Content based image retrieval using maximum color

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요 약

This paper presents image database retrieval based on maximum color occurrenceusing Hue, Saturation and Value (HSV) color space. Our system is based on color segmentation. We dividedthe image into n number of areas based on different selected ranges of hue and value, then each area is partitioned into m number of segments based on the number of pixels it contains, after this we calculated the maximumcolor occurrence in each segment and used its HSV value. This is used as a feature vector.

키워드 Maximum color Occurrence, HSV color space, image retrieval, segmentation

Ⅰ. Introduction

Efficient access to digital data has become an issue of utmost importance recently. In particular, the amount of digital image and video data available is staggering and the challenging issues of cataloging and retrieval has gained increasing importance. Without a doubt, efficient access to relevant data directly determines its value. As digital acquisition and storage grow, a number of industrial fields, such as medical imagery, graphic arts, textile and paint, satellite imagery, neural networks, criminology and film, require efficient access to their data.

Initially, retrieval systems were mostly textbased. They presented text keyword as query material and retrieved images with the same text keyword. However, such retrieval systems have several problems. They require efforts to assign keyword that best represent each image in a database. Keyword selection involves personal subjectivity and there may even be cases in which a unique keyword cannot be selected. The need for users to remember the unique keywords assigned to any given image, during retrieval, is another disadvantage.

Content Based Image Retrieval (CBIR) is a relatively new research area which is dedicated to the image retrieval problem [I] anda number of image database system have been developed [2, 3]. A key aspect of image databases is the creation of robust and efficient segments which are used for retrieval. Color remains the most important low level feature which is used to segment database images. This is not surprising since visual recognition and human recall is highly dependant to color. However, the majority of retrieval techniques implement color histo-

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grams for image retrieval. These histogram-based techniques provide good results, however, issues such as histogram dimensionality, and the lack of good perceptually-based similarity measures call for new methods. Furthermore, the granularity which histogram techniques provide is not essential for efficient retrieval since it is our perception of color that is of utmost importance and, as humans, we cannot discern the difference between very close color values.

Demand for a more objective and automatic retrieval system has grown stronger, and interest has been concentrated on image retrieval systems that use image itself or image related information (for example, feature, texture, color tone or shape) as query material and output images similar to the reference image automatically in order.

In this paper, we presented an efficient image retrieval system that uses color feature as a content based feature. Because RGB color space does not contain information about overall color distribution so HSV color space was used. First, the corresponding image is converted from RGB to HSV color space, and then it is partitioned into nnumber of areas based on different ranges of hue and value. In the next step each area is partitioned into m number of segments based on the number of pixels it contains and this is used as a feature vector. If the area has more pixels then it will be partitioned into more segments and vice versa. Finally, the feature vector for query image is compared with the feature vector of the database images and the images with the high matching factor are output. The proposed system has been implemented and verified on the web.

Section 2provides a brief introduction of CBIR systems. Section 3 discusses the HSV color space and Section 4 describes the complete explanation of the algorithm presented in this paper including the results.Finally, Section 5 concludes the paper with a final discussion.

Ⅱ. CBIR(Content Based Image Retrieval)

Content-based image retrieval (CBIR), also known as query by image content (QBIC) and content-based visual information retrieval (CBVIR) is the application of computer vision to the image retrieval problem, that is, the problem of searching for digital images in large databases. Most important elements in a CBIR system are the features used to express an image and image features can be classified into three levels. First, primitive features include color, shape and texture information of an image. Second, the logical features contain the logical information for recognition of an object Finally, abstract information refers to abstract expressions like feeling, emotion and importance of a scene. Most research on retrieval technology being carried out currently uses primitive features like color, shape and texture as image information.

Technology based on colortone is most widely used due to compactness of calculation and information expression. Histogram is mainly used for color tone information. Representative work is the Histogram Intersection method proposed by Swain [1]. Extended Swain method which compares color tone histogram to recognize objects [2], and Distance Method and Reference Color Table method [3] for comparing color tone were also proposed. Methods using color tone is robust with respect to object movement, rotation and to changes like distortion within an image and may be implemented easily. However, performance will decrease significantly for changes in lighting. There is also the possibility that unwanted image with similar color tone distribution

may be the output [4].

Image retrieval using shape information is the most difficult method to implement. In order to use shape information, separation of objects within an image is important. Therefore, best performance is obtained for cases in which object contour is clear [4]. Once contour of an object is determined, its shape can be expressed with information including area, eccentricity, circularity, form signature, curvature and fractal dimension. Retrieval techniques using shape information that have been proposed include those that use the following feature parameters: Chain Code [5], Zernike Moment [6], Invariant Moment [5] and Fourier Descriptor [7].

Content based image retrieval techniques that have been developed into commercial products include QBIC of IBM, Virage VIR Image Engine by Virage and Image Retrieval Ware from Excalibur. In addition, many experimental demo systems exist on WWW. Representative works include Photobook from MIT, Columbia University's WebSEEk and Carnegie-Mellon University's Informedia. Content based image retrieval systems have started to enter the market and key application areas include crime prevention (finger print recognition and face recognition), intellectual property protection (trade mark registration), broadcast media and advertisements (video material management) and web search. Retrieval engines used by representative web search engines AltaVista and Yahoo provide retrieval functions from Virage and Excalibur, respectively.

