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# Image Retrieval Method Based on Fusion of Edge Features and RGB Color Component

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***Abstract***

*Construct an image retrieval method based on feature fusion of color features of RGB component and edge feature. The execution of this method is divided into the following steps: First, the original image is decomposed into three components images of RGB; Secondly, wavelet decomposition is carried out on each component image; Third, color and edge features are obtained on the low-pass components from each component image; Finally, these two features are combined to complete the image retrieval. Experimental results show that the proposed method has better accuracy than the retrieval method using single feature, and retrieval speed is relatively fast.*

***Keywords**: Image retrieval, RGB component, Color features, Edge features, Wavelet decomposition*

## 1. Introduction

All kinds of information in digital libraries accommodated, image resource have high visit rate, it is because the image contains more image and rich content than text [1-2].Thus, a successful digital library system must be able to accurately and timely feedback the image retrieval results. This makes the image retrieval technology become a hot topic in the field of digital libraries.

Image retrieval techniques commonly used in digital library system can be divided into two categories: text-based image retrieval and content-based image retrieval [3-4].Text-based image retrieval are generally based on the image names and other text information as a search condition, robustness is poor, error detection rate is high. Content-based image retrieval, full use the various features in the image data as a search condition, such as color, texture, structure, etc. [5-7], and therefore have a high degree of accuracy and reliability, has become the mainstream technology which is widely used in digital library.

Now, there are large number of image retrieval method based on the content, but are generally constrained by a fundamental problem. To ensure the accuracy of retrieval, it is necessary to use more reliable retrieval condition; the retrieval condition with higher reliability, have longer processing time. This creates a contradiction between accuracy and speed of retrieval [8], while user requirements the accuracy of search results, on the other hand user requirements efficient retrieval services. Therefore, how to reduce the retrieval accuracy under the premise of ensuring the retrieval time, has become an important topic that the image retrieval technology must be overcome, which is one of the key to promote further development of digital libraries technologies.

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It is in this situation, this article reference image processing ideas of wavelet decomposition, use RGB color component information of the original image, we propose a new image retrieval method, in order to achieve fast and accurate retrieval goal.

## 2. The Proposed Method

Firstly in this paper color image of RGB space is decomposed into R component, G component, and B component, and thus implement wavelet decomposition of the three image components and then use their to strike color and texture features on a low-pass component, the last according to the similarity measure of two characteristics to perform a search. Significance of this method is that the color and texture features by three components of the image are fused, can enhance the reliability of the retrieval process, and obtaining of features of wavelet decomposition run on the obtained low-pass components, the search time can be greatly reduced . Therefore, this method is constructed considering retrieval accuracy and retrieval speed two indicators.

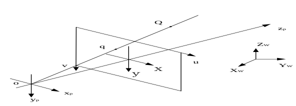
### 2.1. RGB Component Image Generating

A color image is relative to a grayscale image, in gray image three RGB components are equal, a grayscale image can be seen as a color image at extreme.

Currently, the digital images are the mainstream format for image files to stored. Accordingly, the expression of color image data in the computer as shown in Equation (1).

$$C = R \times 256^{0} + G \times 256^{1} + B \times 256^{2} \quad (1)$$

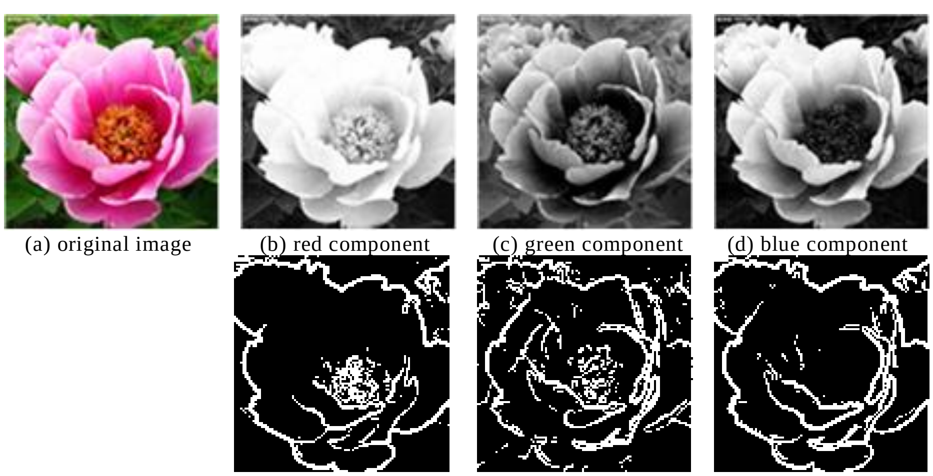
As can be seen from equation (1), color information $C$ of each pixel in a image contains the three components of the RGB. If you know color information of a pixel, strike three RGB color components according to the formula(2).



