Research on Fabric Image Retrieval Method Based on Multi-feature Layered Fusion

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Abstract. In recent years, with the maturity of computer technology and the increasing development of Internet technology, online transaction has become an important and popular sales method. As a necessities of life, clothing accounts for a considerable proportion of online transactions. Whether it is clothing manufacturers buying fabrics, or customers buying clothing online, they rely on fabric images on the Internet to browse, compare and select satisfactory products. This method of manual comparison is both time consuming and error prone. To effectively manage and use the fabric, it is very important to establish a fabric image retrieval system. The variety of fabrics and various styles, and the fabric image itself has the characteristics of large amount of data and large amount of information. The traditional retrieval method cannot achieve fast and accurate retrieval of fabric images. This paper proposes a retrieval method based on multi-feature fusion, which can accurately analyze the characteristics of fabric images. Experiments show that the using this method to retrieve fabric images can achieve good results.

1. Introduction
With the development of the network and the maturity of e-commerce technology, more and more people choose to shop online. According to related statistics, the net purchase of commodities, a larger proportion of clothing. Most users when retrieving clothing products, choose to search by keyword, such as red shirt, black trousers, also part of the user to select a recorded image to retrieve clothing. Keyword search related to artificial differences in the process of manual annotation, image search and affected light shade, color depth and other factors when shooting, resulting in two retrieval method is accurate rate is not high, the search result is not satisfactory. Therefore, it is necessary to establish a system for efficiently searching fabric images.

In recent years, content-based image retrieval [1] has been applied in the field of fabric inspection. According to the characteristics of the fabric image, this paper builds a rich fabric image library, analyzes the color, shape and texture features of the fabric image, and fuses the three features according to the set proportion to achieve accurate retrieval.

2. Basic idea
Since the generation of image retrieval methods, three important branches have been formed: text-based image retrieval [2], content-based image retrieval, and semantic-based image retrieval [3]. Text-based image retrieval uses text to describe user needs, such as image names, image features, etc., but the
limitations of textual expression capabilities and ambiguity in the text annotation process often result in non-conformance between search results and user needs. Semantic-based image retrieval further refines its advanced semantic expression ability based on image visual features, but the retrieval process is complex and the development of the method system is not perfect. Content-based image retrieval uses color, shape, texture, etc. as the feature expression of the image. Based on this, the search is used as the basis for the similarity judgment, which is the research hotspot in the field of image retrieval.

The basic method of this paper is to extract the feature of the fabric image first, including three characteristics: color feature, shape feature and texture feature. The color features are characterized by color moments [4], the shape features are described by Fourier features [5], and the texture features are extracted using wavelet transform algorithm [6]. After the feature is extracted, the feature can be set for the three feature users. During the retrieval, according to the query example image provided by the user, the similarity distance [7] calculated by the multi-feature fusion [8] is compared, and the result set with high comprehensive similarity is returned to the user. The image retrieval process is shown in Fig.1.

3. Feature extraction

3.1. Color feature extraction
Color is one of the most important attributes in an image, and it is also the most direct visual feature for describing image content. Most algorithms for extracting color features need to quantize the image first, which not only makes the image dimension high but also easily leads to false detection. And the color of the moment calculation is simple and versatile, so the representation of the color feature, color moments employed. The color moment is an effective color feature, this method utilizes the concept of linear algebra moment. The color information in the image is concentrated in the lower moments, mainly the first, second and third moments of the image.

Use \( W, H \) to represent the width and height of the image, then the third-order color features can be expressed as follows:
C1 represents the first-order color moment, C2 represents the second-order color moment, and C3 represents the third-order color moment, \( P(i, j) \) indicating the color information of the pixel at the position.

The color perception of the human eye mainly includes hue, saturation and brightness. The HSV color space has three properties, Hue, Saturation, and Value, which match the three properties of the HSV color space. Therefore, the HSV color space is used for color feature extraction. Assuming that M and N represent two images, then their moment distance formula is expressed as:

\[
D[M, N] = \sum_{i=1}^{3} \left( \omega_{i1} \left| \mu_i^M - \mu_i^N \right| + \omega_{i2} \left| \sigma_i^M - \sigma_i^N \right| + \omega_{i3} \left| s_i^M - s_i^N \right| \right)
\]  

where \( \omega_{ij} \geq 0, (1 \leq i, j \leq 3) \) is the specified weighting factor, but the cumulative sum must be 1.

