Retrieval of Clothing Images Based on Color Feature

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Abstract. With the rapid development of e-commerce apparel, clothing online shopping is becoming an increasingly popular way of shopping. At present, text features are often used as search terms. Users need a retrieval tool to realize the clothing information search function efficiently. The content-based image retrieval technology and network shopping based on, with intention of apparel information for the user, is very practical significance. In order to further enhance the convenience when users look for clothes, an image querying and retrieval system based on color feature is designed and implemented. How quickly and accurately retrieve images from a vast image database becomes an urgent problem to be solved. This paper compares a variety of color feature extraction methods and similarity measure methods. Experiments show that Euclidean Metric and global color histogram using RGB space are relatively appropriate for clothing images search.

Introduction

Content-based image retrieval (CBIR) [1], a technique for retrieving images on the basis of automatically-derived features such as color, texture and shape, is opposed to traditional concept-based approaches [2].

Clothing mainly contains information such as color, style, and flower-shaped. In this paper, there are six kinds of implemented feature extraction algorithm: global color histogram using RGB space [3] [4], global color histogram using HSV space [3] [4], cumulative color histogram using RGB space [5], local cumulative color histogram using RGB space [5], 4x4 non overlapping blocks color averaging using RGB space [6] [7], 4x4 overlapping blocks color averaging using RGB space [6]. There are three kinds of implemented similarity measurement algorithm [8]: Euclidean metric [4], Manhattan distance, Histogram intersection [4]. Experiments showed that clothing images retrieval with global color histogram using RGB space and Euclidean metric has relatively good effect.

In this paper, the system consists of two important modules: Spider, Image analysis and processing. System frame diagram see Fig.1. The Web crawler collects apparel e-commerce sites clothing images and the corresponding information, extracts image feature, and then the feature database is established. Users can upload a clothing image and query; the system processes the image, extracts color feature, measures similarity, and returns similar clothing images with the corresponding information.

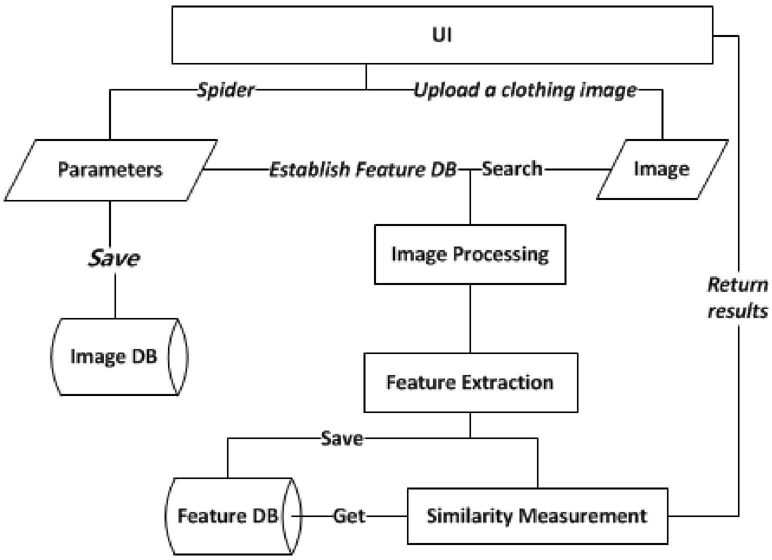

Fig.1: System frame diagram

Design of the Web crawler

The Web crawler is built for providing compact storage for large image databases. When you run the program, some parameters need to be set at start. Enter the URL of the apparel e-commerce site as the seed, set the crawl depth and the number of worker threads, and choose where to save images. In order to save the URL needed to collect and to prevent duplication, the program maintains two data structures: a dictionary storing a not downloaded page and its depth, a dictionary storing a downloaded page and its depth. Our algorithm is developed [9]:

Step 1: place the seed in the dictionary marked as uncollected.

Step 2: Remove one item from the dictionary marked as uncollected, and add the item to the dictionary marked as collected.

Step 3: Collect clothing images and hyperlinks.

