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Study of Image Retrieval Method Based on Salient Points and Comprehensive Characteristics

Chen Yatian

College of Humanities, Changshu Institute of Technology, Changshu Jiangsu 215500, China
E-mail: yatianchen@cslg.cn

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Abstract: Technology has been a very good development in the past twenty or thirty years, content-based image retrieval, many low-level visual features is proposed for image retrieval, real-time problem in image retrieval has got great attention of researchers, content-based image retrieval technique has been widely used in medical, education, digital library, industrial and commercial fields and based on the military field. This paper describes the image retrieval technology research background and significance, introduces the current research situation and research hotspot in content-based image retrieval, the basic method of image retrieval based on content and key problems are explained in detail. The image can cause visual attention point, known as the significant point. The literature and presents a new method for automatic extraction of salient points, and on this basis to achieve significant point based image retrieval. Find the analysis of experimental results: the foreground and background are distinct and image background color of a single, can extract salient points effectively, the recall rate and correct rate was higher; the background image is not obvious, is not conducive to the significant point. Extraction, the retrieval precision rate and recall rate is low. *Copyright © 2013 IFSA.*

Keywords: Automatic, Pattern recognition, Algorithm, Image.

1. Introduction

Information technology has become the main theme of the present times. Extensive use of storage devices and digital equipment, large capacity, sustainable development of multimedia technology and network technology and the rapid popularization, makes the digital media application in people's daily life more and more widely, such as trademark and copyright, multimedia digital libraries, medical image management, computer-aided design and manufacturing, criminal identification system and geographic information system satellite remote sensing image, etc. The image has become one of the main forms of information carrier, and presents the trend of growth index series. Information technology brings convenience to people's lives, but also brings the information expansion [1]. How to quickly, accurately retrieved from the image database the vastness of the images that they need to become in recent years and in the future a considerable period of time in the field of image processing [2-4]. To solve this problem, the technique of image retrieval is proposed for retrieving images that they need from the image database and related information [5].

Began in the nineteen seventies end of text retrieval based on image, image feature extraction method is through the use of manual or automated keywords or text to describe each image data, query, query similarity of text description and calculation of image database image in the text description, returns the image similarity larger [6]. Therefore, the text image retrieval technique of image retrieval is converted to text based retrieval, retrieval technology

provides a good solution for image retrieval of mature text. Text image retrieval based on image search engine is widely used, the mainstream are using this search technology, representative are: Google, Baidu search engine, such as Sohu, Yahoo [7, 8].

Technical manual in advance of the annotation image annotation text based image retrieval, image retrieval results rely heavily on manual annotation information, so this technique also faces many there is no problem [9]. Digital image database is of an exponential growth in size, with manual annotation of each image needs a lot of manual labor, marked on the mass of the image is not only the consumption of resources, access time, and it is difficult to complete. The images contain very rich, simple text is difficult to fully express the image content, and too detailed and complex annotation will increase the workload [10]. Has the very strong subjectivity of image annotation, on the same image, different people have different knowledge and interest, so the annotation results also differ in thousands of ways [11].

This paper studied on the low-level image features classic extraction algorithm, with emphasis on the texture feature block inverse probability difference (BDIP) and color characteristics of main color feature (LBA) research, analysis of the characteristics of block inverse probability difference, combined with the main color feature extraction algorithm, proposes a new feature representation the main block inverse probability difference (DBDIP) [12]. On this basis, this paper presents a fusion of color, texture image retrieval method, it is proved that the proposed method has higher recall and accuracy. This paper mainly introduces the development and research status of the retrieved image, and based on the basic methods of image content retrieval, in-depth study of the CBIR image based on the integrated features retrieval and image retrieval based on salient points [13, 14]. Discussed the basic knowledge and the key problem of content based image retrieval, mainly introduced the feature extraction algorithm, similarity measurement and performance standards [15-18].

2. Summary of Content Based Image Retrieval

2.1. Low Level Feature Description Methods Commonly Used

The most important function of CBIR system is sorted based on the similarity of the query image and images in the database. To achieve this function needs to solve two problems: one is to use mathematical way of describing image, two is based on the abstract mathematical description of the similarity between images. The image's pixel, the pixel itself can't describe the content of the image, image retrieval need to extract features of the image, and the representation of features determines the similarity measure method. This section mainly introduces the common methods of image feature extraction, similarity measure and CBIR image retrieval performance [19].

