



## A Review on Image Compression using Different Techniques

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**Abstract—** *Digital image in raw form require a large amount of storage capacity. Due to limited bandwidth and storage capacity, images must be compressed before storing and transmitting. Image compression means reducing the size of the graphics file, without compromising on its quality. This paper entails the survey of various image compression techniques and highlights the important features of each method. Compression techniques are mainly classified into lossy compression techniques and lossless compression techniques.*

**Keywords—** *Image Compression, DCT, Vector Quantisation, Fractal Image Compression, LZW*

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### I. INTRODUCTION

Image Compression, the art and science of reducing the amount of data required to represent an image, is one of the most useful and commercially successful technologies in the field of digital image processing [1]. Compression is important because it decreases the time and cost required for image transmission and it decreases storage requirements. Compression algorithms can be either lossless (reversible) or lossy (irreversible). Higher degrees of compression are only possible using lossy or irreversible techniques and therefore lossy compression has been subject of considerable investigation. Algorithms for lossless compression include run length encoding, Huffman Encoding and Lempel-Ziv and variants. Various types of lossy encoding algorithms have been investigated including, the full frame discrete time cosine (DCT), vector quantization, wavelets, fractal and others [2].

### II. IMAGE COMPRESSION PRINCIPLES

Correlation between neighbouring pixels and irrelevance data is the common characteristics seen in most of the images which consists of redundant information. Using compression, less correlated representation of the image can be determined. Redundancy and irrelevancy reduction are two fundamental components of compression. Redundancy reduction is done by discarding similar pixels from the signal source (image/video) while irrelevancy reduction discards the part of the signal that will not be noticed by the Human Visual System (HVS) [3].

In general, three types of redundancy can be identified:

#### *Coding Redundancy*

A code is a system of symbols (letters, numbers, bits and the like) used to represent a body of information or set of events. Each piece of information or events is assigned a sequence of code symbols, called code word. The number of symbols in each code word is its length. The 8-bit codes that are used to represent the intensities in the most 2-D intensity arrays contain more bits than are needed to represent the intensities.

#### *Spatial and temporal redundancy*

Because the pixels of most 2-D intensity arrays are correlated spatially, information is unnecessarily replicated in the representations of the correlated pixels.

#### *Irrelevant information*

Most 2-D intensity arrays contain information that is ignored by the human visual system and extraneous to the intended use of the image. It is redundant in the sense that it is not used.

### III. IMAGE COMPRESSION TECHNIQUES

The image compression techniques can be categorized into two fundamental groups: reversible and non reversible. In reversible (also known as bit reversing or lossless, the reconstructed image after compression is numerically identical to the original image on a pixel-by-pixel basis. Obviously reversible is ideally desired since no information is compromised. However only modest compression ratios are possible with reversible compression. In non reversible compression (also known as lossy), the reconstructed image contains degradations relative to the original. As a result, much higher compression ratios can be achieved as compared to reversible compression. In general more compression is achieved at the expense of more distortion. It is important to note that these degradations may or may not be visually apparent [4]. The general framework for compression scheme includes three components: image decomposition or transformation, quantization and symbol encoding. The relative importance of each component varies from one technique to another and not all components are necessarily included in a particular technique. The image decomposition or transformation is usually a reversible operation and is performed to reduce the dynamic range of the signal, to eliminate redundant

information or in general to provide a representation that is more amenable to efficient coding. The primary difference between reversible and non-reversible techniques is the inclusion of next stage, quantization, in non-reversible techniques. By quantizing the data, the number of possible output symbols is reduced. The type and degree of quantization has a large impact on the bit rate and quality of a non reversible scheme. The final stage, symbol encoding, may be as simple as using fixed-length binary code-words to represent the symbols resulting from the decomposition or quantization stages, or it might use a variable-length code as a means of achieving rates close to the fundamental information-theoretic limits. Various compression techniques are discussed below.