Step 4: Determine whether the depth of the hyperlinks is smaller than the crawl depth, filter the hyperlinks and add new hyperlinks to the dictionary marked as uncollected.

Step 5: Determine whether the dictionary marked as uncollected is empty, if not empty, and then repeat the above operations.

Compare image retrieval algorithms

About image retrieval based on color feature, some of the most important are [1] [3] [5]: selecting the appropriate color space, choosing efficient feature matching algorithm, using a certain color quantization method in order to turn the color feature into vector, matching query and stored images in a way that reflects human similarity judgments.

Color feature extraction methods

In this paper, the algorithms used are mature. A color histogram shows the proportion of pixels of each color within the image. Color averaging is a technique of averaging the pixel intensities of an image. The pixel intensity values are used for generating the feature vector of an image. Both 4x4 non overlapping blocks color averaging using RGB space and 4x4 overlapping blocks color averaging using RGB space involve dividing the image to 16 equal sized blocks. In the former, every block is calculated once. In the latter, the four blocks at the corner are calculated only once; the four blocks at the center are calculated four time; the others are calculated twice.

The HSV quantitative method shows as follow:

$$H = \begin{cases} 0, & 0 \le H \le 20 \\ 1, & 20 < H \le 40 \\ 2, & 40 < H \le 75 \\ 3, & 75 < H \le 155 \\ 4, & 155 < H \le 190 \\ 5, & 190 < H \le 270 \\ 6, & 270 < H \le 295 \\ 7, & 295 < H \le 360 \end{cases}$$

$$S = \begin{cases} 0, & 0 \le S \le 0.2 \\ 1, & 0.2 < S \le 0.65 \\ 2, & 0.65 < S \le 1 \end{cases} \qquad V = \begin{cases} 0, & 0 \le S \le 0.2 \\ 1, & 0.2 < S \le 0.65 \\ 2, & 0.65 < S \le 1 \end{cases}$$

On global color histogram using HSV space premise, L is the item of histogram. L is calculated as follows:

$$L = 9 * H + 3 * S + V$$

Table 1: Features Vector dimension

Feature Extraction Method	24bit BMP	8bit BMP
Global color histogram using RGB space	1024	256
Global color histogram using HSV space	36	9
Cumulative color histogram using RGB space	72	72
Local cumulative color histogram using RGB space	1024	256
4x4 non overlapping blocks color averaging using RGB space	64	16
4x4 overlapping blocks color averaging using RGB space	64	16

When the image depth is 8 or 32 bit, BMP files use different feature extraction methods, features vector dimension see Table 1.

Similarity measures

In this section, we briefly elaborate three commonly used distance measures. P = (P1,P2,…,Pn) and Q = (Q1,Q2,…,Qn) are two feature vectors.

The Euclidean metric is the ordinary distance between two points.

$$D_{Euc}(P,Q) = \sqrt{\sum_{i=1}^{n} \left| P_i - Q_i \right|^2}$$

The Manhattan distance is also known as rectilinear distance or city block distance.

$$D_{Euc}(P,Q) = \sqrt{\sum_{i=1}^{n} \left| P_i - Q_i \right|^2}$$

Histogram intersection is given by:

$$D_I(P,Q) = \frac{\sum_{i=1}^{n} \min\left(P_i, Q_i\right)}{\min\left(\sum_{j=1}^{n} P_j, \sum_{k=1}^{n} Q_k\right)}$$

Performance Evaluation

Evaluation criteria for image retrieval algorithms have precision [2], recall [4], time complexity, space complexity, etc. Precision is the proportion of the images that are relevant to the query. Recall signifies the proportion of relevant images in the database that are retrieved in response to a query.

$$Precision = \frac{\text{No. of revlevant images in the retrieved images}}{\text{No. of retrieved images}}$$

$$Recall = \frac{\text{No. of revlevant images in the retrieved images}}{\text{No. of revlevant images in database}}$$

Experiments and analysis

In the experiment, the number of images for testing is 240. The number of pants images is 60. The number of dresses images is 90. The number of jackets images is 90.