Image color feature is the most basic visual features of the image, simple color features can be extracted in different color space, mainly RGB, LAB, LUV, HSV, HSL, YCrCb, HMMD etc. [20]. In content-based image retrieval system, commonly used color covariance matrix, color histogram, color moments and color consistency matrix etc. Color feature extraction of image features can overall effective. Image texture is the definition of the concept of a more difficult. From the visual point of view, when we put an image content understanding into something with a certain degree of uniformity of the overall visual feelings, instead of the number of objects or object parts, this kind of image regions of the visual perception is usually called texture. Objective point, if an image as a matrix, or a two variable function, then an image area arbitrary can be assigned an attribute (the area as the function), some properties and the texture visual comparison [21].

An essential core technologies to achieve these goals is the texture feature extraction, texture information is extracted from the image area effective. Features of the obtained the calculation process is usually a vector composed of a plurality of content [22]. Texture feature has an important role in the field of image retrieval based on content, remote sensing image recognition and understanding, medical imaging diagnosis, surface quality detection etc. The shape is a collection of objects of all geometric information, even when the object's position, scale and orientation changes, the shape is not changed [23]. Therefore the shape features can effectively describe the image object and region. In two-dimensional space, surrounded by a closed contour image contains the region known as the shape. Study shape is divided into using edge information of an image based on the contour shape and the gray distribution information within the region the region based shape [24, 25].

Regional shape descriptor using image segmentation technology to extract the interested objects in images based on region, using pixel color distribution information of image feature extraction. Regional shape descriptor considered all the content and boundary pixel based on shape, its main features are based on distance. Commonly used feature extraction methods with geometric invariant distance, Zernike distance, the grid method and the significant wavelet coefficient method. The contour shape descriptors to describe surround the target region based on the profile. Shape from the rough contours representing discrete sampling [26]. Set can be extracted from the contour of the positioning. The basic idea is to extract the image edge features to describe the shape of the object, such as the descriptors, distance descriptors, area, center,

eccentricity, corner, chain code, points of interest [27, 28]. At present, the method based on contour shape signal, autoregressive model, the polygonal approximation, the operator and the curvature scale space.

Shape feature extraction depends largely on the target shape in the image, the current technology is unable to achieve the accurate image segmentation. Therefore, shape retrieval is generally limited to easily identify objects based on. On the other hand, image difference angle acquisition may be large, address translation, scale, rotation and occlusion invariance problem becomes a challenging problem in image retrieval [29]. In some special field, such as trademarks, marine fish, these images in simple background, foreground and background contrast, can be easily extracted from the image foreground, therefore, shape has become an effective retrieval method. The three primary colors RGB was shown in Fig. 1.

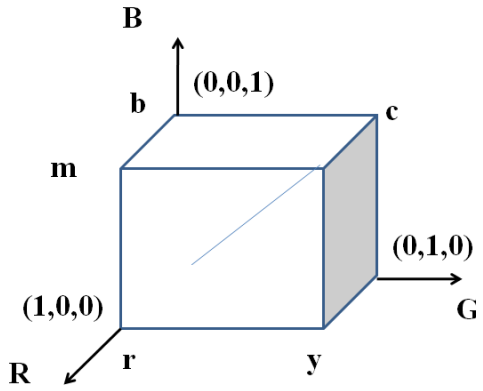

Fig. 1. The three primary colors RGB.

