Multi-characteristics Image Retrieval

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Keywords: Main area; Representative points; Positional relationship; Annulus area; Image retrieval

Abstract. In this paper, according to different images of shifting, rotation and scale invariance properties, we propose a multiple features method for image retrieval. Firstly, we get the main area of the image to avoid the affections by some nonsignificant scenes. Secondly, we split the image into five parts, and utilize the pixels distribute information of every sub-image to get the representative points. Positional relationship among these representative points of the sub-blocks remain the same when the image suffers shifting or scaling transformation. By this means, the image can be expressed in a sample way and avoid complex shape detection. Then, in order to get the more detail information, the image is divided into several concentric rings, and we statistic the number of pixels in each annulus area to construct the third feature. Finally, combining these features with a certain weight coefficients and the hybrid characteristic is put forward. Experiments show that this method can achieve good effect of image retrieval and flexible to compute.

Introduction

With the rapid development of science and technology， the source of the image data is more and more widely, every day a large number of image information spreading and interaction in the network. How to find out the information that user needs in vast amounts of data quickly and accurately has becoming an important problem should to be solved. Text-based image retrieval methods for its simplicity and ease of operation has been widely promoted and used. Such a manner consistent with human habits, especially in the absence of a template image, people search by keyword in the commercial web crawlers on line to get the image with their needs. However, because each person understanding of images, text labels always strong subjective then accuracy of search results are not always satisfactory. And with the rapid increase of the amount of image data, the cost and difficulty of text labels corresponding surge. Content-based image retrieval (CBIR) [1] refers to according to the image content itself, directly extracts representative characteristics, and then based on the similarity between image and target image for searching. Wherein, color, shape and texture are the most important features. However, the characteristic dimensions of the high prevalence of color feature extraction select the color space, color quantization, color characteristics, issues such as the loss of spatial information[2,3,4,5].Texture Images and organizational structure of the image surface is related to the early extraction of texture extraction mostly statistical methods, such as co-occurrence matrix[6,7].And later evolved into the use of Markov random field model and wavelet transform Gabor[8,9,10].But the texture characteristics of large amount of calculation, and is sensitive to noise. Shape is the closest matching features of user demand, often using Fourier descriptor and the same distance, complex structure, large amount of calculations [6].

In this paper, we proposed an image retrieval method that combined three different features together according to the structure of the image and its general distribution. Firstly, the overall outline of the image obtained through the edge detection, based on the connectivity of the edges to remove smaller communication areas, obtaining the main area of the image, and calculating the aspect ratio of the main area as the first feature. Then split the image into five sub-blocks, and utilize representative point to show each block. Positional relationship among these representative points of the sub-blocks used as the second feature of image retrieval. Finally, the geometric center of the rectangular image used as the center of the circle to divide the original image into several annulus areas based on the circular projection method, and obtain pixel characteristic feature vector of each region thereof. These three features are shifting and scaling invariance. The final image similarity obtaining by combining three features with a certain weight coefficient.

Feature Extraction and Similarity Measure

Aspect Ratio of the Image Main Area. Attentions are always focused on the target object when observing images, thus ignoring the unimportant details. Generally speaking, the target object in the image tends to occupy most prominent area with the clearest and most complete contour edge, and not the target objects are relatively small, the connectivity of the edges are weaker. Different target objects with different profiles, so we marked out main area of the image by rectangular, then to calculate the aspect ratio of the main as a feature.

Firstly, the sobel operator has been used to detect the edge for images, and then to determine the main area of the image according to the connectivity of the edges. The pixel connectivity is defined as [11]: S represents the subset pixels of an image, if there is a path between all pixels in S, the two pixels p and q can be referred as connective in S. Edge image is a set b, which composed by a collection of all the edge binary points. By detecting the connectivity, we can obtain all connected sets contained in the edge image, then get rid of the connected set of smaller, leaving the main area M of the image with which marked by a rectangle. Specific algorithm is that marking the remaining set of all pixels with P, $P=\{p_1,p_2,\cdots,p_m\}$ where m is the number of the remaining pixels, the coordinates of each pixel p_i （$i=1,2,...,n$） is (x_i,y_i) . When $c_1=\min\{x_1,x_2,\cdots x_m\}$, $c_2=\max\{x_1,x_2,\cdots x_m\}$, $k_1=\min\{y_1,y_2,\cdots y_m\}$, $k_2=\max\{y_1,y_2,\cdots y_m\}$, the coordinates of the four vertices of the rectangle are (c_1,k_1), (c_2,k_1), (c_1,k_2), (c_2,k_2).

The aspect ratio of the rectangular is

$$ckb=\begin{cases}(k_2-k_1)\big/(c_2-c_1), if\,(k_2-k_1)>(c_2-c_1)\\(c_2-c_1)\big/(k_2-k_1), if\,(c_2-c_1)\geq(k_2-k_1)\end{cases}. \tag{1}$$

And similarity measure is $\delta_1=ckb_1\big/ckb_2$, when $ckb_2\geq ckb_1$, otherwise $\delta_1=ckb_2\big/ckb_1$.

Image Sub-blocking and the Positional Relationship between Its Representative Points of the Sub-blocks. Document [12] shows that for a simple graphics image which combined by a plurality of shape features the internal structure of the image does not change when shifting, scaling or rotation. However, in practical applications, the image is often more complex, and it is difficult to split a whole image into a number of combinations of simple shapes, so we will segment the image artificially and representative points were calculated for each sub-block, and construct the feature vector by the distance between each sub-graph representative point and the representative point of the whole image.

