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Image Retrieval By Reducing The Semantic Gap Problem

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Abstract— Content Based Image Retrieval (CBIR) perform search based on the image contents like Color, Texture and Shape. Though so many query techniques have been implemented in CBIR semantic gap is a major problem. This paper uses the Query By Example (QBE) and Semantic Retrieval (SR) techniques of CBIR to overcome the semantic gap problem. In this paper for QBE the color features of the query image is extracted and is compared with the features stored in the database. In SR the database is searched by giving a keyword as search criteria. The retrieved images from the QBE and the SR is directed to the QUTIC block which will compare the features of the images passed from the QBE with the images of SR. Then the images that best match the query will be shown as the final retrieved images.

Keywords— Content based Image Retrieval, Semantic Retrieval, Query by example, Cosine Distance, Colour histogram, Euclidean distance.

I. INTRODUCTION

The field of image retrieval has been an active research area for several decades and has been paid more and more attention in recent years as a result of the dramatic and fast increase in the volume of digital images. One approach for indexing and retrieving images is using manual text annotations. The annotation is then used to search images indirectly. There are several problems with this approach. First, it is very difficult to describe the contents of an image using only a few keywords. Second, the manual annotation process is subjective. Those problems have created great demands for automatic and effective techniques for Content Based Image Retrieval (CBIR) systems. Most CBIR systems use low-level image features such as color, texture, shape, edge, etc., for image indexing and retrieval. In this paper color information is used as the searching feature in QBE block. The color features are extracted using the color histogram technique. The features of the images in the database are extracted and are stored in a separate folder. In QBE the database is searched by giving an image as a input. In QBE block the feature of the query image is extracted and is compared with the features in the database images and the similarity between the query image and the database images is calculated using cosine distance metric. Finally the image that has best matching with the query image will be ranked first followed by other images based on the distance metric. This type of retrieving will lead to the semantic gap problem. To overcome from that problem Semantic Retrieval technique is used. The images (totally 1000 images) in the database are clustered into several groups based on its features and the clustered images are assigned keyword in the SR block. Then the search is performed by giving keyword as a input in the SR block the output will be the images related to the keyword given. Then the retrieved images of the QBE block and the SR block are forwarded to the QUTIC block. In this block the color feature of the images of QBE block is extracted and is compared with the color features of the images forwarded from the SR block and finally the images that best match with each other are retrieved as the final output images. Figure below shows the overall CBIR system.

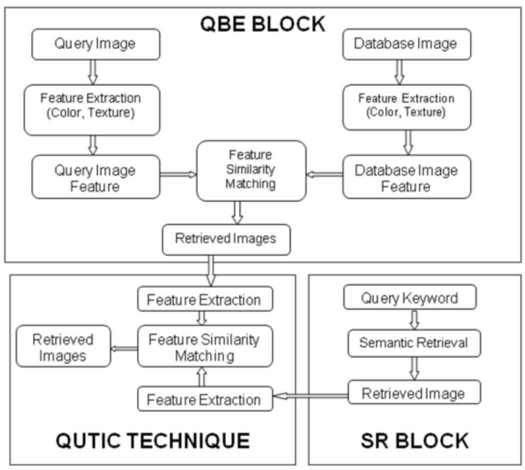

Fig. 1 CBIR SYSTEM

II. EXISTING WORK

Over the last few years the need for retrieving images has been increased. The traditional methods of image indexing have not been sufficient, thus interest has focused on methods of retrieving images based on features such as color texture and shape that is the CBIR approach. The images can be searched by specifying the colors in some assigned proportions [1]. The database can also be searched based on the regions of color in the image by specifying the query [2] [3] as find images containing regions of color Red/Rose/Black and etc., The color histogram used in [4] will compute the Color histograms, which is represented as set of bins where each bin denotes the probability of pixels in the image being of a particular color. Apart from the conventional color histogram there are others techniques too which is used for color feature extraction of the image, that includes Fuzzy Color Histogram [5], A single histogram doesn't give robust result in the presence of a large database images as different images may have same histogram. The reason for this is that histogram doesn't consider the spatial information of images. Multiresoultion [6] histogram instead of single histogram can be used to resolve the problem described above. The database used in this paper includes the images from various fields as shown below.

