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THE TYPES OF IMAGE COMPRESSION TECHNIQUES: A STUDY

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Abstract:-

Image compression is the art of science of science of reducing the amount of data required to represent an image and this technique is the most useful and commercial technology in the modern Internet and multimedia era of Digital Image Processing. In this paper, some of the lossless techniques, such as Huffman, run-length, LZW and chain coding and lossy codes namely vector quantization, block truncation fractal; transform and sub-band coding are discussed.

Keywords: - Digital Image Processing, modern Internet and multimedia

1. INTRODUCTION

The present era of digital world witnessing enormous and tremendous growth in the field of Internet, web and mobile communication led to visual communication and the increasing need for data compression. Data compression is the process of converting data file into smaller compact files for efficiency of storage and transmission. Data compression is the key area for the rapid growth of Information Technology. We cannot imagin the digital world without compression. The main objective of compression of image is to reduce redundancy and irrelevance of the of the image in order to store and transmit data in an effective way. Compression is an option that when naturally select when faced with problems of high cost or restricted space. The main benefit of data compression is concerned with the reduction in the size of digital data. A digital image is a 2-D function f(x.y), rectangular array of x,y where x and y are spatial(plane) coordinates (x,y)is called the intensity or gray level of the image at that point. In a digital image x,y and the intensity values of f are finite, discrete quantities .Our human visual system perceive the image through our senses.

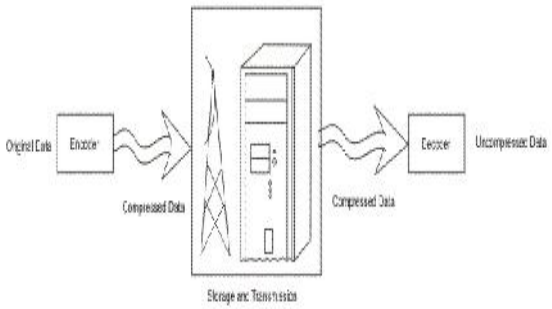

Figure: 1 A general data compression system

As the need is inadvertent du the massive explosive growth of Internet and Multimedia environment image compression is important .It is familiar to most of the Internet users of computers in the form of image file extension, such as the jpg file extension used in JPEG image compression standard. The need of information and computers grow exponentially so we need

efficient ways and methods of storing and transmitting of enormous amount of data.

1.2 Image compression concepts:

Image compression techniques deals with the problems of reduction in size of the file and storage to save an image, or the bandwidth needed to transmit it. Storage capability and transmission capacity should grow simultaneously in order to develop the image compression. A two-dimensional image suffer from three principal types of data redundancies which can be exploited as

1. Coding redundancy
2. Spatial and temporal redundancy
3. Irrelevant redundancy

Coding redundancy suggests a way to compress image by replacing a letter, symbol by assigning a short codes or variable length codes. In Spatial and temporal redundancy (Interpixel redundancy) each pixel is similar to its neighboring ones which is called as spatial pixel correlation. Irrelevant Information(Psycho-visual redundancy) is ignored by human visual systems, human eye ignore small changes in the color than the brightness changes. These three types of redundancies can be eliminated to achieve a good image compression. Inverse of compression is decompression or decoding,the compressed bit stream is applied to the decoder the original image or data is formed. The visual communication requires large storage of data and information, due to limited storage capacity and bandwidth constraint images must be compressed before storing and for transmission over Internet and for multimedia applications. Many methods and algorithms are available for image compression but the methods and techniques should retain the quality and originality of images. The word image compression or data compression means the art of reducing the amount of data to represent a given quantity of information and thus the size of the image is reduced to an acceptable level.

1.3 Image Compression model:

An image compression model consists of two different functional components an encoder and a decoder. The encoder performs compression and decoder performs the decompression action which is the complementary operation of encoding. Both encoding and decoding can be done with software. A codec is a device which can perform both encoding and decoding with software. In the fig 1.1 f(x,y) is the input image fed to the encoder and forms the compressed image, which is stored or transmitted. f^(x,y) is the reconstructed output. The encoder is designed to remove all the three types of redundancies viz coding Interpixel and psycho visual redundancies. The mapper which is the first stage reduces spatial and temporal redundancy. In the second stage aquantizer reduces the mapper's output with pre-established fidelity criterion and keep the irrelevant information out of compressed representation. The symbol encoder generated either a fixed or variable-length code to represent the quantizer output and maps the output in accordance with code. Mostly variable-length is used.

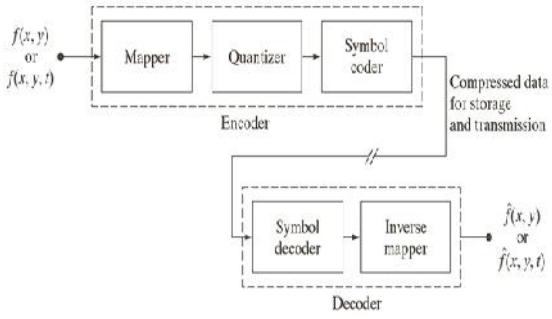

Figure: 2. Image compression models

The decoder contains symbol decoder and inverse mapper both together perform inverse operation of encoding .Quantizer has irreversible information loss, so there is no

need for inverse quantizer block. Several procedures are used to measure the performance of a compression method.

1.Compression ratio

2.Compresssion factor

3.Bits per pixel

4.Compression gain

5. Cycles per byte

6. MSE and PSNR

1.4 Merits and demerits of image compression:

- File reduction which is very advantages for Internet and Web usage without using much bandwidth or storage space.
- Image compression allows for the faster loading of data on a slower devices such as Cameras, Computer CD drives etc.
- Overall execution time is reduced.
- Since few bits are transmitted, the probability of transmission errors also reduced.
- Security is provided against hacking.
- Since lossy compression reduces file by permanently eliminating certain information so when the file is decompressed only a portion of the original information is remaining.

