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The Research for Compression Algorithm of Aerial Imagery

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Abstract: In this study, the new method of the JPEG image compression algorithm with predictive coding algorithm combining was proposed, effectively eliminates redundant information of the sub-blocks and redundant information between the sub-blocks and sub-blocks. Achieved higher compression ratio compared to the JPEG compression algorithm and a good image quality.

Keywords: Aerial imagery, JPEG, predictive coding

INTRODUCTION

Aerial imagery is becoming more and more closely associated with people's lives, is already widely used 3D city modeling, terrain exploration. The camera is usually installed in the satellites or aircraft, if you want real-time access to pictures, you must use a wireless real-time transmission, wireless transmission bandwidth is limited and aerial imagery for the amount of data, so image compression algorithm of high compression ratio and smaller loss of image quality is important.

JPEG image compression algorithms with predictive coding algorithm combined. First, the image is divided into various sub-blocks. Secondly, using JPEG compression to base-block, generate a prediction block using a predictive coding on the basis of the base-block, Last, performs JPEG compression on the difference between the two, so as to achieve greater compression ratio, the study also simulation test of the compression and decompression process to draw the final compressed image effect. Hu (2003) have a research of the still image coding method with international standards. Zhang (1999) make a study of the image processing and analysis. Taubman and Marcellin (2002) have a research of the image compression fundamentals, standards and practice. Wang and Li (2006) study the MATLAB 7.0 graphic image processing. Wn and Li (2009) have a research of the MATLAB JPEG image compression method research. Kong and Chen (2008) have a research of the media technology and application development.

In this study, the new method of the JPEG image compression algorithm with predictive coding algorithm combining was proposed effectively eliminates redundant information of the sub-blocks and redundant information between the sub-blocks and sub-blocks. Achieved higher compression ratio compared to the JPEG compression algorithm and a good image quality.

TO CODING THEORY

The basic principle of the predictive coding: The basic idea of the prediction compression to eliminate redundancy is that the prediction compression by only the new information is encoded in each pixel of the extracted. It is because there was correlation between the pixels, so it makes the prediction compression possible. Prediction coding system the basic structure was shown in Fig. 1. In this study sub-block as a unit, to eliminate the redundant information between the sub-block by the prediction.

The basic principle of JPEG compression encoded: The basic structure of the JPEG encoder shown in Fig. 2, the decoding process is the inverse process of the coding process.

JPEG coding using the Forward Discrete Cosine Transform (FDCT), which is calculated according to operator (1):

$$F(u,v)=\frac{1}{4}C(u)C(v)\left[\sum_{i=0}^{7}\sum_{j=0}^{7}f(i,j)\cos\frac{(2i+1)u\pi}{16}\cos\frac{(2j+1)v\pi}{16}\right]$$

$$\begin{cases} C(u),C(v)=1/\sqrt{2}, & \text{if, u} \quad \text{v}=0 \\ C(u),C(v)=1, & \text{el se} \end{cases} \tag{1}$$

where, f (i, j) represents the color component values for each point.

Then the FDCT transformed frequency coefficients are quantized, the purpose of quantization is to reduce the magnitude of the coefficient of not "0" and to increase the number of coefficients of the value "0". While the human eye to low frequency component of the image is more sensitive than the high-frequency component, so the quantization table of the values in the upper-left corner is smaller than the values in the lower-right corner.

In order to increase the number of consecutive “0”, the quantized coefficients are Z-shaped arrangement.

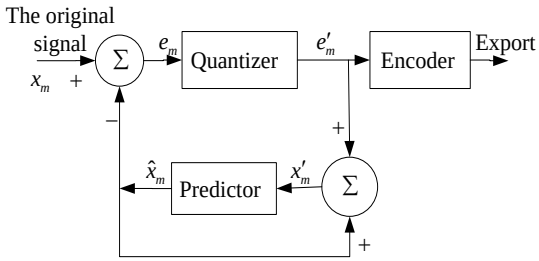

Fig. 1: A configuration diagram of the predict coding system

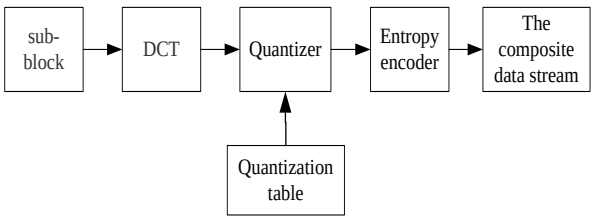

Fig. 2: JPEG encoder flow chart

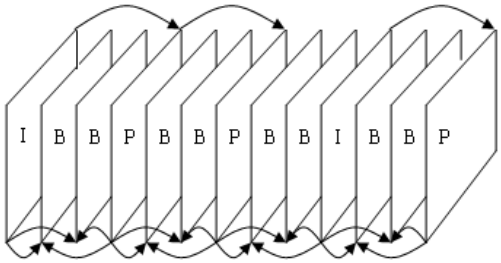

Fig. 3: A structure diagram of the sub-block

Table 1: The quantization table of the light signals

17	18	24	47	99	99	99	99
18	21	26	66	99	99	99	99
24	26	56	99	99	99	99	99
47	66	99	99	99	99	99	99
99	99	99	99	99	99	99	99
99	99	99	99	99	99	99	99
99	99	99	99	99	99	99	99
99	99	99	99	99	99	99	99

Therefore, in the Run Length Encoding (RLE), there are a lot of continuous "0". DC coefficients are compressed by Differential Pulse Code Modulation (DPCM) technology; AC coefficients are compressed using the Run Length Encoding (RLE). Then further compression of the results after the DPCM and RLE using entropy encoding. Finally, the tag code and encoded image data comprising the bit data stream.

