DEVELOPMENT OF LOSSY COMMPRESSION TECHNIQUE FOR IMAGE

Asst.Prof.Deepti Mahadeshwar ,*Prof. V.M.Misra
Department of Instrumentation Engineering, Vidyavardhini's College of Engg. And Tech., Vasai Road, *Prof in Vivekananda Education society, chembur (W)
E-Mail ID : deepti.mahadeshwar@gmail.com.

ABSTRACT
Algorithms and associated software for (1) Embedded Zero Tree (EZW) and (2) Embedded Zero Tree with Huffman have been developed and fully tested with both Standard and Raw images. Algorithms and associated software for WinZip and JPEG have been downloaded directly from the internet for comparison.
The databases have been prepared with six Standard and eight Raw images having different resolutions, to test the developed and downloaded algorithms and associated software.
It is observed that as the Threshold value increases the compression ratio increases but the image quality deteriorates. The compression ratio and PSNR are also reduced due to addition of Gaussian Noise at the input of image.
From the comparative results it can be concluded that new developed combinational method shows better compression ratio with least deterioration in image quality of picture at maximum threshold of 50.

KEYWORDS
Compression, Embedded Zero Tree (EZW),threshold,PSNR

INTRODUCTION

In today's world of digitization, computer and its applications are must in every field. Various applications involve image and video processing. For example to handle large number of images at a time it required huge storage space and bandwidth for transmission. Here compression plays vital role.

Image compression is aimed to minimize the number of bits needed to represent an image without sacrificing the quality of image. Compression is the process of transforming the data description into a more succinct and condensed form. This improves storage efficiency, communication speed and security.
Image compression addresses the problem of reducing the amount of data required to represent a digital image. The underlying basis of the reduction process is the removal of redundant data. The transformation is applied prior to storage or transmission of the image. At some time later the compressed image is decompressed to reconstruct the original image or an approximation of it. Compression leads to significant reduction in the memory required for storage.

THEORY OF EZW ALGORITHUM

It generates a lot of unimportant data after wavelet transforming on image data. It discards some unimportant data after the process of quantizing and coding according to some special rules and the remained data can represent the original data approximately[2]. This is the principle of Image compress algorithm based on wavelet transform.

Zero-tree coding method is one of the most popular image compress algorithms using wavelet transforms and Embedded Zero-tree Wavelets (EZW) coding is the representative method of the zero-tree coding based. EZW was invented by Shapiro in 1993[3]. It is an embedded wavelet image coding algorithms, which has a high compression rate. It is a progressive coding method and can perform well at image compressing from lossy to lossless.

The main features of EZW include compact multiresolution representation of images by discrete wavelet transformation, zero-tree coding of the significant wavelet coefficients providing compact binary maps, successive approximation quantization of the wavelet coefficients, adaptive multilevel arithmetic coding, and capability of meeting an exact target compress rate.

The basic process flow of EZW algorithm can be described as follows: Operate the image through wavelet transform and quantizing the coefficients.

Given a series of threshold values which are sorted from high to low, for every threshold (current threshold value equals to 1/2 of the former threshold), sort all the coefficients and remain the important coefficients and discard unimportant coefficients according to this threshold.

It will generates four symbols, respectively named positive important coefficient(POS), negative important coefficient(NEG), isolated zero(IZ) and zero-tree root(ZTR). Gradually decrease the threshold and find the important coefficients due to a peculiar scan order.

It will form a sequence of important coefficients through this method named Successive Quantization. We can see that, EZW generates an embedded bit-stream thus allowing the progressive transmission and precise control of target bit rate or target distortion[3-4].

Although EZW has a high compress rate and it do well for reverting the image, there still some defects, such as it must cost the same memory as the whole image when operating the image, not suit for browsing image in sub blocks, and so on, needed to be improved.

Algorithum:

