Remote Network Monitoring Technology Based on Computer Technology

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Abstract. With the rapid development of Internet technology, using images to express the characteristics of things more direct, compared with text, audio, image expression content is more ambiguous, which makes the rapid increase of digital images on the Internet. Nowadays one of the hot directions of computer vision research is how to accurately and quickly retrieve the target image from a large amount of image data. This paper summarizes the development of image retrieval technology at home and abroad, and proposes an image search method based on color histogram and Chi-square distance. This paper discusses how to construct an image search system, which can search the image quickly, describe the color distribution of the photo with color histogram, divide the image into five regions, extract image features from the color histogram of each region, and then get the data set of multi-dimensional image features. Then the chi-square distance is used to calculate the similarity of color histogram, and the closest image is selected as the first similar image, which realizes the necessary logic of receiving query image and returning related results.

Key words: Image Search, Color Histogram, Characteristic, Similarity Measure

1. Introduction

The Internet and mobile Internet are constantly developing, which provides a series of data capabilities. Today's society has entered the era of big data. Compared with other multimedia, digital images can more fully and clearly express the information of things and more intuitively express the characteristics of things, so image data is growing rapidly[1-2]. With the continuous improvement of production level, more and more people pursue intelligent life, and more and more users search for images through the Internet, which makes image retrieval become an indispensable part of life[3-4]. The development of image retrieval system can be divided into text-based image retrieval and content-based image retrieval according to its development process [5].

Text-based image retrieval extends from mature text retrieval to image retrieval. It uses text to mark out the content of each image, that is, to write the keywords of each image, such as image features, location and so on. After manual tagging of each image, the image is added to the text index database, which transforms image-based retrieval into corresponding text retrieval. This method is easy to implement, and its search accuracy is relatively high by manual intervention. However, the defects brought by this method of manual text annotation on images are also easy to find: First, the image itself. For images with extremely rich content, the annotators have different cognitive
descriptions of the image, leading to certain ambiguity in the text description of the image content; Secondly, "a picture is worth a thousand words", the tagger cannot fully describe the content of the image, and it is difficult for users to describe the image they really want to search with a few keywords. Thirdly, such description method that requires manual intervention annotation can be realized for small-scale images, but with the continuous increase of image data scale, it will waste energy and money besides wasting time.

Content-based image retrieval uses computers to analyze images, and the process is as follows: feature vectors are established through extracted image features, and the description of feature vectors is stored in the image feature database [6]. Input the images to be queried, calculate the similarity of different features according to the specified similarity measurement criteria, sort the similarity in order from small to large, and output the corresponding images in turn. The retrieval technology has provided unprecedented convenience for people's life and production in various industries. This paper proposes an image search method based on color histogram and Chi-square distance based on machine learning. The fast search for the target image in personal image set is realized.

2. Image retrieval and deep learning theory

2.1. Traditional machine learning image feature theory
Global features refer to the features that represent the overall attributes of the image, such as color, texture and shape [4]. Among these global features that describe the image content, color is the most direct and most widely used. Every object we can see has color.

2.1.1. Color features
(1) Color histogram
Color histogram cannot be directly used to describe the specific things in the image, but can only describe the share of different colors in the target image, and does not care about their exact distribution position. Because it ignores the spatial position of pixels in the image, the retrieval result is directly affected. The color histogram calculation formula of the image is as follows:

\[ p(r_k) = \frac{n_k}{N} \]  

As shown in Formula 2-1, Including the first k a grayscale using \( r_k \) description, \( n_k \) is used to describe any number of pixel grayscale images and N is used to represent the total number of pixels in the image.

Based on color histogram can be clearly observed occupy part of each color in the image size, but because of the color itself exists a series of saturation, brightness, such as the distinction between, cause said color histogram of the image will change the images, there is a little deviation at this time to extract the features of it can no longer be used to represent the characteristics of the original image. This shows that image color is not a good feature in image retrieval.

(2) Spatial color characteristics
Researchers have introduced color spatial information in images to remedy this defect. Currently, the two commonly used spatial color feature models are RGB and HSV.

RGB color space is most commonly used by computers to describe colors, but in image retrieval, HSV is closer to the primary sense that people can accept, so HSV is almost used. The calculation formula of RGB color space is as follows:

\[ F=(s_r(k),s_g(k),s_b(k)) \]  
\[ s_r(k)=(h_r(k),b_r(k),\delta_r(k)) \]
As shown in Formula 2-2 and 2-3, different color channels are represented by $r$, $g$, $b$, and $h_r(k)$, $b_r(k)$, $\delta_r(k)$ are used to represent the mean position and standard variance of $k$ value on $r$ color channel. Similarly, the expression principles of channels $G$ and $B$ are similar to those of channel $R$. Understanding the calculation method of RGB color space can better transform it into HSV color space during system development.

