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A Survey of Various Image Compression Techniques

KEYWORDS: Image Compression, DFT.DCT, DWT

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ABSTRACT Image Compression reduces the size of images or data and also reduces the redundancy of image .Image Compression is one of the emerging task in Image Processing. It is important to decrease the transmission time. In this paper we can discuss the techniques of Image Compression like Fourier based and Wavelet based Main goal of Compression is without effecting the quality of image or data .Discrete Cosine Transform(DCT),Discrete Fourier Transform(DFT),Discrete Wavelet Transform(DWT) are using for Image compression and give better quality.

I. INTRODUCTION

This Paper is a survey of various methods of data compression. When the computer age came about in the 1940's, storage space became an issue. Data Compression was the answer to that problem. The Compression process takes an original data set and reduces its size by taking out unnecessary data [1]. In 1949 Claude Shannon and Robert Fano devised a systematic way to assign code word based on probabilities of blocks [2]. In 1951 David Huffman found an optical method for data compression. Early implements were typically done in hardware, with specific choices of code words being made as compromises between compression and error correction [2].almost all the compression were based on adaptive Huffman coding. There are two main types of compression, Lossy and Lossless [1]. There many methods of compression which deals with the data. Digital images become popular for transferring visual information. There are many advantages to using these images over traditional camera film images. The digital cameras produce instant images, which can be viewed without the delay of waiting for film processing [3]. But these images are large in size. The compression techniques help to reduce the cost of storage and efficient transmission of digital images Compression techniques. In the first one invertible 2D transforms like Discrete transform coefficient, discrete wavelet coefficient etc are used [1][2]. We can apply these techniques to image either by applying to a set of pixels or to the whole images. Lossy methods are especially suitable for natural images such as photographs in applications where minor (sometimes imperceptible) loss of fidelity is acceptable to achieve a substantial reduction in bit rate. The Lossy compression that produces imperceptible differences may be called visually lossless [3]. Lossless compression is preferred for archival purposes and often for medical imaging, technical drawings, clip art, or comics.

In this paper we will briefly study about the Wavelet based image compression and Fourier (DCT, DFT) based Compression techniques.

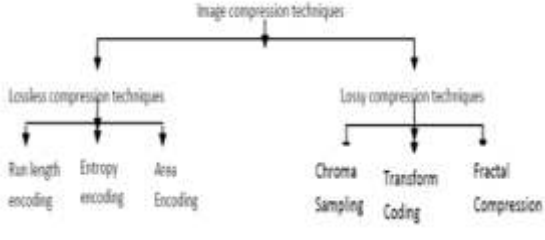

Fig 1: Various Compression Techniques [3]

In figure 1 we can see various techniques of image compression.

I. PROCEDURE

Image Compression system is composed of two distinct functional components such as: an encoder and decoder [4].

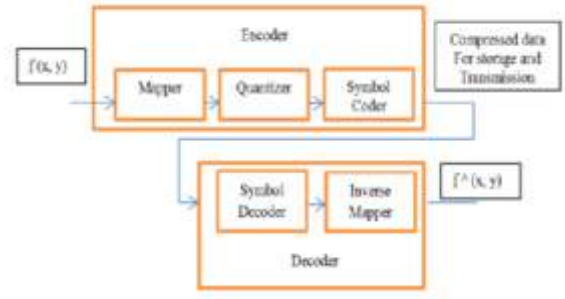

Fig 2: Functional Block Diagram of General Image Compression system [4].

In encoding process, The Mapper will transform the image and reduce the spatial and temporal redundancy. This operation is reversible and it may or may not reduce the amount data required to reduce an image. The Quantizer will reduce the accuracy of the Mapper output in accordance with the pre-established fidelity criteria. The symbol encoder generates a fixed code from a composed data for storage and transmission as shown in the figure 2 [4]. The decoder contains two components such as symbol decoder and inverse Mapper, which perform, in reverse order to recover the original image from the compressed data. The image compression technique mainly having four compression techniques they are: Lossy Compression, Lossless Compression, Predictive Compression and Transform Coding [5].

III. WAVELET BASED COMPRESSION

A wavelet is a wave-like oscillation with amplitude that starts out at zero, increases, and then decreases back to zero [6]. It can typically be visualized as a "brief oscillation" like one might see recorded by a seismograph or heart monitor. A wavelet is a mathematical function used to divide a given function or continuous-time signal into various scale components.

