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# A Survey of Lossless and Lossy Image Compression Techniques

**Manjinder Kaur ***
*Student Masters of Technology*
*Department of CSE*
*Sri Guru Granth Sahib World University*
*Fatehgarh Sahib, Punjab , India*

**Gaganpreet Kaur**
*Assistant Professor*
*Department of CSE*
*Sri Guru Granth Sahib World University*
*Fatehgarh Sahib, Punjab, India*

***Abstract: Image compression is a method through which we can reduce the storage space of images, videos which will helpful to increase storage and transmission process's performance. In image compression,we do not only concentrate on reducing size but also concentrate on doing it without losing quality and information of image.Image compression may be lossy and lossless.In lossless compression the exact original data to be reconstructed from the compressed data. Lossless is in contrast to lossy data compression, which only allows constructing an approximation of the original data, in exchange for better compression rates.We are going to analyze lossy and lossless image compression techniques.***

***Keywords:Image compression,Compression techniques, Lossless image compression techniques, Lossy image compression techniques.***

## I. INTRODUCTION

An image is essentially a 2-D signal processed by the human visual system. The signals representing images are usually in analog form. However, for processing,storage and transmission by computer applications, they are converted from analog to digital form. A digital image is basically a 2-Dimensional array of pixels . In a raw state, images can occupy a large amount of memory both in RAM and in storage. Image compression is to reduce irrelevance and redundancy of the image data in order to be able to store or transmit data in an efficient form. Com-pression is achieved by the removal of one or more of three basic data redundancies: (1) Coding redundancy, which is present when less than optimal (i.e. the smallest length) code words are used; (2) Interpixel redundancy, which results from correlations between the pixels of an image & (3) psycho visu-al redundancy which is due to data that is ignored by the hu-man visual system (i.e. visually nonessential information). Most of the existing image coding algorithm is based on the correlation between adjacent pixels and therefore the compression ratio is not high. Image compression may be lossy or lossless. Lossless compression is preferred for archival purposes and often for medical imaging, technical drawings, clip art, or comics. This is because lossy compression methods, especially when used at low bit rates, introduce compression artifacts. Lossy methods are especially suitable for natural images such as photographs in applications where minor (sometimes imperceptible) loss of fidelity is acceptable to achieve a substantial reduction in bit rate. It is possible to compress many types of digital data in a way that reduces the size of a computer file needed to store it, or the bandwidth needed to stream it, with no loss of the full information contained in the original file. The original contains a certain amount of information; there is a lower limit to the size of file that can carry all the information. As an intuitive example, most people know that a compressed ZIP file is smaller than the original file, but repeatedly compressing the file will not reduce the size to nothing and will in fact usually increase the size.

## II. COMPRESSION TECHNIQUES

Compression techniques come in two general flavors: lossless and lossy. As the name states, when lossless data is decompressed, the resulting image is identical to the original. Lossy compression algorithms result in loss of data and the decompressed image is not exactly the same as the original.

### *A) Lossless Compression*

In lossless compression scheme, shown in Fig.2 the reconstructed image, after compression, is numerically identical to the original image.It is used in many applications such as ZIP file format & in UNIX tool gzip.It is important when the original & the decompressed data be identical.

Some iamge file formats like PNG or GIF use only lossless compression. Most lossless compression programs do two things in sequence: the first step generates a *statistical model* for the input data, and the second step uses this model to map input data to bit sequences in such a way that "probable" (e.g. frequently encountered) data will produce shorter output than "improbable" data.

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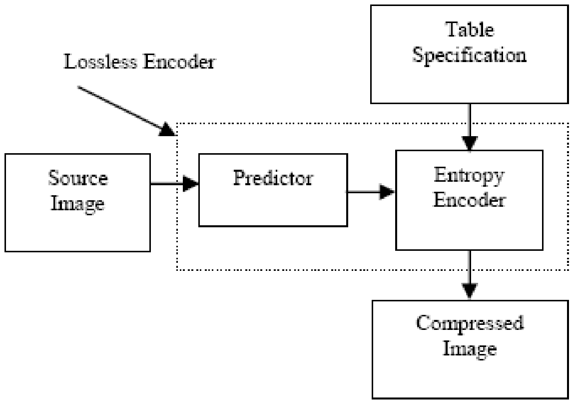
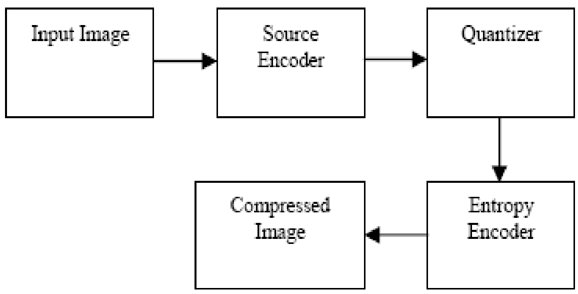



Block Diagram for Lossless Compression

*B) Lossy Compression*

Lossy compression technique provides higher compression ratio than lossless compression. In this method, the compression ratio is high; the decompressed image is not exactly identical to the original image, but close to it. Different types of lossy compression techniques are widely used, characterized by the quality of the reconstructed images and its adequacy for application.

A lossy compression scheme, shown in Fig. 3, may examine the color data for a range of pixels, and identify subtle variations in pixel color values that are so minute that the human eye/brain is unable to distinguish the difference between them .




