OVERVIEW OF IMAGE COMPRESSION

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Abstract— **The paper describe the overview of image compression. Image compression is essential for applications such as Transmission and storage. Image compression means that minimizing the size of digital file, without degrading quality of the image. When reducing the file size than more image storage in given memory space. Image compression is done to increase speed and transmission Bandwidth for efficient transfer of image. Two techniques using for image compression are: Lossy techniques and lossless techniques. This paper describes DWT, DCT and Huffman encoding, Arithmetic encoding , Run length encoding. Because DWT and DCT are Lossy technique and Huffman encoding, Arithmetic encoding, Run length encoding is introduce lossless technique. Lossy compression aim is not to reproduce exact copy of original information after decompressed. Lossless compression involves with compression data which, when decompressed, will be an exact replica of original image. They need to be exactly reproduced original image when decompressed. DWT is much fame because image is compress without any data loss. DWT transforms discrete signal from time domain (spatial domain) into time-frequency domain. DCT is a technique for converting a signal into elementary frequency components.**

Index Terms— **Image compression, DCT (discrete cosine transform), DWT (discrete wavelet transform), Huffman encoding, Arithmetic encoding, Run length encoding**

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I. INTRODUCTION

Images contain large amounts of information that requires much storage space, large transmission bandwidths and long transmission times. Therefore it is advantageous to compress the image by storing only the essential information needed to reconstruct the image. The term image compression refers to the process of reducing the amount of image required to represent a given quantity of information. Because various amount of image can be used to represent the same amount of information represent that repeated information are said to be redundant data or image. I) 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 visual redundancy which is due to data that is ignored by the human visual system .The Joint Photographic Expert Group (JPEG) system, based on the Discrete Cosine Transform (DCT), has been the most widely used compression method [1] [2]. It is a widely used and robust method for image compression. It has excellent compaction for highly correlated data.DCT has fixed basis images DCT gives good compromise between information packing ability and computational complexity. JPEG 2000 image compression standard makes use of DWT (DISCRETE WAVELET TRANSFORM). DWT can be used to reduce the image size without losing much of the resolutions computed and values less than a pre-specified threshold are discarded. Thus it reduces the amount of memory required to represent given image

Huffman coding is a statistical lossless data compression technique. Huffman coding is based on the frequency of pixel in images. It helps to represent a string of symbols with lesser number of bits. In this lossless compression shorter codes are assigned to the most frequently used symbols, and longer codes to the symbols which appear less frequently in the string Discrete Cosine Transform (DCT) is an example of transform coding. Transforms the image from its spatial domain representation to a different type of representation using some well-known transform and then codes the transformed values. This method provides greater data compression compared to predictive methods .One-dimensional DCT is useful in processing Speech waveforms. Two dimensional DCT is used in signal and image processing. Inverse Discrete cosine transform (IDCT) is used for decompression. Compressing an image is significantly different than compressing raw binary data. General purpose compression program can be used to compress image, but result is less optimal. Also some of finer detail in the image can be sacrificed for the sake of saving a little more bandwidth or storage space. This means that Lossy compression technique can be used in this area. Image compression can be Lossy and Looseless compression [3][4].Lossy compression aim to reduce the amount of information to be transmitted in such a way that when the compressed information is decompressed means that there is no loss of information. Lossless compression is not to reproduce exact copy of source information after compression. They need to be exactly reproduced original image when decompressed. An approximation of the original image is enough for most purpose, as long as the error between original and the compressed image is tolerable. An error matrix means Mean square error between compressed and original image. The mathematically formulae for the two are

$$MSE = \frac{1}{MN} \sum_{y=1}^{M} \sum_{x=1}^{N} [I(x,y) - I'(x,y)]^2$$

Where I(x,y) is the original image, I'(x,y) is the approximated version (which is actually the decompressed image) and M,N are the dimensions of the images. A lower error value for MSE means lesser error, and as seen from the inverse relation between MSE and PSNR, this translates a high value of PSNR (Peak Signal to Noise Ratio). Here, the 'signal' is the original image, and the 'noise' is the error in reconstruction.

II. IMAGE COMPRESSION MODEL

Image compression techniques reduce the number of bits required to represent an image by taking advantage of these redundancies. An inverse process called decompression (decoding) is applied to the compressed data to get there constructed image. The objective of compression is to reduce the number of bits as much as possible, while keeping the resolution and the visual quality of the reconstructed image as close to the original image as possible. Image compression systems are composed of two distinct structural blocks: an encoder and a decoder. Image f (x,y) is fed into the encoder, which creates a set of symbols form the input data and uses them to represent the image.

