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Image Retrieval Based on Fuzzy Edge and Trum Fuzzy Histogram

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ABSTRACT

In recent years, many image retrieval systems based on color feature like fuzzy color histogram, have been applied in image retrieval systems based on content (CBIR). Most of this methods are not able to determine pixels accurate colors, especially in combined manner, and only determine whole distribution of color factor in image; therefore they are not efficient in image retrieval. We have suggested weight vector factor in trum fuzzy histogram in this paper to remove these problems. But these methods only demonstrate total distribution of color feature in image and do not consider any kind of place data, like relative positions of objects in image. Therefore do not prepare strong techniques for image retrievals with complex place ornament. since the edge pixels are important places in image and determine objects in an image and often similar images have similar backgrounds, we use competitive fuzzy edge finder algorithm which effectively categorizes image pixels into 5 classes ,including 4 edge classes in different directions and 1 background class. after categorizing pixels, feature vector for each class would be determined, that includes Trum fuzzy color histogram and place position. we compared our suggested method to fuzzy histogram method and compound neighborhood fuzzy entropy method with color _place feature, as tests results show high efficiency of our suggested method for image retrievals from COREL database, including 3000 images.
KEYWORDS: competitive fuzzy edge finder, fuzzy similarity factor,Trum fuzzy color histogram.

INTRODUCTION

With regard to many advantages of image retrieval systems based on content at image databases and internet in recent years, many challenges happened in this area, as many methods, based on visual concepts like color, content, shape, for automatic feature determination in images, have been suggested[1][2][3].Today, new researches in CBIR systems are for the purpose of developing effective features to specify images, as the user can easily be able to use real words to express images, by means of conformity techniques[4][5]. meanwhile, methods based on fuzzy logic, are very suitable, because they allow user to express his needs in a natural language and are strong methods for determined deviation management [6][7][8].

One of the methods based on fuzzy logic is fuzzy color histogram suggested by konstantinidis [9] .

This method only illustrates color feature in image and makes no difference between images in which a specific color is accumulated in one point and make an area and images which this color is distributed in whole image.therefor color histograms ,do not contain any of location data like objects relative positions.

to remove these problems, and with regard to this case , that edges are important places in each images, illustrate the position of different objects in image, as well as in most cases similar images have similar background, therefore in this paper we are going to determine images similarities, more effectively by categorizing pixels into two groups of edge and background and extraction of color and place features for each group and attain a high accuracy in retrieval system, as tests results show higher accuracy of suggested method than other methods.

In second section of this paper ,fuzzy color histogram method is described in section3,compound neighborhood fuzzy entropy method with color place feature is described. In section 4,we describe our suggested method based on competitive fuzzy edge finder to develop fuzzy feature vector which contains color and place data and degree of importance of each group .in section 5, we will do some tests on 3000 images from COREL database and discuss on the results ,and in section 6.the conclusion of paper is presented.

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Image retrieval based on fuzzy color histogram

Fuzzy color histogram is a feature in each color image, that shows color used in an image. Establishing fuzzy color histogram has 3stages.in stage 1 is determining color spaces, stage2 is fuzzy member ship function, and last stage is determining fuzzy rules.

We use l*a*b* color space which is very close to colors that human eyes can realize. in this color space, component l* dimension rates lightness, a* is the portion of green to red, and b* is the portion of blue to yellow. For effective use of these color components in retrieval systems, each of components a*and b* are divided into 5groups and l*divided into 3 groups[10].Therefore by means of this color space and triangular membership functions[10].the amount of fuzzy membership of each pixel to each color was determined and then by means of fuzzy rules27,that is shown in[9] output of fuzzy system, which is the operation of exact determining of color of each pixel in one of 10 "blue, grey, red, orange ,yellow ,green, green blue, blue, mauve ,white " colors, will be determined.

