Content-Based Image Retrieval Method using the Relative Location of Multiple ROIs

Jongwon LEE[1], Jongho NANG[2]
[1]*School of Creative Contents, Chungkang College of Cultural Industries*
162 Chungkang-Ro, Majang-Myun, Ichon-Si, Gyunggi-Do 467-744, Korea
[2]*Department of Computer Science and Engineering, Sogang University*
1 Shinsoo-Dong, Mapo-Ku, Seoul 121-742, Korea
[1]*jw@ck.ac.kr,* [2] *jhnang@sogang.ac.kr*

Abstract—**Recently the method of specifying multiple regions of interest (ROI) based image retrieval has been suggested. However it measures the similarity of the images without proper consideration of the spatial layouts of the ROIs and thus fails to accurately reflect the intent of the user. In this paper, we propose a new similarity measurement using the relative layouts of the ROIs. The proposed method divides images into blocks of certain size and extracted MPEG-7 dominant colors from the blocks overlapping with the user-designated ROIs to measure their similarities with the target images. At this point, similarity was weighted when the relative location of the ROIs in the query image and the target image was the same. The relative location was calculated by four directions (i.e. up, down, left and right) of the basis ROI. The proposed method by an experiment using MPEG-7 XM shows that its performance is higher than the global image retrieval method or the retrieval method that does not consider the relative location of ROIs.**

Index Terms—**Image retrieval, Information retrieval, Content based retrieval, Search methods, Nearest neighbor searches**

I. Introduction

Image retrieval methods can be broadly divided into those using text information included in the images [1],[2] and those based on the contents of images themselves [3]-[10]. Recently, using images on the Internet rapidly increases, additional information such as text attached to images is often unavailable—hence the need for retrieval methods based on the contents of images has been on the increase.

Content-based image retrieval methods can be divided into those using the global feature values of whole images [3]-[7] and those based on the local feature values of regions of these images [8]-[10]. The former can compare the global features of images but fails to compare the similarity of objects that the user is interested in, as no information is available regarding the user's region of interest. Accordingly, methods for specifying regions of interest (ROI) and retrieving the contents of the images on this basis have been proposed, which are generally called "ROI-based image retrieval" methods.

The methods of selecting ROIs from images are divided into methods in which the retrieval system recognizes key objects in the images and automatically specifies them as ROIs [9] and those enabling the user to choose ROIs directly[8],[10]. If the system automatically designates ROIs, they may not correspond to the regions that the user wishes to retrieve.

To measure the similarity of ROIs requires the calculation of distance between the ROIs of the query images and the feature values of the target images. Extracting the feature values of images generally takes a lot of time, so the values are extracted in advance and saved in the database for later use [3]-[10]. If the user chooses ROIs randomly, however, it is impossible to tell which parts of the images will be selected, so existing studies[8]-[10] have divided images into smaller blocks to extract their feature values and match them with ROIs for retrieval. Here how to match the ROIs and the blocks is a problem. In measuring the similarity of ROIs, reflecting the location of ROIs is important. Especially when multiple ROIs are selected, it is vital how to consider the location of ROIs. Previous studies [8],[9] have not taken into consideration the regions in different locations from ROIs in the query image. Reference [10] does consider the location of ROIs but only determines whether ROIs are in the same location, without telling exactly how their locations differ. In this case, the user's intent of retrieval cannot be accurately reflected.

As such, how to select blocks overlapping with ROIs and how to reflect the location of ROIs in multiple ROI-based image retrieval have been important issues in existing studies relating to ROI-based retrieval, but these studies have failed to suggest effective methods in this regard. To address problems with the methods suggested in previous studies, this paper proposes the method of selecting only those blocks whose ROI-overlapping areas exceed the threshold and reflecting the relative location of multiple ROIs to measure similarity. For this purpose, images are divided into coordinate planes with four quadrants centering on the basis ROI to determine which quadrants individual ROIs are located in. To verify the validity of this method, MPEG-7 XM is used to extract DCD as feature values and measure the level of similarity. The proposed method by an experiment shows that its performance is higher than the global image retrieval method [3]-[7] or the retrieval method that does not consider the relative location of ROIs [8]-[10].

The rest of the paper is organized as follows: Section 2 introduces related work on ROI-based image retrieval, and Section 3 describes our image retrieval method that considers the relative location of multiple ROIs. Section 4 explains the experimental environment and results of the proposed method and examines its validity; Section 5

This research was supported by the MKE(The Ministry of Knowledge Economy), Korea, under the ITRC(Information Technology Research Center) support program supervised by the NIPA(National IT Industry Promotion Agency(NIPA-2011-(C1090-1131-0008))).