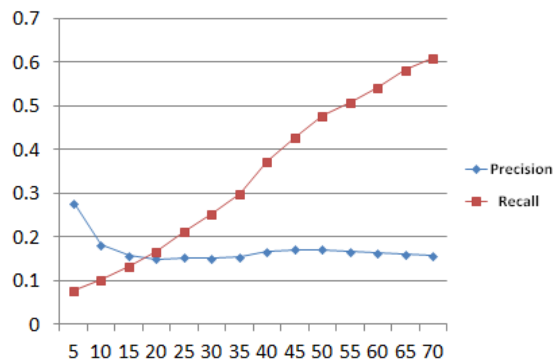

Fig.2: Whole database

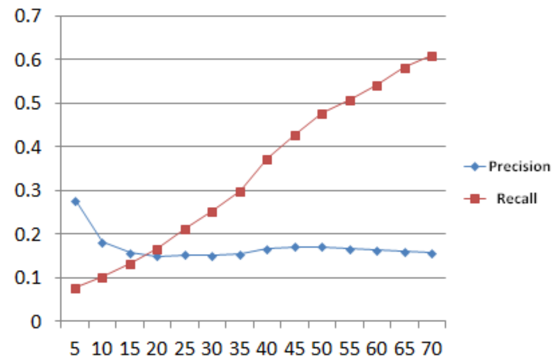

Fig.3: Solid color short-sleeved jackets

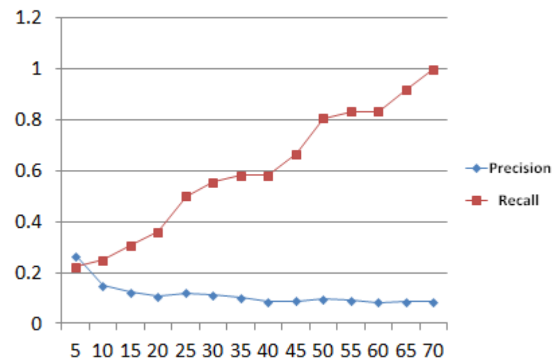

Fig.4: Sleeveless denim dresses

Dealing with all the images for testing, Precision-Recall curves see Fig.2. Fig.2 shows that with the increase of results returned, the recall rate of the system is on the rise, but the precision of the system is declining. Dealing with solid color short-sleeved jackets, Precision-Recall curves see Fig.3. Dealing with sleeveless denim dresses, Precision-Recall curves see Fig.4. When the number of the returned results is 25, the difference between the average recall and the average precision is smaller and both of them have larger values. Therefore, the number of results returned is set to 25.

