieved. Various optimization techniques are explained below:

A. Genetic Algorithm

Genetic algorithms (GA's) are mathematically motivated search techniques that try to emulate biological evolutionary processes to solve optimization problems. Instead of searching one point at a time, GA's use multiple search points. GA's attempt to find near-optimal solutions without going through an exhaustive search mechanism.[5]

B. Ant Colony Optimization(ACO)

Ant Colony Optimization (ACO) is a paradigm for designing meta-heuristic algorithms for combinatorial optimization problems. The essential trait of ACO algorithms is the combination of a priori information about the structure of a promising solution with a posteriori information about the structure of previously obtained good solutions.[5]

C. Particle Swarm Optimization(PSO)

PSO is a general-purpose optimization algorithm which also uses the concept of fitness. It provides a mechanism such that individuals in the swarm communicate and exchange information, which is similar to the social behavior of insects and human beings. Because of the mimicking of the social sharing of information, PSO directs particles to search the solution more efficiently. Since the paradigm of PSO requires only primitive mathematical operations, this computationally inexpensive algorithm can be implemented in a few lines of computer code.[5]

VI. CONCLUSION

As studied in different papers related to lossy and lossless compression techniques, different compression techniques are used for better compression ratio for different types of data inputs. There are different types of entropy coding techniques that can be used for image compression. According to the studied papers, the arithmetic coding provides better CR than Huffman coding. But the time taken by arithmetic coding is more than Huffman coding. So for more improvement in the arithmetic coding we can apply the concept of hybridization of arithmetic coding and data folding.

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