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Study of Image Compression Based on Wavelet Transform

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***Abstract*-The key technology of image compression is that image data is transformed, the transformed data is quantized and the quantized data is entropy coding. Using wavelet image compression is a common method of image compression, and this paper uses wavelet transform, multi-resolution analysis and quantization and coding of different scale wavelet coefficients to achieve image compression. And at the same time, the paper adopts two different methods that the first method is to take the low frequency and abandon high frequency and the second method is the threshold method to achieve image compression. For the threshold method, it also takes different research programs in order to achieve high image compression.**

Keywords- Wavelet Transform; Image Compression; Wavelet Coefficients; Quantization; Coding

I. INTRODUCTION

Image compression [1] is the technology that refers to a little loss bit rate or lossless to represent the original matrix of pixels. In information theory, it is called the validity of the source coding problem, namely by removing redundant or unnecessary information to achieve this objective. Compression of the image information has two methods of analog and digital, since the digital compression method has incomparable superiority analog compression method, the vast majority of systems use digital compression method.

All along, the common method of the signal analysis and processing is the Fourier Transform (FT), and is also the most widely analytical tool used in image processing, but because the Fourier Transform cannot meet characteristics of localization of the time domain and frequency domain, while the wavelet transform has these two characteristics, and these two characteristics make the wavelet transform coefficients of the same spatial position described on different scales of have similarity, which makes data structure of the wavelet transform is very suitable for encoding. In recent years, the use of wavelet transform for image compression has made great progress, and transform algorithm also makes full use of the wavelet coefficients which has the statistical properties [2].

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II. THE BASIC PRINCIPLE OF IMAGE COMPRESSION CODING

Image coding research focuses on how to compress the image data information, under the condition of allowing a certain degree of distortion of the image (including the subjective visual effects), which is referred to as image compression coding. After the system makes image signal from the signal source encoded by linear PCM through the PCM encoder, the compression encoder compresses the image data and then gets rid of code word of the redundant data. The basic principle of image compression coding is shown Figure.1 [3].

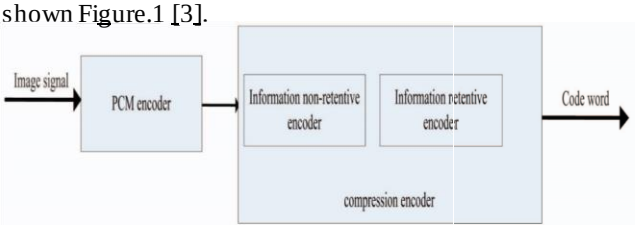

Figure.1: The basic block diagram of image compression coding

Thus the image coding is to use the statistical properties of the inherent image and visual characteristics, which extracts valid information from the original image information by the compression coding and removes some useless redundant information so as to allow for efficient transmission of the digital image or a digital storage. When the image is recovered, the recovery of the image that is a little different from the original image is obtained, which maintains valid information of the image.

III. THE BASIC THEORY OF WAVELET ANALYSIS

The wavelet transform has good localization features of time and frequency domain, which makes full use of the non-uniform distribution of resolution, and for high-frequency signals, uses hour window, and for the low-frequency signal analysis, uses a large time window. This coincides with a time-frequency distribution characteristics that high-frequency signals continue shortly in the general nature, and the low-frequency signal lasts a long time, which is well suited for image processing.

IV. IMAGE COMPRESSION BASED ON WAVELET TRANSFORM

A. Basic Idea That Wavelet Transform Is Used for Image Compression

Basic idea that wavelet transformation is used for image compression [4]: first wavelet is selected to transform the original image, and a series of wavelet coefficients are obtained, and then these coefficients are quantized and encoded. Using certain characteristics same sub-band wavelet coefficients of between adjacent

elements and in quantized wavelet coefficients achieve the purpose of image data compression.

B. *Two-Dimensional Multi-resolution Analysis and Matlab Algorithm [5] [6]*

The image signal is changed by dimensional wavelet transformation, which needs to introduce two-dimensional multi-resolution analysis and Matlab algorithm. The case of two-dimensional separable multi-resolution analysis and Matlab algorithm can easily be marketed by a one-dimensional case.

Figure.2 and Figure.3 are respectively two-dimensional Matlab decomposition diagram and reconstruction algorithm diagram [7].

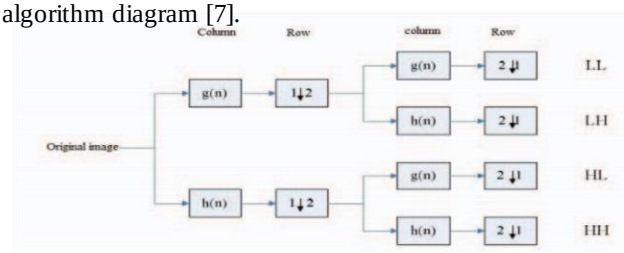

Figure.2: Two-dimensional Matlab decomposition diagram

represents each of the two columns takes out a column and indicates every two lines takes one line, and LL denotes a low-pass sub-picture, LH shows the horizontal edge sub-image, HL represents the vertical edges of the sub-picture, HH represents the oblique direction edge of the sub-picture.