The corresponding author of this work is Prof. Jongho Nang.

Digital Object Identifier 10.4316/AECE.2011.03014

concludes with a summary and discussion of some directions for future research.

II. Related Works

For ROI-based image retrieval, ROIs should be specified in images and then the feature values of these ROIs extracted to compare their similarity to the target images. ROI selection methods can be divided into manual selection by human beings [8],[10] and automatic designation by computer system [9]. Reference [8] enables the user to select ROIs on his/her own. It is inefficient to extract the feature values of ROIs randomly selected by the user on a real-time basis. Therefore [8] divides images into blocks of certain size (e.g. 2x2, 3x3, 4x4, 5x5) and defines ROIs as blocks that overlap with user-selected ROIs, in an effort to calculate ROI similarity based on the feature values extracted per block in advance. In this case, the user-selected ROIs and the blocks may not be perfectly identical. To address this problem, [8] reflects the proportion of overlap between ROIs and blocks. In other words, for blocks overlapping with ROIs in part, their feature values are reflected on similarity measurement by the proportion of overlap.

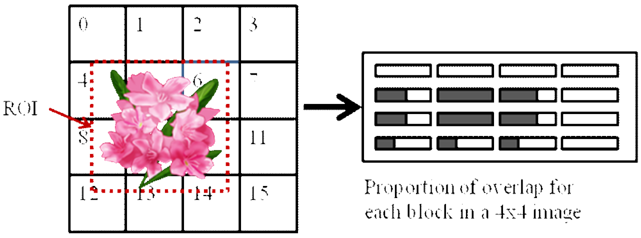


Figure 1. Reflection of the proportion of ROI-overlapping blocks in [8]

In Figure 1, for instance, the feature values of blocks #4, #6, #8, #10, #12, #13 and #14, which partially overlap with user-selected ROIs, are reflected only by their respective proportions of overlap. Reference [8] suggests $D_j(Q,I^j)$ as a method to measure ROI similarity by the distance between query image Q and the j^{th} image of the database.

$$D_j(Q,I^j)=\sum_n\sum_i \lambda W_{n,i} S^j(n,i),\ j=1,\dots,M \qquad (1)$$

Equation (1) divides the query image Q and the j^{th} image of DB, I^j, into n blocks and extracts i feature values from each block to calculate the similarity. M is the number of entire images, and $S^j(n,i)$ is a function that measures the distance between Q and the i^{th} feature of the n^{th} block of I^j. $W_{n,i}$ is the weight of the i^{th} feature of the n^{th} block; λ, which is reflected together with $W_{n,i}$, is the proportion of overlap between the ROIs and the blocks. In other words, $D_j(Q,I^j)$ in Equation (1) is obtained by calculating the distances between individual blocks and summing them up by their respective proportions. This method, however, merely measures the distance of blocks in the target image that are in the same location as in the query image, without considering blocks in different locations. In this case, blocks in different locations that are similar to the ROIs are not retrieved.

Reference [9] uses the dominant colors of images to automatically extract regions. This method employs color, shape and location as feature values. 25 colors selected here are mapped to be compared by differences in color histogram value; to locate individual regions, images are divided into 3x3 blocks as illustrated in Figure 2, and the number of block with the largest area of region is designated. For instance, the location of region in Figure 2 would be indexed as "5." In other words, the regions are compared only from fixed locations, as the locations are compared by index number.

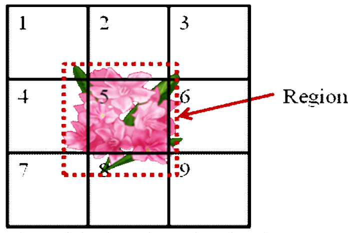


Figure 2. Designation of the location of region in [9]

This method has a problem that is not directly selected by the user, for the regions are automatically classified from the images by color. Also, the method does support multiple regions but merely compares the absolute location of blocks as the locations are compared by index number.

