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Transmission and storage of images Using Discrete Wavelet Transform

[1]Santosh Kumar Sahoo,[2]B.B.Choudhury
[1]*(PhD. Scholar, Utkal University, ODISHA, INDIA)*
[2]*(Dept. of Mechanical Engg., IGIT , Sarang,ODISHA,INDIA)*

ABSTRACT: As the massive data associated with the Image so for transmission and storage of digital images. It is necessary to compress the image in a perfect manner. This paper proposes a novel image compression structure centered on wavelet transformation (WT). The efficiency of the algorithm has been justified over several real images, and the performance of the algorithm has been matched with other common compression criteria. The procedure has been implemented using Visual C++. Experimental results prove that the proposed technique provides sufficient high compression ratios compared to other compression techniques.

KEYWORDS: Image Compression, Wavelet Transform,Digital images

I. INTRODUCTION

Image compression is imperative for many applications that involve huge data storage, transmission and retrieval such as for cinematographic, documents and videoconferencing. Uncompressed images require considerable storage capacity and transmission bandwidth. The objective of image compression technique is to reduce redundancy of the image data in order to store or transmit the data in an efficient form. This fallouts in the reduction of file size and allows more images to be stored in a given amount of disk or memory space. Image compression can be lossy or lossless. In a lossless compression algorithm, compressed data can be used to re-form an exact carbon copy of the original; no information is lost to the compression process. This type of compression is also known as entropy coding. This name comes from the fact that a compressed signal is generally more random than the original; patterns are removed when a signal is compressed. Lossless image compression is particularly useful in image archiving as in the storage of legal records. Methods for lossless image compression includes: Entropy coding, Huffman coding, Bit-plane coding, Run-length coding etc. In lossy compression, the original signal cannot be exactly restored from the compressed data. The purpose is that, much of the feature in an image can be discarded without greatly changing the presence of the image. As an example consider an image of a Cow, which occupies several hundred megabytes. In lossy image compression, though very fine details of the images are lost, but image size is considerably reduced. Lossy image compressions are useful in applications such as broadcast television and replica communication, in which a certain amount of error is an acceptable trade-off for increased compression performance. Procedures for lossy compression include: Fractal compression, Transform coding, Fourier-related transform, DCT (Discrete Cosine Transform) and Wavelet transform.

In this research a novel image compression scheme is proposed based on discrete wavelet transform that results less computational complexity with no loss in image eminence. The performance of the projected algorithm has been compared with some other common compression standards. Several quality measurement variables like peak signal to noise ratio (PSNR) and mean square error (MSE) have been estimated to determine how well an image is reproduced with respect to the reference image.

II. LITERATURE REVIEW

DeVore et.al [1] described a novel theory that introduced for analyzing image compression methods based on compression of wavelet decompositions. Their theory precisely relates (a) the rate of decay in the error between the original image and the compressed image as the size of the compressed image representation increases (i.e., as the amount of compression decreases) to (b) the smoothness of the image in certain smoothness classes called Besov spaces. Grgic, S. et.al [2] examined a set of wavelet functions (wavelets) for implementation in a still image compression system and to highlight the benefit of this transform relating to today's methods. They discussed important features of wavelet transform in compression of still images, including the extent to which the quality of image is degraded by the process of wavelet compression and decompression. Tsung-Ching et.al [3] described the variety of arrhythmia ECG signal utilized for optimizing the quantization scheme of wavelet-based ECG data compression based on a genetic algorithm (GA). The compression performance and convergence speed of reconstruction quality maintenance were evaluated by using the MIT-BIH arrhythmia database. Dr.BEswara et al[4] analyzed different wavelet techniques for imagecompression. Both hand-designed and lifting based wavelets are considered. Hand designed wavelets considered in this work are Haar wavelet,Daubechie wavelet, Biorthognal wavelet, Demeyer wavelet, Coiflet wavelet and Symlet wavelet. Lifting based wavelettransforms considered are 5/3 and 9/7. A.Alice et.al [5]presented an image compression using 9/7 wavelet transform based on the lifting scheme. This is simulated using ISE simulator and implemented in FPGA. The 9/7 wavelet transform performs well for the low frequency components. Implementation in FPGA is since because of its partial reconfiguration. The project mainly aims at retrieving the smooth images without any loss. This design may be used for both lossy and lossless compression. Prabhakaret.et.al [6] described the image compression using DCT and Wavelet transform by selecting proper threshold method, better result for PSNR have been obtained.S.Bhavaniet. al [7] explained about the various coding algorithms and advancements in an image compression. Several lossless schemes based on linear prediction and interpolations have been proposed. G. K. Kharate et.al [8] proposed the proper selection of mother wavelet on the basis of nature of images, improve the quality as well as compression ratio remarkably. They suggest the novel technique, which is based on wavelet packet best tree based on Threshold Entropy with enhanced run-length encoding. This method reduces the time complexity of wavelet packets decomposition as complete tree is not decomposed. Their algorithm selects the sub-bands, which include significant information based on threshold entropy.