Fig. 2 CBIR database

III.COLOR FEATUER EXTRACTION

One of the most important features that make possible the recognition of images by humans is color. Color is a property that depends on the reflection of light to the eye and the processing of that information in the brain. Colors are commonly defined in three-dimensional color spaces such as RGB, CMY, YIQ, HSV and etc., The HSV color space is a popular choice for manipulating color [7]][8][9][10]. The HSV color space is developed to provide an intuitive representation of color and to approximate the way in which humans perceive and manipulate color. RGB to HSV is a nonlinear, but reversible, transformation. The hue (H) represents the dominant spectral component color in its pure form, as in green, red, or yellow. Adding white to the pure color changes the color: the less white, the more saturated the color is. This corresponds to the saturation (S). The value (V) corresponds to the brightness of color. HSV color space is a hexacone, where the central vertical axis represents the Intensity [9]. Hue is defined as an angle in the range $[0,2\pi]$ relative to the Red axis with red at angle 0, green at $2\pi/3$, blue at $4\pi/3$ and red again at 2π. Saturation is the depth or purity of the color and is measured as a radial distance from the central axis with value between 0 at the centre to 1 at the outer surface. For S=0, as one moves higher along the Intensity axis, one goes from Black to White through various shades of gray. In this paper RGB image is converted into HSV image and the color features of the image is extracted. The common approach used for representing color information of images in CBIR system is through color histograms. A color histogram is a type of bar graph, where each bar represents a particular color of the color space being used. HSV color space can be partitioned as shown in table below

TABLE I
PARTITIONING OF HSV COLOR SPACE

Total No. of bins	H	S	V
16	4	2	2
32	8	2	2
34	8	2	4
128	8	4	4
256	16	4	4

In this paper HSV color space is quantized into 256 bins which include 16 levels in H, 4 levels in S and 4 in V. The bin values truncated to 4 bit values. These bin values are used for similarity matching.

IV.EDGE HISTOGRAM EXTRACTION

Edge histogram is an efficient technique for best image matching. In this paper apart from the color histogram edge histogram of the image is evaluated and is compared to measure the similarity ratio. Edge histogram descriptor is defined using five edge types such as four directional edges and a non directional edge. Four directional edges include vertical, horizontal, 45 degree, and 135 degree diagonal edges. These directional edges are extracted from the image-blocks. If the image-block contains an arbitrary edge without any directionality, then it is classified as a non-directional edge.

A. Edge Identifications and Localization

D The input image of size 256x256 is divided into 8 sub images of size 32x32 each. The sub image is further divided into small image blocks. The size of the image block depends on the image size and is calculated using the equation shown below

$$X=\sqrt{w*h}/n$$

where 'w' represent image width, 'h' specifies image height and n denotes the desired number of blocks. Then the block size is calculated as follows

$$block\_size = \frac{x}{2}*2$$

the image block is further subdivided into 4 sub blocks and the mean value of each block is obtained. The mean values are convolved with the filter coefficients given below.

Vertical edge filter	= [1 -1 1 -1]
Horizontal edge filter	= [1 1 -1 -1]
Directional 45 degree filter	= [√2 0 0 -√2]
Directional 135 degree filter	= [0 √2 -√2 0]
Non-directional edge filter	= [2 -2 -2 2]

Using these filter coefficients the directional edge strengths are obtained using the equations shown below. Among the calculated five directional edge strengths for five edge types, if the maximum of them is greater than a thresholding value (Th_{edge}), then we accept that the block has the corresponding edge type.

$$ver\_edge\_stg(i,j) = \sum_{k=0}^{3} |A_k(i,j)*ver\_edge\_filter(k)|$$

$$hor\_edge\_stg(i,j) = \sum_{k=0}^{3} |A_k(i,j)*hor\_edge\_filter(k)|$$

$$d45\_edge\_stg(i,j) = \sum_{k=0}^{3} |A_k(i,j)*d45\_edge\_filter(k)|$$

$$d90\_edge\_stg(i,j) = \sum_{k=0}^{3} |A_k(i,j)*d90\_edge\_filter(k)|$$

$$nond\_edge\_stg(i,j) = \sum_{k=0}^{3} |A_k(i,j)*nond\_edge\_filt(k)|$$

V. SIMILARITY MATCHING

The most common method for comparing two images in content based image retrieval (typically an example image and an image from the database) is using an image distance measure. In this paper cosine distance and euclidean distance metrics are used to measure the similarity between the query image and the database images. For calculating the cosine distance consider two vectors A and B where $A=(a_1,a_2,a_3....a_n)$ and $B=(b_1,b_2,b_3...b_n)$ then cosθ may be considered as the cosine of the vector angle between X and Y in n dimension and is defined as follows

$$\cos\theta = \frac{\sum_{i=1}^{n} A_i \times B_i}{\sqrt{\sum_{i=1}^{n} (A_i)^2} \times \sqrt{\sum_{i=1}^{n} (B_i)^2}}$$

