Study on Image Retrieval based on Image Texture and Color Statistical Projection

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Abstract: This article presents an image texture and hue statistical projection based retrieval. First the image is converted to HSI color model, the gray value of the image extraction, and Robert algorithm to extract the texture, then the image is divided into blocks and extracts the main color block, the main color image blocks are respectively projected in the horizontal and vertical direction of 2, get 2 projection histogram, the 2 projection histograms of the first three order center extraction distance and Robert algorithm as the features of texture, image similarity calculation. Make a very full pave the way for future Canny edge processing algorithm research of image retrieval.

Keywords: Main Hue; Robert Algorithm; Projection Histogram; Canny Edge Algorithm; Image Retrieval;
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0 Introductions

The article’s contents are based on image retrieval (Content-based Image Retrieval, referred to as CBIR) Algorithm. It is the use of image visual features, such as color, texture, shape, the query image and database for matching similar images to the user returns. The color is the most striking feature of visual image, is also the main perceptual features people image recognition. In image retrieval has gained wide attention and Research on [1]. Swain and Ballard [2] put forward the global color histogram for histogram intersection, L1 measurement, as the color histogram similarity measure [3]. Color histogram is the statistics of pixel in an image value of the times, can only reflect the frequency of image color values, cannot reflect the distribution the relationship between color space, the image retrieval accuracy is not high.

The author uses the principal value of projection method not only realized the similarity measure of color histogram, and can reflect the spatial distribution of color, in ensuring the success rate of detection and reduce the projection algorithm complexity. But the main value of projection method is only the color features were extracted, ignoring the image texture feature. The author will Robert the main value of projection algorithm and combine together, put forward the algorithm of image retrieval image texture and color statistics based on projection, which greatly improves the accuracy of image retrieval, and ensure the efficiency of the algorithm.

Image texture and hue statistical retrieval algorithm based on the projection of thought are as follows: firstly, the image is transformed from model to HSI model, the extraction of image gray value, extract the texture of the Robert algorithm, and then the image block, the characteristics of main hue block are respectively projected in horizontal and vertical direction, to get the 2 projection histogram, using projection histogram of the first three order central moment and texture computing image similarity.
1 Main Color Projection Method

1.1 Color Model

In the use of colors in the image, select the appropriate color model is especially important for the retrieval results. The commonly used color model mainly has: the RGB color model, namely the use of R(red), G (green), B (blue) color to represent the color, RGB color model is widely used in display system, but the visual perception of RGB color model and people do not correspond, in the color similar to that of the RGB model does not reflect the similarity of the color itself, in the use of RGB color model for image retrieval are often RGB color model will be converted to other color space.

The HSI color model of human vision system with the most close to, is a suitable eye resolution model [4]. HIS model, H (Hue S), said the hue that the color saturation (Saturation), I denote brightness or gray (Intensity). For any 3 R, G, B value in the range of [0, 1], can be converted to color model HSI by the following formula [5]:

\[ I = \frac{1}{3}(R + G + B), \quad (1) \]

\[ S = 1 - \frac{3}{R + G + B} \min(R, G, B), \quad (2) \]

\[ H = \begin{cases} \arccos \frac{(R - G) + (R - B)}{2\sqrt{(R - G)^2 + (R - B)(G - B)}}, & G \geq B; \\ 2\pi - \arccos \frac{(R - G) + (R - B)}{2\sqrt{(R - G)^2 + (R - B)(G - B)}}, & G < B. \end{cases} \quad (3) \]

Calculated by formula the range I and S is the [0, 1], the range of H [0, 2\pi], in order to make H between also in [0, 1], order \( H = H / (2\pi) \) conversion.

1.2 Extract Main Hue

The algorithm in this paper uses for the use of fixed block image segmentation
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method. Firstly adopts the block fixed, will have the same size grid image into $n \times n$. In order to simply describe color feature and gray feature of each block, this paper adopts the main value of this concept.