Block Diagram for Lossy Compression

## III. LOSSLESS COMPRESSION TECHNIQUES

a) Run length encoding
b) Entropy encoding
c) Huffman encoding
d) Arithmetic coding
e) LZW coding

*a)Run Length Encoding*:

Rle is used in lossless data compression.RLE is a simple form of data compression in which data is in the form of runs.Runs is sequences in which the same data value occurs in many consecutive data elements are stored as a single data value and count, rather than as the original run. RLE may also be used to refer to an early graphics file format. It does not work well at all on continuous-tone images such as photographs, although JPEG uses it quite effectively on the coefficients that remain after transforming and quantizing image blocks.

*b)Entropy encoding*:

An entropy encoding is a coding scheme that involves assigning codes to symbols so as to match code lengths with the probabilities of the symbols. Typically, entropy encoders are used to compress data by replacing symbols represented by equal-length codes with symbols represented by codes proportional to the negative logarithm of the probability. Therefore, the most common symbols use the shortest codes.

*c)Huffman coding*:

The Huffman's algorithm is generating minimum redundancy codes compared to other algorithms. The Huffman coding has effectively used in text, image, video compression, and conferencing system such as, JPEG, MPEG-2, MPEG-4, and H.263 etc.. The Huffman coding technique collects unique symbols from the source image and calculates its probability value for each symbol and sorts the symbols based on its probability value. Further, from the lowest probability value symbol to the highest probability value symbol, two symbols combined at a time to form a binary tree. Moreover,

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allocates zero to the left node and one to the right node starting from the root of the tree. To obtain Huffman code for a particular symbol, all zero and one collected from the root to that particular node in the same order.

*d)Arithmetic Encoding*:

AC is the most powerful technique for statiscal lossless encoding that has attracted much attention in the recent years. It provides more flexibility and better efficiency than the celebrated Huffman coding does. The aim of AC is to define a method that provides code words with an ideal length. Like for every other entropy coder, it is required to know the probability for the appearance of the individual symbols.

AC is the most efficient method to code symbols according to the probability of their occurrence. The average code length is very close to the possible minimum given by information theory.

The AC assigns an interval to each symbol whose size reflects the probability for the appearance of this symbol. The code word of a symbol is an arbitrary rational number belonging to the corresponding interval.

*e) LZW Coding:*

LZW algorithm is working based on the occurrence multiplicity of character sequences in the string to be encoded. Its principle consists in substituting patterns with an index code, by progressively building a dictionary. The dictionary is initialized with the 256 values of the ASCII table. The file to be compressed is split into strings of bytes (thus monochrome images –coded on 1 bit – this compression is not very effective),each of these strings is compared with the dictionary and is added, if not found there. In encoding process the algorithm goes over the stream of information, coding it; if a string is never smaller than the longest word in the dictionary then it s transmitted. In decoding process, the algorithm rebuilds the dictionary in the opposite direction; it thus does not need to be stored.

## IV LOSSY CODING TECHNIQUES

a)Transform coding
b) DCT
c) DWT
d) Fractal Compression

*a)Transform Coding*

Transform coding algorithm usually start by partitioning the original image into sub images (blocks) of small size (usually 8 x 8). For each block the transform coefficients are calculated, effectively converting the original 8 x 8 array of pixel values into an array of coefficients closer to the top-left corner usually contain most of the information needed to quantize and encode the image with little perceptual distortion .The resulting coefficients are then quantized and the output of the quantizer is used by a symbol encoding technique(s) to produce the output bit stream representing the encoded image. At the decoder's side, the reverse process takes place, with the obvious difference that the 'dequantization' stage will only generate an approximated version of the original coefficient values; in other words, whatever loss is introduced by the quantizer in the encoder stage is not reversible.

*b)DCT*

The DCT process is applied on blocks of 8 * 8 or 16 * 16 pixels, which will convert into series of coefficients, which define spectral composition of the block. The Transformer transforms the input data into a format to reduce interpixel redundancies in the input image. Transform coding techniques use a reversible, linear mathematical transform to map the pixel values onto a set of coefficients, which are then quantized and encoded. The key factor behind the success of transform-based coding schemes is that many of the resulting coefficients for most natural images have small magnitudes and can be quantized without causing significant distortion in the decoded image.DCT Attempts to decorrelate the image data after decorrelation each transform coefficient can be encoded without dropping off compression efficiency.

*c)Discrete Wavelet Transform (Dwt)*

The DWT represents an image as a sum of wavelet functions, known as wavelets, with different location and scale. The DWT represents the image data into a set of high pass (detail) and low pass (approximate) coefficients. The image is first divided into blocks of 32×32. Each block is then passed through the two filters: the first level decomposition is performed to decompose the input data into an approximation and detail coefficients. After obtaining the transformed matrix,the detail and approximate coefficients are separated as LL,HL, LH, and HH coefficients. All the coefficients are discarded except the LL coefficients that are transformed into the second level.The coefficients are then passed through a constant scaling factor to achieve the desired compression ratio.

*d)Fractal Compression*

The fractal compression technique relies on the fact that in certain images, parts of the image resemble other parts of the same image. Fractal algorithms convert these parts, or more precisely, geometric shapes into mathematical data called "fractal codes" which are used to recreate the encoded image. Once an image has been converted into fractal code its

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relationship to a specific resolution has been lost; it becomes resolution independent. The image can be recreated to fill any screen size without the introduction of image artifacts or loss of sharpness that occurs in pixel-based compression schemes.

## V. CONCLUSION

By studying and discussing all the techniques we find lossy compression techniques provides high compression ratio than lossless compression scheme. Lossy compression is used for more compression ratio and Lossless compression is used when the original image and reconstructed image are to be identical.

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