Compound neighborhood fuzzy entropy method with color place feature

in this method besides color feature ,based on fuzzy color histogram discussed in section2,edge and place data are also used to describe images more. effectively one of the methods based on fuzzy logic to consider edge data is applying quantized fuzzy entropy histogram (11) (12).in this method firs the color amount of all pixels by means of HSV space are quantized into 72 classes and include 8 components to describe clue amounts, 3components to describe degree of darkness and3 components to determine degree of color lightness. So 3 dimensional HSV color space, changes into 1dimentional space:

$$Q=9H+3S+V \qquad (1)$$

As, Q amounts range into the set between 0 to 71.

to determine the amount of fuzzy entropy of each pixel ,one neighborhood with radius1 around each pixel is considered and 3 amount of max, min, mean which are maximum amount, minimum amount and ,mean amount of quantized color, respectively are in considered neighborhood ,will be determined and parameter H based on these amount is defined as:

$$I=\max\{\text{max-mean, mean-min}\}$$

Membership function by use of parameter I is determined as:

$$\mu(i,j)=1-\frac{1}{2}\left(\frac{Q(i,j)-mean}{I}\right)^2 \qquad (2)$$

fuzzy entropy of pixel existing in place position (i,j) is determined as:

$$H(i,j)=-\mu(i,j)\times\log(\mu(i,j))-(1-\mu(i,j))\times\log(1-\mu(i,j)) \quad (3)$$

Then, the mean of quantized fuzzy entropy in chosen neighborhood will be determined and is considered as E (i,j)will be quantized into 20 columns for the purpose of describing edge data with uniformity:

If $k*0.05<= E(i,j)<=(k+1)*0.05$ then $p(i,j)=E(i,j)$ for k=0,…18

If $0.95<= E(i,j)<=1$ then $p(i,j)=19$

fuzzy entropy histogram is also formulated as:

$$H_e(p)=\frac{1}{mn}\sum_{i=1}^{m}\sum_{j=1}^{n}\delta(p(i,j)-p),\forall p\in p \quad (4)$$

to consider place data ,place position of each group determined edges was put into a separate formula and finally will be determined by verifying the mean of them to define place position of each 20 edge groups, based on formulas:

$$\overline{X_i}=\frac{1}{|A_i|}\sum_{(x,y)\in A_i}x \qquad (5)$$

$$\overline{y_i}=\frac{1}{|A_i|}\sum_{(x,y)\in A_i}y \qquad (6)$$

A_i: number of pixels in ith edge group

X_i, Yj: means of the ith edge place position

After feature extraction procedure from images, similarity feature will be used as an important parameter to determine the extent of similarity or dissimilarity between images to human sense (understanding).formula 10 shows fuzzy similarity factor which covers3 color, edge and place position features very well:

$$sim(q,t)=\frac{\sum_{i=1}^{N}\min(H_c^q(i),H_c^t(i))}{\min(\sum_{i=1}^{N}H_c^q(i),\sum_{i=1}^{N}H_c^t(i))} \quad (7)$$
$$+(1-(\sum_{k\in Q}\frac{|H_e^q(k)-H_e^t(k)|}{1+\mathrm{H}_e^q(k)+H_e^t(k)}\times\sqrt{\frac{(\overline{x_q(k)}-\overline{x_t(k)})^2+(\overline{y_q(k)}-\overline{y_t(k)})^2}{2}}))$$

H (i): ith column of fuzzy color histogram
H (k): kth column of quantized fuzzy entropy histogram (edge) of query image.
X_q (k), Yq (k): mean of place position of kth column of quantized fuzzy entropy histogram (edge) of query image.

Fuzzy edge finder and trum color histogram

with regard to the fact that usually similar images have similar backgrounds, we tried to categorize pixels into 5classes including one background and4 edge classes in our suggested method by use of fuzzy and competitive fuzzy edge rules, so a estimation of different objects and background within images was established [13].grouping pixels in their classes by use of competitive fuzzy edge finder method includes following stages:

Stage one:

A group of parameters w, lo, hi are determined by user. Parameters hi, lo that represent maximum and minimum and minimum limits of total differences amplitude in determined directions will be used to element center of each class. For example center of background class is shown as: Co= (lo, lo, lo, lo). Width parameter is radius of fuzzy group membership function.

