Comparing Different Image Compression Techniques

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Abstract - This paper tries to summarize the basic image compression techniques and allowing to choose the right compression technique from the popular and widely used image compression techniques. Image compression is one of the important parts, of the digital image processing in order to reduce the data transmission and data storage cost. This paper covers the two broad categories of the image compression such as lossy and lossless image compression and there algorithms along with the standards used by then such as JPEG/PNG/GIF/TIFF/TCX etc.

Key Words: **Image, Image Compression, Lossy Compression, Lossless Compression, Digital Image Processing, PNG, Entropy coding, Huffman coding, Wavelet Compression, Fractal Compression, Discrete Cosine Transform**

1. INTRODUCTION

After the coming of the WEB2.0, Social media cloud technologies and other disruptive technologies there is exponential increase in the amount of data.

The devices are getting more capability to process and record data in higher quality. This results in the increase in the storage cost. Graphical content which mainly includes the images and video whereas videos are nothing but the series of images thus storing images and videos of higher resolution which are higher in the size are difficult and difficult to transfer over the internet to other users around the globe to counter these problems many Image compression techniques are used and choosing the right image compression technique is also essential while creating image processing applications. There are many image compression algorithms out there and they are divided into two broad categories one is lossy compression and other one is lossless compression.

2. LOSSY COMPRESSION AND LOSSLESS COMPRESSION

Both lossy and lossless compression techniques have their own advantages and disadvantages in the real-world application and both have wide range of compression algorithms available. In both the techniques in order to reduce the storage cost there may be loss of some quality from the image data which is given to the application.

2.1. LOSSY COMPRESSION

The lossy compression is one of the widely used image compression technique used for the compression of the image data in order to reduce the storage cost it is also known as irreversible compression the lossy compression leads to the somehow loss of quality from the image and have to hold certain space to contain the necessary information. A well-defined lossy compression algorithm or technology have the capability or can be used to find the perfect balance between the image quality and the storage cost. In lossy compression there is also a phenomenon called the generation loss which is continues compression and decompression leads to loss of overall quality. Lossy compressed images or data require less bandwidth to transfer over the devices or internet and widely used in the technologies such as streaming services such as amazon prime, Netflix etc. and internet VoIP or internet telephony. There are many lossy compression techniques some wide used are as follows:

1. **Discrete cosine transform (DCT)**
   1.1. JPEG
   1.2. Web
2. **Cartesian Perceptual Compression**
3. **Fractal compression**
4. **Wavelet Compression**

2.1.1 DISCRETE COSINE TRANSFORM(DCT)

The discrete cosine transform is one the popular techniques used for the data compression it is used not only for the image data but can be also used for the other types of data such as the videos, audio and other digital media formats. It was first proposed by the Nasir Ahmed in 1972 while he was working at the Kansas state university and widely used in the applications such as the digital signal processing, communication devices etc. In the discrete cosine transform the sequence of the data points are represented in the form of the cosine functions which are oscillating at different frequencies and this technique have the capability to achieve the compression ratios from 8:1 to 14:1 and up to 100:1 for acceptable quality of the data its biggest advantage is to retain acceptable quality and much more smaller size and standards such as JPEG provide faster processing and provide large support base of devices. Every technique has some advantages and disadvantages of their own so that of discrete cosine transform it do not support the multi layered images and lead to some data loss after the compression.

2.1.2. CARTESIAN PERCEPTUAL COMPRESSION

The day by day increase in the amount of data not only in the form of audio, video and images but also from documents which may be government documents corporate documents or even documents like this which contains information in multiple formats single document can have both text and image in it so in order to store and transmit the data over internet, fax machines, mobiles require some sort of compression. The cartesian perceptual compression is one of the popularly used compression technique for the compression of black and white images, documents for the archival scans in order to reduce the storage cost. It was developed and owned by a private organization known as Cartesian Inc which is located at Cambridge, Massachusetts. This technique is further divided into three more groups of compression methods they are as follows:

- **GROUP 3 1D**
- **GROUP 3 2D**
- **GROUP 4**

The principle of the cartesian perceptual compression it uses the raster document imaging process to generate a dot matrix data structure to represent the rectangular pixels of a document image. The cartesian perceptual compression generated files is denoted with the extension. cup and this compression technique are lossy compression means some part of data may loss after the compression and it is not recoverable.

