A Survey on Image Compression Techniques

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Abstract

Image compression is the process of converting an image file into fewer bits than the original file. The image compression not only reduces the size of image but also ensures that quality of image is degraded. The goal of an image compression is to decrease the redundancy of the image and to store data in an effective form. In this paper, we will describe about the various compression techniques. The purpose of this paper is to survey some image compression techniques. As the quality of digital images improves, the size of digital images needs to be increased. In order to store the largest image files, the storage disk needs to be increased. Hence image compression techniques can be used to reduce the cost and increase resources for better result. In this paper, we discuss several image compression techniques such as lossless or lossy image compression techniques briefly.

Keywords: Image Compression Techniques, lossless, lossy, Redundancy, JPEG/DCT, wavelet compression.

1. Introduction

Image compression is the use of data compression on digital images. Image compression is a way to reduce the amount of data needed to represent a digital image. It is also used to reduce useless redundancy, except to avoid duplication of information that will help increase the efficiency of the storage and broadcast process. The image compression not only decreases the size of image but also ensures that quality of image is degraded. Image compression is the process of converting original image into reduced modified image that occupies less number of bytes on the disk and transmits quickly from one place to another [8]. Image compression plays a very important role in the transmission and storage of image data due to storage constraints. The purpose of image compression is to represent an image with a minimum number of bits without losing essential information in an image. Compression techniques [6] are quickly evolving to compress large data files, such as images. As technology advances, so does the need to handle large amounts of image data. Successful image compression with effective techniques. Some algorithms that compress this way - lossless and lossy. Lossless stores information along with the original image and in lossy some information lost when the image is compressed. Image compression is data compression that encodes the native image slightly. The purpose of image compression is to reduce unnecessary images and to efficiently store or stream information [2].

The compression ratio (CR) is measured by comparing the size of the image to the original size.

$$CR = \frac{N_1}{N_2}$$

Let $N_1 = \text{the data of original image}$ $N_2 = \text{the data of compressed image}$

2. Fundamental Flow of Image Compression

Image compression is intended to reduce the inconsistency and unnecessary clutter of image data for efficient data storage. This can be achieved by reducing the number of bits needed to represent each pixel in an image. This reduces the amount of memory required to store images and photos in a short period of time. Figure 1 shows the fundamental flow of the image compression. Supports encoder that converts image into bit streams. When the decoder gets these encoded bit streams, it decodes them and the result is obtained from the decoder output. Image compression occurs when the total data volume of the input image exceeds the received bit stream[10].

![Figure 1. Fundamental flow of image compression](image-url)

Every image contains unnecessary data. Redundancy refers to the duplication of information in an image. Whether you are repeating a pixel in an image or across a shape. Repeat the image more often. Image compression occurs by capturing unnecessary information in an image. Reduction redundancy saves storage space for photos. The image is reduced when one or more of these unnecessary items are minimized.
or removed [2]. In digital images, there are three basic redundancies:
- Coding Redundancy
- Inter-pixel Redundancy
- Psycho-visual Redundancy

2.1 Coding Redundancy

Coding redundancy is related to the representation of information. Represents the format of the information code. If the gray scale of an image represents each of the gray scale with more coding, the resulting image has coding redundancy [13]. Includes the use of variable length codes selected to match the source code. This category is always reversed and is usually implemented using lookup tables (LUTs). For example, Image coding programs that study coding redundancy includes Huffman codes and arithmetic coding techniques.

2.2 Inter-pixel Redundancy

Inter-pixel redundancy is due to the correlation between neighboring pixels in an image. This means that the neighbors are statistically independent. Gray levels are not likely to be the same. The value of a given pixel can be considered very much related to the value of the neighbors. The information carried by each pixel is very small. The difference between adjacent pixels can be represented by the image to reduce inter-pixel redundancy [13].

2.3 Psycho-visual Redundancy

The human eye is sensitive to all the visual information it receives due to its analysis of the psychological and physiological aspects of human vision. Some facts are more important than others. Most of the image coding algorithms used today use unnecessary types, such as the Discrete Cosine Transform (DCT) algorithm, which is the core of the JPEG coding standard [8].

3. Image Compression Techniques

Image compression techniques are discussed in detail. They are lossless compression techniques and lossy compression techniques.