As shown in the figure 1, the encoder is responsible for reducing the coding, interpixel and psychovisual redundancies of input image. In first stage, the mapper transforms the input image into another form it designed to reduce interpixel redundancies. The second stage, qunatizer reduce number of possible amplitude value for coding. It also reduces psychovisual redundancies. In third and final stage, a symbol decoder creates a code for quantizer output and maps the output in accordance with the code. These blocks perform, in reverse order, the inverse operations of the encoder's symbol coder and mapper block. As quantization irreversible, an inverse quantization is not included.

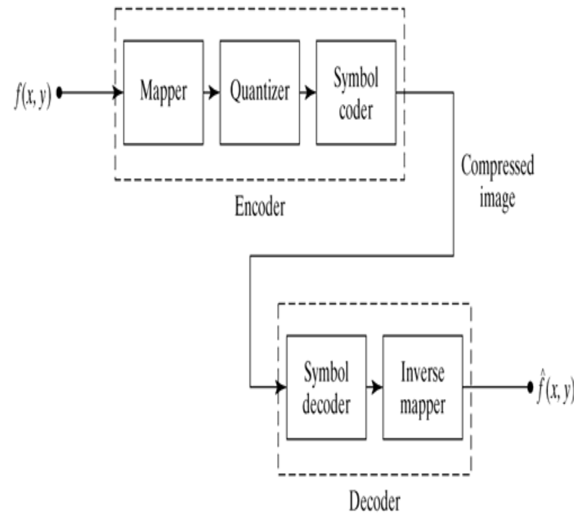

Figure 1 Image compression model

III. COMPRESSION TEACHINQUES

The image compression techniques are classified in two general types: lossless, lossy. As the name indicates that, when lossless data is decompressed, the resulting image is exactly to the original image. Lossy compression algorithms result in loss of some data and the decompressed image is not exactly the copy of the original image.

A) *Lossless compression techniques*: Lossless compression is numerically identical to the original image. It is otherwise called as noiseless compression because they do not add noise to the signal (image) [5].It is also known as entropy coding. Lossless compression algorithms reduce file size without losing image quality, though they are compressed into as small a file as a lossy compression file. When image quality is valued above file size, lossless algorithms are choose. Some image file formats like PNG or GIF use only lossless compression. The lossless PNG is most suited for editing picture.

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 [6]. Different types of Lossy compression techniques are widely used, characterized by the quality of the reconstructed image. The compression algorithms take advantage of inherent limitation of the human eye and discard invisible information. A very popular image format, jpeg, is also Lossy.

IV.LOSSLESS COMPRESSION TECHNIQUES

A. Run length encoding
B. Huffman encoding
C. Entropy encoding
D. Arithmetic coding
E. LZW coding

A*) Run length encoding*: Run length coding is a simple form of data compression in which runs of data are stored as a single data value and count, rather than as the original run [7],[8]. In binary images or Black-and-White images pixel value is 0 or 1. Here 0 values for black pixel and 1 values for white pixel. When scanning type document the scanner produces long substrings of either binary 0s and 1s.Instead of transmitting these directly, they are sent in form of a string of code words .if the output of a scanner 0000001111110000011.

B) *Huffman encoding:* The basic idea in Huffman coding is to assign short code words to those input blocks with high probabilities and long code words to those with low probabilities. A Huffman code is designed by merging together the two least probable characters, and repeating this process until there is only one character remaining. A code tree is thus generated and the Huffman code is obtained from the labeling of the code tree. As Huffman code tree varies for different sets of characters being transmitted, for receiver to perform the decoding operation it must known the codeword relating to data being transmitted.

C*) Entropy encoding*: Entropy encoding is a lossless data compression scheme; it is created and assigns a prefix code to each unique symbol that occurs in the input. These entropy encoders then compress data by replacing each fixed-length input symbol by the corresponding variable-length codeword. The length of each codeword is approximately proportional to the negative logarithm of the probability. Therefore, the most common symbols use the shortest codes [9]. Two of the most common entropy encoding techniques is Huffman coding and arithmetic coding.

D) *Arithmetic coding*: A rithmetic codes generate non-block code. A one-to-one corresponding between source symbols and code words not exist. Instead, an entire sequence of source symbols is assigned a single arithmetic code word. The codeword itself define an interval of real numbers between 0 and 1. As the numbers and symbols increase the interval becomes smaller and numbers of bits necessary to represent it become larger. Each symbol of message reduces size of interval in accordance with its probability occurrence.

E*) LZW coding: LZW* (Lempel- Ziv – Welch) is a dictionary based coding. Dictionary based coding can be static or dynamic. In static dictionary coding, dictionary is fixed during the encoding and decoding processes. In dynamic dictionary coding, the dictionary is updated on fly. LZW is widely used in computer industry.