The value ranges from -1 to 1 so in order to normalize the values in between the range of [0,1] angular similarity is calculated using the angle measured using the above equation.

$$Dist = (2 * \cos^{-1}(\cos\theta))/\pi$$

Dist provides the value of distance measure between the query image and the images in the database. Once the cosine distance has been calculated then the euclidean distance between the query image and the images in the database is calculated using the equation given below

$$d = \sqrt{\sum_{i=1}^{n} (x_i - y_i)^2}$$

where X and Y represent the feature vectors of query image and database image and 'd' the distance between the vectors. After the distance has been measured then the result is sorted in increasing order (the image that best match with the query image is ranked first followed by the other images) as shown in table1.

VI. SEMANTIC RETRIEVAL

In Semantic Retrieval the database is clustered into various clusters and is assigned keywords. And in this module the search is done by giving keyword as a input. The images in the database are clustered into separate group using K-Means clustering based on the color features of the image. In K-Means clustering, a centroid vector is computed for every cluster. This centroid vector is chosen to minimize the sum of within-cluster distances. K-Means algorithm [13] is an unsupervised clustering algorithm that classifies the input data points into multiple classes based on their inherent distance from each other. K-Means algorithm is given as follows.

1. For a given cluster assignment C of the data points, compute the cluster means m_k:

$$m_k = \frac{\sum_{i:C(i)=k} x_i}{N_k},\ k = 1, \ldots, K.$$

2. For a current set of cluster means, assign each observation as:

$$C(i) = \arg\min_{1 \le k \le K} \|x_i - m_k\|^2,\ i = 1, \ldots, N$$

3. Iterate above two steps until convergence
   In K-means "K" stands for number of clusters, it is typically a user input to the algorithm. Once the images are grouped into different clusters then the clusters are assigned keywords. Then the search is performed by giving a keyword as input and the images retrieved are forwarded to the QUTIC block.

The images are then assigned keyword using the image keyworder tool.

VII. QUTIC TECHNIQUE

In QUTIC technique the retrieved images from the Query by Example and the Semantic retrieval module and compared with each other and the images that best matches are assigned rank1 followed by other images based on their similarity matching.

VIII. EXPERIMENTAL RESULTS

In this result color feature of the query image (number-555) is compared with the color features of the database images (which are saved in the form of .mat file in a folder named features). At last 8 images are displayed in the output screen in the form of 3 rows and 3 columns. The images are displayed based on the color distance measure shown in the table below

