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Content Based Image Retrieval using User Interaction

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Abstract: ***Due to the enormous increase in image database size as well as its vast deployment in various applications the need of Content Based Image retrieval (CBIR)systems becomes an crucial part of today's cutting edge technology. In this paper we have proposed a CBIR system using color and texture feature. To reduce the semantic gap between the low level feature and high level semantics, relevance feedback mechanisms have been applied to the system. In most existing CBIR systems the current RF techniques still lack satisfactory user interaction to improve the search accuracy and interaction as well. In this paper, we proposed a user interaction model using Support Vector Machine. Experimental results show that our system gives improved results as compared to other systems available in the literature.***

Keywords: Content Based Image Retrieval, GLCM, HSV, Semantic Gap, SVM, Relevance feedback, User Interaction

1. INTRODUCTION

In this modern age the need for Content-Based Image Retrieval has increased enormously in many application areas such as military, biomedicine, education, commerce hospitals, crime prevention, engineering, architecture, journalism, fashion, graphic design, web image classification and searching methods. Currently an important research topic includes two things such as effective and rapid searching for desired images from large database. An image database is a system where images data are integrated and stored. In a small collection of images simple browsing can identify an image but this is not the case for large and varied collection of images where the user faces the image retrieval problem. To overcome this drawback Text base and Content base are the two techniques adopted for search and retrieval in an image database.

In Text based retrieval images are indexed using keywords, subject headings which are used as retrieval keys during search. Text descriptions are sometime subjective and incomplete because they cannot depict complicated image feature very well. Also it is non-standardized because different users employ different keyword for annotation. To overcome this drawback Content-based Image Retrieval (CBIR) technology is used. It makes full use of image content features such as color, texture, shape, etc, to search and retrieve digital images. The main challenge for Content Based Image Retrieval is the semantic gap that is the gap between low level features and high level semantics. In order to reduce the gap between low level features and high level concepts, relevance feedback was used into CBIR systems. This Relevance Feedback bridges the semantic gap and also improves the accuracy of retrieval.

2. RELATED WORK

Recently many image retrieval search engines have been developed such as in the commercial domain, QBIC [1] is one of the earliest systems. Virages VIR search engine [2] and Bell laboratory WALRUS [3]. In academic domain, MIT [4] photobook is one of the earliest systems. Columbia visualseek and webseek [5], Netra [6] are some of the recent well known systems. Some of the existing CBIR systems extract features from the whole image not from certain regions in it these features are referred as global features. Region based retrieval systems overcome the defects of global feature based search by representing images at the object level. This system applies image segmentation to decompose an image into regions, which correspond to object. Ivan lee, et.al. [7] Present the analysis of the CBIR system with human controlled and machine controlled Relevance feed-back, over different network topologies. Zhao Grosky [8] views that bridging the semantic gap between the low-level features and the high-level semantics is within the interface between the user and the system. The performance of the retrieval systems is usually improved by user interaction mechanisms. The goal is to adjust the system parameters in order to achieve a better search in the image database.

The rest of the paper is organized as follows: Section 3 describes Proposed System Architecture, Section 4 describes

Feature Extraction, Section 5 describes User Interaction using Support Vector Machine to improve the retrieval result, Section 6 gives Experimental Results and section 7 concludes work and future scope

3. PROPOSED SYSTEM

3.1 System Architecture

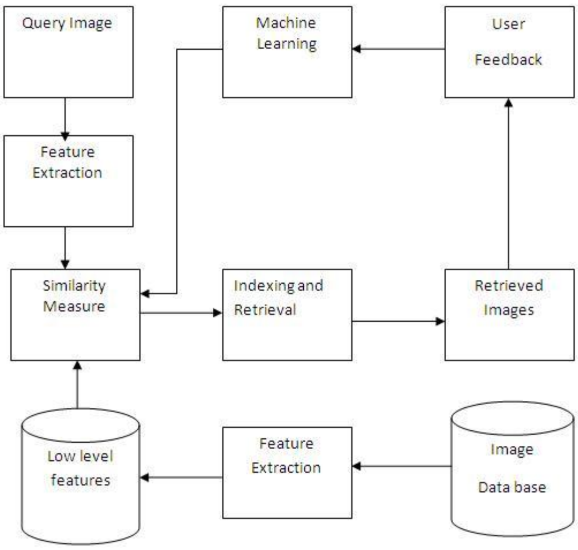

Figure 1: CBIR system architecture

Figure 1 shows the architecture of CBIR system using Relevance Feedback. To retrieve the image from the database, we first extract low level feature vectors from images (the features may be shape, color, texture etc), then store these feature vectors into another database for future use. When given query image, we similarly extract its feature vectors, and match those features with database image features. If the distance between two images feature vectors is small enough; we consider the corresponding image in the database similar to the query.