IV. Experiment and Results

Our method implements adaptive segmentation to extract regions within the image. We do that by using HSV histogram of the image. It is the hue histogram which contains most of the color information. We know that the HSV color space is closer to human perception, so we used HSV instead of RGB color space. We first convertedthe input image from RGB color space to HSV color space. Following equations are used for conversion from RGB color space, which is the most general method to express color, to HSV color space.

h = (cos-1)* {[((R -G) + (R - B)) / 2]*[(R -G)*2 + (R -G)*(G - B)]*(1/ 2) }

H = h where G > B
H = 2 * PI - h otherwise
V = (R +G + B) / 3
S = 1- min(R,G, B) /V

Where, R, G and B represent red, green and blue components respectively with values between 0-255. H stands for hue, V stands for value and S stands for saturation.

Now for convenience in computation we converted the values of hue from 0-255 to 0o-360o, saturation and value from 0-255 to 0-1. To achieve this we used following equations:

H = ((H/255) *360)mod360
V = V/255
S = S/255

After using these equations the hue will rang from 0o to 360o, saturation and value will range from 0 to1. Since we know hue represents the angle that is why we have converted the value of hue from 0-255 to 0o-360o. This will make the computation easier.

Fig 1 shows different colors at different ranges of hue, saturation and value in HSV color space.

HSV color space is partitioned into n number of areas, by using different ranges of hue and value, and then each area is further partitioned

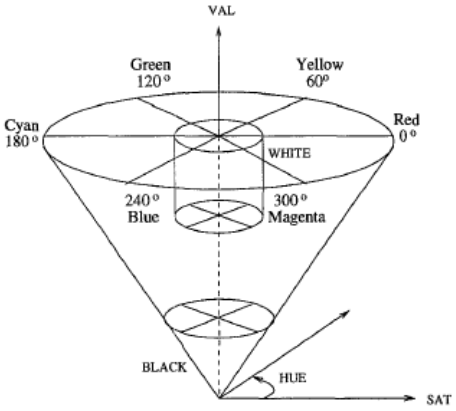

Fig 1. HSV Color Space

into m number of segments depending upon the number of pixels in that area. The area which has more pixels is partitioned into more number of segments and the area which has fewer pixels is divided into less number of segments. We performed this adaptive segmentation task to get more accurate color distribution in different segments of the image. After performing segmentation we calculated the maximum color occurrence in each segment of the image and we used it as a feature vector. Through this procedure we are able to get the distribution characteristicsfor the color tone distributed in the corresponding image. Such operations are carried out for the entire image.

Following equation is used to partition each rea in m number of segments m can have different values for different areas.

$$mi = (Xi / T) * S \qquad 0<i<=n$$

Where mi represents the segments in area i, Xi represents the number of pixels in area i (where i reaches from 0 to n), Trepresents total number of pixels of the image and S represents total number of desired segments of the image.

After performing this we selected the maximum color by using the hue histogram.

Feature vector comparison is done by using Euclidean distance equation:

$$f(t) = \sum_{i=1}^{m} \left| Q_i(h,s,v) - D_i(h,s,v) \right| \qquad 1<i<m,$$

Where, Qi is the query image maximum color value of segment i and Diis the comparison image maximum color value of segment i, where i ranges from 1 to m.

When matching calculation is completed, results are sorted in ascending order and the image which resembles more with the query image is brought to the top.

In order to test the algorithm proposed in this paper, a simple retrieval system was implemented on the web.

Experiments show that even if we rotate or reduce the size of the image the results are still accurate.

Fig 2 shows the experiment results, when we executed the query on image database which contains 1000 images. We can see from different results that the first image retrieved is always thequery image, since the query image is also the part of database images.

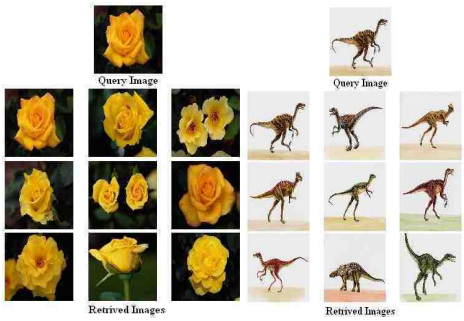

Fig 2. Experiment Results

Experiments also show that if we change the size of the image or rotate the image to

different angles the results are even then good. Fig 2. shows those results.

We used an image database of 450 different images using which we got the results which were shown in Fig 3. In this database some of the images were changed in size and rotated (90o and 180o). As shown in the experiment results, retrieval is carried out for the corresponding image even when the image is rotated or the size is changed.

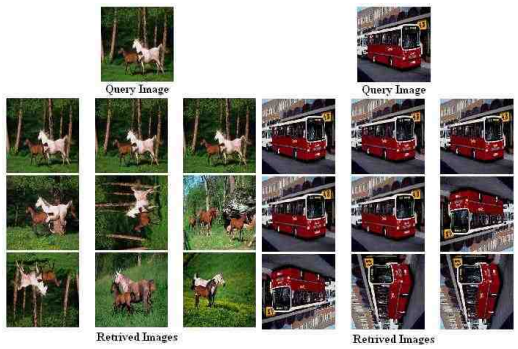

Fig 3. Image is successfully retrieved even if it is rotated or changed in size

V. Conclusion

In this paper, we presented content based image retrieval system using the maximum color. Image is first converted into HSV color space, and then it is partitioned into n number of areas based on different ranges of hue and value. In the next step each area is partitioned into m number of segments based on the number of pixels it contains. After performing segmentation we calculated the maximum color occurrence in each segment of the image and we used it as a feature vector. Through this procedure we are able to get the distribution characteristicsfor the color tone distributed in the corresponding image. Such operations are carried out for the entire image. Finally, the feature vector for query image is compared with the feature vector of the database images and the results are retrieved and sorted in ascending order. We verified through experiments the feasibility of carrying out robust retrieval using this information even when images are changed in size or rotated.

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