Reference [10] enables the user to select multiple ROIs and retrieves blocks in different locations from the ROIs'. It is also compared and reflected whether blocks in the target image are in the same location as multiple ROIs in the query image. Here the similarity of spatial layouts for ROIs is compared using Equation (2).

$$S(Q,T)=\sum_{i=1}^{n-1}\sum_{j=i+1}^{n} f(x_i^t-x_j^t)sign(x_i^q-x_j^q)+f(y_i^t-y_j^t)sign(y_i^q-y_j^q) \quad (2)$$

In Equation (2), $f(x)$ is a bipolar sigmoid function. x^t, y^t are the central coordinates of blocks in the target image that correspond to ROIs in the query image, and x^q, y^q are the central coordinates of ROIs in the query image. In other words, Equation (2) converts the distances between ROIs in the query image (Q) and the target image (T) as bipolar sigmoid and sin function values to multiply and sum them up. The method, however, fails to provide a detailed level of similarity as it simply tells whether blocks in the target image are in the same location as ROIs in the query image.

In ROI-based image retrieval, it is vital to reflect the user's intent and enhance the accuracy of retrieval. Existing works, however, have been problematic in the selection of ROI-overlapping blocks [8] or the reflection of ROI locations [8]-[10]. In this context, this paper suggests a modified method for selecting ROI-corresponding blocks and reflects the relative location of ROIs in distance measurement to improve the accuracy of image retrieval.

III. Image Retrieval Method Using the Relative Location of Multiple Roi

A. Selection of blocks corresponding to ROIs

For ROI-based image retrieval, the user should be able to select ROIs directly to reflect his/her interest on the retrieval process. For the efficiency of retrieval, the images should be divided into blocks of certain size in advance and the feature values of blocks overlapping with ROIs utilized, as indicated in [8]. To use the feature values of blocks, it is instrumental to determine blocks overlapping with ROIs first, which can be done in the following two ways: First, the feature values of blocks overlapping with ROIs are fully reflected. Second, the proportion of overlap between ROIs and blocks is taken into account [8].

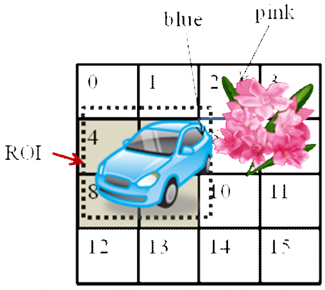


Figure 3. Comparison of ROI and image block locations

For example, let us assume, as illustrated in Figure 3, that the blocks are divided into 4x4 and that the ROIs overlap with blocks are #0, 1, 2, 4, 5, 6, 8, 9 and 10. The first method reflects the feature values of all blocks overlapping with ROI, so it considers all the feature values of blocks #0, #1, #2, #4, #5, #6, #8, #9 and #10 as ROI feature values. This method has a defect that the feature values of region not overlapping with ROIs are overly reflected. The second method, on the other hand, does reflect the entire feature values of block #5 but considers the feature values of other blocks based on their respective proportion of overlap with ROI. As for this method, feature values that are totally different from the ROIs may be reflected when applying the feature values of blocks overlapping with ROIs by proportion. Let us take block #6 as an example: The color of the ROI overlapping with block #6 is blue. The block as a whole, however, is predominantly pink, so its color is determined as pink. As a result, the feature values of the block are reflected by the proportion of overlap for its "pink" areas—totally different from the ROI.

This paper suggests a method that reflects feature values depending on the proportion of blocks overlapping with ROIs as in [8] but selects only those blocks where regions overlapping with ROIs are greater than a threshold. This is because, when people recognize an image, the level of importance tends to decrease as the distance from the center of the image becomes farther. Therefore, it is unnecessary to take into consideration the feature values of regions where ROIs and blocks overlap slightly with each other in the edge. In the case of Figure 3, the feature values of blocks #4, 5, 8, and 9—those with greater overlapping areas than the threshold—are reflected and retrieved as ROI feature values, ignoring those of blocks #0, 1, 2, 6, and 10 where the areas overlapping with ROIs do not exceed the threshold, assuming the threshold stands at 20%. In this case, blocks affected by colors other than those in ROIs (e.g. block #6) can be ruled out. The value to be used as the threshold will be determined through experiments in Section 4.

B. Measurement of ROI similarity

Similarity between ROIs of the query image and the target image is measured by the feature values of ROI-overlapping blocks of the query image and the distance from the target image. The degree of similarity becomes greater when the measured distance has a smaller value. The degree of similarity between blocks overlapping with ROIs is compared either between blocks in the same location alone [8],[9] or between blocks in different locations [10]. When blocks in the same location are only compared, it is impossible to retrieve blocks that are in different locations but have similar feature as user-selected regions. Image retrieval is not finding exactly matched image but finding similar image, so blocks with a high degree of similarity with user-selected regions should be retrieved although they may be in different locations. For this reason, this paper does not only compare the feature values of blocks selected as ROIs but also considers blocks in different locations of the target images.