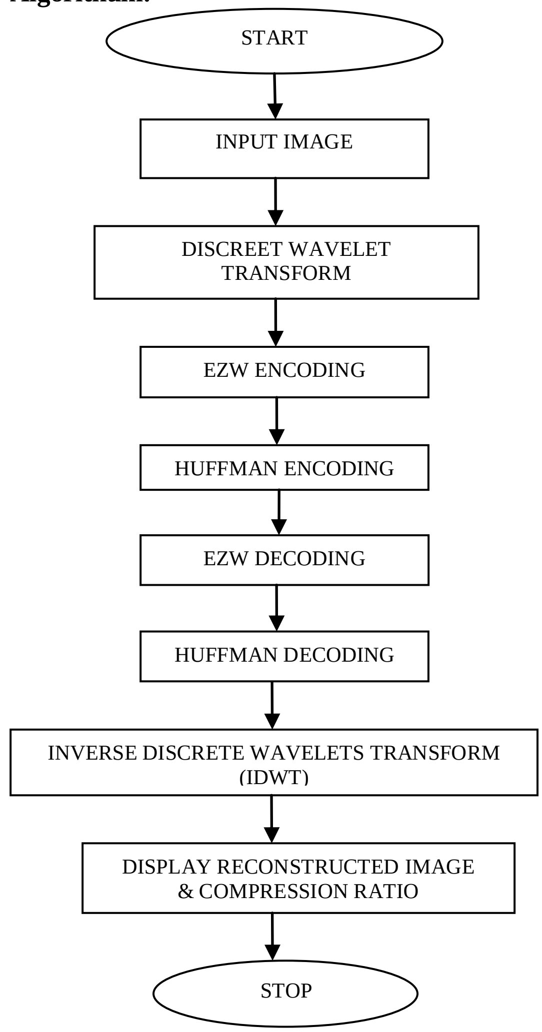

Figure 1: Algorithm of embedded zero tree

DOUBLE CODING TECHNIQUE:
Looking into the above problem the new method also called combinational method/double coding technique was developed using Embedded Zero Tree wavelet (EZW) followed by Huffman.

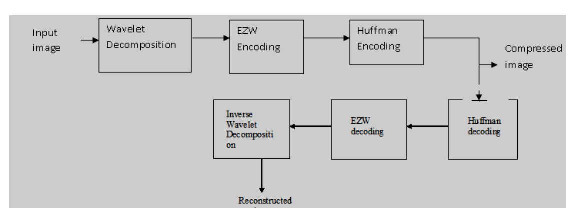

Figure 2: Double Coding Technique

After compression of the interested area an image is suitable to transmit real time on web. When the image is compressed by Embedded Zero Tree wavelet (EZW) algorithm ,some redundant data is still remaining .The above image and compression ratio can be improved further by using combinational technique. It uses Huffman coding method to compress the image continually after the image is compressed by Embedded Zero Tree wavelet (EZW) method .This combinational algorithm make use of coefficient relationship generated by Embedded Zero Tree wavelet (EZW) coding and also improves the compression ratio.

In the combinational technique the image data compressed by Embedded Zero Tree wavelet (EZW) coding, first counts the number of pixels and computes the probability for every pixel occurring in the image. Then sorts the probability in descending order. It develops a bitree, based on the smallest two probability values on the left leaf node and put the smaller on the right leaf node. The root node of the bintree is the sum of the probability of the two leaf nodes. Repeat the steps are repeated until a Huffman Tree is generated. Coding is done in binary format (0, 1). it develops classes that describe the probability of the image pixel . It needs to scan all codes to compress stage and slow down the processing speed. But the problem doesn't arrive at decoding stage.

Huffman coding is a lossless coding method. But together working with Embedded Zero Tree wavelet (EZW) displays as lossy compression.

The image is reconstructed by using Huffman decoder, Embedded Zero Tree wavelet (EZW) decoder, Inverse Wavelet Transform with better compression ratio.

WINZIP 11.0 and JPEG:

To prove the correctness of the results obtained with the developed algorithm and software, these were compared with those results got from the standard lossless algorithm WinZip 11.0 and lossy algorithm JPEG. (Both of which are downloadable from the internet directly.)

The accuracy and repeatability were in agreement in both cases.

IMAGE QUALITY EVALUATION:

SNR:

A standard objective measure of coded image quality is signal-to-noise ratio (SNR) which is defined as the ratio between signal variance and reconstruction error variance [mean-square error (MSE)] usually expressed in decibels (dB)

$$SNR(db) = 10\log_{10}\left(\frac{\sigma_x^2}{\sigma_r^2}\right) = 10\log_{10}\left(\frac{\sigma_x^2}{MSE}\right)$$

When the input signal is an R-bit discrete variable, the variance or energy can be replaced by the maximum input symbol energy . For the common case of 8 bits per picture element of input image, the peak SNR (PSNR) can be defined as

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

SNR is not adequate as a perceptually meaningful measure of picture quality, because the reconstruction errors in general do not have the character of signal-independent additive noise, and the seriousness of the impairments cannot be measured by a simple power measurement [22]. Small impairment of an image can lead to a very large value of σ_r^2 and, consequently, a very small value of PSNR, in spite of the fact that the perceived image quality can be very acceptable. In fact, in image compression systems, the truly definitive measure of image quality is perceptual quality. The distortion is specified by mean opinion score (MOS) [23] or by picture quality scale (PQS) [24].