#### **A. Huffman Coding**

Huffman code is a technique for compressing data. Huffman's greedy algorithm converts each character as a binary string in an optimal way. Huffman coding is a form of statistical coding, which is used to reduce the amount of bits required to represent a string of symbols [5]. The algorithm accomplishes its goals by allowing symbols to vary in their length. It allows variable length symbols to be assigned for longer codes which appear less frequently and shorter codes are assigned for most frequently used symbols. Code word lengths are no longer fixed like ASCII. The Huffman code procedure is based on the two rules. First, more frequently occurred symbols will have shorter code words than symbol that occur less frequently. The two symbols that occur less frequently will have the same length. Second, The Huffman code is designed by merging the lowest probable symbols and this process is repeated until only two probabilities of two compound symbols are left and thus a code tree is generated and Huffman codes are obtained from labelling of the code tree. So, the Huffman encoding algorithm starts by constructing a list of all the alphabet symbols in descending order of their probabilities. Huffman's procedure creates the optimal code for a set of symbols and probabilities subject to the constraint that the symbols be coded one at a time. Decoding of encoded image is simple. Start from the root and read the first bit of compressed file in the left to right manner. When the decoder reaches at a leaf, it finds there the original, uncompressed image, symbol and that code is reflected by the decoder. The process initiated again at the root with the next bit, then it read and can decode the rest of its input. It is basically based on the symbols, i.e. the probability of the symbols. The probabilities must be written, as sub information, on the output. The block code is a unique code itself. The block code refers to that each source symbol is mapped into a sequence which is fixed, order of code symbols. It is instantaneous, for the reason that each code word in the series of code symbols can be decoded without taking reference of the succeeding symbols. It is decodable uniquely, because any series of code symbols can be decoded in only one way.

#### **B. Run Length Encoding**

One of the simplest forms of data compression is known as Run Length Encoding (RLE). In RLE the runs of data i.e. the sequence of similar data elements in the input data stream (repeating string) are replaced by a single data element value or the count. The RLE plays a vital role in cases where the data stream contains many runs. If any files that do not have many runs there is a chance of increase the file size and hence it is not useful.

#### **C. Lempel Ziv Welch Coding**

Lempel Ziv Welch (LZW) coding is a dictionary based coding which can be static or dynamic. In static LZW coding, dictionary is fixed during the encoding and decoding processes. While the dictionary is updated on fly in dynamic LZW dictionary coding, this type of coding is widely used in computer industries. LZW works 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, 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 is transmitted. In decoding, the algorithm rebuilds the dictionary in the opposite direction; it thus does not need to be stored.

#### **D. DPCM**

Differential Pulse Code Modulation (DPCM) is transformation for increasing the compressibility of an image. It consists of scanning the image and predicting the next pixel's value [6]. There are several modes to predict the next pixel's value. One is to use the average of the pixels to the left and the pixel above as the predicted value. In a lossless coding scheme, the original image is reproducible by storing the pixels at the beginning of the scan and decoding in the same scan order. The set of differences between each pixel and its predicted value is the residual image. The residual distribution is typically zero-mean and much more compact than the distribution of the original image. A more compact distribution results in lower entropy which determines the minimum average codeword length that is attainable without information loss.

#### **E. DCT**

Discrete Cosine Transform (DCT) is generally used for image and video compression. This technique expresses a sequence of finitely many data points in terms of a sum of cosine functions oscillating at different frequencies [7]. Basically DCT separates an original image into parts of differing frequencies. Quantization is to be done after the DCT process in which less important frequencies are discarded. Hence this technique is termed as lossy. As a result, reconstructed images contain some distortion; but these distortions can be adjusted during the compression stage. DCT has many advantages; First, It has been implemented in single integrated circuit. Second, It has the ability to pack most

information in fewest coefficients. Third, It minimizes the block like appearance called blocking artifact that results when boundaries between sub-images become visible. There are mainly two types of DCT: one dimensional (1 -D) DCT and two dimensional (2-D) DCT. Since an image is represented as a two dimensional matrix, for this 2-D DCT is considered.