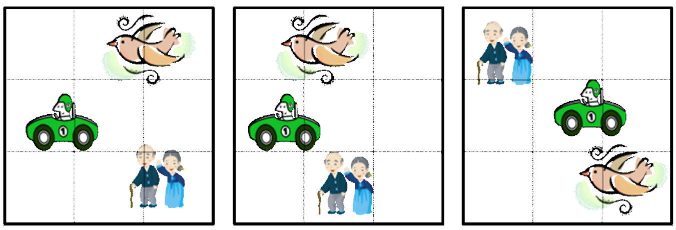
The similarity is measured by obtaining the list of blocks in the query image corresponding to ROIs(R_b) and scanning the target image m times by the unit of blocks to find the nearest block list to R_b. The distance is determined by the similarity measure between ROIs and the query image. This can be written as Equation (3).

$$SD(R_b, I^j) = \min(RD_i(R_b, I^j_{b_i})), i = 1, \ldots, m \qquad (3)$$

$SD(R_b, I^j)$ of Equation (3) measures the degree of similarity between R_b and target image, and I^j represents the j^{th} image of the image database. $RD(R_b, I^j_{b_i})$ measures the distance between R_b and each block list($I^j_{b_i}$) in the target image (I^j). $I^j_{b_i}$ means the i^{th} block list of the j^{th} image that corresponds to R_b. In $RD(R_b, I^j_{b_i})$, the similarity of blocks is measured using different similarity calculation methods by the property in use. For $SD(R_b, I^j)$, the smallest value (i.e. min value) is applied among the distances calculated by scanning blocks from the target image and comparing them m times.

C. Multiple ROI-based image retrieval

Using more than two ROIs for image retrieval involves different considerations from the use of a single ROI, as the locations of ROIs can serve as a crucial element of retrieval from the user's viewpoint in this case. For instance, let us assume, as illustrated in Figure 4, there are three regions in which the user is interested in query image (a).



(a) Query image (b) Target image #1 (c) Target image #2

Figure 4. Comparison of locations in multiple ROIs

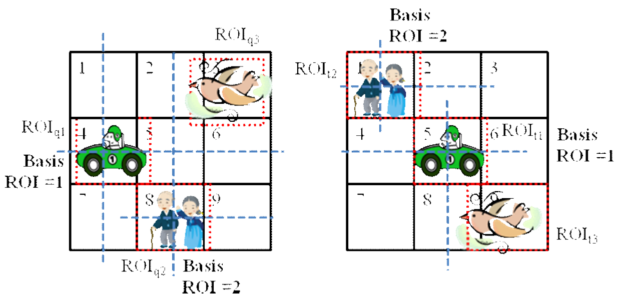
Target image 1(b) is slightly different from query image (a) but the location of ROIs—the bird at the top, the car in the middle and the person at the bottom—is the same. In target image 2(c), on the other hand, the locations of the bird and the person are switched. In this case, the user's intent for retrieval is not realized, so target image 2(c) should be excluded from the retrieval results or be given a lower priority. Therefore, in multiple ROI-based retrieval, it is crucial to consider the relative location of ROIs so that the user's intent can be fully reflected. Thus, this paper proposes a method that compares the relative location of ROIs in multiple ROI-based image retrieval. Comparison of relative location between ROIs is carried out as illustrated in the algorithm of Figure 5.

```
Phase 1: The relative location of ROIs is
         calculated in the query image.
  (a) Set the leftmost side of the query
      image as the basis ROI.
  (b) Divide an image into four quadrants,
      with the central coordinates of the
      basis ROI.
  (c) Calculate the relative location of
      other ROIs to determine which quadrant
      they lie in. Do not calculate the
      location of the ROI already designated
      as basis ROI.
  (d) Choose the closest ROI to the basis
      ROI as the new basis ROI.
  (e) Repeat (b) through (d) by (# of ROIs-
      1) times.

Phase 2: The results are compared with the
         target image.
  (a) Calculate the location of blocks in
      the target image that are most similar
      to ROIs of the query image.
  (b) Calculate the relative location of
      blocks derived in (a) by order of
      basis ROI in Phase 1.
  (c) Compare the relative location of
      blocks identified in (b) with that of
      ROIs obtained in Phase 1 to determine
      whether their relative location is the
      same.
  (d) Increase the distance if the location
      differs.
```

