Paper-cutting Image Retrieval Technology based on LSH Improvement

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Abstract. Characteristics of paper-cutting, paper-cutting gallery construction, etc. are analyzed aiming at existing problems of folk traditional paper-cutting art multimedia interactive platform. It is proposed that rotation invariant LBP (Local Binary Pattern) is combined with LSH algorithm to present a large-scale paper-cutting image fast retrieval method. Firstly, the background image is eliminated with OTSU, then the paper-cutting image rotation LBP feature. In addition, high-dimensional data is mapped to low dimensional space, and a hash index was constructed by local sensitive hash algorithm to find the approximate KNN. Experimental result in the dataset shows that the improved algorithm has high accuracy on paper-cutting image retrieval, and it is significantly higher than traditional algorithm on retrieval speed.

Keywords: paper-cutting image retrieval; OTSU algorithm; LBP textural features; LSH index.

1. Introduction

Information technology means is utilized to protect the resources of intangible cultural heritage, which is one of the hot topics in current research. Currently, the paper-cutting art of world-class intangible cultural heritage is becoming more and more popular among the public. The full-bodied style charm of paper-cutting art is yearning for people since Pre-qin Dynasty. Currently, it is widely used in interior design, stage design, logo design, landscape design, architectural design and other fields. More and more designs have been created one after another up to several thousands to ten thousand dues to the changeability of paper-cutting shapes. in order to better protect and inherit digitization [2] A java-based paper-cutting art multimedia interaction experience is constructed, the scattered folk paper-cutting works are collected, and database is constructed for retrieval, etc., and more than 3000 paper-cutting works are collected into the database currently.

In the actual retrieval process, it is necessary to find out whether there are the same or similar products in the database storing paper-cutting according to samples. How to search own interested work rapidly and accurately is a to-be-solved problem. The traditional text-based retrieval method is artificially annotated. Its retrieval results are influenced by subjective factors so that the accuracy of the retrieval is not high and the efficiency is low. It cannot meet the retrieval demand of users. The researchers put forward a new Content -based Information Retrieval technology (hereinafter referred to as CBIR) [3]. The image retrieval based on textural features is the cutting-edge technology in CBIR research.

A new fast retrieval algorithm is designed based on LSH algorithm for large-scale paper-cutting image retrieval application requirements. Experimental result shows that the paper-cutting method is simple and efficient.

Firstly, paper-cutting is soft and extensible material, which can be easily deformed. Secondly, the paper-cutting gallery retention sample is characterized by the scanning image containing the paper background. It is necessary to divide the image and delete the background in order to characterize the paper-cutting texture so as to retain the material. In the paper, a method of segmentation by using Otsu algorithm [4] is proposed to remove the image background and extract features in view of the above problems. If it is a low dimensional small dataset, we can easily solve by linear search. However, if linear search matching is adopted for mass high dimension dataset, the process is very time-consuming, the key technology to solve the problem of high-dimensional index [5] is locality sensitive hashing or LSH. However, because of the shortcomings of low accuracy, and there are various patterns between paper-cutting images [6], retrieval can be implemented based on texture so that it is proposed in the paper that rotation invariant LBP (Local Binary Pattern) is firstly utilized for

extracting paper-cutting image textural features so as to improve the efficiency and accuracy of retrieval.