In addition to the commonly used PSNR, we chose to use a perception based subjective evaluation, quantified by MOS,and a perception-based objective evaluation, quantified by PQS.For the set of distorted images, the MOS values were obtained from an experiment involving 11 viewers. The viewers were allowed to give half-scale grades. The testing methodology was the double-stimulus impairment scale method with five-grade impairment scale described in [25]. When the tests span the full range of impairment, the double impairment scale method is appropriate and should use.

RESULT

Below summarizes the comparative results with threshold values of 30 ,50 and 70 for all the 06 Raw images with WinZip 11.0, JPEG, Embedded Zero tree Wavelet (EZW), Huffman and Embedded Zero tree Wavelet (EZW) with Huffman (new method developed and reported in the report) algorithms. WinZip11.0 and JPEG algorithms and software have been taken from the software available on the internet while other algorithms and software have been developed and fully tested with the listed 06 Raw images.

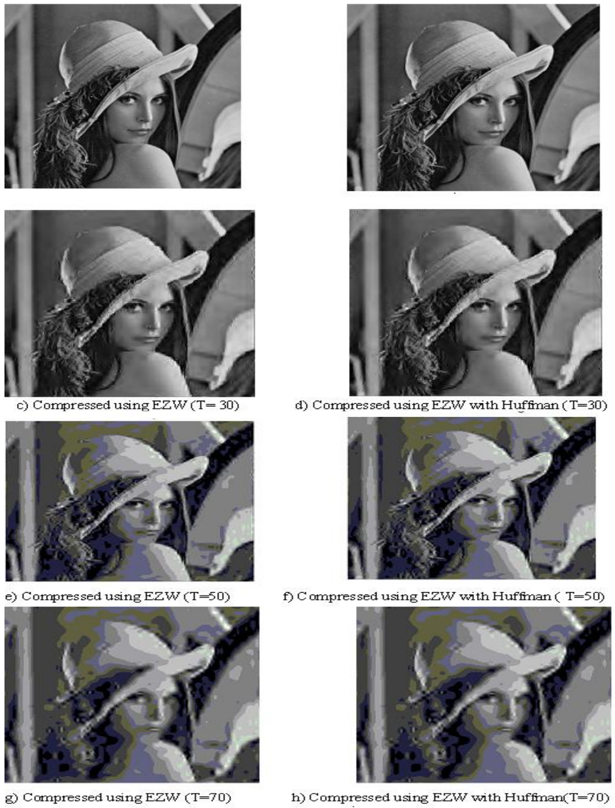

Figure3 :result of compressed image Lena

Summarized Result:

IMAGE	FILE SIZE	65KB		
	NAME	LENA		
COMPRESSED FILE SIZE	WINZIP	59KB		
	JPEG	9KB		
		THRESHOLD 30	THRESHOLD 50	THRESHOLD 70
	EZW WITHOUT HUFFMAN	9KB	5KB	2.15KB
	EZW WITH HUFFMAN	6KB	4KB	1.43KB
COMPRESSION RATIO	WINZIP	1.1:1		
	JPEG	7.40:1		
		THRESHOLD 30	THRESHOLD 50	THRESHOLD 70
	EZW WITHOUT HUFFMAN	6.42:1	13.48:1	30.14:1
	EZW WITH HUFFMAN	10.22:1	21:1	45.37:1
PSNR	JPEG	32.26		
	EZW AND EZW+HUFFMAN	THRESHOLD 30	THRESHOLD 50	THRESHOLD 70
		27.65 dB	26.21 dB	23.53 dB

Table 1: Summary Result

CONCLUSION:

The system is fully designed and developed with algorithms based on Embedded Zero Tree Wavelet (EZW) with Huffman. The developed dual algorithm method results in better compression ratio, less memory requirement and also retains fair amount of image quality.

From the comparative results it can be concluded that new developed method shows better compression ratio with least deterioration in image quality at maximum Threshold value of 50.

Embedded Zero tree wavelet (EZW) algorithm and Embedded Zero Tree Wavelet (EZW) with Huffman algorithms have been compared with WinZip and JPEG.

The results prove that combined method i.e. Embedded Zero Tree Wavelet (EZW) with Huffman algorithms gives better compression ratio with less memory requirement and also reasonable quality of image.

FUTURE SCOPE:

The scope of the project work can be further enhanced as described below:

1) The project deals with still images only and since, Video is a combination of frames of images. The method can be further developed for compression of Video.

2) The present design considers only bitmap images, the scope can be further improved for other types GIF, PNG, TIFF, PDF, PBM of images.

3) The developed system deals only for images with resolution of 256*256 and 512*512 modified algorithm can consider all image sizes.

4) Further the algorithm can be developed for compression of color images.

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