Figure 5. Algorithm of comparing relative location between multiple ROIs

Take Figure 6 as an example: ROI_{q1} is located in block #4, ROI_{q2} in block #8 and ROI_{q3} in block #3. The relative location of each ROI in the query image is as follows: With ROI_{q1} as the basis, ROI_{q2} is located in the fourth quadrant and ROI_{q3} in the first quadrant. When ROI_{q2} becomes the basis ROI, ROI_{q3} will be located in the first quadrant. This corresponds to the first-phase task in Figure 5.



(a) Query image (b) Target image

Figure 6. Comparison of relative location between multiple ROIs

Figure 6(b) shows the Phase 2 process of the algorithm. First, blocks in target image (b) are retrieved based on their similarity to each ROI in the query image. For instance, the block with the greatest similarity to ROI_{q1} would be block #5 (ROI_{t1}). Next, the relative location of ROIs is calculated. With the central coordinates of ROI_{t1} that corresponds to ROI_{q1} as the basis, ROI_{t2} is located in the second quadrant and ROI_{t3} in the fourth quadrant. In other words, its relative location is different from the query image. In this case, the distance between the query image and the target image should be calculated as farther than that of the images whose relative location is the same. This can be summarized as Equation (4).

$$MD(R, I^j) = \omega_1 \sum_{k=1}^{r} SD(R_b^k, I^j) + \omega_2 \sum_{k=1}^{r-1} LD(R_b^k, I^j) \qquad (4)$$

In Equation (4), $MD(R, I^j)$ calculates the degree of similarity between the query image's ROI combination (R) and the j^{th} image of the database (I^j). Here the degree of similarity is calculated as the weighted sum of the distance between feature values and the distance at which the relative location is measured, with the weight being $\omega_1 + \omega_2 = 1$. The similarity measure is higher when the distance is nearer. r refers to the number of ROIs; R_b^k is the list of blocks in the query image that correspond to the k^{th} ROI. In Equation (4) $\sum_{k=1}^{r} SD(R_b^k, I^j)$ is calculated by summing up each ROI's similarity measure with Equation (3). A function that measures the relative location of ROIs, $LD(R_b^k, I^j)$ is calculated using Equation (5).

$$LD(R_b^k, I^j) = \sum_{s=k+1}^{r} rpos(R_b^k, I_s^j) \qquad (5)$$

Using the method illustrated in Figure 5, Equation (5) compares the relative location of the s^{th} block list(I_s^j)—among block lists in the k^{th} ROI(R_b^k) of the query image and the j^{th} image of the database—against the central coordinates of the basis ROI. S is repeated from $k+1$ through r. This is because blocks that have already served as basis ROIs are excluded. The relative location is reflected as shown in Equation (6).

$$rpos(R_b^k, I_s^j) = \begin{cases} 0, & \text{when the relative location is the same} \\ x, & \text{when the relative location is different} \end{cases} \qquad (6)$$

In other words, the value of "0" is applied if the relative location of blocks in the target image that correspond to ROIs in the query image is the same in Equation (6), and the distance increases if the relative location differs.

IV. Experimental Results

A. Experimental environment and performance evaluation method

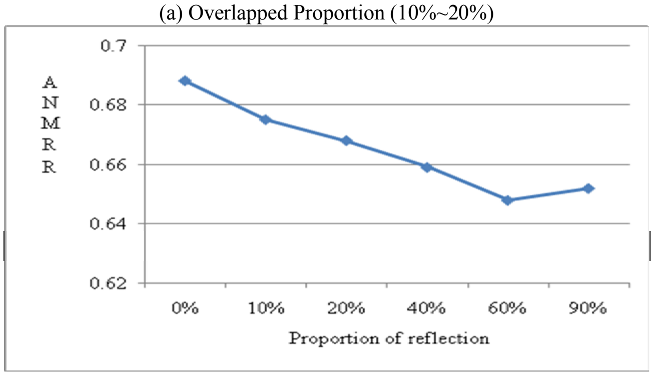
This paper uses color for comparison between ROIs, as the property has been used most widely in content-based image retrieval [3]-[10]. This paper utilizes MPEG-7 DCD (Dominant Color Descriptor) as the color property. By extracting representative dominant colors from images, DCD effectively distinguishes images using a few of colors. This experiment is structured around the MPEG-7 experiment model (XM) [11]. MPEG-7 Common Color Dataset (CCD) and Common Color Query (CCQ)—image database provided together with MPEG-7 XM [11]—are utilized here.