2. Improved Feature Extraction Algorithm

2.1 Image Processing

Image segmentation principle of OSTU threshold method [7]: namely, the entire image M grey value is traversed. The between-cluster variance of each grey value is calculated. Then, the maximum value is discovered for finally getting the best threshold. In simple terms, it is assumed in the algorithm that an image consists of foreground color and background color. A threshold is selected through a statistic method; therefore, the foreground and background colors can be separated as far as possible by the threshold. The paper-cutting image has no requirements on color. Therefore, it is insignificant to change the color information into grey image in our application. In Dajin segmentation method, it is assuming that the image contains two sets of pixel two-mode histogram. Then, the optimal threshold is calculated to separate the two groups, and the combined propagation (the in-class variance) can be minimized. Figure 1 shows the paper-cutting image after processing (a) and processing (b), and (c) shows the two-mode histogram.
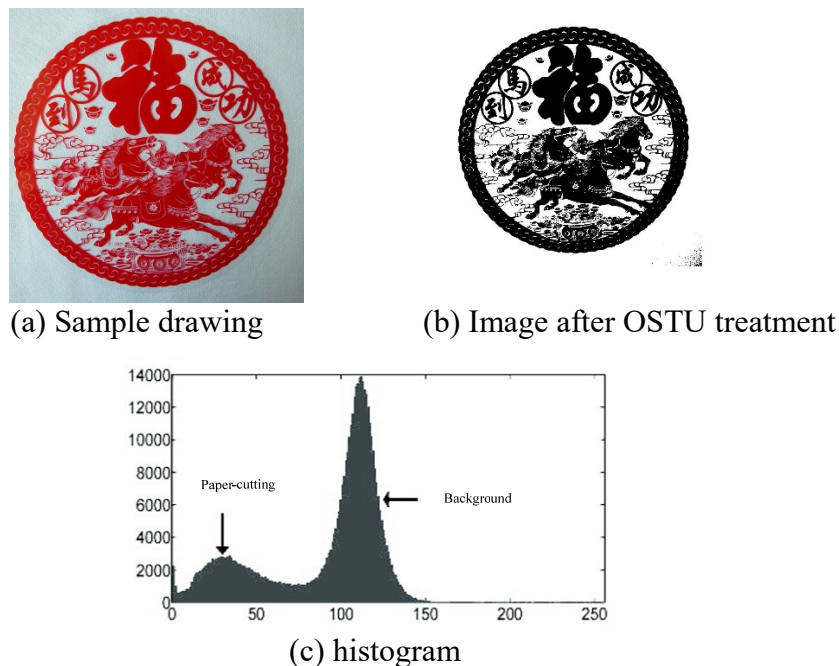

(a) Sample drawing   (b) Image after OSTU treatment

(c) histogram

Fig 1. Image processing results

The paper background is eliminated during scanning and warehousing after OSTU treatment, and the texture is clearer.

2.2 Rotation Invariant LBP Algorithm

Based on LBP algorithm principle [8]:

(1) In a 3*3 neighborhood of pixel, the center pixel is regarded as the threshold, 8 neighboring pixel grayscale values are respectively compared with the center threshold. If the greyscale value in the neighborhood is greater than or equal to the greyscale value of the center point, the value is recorded as 1; otherwise, it is recorded as 0.

(2) Values are read clockwise through the method to form a binary string.

(3) 8 binary bits are respectively multiplied with weights corresponding to each location.

(4) The obtained products are added to obtain a decimal number. It is LBP eigenvalue of the center point.

(5) Finally, each point is treated to obtain the eigenvalue of all the points in the image.

The steps are shown as follows:
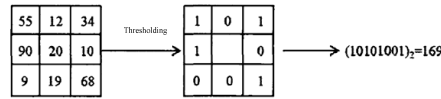
The disadvantages of the above LBP features are rotation-related, which is further improved. Ojala, et al. [9] achieved LBP feature with rotation invariance. The rotation invariant LBP feature can be realized by using the cyclic shift operation of data. The calculation formula is shown as follows:

$$\text{LBP}_{p,r}^{ri} = \min\left(\text{ROR}\left(\text{LBP}_{p,r}^{ri}, i\right)\right), i = 0,1,\cdots,P-1$$

Where in, ROR (z, k) represents P-bit binary number z is circulated and displaced rightwards for k times.

3. Paper-cutting Image Retrieval based on LSH Index

In practical application of paper-cutting image, there are large quantities on the one hand, images are different from text data and the data dimension is high. If it is low dimensional small dataset, it can be easily solved through linear search. If linear search matching is adopted for a mass high-dimensional dataset, the process is very time consuming. Therefore, LSH algorithm is introduced to set up the index structure in order to solve the problem, thereby improving the retrieval speed.

3.1 LSH Principle

LSH basic idea [10]: data points in the original space undergo the same mapping or projection. The neighboring probability of adjacent data points in the new space is still very high. The neighboring probability of non-adjacent data points is low, namely the adjacent data points are projected to the same hash bucket with higher probability.

