Journal of Computational Science & Engineering 6 (2013) 250-254

Journal of Computational Science & Engineering

Available at http://www.asocse.org ISSN 1710-4068

Research on Image Compression Algorithm Which is Based on Block and Classification

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Article Information

Article history:
Received 16 March 2013
Revised 11 April 2013
Accepted 20 April 2013
Available online 10 May 2013

Keywords:
Block
Entropy
JPEG
JPEG 2000

Abstract

This paper describes the principle of compression for JPEG and JPEG2000 image compression algorithms. Firstly make the images chunk, and then submitting a new image compression algorithms, which is based on the important property of entropy, verify the new compression algorithms by simulation and data processing, and indicate that the new compression algorithm has good feasibility.

1. Introduction

Most of the current image compression algorithm of the work has focused on the improvement of the compression algorithm itself. However, as the different image features, the compression algorithm effects are different. According to the characteristic of the image, it makes the image characteristics better match to compression algorithm. This paper supplies a new algorithm for block classification image compression. Entropy is an important properties of the image which as an important basis for classification. Then we use the block classification results to put forward an image compression algorithm that based on classification of image characteristic.

2. Algorithm Description

2.1 JPEG Image Compression Algorithm.

JPEG compression algorithm is based on DCT.

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Firstly, the original images make image divide, and then DCT encode, the DCT encoder consists of discrete cosine transform (DCT), quantization, code, finally getting the compression image. Transmitting by the cable, wireless is equipment. At the receiving end, the compressed images conducted DCT decode, and reconstructed images information. DCT is as a main operating. The diagram is as follows.

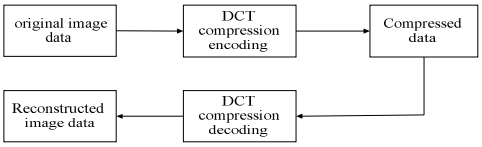

Fig. 1 JPEG image compression algorithm

DCT transformation use the properties of fourier transformation that make use of the images boundary folding to an even function form. It conducts two-dimensional fourier transformation, and the transformed only contains cosine terms, that is called the discrete cosine transformation. The definition of two-dimensional discrete cosine transform for DCT. Assuming that the matrix A is in the size M*N.

$$B_{pq} = \alpha_p \alpha_q \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} A_m \cos \frac{\pi (2m+1) p}{2M} \cos \frac{\pi (2n+1) q}{2M} \quad (1)$$

$$\alpha_p = \begin{cases} 1/\sqrt{M}, P = 0 \\ \sqrt{2/M}, 1 \le P \le M-1 \end{cases} \qquad \alpha_q = \begin{cases} 1/\sqrt{N}, q = 0 \\ \sqrt{2/N}, 1 \le q \le N-1 \end{cases}$$

B_{pq} is called the DCT coefficient matrix of A. In JPEG algorithm, M and N are both eight.

Inverse discrete cosine transform is defined as follows.

$$A_{mn} = \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} \alpha_p \alpha_q B_{pq} \cos \frac{\pi (2m+1) p}{2M} \cos \frac{\pi (2n+1) q}{2M}$$

$$0 \le m \le M-1, 0 \le n \le N-1 \quad (2)$$

The formula is that any M*N matrix of A can be expressed as the following function forms.

$$\alpha_p \alpha_q B_{pq} \cos \frac{\pi (2m+1) p}{2M} \cos \frac{\pi (2n+1) q}{2M}$$

$$0 \le m \le M-1, 0 \le n \le N-1 \quad (3)$$

These functions are called the base function of DCT transformation. So B_{pq} can be seen as a weighting that is applied to each basis function. The input images are divided into data blocks of 8 *8 size, then make each block into 64 values, and there is a numerical DC coefficient. That is the average of the 8*8 image block. The remaining 63 blocks are ac coefficient. Secondly, make quantization to the DCT coefficients. Finally, coding and transmitting the quantized DCT coefficients, and form the format of images compressed. In the decoding process, we decode the quantized DCT coefficients, and then inversing quantization DCT coefficients into the sample blocks. Finally it is combined a single image.

JPEG compression algorithm uses uniform quantization. It can be expressed as follows.

$$Q(u,v) = Round\left(\frac{F(u,v)}{S(u,v)} \right) \quad (4)$$

$Q(u,v)$ is the coefficient of amplitude quantization. $S(u,v)$ is the quantization step, it is the quantization table elements, which usually takes different values with the DCT coefficients of the position and color components. The table size is 8*8, and matching with the 64 DCT coefficients.

2.2. JPEG2000 image compression algorithm.

Firstly, the source image is divided into blocks, then conducting discrete wavelet transformation to the processed results that obtains the wavelet coefficient. Secondly, quantizing and coding the wavelet coefficients. Decoding is the inverse

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process code. Firstly, decoding, and then inverse quantization and inverse discrete wavelet transformation. Finally, reconstructing the original images. The coding block diagram as follows.

