Color, Texture and Shape Based Relevance Feedback Image Retrieval for Web Applications

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Abstract- Content Based Image Retrieval (CBIR) plays a very vital role in the retrieval of relevant images queried by a user for web applications. This paper describes an efficient Relevance Feedback (RF) mechanism for CBIR. The image retrieval is performed based on the retrieval of color, texture and shape features. The RGB input image is converted to three different color spaces like HSV, YC_bC_r and CIE Lab color spaces. The statistical color features such as mean, variance and skewness are extracted from the above color space. The local texture information from each pixel determines the fuzzy texture unit. The shape feature is obtained through the segmentation process. Then these feature dimensions such as 'color-27', 'texture- 2020', and 'shape- 128' are combined to form feature vector. This feature vector of the query image is compared with the feature vector of the images in the Benchmark databases such as General database, Medical database, Berkeley databases, COREL database and COIL database using Euclidean distance. Finally RF is incorporated to improve the accuracy of the image retrieval. Results have proved that the Precision and Recall are much improved through the increase of iteration of RF.

Keywords: Color feature, Texture feature, Shape feature and Relevance Feedback

I. Introduction

CBIR systems retrieve the relevant images in the database using visual content of images, color, texture, shape and so on. The CBIR system so called iPURE (intra-query Perceptual and User-friendly Retrieval) proposed by Gaurav aggarwal et al [6] incorporates a novel methodology of intra-query modification and learning of user perception at the client-site in addition to RF in successive iteration. All these approaches (color, texture or shape based) can perform well when applied to a specific type of data set. They produce poor results across the datasets or when different datasets are used. By integrating these three distinct features of the image may produce better results across data sets [4]. Features from color, texture and shape properties are extracted and fused before comparison for retrieval of images with the image database. The paper attempts to bridge the lacuna between the descriptors of the query image and the database.

II. Methodology

The entire system operates in three phases. In the first phase, the features are extracted from the query image. In the second phase, based on the feature extracted the similarity is measured between the descriptors of the query image and the images in the database, to retrieve similar images posted against the query image. In the third phase, RF mechanism with user interaction is adopted to improve the retrieval performance.

A. Color Descriptors Based on Color Spaces

Color is a widely used important feature for image representation. First the entire query image is converted into Hue, Saturation, Value (HSV color space), YC_bC_r and Luminance, Chrominance (Lab color space) color spaces. Then the mean, variance and skewness of each color space is calculated to represent a color feature vector of H,S,V, Y,C_b,C_r and Lab. Finally 27-dimensional color vector is obtained for the entire image by concatenating the mean, variance and skewness feature vector of different color spaces. These statistical features are calculated based on an overlapped window size of 3x3.

B. Texture Descriptors Based on Texture Spectrum Method

Texture is another important property of images. Textures are represented by texels. The identification of texture spectrum in an image is achieved by the extraction of local texture information for each pixel[1]. The local texture information for a pixel can be extracted from a neighborhood of 3x3 pixels, which represents the smallest complete unit (in the sense of having eight directions surrounding the pixel). A neighborhood of 3x3 pixels is denoted by a set containing nine elements: $V = \{V_0, V_1, V_2, \ldots .V_8\}$ where V_0 represents the intensity value of the central pixel and $V_i (1 \leq i \leq 8)$ the intensity value of each neighboring pixel. Then the corresponding Texture Unit can be represented by $TU = \{E_1, E_2, \ldots .E_8\}$,

$$Where E_i = \begin{Bmatrix} 0 & if V_i < V_0 and V_i \leq X \\ 1 & if V_i < V_0 and V_i > X \\ 2 & V_i = V_0 for i = 1,2, \ldots 8 \\ 3 & if V_i > V_0 and V_i \leq Y \\ 4 & if V_i > V_0 and V_i > Y \end{Bmatrix}$$

Where x, y, are user-specified values?

The texture information can be calculated using $N_{TU} = \sum_{i=1}^{8} Ei * 5^{\left(\frac{i-1}{2}\right)}$. The N_{TU} reaches the Maximum value of 2020 for E_i=4. Texture descriptor is represented by 2020 dimensional texture vector.