2 IMAGE COMPRESSION TECHNIQUES

Based on the requirements of data reconstruction Image compression techniques are classified into lossless and lossy compression techniques.

2.1 Lossless Compression scheme:

In this scheme, there is no loss of information involved or accepted. The original data can be recovered exactly from the compressed data. This type of image compression generally is used in Medical images (DICOM), Text compression, satellite images and in astronomical data. Huffman coding, Run-length, LZW, Area coding and Chain coding are some of the lossless methods.

2.2 Lossy Image compression:

A compression scheme where the output of the decoder is different from the original input data compressed by the encoder, but the loss in information is acceptable to a user. Lossy compression scheme is suitable for natural images like photographs ,still images where in some amount of loss of information or data is acceptable to achieve a substantial reduction in bit rate.

A lossy compression technique includes the following types:

Transform coding, Fractal coding, Vector quantization, Block truncation coding, sub-band coding

2.3 Lossless compression scheme

2.3.1 Huffman coding

Huffman coding is one of the most popular lossless coding for removal of coding redundancy. Huffman code assigns a set of best variable-length codes to a set of symbols on their probabilities. Based on their statistical occurrence the pixels are ordered. The symbol which occur more frequently are assigned a lower bit level than the symbols that occur less frequently are assigned a larger number of bits. Huffman constructs a code tree from right to left.

2.2.2 Run-length coding

Run-length encoding is a very simple data compression, which used runs of identical intensities either in the row of images as run-length pairs, where each run-length pair specifies the start of a new intensity value. Run-length coding removes

spatial redundancy This is particularly useful in binary image compression, because a binary image contains only black and white and adjacent pixels are more likely to be same. Hence additional compression of binary images can be achieved by variable length coding. Run-length coding is used in facsimile machines.

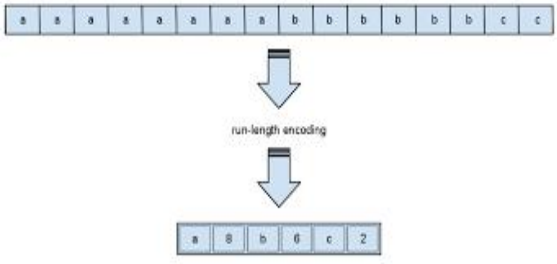

Figure: 3 Run-length coding

2.2.3 LZW coding

Lempel-Zir-Welch(LZW) coding assigns fixed-length code words to variable length sequences of source symbols. It is a dictionary based addresses the spatial redundancy. It does not require the probability of occurrence of the symbols. It uses a codebook or dictionary which contains the source symbols.LZW compression integrated with GIF,TIFF and PDF.The PNG format was created for LZW licensing requirements and it is basically dictionary based coding.

2.4 Lossy compression Techniques

2.4.1. Transform coding

An image can be compressed by transforming its correlated pixel values to a representation where they are de-correlated. Compression is achieved if the new values are smaller than the original ones. Lossy compression can be achieved by quantizing the transformed values. The decoder reconstructs the original code by inverse transform. This type of transforms are called orthogonal transforms.DCT (Discrete Cosine transform) is one of the most popular orthogonal transform. The JPEG image format is a type of transform coding in which small blocks of image averages out the color using discrete cosine transform.

2.4.2 Fractal coding

Fractal compression is also a lossy compression for digital images which is based on fractals.

In a fractal, parts of an image often resemble other parts; so it is best suited for textures and natural images. These fractal parts are converted into mathematical data by fractal algorithms and the fractal codes are used to create the encoded image.

In Fractal compression encoding is extremely computationally expensive, since the search involves self-similarities, but decoding is quite very fast than encoding.

At low compression ratios, up to 50:1 this is similar to DCT based algorithms such as JPEG.

At high compression ratios fractal compression offer superior quality. Compression ratio 170:1 have been achieved or satellite images.

2.4.3 Vector quantization

Vector quantization is suitable for both image and audio compression. It is based on two facts

1. Compression of strings than compression of individual symbols produce better results
2. Pixel correlation. So that near neighbors of a pixel P will have the same values as P or very similar values.
3. It works on selecting a parameter N that will be the size of the vectors and work with vectors of N adjacent pixels.

Preparing a codebook of vectors V and the best vector for the code book is determined and the input vector is scanned vector by vector and compressing each vector v_i by finding the code book vector v_j that is nearest. The index j is written on the output.

2.4.4 Block truncation coding

Block truncation coding (BTC) is a lossy compression technique for grey scale images. The original image is divided into

blocks ,a quantizer is used to reduce the number of grey levels in each block whilst maintaining the same mean and variance .For each block the mean and variance are calculated and these values change from block to block.

2.4.5 Sub-band coding

The transforms are of two types. Orthogonal and sub band transforms. They transform the original pixels into a few large numbers and many small numbers. Wavelet transforms, such as the Haar transform, are subband transforms. They partition the image into regions such that one region contains large numbers (averages in the case of the Haar transform) and the other regions contain small numbers (differences). These regions are called subbands, are just sets of large and small numbers. They reflect different geometrical artifacts of the image.

CONCLUSION

This paper explains the various types of image compression methods. These techniques are classified into Lossy compression techniques and lossless compression technique. In Lossless technique the image can be retrieved without any loss of information. But in case of lossy compression it causes some amount of information loss. These techniques are good for various applications. Lossy compression is mostly used to compress multimedia data like audio, video, and still images, especially in applications such as viewing low resolution photos and streaming media. By contrast, lossless compression is required for text and data files, such as text books, bank records and text articles.

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