The hash function should satisfy the following two conditions:

1) If $d(x,y) \leq d1$, the probability of $h(x) = h(y)$ is at least p1;

2) If $d(x,y) \geq d1$, the probability of $h(x) = h(y)$ is at most p2;

Wherein, d (x, y) represents the distance between x and y, d1<d2, h(x) and h(y) respectively represent the hash change to x and y.

3.2 Construction of Hash Index

The process LSH of hash table is constructed from a large number of data and approximate KNN is searched through index as follows:

3.2.1 Off-line Establishment of Index

(1) Select LSH function meeting (d1, d2, p1, p2)-sensitive;

(2) Determine the quantity of hash table L, the hash function quantity in each hash table and parameters related to LSH algorithm according to the accuracy of search results (i.e., the probability of searching adjacent data);

(3) Extract LPB textural features in all images in the paper-cutting image database, and the above hash function is utilized for projecting it to corresponding hash bucket, thereby forming many hash tables.

3.2.2 Online Search

(1) Obtain corresponding bucket number from search data through LSH algorithm hushing;

(2) Former 2L [11] corresponding in the bucket number is obtained;

(3) The similarity or distance between the search data and the 2L data is calculated, and the nearest data is returned;

4. Experimental Result and Analysis

4.1 Experimental Platform and Procedure

Our programming language is Matlab, and the operation platform is Windows 8, and Intel(R) Core (TM) i7-4870HQ CPU is equipped on the machine, 2.50GHz and 16.0GB memory. The paper-cutting images in the gallery are divided into 11 categories, there are a total of 3,000 images which can be rotated and processed to enrich the rotational diversity of the library. The final required test library is obtained, and there are 9000 paper-cutting images.

Firstly, each paper-cutting image is processed by OSTU to eliminate the background. Then, the rotation invariant LBP features of each paper-cutting image are extracted. In the experiment, LSH index and exhaustion search method as LSH limit are used in the retrieval, and the retrieval test is conducted for 9000 paper-cutting images in the test library, thereby validating the validity of the proposed algorithm in the paper-cutting image retrieval.

4.2 Experimental Result and Analysis

Sample drawing as shown in Fig.2:

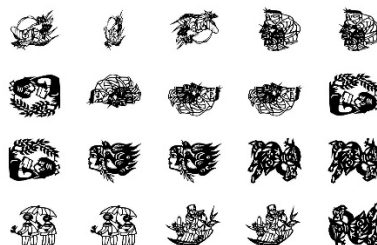Fig 2. Sample drawing

Search result as shown in Fig.3:

Fig 3. Search result

As shown in the figure, the first image is the same as the sample drawing, and the second and the third images are pictures after rotation of the sample drawing. It is obvious that the algorithm proposed in the paper can successfully retrieve required pictures, and the similar selected images can be tested.

Accuracy and speed as shown in table 1.

Table 1. Accuracy and speed

Algorithm comparison	Speed	Accuracy
Rotation invariant LBP+exhaustion index	12.2037	94.2%
Rotation invariant LBP+LSH index	2.1423	93.7%

Experimental result shows that LSH is selected for retrieval and linear exhaustion search similarly in the aspect of search accuracy. However, LSH index is more prominent obviously. Most images in the test set are obtained through rotation and change as shown in the figure. The retrieval method

based on rotation invariant LBP features and LSH index not only can meet the demand of similar retrieval, but also is more accurate to retrieval effect of rotation images. Therefore, the retrieval algorithm integrating rotation invariant LBP features and LSH index is applicable to retrieval of large-scale paper-cutting images.

5. Conclusion

In the paper, paper-cutting image retrieval technology is improved on the basis of LSH. Experimental result shows that the algorithm proposed in the paper still has low complexity and higher real-time performance binary descriptors. The scope of scale change is expanded, and the time of the algorithm is reduced effectively. Our algorithm is more efficient compared with traditional image retrieval algorithm such as LBP, etc. Meanwhile the hash-based image retrieval content index structure is faster than traditional method.

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