(2)

Wherein, $[\bullet]$ represents rounding operation.

The effect of striking RGB components in color image shown in Figure 1.



(a) original image (b) red component (c) green component (d) blue component

(e) the edge of (b) (f) the edge of (c) (g) the edge of (d)

**Figure 1. RGB Decomposition of Color Image**

As can be seen from Figure 1, component image of three-color of RGB, with a more rich feature information than the original image, while having a higher reliability for image retrieval. However, respectively compare RGB color component images of the original image , time equivalent to three times of original image comparison only ,which will increase the search time.

## 2.2. RGB Component Images Wavelet Decomposition

In order to improve the overall time of the image retrieval process, this paper in comparison of RGB color component images, introduction the ideas of wavelet decomposition. Schematic of an image wavelet decomposition shown in Figure 2.

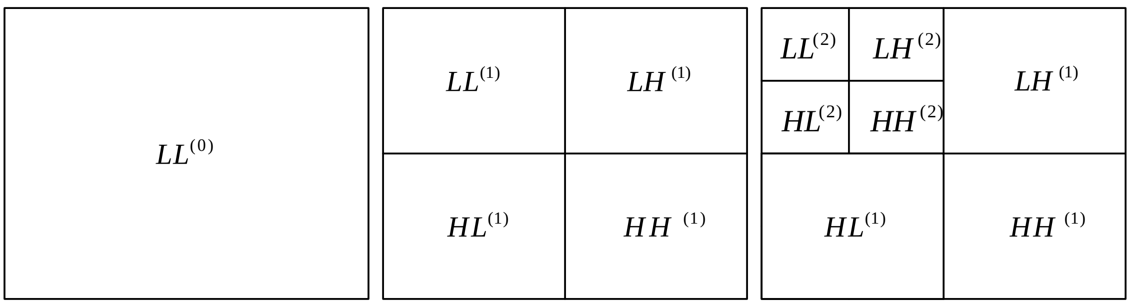



**Figure 2. Wavelet Decomposition of the Image**

In Figure 2, $LL^{(0)}$ is the original image, $LL^{(1)}$ is the outputted sub-picture by the wavelet decomposition in the low-pass filter, $LH^{(1)}$, $HL^{(1)}$, and $HH^{(1)}$ are outputted sub-pictures which are decomposed in the high-pass filter. This four glyphs have the same size,but they characterize the different details in different directions of the original image, such as the horizontal detail, the vertical details and diagonal details. Level 2 and even higher levels of decomposition of the same principle as described above.

After each level of wavelet decomposition, $LL^{(k)}$ and the image $LL^{(k-1)}$ of the former level is most similar on the visual effects, but the size is reduced to 1/4. Thus, use sub-images $LL^{(k)}$ instead of the image $LL^{(k-1)}$ of the former level to compare, retrieval accuracy can be guaranteed, and the search time is greatly reduced.

The implementation of wavelet decomposition on an image of sized $M \times N$ , the mathematical description can use the following formula of a group to express.

$$LL^{(k)}(m,n) = [[LL^{(k-1)}_{rows} * \overline{H}]_{2\downarrow 1 columns} * \overline{H}]_{1\downarrow 2} \tag{3}$$

Where, $m = 1, \cdots, M/2^k, n = 1, \cdots, N/2^k$ .

$$LH^{(k)}(m,n) = [[LL^{(k-1)}_{rows} * \overline{H}]_{2\downarrow 1 columns} * \overline{G}]_{1\downarrow 2} \tag{4}$$

Where, $m = M/2^k + 1, \cdots, M/2^{k-1}, n = 1, \cdots, N/2^k$ .

$$HL^{(k)}(m,n) = [[LL^{(k-1)}_{rows} * \overline{G}]_{2\downarrow 1 columns} * \overline{H}]_{1\downarrow 2} \tag{5}$$

Where, $m = 1, \cdots, M/2^k, n = N/2^k + 1, \cdots, N/2^{k-1}$ .

$$HH^{(k)}(m,n) = [[LL^{(k-1)}_{rows} * \overline{G}]_{2\downarrow 1 columns} * \overline{G}]_{1\downarrow 2} \tag{6}$$

Where, $m$ , $n$ are respectively take the value of $m$ in (4) and the value of $n$ in (5) .

Here, $\overline{H}$ and $\overline{G}$ respectively represent a low-pass and high-pass filters in wavelet decomposition, $2\downarrow 1(1\downarrow 2)$ represents samples along the column direction (row direction) , $k$ is the number of wavelet decomposition.

According to the above equation, the sub-picture $LL^{(k)}$ can be calculated according to the original image information $LL^{(k-1)}$ of the former level. When the wavelet transform decomposition to two level , the sub-image from a visual point of view $LL^{(k)}$ still enough to express the original image $LL^{(k-2)}$, which has become 1/16 of its size, will be greatly reduced comparison time of the image retrieval.