V. LOSSY TECHINQUES

A. Transform coding
B. DCT
C. DWT
D. Fractal compression

A) *Transform coding*: Transform coding scheme image data compression is lossy compression scheme. The encoding involves transforming the source information one form into another. The rate of change in magnitude as one transverses the matrix gives rise to a term known as spatial frequency and for any particular image, there will be mix of different spatial frequencies whose amplitude are determined by the related change in magnitude of pixels. If we scan the matrix both horizontal or vertical direction and this turn, given rise to term horizontal or vertical frequency components of image. The transform of two-dimensional matrix of spatial frequency components can be carried out using a mathematical technique known as discrete cosine transform (DCT).

B) DCT (Discrete cosine transforms): Like other transform DCT attempts to decorrelate the image data. After decorrelation each transform coefficient can be encoded indepently without losing compression efficiency. The performance of DCT is very close to the Karhunen-Loeve Transform (KLT) and requires less computational complexity [10]. The discrete cosine transform (DCT) helps separate the image into parts (or spectra sub-bands) of differing importance (with respect to the image's visual quality). A discrete cosine transform (DCT) expresses a finite sequence of many data points in terms of a sum of cosine functions oscillating at different frequencies. DCTs are important to numerous applications in science and engineering, from lossy compression of audio (e.g. MP3) and images (e.g. JPEG) (where small high-frequency components can be discarded), to spectral for the numerical solution of partial differential equations. Discrete Fourier transform: it transforms a signal or image from the spatial domain to the frequency.

The most common DCT definition of a 1-D sequence of length N is

$$c(u) = a(u) \sum_{x=0}^{N-1} f(x)\cos\left[\frac{\pi(2x+1)u}{2N}\right] \quad (1)$$

for $u=0,1,2,\ldots,N-1$. Similarly, the inverse transformation is defined as

$$f(x) = \sum_{u=0}^{N-1} a(u)c(u)\cos\left[\frac{\pi(2x+1)u}{2N}\right] \quad (2)$$

for $x = 0, 1, 2\ldots, N-1$. N is the size of the block that the DCT is applied on. The equation calculates one entry (I , jth) of the transformed image from the pixel values of the original image matrix.

C) DWT: DWT is multi-resolution transform technique, generally used for image and video compression to achieve higher compression ratio. 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. In case of 2-D DWT, the input data is passed through set of both low pass and high pass filter in two directions, both rows and columns .First, the low pass filter is applied for each row of data, thereby getting the low frequency components of the row. The output data contain frequencies only in first half of original frequency range. Now the high pass filter is applied for the same row of data, and similarly high frequency components are separated and placed by side low frequency component. This procedure is done. The resulting two dimensional array of coefficients contain for band of data, each labeled as LL(low-low),LH(low-high),HL(high-low),HH(high-high). The LL band can be decomposed again in same manner. The alphabet L means low pass signal and H means high pass .

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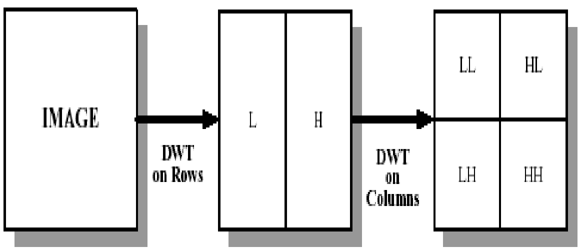

Figure 2(a) Discrete wavelet transform

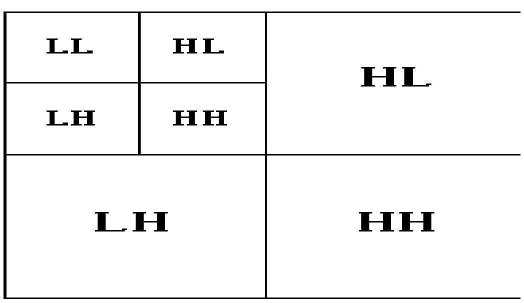

Figure 2(b) Two level decomposition

The inverse DWT of an image which we also use high pass filter and low pass filter. The filter procedure is just opposite –we start from the topmost level, apply the filter column wise first and then row wise, and proceed to next level, till we reach first level.

D) Fractal compression: Fractal compression is a lossy compression method for digital image. Image is divided into block. Then for each compression, the most similar block if found in half size version of image and stored. Then during decomposition recover the original image. 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.

IX.CONCLUSION

We have reviewed and discuss the Image compression, different classes of compression technique. We find lossy compression techniques provides high compression ratio as compare to lossless compression techniques. Lossy compression is used for high compression ratio. Loseless compression techniques are used when original image is same as reconstruct image.

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