C. Edge Descriptors Based on Canny Operator

Shape feature is obtained by segmentation process such as Improved Adaptive Kernelized Fuzzy C Means clustering (IAKFCM) strategy.

Algorithm (IAKFCM)

Step 1: Initialize g_i with i (i=1,...,N) and cluster centers c_k (k=1,...,NC) with random values within the image intensity, where NC is the number of clusters.

Step 2: Update the membership function U_{ik} by using the following expression

$$U_{ik} = \frac{\|K(y_i, g_i c_k)\|^{\frac{2}{q-1}}}{\sum_{i=1}^{NC} [K(y_i, g_i c_l)]^{\frac{1}{q-1}}}$$

Step 3: Update the cluster centers c_k by using the following expression

$$c_k = \frac{\sum_{i \varepsilon D} U_{ik}{}^q G_i y_i}{\sum_{i \varepsilon D} U_{ik}{}^q G_i^2} X g_i \sum_{k=1}^{NC} U_{ik}{}^q \langle c_k, c_k \rangle - \sum_{k=1}^{NC} U_{ik}{}^q \langle y_i, c_k \rangle + \frac{\lambda}{N} \sum_{i \varepsilon D} \{(g_i - (g_i - (H * g)_i))\} = 0$$

Step 4: Calculate the gain field g_i by using the following expression

$$g_i = \frac{\sum_{k=1}^{NC} U_{ik}{}^q \langle y_i, c_k \rangle}{\sum_{k=1}^{NC} U_{ik}{}^q \langle c_k, c_k \rangle}$$

Step 5: Update the gain field g_i by using the following expression

$$g_i = (H * g)_i , i \varepsilon D$$

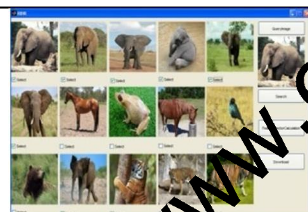
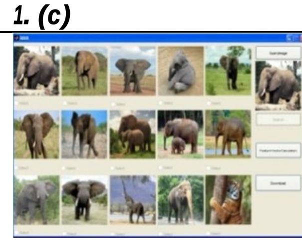
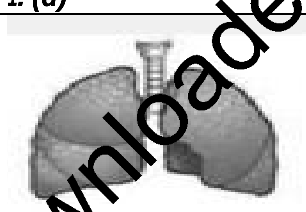
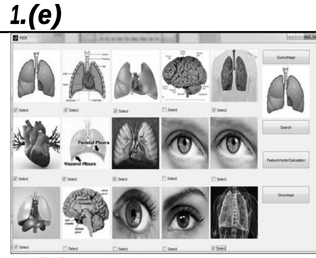
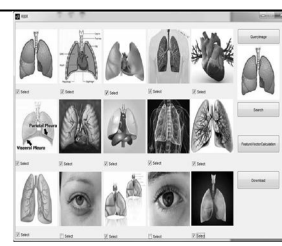
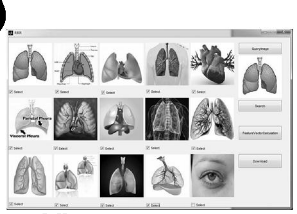
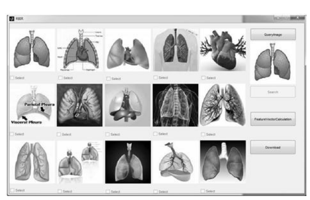
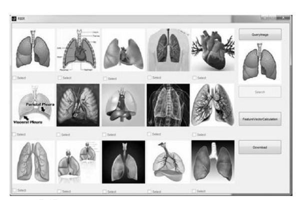
If the maximum change of U_{ik}< tolerance U and the maximum change of g_i <tolerance G break. Otherwise go to step 2.Shape information is obtained from the edge of the segmented image. Edge of an image constitutes the content of the image. The edge information contained in the image is generated by using the canny operator. Then the histogram of the edge points in the image is calculated. Finally, a 128-dimensional feature vector by normalizing the histogram is generated.