#### **F. DWT**

DWT is multi-resolution transform technique, generally used for image compression to achieve higher compression ratio. This technique is based on sub-band coding and it provides a time frequency representation of the signal [8]. The JPEG2000 is based on the concept of DWT-technique. Wavelet Transform has become an important method for image compression. Wavelet based coding provides substantial improvement in picture quality at high compression ratios mainly due to better energy compaction property of wavelet transforms. Wavelets are functions which allow data analysis of signals or images, according to scales or resolutions. The DWT represents an image as a sum of wavelet functions, known as wavelets, with different location and scale. It represents the data into a set of high pass (detail) and low pass (approximate) coefficients. The input data is passed through set of low pass and high pass filters. The output of high pass and low pass filters are down sampled by 2. The output from low pass filter is an approximate coefficient and the output from the high pass filter is a detail coefficient. In two dimensional (2-D) DWT this is done in two directions, both rows and columns. The outputs are then down sampled by 2 in each direction as in case of 1-D DWT. Output is obtained in set of four coefficients LL, HL, LH 2-D DWT, the input data is passed through set of both low pass and high pass filter and HH. The first alphabet represents the transform in row where as the second alphabet represents transform in column. The alphabet L means low pass signal and H means high pass signal. LH signal is a low pass signal in row and a high pass in column. Hence, LH signal contain horizontal elements. Similarly, HL and HH contains vertical and diagonal elements, respectively.

#### **G. Vector Quantization**

Vector quantization is a lossy type image compressing technique because in VQ technique some information may be lost due to quantization [9]. First, the image is divided into fixed size block called training set and also create a codebook which has indexed image block of the same size of representing types of image block. Then it prepares a string for image by finding corresponding block index and arranging them. There are also shown corresponding block index from codebook or closest match block index. Instead of transmitting pixel value, transmit codebook and encoded string "0 0 1 0 2 2 2 0 3 2 2 0 0 4 0 0" so at the decoded side we can reconstruct original image by using this encoded string and codebook by putting the corresponding block from codebook. Important part of vector quantization is designing the codebook. There are many algorithms are available for designing the codebook.

#### **H. Fractal Image Compression**

The fundamental idea of fractal image compression is the partitioned iteration function system (PIFS) with the underlying theory founded by the fixed-point theorem and the Collage theorem [10]. In the coding process; we set the size of coding units. For encoding a gray level image, there are non-overlapping blocks forming the range pool. Let the contractivity of the fractal coding be a fixed value  $\alpha$ . Thus, the domain pool is composed of the set of  $(N-2L+1)^2$  overlapping blocks, each of which has size  $(2L) \times (2L)$ . At each search entry, the domain block is first down-sampled to  $L \times L$  and denoted by  $u$ . Denote the set of all down-sampled domain blocks by  $D$ . For fractal coding, each  $u$  in  $D$  is further transformed subject to the eight transformations in the Dihedral group. The similarity between two image blocks and of the same size is measured in terms of the MSE (mean squared error). For fractal coding, eight MSE computations between a domain block and a range block are needed due to the eight Dihedral transformations performed on  $u$ . When encoding a given range block, the fractal code is obtained by searching the most similar domain block with minimal MSE. To decode, we first make up the 1024 affine transformations from the compression codes and choose any image as the initial one. Then, perform the 1024 affine transforms on the image to obtain a new image, and proceeds recursively. According to PIFS Theorem and the Collage theorem, the sequence of images will converge. The stopping criterion of the recursion is designed according to user's application. The final image is the retrieved image of fractal coding.

### **IV. CONCLUSIONS**

In this paper different image compression techniques are presented. Image Compression plays a significant role in reducing the transmission and storage cost. There are mainly two types of image compression techniques exist. In Lossless compression, the image is compressed and decompressed without any lose of information. In Lossy Compression there is some loss of information. Lossy techniques provide a higher compression ratio than lossless.

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