2.2. Similarity Measurement Method

The traditional database system matching strategy can be divided into complete matching and similarity matching. Similarity matching result is the probability of uncertainty. The main use of image low-level visual feature indexing in content-based image retrieval is based on similarity measure. The query images in the database to calculate similarity measure distance between feature vectors of target images to determine the similarity between the query image and the target images in image database. Similarity measurement methods have direct influence on image retrieval results. Therefore, image retrieval, in addition to select proper image features, the similarity measure method of choice is also very important. The similarity measure method of the complexity is the image retrieval response time. The ideal similarity measurement method should not be too complicated, and should meet the human visual feature, namely between the image looks similar to the visual distance is smaller, between image visual don't look similar to a larger distance. At present, people have proposed many kinds of measure method of similarity, commonly used image similarity measure. Minkowsky distance based on norm, which was:

$$D_p(A,B)=\left[\sum_{i=1}^{n}|ai-bi|^p\right]^{\frac{1}{p}} \quad (1)$$

If p=1, D_1 was called the city-block distance, which was shown as follow:

$$D_1(A,B)=\left[\sum_{i=1}^{n}|ai-bi|\right] \quad (2)$$

If p=2, D_2 was called the Euclidean distance, which was shown as follow:

$$D_2(A,B)=\left[\sum_{i=1}^{n}|ai-bi|^2\right]^{\frac{1}{2}} \quad (3)$$

If $p->\infty$, D_3 was called the Chebychv distance, which was shown as follow:

$$D_3(A,B)=max\left[\sum_{i=1}^{\infty}|ai-bi|\right] \quad (4)$$

The calculation is fast and simple histogram intersection method, and can effectively restrain background, let Q be a query image, T as the target image, the similarity is defined as follows:

$$D(Q,T)=1-\sum_{i=1}^{n}min(Q_i,T_i) \quad (5)$$

Image retrieval using two distances is better than Euclidean distance or using histogram intersection method of retrieval results. Two times the distance can be expressed as:

$$D(Q,T)=(Q-T)^T M(Q-T) \quad (6)$$

Among them, M said. For the histogram similarity between two colors in I and j, similarity matrix M is obtained through the study of color psychology. The color similarity matrix M, the similarity between different color is considered. The correlation coefficient can be used to close linear relationship between the characterizations of two vectors, its mathematical description is as follows:

$$p(A,B)=\frac{\sum_{i=1}^{n}(ai-a)(bi-b)}{\sqrt{\sum_{i=1}^{n}(ai-a)^2\sum_{i=1}^{n}(bi-b)^2}} \quad (7)$$

2.3. The Performance Criterion

A comprehensive evaluation of the retrieval image retrieval system is the result of challenging, on one hand, image retrieval has very strong subjectivity, and on the other hand, it is difficult to find a unified image test library. This section describes several recognized image retrieval algorithm evaluation criteria.

The accuracy rate and the recall rate are not only used in CBIR, in the various retrieval systems has been widely used. As the name suggests, the correct rate is the image retrieval system to the relevant number of images, and all return the number of images ratio; recall rate refers to the image retrieval systems, ratio of total number of all relevant image correlation image and the images in the database.

To determine the mode belongs to the category of algorithms for classifier. The design of classifier: mathematical basis including logic structure for building the classifier and classification rules. Usually the object every encounter, the classifier calculates that the objects and between each kind of typical similarity degree, the value is a function of the characteristics of the object, is used to determine which class of the objects belonging to the. Most classification rules are converted to a threshold rule, the measurement space into non-overlapping regions, each corresponding to one (or more) region. If the feature value in a certain region, the object is the corresponding category. Methods based on the classification of distance calculation is relatively simple, intuitive, several commonly used methods.

2.4. Image Retrieval Based on Comprehensive Characteristics

Feature extract directly influence the retrieval image retrieval results. Only a method based on feature of image content description is one-sided, lack the ability to distinguish, cannot have larger changes in image content circumstances better retrieval results. Most of the current work in the system using a combination of color, texture, shape and other characteristics of tectonic feature, image retrieval. The work image low-level feature extraction algorithm of classical learning, focusing on the texture characteristics of block inverse probability (BDIP) block algorithm for linear and main color feature points (LBA) study. The BDIP values of the one or two moments as image features and characteristics of large dimensions, these blocks are classified by means of two to belong to the same target blocks are divided into different categories.

In view of the above problems, this paper proposes a new feature representation, the main block inverse probability difference (DBDIP, Dominant Block Difference of Inverse Probabilities). The one or two order moments as image features of different BDIP value, DBDIP uses the main color feature extraction of thought, BDIP value representative value and proportion as feature. The DBDIP feature vector dimension is small, can effectively express the image content. On this basis, the paper realized image retrieval method combining DBDIP and LBA, the treatment process is shown in Fig. 2.