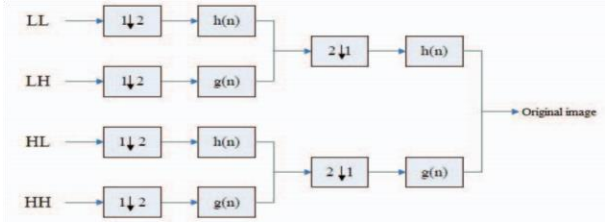

Fig.ure.3: Reconstruction algorithm diagram

Among them, represents that each two rows insert a row zero and represents that each two inserts a column zero.

V. THE SCHEME AND REALIZATION OF WAVELET IMAGE COMPRESSION

A. *Structure Diagram of Wavelet Transform Coding*

Process of the image compression is often referred as encoding. After the original image is transformed by wavelet transform, it is transformed into the wavelet coefficients of wavelet domain, then the wavelet coefficients are quantized and then. Because the wavelet transform allows that the original image energy is concentrated in a small portion of the wavelet coefficients, so the easiest way to a coefficient quantization is to omit below the threshold, which is expressed as a constant parameter and leaves only those Wavelet coefficients of a larger energy, so as to achieve the purpose of data compression. The process of image compression based on wavelet transforms [8] is shown in Figure.4:

Figure.4: The process of image compression based on wavelet transforms

At first, two-dimensional image is decomposed according to the multi-level wavelet decomposition, which makes the original image be decomposed into low-frequency component and a corresponding different directions (horizontal, vertical, and diagonal) high frequency components.

The second, frequency, high frequency components obtained are adopted to quantify the coding based on physiological characteristics of human vision different strategies. For the low-frequency component can be transformed by using fast cosine, and the high frequency component can be used for vector quantization so as to obtain a binary symbol stream.

B. *The Scheme and Implementation of Image Compression*

1) Abandoning High-Frequency Care and Taking Low-Frequency [9]

The most important part of an image is the low-frequency part, so when wavelet is reconstructed, we can leave only the low-frequency part of the wavelet decomposition, while the high frequency part of the coefficient is set to 0. Alternatively, a partial area of the high frequency coefficients set to 0, so the reconstructed image will have partial blur, remaining clear results.

Experiment uses the "bior3.7" wavelet and experimental artwork is the "comp.bmp". It decomposes the comp.bmp image by using wavelet first, which removes the high frequency part of the image and retains only the low-frequency part, then quantifies coding to achieve compression.

Results:

The size of the image before compression of comp:

Name	Size	Bytes	Class	Attributes
I	740x740x3	1642800	unit8	

The first compressed image size of the comp is:

Name Size Bytes Class Attributes Ca1 377x377x3 426387 unit8

The second compressed image size of the comp is:

Name	Size	Bytes	Class	Attributes
Ca2	193x193x3	111747	unit8	

From the results point of view, at the first time, we extract low frequency information of the first layer of the original image compression wavelet decomposition, and the compression is better, the compression is relatively small, about 1/4 size; the second compression is to extract low-frequency part of the decomposition frequency portion of the first layer, namely the low frequency part of the second layer, and the compression is relatively large, about 1/12, and the effect is not ideal. With the decomposition level

The first compression ratio is: 3.9. The second compression ratio of: 14.7.

