영상 검색을 위한 Shifted 히스토그램 정합 알고리즘*

유기형** · 유승선*** · 육상조**** · 박길철****

요 약

본 논문은 영상의 주요한 색채들을 기반으로 하는 histogram-based 영상 검색을 위한 변형된 히스토그램 방법(SHM)을 제안한다. 히스토그램을 기초로 하는 방법은 이행이나 로테이션과 같은 이미지의 기하학적 변화에 영향을 받지 않기 때문에 컬러 영상 검색에 있어 매우 적합하다. 동일하고 비주얼한 정보를 지녔지만 컬러 강도가 변화된 영상의 경우, 전통적인 히스토그램 인터섹션(HIM)을 이용할 경우에는 현저히 성능이 떨어질 수도 있다. 이 문제를 해결하기 위해 변형된 히스토그램 방법(SHM)을 사용하였다. 실험 결과 변형된 히스토그램 방법(SHM)은 기존의 히스토그램 방식에 비해 더 높은 영상 검색 성능을 보였다.

Shifted Histogram Matching Algorithm for Image Retrieval

Gi-Hyoung Yoo** · Seung-Sun Yoo*** · Sang-Jo Youk**** · Gil-Cheol Park****

ABSTRACT

This paper proposes the shifted histogram method (SHM), for histogram-based image retrieval based on the dominant colors in images. The histogram-based method is very suitable for color image retrieval because retrievals are unaffected by geometrical changes in images, such as translation and rotation. Images with the same visual information, but with shifted color intensity, may significantly degrade if the conventional histogram intersection method (HIM) is used. To solve this problem, we use the shifted histogram method (SHM). Our experimental results show that the shifted histogram method has significant higher retrieval performance than the standard histogram method.

Key words : Color Histogram, Image Retrieval, Image Shifted Histogram, Database

---

* This work was supported by a grant from Security Engineering Research Center of Korea Ministry of Commerce, Industry and Energy.

** 전북대학교 컴퓨터공학과 교수

*** 목원대학교 지능로봇공학과 교수

**** 한남대학교 멀티미디어공학부 교수

1. Introduction

The number of digital images and video that are being captured and stored is increasing rapidly. In order to use this information effectively, an efficient retrieval technique is required. One major development in this area is content based image retrieval, which uses image features for image indexing and retrieval. Content-based image retrieval (CBIR) is a promising approach to search through an image database by means of image feature, such as appearance, color, texture, shape, pattern, or a combination these factors [1-4]. In the Histogram intersection method (HIM) [5, 6] is the most common approach for using the intersected area of histograms acquired from image features.

Among different types of low level features, color is the most basic of information, which can be easily retrieved from digital images, using a simple and compact description, while others require more pre-processing and computational tasks such as pattern recognition or texture analysis. Feature vectors can be calculated efficiently because of image invariance to rotation and translation of the content. In the early 90's, Swain and Ballard first proposed that the color of an image can be represented through a color histogram [2]. Then, they performed similar retrieval by evaluating the histogram intersection between sample and database images. After, many researchers proposed the use of different kinds of color histograms as feature vectors to be stored in the index.

However, although the conventional color histogram method can describe the global color distribution of images in a straightforward manner, it only provides a very coarse characterization of images. There is no spatial information included in the color histogram. Thus, two completely different images may have very similar histograms. Also, the lighting conditions will alter the histogram of an image. Even two pictures with little difference in lighting conditions can not easily be matched.

Lu et al [7] propose a perceptually weighted histogram (PWH) method to use weighted quantization to generate histograms in a uniform color space CIEluv, in which the color palette is uniformly distributed throughout the color space. In PWH, each color from an image is represented by its 10 nearest similar colors. However, HIM still takes place of the full color-range (e.g. 256 colors) of the two images being compared.

A merged histogram method (MHM) is proposed for histogram-based image retrieval based on the dominant colors in images. In MHM, colors from individual images and between images are merged to form a dominant color set, instead of color components. The idea behind MHM is to retrieve images in a database of which the intensity has been changed by light. However, this method requires greater processing capability to generate feature vectors.

In this paper, we propose a novel shifted histogram method (SHM), to overcome the disadvantages of the conventional histogram.

The SHM operates as follows :

a. Build a histogram of query and target images in the database.
b. Find the start point of the histogram of a query and target images in the database.
c. Shift the start point of the histogram of query

image to match the start point of the histogram of the target image.

d. Calculate the histogram intersection.