III. IMAGE COMPRESSION AND RECONSTRUCTION

Fig. 1 shows the basic steps in an image compression system. The image compression system is composed of two distinct structural blocks: an encoder and a decoder. Image $f(i,j)$ is fed into the encoder, which creates a set of symbols from the input data and uses them to represent the image. Image $\hat{f}(i,j)$ represents an approximation of the input image that results from compressing and subsequently decompressing the input image.

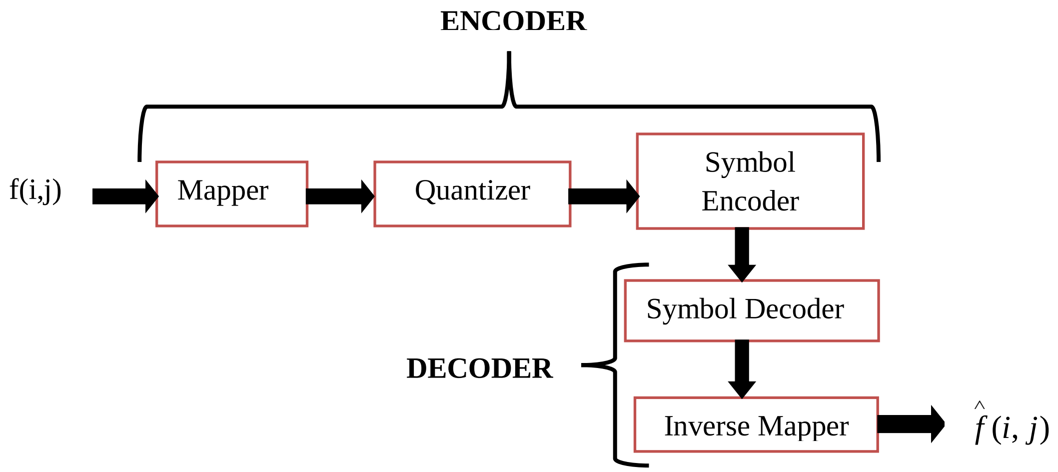

Fig. 1 Basic steps in an image compression system

The compression that is achieved can be quantified by the compression ratio given by the following formula:

$$C_R = \frac{n_1}{n_2} \qquad (1)$$

where*n1*and *n2* denote the number of information carrying units (bits) in the original image and the compressed image respectively. A compression ratio like 10 (or 10:1) indicates that the original image has 10 information carrying units (e.g. bits) for every 1 unit in the compressed data set. Several quality measurement variables like, PSNR (peak signal-to-noise ratio), MSE (mean square error) etc. can be measured to find out how well an image is reproduced with respect to the reference image. These variables are signal fidelity metrics and do not measure how viewers perceive impairments. Numerical values of these variables for any image tell us about the quality of that image [6-8]. The measure of peak signal-to-noise ratio (PSNR) is defined as the following formula:

$$PSNR = 10\log_{10}\left(\frac{255^2}{MSE}\right)dB \qquad (2)$$

and, mean square error (MSE) is given by,

$$MSE = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}\left[f(i,j) - \hat{f}(i,j)\right]^2 \quad (3)$$