(3) **The color moment**
Color moment is another way to describe image color, which is a color moment method based on the idea of moments. Different from color histogram, color feature distribution is obtained by calculating three color moments, and other visual features are often combined to improve the retrieval effect.

### 2.2. Texture features

Texture features mainly contain some important information on the surface of the object as well as the relationship between the object and the object, the analysis and research on texture has achieved significant results after decades, so a variety of texture features are applied in the study of image retrieval.

There are many methods based on texture feature extraction, and the most used texture feature extraction methods are mainly divided into the following three:

(1) **Statistical method**
Core is to use mathematical methods to construct the feature values of a particular area of the image and then carry out regular statistical calculation. This method is first applied to texture features, its idea is simple and easy to implement.

(2) **Spectrum method**
Core idea is to use the digital signal processing method for reference, use some transformation, filter, etc., to transform the image texture into the frequency domain space, and then obtain the texture features of the image through the difference between the energy spectrum.

(3) **Structure method**
Structure method believes that the texture distribution of images is regular. It is mainly to divide the image first and then extract the features. After obtaining the relationship between each part, the structural relationship between them can be calculated. The limitation of this method lies in the fact that the existing images do not have texture rules, which leads to the limitation of this method in use.

### 2.3. Shape characteristics

Shape features can be widely used in image retrieval only when they fully meet the invariance of image transformation, rotation and scaling, which is difficult to calculate and analyze shape similarity. Shape feature description can be divided into contour based and region based character description. The contour based shape description can use Fourier descriptor, chain code and wavelet transform, while the region based shape description is aimed at the pixels in the image region.

### 2.4. Local features

When the global feature is not applicable, the local feature can effectively solve a series of defects such as the large computation of global feature. In the processing of various types of image transformation, feature descriptors representing the local representation of feature points become the key, among which SIFT is widely used because of its invariance and stability.

### 2.5. Image similarity measurement

Generally speaking, in image retrieval, the similarity between the target image and the existing image
is determined through some algorithm to calculate the similarity measure between the two images. However, there are big or small differences between each similarity measurement method, which will directly affect the retrieval results. Therefore, it is necessary to choose an appropriate similarity measurement method to deal with the different types of feature vectors obtained by different feature extraction methods. Euclidean distance, histogram intersection and cosine distance are well-known methods used for similarity measurement.

From the known A and B images, the eigenvectors with n dimensions are A=(a1, a2, …, an) and B=(b1, b2, …, bn), where the distance between A and B vectors is denoted by d(A, B), and the dimension between the two vectors is denoted by ai and bi. Distances can be calculated in the following ways:

1. **Euclidean distance**
   The Euclidean distance can also be called the Euclidean measure, which is more suitable for the orthogonally independent eigenvectors. Later, some scholars considered the importance of different dimensions in calculating Euclidean distance, which is weighted. The formula for calculating the distance between A and B is:
   \[ d(A, B) = \sum_{i=1}^{n} \sqrt{w_i(a_i - b_i)^2} \]  \[ (2-4) \]
   As shown in Formula 2-4, ai represents the ith dimension of vector A, bi represents the ith dimension of vector B, Wi represents the weight of each dimension, when Wi is equal, this formula can be used as a general formula for calculating Euclidean distance.

2. **Histogram intersection**
   The main point of this method is to calculate the sum of the minimum values in each dimension of the two feature vectors. The biggest advantage of histogram intersection method is simple and fast calculation. Its calculation formula is as follows:
   \[ d(A, B) = \sum_{i=1}^{n} \min(a_i, b_i) \]  \[ (2-5) \]
   As shown in Formula 2-5, d(A, B) represents the sum of the minimum values in each dimension of A and B vectors, and the dimension between the two vectors is represented by ai and bi. The standard can be obtained by dividing the above formula by a standard vector with the minimum sum of vectors as standardization.

3. **Cosine distance**
   The cosine similarity can be obtained by calculating the included Angle between the two vectors, and the cosine distance is 1 minus the calculated cosine similarity [6].