2.1.3. FRACTAL COMPRESSION

The fractal compression is a lossy digital image compression technique which is used in the compression of the image data. It uses the concept of fractals. Fractals are known as the never-ending patterns which resemble infinite complex patterns that are similar and are create by a repeated process over and over. As this technique name suggests it uses the concept of fractal in order to compress the image data. The fractal compression is mostly used for the natural and images containing textures. The fractal compression divides the image into segments based on the color, different textures, edges, frequency etc. and use a dictionary to look up and called it the fractal segments and then the segments are then encoded thus it is very efficient possible way to encode the natural images containing the textures. Being a lossy compression technique, the quality of image gets low as compare to the original one because of loss of data during the compression.

2.1.4. WAVELET COMPRESSION

Wavelet compression is a type of discrete cosine transformation image compression technique in which it uses a wavelet instead of the DCT block in the algorithm. It comes in both types lossy and lossless compression. The wavelet compression is widely used for the transient data and not suitable for the smooth, periodic signals which can be compressed by the help of other transformations. The wavelet transformation has slight advantage over the Fourier transformation. There are several practical implementations of the wavelet compression technique some of them are as follows:

- **JPEG 2000**
- **DjVu**
- **ECW**

2.2. LOSSLESS COMPRESSION

The lossless compression is a type of compression technique in which the data which is reconstructed cannot work or function without incomplete data or malfunction in the absence of accurate data. The lossless compression techniques can be used for wide range of data type such as images, videos, text, documents etc. to compress the data and reduce the storage cost. In image compression the image which is compressed using the lossless compression method can be recovered in original quality without losing out any detail and without adding any noise in the image. There are many lossless compression techniques some of them as follows:

- **Run length encoding**
- **Entropy encoding**
- **DEFLATE**

2.2.1. RUN LENGTH ENCODING

The run length encoding is a popular lossless image compression technique in which the run data is being generated and given the single value or the count the run data is the segment which is mostly used where the data contains several run data. This technique was patented by Hitachi and used as transmission of the analog television signals and suitable for the bitmap images and computer icons. This technique has several standards some of them as follows:

- **PCX**
- **TIFF**
- **TCX**

2.2.2. ENTROPY ENCODING

The entropy encoding is a type of lossless data compression technique in which the algorithm assigns unique prefix code to the input data of fixed length and the length of each codeword is directly proportional to the probability of the occurrence and taking the negative logarithm of the input data and replacing each input data with the generated codes in the output as compressed data and the entropy encoding can be used to large extent of data

types and able to compress data at certain level and cannot compress more than that level of compression. There are two popular algorithms for the implementation of the entropy encoding.

- **Huffman Coding**
- **Arithmetic Coding**

2.2.3. DEFLATE

The DEFLATE is popular lossless data compression technique which is implemented with the help of two algorithms one is **Huffman coding** and other one is **LZ77.** In this compression technique the data is compressed based on the combination of the encoded bytes and matching string. It uses the properties of both of the algorithms to compress the data where LZ77 is used to compress the repeated sequence of characters and then generating the Huffman code in order to compress the data some popular standards of the DEFLATE are:

- **PNG**
- **MNG**

3. CONCLUSION

This paper points to compare basic image compression algorithm or techniques and the current standards which are used by that technique and since there are two types of the compression techniques which are widely used its difficult to figure it out which compression technique should be used. Data critical application such as banking and medical imaging where loss of any data is not tolerable there we can use lossless data compression techniques such as DEFLATE, Huffman coding etc. and where the small loss of data that are not noticeable and tolerable lossy compression technique such as wavelet compression, conceptual perception compression etc. can be used. Thus, an enhanced and properly implemented lossless compression is used over the lossy compression techniques.

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