3.1. Lossless Compression Techniques

Lossless compression is a class of data compression algorithms that allows the original data to be perfectly reconstructed from the compressed data. Lossless data compression is used in many applications. For example, it is used in the ZIP file format and in the GNU tool gzip. It is also often used as a component within lossy data compression technologies (e.g. lossless mid/side joint stereo preprocessing by MP3 encoders and other lossy audio encoders) [12]. It can be used to store computer-generated data; it is also used for specific data such as text and some images and video information. It only provides modest amounts of data and is not useful for high enough compression ratios. Deformation lossless compression is preferred for images such as graphics. There are some techniques of lossless compression:

1. Run length encoding
2. LZW coding
3. Huffman coding
4. Area coding.

3.1.1. Run Length Encoding

Run length encoding (RLE) is one of the simplest data compression methods in data compression. It saves data as a single value rather than the original run when running the data. This compression method is useful in the case of repetitive data and it is used for sequential data. This method [2] replaces a series of identical pixels called run. The run length code for a gray scale image is represented by sequence \([V_i, R_i]\) where \(V_i\) refers to the intensity of the pixel, and \(R_i\) refers to the number of consecutive pixels with the intensity \(V_i\) as shown in Figure 2.

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82  82  82  82  82  89  89  89  90  90
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Figure 2. Run length encoding

3.1.2. LZW Coding

LZW code is a basic dictionary symbol used in the computer industry. LZW is basically two types, static and dynamic. The dictionary is used for encoding and decoding in static dictionary coding. When a new word is introduced in the dynamic dictionary, it is updated [1].

3.1.3. Huffman Coding

The Huffman symbol [1] is based on statistical frequency or probability of occurrence. You can reduce the file size by 10% to 50% by removing the irrelevant data. In this encoding, each pixel is defined as a symbol. Higher frequency symbols are assigned lower frequency numbers and lower frequency symbols are assigned a larger number.

3.1.4. Area Coding

It is a better form of run length coding for lossless compression. It produces a very efficient and better pressure ratio (CR), but it has limitations that make it unusable in hardware due to its non-linear approach [1].

3.2. Lossy Compression Techniques
Lossy compression procedures mention to the loss of some data when data is compressed. However, this distortion results in a higher compression ratio compared to lossless methods in image reconstruction. It removes unnecessary objects and creates the closest approximation to the native image. This program is very effective for compressing images. The lossy compression technique has a higher compression ratio than lossless compression. The lossy compression procedure is as shown in Figure 3.

![Figure 3. Lossy compression](image)

The main features of the lossy compression method are:
- Compression ratio
- Noise and signal ratio
- Accelerated encoding & decoding

Some examples of lossy compression are as shown in below:
1. Transform coding
2. Vector quantization
3. Block truncation coding
4. Fractal coding
5. Sub band coding.

### 3.2.1. Transform Coding

In this coding, to change the pixels in the original image into frequency domain coefficients used different transform such as DFT (Discrete Fourier Transform) and DCT (Discrete Cosine Transform). These coefficients have several desirable properties. Among all the transforms, DCT coding has been the most general technique of transform coding. It is also adopted in the JPEG image compression standard [11].

### 3.2.2. Vector Quantization

The fundamental concept of the procedure is to create a dictionary of fixed size vectors called code vectors. The given image is divided into different blocks called image vectors. The dictionary defines a close match for each image. It encodes the original vulnerability of its index in the dictionary. It is most commonly used in multimedia applications.

### 3.2.3 Block Truncation Coding

Block truncation coding [1] is a popular technology for image compression. It splits the native image into smaller n x n pixels. After printing, it reduces the grayscale of each individual. Gray phase reduction is done by a quantizer. The gateway and the reconstruction values are calculated individually and a bitmap of the block is obtained for those values. We replace all pixels in the bitmap that are greater than 1 (0) or equal to (less than). It then calculates the reconstruction value for one part of the bitmap (groups 1s and 0s).

### 3.2.4. Fractal Coding

The main concept is color separation; Image transformation techniques, such as sharpening and contrast and texture analysis, are used to break down images into fragments. View each section in the Fractals Library. The library actually contains narrow numbers called iterated function system (IFS) codes. By using a systematic procedure, the IFS code defines the code for an image that produces an image that is very close to the original when applied to the appropriate image block. This program is very effective at compressing images that look and feel normal.

### 3.2.5. Sub band coding

In this program, the image is bound to be precisely bound; the sub-sections are designed to produce components with frequency. Later controls and codes are used. The advantage of this program is that it can be designed separately for quantization and coding, which is best suited for each sub-band.[11].