Stage two: in this stage, for each pixel we will consider, 3*3 neighborhood around the center pixel P5 as follow as its clear in figure, edges appear in 4 directions.

4 directions were as d1, d2, d3, d4 and show the total amplitude changes in grey surfaces between P5 and its neighbor in4 different directions and as an example d1 are formulated as follow:

d1=|p1-p5| +|p9-p5| (Direction 1) (8)

Therefore for each pixel one 4dimensional feature vector as X= (d1, d2, d3, d4) is considered, that shows total differences amplitude at 4 directions on the neighborhood of central pixel [7][3].

Stage three:

Now by use of fuzzy categorizer, each pixel during processing is categorized in one of the each class. Six classes are used in this algorithm.

As class 0 is related to background pixels and each of 4 remained classes is related to edge pixels in one of 4 dimensions, and next class is related to noisy pixels. The center of each class is determined by use of the amount of hi, lo.the degree of each pixels membership in ith class is determined as follow:

$$\mu_i(x)=\max\left\{0,\frac{1-\|x-c_i\|^2}{w^2}\right\} \quad (9)$$

Membership function used above is going (Gaussian) membership function.

Finally maximum amount will be identified amount belonging amounts, and the pixel under process is considered as member of that class stage four: in this stage because all pixels in image were categorized in previous stage ,with considering competitive rules ,each pixel that is a member of edge classes ,was compared to its neighbor pixels in edge class in opposite direction to choose the most suitable pixel as edge. this stage results in thick edge become thin[4].

An example of these rules is as follow:

1) if X is a member of class 0(background),then ,the pixel will be white.
2) if X is a member of edge class 1 then competes to neighbor pixels at direction 3,and if it win, it will be back ended as edge ,otherwise it would be white.
3) if X is a member of class 5(noisy pixels),then the pixel would be white.

Now for each class we will determine fuzzy feature vector which including color, place position.

Fuzzy color histogram is a feature in any color image, that shows color used in an image. Human eyes see the results of different colors combinations as a unite color, but is not able to recognize percent of combined colors. But we understand accurate color of each pixel only when we analyze its color exactly and determine its different colors percents. In printing industry a method called trum is applied in which combination percents of 4 main colors, beryl (Bluish green), purple, yellow and black are used to make desired color is determined accurately. Colors variety and their clearance suggest high

accuracy of trum method for determining different colors.

So we applied trum method to determine fuzzy color histogram, for this purpose we use CNYK color space. This color space consists of four main colors, yellow, purple, beryl and black. It is clear from figure 1[color hexagon] that colors yellow, purple and beryl complete colors blue, green and red (magenta). To determine yellow, purple and beryl color amounts by means of RGB color spaces, first we should normalize color amounts in RGB space which is between 0 to 255 and then we will determine CMY color amounts from equation below:

$$\begin{bmatrix} C \\ M \\ Y \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} - \begin{bmatrix} R \\ G \\ B \end{bmatrix} \qquad (10)$$

(1)

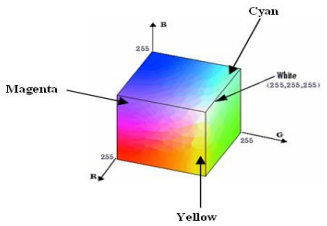
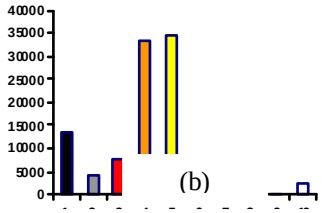


Figure1*. color hexagon*

We use tension dimension (1) in HIS color space to determine black color which include K dimension in CMYK color space. Therefore we should find color factorial vector to determine yellow, purple, beryl and black color amount percents. Then accurate color of each pixel will be determined by means of each pixel color factorial vector and fuzzy rules shown in table I. So, each pixel belongs to one of the 10 colors including black, gray (cyan), red (magenta),orange, yellow, green, beryl, blue, purple and white will be categorized. Konstantinidis suggested a method called "fuzzy color histogram in space L*a*b* in 2005. But in this method problem of extra overlapping or lack of overlapping happens in many columns of histogram, because of applying inappropriate rules and thus does not result in a suitable color histogram for image. [21]. The query image and result of trum color histogram for it are shown in figure 2. This image is representative of a group of similar images in database, histogram columns shown in figure 2 include, white, purple, blue, beryl, green, yellow, orange, red(magenta), gray(cyan) and black. In image 2b, columns 1, 4 and 5 contain more pixels in comparison to other columns. Because these 3 columns contain black [background], orange [sky] and yellow [sun].