**Definition 1 (the main value)**

For a characteristic block value (tonal values or gray values), if has the most number of pixels in the block, then the values (hue values or gray value) is defined as the block principal values [6]. Set $M$ indicates that the $i$ block of the main value is:

$$M_i = \{k \mid \text{num}(i, k) = \max_{j=1}^{256} (\text{num}(i, j))\}, 1 \leq k \leq 256,$$  \hspace{1cm} (4)

Among them, $i$ said the hue value (or gray value), $\text{num}(i, j)$ said the number of color blocks of all $j$ pixels for.

However, for the block the whole image to the extracted principal value is not may reflect the color feature and shape feature block, if the extracted principal value in the whole block contains value ratio is very small, the main value is extracted is not enough to reflect the characteristics of the block, in order to eliminate the influence caused by this kind of feeling condition, using principal values of the following decision strategy to determine the extracted principal value as block whether class:

1. Set the threshold (threshold1). If $\text{num}(i, k)/(m \times n) \geq \text{threshold1}$, make $M_i = k$ As the block principal value.

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(2) If \( \text{num}(i,k)/(m \times n) < \text{threshold1} \), you need to consider the block near the block main value to determine the block main value, if the principal value of adjacent blocks to satisfy the condition (1) and with the same block principal value or the difference is less than a certain value (\text{threshold2}) , still make \( M_i = k \) As the block principal value. Otherwise, do not specify a block main value. Among them, \( m \) and \( n \) Represent each block size. Extract the principal value to see figure as follows.

Figure 1 Example Diagram

Figure 2 Gray Sample Diagram

Figure 3 Gray-Scale Histogram

Figure 4 Grey histogram in to extract the principal value
1.3 Projection Histogram

For a certain image features (such as component or components), may use the feature histogram, the histogram is a discrete function, i.e.:

\[ H(k) = \frac{n_k}{N}, k = 0, 1, L - 1, \quad (5) \]

Among them, \( k \) Characteristics of representative value of the image, \( L \) are numbers of features can be value, \( n_k \) is a number with characteristic of pixel value \( k \) in the image, \( N \) is the total number of pixels of the image.

Due to the statistical histogram is each pixel in an image of a statistical characteristic value of the frequency of occurrence, only reflect the frequency of certain image of a feature, spatial relationship without inclusion of image features, is applied to image retrieval, will reduce the accuracy of retrieval system[7].

In order to overcome the statistical histogram can not reflect the image of a spatial distribution relationship, based on the statistical basic block principal value by projection histogram. The one feature an image of each pixel is projected on the horizontal axis \( x \) and the vertical axis \( y \), we get the distribution of the characteristics of the information in the 2 directions. The \( H \) projection component in the \( x \) direction and \( y \) the direction, reflecting the distribution of image colors in space. For an image of the \( H \) component in the \( x \) direction and the \( y \) direction of projection histogram is defined as follows:

\[ P_{H_x}(x) = \frac{1}{w} \sum_{y=1}^{h} H(x, y), x = 1, 2, L , w, \quad (6) \]

\[ P_{H_y}(y) = \frac{1}{w} \sum_{x=1}^{w} H(x, y), y = 1, 2, L , h. \quad (7) \]

Among them, \( w \) and \( h \) As image width and height, \( H(x, y) \) is the \( H \) component
images in the \((x, y)\) pixel values.

Similar projection histogram can be obtained, and the \(x\) direction and in the \(y\) direction of the image \(I\) component: \(P_I(x)\) and \(P_I(y)\).

### 1.4 Feature Extraction

Projection histogram of the image is discrete sequence; sequence length depends on the image width and height \(^8\). Different image through projection histogram processing, projection histogram will get different length. In this paper, in the calculation of the similarity of image, is used in the first three order central moment projection histogram.