First of all, the user makes a query submitted sample images, feature extraction module extracts the query main color feature and texture feature of image. Then the color feature and texture feature as the similarity measure of the input is used to calculate the similarity query vector of target image feature vector and image database of the distance measure; finally, according to the similarity from big to small order of image retrieval results returned as. The experimental results show that this method has higher recall and accuracy.

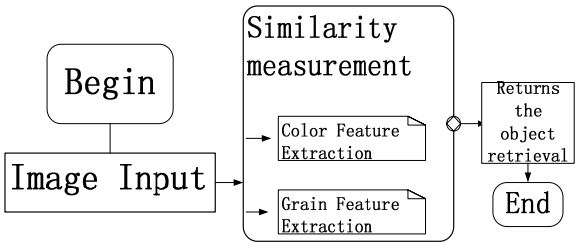

Fig. 2. Comprehensive features based on image retrieval.

3. Result and Discussion

3.1. Color Feature and Texture Feature Extraction

Color feature is a low level visual features one of the most important distinction, large for images. Many systems use are using this feature, such as: QBIC, Visual SEEK. The use of images directly from the theory, color as features for retrieval can minimize error, however, this will bring about computation and storage overhead is huge, and it is difficult to be applied to the actual system. Under normal circumstances, the actual possession of color only in the color space in a small percentage of the image pixels, and most contain only few colors, which therefore, if the use of the several main color instead of a pixel value in the image, impact for not understanding the image.

The MPEG-7 standard recommended many color descriptors, including color histogram descriptor and main color descriptor (DCD). The main color feature representation to two forms: main color and main color ratio. The main color feature can represent significant color effectively, intuitive, concise description of image region of interest, or the color distribution. And the distribution of color value determines the main color values, wide distribution of color is used to calculate the main colors, and these colors are often quite similar, the main color thus extracted from the short. Human vision can't distinguish the color distance is short, so the main color paper might be associated with human cognitive dissonance. In addition, DCD similarity matching results with human cognitive differences, may lead to similar color distribution of the image back order difference.

This paper uses the (LBA) Linear Block Algorithm as the main color feature extraction. The

experiment of 3 images was extracted from the main color feature of image, respectively, automobile, elephant, horse. Fig. 3 shows the 3 images and extracts the image color features were quantified after using the image color, image color feature representation with two forms. Fig. 3 experimental results can be seen in the image of an object, each quantized in can be clearly identified, that the main color feature use LBA to extract can keep consistent with the human visual perception, the use of a small amount of color information, but retain most of the image content, image content understanding and cause great influence not.

Fig. 3. The corresponding quantized images of automobile, elephant, horse.

The image gray value of mutation of the place is called the edge, local gray minimum place called ridge, they all contain the skeleton feature image has rich visual information. The literature proposes inverse probability model for extracting gray image contains ridge and the edge skeleton feature, it is simple in calculation, and can effectively extract the skeleton of image features. In the DIP model, the gray one pixel of image grey values of all pixels in the window and the window of the sum of the value of the ratio is considered to be a probability event. Gray inverse probability and the window image window center pixel values of pixels in the largest inverse probability difference is called inverse probability. By BDIP and wavelet transform has good retrieval effect, block inverse probability difference image block of pixels and the number of pixel gray value and the maximum divided by the sub-block gray value difference quotient, defined as follows:

$$B = M - \frac{\sum_j^i I(i,j)}{\max I(i,j)} \tag{8}$$

In order to facilitate observation, BDIP image pixels in the experiment value of 1-BDIP, so the BDIP value is greater, more close to the black image display. Experimental neutron block Size value is 2 × 2, can be seen in Fig. 3 luminance edges and ridges objects in the dark, and the targets and background brightness is bright, therefore, BDIP skeleton feature extraction of image feature can effectively ridge and edge.