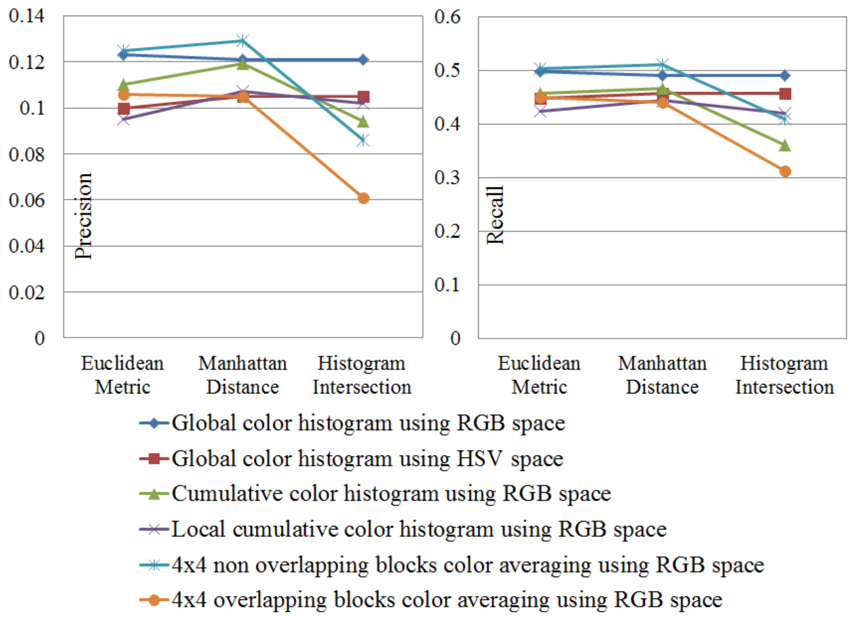

Fig.5: Precision and recall curves

When using different color feature extraction methods and different similarity metric methods, precision curves see the left half of Fig.5, recall curves see the right half of Fig.5. As can be seen from figures, under the circumstance of Euclidean metric or Manhattan distance, global color histogram RGB space and 4x4 non overlapping blocks color averaging using RGB space perform better than others with high precision and recall rate.

Furthermore, space complexity of all implemented feature extraction algorithms is o(n). Time complexity of 4x4 non overlapping blocks color averaging using RGB space and 4x4 overlapping blocks color averaging using RGB space is o(n3), while the others is o(n). Space complexity and time complexity of all implemented similarity measurement algorithm is o(n).

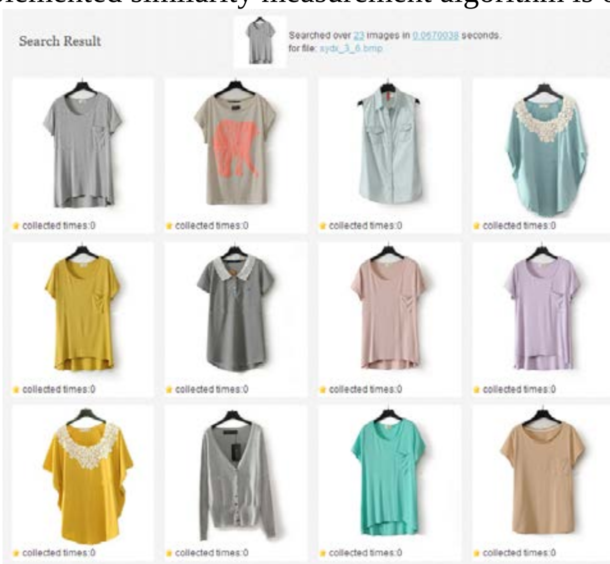

Fig.6: Search Results

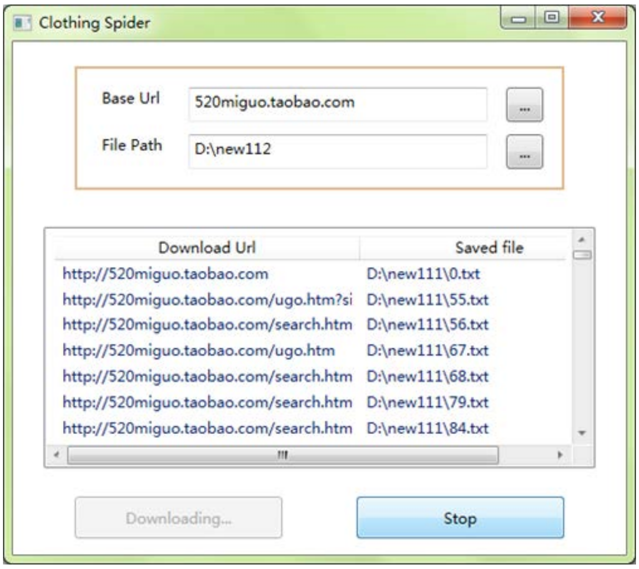

Fig.7: The running web crawler

In conclusion, choosing global color histogram using RGB space and Euclidean metric is better. Besides, with the increase of the running time, the number of images in database is rising. Setting the number of the returned results as 25 is no longer suitable. Based on a large number of experiments, the method, an item is returned when its similarity distance is smaller than 0.12, performs better. View an example of search in Fig.6; Check the state of the running web crawler in Fig.7.

Conclusion

This pager presents a method of image querying and retrieval based on color feature. Experiments show that the system has higher accuracy and stability when choosing global color histogram using RGB space and Euclidean metric. Furthermore, texture and shape features may be considered in the experiment, in order to improve the accuracy and efficiency.

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