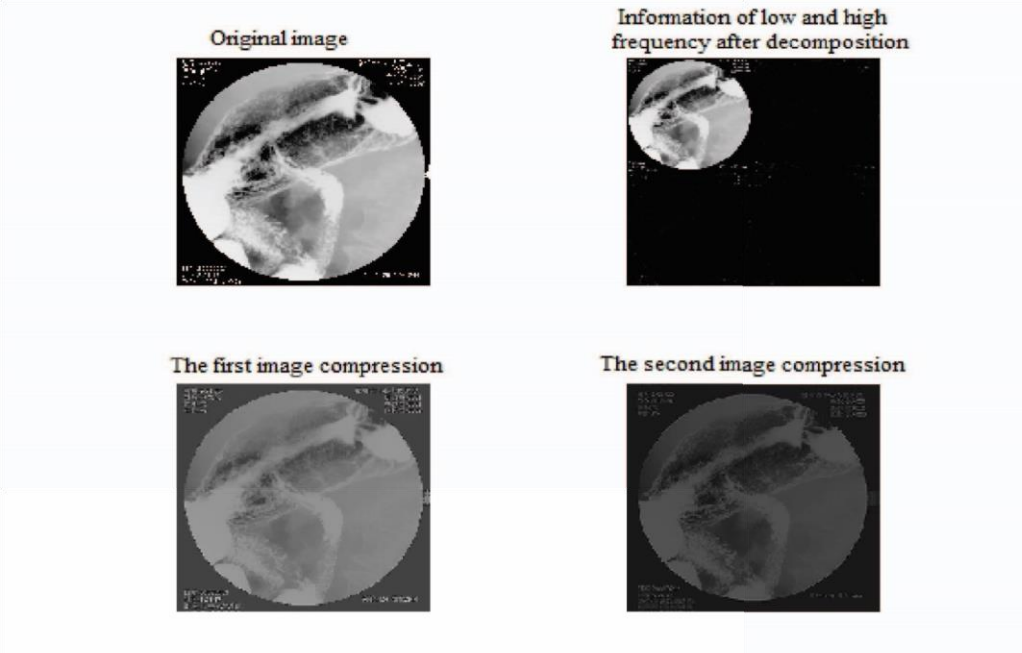

Figure.5:Theresultofabandoninghigh-frequencycareandtakinglow-frequency

increases, the compression ratio is decreasing. The way of reserving low frequency information of the original image compression is the simplest compression method. It does not require additional processing to obtain better compression results. Theoretically, any compression ratio can be obtained.

2） The Threshold Method [10]

After the image is deposed by multi-level wavelet decomposition, the low frequency coefficients are retained unchanged, then a global threshold is selected to handle the high frequency coefficients; or high frequency coefficients of different levels are processed by different thresholds. High frequency coefficients whose absolute values are below the threshold value are set to 0, or retained. Wavelet coefficients of using the remaining non-zero are reconstructed. Matlab uses the function ddencmp () to obtain default threshold during compression, and uses the function wdencmp( ) can compress one-dimensional, two-dimensional signal by wavelet.

This paper adopts a global threshold compression and hierarchical threshold compression and compares them. The results are as follows:

The experimental result of global threshold of the image:

The percentage of coefficients that are set to zero in Wavelet decomposition coefficients: perf0 = 56.3386

The percentage of residual energy after the image is compressed: perfl2 = 99.9999

The experimental result that the image is processed by layering threshold:

The percentage of coefficients that are set to zero in Wavelet decomposition coefficients: perf01 = 94.9958

The percentage of residual energy after the image is compressed: perfl21 = 97.4490

By comparing hierarchical threshold compression with the global threshold, it can get the conclusion that under the condition that the energy loss is not large, threshold compression can obtain higher compression, because the relevant direction threshold and the layers can use the information finer details to process by threshold analysis. The result is shown in Figure. 6.

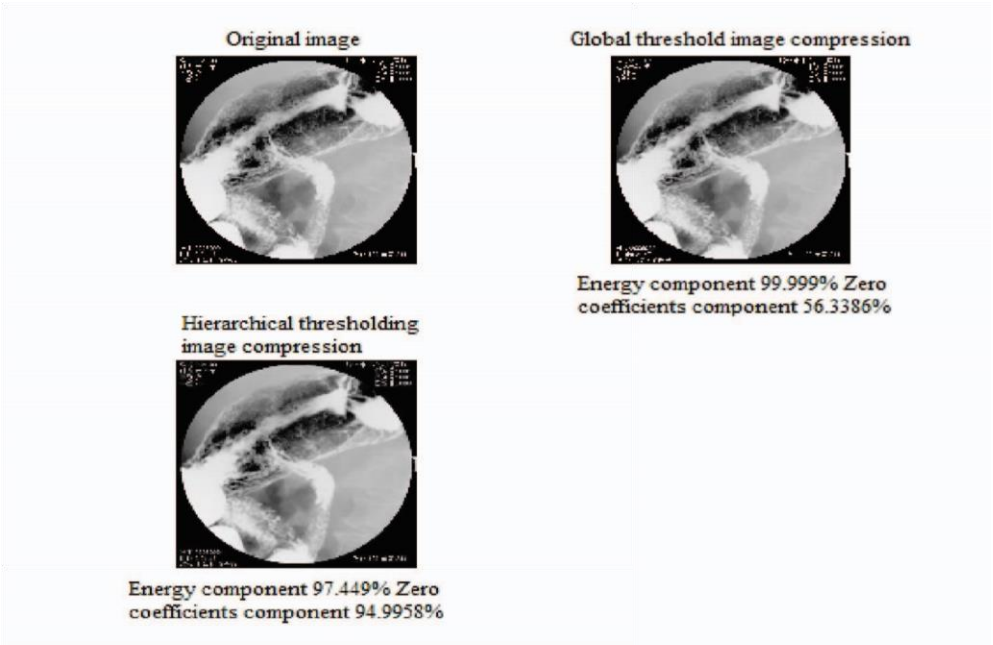

Figure. 6: The result of threshold method

VI. CONCLUSIONS

Image is an important medium for people to transmit information, and the large amount of data is a distinctive feature of a digital image, so the image compression is very important for the rapid growth of information today. This paper uses the wavelet transform for image compression, introduces the basic theory of wavelet transform and thoughts of wavelet transform in image compression. At the same time, it details the two different methods of image compression: rounding high frequency, taking low frequency and the threshold method. For threshold method, this paper uses global threshold compression and hierarchical threshold compression, and according to the experimental results, it can get the conclusion which under the condition that the energy loss is not large, threshold compression can obtain higher compression.

VII. ACKNOWLEDGMENT

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