Document the sub-block image is divided into M×M, BDIP calculation of each block, and then according to the BDIP value of the blocks into eight classes, calculating the mean and standard deviation as each kind of image features. In the image, BDIP belong to the same target blocks similar values, these blocks are classified by means of two to belong to the same object blocks are assigned to different categories, also cannot distinguish between foreground and background is very good; secondly, the one or two order moments are used for each subclass block BDIP as the feature, the feature vector dimension is large, is not conducive to the image storage and retrieval. In view of the above problems, the paper proposes a new feature representation method (DBDIP, Dominant Block Difference of Inverse Probabilities). And the one or two order moments as image features of different BDIP value, DBDIP uses the main color feature ideas, representative value and BDIP value in proportion as feature extraction. The DBDIP feature vector dimension is small, can represent the image content effectively, the algorithm is shown as follows:

1) Input: Image I;

2) Output: The main block inverse probability difference;

3) Step1: In RGB color space, the input image is calculated in each color channel of BDIP images;

4) Step2: BDIP image RGB three color channels as input, according to the formula structure color BDIP image;

5) Step3: Color BDIP image as the input image, extracting main color and the proportion of color BDIP image using LBA algorithm, namely the main block inverse probability difference;

6) Step4: Returns two tuples (the main block inverse probability difference, ratio) as DBDIP feature.

The experiment of 3 images was extracted from DBDIP image. Fig. 4 shows the experimental results of 3 image texture feature extraction BDIP. BDIP image retains the ridge and skeleton feature edge, but in the internal object or background region BDIP value approaches 0, in order to retain more texture information, calculation of color BDIP image main block inverse probability difference, the color BDIP image pixel projection into eight subspaces, no color combination, i.e. the main color feature extraction algorithm in Td=0, DBDIP characteristics of Tm=0. Image represents two tuples main block inverse probability difference and ratio.

Fig. 4. The experimental results of 3 image texture feature extraction BDIP.

From the experimental results of Fig. 4 can be seen, the original image texture information rich region and the target image, such as the horse, the car and the elephant, the image DBDIP quantized retained a lot of information, regional color corresponding to the rich; and the original image texture information of single area, such as the background, in the image DBDIP quantized color to black, the corresponding DBDIP value close to 0. Therefore, DBDIP can effectively extract texture feature vector, and the dimension of feature vector is low.

Extraction of color and texture features, the feature vector of image retrieval system extracting color and texture features of the composition of the portfolio, according to the feature vector to calculate similarity between the query image and database image, and returns an N image has the maximal similarity. The main color feature similarity method using two equations computed, DCD similarity calculation method is consistent with human perception is not very good. To observe the image similarity with the main color value and the proportion of relevant literature, using a new similarity calculation method. There are two reasons may lead to inaccurate similarity: the main color, the increase of the number of target image may result in inaccurate similarity. Two, if the target image and the query image contain the same main color, the color of the target image proportion will lead to inaccurate similarity. The two equations to calculate the D1 distance and D2 distance are shown as follows:

$$D^2(D1,D2)=\sum_{i=1}^{N1}p_i^2+\sum_{j=1}^{N2}p_j^2-\sum_{i=1}^{N1}\sum_{j=1}^{N2}2ap_iq_j \tag{9}$$

A query image to Q, D1 and D2 are the target image, the main color and proportion was shown in Fig. 5.

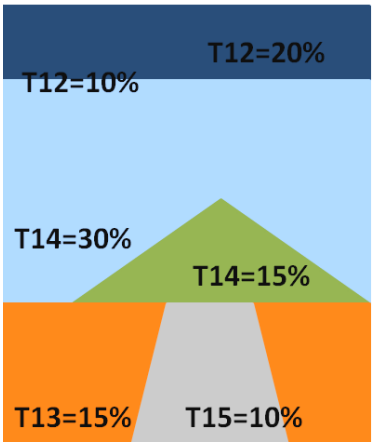

Fig. 5. The main color and proportion of target image.

Suppose that Q, F1, F2, and q2=t11=t22 and q3=t23. Other colors are not the same, and the distance is greater than the threshold Td. Image F1 and Q have a similar color, image F2 and Q are two kinds of color similarity. And image F2 and Q ratio is larger than the image and color similarity F is similar to Q color ratio and (40 %>35 %). Straight sleep on the query image and F2 is more similar.