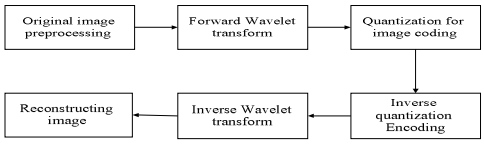

Fig. 2 JPEG2000 image compression algorithm

3. Simulation Evaluation Index.

In evaluating the performance of the algorithm for the image compression effect, it mainly has the compression ratio, the quality of reconstruction, time complexity, space complexity, cost and other aspects are considered. One of the most important is the compression ratio and the quality of reconstruction. This paper uses the performance index of compression algorithm to a macroscopic evaluation such as PSNR and MSE. Generally speaking, the smaller of MSE is the better quality of the reconstructed images. But at the fixed conditions of the images quality, the compression efficiency and image quality has a closely relationship. Sometimes, if improved the compression efficiency, the images quality will deteriorate.

$$PSNR = 10\log\left\{\frac{f_{\max}^2}{\sum_{x=0}^{N-1}\sum_{y=0}^{N-1}[g(x,y)-f(x,y)]^2}\right\} \quad (5)$$

$f_{\max}$ is the maximum value of the image gray scale.

f(x,y) is the inputting image, *x, y=0, 1, 2, ..., N-1*, *g(x,y)* is the image that *f(x,y)* compressed and decompress.

$$MSE = \frac{1}{N^2}\sum_{x=0}^{N-1}\sum_{y=0}^{N-1}[g(x,y)-f(x,y)] \quad (6)$$

4. Simulation and Analysis

4.1 Entropy Classified Algorithm.

Following is 100 images that simulate by MATLAB software. Calculating each images' entropy, and calculate the PSNR of JPEG and JPEG2000 compression algorithm. The data was distributioned as follow.

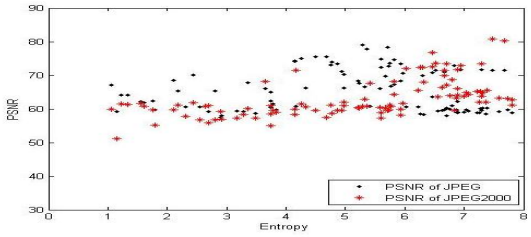

Fig. 3 Comparison of JPEG and JPEG2000 PSNR

From the graph, when the entropy value between 0 and 6, JPEG'PSNR is bigger than the JPEG2000. That is to say, the JPEG compression is better when reconstructed images. JPEG2000'PSNR is bigger when the entropy value between 6 and 8. JPEG2000 is better when reconstructed images.

To classify the 100 images, it uses JPEG compression when the entropy value between 0 and 6, and when the entropy value between 6 and 8, it uses the JPEG2000 to images compression. Compared the new ideas with each compression, the results is as follows.

Table 1 Classification data processing

Average Entropy	Average PSNR		
	JPEG	JPEG2000	Entropy Classification Algorithm
5.1263	65.9387	63.6757	67.6444

The new compression algorithm is better quality which can see from table 2.

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4.2 Block of image processing.

The image is decomposed into 4 pieces. On the left is M1, right M2, lower left M3, lower right M4. The simulation diagram and data table as follows.

Fig. 4 Image simulation of block

Table 2 Processing data of block

Name of images	Entropy	PSNR	
		JPEG	JPEG2000
M1.jpg	5.4682	59.4527	57.6033
M2.jpg	6.2417	64.5736	79.2647
M3.jpg	6.3830	54.4326	75.2235
M4.jpg	6.1422	56.6302	78.3452
Average Entropy of Divided	6.0588	58.7723	72.6092
Average Entropy of Undivided	6.2534	58.4326	72.4319

Divided image can get a better effect than the anterior from the data of table.

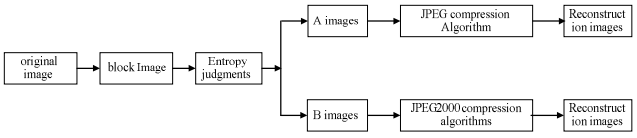

Fig. 5 Block diagram of new algorithm

5. New Algorithm Simulation.

Block the above images, and calculate the entropy value. Try to classify the images by the entropy range, and then choose different compression algorithm for images compression. Through a large number of calculations, the analysis shows that the new compression algorithm has certain advantages. The following is the compression and reconstruction results of a picture and data comparison of 100 images.

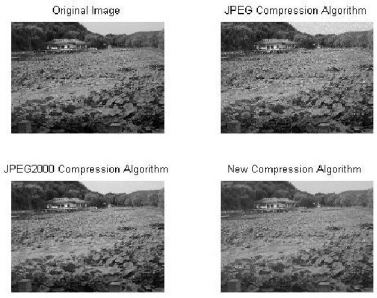

Fig. 6 The simulation comparison chart

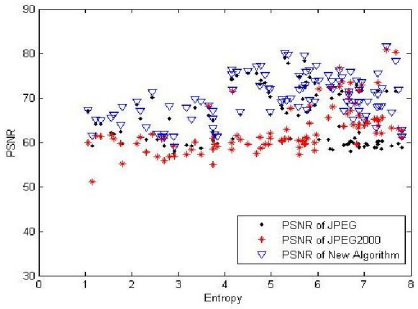

Fig. 7 Different algorithms comparison of average PSNR

Table 3 Processing the data after block and classification.

Average Entropy	Average of PSNR		
	JPEG	JPEG2000	PSNR of new Algorithm
6.0588	58.7723	72.6092	73.0715

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6. Conclusions

This paper studies on the JPEG and JPEG2000 image compression algorithm that existing, and put forward the blocking and classifying images compression algorithm which is based on entropy. It makes some validation in the compression efficiency of the theory, and the algorithm is better than the other two algorithms.

Acknowledgment

This work was supported by Science and Technology Development Plan of Jilin Province (201201107) and Doctoral Scientific Research Fund of Northeast Dianli University (bsjxm-201104).

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