3. **image search method based on color histogram and Chi-square distance**
   Based on the color histogram and chi-square distance image search, the final goal is to build an individual image search system. This will be an image retrieval system for personal use, using personal albums or collections of pictures as a data set for image search, by creating a "like this" function to make this data set found by the user. For example, if we submit a random photo of ourselves on a boat, the image search system should be able to find the image we want about a person, the ocean, or a sailboat. To build this system, you will use a simple but effective image descriptor: the color histogram.

3.1. **Define image descriptors**
   Instead of using standard color histograms, we changed our mindset to make the histogram look stronger and fuller. The image descriptor will be a three-dimensional color histogram in the HSV color space [7]. The image can be represented by a triplet of red, green, and blue (RGB). This color
space can be viewed as a cube, as shown in Figure 1. Although RGB values can be more easily accepted by people, the form of human perception of color is impossible to simulate. So HSV color space will be used to build multi-color cylinders, as shown in Figure 2.

![Figure 1. RGB cube](image1)

![Figure 2. HSV cylinder](image2)

Once you have determined the desired color space, you should define the number of square columns in the histogram. The purpose of a histogram is to roughly describe the intensity of pixel density in an image. However, if too few square columns are selected, the components of the histogram will be reduced and the ambiguity between images with intrinsically different color distributions will not be eliminated. Similarly, if you use too many square columns, the histogram will have many components that are very similar to the image and may end up being considered irrelevant. The following is the comparison of using fewer and more square columns. In the nine-box histogram shown in Figure 3, entries are set for HSV color space to represent the density of each pixel intensity. The horizontal axis of the histogram shows the color of each pixel, and the vertical axis shows the probability of each pixel appearing.

![Figure 3. Nine boxes of histogram](image3)

![Figure 4. Multi-box histogram](image4)
Figure 4 shows a color histogram of 128 boxes. As you can see, the latter uses a large number of square columns, but as more square columns appear, the histogram loses its perceptual ability to summarize similar content between images, because all peak-valley histograms must match whether the two images are similar. Therefore, you want to use an iterative method to adjust the number of columns, which is usually tailored to the size of the data set. If the data set is small, the number of square columns used will be small. If the data set is large, more square columns must be used to make the histogram larger and more differentiated.

The following is represented by the actual process of image query for a target image as shown in Figure 5.

**Figure 5.** target image

In this photo, the blue sky can be seen at the top of the image and the beach at the bottom. If the global histogram is used, it is impossible to determine the location of different colors and objects in the image. To solve this problem, you can calculate the color histogram of the distribution of different regions of the photo:

As shown in Figure 6, the image is divided into five different regions: upper left corner, upper right corner, lower right corner, lower left corner and image center. Then a mask is constructed for each region of the image to extract its features.

The process of constructing a mask for the upper left region. Firstly, the segments function divides the image into four parts, defines the center of the ellipse with binary groups, and stretches the ellipse to 75% of the width and height of the image we describe.

When the mask is constructed for the upper left region, a white matrix is drawn for the upper left corner of the image, and then the mask of the upper left region of the image can be constructed by subtracting the part of the central ellipse from the matrix.

The process of constructing the mask in the upper right region. The specific process is the same as the process of constructing the mask for the upper left region. Draw a white matrix for the upper right corner of the image, and then subtract the part of the central ellipse from the matrix to construct the mask for the upper right region of the image.

The process of constructing the mask in the lower right region. The specific process is the same as that of constructing the mask for the upper left region. Draw a white matrix for the lower right corner of the image, and then subtract the part of the central ellipse from the matrix to construct the mask for the lower right corner of the image.

The process of constructing the mask in the lower left region. Draw a white matrix for the lower left corner of the image, then subtract the part of the central ellipse from the matrix to construct the mask of the lower left area of the image.

We examine each different part separately, removing the center part of the ellipse from the rectangular position during each update. This leads to the final reason why these camouflage problems are performed when extracting color histograms, which is roughly the need for masks to indicate where the histogram function extracts color histograms. If you need to express these parts separately, using masks is obviously the most effective way.
the color histogram is extracted with the image to be extracted as the first parameter, and the mask to
represent the region to be described as the second parameter. A color histogram method representing
the current region is then returned, automatically added, and the property list has an image descriptor.

The process of applying the upper left mask region to an image. Histogram method histogram is
used. The first parameter of the method is the image of the feature to be extracted, and the second
parameter represents the parameter of the mask region, thus extracting the color histogram of each
region. Each region mask is applied to the image to extract the color histogram of each region, which
is returned to the feature list storage.

The upper right mask region, lower right mask region, lower left mask region and image center
region are also applied to the image according to the above method. After that, the data features of
each image in the data set are extracted and all of them are returned to the feature list.