The target image F1 and F2 contains the number of main color the same, cause $D^2(Q, F1) < D^2(Q, F2)$ the main reason is the same color ratio. Experimental results show that the query image and the image of Q and F1 are more similar to that of human vision, and cognition is still inconsistent. The above two examples show that the formula of the calculated results by the number and proportion. Increase the main color numbers lead to shorten the distance between the image, target image and the query image. The main colors in the target image with the larger proportion, the distance between the image shorter, and the Yan query image the proportion of independent color.

3.2. Image Retrieval Based on Salient Points

In an image to the human eye is sensitive to some important points, and to remember the image information these points and its nearby points, these points can cause visual attention point, known as the significant point. They are relatively stable and prominent point in the image, the point is the visual focus, can be smooth boundary points can also be a corner, their distribution in the image by visual attention region.

This study first extract salient points in the image, and then extract the salient features for image retrieval. The advantage of the salient points that need to use only significantly small and need not compute all the images to calculate the feature of image, to reduce the amount of computation, improve the computational speed; in addition, local feature point extraction is significant for some classic change more healthy, such as: additional noise, moving transformation, rotation transform, size transform, gradient and so on. Extraction of salient points in the image are extracted by wavelet transform, scattered distribution of significant points of these algorithms in the image, extracting algorithm and the algorithm complexity is high. Inverse probability image difference block the image block improved inverse probability model to extract the original image (BDIP image), and then using them as a clue, the shape feature and spatial distribution characteristics of color image of the organic combination of retrieval, but the salient point extraction approach is the need to manually specify the significant point selection threshold, different for the threshold values of different database, is not conducive to the automatic extraction of salient points.

Therefore, this chapter presents a new method for automatic extraction of salient points of artificial intervention, automatic extraction of salient point is not necessary in this method, the salient points and extracted in visual focus position. The image retrieval was based on salient points. In view of the above problems, this section presents an automatic extraction of image new significant point of the algorithm, as shown below:

1) Input: Image I;

2) Output: Significant point set;

3) Step1: Quantification of the input image to a 72 color space, the gray image is obtained after quantification;

4) Step2: Calculation of BDIP image quantization image;

5) Step3: Extraction of salient points of BDIP images;

6) Step4: Extraction of salient points of original image.

Iterative threshold segmentation algorithm to choose corresponding significant points of BDIP images to the image in the original image block, significant point contains rich texture information, rather than the relatively smooth significant points, can be considered significant non-point mainly contains the color information. Therefore, the significant and non-significant points were extracted from different feature, namely the non-significant point to extract color feature -- LBA feature, texture feature extraction and DBPSP characteristics of the salient points. Fig. 6 shows the image scanning of two 2*2 image block and its corresponding.

This chapter from a new method for automatic extraction of salient points of artificial intervention, automatic extraction of salient point is not necessary in this method, the salient points and extracted in visual focus position. Firstly, the query image input by the user are salient point extraction, significant point set and non-significant point set. Significant points around the rich information, including the texture edge information around more, texture feature not significantly less points, therefore, the feature extraction of significant points for texture feature extraction, extraction of color feature of significant non-point. Finally, feature vectors are constructed to realize image retrieval. The experimental results indicate that the proposed based on foreground and background are distinct and image background color single get higher positive image salient point retrieval precision and recall rate; and the background image is not obvious for retrieval precision rate and recall rate is low.

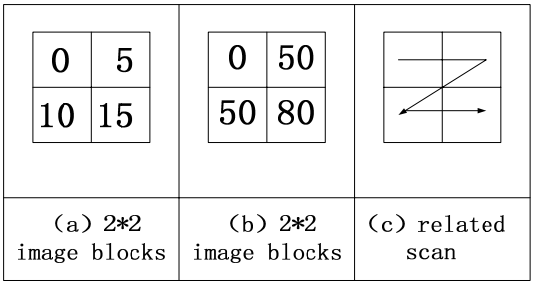

Fig. 6. The image scanning of two 2*2 image block and its corresponding.

