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Research Article

Research on Fruit's Fractal Image Based on the Characteristic Structure of Wavelet Coefficients

Xin Zhang and Mianrong Yang
Xinxiang University, Xinxiang, China

Abstract: After the natural images are decomposed by the wavelet, each sub-band images in the same direction show strong similarity, by using this kind of similarity to carry on the image coding, which can gain much higher compression ratio than that of coding the fruit fractal image or coding the wavelet image. In this study, it takes the principle of image compression as the breakthrough point, with the interpretation of the principle of fractal circle coding and wavelet transform coding, exploring the realization of the application of wavelet transform to the fruit's fractal image compression.

Keywords: Coding, fruit fractal image, wavelet transform

INTRODUCTION

Wavelet analysis is a kind of milestone development in the history of the analysis of traditional Fourier, in recent years, it has got more focus of attention by many scientists, which has profound significance both in theory and application. Wavelet analysis has good localization properties both in time domain and frequency domain, which also can analyze the steady local signal of fruit's image effectively (Jacquin, 1993). The basis of data compression lies in that data is the combination of information and redundancy, thus reducing or eliminating redundancy can make data be compressed. A simple example for the redundancy compression is to remove the redundant data (Jacquin, 1992). If the sending data is unchanged for a long time, then many continuous sampling value will be repeated. Therefore, there is no need sending the sample code one by one, what it needs to do is to simply send a sample code value as well as the repeated number, this is the concept of run length coding. Since the source of information is different and the degree of redundancy is different, therefore, the corresponding coding method is also different. The image compression system is composed by the following parts, which can be shown in Fig. 1:

- Transducer (T) can make the inputting image data transform one by one, the image data after being transformed is more conducive to be compressed than that of the original image data.
- Quantizer (Q) can generate a finite set of symbols that can be used to represent image compression.
- Coder (C) can specify a code for each symbol that the quantizer output, namely, binary bit stream. The coder can use fixed length coding or variable lengcoding (Rinaldo and Calvagno, 1995).

MATERIALS AND METHODS

Wavelet transform coding: Wavelet transform is proposed by French geographer Mallat and another mathematician Gorssman, they have proved that: any function in L^2 (R) space can be represented by a group that is called the decomposition of the wavelet function. If function φ satisfies $C_\varphi = \int_R |\varphi\,(\hat{w})|^2 \,/\, |w| \; dw \,\langle \infty$, then we call it as "basis wavelet" or "mother wavelet", after the base wavelet through extension and translation, a wavelet sequence can be acquired.

As for the case of the continuous situation, the wavelet sequence is:

$$\psi_{a,b}(t) = \frac{1}{\sqrt{|a|}}\psi(\frac{t-b}{a}) \quad a, b \in R; a \neq 0$$

Among them, a is the scalability factor, b translation factor.

Wavelet transform is used to realize the compression of fruit's fractal image: Wavelet transform can make up the shortcomings from DCT transform that is not suitable for the signal of wide bandwidth compression. It is a kind of telescopic frequency transform, which has the characteristic of multi-resolution. Its essence is that the related calculation between the original signal and the wavelet kernel function. The Fourier transform of the wavelet function $\psi\,(\frac{t}{a})$ is:

Corresponding Author: Xin Zhang, Xinxiang University, Xinxiang, China

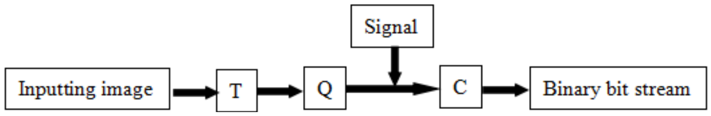

Fig. 1: The diagram of image compression system

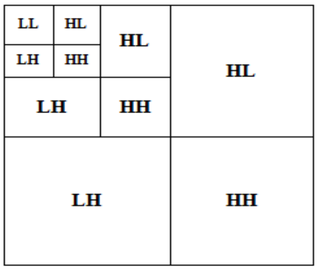

Fig. 2: Schematic diagram of wavelet transform

(a) (b) (c)

Fig. 3: (a): Tangerine; (b): Orange; (c): Apple

$$\psi\left(\frac{t}{a}\right) \xrightarrow{F} |a|\psi(a\omega)$$

When the scale a is gradually increased, the longer the corresponding length of the wavelet function in the time domain is, the larger the scope of the observation in the time axis is, the angular frequency of wavelet function in the frequency domain is reduced, in some degree, it is equivalent to making low resolution analysis for the signal by using a lower frequency, namely, making profile observation for the signal by using low frequency wavelet; when the scale a is smaller, the shorter the corresponding wavelet function is in the time domain, the smaller the scope of observation in the time axis is. In some degree, it is equivalent to making high resolution analysis for the signal by using high frequency, namely, making detailed observation for the signal by using high frequency wavelet shown in Fig. 2.

The processing of fruit's fractal image: Putting tangerine, orange, apple, etc., as shown in Fig. 3a to c. Three kinds of fruits into the light box. The calyx image and profile image of each fruit can be collected once.