This paper compares image retrieval results with the ground truth of CCD and uses "Averaged Normalized Modified Retrieval Rank (ANMRR)", for a performance evaluation, a performance evaluation method suggested by MPEG-7. ANMRR does not only determine if a correct answer is found from the retrieval results but also calculates the rank of the particular answer in the retrieval results. A lower ANMRR value represents better performance.

B. Decision of a threshold of overlapped block selection

In Section 3-A, a threshold is applied to determine how much the proportion of overlap should be when selecting ROI-overlapping blocks. Here the right value for the threshold is experimentally verified.

(a) Overlapped Proportion (10%~20%)



(b) Overlapped Proportion (30%~50%)

Figure 7. Results of threshold proportion calculation for ROI-overlapping blocks (ANMRR)

In the experiment, the proportion of partially overlapped area between blocks and the upper side of ROI are about 30%~50%. And the overlapped proportion between blocks and the lower side of ROI are about 10%~20%. In Figure 7, "0%" means that partially overlapping blocks are excluded from the retrieval. First, in figure 7(a), as shown in the graph, the retrieval performance tends to decrease when the proportion of overlap is greater than 0%. This is because feature values unrelated to ROIs may be excessively reflected as ROI-overlapping areas constitute only a part of the blocks.

Next, in figure 7(b), the retrieval performance is better than when partially overlapping blocks are completely ignored for these blocks, though overlapping with ROIs only in part, have an unignorably high share in the ROIs. The results show that the proportion of overlap is low, it would be undesirable to select such blocks as those corresponding to ROIs. Against this backdrop, this paper does not select blocks whose proportion of overlap with ROIs is below 20% as ROI-corresponding blocks.

C. Comparison of ROI-overlapping block selection methods

There are various measures for selecting blocks overlapping with ROIs. First, the proportions of all ROI-overlapping blocks may be reflected as suggested by [8]. Second, blocks whose overlapping areas do not exceed the threshold may be ignored, as proposed in this paper. Lastly, all the feature values of blocks that overlap with ROIs may be reflected. The retrieval performance of each method is compared through experimentation by using 50 MPEG-7 CCQ images. Figure 8 shows the results of retrieval performance comparison.

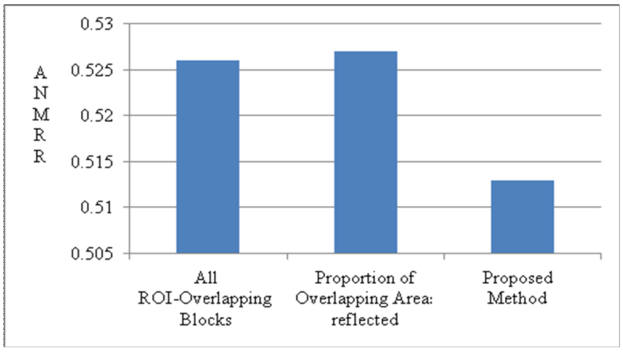
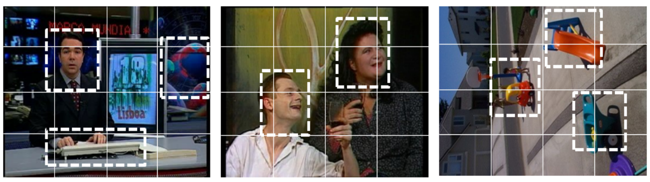


Figure 8. Comparison of retrieval performance by ROI-overlapping block selection method

In Figure 8, the proposed method shows better retrieval performance than the consideration of all blocks overlapping with ROIs or the consideration of ROI-overlapping blocks by the proportion of overlapping areas [8]. This is because the blocks selected using the proposed method fully reflect the properties of core areas while ignoring those weakly correlated with ROIs.