The retrieved image features are then indexed according to their minimum Euclidean distance and hence retrieved results gets displayed. User provides feedback whether retrieved images are relevant or non-relevant with query image. The basic idea of User feedback is to find out the right query formulation from the user to the system If the results are non-relevant then feedback loop is repeated many times until the user is satisfied. With this relevant or positive feedback the machine learning algorithm is used for better accuracy of result.

3.2 Proposed System Algorithm

The steps of proposed CBIR algorithm are as follows.

1. Color and Texture feature extraction for the database images has been carried out which consisting of M images.
2. Then query image is submitted to system, system gives initial retrieval images.
3. Then user submits his feedback by marking which images are relevant one and which are not.
4. This feedback is given to SVM. Then SVM learns this feedback and modify the output. Repeat steps 2-4 until user satisfies with retrieval results.

4. FEATURE EXTRACTION

Feature extraction is nothing but extracting the meaningful information from the images. Because of this it required the less storage and hence the system becomes faster and effective in CBIR. Once the features are extracted, they are stored in another database for future use. In this work two low level features are used Color and Texture.

4.1 Color Feature Extraction- HSV Color Space

One of the popular color feature extraction is color histogram in terms of color space. The available color spaces are RGB color space and HSV color space. In this paper the HSV color space is used. The advantage of HSV color space is that it is closer to human conceptual understanding of colors and has the ability to separate chromatic and achromatic components. Hue, Saturation, Value or HSV is a color model that describes colors (hue or tint) in terms of their shade (saturation or amount of gray) and their brightness (value or luminance). HSV color space is widely used in computer graphics, visualization in scientific computing and other fields. In this color space, hue is used to discriminate colors, saturation is the percentage of white light added to a pure color and value refers to the apparent light intensity. Hue ranges from 0-360 deg. Saturation ranges from 0 to 100%. In this paper saturation and value are presenting in range 0 to 255[10].

For a large range of each component, if we directly calculate the characteristics for retrieval, then computation will be very difficult to ensure rapid retrieval. It is essential to know HSV space component to decrease computation and improve efficiency. At the same point, because the human eye to distinguish colors is limited, do not need to calculate all segments. Uneven interval quantization according the human color perception has been applied on H, S, V components. Based on the color model of substantial analysis, we divide color into eight parts [10]. Saturation and intensity is divided into three parts separately in accordance with the human eyes to distinguish. In accordance with different colors and subjective color perception quantification, quantified hue (H), saturation (S) and value (V) are showed as equation (3).

In accordance with the quantization level above, the H, S, V three-dimensional feature vector for different values of with different weight to form one-dimensional feature vector named G [10]:

$$G = Q_s Q_v H + Q_v S + V \qquad (1)$$

Where QS is quantified series of S, QV is quantified Series of V.
Here we set $QS = QV = 3$, then

$$G = 9H+3S+V \qquad (2)$$

$$H = \begin{cases} 0 \text{ if } h \in [316,20] \\ 1 \text{ if } h \in [21,40] \\ 2 \text{ if } h \in [41,75] \\ 3 \text{ if } h \in [76,155] \\ 4 \text{ if } h \in [156,190] \\ 5 \text{ if } h \in [191,270] \\ 6 \text{ if } h \in [271,295] \\ 7 \text{ if } h \in [296,315] \end{cases} \quad S = \begin{cases} 0 \text{ if } s \in [0,0.2] \\ 1 \text{ if } s \in [0.2, 0.7] \\ 2 \text{ if } s \in [0.7,1] \end{cases} \quad V = \begin{cases} 0 \text{ if } v \in [0,0.2] \\ 1 \text{ if } v \in [0.2,0.7] \\ 2 \text{ if } v \in [0.7,1] \end{cases} \qquad (3)$$

Thus, three-component vector of HSV form one-dimensional vector, which quantize the whole color space for the 72 kinds of main colors. So we can handle 72 bins of one dimensional histogram. This reducing the computational time and complexity.