The SHM provides a very coarse characterization of image changed by intensity.

Section 2 introduces the conventional histogram method. The difficult areas are noted with regard to the change in intensity. Section 3 describes the new method using the shifted histogram. The experimental results are reported in Section 4. Section 5 provides the conclusion.

2. Histogram-based color image retrieval

The histogram-based method is very suitable for color image retrieval, because this method is unaffected by geometrical information in images, such as translation and rotation. The histogram intersection method (HIM) [5, 6] measures the intersections between the two image histograms. These intersections are usually named query image for the query input and target image for the image database. A image histogram is an n-dimensional vector, in which each element represents the number of pixels of color in the n-color image. Regardless of image size, each element is normalized before comparison. The resulting normalized histogram is shown in Equation (1).

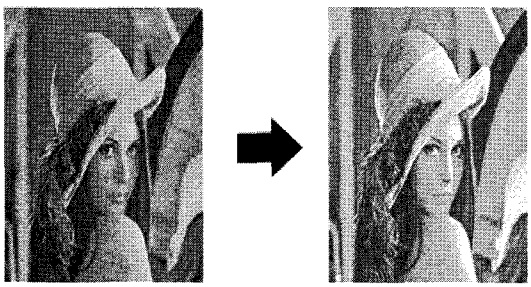
$$H(T) = T_c : T_c = \frac{T_c}{\sum_{k=1}^{n}} \qquad (1)$$

The similarity measure is then calculated by calculating the histogram intersection, as shown in Equation (2).

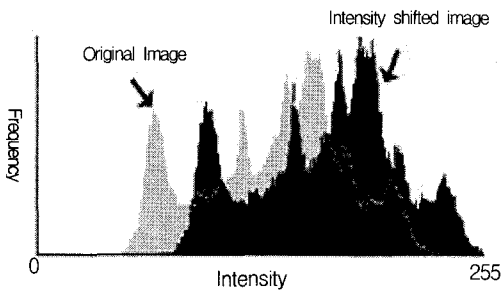
$$I(T,Q) = \sum_{k=1}^{n} \min(T_k, Q_k) \qquad (2)$$

In Equation (2), the larger the value the more similar the images. Images can then be ranked from the image database.

However, the histogram is very sensitive to lighting conditions, due to the nature of color space. Perceptually, similar colors are interpreted as completely different, thus giving non-appealing results. In (Figure 1) and (Figure 2), the similar histograms in different brightness conditions of the two images (a) and (b) are demonstrated. The intersection of the two histograms shows a smaller result, although the two images are visually similar.



(Figure 1) Original image and intensity shifted image



(Figure 2) Histogram of the original image and image shifted by light change

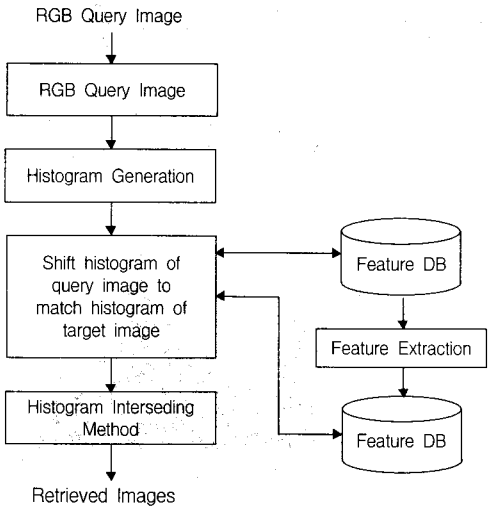
In (Figure 2), the intensity of the shifted image is slightly higher than that of the original image. The limitation of the CHM is: low similarity rank for visually similar images, similar to the original image and intensity shifted image in (Figure 1).

3. Shifted Histogram Method

In a more general mathematical sense, a histogram is simply a mapping that counts the number of observations that fall into various disjoint categories (known as bins), whereas the graph of a histogram is merely one way to represent a histogram. Thus, if we let the total number of observations be the total number of bins, the histogram meets the following conditions :

$$N = \sum_{k=1}^{n} h_h \qquad (3)$$

which is an index over the bins.



(Figure 3) Block diagram of the proposed retrieval method using SHM

The proposed SHM can be divided into 4 stages before similarity measurement.

The process is as follows :

(1) Transform RGB color space into HSV color space.

(2) Generate a histogram of the query image.

(3) Find the first index of the histogram for the query image.

fk_Q : first index is k if $h_k > Th$ for query image.