D. Comparison of multiple ROI-based image retrieval methods

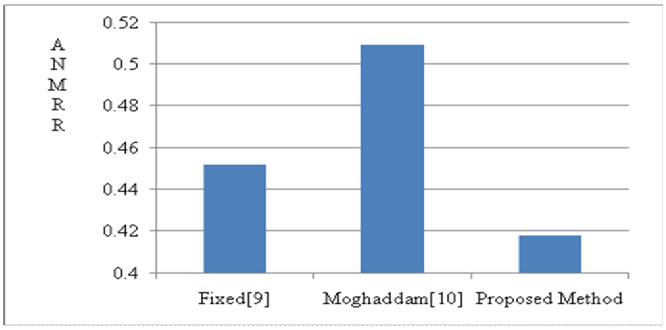
Image retrieval experiments based on multiple ROIs are: (a) comparing blocks in the same location alone to measure the degree of similarity as in [9]; (b) merely examining whether the location of ROIs is the same as in [10]; and (c) reflecting the relative location of ROIs as suggested in this paper. Here all three types of experiment are performed to compare their retrieval performance. Figure 9 shows an example of multiple ROIs selected from the query image, and the results are visualized in Figure 10.



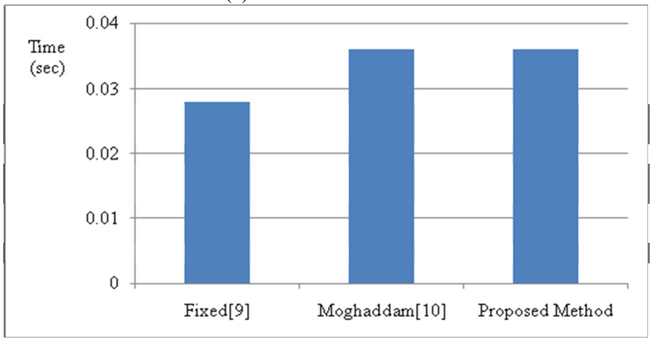
(a) Anchor (b) Couple (c) Playing on the street

Figure 9. Examples of multiple ROIs selected from the query image

In Figure 10(a), the result of retrieval based on the proposed method shows the best performance, which is 7.5% greater than fixed location retrieval [8],[9] and 21.8% greater than [10]. This shows that the method considering the relative location of ROIs is useful in multiple ROI-based image retrieval. Figure 10(b) presents the average retrieval time of the three methods. The proposed method takes an average of 12.9% longer than fixed location retrieval [8], [9]. Compared to the average level of retrieval performance improvement measured by ANMRR, 14.7%, this increase in retrieval time is not that huge. The actual results of multiple ROI-based image retrieval are demonstrated in Appendix A, which indicates that the proposed method retrieves the largest number of images similar to ROIs.



(a) Retrieval Performance



(b) Retrieval Time

Figure 10. Comparison of multiple ROI-based retrieval performance

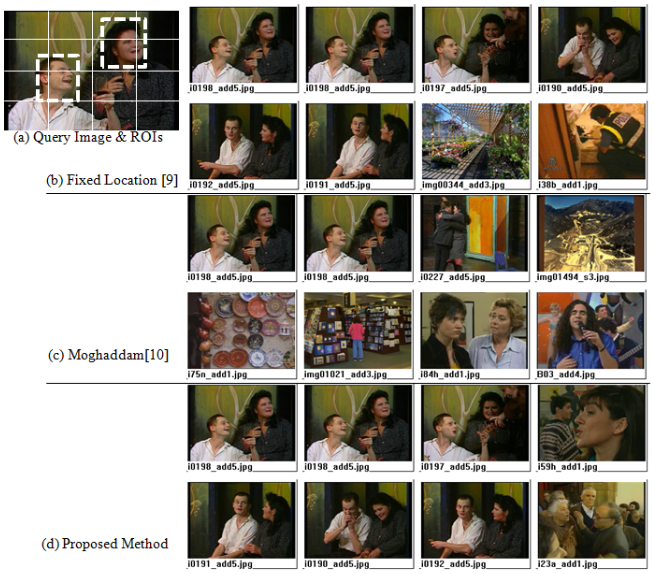
The above experiment proves that, in multiple ROI-based image retrieval, searching other locations than those designated as ROIs and considering the relative location of ROIs improves the efficiency of retrieval and better reflects the user's intent.

V. Conclusion

Recently in the field of content-based image retrieval system, the method of specifying multiple regions of interest (ROI) and undertaking image retrieval on this basis has been suggested. However, this method is considered problematic, for it measures the similarity of the images without proper consideration of the spatial layouts of the ROIs and thus fails to accurately reflect the intent of the user. Against this backdrop, this paper has proposed a new method for multiple ROI-based image retrieval that considers the relative location between ROIs and has verified its validity through experimentation. The feature values of blocks overlapping with user-selected ROIs that have greater overlapping areas than the threshold have been extracted and compared with those of the target image to measure the degree of similarity.