## 2.3. Color Extraction of RGB Component Images

This article uses the RGB color component features of the original image, with the speed strategy of wavelet decomposition, similarity comparison need to consider the question of how to implementation. Based on the above considerations, the paper extract color feature formed as retrieval measurement shown in equation (7).

$$
\begin{aligned}
C(Q, I_n) = & \sqrt{(RLL_q^{(k)}(m,n) - RLL_{I_n}^{(k)}(m,n))^2} \\
& + \sqrt{(GLL_q^{(k)}(m,n) - GLL_{I_n}^{(k)}(m,n))^2} \\
& + \sqrt{(BLL_q^{(k)}(m,n) - BLL_{I_n}^{(k)}(m,n))^2}
\end{aligned} \tag{7}
$$

Where, $RLL_q^{(k)}(m,n)$, $GLL_q^{(k)}(m,n)$, $BLL_q^{(k)}(m,n)$ respectively represent frequency component after the $k$ time wavelet decomposition of R, G, B three color component images of query image, $RLL_{I_n}^{(k)}(m,n)$, $GLL_{I_n}^{(k)}(m,n)$, $BLL_{I_n}^{(k)}(m,n)$ respectively represent frequency component after the $k$ time wavelet decomposition of R, G, B three color component images of the $n$ image to be retrieved. $C(Q, I_n)$ representative of the similarity measure.

As can be seen from the formula (7), the paper design similarity measure, that is, considering the information of R, G, B three color components, but also take into account the processing operations of wavelet decomposition. The smaller $C(Q, I_n)$, indicating that the more similar of the two images.

## 2.4. Extraction Edges of RGB Component Images

In addition to the color features, the paper in the image retrieval process also uses edge features. Using equation (2) to obtain the three color component in the original image, the correspond edge image in Figure 1 (e), (f), (g). These three pieces of edge images also perform wavelet decomposition in Section 2.2, count the number of edges block in the low-frequency component of the $k$ -th wavelet decomposition of each edge images.

Use conservation law of momentum to determine the sub-image block whether is an edge block. For each sub-image in a complete image, percentages of its edge block can be calculated using the following equation:

$$
Rate(Edge) = \frac{Num(EdgeBith)}{Num(SubBith)} \tag{8}
$$

In the formula, $Rate(Edge)$ represents the percentage of edges, $Num(EdgeBith)$ represents the number of edge blocks, $Num(SubBith)$ represents total number of images of sub-block in the original image.

An image can be described by a signature sequence, as shown in equation (9) below.

$$F(I) = \{ f_i^I \mid i = 1,2,\cdots,2\times(3\times n\times m)\} \quad (9)$$

Here, $F(I)$ represents the features sequence of the image $I$, $f_i^I$ denotes features of the n-th image $I$. Second half of the signature sequence, that is, the percentage of the image edge features described herein.

To set the similarity measurement of the image retrieval for edge feature , such as the formula (10) shown.

$$E(Q,I) = \sqrt{\sum_j (f_j^Q - f_j^I)^2} \quad (10)$$

Combined with the previous similarity measurement of color feature , the paper eventually form the overall similarity measurement as formula (11) below.

$$S(Q,I) = 0.5C(Q,I) + 0.5E(Q,I) \quad (11)$$

## 3. Experimental Results and Analysis

### 3.1. Experimental Results

In order to verify the effectiveness of the method, we self-built a small image database. This system consists of 1000 images, divided into 10 categories of flowers, birds, mountains, water, cars, trees, grass, clouds, stars, fog, etc, 100 of each type of images. These images have the same resolution size of 128 × 128 pixels.

Computer configuration used during the experiment is: Core Duo CPU, single-core frequency of 2.0GHz; Memory of 4G; graphics card, memory of 1G.

Software system used during the experiment, we designed and developed a small images retrieval system. The system used the image retrieval method proposed in this paper based on wavelet decomposition of RGB component as the core retrieval procedures and made corresponding functional package and interface design, system functions reserved for further expansion interface. Realization of the entire system using Visual C + + programming language.

As shown in Figure 3, is to a flower image as a query image, according to the image retrieval methods and systems established herein, the retrieval results obtained from images database created by our own.