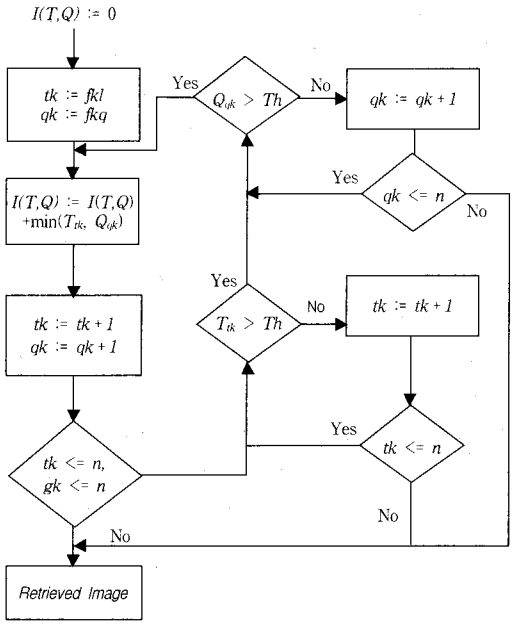
Th : Threshold.

(4) Find first index of histogram for target image.

fk_T : first index is k if $h_k > Th$ for target image.

Th : Threshold.

(5) Compare as follows :

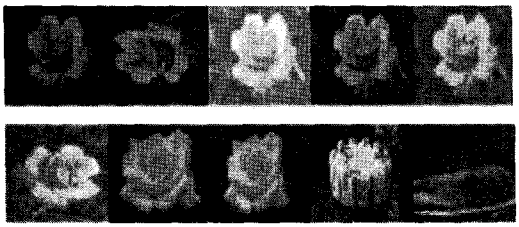


(Figure 4) Procedure to compare the histogram of query image with the histogram of target image

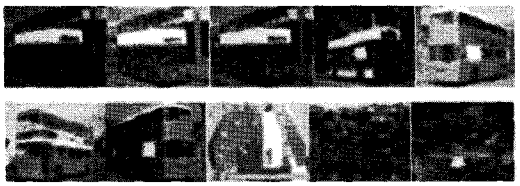
4. Experiments

The analysis of histogram effectiveness in image discrimination is mainly used for the design of image retrieval systems. In order to test the performance of our method, we have implemented several groups of experiments. The testing image database includes images with a wide range of image content, such as nature scenes, animals, cars, and so on.

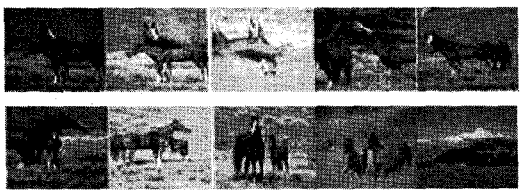
Using our method, we obtain results as shown in (Figure 5), (Figure 6), and (Figure 7). The left block in the first row is the sample image; other blocks are the retrieval image series.



(Figure 5) Query image and retrieved images list (1)



(Figure 6) Query image and retrieved images list (2)



(Figure 7) Query image and retrieved images list (3)

The performance of the retrieval results is measured by Precision, Recall [8] and AVRR (AVerage Rank of Relevant images) :

$$precision = \frac{No.of\ relevantimagesretrieved}{Total\ no.of\ images\ retrieved} \quad (4)$$

$$recall = \frac{No.of\ relevantimagesretrieved}{Total\ no.of\ relevant\ in\ database} \quad (5)$$

$$AVRR = \frac{1}{N}\sum_{i=1}^{n} R_i \quad (6)$$

Relevant images are referred to as images in the same class. Equation (4) gives the precision, that shows that the hit-rate that the class of the retrieved images is the same as that of the input reference image of the entire database. Equation (5) gives the recall, which measures the capability of finding images with the same class from all images in the database. AVRR presented in (6) means the average rank of relevant images. R_i means the rank of the relevant image. The number of images is presented by n.

In <Table 1>, <Table 2> and <Table 3>, the performance of SHM, MCH and CHM is compared in terms of precision, recall and AVRR.