The representative attribute of color is used to determine image similarity, and the measurement is done with MPEG-7 DCD which excels in extracting representative colors of an image. This paper has suggested the method of considering the relative location of ROIs, along with the similarity of image feature values, in multiple ROI-based image retrieval. The experiment has shown that the proposed method improves retrieval performance by 14.7% on average compared to the comparison of global image feature values and the comparison of blocks in the same location only [8]-[10] whereas retrieval time increases by an average of 12.9%. The increase in retrieval time is minimal compared to the improvement in retrieval performance. The proposed method will be useful in ROI-based image retrieval. This paper has only used DCD as the feature value of images. Further research should perform as to how to reflect various feature values other than color—such as texture and object shape—in ROI-based retrieval.

Appendix A. Example of Experimental Results



References

[1] S. Sclaroff, L. Taycher, and M. L. Cascia, "Image-Rover: A Content-based Image Browser for the World Wide Web," Proc. of IEEE Workshop on Content-based Access of Image and Video Libraries, pp.2-9, 1997. [Online]. Available: http://citeseer.ist.psu.edu/viewdoc/summary?doi=10.1.1.1.7543

[2] S. Mukerjea and J. Cho, "Automatically Determining Semantics for World Wide Web Multimedia Information Retrieval," Journal of Visual Languages and Computing, vol.10, pp.585-606, 1999. [Online]. Available: http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.59.4635&rank=1

[3] N.C. Yang, W.H. Chang, C.M. Kuo, and T.H Li, "A Fast MPEG-7 Dominant Color Extraction with New Similarity Measure for Image Retrieval," Journal of Visual Communication and Image Representation, vol.19, pp.92-105, 2008. [Online]. Available: http://dx.doi.org/10.1016/j.jvcir.2007.05.003

[4] L.M. Po, and K.M. Wong, "A New Palette Histogram Similarity Measure for MPEG-7 Dominant Color Descriptor," Proc. of IEEE Int. Conf. on Image Processing(ICIP'04), pp.1533-1536, 2004. [Online]. Available: http://dx.doi.org/10.1109/ICIP.2004.1421357

[5] H. Shao, Y. Wu, W. Cui, and J. Zhang, "Image Retrieval Based on MPEG-7 Dominant Color Descriptor," Proc. of IEEE Int. Conf. on Young Computer Scientists(ICYCS 2008), pp.753-757, 2008. [Online]. Available: http://dx.doi.org/10.1109/ICYCS.2008.89

[6] K.-M. Wong, K.-W. Cheung, and L.-M. Po, "MIRROR: An Interactive Content Based Image Retrieval System," Proc. of IEEE Int. Symposium on Circuits and Systems(ISCAS 2005), vol.2, pp.1541-1544, 2005. [Online]. Available: http://dx.doi.org/10.1109/ISCAS.2005.1464894

[7] E.L. Broek, P.M.F. Kisters, and L.G. Vuurpijl, "The utilization of human color categorization for content-based image retrieval," Proc. of the SPIE, vol.5292, pp.351-362, 2004. [Online]. Available: http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.66.2354

[8] Q. Tian, Y. Wu, and T.S. Huang, "Combine User Defined Region-of-Interest and Spatial Layout for Image Retrieval", Proc. of IEEE Int. Conf. on Image Processing(ICIP'2000), vol.3, pp.746-749, 2000. [Online]. Available: http://dx.doi.org/10.1109/ICIP.2000.899562

[9] B.G. Prasad, K.K. Biswas, and S.K. Gupta, "Region-Based Image Retrieval using Integrated Color, Shape and Location Index," Computer Vision and Image Understanding, vol.94, pp.193-233, 2004. [Online]. Available: http://dx.doi.org/10.1016/j.cviu.2003.10.016

[10] B. Moghaddam, H. Biermann, and D. Margaritis, "Regions-of-Interest and Spatial Layout for Content-Based Image Retrieval," Multimedia Tools and Applications, vol.14, no.2, pp.201-210, 2001. [Online]. Available: http://dx.doi.org/10.1023/A:1011355417880

[11] ISO/IEC JTC1/SC29/WG11, MPEG-7 Visual Part of Experimentation Model Version 11.0, 2001.