IV. THE WAVELET TRANSFORM

A wavelet is a waveform of efficiently limited duration that has an average value of zero. The term 'wavelet' comes from the fact that they integrate to zero and they wave up and down across the axis. Many wavelets also display a property ideal for compact signal representation like orthogonally. This property ensures that data is not over represented. A signal can be decomposed into many shifted and scaled representations of the original mother wavelet. A wavelet transform can be used to decompose a signal into component wavelets. Once this is done the coefficients of the wavelets can be decimated to remove some of the details. Wavelets have the great advantage of being able to separate the fine details in a signal. Very small wavelets can be used to isolate very fine details in a signal, while very large wavelets can identify coarse details. One particular wavelet may generate a more sparse representation of a signal than another, so different kinds of wavelets must be examined to see which is most suited to image compression.

A wavelet function Ψ(t) has two main properties, $\int_{-\infty}^{0}\psi(t)dt = 0$

That is, the function is oscillatory or has wavy appearance. $\int_{-\infty}^{0}|\psi(t)|^2 dt \le \infty$

That is, the most of the energy in Ψ(t) is confined to a finite duration.

V. PROPOSED COMPRESSION METHOD USING DWT

This section illustrates the proposed compression technique with lopping proposal based on discrete wavelet transform (DWT). The proposed technique first decomposes an image into coefficients called sub-bands and then the resulting coefficients are compared with a threshold. Coefficients below the threshold are set to zero. Finally, the coefficients above the threshold value are encoded with a loss less compression technique.

The compression features of a given wavelet basis are primarily linked to the relative scarceness of the wavelet domain representation for the signal. The notion behind compression is based on the concept that the regular signal component can be accurately approximated using the following elements: a small number of approximation coefficients (at a suitably chosen level) and some of the detail coefficients.

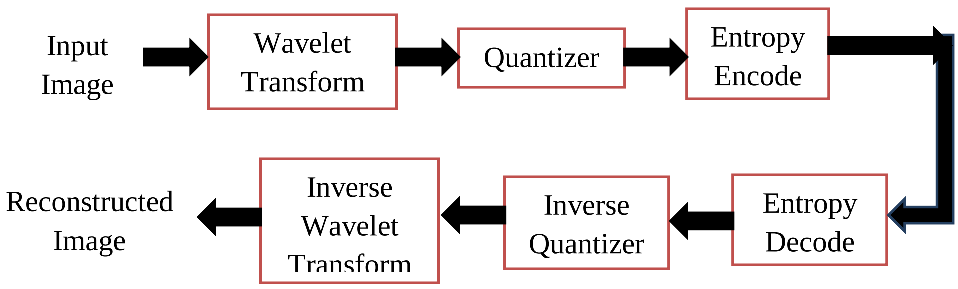

Fig. 2 The structure of the wavelet transform based compression.

The steps of the proposed compression algorithm based on DWT are described below:

[A]. Decompose

Choose a wavelet; choose a level N. Compute the wavelet. Decompose the signals at level N.

[B]. Threshold detail coefficients

For each level from 1 to N, a threshold is selected and hard thresholding is applied to the detail coefficients.

[C]. Reconstruct

Compute wavelet reconstruction using the original approximation coefficients of level N and the modified detail coefficients of levels from 1 to N.

VI. EXPERIMENTAL RESULTS AND DISCUSSION

In this research, an efficient compression technique based on discrete wavelet transform (DWT) is proposed and developed. The algorithm has been implemented using Visual C++. A set of test images (bmp format) are taken

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to justify the effectiveness of the algorithm. **Fig. 3** shows a test image and resulting compressed images using JPEG,GIF and the proposed compression methods.