Central moment histogram shows the distribution histogram. The histogram \(P(i)\), the first three order central moment respectively:

\[
M_1 = \frac{1}{L} \sum_{i=1}^{L} P(i),
\]

\[
M_2 = \sqrt{\frac{1}{L} \sum_{i=1}^{L} (P(i) - M_1)^2},
\]

\[
M_3 = \sqrt[3]{\frac{1}{L} \sum_{i=1}^{L} (P(i) - M_1)^3}.
\]

Using HSI model, the \(H, I\) components are projected to the \(x\) direction and the \(y\) direction, to get the 4 projection histogram, i.e. \(P_H(x), P_H(y), P_I(x)\) and \(P_I(y)\) the first three order central moments were calculated for 4 histogram, get 12 central moment. With the 12 center distance as features to describe the image, the image can be represented by a 12 dimensional \(m\) vector:

\[
m = (M_{1x}^{H}, M_{2x}^{H}, M_{3x}^{H}, M_{4x}^{H}, M_{1y}^{H}, M_{2y}^{H}, M_{3y}^{H}, M_{4y}^{H}, M_{1x}^{I}, M_{2x}^{I}, M_{3x}^{I}, M_{4x}^{I}),
\]

Among them, the element \(M_{1x}^{H}\) represents an order central moment projection histogram in the \(x\) direction of the image \(H\) components, other elements in the vector meaning is similar.
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1.5 Similarity Computation

Making the query image $Q$ is an image $D$ in the database, they can be the method above is expressed as the 12 dimension vector, respectively, $q$ and $d$ said:

$$q = (Q_{1x}^{H}, Q_{2x}^{H}, Q_{3x}^{H}, Q_{4y}^{H}, Q_{5y}^{H}, Q_{6y}^{H}, Q_{7y}^{H}, Q_{8y}^{H}, Q_{9y}^{H}, Q_{10y}^{H}, Q_{11y}^{H}, Q_{12y}^{H}), \quad (12)$$

$$d = (D_{1x}^{H}, D_{2x}^{H}, D_{3x}^{H}, D_{4y}^{H}, D_{5y}^{H}, D_{6y}^{H}, D_{7y}^{H}, D_{8y}^{H}, D_{9y}^{H}, D_{10y}^{H}, D_{11y}^{H}, D_{12y}^{H}), \quad (13)$$

The distance between image $Q$ and $D$ the vector is the distance between $q$ and $d$ the weighted Euclidean distance to measure, as follows:

$$||q - d|| = \sqrt{W_{H} \sum_{i=1}^{3} \sum_{j=x,y} (Q_{i}^{Hj} - D_{i}^{Hj})^2 + W_{I} \sum_{i=1}^{3} \sum_{j=x,y} (Q_{i}^{Ij} - D_{i}^{Ij})^2}, \quad (13)$$

Among them, $n$ is the number of pixels in image; $W_{H}$, $W_{I}$ weighting coefficient, is a group of experience value, can be adjusted according to the test results. In this paper, $W_{H} = 0.7$, $W_{I} = 0.3$, because the $H$ component description ability and human color vision approach, $I$ component in horizontal and vertical direction projection can only reflect the image shape information.

1.6 Experimental Analysis

In order to verify Hue Projection retrieval results, the author designed a set of experiments, to retrieve the scenery for a class of image, image number for 100 images, including images similar to figure 1 image has 10 beds, and each query returns with the query before the 20 pictures the most similar images.

![User submitted images](image_url)
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Figure 6 Comparison for global color histogram

Figure 7 Retrieval results for hue projection method
**2 Retrieval Algorithm based on the Image Texture and Hue Statistical Projection**

**2.1 Robert Algorithm**

Robert algorithm belongs to the statistical method of texture description; the main idea is one derivative $\frac{\partial f}{\partial x}$ and $\frac{\partial f}{\partial y}$, namely, finds the change in the rate $x$ and $y$ direction of gray image function. Design $f(x, y)$, its derivative (gradient) for

$$G(f(x, y)) = \frac{\partial f}{\partial x} i + \frac{\partial f}{\partial y} j ,$$