3.2. Extraction of shape features

Fabrics have a lot of image shape information, shape features are also an important means of describing high-level visual features. The Fourier descriptor can describe the contour features well and has good robustness. Therefore, the Fourier descriptor has the best shape recognition performance. When Fourier shape descriptors are used to represent shape features, each coordinate pair needs to be expressed in multiple numbers. The formula is as follows:

\[
s(k) = x(k) + jy(k) \quad k = 0, 1, 2, \ldots, K - 1
\]

where \( x(k) \) represents the abscissa of the pixel and \( y(k) \) represents the ordinate of the pixel.

Discrete Fourier transforms as:

\[
a(u) = \sum_{k=0}^{K-1} s(k) e^{-2j\pi uk / K}
\]

After the complex processing, the shape characteristics of the image can be calculated. The formula is as follows:

\[
s(k) = \frac{1}{K} \sum_{u=0}^{K-1} a(u) e^{2j\pi uk / K} \quad k = 0, 1, 2, \ldots, K - 1
\]
3.3. Extraction of texture features
Texture is an important visual feature in images, which embodies the gray space distribution law of pixel fields. Texture is a key part of the research process image analysis. Texture analysis has been widely used in computer graphics. At present, there are various research methods for texture features, such as statistical methods [9], structural methods [10], transformation methods [11], and so on.

In this paper, the wavelet transform method is adopted in the extraction of fabric image texture features. The feature extraction algorithm is as follows:

1. Convert images to grayscale images;
2. When performing wavelet transform, the Gabor function is used as the basis function. Use $I(x, y)$ to represent an image, it can be expressed as:

$$W_{pq}(x, y) = \sum_s \sum_t I(x-s, y-t)g^*_pq(s, t)$$

(6)

Calculate the mean and variance of the transform coefficients:

$$\mu_{pq} = \int \int |W_{pq}(x, y)| \, dx \, dy$$

(7)

$$\sigma_{pq} = \sqrt{\int \int (|W_{pq}(x, y)| - \mu_{pq})^2 \, dx \, dy}$$

(8)

The resulting mean and variance are used as components in the texture feature vector.

3.4. Feature fusion
After the feature extraction step, the color, texture and shape features of the fabric image have been obtained. Fabric images come in a variety of colors and styles, in order to ensure accurate retrieval of images, this paper combines the color features, shape features and texture features of images. Feature fusion uses methods that give different weights to different features, the sum of the weight values is 1. $\alpha_c$, $\alpha_t$, $\alpha_s$ represent weights under three different feature extractions. Q, I represents the image to be retrieved and the database image. The hierarchical multi-feature fusion similarity calculation formula is as follows:

$$D(Q, I) = \alpha_c \left( \sum_{i=1}^{3} |C_i^q - C_i^l| \right) + \alpha_t \left( \sum_{i=1}^{3} |T_i^q - T_i^l| \right) + \alpha_s \left( \sum_{i=1}^{3} \beta_i |S_i^q - S_i^l| \right)$$

(9)

Calculate the similarity between all images in the database and the image to be queried according to the above method. Rank according to similarity, back to the predetermined number of most similar image to the user.

4. Experiment and discussion
In order to verify the validity of the retrieval method, the following experimental research was carried out. The software used in the experiment is configured as Windows 8 operating system, the programming language is Matlab. Image database used in the experiment is self fabric image library, the sum of the pictures is 1000.

According to the multi-feature fusion retrieval technology of this paper, Fig. 2 is used as the image to be retrieved, and the result of image retrieval is shown in Fig. 3.
Figure 2. Image to be retrieved

It can be seen from the search results in Fig. 3, the image of Fig. 2 is retrieved in the database, and the similar image is accurately retrieved. The image with the similarity ranked first is the image to be retrieved itself, and the next five images are based on the weights given. The three characteristics are sorted, and the results are similar to the images to be retrieved, which fully reflects the effectiveness of the retrieval method.

In order to further prove the retrieval efficiency, three single feature retrieval algorithms are compared with the multi-feature fusion algorithm. The comparison results of the four methods are shown in Fig. 4.

As can be seen from Fig. 4, the accuracy [12] of the image retrieval method based on multi-feature fusion is significantly higher than that of the three single feature-based retrieval methods, thus demonstrating the superiority of the integrated feature method.

Figure 3. Multi-feature fusion search results
Figure 4. Contrast results

5. Conclusion
This paper proposes a fabric image retrieval method based on three layers of integrated layering. Firstly, three image features are extracted separately, then three kinds of feature fusion retrieval using similarity measure sort the search results. The experimental results show that the multi-feature based retrieval effect is better than the single feature and has certain practical significance. The future work will focus on how to automatically adjust the weights, without human intervention on this basis, to make retrieval more intelligent.

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