D. Color, Texture and Shape based Feature Vector Generation

Image retrieval is done based on the combination of color (LAB, YC_bC_r and HSV), texture and shape features. A set of mean, variance and skewness of the three different color spaces, fuzzy spectrum unit and edge of the segmented image are used as a feature vector in CBIR. When the query color image is given as input to the system, color, texture and shape features are extracted. Similarity measure calculates the distance between a query image and images in a database. In this paper Euclidean distance is used as similarity measure. The goal is to select the n best images that resemble the query image. This involves the selection of n top-matched images by measuring the distance between the query image and the image in database. In this work, Euclidean distance is used as similarity measure

E. Relevance Feedback

The concept of RF was introduced into CBIR from text-based information retrieval in the 1990s and has become a popular technique in CBIR [5]. Figure 1 shows the retrieved results of 'Elephant' query when posted to the database. It shows the 10 best matched images out of 15 displayed before applying RF with the query image displayed in the top-right corner. It is observed that some retrieved images are similar to the query in terms of its feature extraction. However this method gives about 47% precision in the first iteration. RF that had been introduced into the image retrieval system adjusts the search automatically according to the user's RF with preceding retrieval result. It is a very effective mechanism and has shown significant improvement in the retrieval results within few iteration. Figure 1.f shows the improvement of retrieval after 5 iterations. Further, it is observed that when subject to five iterations the performance has been increased to 93% precision level. Figure 1(a)-1(f) shows the retrieval results when Elephant', 'Lung',' Woman' 'Dinosaur' and 'Tomato' query from the General , Medical,Berkeley, COREL and COIL database are posted. This system improves the retrieval performance in successive iterations of RF as compared to existing algorithms.

 ***1.(a)***	 ***1.(b)***	 ***1. (c)***
 ***1. (d)***	 ***1.(e)***	 ***1.(f)***
 ***2.(a)***	 ***2.(b)***	 ***2. (c)***
 ***2. (d)***	 ***2.(e)***	 ***2.(f)***

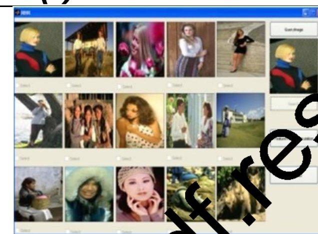

3.(a)


3.(b)

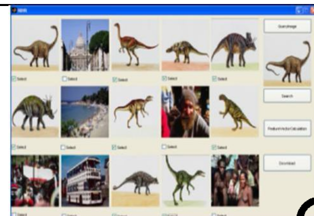

3. (c)


3.(d)


3.(e)


3.(f)


4.(a)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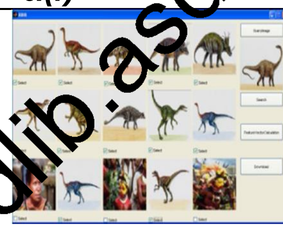
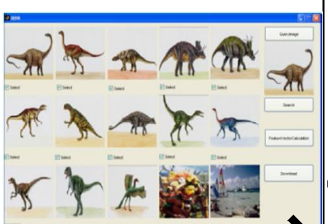
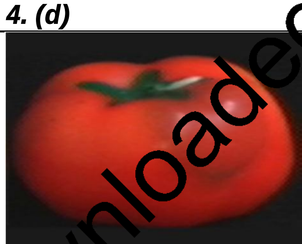
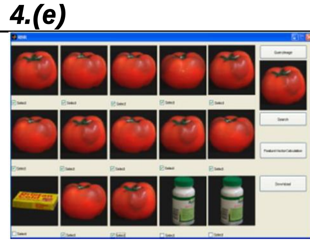

4. (c)

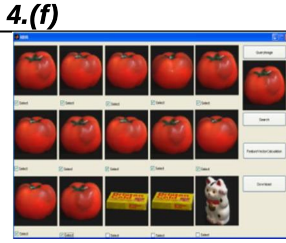

4. (d)