(12)

Gradient die

$$G(f(x, y)) = \sqrt{\left(\frac{\partial f}{\partial x}\right)^2 + \left(\frac{\partial f}{\partial y}\right)^2} .$$

(13)

For digital image, type (13) is to adopt the form of discrete, therefore using the difference operation to replace the differential operation. In the $x$ direction of the first order difference

$$\Delta_x f(x, y) = f(x, y) - f(x + 1, y) ,$$

(14)

In the $y$ direction of the first order difference

$$\Delta_y f(x, y) = f(x, y) - f(x, y + 1) ,$$

(15)

The gradient of the model can be simplified to

$$G(f(x, y)) = \sqrt{|f(x, y) - f(x + 1, y)|^2 + |f(x, y) - f(x, y + 1)|} ,$$

(16)

In order to facilitate the computer calculation, usually using absolute values instead of type (16), i.e.

$$G(f(x, y)) \approx |f(x, y) - f(x + 1, y)| + |f(x, y) - f(x, y + 1)| .$$

(17)

Robert algorithm as

$$G(f(x, y)) = \sqrt{|f(x, y) - f(x + 1, y + 1)|^2 + |f(x + 1, y) - f(x, y + 1)|^2} ,$$

(18)

Type (18) with the absolute value was expressed approximately as

$$G(f(x, y)) \approx |f(x, y) - f(x + 1, y + 1)|^2 + |f(x + 1, y) - f(x, y + 1)|^2 | .$$

(19)
2.2 Results from Robert Algorithm

In order to prove the effectiveness of texture retrieval, design a set of Robert algorithm using image retrieval. Because of the Robert algorithm only use $I$ components, without taking into account of $H$ and $S$ components. Figure 1 is submitted assure an example, the sample texture extraction algorithm for Robert diagram in Figure 2, figure 3 focusing the Robert algorithm to search results.

Figure 8 Example Diagram

Figure 9 The example texture map through Robert processing algorithm
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![Image](image.png)

**Figure 10 The retrieval results of Robert algorithm**

Because the image texture and hue statistical projection retrieval algorithm and the main color projection harmonic projection histogram steps based on consistency in the main color, this is no longer a detailed description, the main color extraction and projection histogram steps can reference hue projection method.

### 2.3 Feature Extraction

Projection histogram of the image is discrete sequence; sequence length depends on the image width and height [8]. Different image through projection histogram processing, projection histogram will get different length. In this paper, in the calculation of the similarity of image, is used in the first three order central moment projection histogram.

Central moment histogram shows the distribution histogram. The histogram $P(i)$, the first three order central moment respectively:


\[
M_1 = \frac{1}{L} \sum_{i=1}^{L} P(i),
\]

\[
M_2 = \sqrt{\frac{1}{L} \sum_{i=1}^{L} (P(i) - M_1)^2},
\]

\[
M_3 = \frac{1}{L} \sum_{i=1}^{L} (P(i) - M_1)^3.
\]

Using HIS model of the \( H \) components is projected to the \( x \) direction and the \( y \) direction, to get the 2 projection histogram \( P_h(x) \) and \( P_h(y) \) is calculated respectively, and the first three order central moment of 2 histograms, get 6 central moments. With the 6 center distance as features to describe images, the image can be represented by a 7 dimensional \( m \) vector:

\[
m = (M_1^{Hx}, M_2^{Hx}, M_3^{Hx}, M_1^{Hy}, M_2^{Hy}, M_3^{Hy}, R),
\]

Among them, the element \( M_1^{Hx} \) represents an order central moment \( x \) projection histogram in the direction of the image \( H \) components, other elements in the vector meaning is similar, numerical \( R \) for Robert extraction algorithm.