(a)



(b)

Fig. 2.*(a) second query image, (b) Eten fuzzy color histogram*

Like equation 8 and 9, the mean of place position of pixels in each class are used as place data besides clue feature.

As this fuzzy feature vector in each image, includes color, place position. Thus suggested fuzzy similarity factor, by means of these three fuzzy features, determines degree of similarity and dissimilarity to different images accurately. Equation 17 illustrates suggested fuzzy similarity factor:

$$sim(q,t)=\sum_{i=1}^{5}\ (\frac{\sum_{j=1}^{N}\min(H_c^{q_i}(j),H_c^{t_i}(j))}{\min(\sum_{j=1}^{N}H_c^{q_i}(j),\sum_{j=1}^{N}H_c^{t_i}(j))} \quad (11)$$
$$\times(w_i)\times(1-(\sqrt{\frac{(\overline{x_{q_i}}-\overline{x_{t_i}})^2+(\overline{y_{q_i}}-\overline{y_{t_i}})^2}{2}})))$$

H (i): ith column of fuzzy color histogram
H (k): kth column of quantized fuzzy entropy histogram (edge) of query image.
X_q1,Y_q1: mean of place position of ith class of query image
W_i: degree of importance in each class.
H_i (j): jth column of fuzzy color histogram.ith class of query image.

Figure 3 . *results of retrieval for 4 query images by suggested approache in left position and compound neighborhood fuzzy entropy method with color _place feature in right position*

(in per groups ,initial image from left position is query image)

Experimental results

We used 3000 images in size of 384*236 in our tests which includes 30 different image groups from COREL database. This data base includes different kinds of image like, flower, view, house, mountains, sea, sky ,sunset, fruit, public places, and fire work. All tests were done on text software and process or 3500 and 1G memory. To measure quality of retrieval effects of suggested algorithm in this paper. Called "fuzzy edge and Trum fuzzy color histogram"3000 image from COREL database were used. 4 images were randomly selected as query and with concepts of sea, building, flower and sunset. We determined, the accuracy of results based on retrieved images by system, for each query image. The results of 11retrieved images for each query image by means of suggested method in this paper and" compound neighborhood fuzzy entropy with color place feature "method that is better than fuzzy entropy histogram method are shown in figure 3. It is clear from figure 3 that the result of suggested method in this paper is much more eligible for query, than different concepts. our suggested method in this paper have more satisfying for "flower" image. While ,compound method results in appropriate images (with less similarity Our method has better result for "building" and "sunset" queries than compound method because of uniformity of competitive fuzzy edge finder and Trum fuzzy color. Besides color and place data in image retrieval system.

Database used in this paper, contains 50 groups, and each group contains 100 images, as each group has its own concepts. We used 150 images as query, 20 images as retrieval images which retrieve by system, to compare three methods. Table 1 shows details of comparison between different groups and shows methods as mean of retrieval accuracy. Based on this table, it is clear that our suggested method in all image groups is much better than two other methods, as it increased retrieval accuracy mean to33.30 percent more than compound method and to 59.98 more than fuzzy color histogram method.

Fore determining total retrieval accuracy, we have continued tests with additional images which were retrieved by retrieval system. Figure 4 illustrates comparison of total retrieval accuracy Mean of 6 different image group based on 20 to 100 Retrieved images by system and by means of three described methods on3000 images from COREL database by means of 150 query images. It is clear in figure 4 that our suggested method for any number of retrieved images from 20 to 100 is the best methods with the highest total retrieval accuracy.Based on all tests done and processing the results ,we can say that fuzzy color histogram only consider whole distribution of colors in image and doesn't consider any place data and relative position of objects in image. which caused in low efficiency of this method.