This study in the principle of compression algorithm: The basic idea of this algorithm is the JPEG compression algorithm and the predictive coding algorithm is combined to achieve the purpose of high compression ratio. The coding algorithm steps:

Table 2: The quantization table of the color difference signals

16	11	10	16	24	40	51	61
12	12	14	19	26	58	60	55
14	13	16	24	40	57	69	56
14	17	22	29	51	87	80	62
18	22	37	56	68	109	103	77
24	35	55	64	81	104	113	92
49	64	78	87	103	121	120	101
72	92	95	98	112	100	103	99

- The RGB image is converted to a YUV image
- The image is divided into sub-blocks
- Base-block compressed using the JPEG algorithm
- Generate prediction block using a predictive coding on the basis of the base-block
- Generating bidirectional prediction block

Step 1: Because the human eye is more sensitive to light signals than the color difference signals, in this study first conversion RGB images into a YUV images and then quantizes the light signals and the color difference signals using two different quantization tables. The formula of RGB image is converted to a YUV image is:

$$\begin{aligned} Y &= 0.299R + 0.587G + 0.114B \\ U &= -0.147R - 0.289G + 0.436B + 128 \\ V &= 0.615R - 0.515G - 0.1B + 128 \end{aligned} \tag{2}$$

Step 2: The image is divided into 8*8 sub-blocks and three types of sub-block are defined: base-block (I), the Prediction block (P) and Bidirectional prediction block (B). Beginning of the line as defined in the first sub-block as a base-block, the base-block appears interval is N. N sub-blocks of between base-blocks are the prediction block or bidirectional prediction block. M bidirectional prediction blocks are between base-block with the prediction block or prediction block with prediction block. The sub-blocks arranged in the basic structure shown in Fig. 3.

Step 3: Base-block (I) is compressed using standard JPEG compression algorithm. This study using different quantization table to quantize the frequency coefficients of the light signals or the color difference signals. The quantization table of the light signals is Table 1.

The quantization table of the color difference signals is Table 2.

Step 4: The generation of the prediction sub-block: The first sub-blocks are transformed using FDCT and then the use Table 1 and 2 quantize respectively the light signals or the color difference signals, the result of quantization with previous quantization result of base-block or prediction block differencing operator by the formula (3). Then the difference result of the Z-

(a) Original image

(b) The compression and decompression of image effect

Fig. 4: The original image and the processed image effect

Table 3: Test data results

Original image data	Compressed data amount	Compression ratio	JPEG compression ratio	Image class
28.7139 MB	1.1440 MB	12.1	6.75	A
28.7139 MB	1.4148 MB	10.3	6.83	B
28.7139 MB	1.8059 MB	9.9	6.92	C

shaped arrangement or the entropy coding to obtain a final code:

$$Delta_P(i, j) = D_I(i, j) - D(i, j) \quad (3)$$

where,

D_I (i, j) : The frequency coefficient of the current sub-block in front of the base-block or prediction block

D (i, j) : The frequency coefficient for the current sub-block is quantized

Step 5: Bidirectional prediction generation of the sub-blocks: Similarly the first sub-block is FDCT transformed and then the light signal and the color difference signals is respectively quantized using Table 1 and 2, a quantization finished after is calculated using Eq. (4). And the results then later work of the JPEG compression algorithm: Z-shaped arrangement, entropy coding, etc., to obtain a final code word.

$$Delta_B(i, j) = \frac{D_I(i, j)_{K-1} + D_I(i, j)_{K+1}}{2} - D(i, j) \quad (4)$$

where,

D_I (i, j)$_{k-1}$: The front of the base block, or prediction block quantization after the frequency coefficients

D_I (i, j)$_{k+1}$: For the back of the base block, or prediction block quantization after the frequency coefficient

D (i, j) : To be generated after a bidirectional prediction block is quantized frequency coefficients

In the decoding process is the inverse process of encoding, decoding the first base block and then according to the base-block, the prediction block is decoded, then a bidirectional prediction block is decoded according to the base-block and the predicted block and finally the individual sub-blocks are combined into a decoded whole images.

THE EXPERIMENTAL RESULTS

Compression algorithm simulation test: All of the parameters in this study are: the interval between the base block N is 15, the interval between the predicted block M is 3. Image resolution is 3872*2592 and 24 bit Bmp image used to compression test, the original image is shown in Fig. 4a, after compression and the decoded image effect shown in Fig. 4b.

In this study the image is divided into three categories for the different image content: aerial image of a single background (class A), the general aviation image (class B) and the aerial imagery of the image content changes quickly (class C). Respectively have been tested, 20 images of each class are tested and then the results were averaged and the result of compressed as shown in Table 3.

New compression algorithm for a higher compression ratio than JPEG still images can be obtained from the results can be seen. But the compression ratio and the contents of the image related, the compression ratio will decline when rapid changes of the image content.

CONCLUSION

This study presents a JPEG compression algorithm with predictive coding algorithm combining algorithm and its application to the static image compression. The new method on the basis of ensuring the quality of the image, greatly improve the compression ratio of the image. Especially in a single background image more good compression.

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