### 2.4 Similarity Calculation

Let \( Q \) be a query image, \( D \) is an image in the database, they can be the method above is expressed as the 7 dimension vector, respectively, \( q \) and \( d \) said:

\[
q = (Q_1^{Hx}, Q_2^{Hx}, Q_3^{Hx}, Q_1^{Hy}, Q_2^{Hy}, Q_3^{Hy}, R_q),
\]

\[
d = (D_1^{Hx}, D_2^{Hx}, D_3^{Hx}, D_1^{Hy}, D_2^{Hy}, D_3^{Hy}, R_d),
\]

The distance between image \( Q \) and the \( D \) vector and are the distance between \( q \) and \( d \) the weighted Euclidean distance to measure, as follows:

\[
\| q - d \| = \sqrt{W_H \sum_{i=1}^{3} \sum_{j=x,y} (Q_i^{Hj} - D_i^{Hj})^2 + W_R \sum_{i=1}^{n} (R_q - R_d)^2},
\]

Among them, \( n \) is the number of pixels in image; \( W_H, W_R \) are weighting coefficient, is a group of experience value, can be adjusted according to the test results. In this paper, \( W_H = 0.7, W_R = 0.3 \), because the \( H \) component description ability and human color vision close, texture component reflects the image texture.
information in gray.

### 2.5 Experimental Analyses

In order to validate the retrieval system, the author designed 3 experiments, retrieval of the scenery of a class of image, image number for 100, which contains similar to that of the target image, has 5 beds, each query returns the object image and the most similar to the previous 10 picture retrieval results shown in figure as follows.

![Figure 11](image.png)

**Figure 11** The first 10 pictures before retrieval feedback

Figure 11, the first row of the image for the users to submit images, second and third row image search results analysis figure 11 shows:

1. Due to the using result according to the sorted result is from small to
large, from left to right, from top to bottom. Therefore, the first image of Figure 11 is the target image for second row.

(2) Theoretically, as used in this paper is the extraction of Robert numerical algorithm, principal value, projection histogram and weighted Euclidean distance, and in the weighted Euclidean distance, \( W_H = 0.7, W_R = 0.3 \), make the system high dependence on \( H \) components. From the retrieval results, can be seen as an upper image of user submitted, mainly in color blue and white, and thus in the global color retrieval result, the upper image searching out is mainly in blue; at the same time using the Robert algorithm, the target image texture from the image retrieval results were revealed.

3 The Works in Next Step and Prospects

The author of the image texture and hue statistical retrieval algorithm based on projection for inspection found that this algorithm is also flawed. After block test, found the defects caused by the Robert algorithm, the reasons are as follows:

(1) As shown in Figures, the Robert algorithm for example image, image texture display, but non texture part account for much of the image, and a monochrome (black or white), following the similarity calculation, it is bound to bring a lot of meaningless operation, increase the running time cost of the algorithm.

(2) Congenital defect of Robert algorithm, that is only for \( I \) (gray) for texture extraction, it is not the image texture extraction, \( H, S \) components are therefore, Robert algorithm to get the texture features of image is limited, the expression of image texture information can not accurately.

(3) There is no directional texture characteristics of Robert algorithms, on the texture description are too vague.

The Canny edge detection algorithm is the Canny J F in a multi-scale edge detection algorithm is developed in 1986, the main step to go looking
for low noise, brightness in the image and tracking edges in an image. Since the Canny edge detection algorithm can track the trend of texture and edges in the image, therefore, the next step of work will use the Canny edge detection algorithm and the main color projection method are combined to improve the accuracy of retrieval system, retrieval system algorithm to reduce the complexity and time consumption.

4 Conclusions

Image texture and hue statistical projection based retrieval, which can describe the color spatial distribution and texture information of the image, but the texture feature information of image representation is not very accurate. The method not only can the redundant information of color filter in image, reflects the image texture description, and in the retrieval, small amount of calculation and speed soon, can also feature selection and weight according to the different needs. In future work, we will try to use the method introduced in this paper to solve the problems in some new and promising fields such as mobile visual search [12-16] and computer vision based 3D reconstruction [17].

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6 Reference Documentations

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