Every image is a discrete points set arranged by a particular order $\{(x_i,y_i)\mid i=1,2,3\cdots,\ n\}$. And we can construct a point A which can represent the entire image by pixels point distribution of the image, thus reducing the large amount of pixel information to the very smaller. Then quartering the entire image, in general, the central region of the image often contains a large amount of information which is of much more importance than the four corners of the image , so we take the 5th sub-image at the central region with the same size as the former 4 sub-images. There are 5 sub-images $S_i\,(i=1,2,\cdots,5)$ in the original image I .

Then calculate the representative points $A_i\left(i=1,2,\cdots,6\right)$ of each sub-image and the whole image respectively according the Eq.2. Among them $A_i\left(i=1,2,\cdots,5\right)$ corresponding to the sub-image $S_i\left(i=1,2,\cdots,5\right)$, and A_6 is the representative point of the whole image.

Representative point of the image: $A=f_A(S)$,

$$f_A(S)=\begin{cases} X_A=\dfrac{1}{n}\sum_{i=1}^{n}x_i \\ Y_A=\dfrac{1}{n}\sum_{i=1}^{n}y_i \end{cases}. \tag{2}$$

Then bridging A_6 and $A_i\left(i=1,2,\cdots,5\right)$, and calculate the length of line segment, respectively. According to the length of the line segments from short too long to remark corresponding points $A_i\left(i=1,2,\cdots,5\right)$ as $A_1, A_2, \cdots, A_5$.

Distance invariant feature:

$$d_1, d_2, d_3, \cdots d_n = A_6A_i\Big/\sum_{i=1}^{5}A_6A_i,\ A_6A_2\Big/\sum_{i=1}^{5}A_6A_i, \cdots, A_6A_n\Big/\sum_{i=1}^{5}A_6A_i. \tag{3}$$

Therefore, similarity measure function between image I and its shifting or scaling variant I' can be defined as:

$$\delta_2=1-\left[\sum_{i=1}^{5}\left[\frac{d_i-d'_i}{\left(d_i+d'_i\right)/2}\right]^2\right]^{1/2}\Big/\sqrt{5}. \tag{4}$$

The Distribution Characteristics of Pixels in Annulus Areas. Take the geometric center (x_I, y_I) of the edge image I as the center of circle to conduct circular projection. Convert the image $I(x,y)$ to $I(r,\theta)$ and the value of r is equal to $I(x,y)$ inscribed circle radius.

Then, with radius as $r/4$ 、 $r/2$ 、 $3r/4$ 、 r for circle respectively, the images I is divided into 5 parts. From the inside to out, statistic the number of pixels W_i in each ring area and the outer area in turn, then construct them as a feature vector $W=[W_i],(i=1,2,\cdots,5)$.

Therefore, similarity measure function between image I and database image I' can be defined as:

$$\delta_3=1-\left[\sum_{i=1}^{5}\left[\frac{W_i-W'_i}{\left(W_i+W'_i\right)/2}\right]^2\right]^{1/2}\Big/\sqrt{5}. \tag{5}$$

Similarity Function. Combining with the three separate characteristics for image retrieval, the similarity metric function is:

$$\delta=k_1\delta_1+k_2\delta_2+k_3\delta_3. \tag{6}$$

$k_1+k_2+k_3=1$ and they indicate the proportion that these three characteristics are occupied, respectively.

The Experimental Results and Analysis

In order to verify the performance of this algorithm, we select the following 5 images in Fig. 1for testing. The main contents of the images in the database are: European classical architecture, buses, dinosaurs, elephants, flowers, and horses, each with 100 pieces and a total is 600 images. All the images are selected from the Corel Image Library. Experimental results are aligned based on the similarity values, and the high degree of similarity of 12 images are displayed in descending order of similarity from left to right and top to bottom .

Figure 1.Test images

Performance Validation of the Individual Characteristics and the Combinational Feature. We choose 1.jpg as the test image. And the results show as Fig.2. When using the aspect ratio of the image main area as the feature for retrieving, we just get 4 images containing bus. The performance better than former when the positional relationship between representative points of the sub-blocks as the retrieval feature. Buses in all pictures have larger size. Seeing the image database can find that the European buildings have bigger size, too. Pixels within them have a uniform distribution, and they overall structure are similar, so taking the distribution characteristics of pixels in annulus areas for retrieval, emerging buses and European classical architectures confused phenomenon. According to the performance of the three characteristics, we select $k_1 = 0.3$ $k_2 = 0.3$ $k_3 = 0.4$ as the weighting coefficient to combine them for retrieval, result as Figure 2(d). Comparing 4 results in Figure 2, it is clear that the combinational characteristic performance is far better than any single feature.

(a) (b) (c) (d)

Figure. 2 Performance of the individual characteristics and the combinational feature: (a) the aspect ratio of the image main area as the feature; (b) the positional relationship between its representative points of the sub-blocks as the feature; (c) the distribution characteristics of pixels in annulus areas as the feature; (d) combine the above three characteristics for retrieval

Conclusion

The paper uses the aspect ratio of the image main area, the positional relationship between its representative points of the sub-blocks and the distribution characteristics of pixels in annulus areas as features for image retrieval. Those three features not only take the structure of the image into consideration, but also take the distribution of the pixels into account. The experimental results show that the method has a good retrieval effect. Follow-up studies will introduce more underlying characteristics, such as color, texture, etc., to get a further improvement in the retrieval.

Acknowledgement

The work was supported by National Natural Science Fund (Grant No. 61375055)

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