Cutting image: As for one RGB image with $M \times N$ size can be described by the matrix of $M \times N \times 3$. Each pixel in the image can be corresponding to Red (R), Green (G), Blue (B), which can be formed a tuple by these three components. Defining the window of cutting image:

$$F(x, y) = M(L^{(1)}_t - L^{(1)}_l) \times N(L^{(2)}_t - L^{(2)}_l) \times 3$$

In the formula, $L^{(1)}_t$ and $L^{(1)}_l$ can be the beginning point and terminal point of the window of the cutting in line respectively, while $L^{(2)}_t$ and $L^{(2)}_l$ I can be the starting point and terminal point of the window of cutting in column respectively. Through Eq. (1), it can cut the fruit's image, both Keeping the pixels from $ML^{(1)}_l$ to $ML^{(1)}_t$ and from $NL^{(2)}_l$ to $NL^{(2)}_t$, by removing the pixels out of the window, it can make the information amount of the processing image small, so as to improve the speed of processing.

The binarization of images: Transforming the fruit's RGB image to the double type, which can the corresponding to be the area of fruit and background, respectively.

Determining the threshold of three kinds of fruits' color and image as T, the transformation of tangerine can be as follows:

$$f(3,R,G,B) = \begin{cases} R,G,B = 1, B > T_1 \\ R,G,B = 0, \ B \le T_1 \end{cases}$$

$$f(3,R,G,B) = \begin{cases} R,G,B = 1, R < T_2 \\ R,G,B = 0, \ R \ge T_2 \end{cases}$$

In the formula, T_1 is the threshold of tangerine's color image and T_2 is the threshold of orange and apple's color images. Through the above transformation, among the images, the area of fruit namely, R, G, B is 1, besides the area of R, G, B is 0, thus the image can be transformed into black, white, namely the two gray-scale image. Setting any threshold between 0 and 1, transforming the gray image into black and white, namely the binarization image. Compared with the iterative method of binarization image and Otsu method of the binarization image, by using this method, the acquired image with clear and accurate boundary, there is no perforation in the region of fruit area, the background can be clear up thoroughly (Ramamurthi and Gersho, 1986).

By tracking four connectivity method boundary, after binarization, making the fruit image into the formation of closed fruit contour, but the boundary line of multi pixel can affect the calculation of perimeter in the image of the fruit area, therefore, it needs to divide the boundary into the single pixel, so as to maintain the connectivity of the original boundary and improve the accurate calculation of the measuring the perimeter.

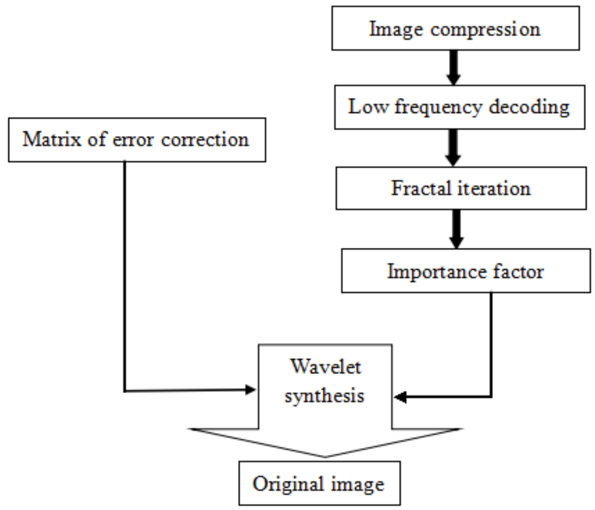

Fig. 4: The flow chart of decoding fractal image based on the characteristic structure of wavelet coefficients

RESULTS AND DISCUSSION

The fruit image after wavelet transform can generate new images, at the same time, the amount of data should be equal to the amount of the original image, namely, wavelet transform itself does not have the function of compression (Kim *et al*., 1998). The reason why use it to make image compression is that wavelet image can have different characteristics from the original image, which can be shown by focusing the image energy on the low frequency part, while there is less energy in horizontal part, vertical part and diagonal part; the horizontal, vertical and diagonal part of the original image can be characterized in horizontal, vertical and diagonal edges of the information that has obvious characteristics in direction. The low frequency part can be called as brightness image, while horizontal part, vertical part and diagonal part can be called as detailed image. As for the four sub-images, it can have quantization and coding processing with different strategies respectively according to human visual physiological and psychological characteristics as shown in Fig. 4.

CONCLUSION

Fractal image coding is a new technology used for image compression that has developed quickly in recent years, it is a kind of new idea based on the theory of fractal image coding and iterative function system, which is essentially different from the previous orthogonal transform coding. The basis of fractal coding is based on the image's similarity. It uses a group of iterative transform to describe the image, during the period of decoding, it can only transform any the initial image, at last it can converge the decoded image. Since the idea of fractal coding is very novel, plus the advantage of having high compression ratio, it has gained widespread attention, which can become one of the most promising methods for image coding.

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