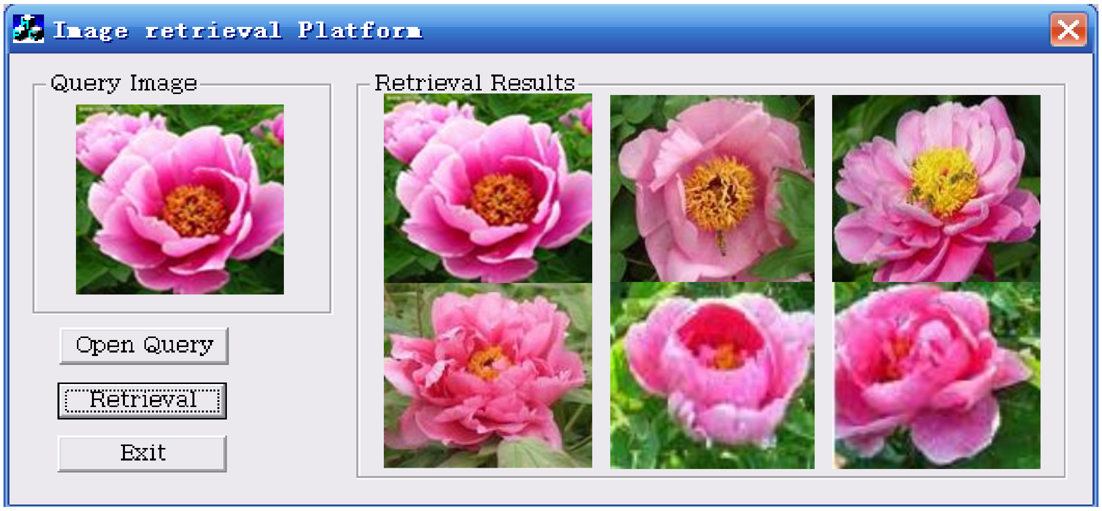



**Figure 3. Image Retrieval Results**

Figure 3 shows the status of interface and search results of the image retrieval system established in this paper. In this system interface, the left is the query image display area and the function button area, on the right is the retrieval results display area.

From the retrieval results display area in the right of screen, the total shows five retrieval results similar to the query image, and in accordance with the similarity size from the way of left to right, top to bottom, to sort.

From this retrieval results, according to the image retrieval method in this paper, get search results really close to the query image. Only five images are all image of flowers and the information on color and structure of flowers is also similar to the query image, indicating that the proposed method has high accuracy and reliability.

### 3.2. Experimental Analysis

To illustrate the retrieval accuracy and retrieval speed of this method, the accuracy and speed of the results with the use of this method and the use of color feature individually and edge features separately are compared. Comparison results of the accuracy shown in Figure 4.

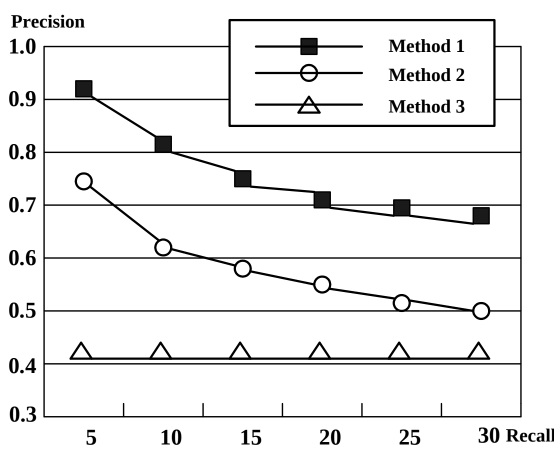



**Figure 4. Comparison of Three Image Retrieval Method**

In Figure 4, the horizontal axis is the percentage of the number of images you want to retrieve in the total number of images that is recall requirements; the vertical axis is the retrieval accuracy, namely precision requirements. Three curves representing the proposed method (Method 1), single color retrieval method (Method 2), single retrieval method using edge feature (Method 3).

Search time of three methods shown in Table 1.

**Table 1. Time of Three Image Retrieval Methods**

| | Method 1 | Method 2 | Method 3 |
|---|---|---|---|
| Feature extraction (s) | 0.774 | 0.218 | 0.831 |
| Similar searches (s) | 0.802 | 0.517 | 1.283 |

As can be seen from the data in Table 1, retrieval time of this method is higher than using separate color feature to retrieval, but less than using separate edge feature to retrieval. That is the color features striking quickly, but more time-consuming to strike edge features. Although this method simultaneously uses the two features, but by performing the wavelet decomposition, features obtaining are focused on a low-pass component in the wavelet, the search time is ideal.

## 4. Conclusion

Retrieval accuracy and speed of retrieval of image retrieval technology are two important indicators, how to complete reliable retrieval in a short time, is an important design goal of image retrieval method. In this paper, in order to enhance the accuracy of image retrieval method, use RGB components images instead of the original image, making the retrieval of information more abundant. Simultaneously, on each RGB color component of the image use color features and edge feature to further improves the reliability of the retrieval process. In order to reduce striking time of the two features about the three components, this article carries out the wavelet decomposition of the original image. The process of striking features carries out on low-pass components of each component, so as to ensure the rapid and accurate retrieval. Experimental results show that the image retrieval method constructed in this paper, have higher retrieval precision than the image retrieval method using single color features and using single edge features, simultaneously the retrieval speed is ideal.

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