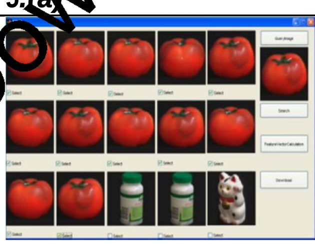

4.(e)

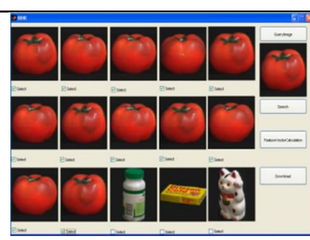

4.(f)


5.(a)


5.(b)


5.(c)


5.(d)


5.(e)

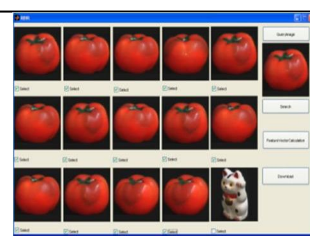

5.(f)

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Figure 1 Top 15 retrieved images obtained by retrieving 'Elephant', 'Lung',' Woman' ,'Dinosaur' and 'Tomato' query from the General , Medical,Berkeley, COREL and COIL database. (a) Query Image, (b) iteration 1, (c) iteration 2, (d) iteration 3, (e) iteration 4, (f) iteration 5

III. Performance Measure

Performance analyses were done for over a total of 1200 images from the General, Medical, Berkeley COREL and COIL database. For each query, the top 15 images were retrieved to provide necessary RF. Five iterations of feedback are recorded. Precison and Recall are the standard performance measures are used in Information Retrieval .It is observed that this method has shown 93 percentage in the precision value where 15 images are returned during the retrieval process.

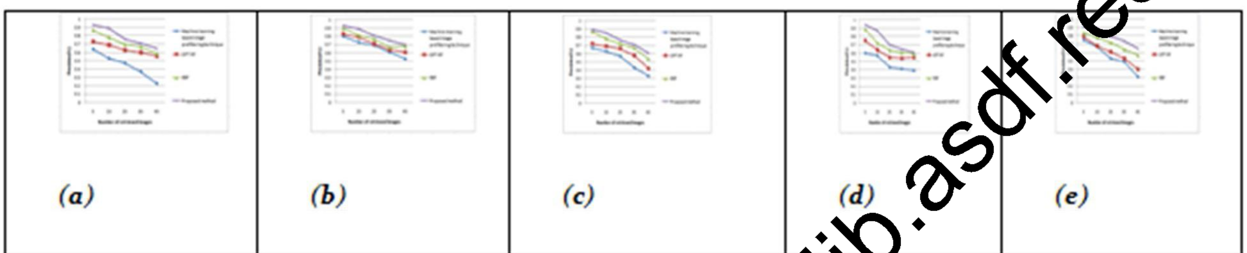

Figure 2 Comparison of Average precision (General database) versus different number of retrieved images for the four models a) General database,b) Medical database, c)Berkeley database d) COREL database e) COIL database

The proposed method has a better performance when compare to that of OPT-RF, RBF [2] and Machine learning based image pre-filtering technique [3]. OPT-RF and RBF deal with the retrieval of the image based on color, texture and shape. Machine learning technique consists of machine learning methods for image prefiltering, similarity matching using statistical distance measures and a RF scheme. For retrieval purposes color features, texture features and to represent the shape feature on a global level a histogram of edge direction is constructed. But the proposed technique deals with statistical color features, texture spectrum and shape. These features increase the performance of the retrieval system. The average precision for Benchmark database versus different number of retrieved images for the four models is shown in figure 2. The results show that the proposed method achieves better performance than other existing methods.

IV. Conclusion

In this paper color, texture, shape and pattern feature based RF image retrieval is proposed. The color feature (27), texture feature (2020) and shape feature (128) are extracted from an input image to form feature vector and is compared with query feature vector using Euclidean distance. Finally, RF mechanism is incorporated to increase the performance of the image retrieval. However increase in the iterations will certainly improve the retrieval results with high precision. Also this work has to be evaluated for robustness on various databases.

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