3.2. Extracting image data features

After the image descriptor is defined, features in each image obtained from the dataset can be
extracted. The feature extraction algorithm is shown:

The process of image feature extraction. First, Opencv will convert the RGB color space of the
image into HSV color space, set the color histogram entries and divide the subspace area of the image.
The feature is extracted by intercepting the subregion of the image and calculating the color histogram
of the subregion. If it is the last subregion, the feature list is returned after feature extraction;
otherwise, the subregion features are extracted.

The process of creating an index. Indexing is a process of extracting features and storing them in
persistent storage. First, input the original image path, scan the image path and generate the path list,
obtain the image ID and read the image, calculate the feature value of each image to generate the
feature list, and write the feature list into the CSV file. The feature of each image is a column in the
CSV file. If it is already the last image, the index creation is complete. Otherwise, the image ID
calculation feature is obtained again before writing to the file.

3.3. Define the similarity measure

After the features of the dataset are extracted, the similarity of features needs to be compared by
devising a method. After extracting the color histogram associated with the index image, it is
compared with the features of the query image. Since it is the color histogram that does the
comparison, and it is defined by probability distribution, card convenience is the most appropriate and
practical function. According to the list of similarity values, the specific chi-square distance can be
calculated.

The image was previously divided into 5 regions, and the color histogram was assigned H channels
of 8 items, S channels of 12 items, and V channels of 3 items. Each region is represented by a
histogram of 8*12*3=288 items, that is, the overall feature vector is 5*288=1440 dimensions. Each
image is quantized and represented by the 1440 digits, and the chi-square distance is calculated by
comparing the calculated target image with the 1440 digits of each image in the data set.

3.4. Searching for images

In fact, performing a search is just a driver that imports all the packages defined above and mixes them
together to produce a complete content-based image search system.

System search process. Firstly, the image to be searched is opened in the system. The front end
sends an image to the background through Ajax, and the background extracts the features of the image,
compares them with the features in the data set, calculates the Chi-square distance, and generates a list
sorted by chi-square distance. Then, the function is used to sort the distance results, return the specific
file path according to the order of chi-square distance from small to large, and then return to the front
display, that is, a search is completed.

To build an image search engine, the need to search pictures of searchable, here USES color
histogram distribution used to describe the color of the pictures, to the image is divided into five
regions, color histogram is used to extract the image feature and form data set [8], the similarity calculation using the chi-square distance, select the nearest introduced as primary similar images. Finally, the necessary logic to accept the query image and return the coherent result is realized.

4. Software Implementation

4.1. Overall software design
The complete image search framework: First open the need to search images within the system, through the analysis will generate object feature extraction and generate search feature, then came a read data set file system, a feature extracting and search features used to calculate chi-square distance, to calculate a good distance into the dictionary, the key for the id of the picture, the value for the chi-square distance value. Detect whether this feature is the last feature of the data set. If so, generate a list sorted from small to large distance, and the search is complete. If not, the search is performed after recalculation [9].

4.2. Software implementation
The retrieval interface design of this system is very simple, as a search tool to use very convenient. The design of the interface maximizes the consideration of how to upload pictures and how to search for similar pictures in the most intuitive way. Even if there are no really the same pictures, we can also search for the required pictures according to the similarity of pictures.

300 graduation photos from the graduation photo collection and 110 photos from the personal photo data set are selected as experimental objects to form the test library of the search system respectively. The test was carried out on a Win10 operating system, Core i5-6200U, Kingston SA400S37240G(240GB/ SSD), and 8GB of memory.

Different scene images were extracted from 300 photos in the graduation photo test library for testing. The image resolution of the test library was 780*520, belonging to 15 different categories. Through background data display, it takes 6 seconds to search a target image on average. The images returned from the search are output in the order of chi-square distance from small to large, and the 20 most similar photos are output.

110 images from the personal photo dataset are selected as experimental objects. The image resolution of the test library is not equal, and there is no specific category number. Through background data display, the average search time for a target image is 1 second. The images returned from the search are output in the order of chi-square distance from small to large, and the 20 most similar photos are output.

Through the different configuration of the computer, different resolution photos, different size of the test library test, the results are not the same, this experiment also proves that the system through adjusting different factors to improve the speed of search has a certain feasibility.

5. Conclusions
This article designs and implements an image search system based on machine learning, which is actually an image search system based on color histogram and Chi-square distribution, providing users with a fast service to search out the target image. Users can import their own personal data set, and then upload the images to be detected locally to complete the search process of images similar to the target images.

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