4.2 Texture feature extraction – Grey level Co-occurrence matrix

Texture feature is one of the visual patterns which differentiate between two similar color images. There are three methods to extract the Texture feature such as Tamura matrix, Co-occurrence matrix and wavelet transform. In this paper we using co-occurrence matrix. Co-occurrence matrix which is one of the traditional technique for encoding texture information. It describes spatial relationship among gray levels in a image. A cell is define by position (x,y), in this matrix registers, the probability at which two pixels of gray levels x and y occur in two relative positions. A set of co-occurrence probabilities such as energy, contrast, entropy and inverse difference characterize Texture feature. [10]

$$\text{Energy} = \sum_x \sum_y p(x,y)^2 \qquad (4)$$

Where p(x, y) is the gray-level value at the coordinate (x, y). Energy gives information about the image gray-scale uniformity of weight and texture. Also it is a gray-scale image texture measure of Homogeneity changing

$$\text{Contrast} = \sum\sum (x-y)^2 p(x,y) \qquad (5)$$

Contrast which measure the value of the matrix and images of local changes in number, gives the image clarity and texture of shadow depth. Contrast is large means texture is deeper.

$$\text{Entropy } S = -\sum_x \sum_y p(x,y) \log p(x,y) \qquad (6)$$

Entropy measures image texture randomness, when the Space co-occurrence matrix for all values are equal, it Achieved the minimum value; and vice versa. Therefore, the maximum entropy implied by the image gray distribution is random.

$$\text{Inverse difference } H = \sum_x \sum_y \frac{1}{1+(x-y)^2} p(x,y) \qquad (7)$$

It is also called as homogeneity, which measures local changes in image texture number. Here p(x, y) is the gray-level value at the coordinate (x, y).

5. USER FEEDBACK

User feedback is a powerful technique in CBIR systems, in order to improve the performance of CBIR effectively. It is an open research area to the researcher to reduce the semantic gap between low-level features and high level concepts. The concept of user feedback was introduced into CBIR in the 1998's and then has become a popular technique in CBIR.

Relevance Feedback is an interactive process between the user and the retrieval system. In each RF round, the user assesses the previously retrieved images as relevant or irrelevant to the initial query and provides this assessment as feedback to the system. This feedback is used, subsequently, by the system so that the ranking criterion is updated and a new set of images is retrieved. In this way, the retrieval results are expected to improve, according to the user's viewpoint, with the RF rounds.

To learned the User feedback for better accuracy of result there are so many techniques used. In this paper we proposed the system which uses Support Vector Machine to learn the user feedback

5.1 Support Vector Machine

Support Vector Machines (SVMs) are supervised learning methods used for image classification. It views the given image database as two sets of vectors in an ' n ' dimensional space and constructs a separating hyper plane that maximizes the margin between the images relevant to query and the images not relevant to the query. SVM is a kernel method and the kernel function used in SVM is very crucial in determining the performance. The basic principle of SVMs is a maximum margin classifier. Using the kernel methods, the data can be first implicitly mapped to a high dimensional kernel space. The maximum margin classifier is determined in the kernel space and the corresponding decision function in the original space can be non-linear. The non-linear data in the feature space is classified into linear data in kernel space by the SVMs. The aim of SVM classification method is to find an optimal hyper plane separating relevant and irrelevant vectors by maximizing the size of the margin (between both classes) [11], [12].

The kernel function is used when we want to add implicitly a new data point on feature space. In this paper the linear kernel used which is dot product of the new data point feature vector and support vector. Default value for this kernel is 1. The types of kernels are Polynomial kernel and Gaussian kernel.

6. EXPERIMENTAL RESULTS

In this paper, experimental data set contains 1000 images with bitmap file extension and these 1000 images contain 10 categories of images. The color feature extraction is done using Color histogram in HSV color space and Texture feature extraction is done using co-occurrence matrix. Co occurrence matrix which is set of probabilities such as Energy, Contrast, Entropy and Inverse Difference.

6.1 Evaluation parameter

To calculate the performance of the system, the evaluation parameters Precision (P) and Recall (R) are used. Precision and recall are the basic measures used in evaluating search strategies.

6.1.1 Precision

Precision is the ratio of the number of relevant records retrieved to the total number of irrelevant and relevant records retrieved. It is usually expressed as a percentage. In the field of information retrieval, precision is the fraction of retrieved documents that are relevant to find:

$$P = r/n1$$

Where,
r - Number of relevant images
n1- Number of retrieved images

6.1.2 Recall

Recall is the ratio of the number of relevant records retrieved to the total number of relevant records in the database. It is usually expressed as a percent-age. Recall in information retrieval is the fraction of the documents that are relevant to the query that are successfully retrieved.

$$R = r/n2$$

Where,
r - Number of relevant images
n2- Total number of relevant images in database.

6.2 System Implementation

The image database used in this system is consisting of 1000 images. The database images consist of 10 different categories of bitmap files (.bmp files). The whole system is implemented using MATLAB software. After the implementation of the system the GUI is designed for the system.