3.3. Experimental Results and Analysis

In order to verify validity of image retrieval method is proposed in this paper, compared with the literature retrieval methods will be presented in this paper, the correct rate of the image retrieval results and recall. The main color feature extraction algorithm is proposed in the literature LBA, compared with DCD algorithm in MPEG-7 standard, greatly improving the speed of feature extraction, the similarity measurement in new ways, making the search results more stick the human eye's visual cognition. BDIP and BVLC proposed in the literature of image features for the image retrieval, the experimental results show that the ratio of traditional image features, such as color histogram, wavelet moment, the edge histogram (EHD), color structure description (CSD), with higher precision and recall rate. Table 1 shows the number of cases to return different images, the correct rate of three kinds of specific methods and recall.

Table 1. The correct rate of three kinds of algorithms and the recall rate comparison.

Number	Accuracy			Recall rate		
Algorithm	30	50	70	30	50	70
LBA	46.0	42.1	37.4	14.1	21.0	26.2
BDIP+BVLC	50.7	44.7	40.3	15.2	22.4	28.2
LBA+DBDIP	54.1	48.4	44.9	16.2	24.2	37.3

This work focuses on the texture feature block inverse probability (BDIP) and color features – the main color feature (LBA) study. Proposes a new texture features – the main block inverse probability difference. On this basis, the paper realizes the image fusion of color and texture feature retrieval method. The method using DBDIP feature and LBA feature to construct image feature vector; compare the similarity metric similarity method and the new measure method of traditional. The experimental results show that compared with LBA method, the method proposed in this paper, the correct rate higher than 7.6 percentage points, high recall rate of 3.8 percentage points, compared with the BDIP+BVLC method, the correct rate is higher than 3.8 percentage points, 2.1 percentage points higher recall rate. The experimental results show that, the proposed method is effective for image retrieval. The three algorithm recall rate and correct rate was shown in Fig. 7.

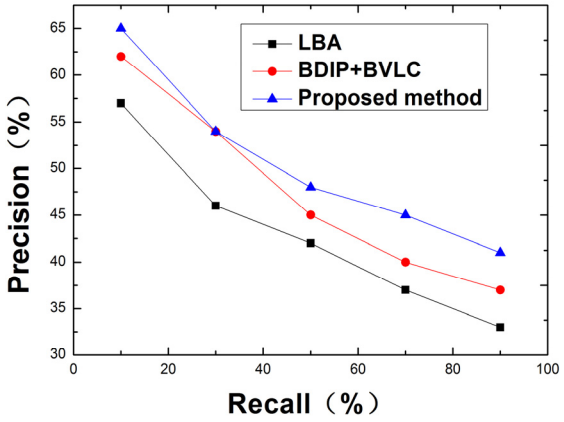

Fig. 7. The three algorithms recall rate and correct rate.

Fig. 6 shows the three algorithms of the recall rate and accuracy rate of. Black box at the top of the digital representation of the number of returned images, as can be seen from the graph based on the image salient points retrieval recall and precision are higher than the other two methods, compared with the LBA method, the correct rate higher than 7.6 percentage points, high recall rate of 3.8 percentage points, compared with the BDIP+BVLC method, the correct rate higher than 3.8 percentage points, 2.1 percentage points higher recall rate. Therefore, based on the image feature retrieval method has good retrieval performance.

Semantic-based image retrieval is a research hotspot in image retrieval, and semantic image retrieval technique based on the most close to the user demand, the most reasonable retrieval methods. But the semantic gap between low-level features and high-level semantics has been plagued by the researchers, if a reasonable representation of semantic feature; semantic feature extraction will require researchers to further thinking.

4. Conclusions

This paper describes the image retrieval technology research background and significance, introduces the current research situation and research hotspot in content-based image retrieval, the basic method of image retrieval based on content and key problems are explained in detail. The image can cause visual attention point, known as the significant point. The literature and presents a new method for automatic extraction of salient points, and on this basis to achieve significant point based image retrieval. Find the analysis of experimental results: the foreground and background are distinct and image background color of a single, can extract salient points effectively, the recall rate and correct rate was higher; the background image is not obvious, is not conducive to the significant point.

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