1. Continuous Wavelet Transform: In continuous wavelet Transforms, a given signal of finite energy is projected on a

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continuous family of frequency bands. For instance the signal may be represented on every frequency band of the form [f, 2f] for all positive frequencies f>0. Then, the original signal can be reconstructed by a suitable intention over all the resulting frequency components.

2. Discrete Wavelet Transforms: It is computationally impossible to analyze a signal using all wavelet coefficients so one may wonder if it is sufficient to pick a discrete Sub set of the upper half plane to be able to reconstruct a signal from the corresponding wavelet coefficients.

The Haar wavelet's mother wavelet function (t) can be described as:
(t) = 1 0 ≤ t ≤ 1/2,
-1 ½ ≤ t ≤ 1,
0 otherwise
Its scaling function (t) can be described as
Φ (t) = 1 0 ≤ t ≤ 1,
0 otherwise
Advantages of Haar Wavelet transform [6]:
1. Best performance in terms of computation time
2 .Computation speeds is high
3. Memory efficient
4. Simplicity
5. Easily implementable in hardware

For image compression, transform coding is of two types:
1. Discrete Cosine transform
2. Discrete Wavelet transform

In this paper, discrete Haar wavelet transform is used which has following advantages over discrete cosine transform:

1. DCT is used for transformation in JPEG standard whereas DWT is used for transformation in JPEG 2000 standard.

2. DWT avoids blocking artefacts which degrades reconstructed images which DCT can't do.

3. Compression increases with increase in window size for DCT and decreases with increase in window size for DWT.

A. Haar Wavelet Transform: Haar wavelet transform (HWT) consists of both: low pass and high pass filters is the preferred wavelet because it can be readily implemented in hardware [6]. The approximation band (LL) is the result of applying low pass filter in vertical and result of applying low pass filter in vertical and applying horizontal low pass filter and vertical high pass filter, while the (HL) band is the result of horizontal high pass filter and vertical low pass filter and finally (HH) band is the result of horizontal and vertical high pass filter. In this transform each (2x2) adjacent pixels are picked as group and passed simultaneously through four filters (i.e., LL, HL, LH and HH) to obtain the four wavelet coefficients, the bases of these 4-filters could be derived as follows [6]:
1. L= 1/√2 (1 1)
2. H= 1/√2 (1 -1)
3. LL= vertical LPF+ horizontal HPF
4. HL= horizontal HPF+ vertical LPF
5. LH= horizontal LPF+ vertical HPF
6. HH= horizontal HPF+ vertical HPF

If we apply forward (HWT) on test color image (e.g., luminance component),at the beginning of decomposition, the image will be divided into four sub-bands LL, HL, LH, and HH , this procedure defines first level sub-band coding, while divided sub-band LL of first level into four sub-bands defines second level, and divided sub-band LL of second level into four sub-bands defines third level.[7] In other words, the time resolution of the Fourier series representation is not very good [6][7].In a wavelet representation, we represent our signal in terms of functions that are localized both in time and frequency. Recently, wavelets have become very popular in image processing, specifically in coding applications for several reasons [7]. Various levels of Decomposition [8].

ERROR METRICS:
Two of the error metrics used to compare the various image compression techniques is the Mean Square Error and the Peak Signal to Noise ratio to achieve desirable compression ratios. The MSE is the cumulative squared error between the compressed and the original image, whereas PSNR is a measure of the peak error. Logically, a higher value of PSNR is good because it means that the ratio of Signal to Noise is higher. Here, the 'signal' is the original image, and the 'noise' is the error in reconstruction [8].

DATA COMPRESSION RATIO:
Data compression ratio, also known as compression power, is used to quantify the reduction in data-representation size produced by data compression. The data compression ratio is analogous to the physical compression ratio it is used to mea- sure physical compression of substances, and is defined in the same way, as the ratio between the uncompressed size and the compressed size [8].

PEAK SIGNAL-TO-NOISE RATIO (PSNR):
It is the ratio between the maximum possible power of a signal and the power of corrupting noise. The PSNR is most commonly used as a measure of quality of reconstruction in image compression etc. PSNR = 20 * log10 (255 / sqrt (MSE)) [9].It is most easily defined via the mean squared error (MSE) which for two m×n monochrome images. I and K where one of the images is considered noisy [9].