The Feature Extraction is done using Color and Texture low level features. For Color feature the proposed system uses Color Histogram in HSV Color space. The concept of HSV color space is explained in detailed in Chapter 4. The combination of using Color and Texture gives better retrieval results instead of using single feature. The following figure shows GUI for proposed system retrieval result without feedback. The test is done on 1000 Corel database images in .bmp format file.

For Zeroth feedback iteration Precision = 20%

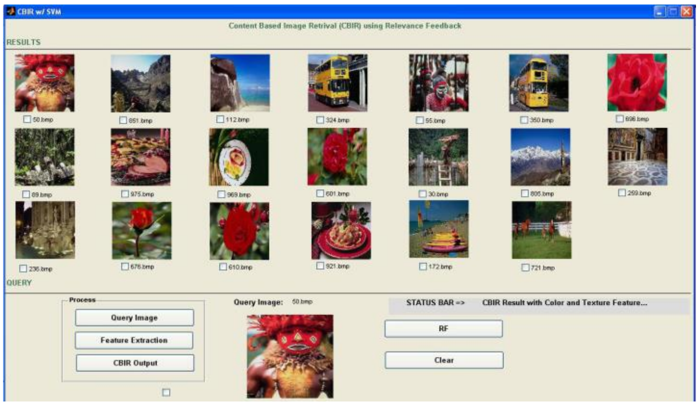

Figure 2: CBIR retrieval results using Color and Texture features

User feedback which is powerful technique to reduce the semantic gap between low level features and high level semantics. The algorithm uses in proposed system is Support Vector Machine which is explained in detailed in Chapter 6. The following shows retrieval results with user feedback. The figure 7.4 shows proposed system retrieval results with feedback - First Iteration. Thus results get improved by number of iterations using SVM-RF proposed algorithm.

For first iteration, Precision with user feedback = 45%
For second iteration, Precision with user feedback = 65%
For fifth iteration, Precision with user feedback = 85%

For first feedback iteration Precision = 45%

Figure 3: Proposed system retrieval results with feedback first iteration

For Second feedback iteration Precision = 65%

Figure 4: Proposed system retrieval results with feedback second iteration

Likewise for third, fourth, fifth iteration the precision get improves till 85% for 50.bmp image.

The following Table 7.1 shows the precision and recall result calculated for 4 test images with and without feedback for Proposed System. Figure 8.1 shows the Comparison of graph representation of the recorded result for SVM-RF and Semi BMMASVM [13].

Table 1: Precision (%) and Recall (%)

	Precision Recall w/o feedback		Precision Recall after first iteration		Precision Recall after Nth ite		
Query Image	Precision (%)	Recall (%)	Precision (%)	Recall (%)	N	Precision (%)	Rec
Mountain 805.bmp	5	1	50	10	4	80	
African people 50.bmp	10	2	45	9	5	85	
Elephant 523.bmp	65	13	80	16	6	85	
Flower 663.bmp	90	18	90	18	2	95	

Table 2: Precision comparision table

Approach	Ite 0	Ite 1	Ite 2	Ite 3	Ite 4	Ite 5	Ite 6
SVMRF	10	45	65	70	70	85	85
Semi BMMA SVM	21	40	55	68	72	78	81

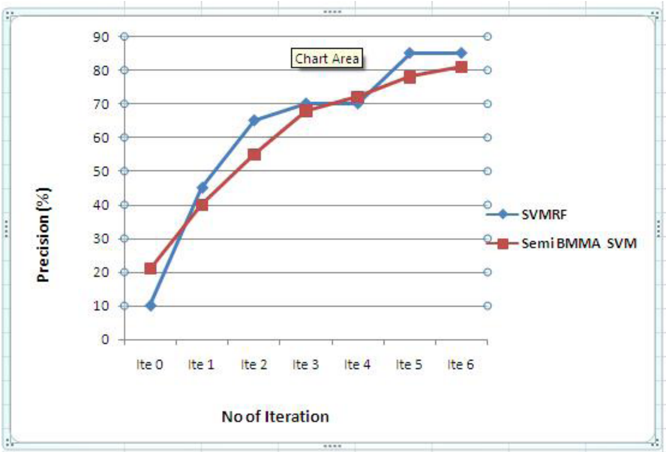

Figure 5: Precision Graph Comparison

7. Conclusion

In this work, we proposed a relevance feedback based on SVM learning method to retrieve images according to the user preference. This proposed method has been used to support the learning process to reduce the semantic gap between the user and the CBIR system. The experimental result shows that the proposed method achieved the best performance when it compare with Semi BMMA SVM [13] Method.

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