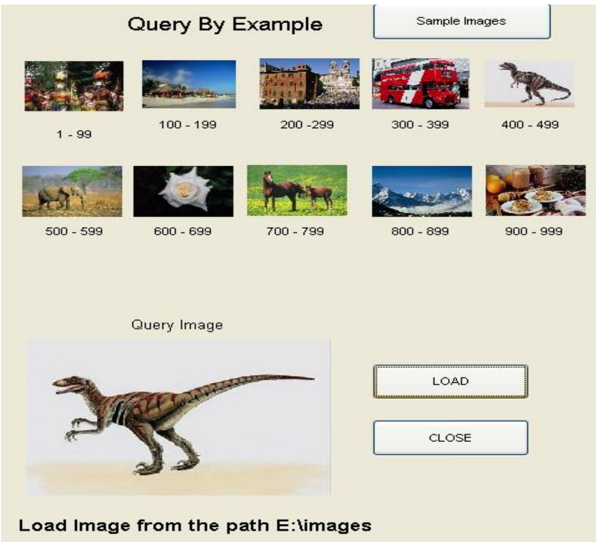

Fig. 3 Query Image

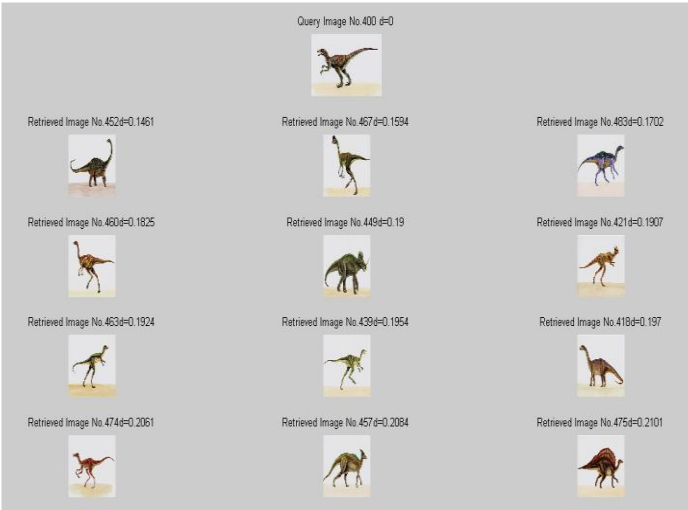

Fig. 4 Retrieved Images

TABLE II
COLOR DISANCE FOR RETRIEVED IMAGES

File Name/ Image Number	Color Distance Measure
400 (Query Imaage)	0
452	0.1461
467	0.1594
483	0.1702
460	0.1825
449	0.19
421	0.1907
463	0.1924
439	0.1954
418	0.197

In Sematic retrieval using the Image Keyworder tool 30 keywords is set to search the database. Some of the keywords used are rose, horse, water, grass land, sky, clouds, green rhinoceros, bus, red rose, pillars, building, beach etc.,

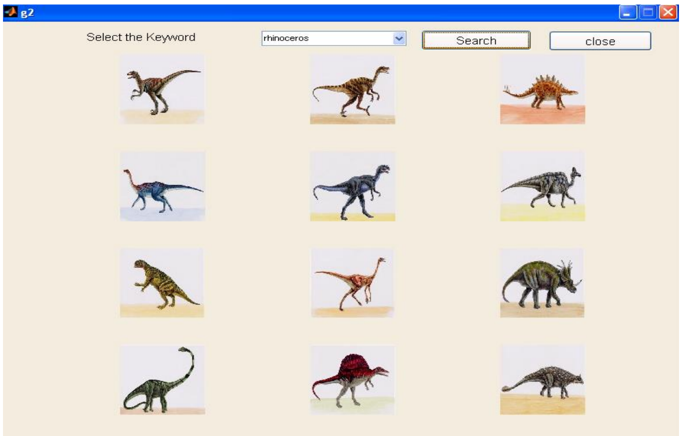

Fig. 5 The keyword used is RHINOCEROS and the results are retrieved in the SR block

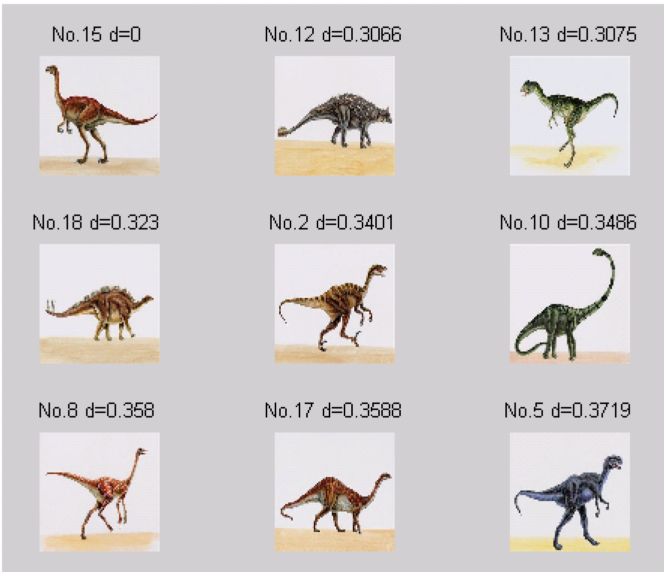

Fig. 6 Result of the QUTIC block which compare the results of QBE and SR block

IX. CONCLUSION

In this typical content-based image retrieval system (Figure 1) the visual contents (color) of the images in the database are extracted and described by multi-dimensional feature vectors. The feature vectors of the images in the database form a feature database. To retrieve images, users provide the retrieval system with example images. The system then changes these examples into its internal representation of feature vectors. The similarities /distances between the feature vectors of the query example and those of the images in the database are then calculated and retrieval is performed with the aid of an indexing scheme. The indexing scheme provides an efficient way to search for the image database. Then the same database is searched by giving keyword as the search criteria. The results of both the QBE and SR are compared with each other in the QUTIC block and the results are retrieved with highest matching.

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