〈Table 1〉 Result of the three methods using (Figure 5)

Method	Result	Recall	Precision	AVRR
SHM	7	0.78	0.67	4.2
MCH	6	0.59	0.61	4.0
CHM	4	0.47	0.51	3.5

〈Table 2〉 Result of the three methods using (Figure 6)

Method	Result	Recall	Precision	AVRR
SHM	7	0.64	0.73	3.4
MCH	7	0.55	0.59	3.0
CHM	5	0.46	0.41	2.4

〈Table 3〉 Result of the three methods using (Figure 7)

Method	Result	Recall	Precision	AVRR
SHM	9	0.83	0.90	4.9
MCH	7	0.71	0.62	4.1
CHM	7	0.68	0.57	3.5

With these results, we can see that our method is efficient and presents good performance in image retrieval using the adaptive histogram.

5. Conclusion

The shifted-color histogram method (SHM) is proposed for histogram-based image retrieval, and is based on the dominant colors in images. The histogram-based method is very suitable for color image retrieval because it is unaffected by geometrical changes in images, such as translation and rotation. However, images with similar visual information but with shifted color intensity, may result in a significant degradation in the similarity level, if the conventional histogram intersection (HIM) method is used. To solve the problem, the shifted histogram method(SHM) is proposed.

In comparison with other methods, our method is more straightforward. It doesn't haves special requirements or extra restrictions for images, for content-based image retrieval. Our experimental results show that the shifted histogram method has significantly higher retrieval effectiveness than the standard histogram method. In future study, the proposed retrieval method is expected to be applied to large scale image and video databases.

References

[1] M. Flickner et al., "Query by image and video content : The QBIC system", IEEE Computer, Vol. 28, No. 9, pp. 23-32, September 1995.

[2] M. J. Swain and D. H. Ballard, "Color indexing. Int Journal of Computer Vision", Vol. 7, No. 1, pp. 11-32. 1991.

[3] G. Gagaudakis and P. Rosin, "Incoprerating shape into histograms for CBIR", Proc. Int Conf, on Image Processing, Thessaloniki, Greece, pp. 7-10, 2001.

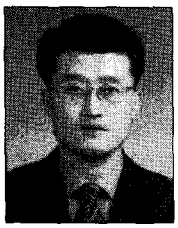
[4] Y. Rui, T. Huang, and S. F. Chang, "Image Retrieval : Current Techniques, Promising Directions and Open Jssues", Journal of Visual Communicationand Image Representation, Vol. 10, pp. 39-62, March 1999.

[5] Ka-Man Wong, Chun-Ho Cheung, Lai-Man Po, "Dominant Color Image Retrieval using Merged Histogram", Circuits and Systems, 2003, ISCAS '03. Proceedings of the 2003 International Symposium on, 2, May 2003.

[6] Ka-Man Wong, Chun-Ho Cheung, Lai-Man Po, "Merged-color histogram for color image retrieval", Image Processing, 2002, Proceedings, 2002 International Conference on, Vol. 3, pp. 24-28 June 2002.

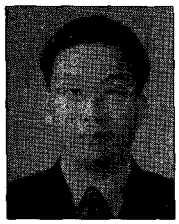
[7] Seong-O shim, Tae-Sun Choi, "Edge Color Histogram for Image Retrieval", Korea, IEEE ICIP 0-7803-7622-6/02/2000.

[8] H. Muller, W. Muller, D. Squire, S. Marchand Maillet, and T. Pun, "Performance Evaluation in Content-Based Image Retrieval : Overview and Proposals", Pattern Recognition Letters, Vol. 22, No. 5, pp. 593-601, 2001.



유 기 형

1989년 전북대학교 컴퓨터공학과 (공학사)
1991년 전북대학교 전자공학과 (공학석사)
2007년 전북대학교 컴퓨터공학과 (공학박사)
2003년~현재 비전정보 대표



유 승 선

1988년 한남대학교 전자계산학과 (이학사)
1994년 한남대학교 컴퓨터공학과 (공학석사)
2003년 전북대학교 시각정보공학과(공학박사)
2004년~현재 (주)비젝 이사

육 상 조

1990년 한남대학교 전자계산학과 (이학사)
1994년 한남대학교 컴퓨터공학과 (공학석사)
2004년 한남대학교 컴퓨터공학과 (공학박사)
2006년~현재 한남대 멀티미디어학부 전임강사

Gil-Cheol Park

1979년~1983년 HanNam Univ. (BA)
1983년~1985년 SungSil Univ., Graduate School (MA)
1994년~1998년 SungKunKwan Univ., Graduate School (Ph.D)
1985년~1990년 SamSung Advanced Institute of Technology
1991년~1996년 DaeKyo Computer Co., LTD
1996년~1998년 HanSeo University, Professor
2005년 Visiting Professor of UTAS., Australia
1998년~Now HanNam Univ., Professor