Table1:comparison of retrieval accuracy mean for each image group by means of three described method

Group of images	Proposed	Combining(neighbor fuzzy entropy, color-spatial feature)	Fuzzy color histogram
Building	0.5467	0.4667	0.4133
Flower	0.8233	0.6867	0.4933
Sea	0.8900	0.7633	0.6 033
Horse	0.5067	0.3000	0.2367
Sunset	0.8423	0.6512	0.6123
Food	0.5067	0.3298	0.2376
Average	0.68595	0.53295	0.43275

Also in compound method, because determining edge feature, is based on quantized color amounts and is a parameter that is determined in a neighborhood around each pixel relatively, thus cannot be an accurate method for determining edge feature in images, but only considers an approximation in each image.

Conclusion

In recent years many methods have been suggested for image retrievals based on content. All of them have tried to suggest new methods for extracting efficient features and determining optimum methods for measuring similarity between images. One of the basic problems in image retrieval methods is semantic gap between systems understanding and human understanding. As if a method (process) is able to decrease this parameter more, it is more efficient. Since by fuzzy logic, the user is able to express his needs in a natural language and use it by retrieval system, it is suitable method to remove this problem as in recent years, many method were suggested in retrieval systems, based on fuzzy logic. Fuzzy color histogram and compound neighborhood fuzzy entropy method with color_placefeature are two methods based on fuzzy logic .which were suggested recently. Fuzzy color histogram because of doing retrieval process based on only color distribution in image and neighborhood fuzzy entropy method because of it's high dependence on quantized colors for determining edge feature, and because they are relative parameters, connot be suitable for image retrievals with complex place ornament.

To remove these problems and determining edge feature, efficiently we have suggested Trum fuzzy color feature in competitive fuzzy edge finder in this paper.

In this method, edge pixels their directions and background pixels are determined by means of competitive fuzzy edge finder algorithm based on asset of rules and comparison of each pixel with its neighbor pixels, effectively, and the similarity between different images will be determined b Means of color and place features extracted from each class .test results in this paper(tests on 3000 images from COREL database.)Shows high accuracy of our suggested method in retrieval process, as it has increased retrieval accuracy mean to 46.64 percent more than two other methods.

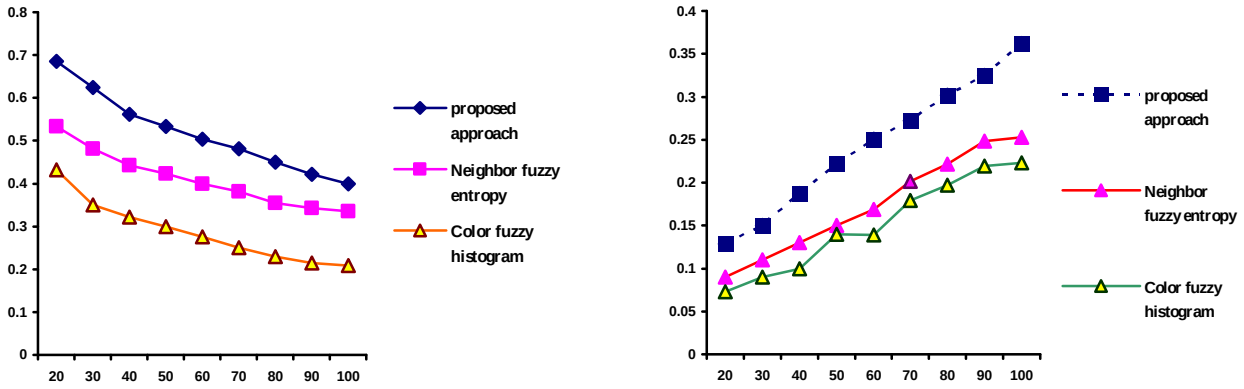


***Figure4**: comporison of total retrieval accuracy by means of different number of images retrieval by three described methods.*

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