The experimental results with the proposed compression method have been arranged in the **Table 1** for different threshold values. From this table, we find that a threshold value of δ = 30 is a good choice on the basis of trade-off for different compression ratios. **Table 2** shows the comparison between JPEG, GIF and the proposed compression method. Experimental results demonstrate that the proposed compression technique gives better performance compared to other compression techniques.

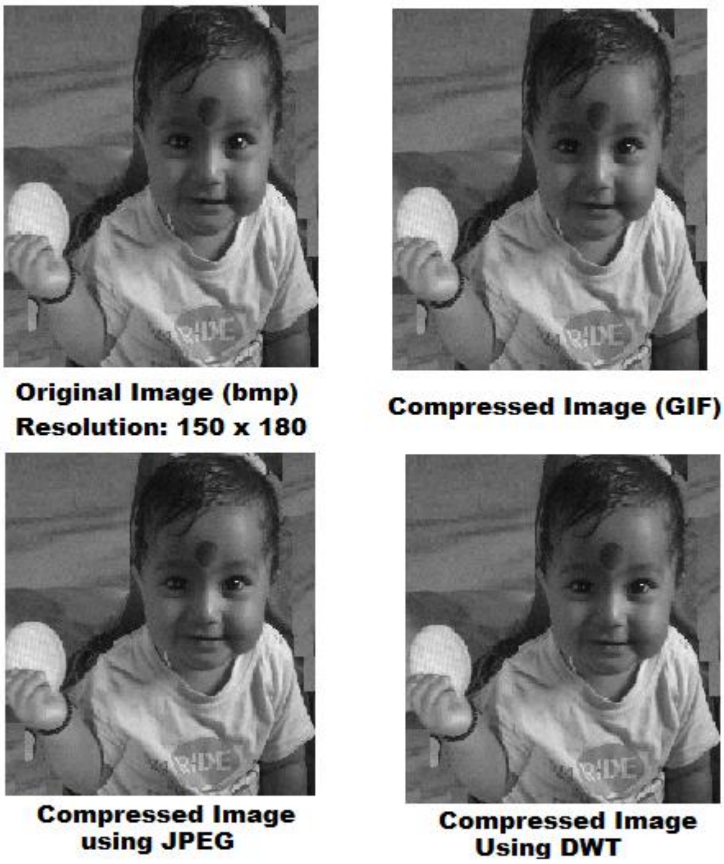

Fig.3 A real image and corresponding compressed images with GIF, JPEG and proposed DWT methods.

Table 1. Compression Results with Proposed Method for different threshold values

Threshold Values	**Size of the original image**	**Size of the Compressed image with DWT**	**Compression Ratio**
Without Threshold	52KB	2.45KB	18.75:1
$\delta = 10$	52KB	2.26KB	21.25:1
$\delta = 20$	52KB	2.18KB	22.33:1
$\delta = 30$	52KB	1.99KB	24.23:1
$\delta = 40$	52KB	2.11KB	21.88:1
$\delta = 50$	52KB	2.09KB	22.26:1

Table 2. Comparison between DWT and other Compression methods

Compression Techniques	**File Sizes**	**Compression Ratio**	**PSNR (dB)**
Original Image (Bitmap)	52 KB	-	-
GIF	6.60KB	7.34:1	27.38
JPEG	3.55KB	13.90:1	24.32
DWT (Proposed Method)	1.99	24.23:1	19.36

VII. CONCLUSIONS

A new image compression scheme based on discrete wavelet transform is proposed in this research which provides sufficient high compression ratios with no appreciable degradation of image quality. The effectiveness and robustness of this approach has been justified using a set of real images. The images are taken with a digital camera (SONY-DSC-W830). To demonstrate the performance of the proposed method, a comparison between the proposed technique and other common compression techniques has been revealed. From the experimental results it is evident that, the proposed compression technique gives better performance compared to other traditional techniques. Wavelets are better suited to time-limited data and wavelet based compression technique maintains better image quality by reducing errors. The future direction of this research is to implement a compression technique using neural network.

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