IV. FOURIER BASED COMPRESSION.
The Fourier Transform may be defined as a mathematical process with many uses in physics and engineering that states a mathematical function of time as the function of frequency, called as its frequency spectrum [11]. Fourier transforms used to transform time domain signals into a frequency domain signals into a frequency domain [11]. Fourier transform is categorized by various transforms like Discrete Fourier transform(DFT), Discrete Cosine Transform (DCT), Windowed Fourier Transform (WFT), Fast Fourier transform (FFT).Time domain representation is the function of time that the frequency spectrum and the frequency domain n representation. It works by transforming a function from a time domain to the task in the frequency domain [4]. The signal can be examined for its frequency content because the Fourier coefficient of the changed function shows the influence of every sine and Cosine function at every Frequency [11]. An Inverse Fourier Transform do just the same as what you expect, alter data from the frequency domain to the time domain.
Category of Fourier Analysis.:
1 .DFT
2. DCT
3. WFT
4. FFT.

1. Discrete Fourier Transform (DFT).
The Discrete Fourier Transform (DFT) used in Fourier analysis of a function. It converts one function into another that is named the frequency domain representation. The Discrete Fourier Transform needs an input function that is discrete.

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Sampling of a continuous function represents these inputs. The discrete input functions containing a finite duration having one period of a periodic sequence. The Discrete Fourier Transforms containing the properties of the Continuous Fourier transform. The formulae of the inverse discrete Fourier transform can be simply determined with the help one of the Discrete Fourier Transform (DFT), as both the formulae are very much the same. So the DFT is called as a transform for Fourier analysis of finite-domain Discrete-Time functions [11].

2. Discrete Cosine Transform (DCT).

DCT expresses a sequence of finitely many data points in terms of sum of Cosine Functions oscillating at different frequencies. In particular, a DCT is a Fourier related Transform similarly to the Discrete Fourier Transform, but using only real numbers. DCTs are equivalent to DFTs of roughly twice the length, operating on real data with even symmetry, where in some variants the input and output data are shifted by half a sample. DCT proposed block diagram [10].

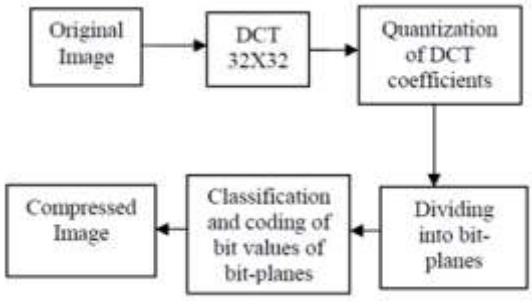

Fig 1: The Block Diagram Of Image Coding [10].

An image to be compressed is divided into 32X32pixels blocks. Then, DCT for pixel values of each block is computed. After this, the quantization of DCT coefficients of image blocks is carried out [10]. At this stage the basic losses are introduced into compressed image. Larger Quantization step provides larger compression ratio with same time it leads to larger lossless [10].

3. Windowed Fourier Transform (WFT) [11].

Window Fourier Transform is performed over a local area in which signal at one place will never disturb the signal at alter native location of spectral analysis [11]. The spectrum of the signal in a native area is much easier than the spectrum of a complete field signal. The Windowed Fourier Transform (WFT), a Windowed Fourier Filtering (WFF)algorithm and a Windowed Fourier Ridges (WFR)algorithm have been planned for fringe pattern analysis. The WFT provide info about signal in the frequency domain and in the time domain [11].

4. Fast Fourier Transform (FFT) [11]

Fast Fourier Transforms is an appropriate algorithm, which is used for computing Discrete Fourier Transform and its opposite. There are many FFT algorithms, which should contained wide Variety of Mathematics functions and arithmetic functions of complex numbers. To find the approximated function of a sample and to find the proximate Fourier integral by a discrete Fourier Transform should be looked-for relating a matrix having order is the number of the sample point n. If multiplying a matrix by the vector cost on the order of arithmetic operations then a problem can occur and number of sample point increase. If the samples are uniformly spread out then the Fourier matrix will be divided to a product of limited scant matrices and the resultant factors should be applied to a vector in a total of order arithmetic operations. It is known as Fast Fourier Transform (FFT) [11].

V. CONCLUSION

In this paper we have studied about various technique related to image Compression. These techniques are used to maintain the image quality. These basically classified in to two categories: Lossy Compression and Lossless technique. The image can be decoded without any Loss of information. These techniques are used for various applications.

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