### 4. Several Compression Techniques

There are several types of compression algorithm that can be used for both text and images. The purpose of image compression is to digest the size of the image to save storage space. It aims to achieve a high compression ratio to maintain good stability of encrypted images. Techniques that compress and decompress a single gray image are expected to be easy. Sends image program prepared to encode/decode color images. There are several types of compression techniques; we discuss three of them named.

1. JPEG/DCT
2. Wavelet compression
3. VQ
4. Fractal methods

### 4.1. JPEG/DCT

JPEG / DCT image compression has become the norm. Designed to reduce the color or grayscale of real-world scenes. Take advantage of this approach; the first one divides an image into 8 x 8 blocks. DCT uses the gray definition of the solid domain in each block domain to change the number in the frequency domain. According to the JPEG standard, which is made with some psychological perspective, the numbers are normal to varying degrees. The calculated numbers are designed to be zigzag scanned. Long scratching; Compact with more efficient lossless coding approaches
such as arithmetic coding or Huffman coding. The coding is simply the reverse procedure of encoding [3, 5]. Therefore, JPEG compression requires the same time for both encoding and decoding. There are encoding / decoding algorithms provided by autonomous JPEG teams to test real-world images.

Data loss is just a way of calculating numbers. The JPEG typical defines a standard 8 x 8 quantization table for inappropriate images. By using multiple DCT images, a flexible quantization table can be used instead of using a standardized spreadsheet to get better code quality with the same compression [9].

4.2. Wavelet Compression

Wavelets are zero values defined in a finite interval. The fundamental concept of wavelet transformation is to define any behavior (t) that determines the superposition or basic functions of such wavelets. These basic functions, or embracing babies, are supported by dilatations or contraction and translation by the wavelet, a signaling model called mother wavelet. For example, a Discrete Wavelet Transform (DWT) of x (n) of a long signal with N components is represented by an N x N matrix.

The benefits of JPEG compression technology are simple based on DCT. Availability of hardware specifically designed for satisfactory performance and implementation; these are not without their flaws. The connection between the block boundaries cannot be removed because the input image needs to be blocked. This result is noticeable, and distractions are usually low rates. Lapped Orthogonal Transforms (LOT) seeks to solve this problem by smooth and repetitive work. Blocking effects fall on LOT compressed images. The extended computational complexity of such algorithms does not equate the widespread replacement of DCT with LOT [7].

4.3. VQ Compression

One disadvantage is the composition of the two quantizes operation encoder and codec. The encoder takes an input vector and generates an indication of the codeword that gives the minimum format. In this case, the minimum distortion is found by estimating the Euclidean distance by the input vector and the codebook. As soon as the nearest codeword is available, the index of that codeword is sent one way.

When the encoder receives the codeword index, it replaces the connection codeword with the index. The basic concept of VQ for image compression is to build a codebook containing each code vector. Each code number represents a group of images of size m x m (m = 4 is always used). An image that represents m2-tuple viruses, called training vectors, is first subdivided into non-m x m first identical blocks. The size of the training weakness can be very huge. For example, The 512 x 512 images is a 16384 training transport device. The purpose of the Codebook design is 256, to set up a small number of viruses represented by 512-year-old code vectors. The encoding method is to find the nearest code vector in a codebook that differs from each 4 x 4 block of the encoding image [7].

4.4. Fractal Compression

Fractal coding is based on the theorem defined for the collage theorem and the local iterated function system (IFS). This compression algorithm splits the first image into identical 8 x 8 blocks without images. It is related to isometrics 8 from reflections and rotations called domain blocks. For each distance the contract negotiation changes in a domain set are then applied to the domain pool to get the minimum square error and the best match domain block after applying the domain block. The fractal compression code for distance blocking includes a quantized contract for the affine transformation. Refers to the pixel gray level within range. The offset blocks the best-fitting domain block and its type of isometrics. This code is used to find the default code image, starting with any initial image. The two main problems with fractal encoding are computational requirements and optimal distance domain compatibility problems. The most important and attractive property is the resolution independent decoding property [9].

6. Conclusions

This paper discusses four types of image compression techniques. After surveying, several techniques lossless image compression techniques. We find out pros and cons of lossy and lossless due to the result of surveying on image compression techniques. The result of lossy compression is the better compression ratio than the lossless compression technique but it cannot retrieve the original image. In other hand, lossless compression ratio is the lower end but it retrieves the original image.

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