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Improved Image Search and Retrieval based on Dominant Colors



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Abstract - Growth and development of multimedia technology has led to an exponential increase in visual information. Where traditional keyword based information retrieval techniques just do not meet the users demand, CBIR hopes to prevail. CBIR refers to the retrieval of images from a database using information derived from the images themselves rather than solely from accompanying text indices. In this paper we describe an approach of content based retrieval of images from a database, based on dominant colors in the foreground and background of the image. These dominant colors along with histogram and some statistical features form a substantial set to determine the overall similarity between the images. This technique is tested on Simplicity test database and promising results are observed.

Keywords— Content Based Image Retrieval, image querying, dominant colors, feature extraction, histogram values.

I. INTRODUCTION

With the extensive development of networking and multimedia applications, the amount of visual data has become so vast that it is impossible to retrieve, and keep track of relevant information, without a proper technique. CBIR is one such promising image retrieval approach. Overcoming difficulties encountered in textual annotation for large image databases, it has received increasing attention in fields such as medicine, science, commerce and military. The history of content-based image retrieval can be based on artificial notes such as labels or tags, and vision character of image contents (based on low-level features like color, shape and texture)[5]. Content-Based image retrieval (CBIR) involves the following four parts in system realization:

- Data collection, where the set of features for each image are stored for further processing and querying.
- A feature database that uses an index system program to analyze the collected images and extract the feature information. Currently, the features that are used widely include low-level features such as Color.
- The database search, where in the system extracts the features of the user's input image, and the search engine finds the suited feature from the database and calculates the similar distances.
- Ranking the images and assessing the results of the retrieval [3].

This method uses image features such as color, texture, shape or any combination. Image features are represented as a vector of discrete values. Focus on the color based features, is the central theme of our paper. For any given query image, the goal is to retrieve all images whose dominant foreground and background colors are similar to those of the queried image.

The dominant colors together with the histogram features are used to compare the data set and the query image. Those images in the database having the highest similarity to the query image are retrieved and displayed for the user.

II. OVERVIEW OF EXISTING TECHNIQUES

Traditional text-based retrieval relied on a text key word database while content-based image retrieval uses an image feature. In addition, content-based retrieval searches the similar distance of the images' features, however the text retrieval searches the matching key words [2].

Conventional Histogram-based Matching is another existing technique [4]. This histogram-based method is suitable for color image retrieval because they are invariant to geometrical information in images, such as translation and rotation. Histogram of an image is an n-dimensional vector, in which each element represents the number of pixels of color in the n-color image. Images could then be ranked from the image database. The same color distribution histograms between different

brightness conditions of the two digital images result in smaller intersection value and make the highly visually similar images becomes lower ranked.

III. BACKGROUND

Dominant color region in an image can be represented as a connected fragment of homogeneous color pixels which is perceived by human vision. Image Indexing is based on this concept of dominant color regions present in the image. The segmented out dominant regions along with their features are used as an aid in the retrieval of similar images from the image database. The color represented by each of these dominant regions is stored in a file for further processing. The main drawback of this technique is that it never retrieves the same objects of varying sizes as the similar image. In order to overcome this drawback, we can use histogram values and the mean, mode and median of the values in the matrix that represents the image.

An image histogram represents the tonal distribution in an image. It plots the number of pixels in the image with a particular brightness value. We can take advantage of the information obtained from these histograms to visually interpret the image content. The mean, mode and median of the image matrix, serve as indicators of the pixel distribution.

IV. PROPOSED METHOD

Using K-means clustering technique, we segment each image into two parts having a dominant concentration of a particular color. The K means technique is superior to the traditional hierarchical clustering, since it uses an iterative algorithm, minimizing the distance from the object to the cluster centroid. Although a basic method, it proves to be essential in segregation of images into mutually exclusive color zones. This enables us to differentiate between the two most dominant areas in the image and allows us to perform computations on the required portions.

The color table is as follows:

Color Name	R	G	B
Black	0	0	0
White	255	255	255
Brown	140	100	70
Pink	255	85	108
Yellow	255	201	10
Orange	222	128	10
Dark Blue	4	24	124

Green	112	142	107
Gray	100	111	100
Sky Blue	119	143	167
Grass Green	96	128	62
Horse Brown	123	54	41
Light Red	160	0	0
Magenta	182	73	170
Purple	128	0	128
Grayish Blue	105	133	105
Canyon Brown	121	48	18
Evening Blue	69	81	113
Dark Red	200	36	0
Light Gold	238	221	130

Based on the two clusters obtained after segmentation, the RGB components of the pixels in the cluster are compared to a lookup table. Using the color table entry, C, color distance Cd is calculated using Euclidean distance formula as specified in the equation below.

$$D(p, q, \dots, n) = \sqrt{((p_1 - q_1)^2 + (p_2 - q_2)^2 + \dots + (p_n - q_n)^2)}$$

i=1 to 20.

Cd is the minimum Euclidean distance.

And hence we determine the dominant colors which formulate the basis of the criterion that reduces the search space. Histogram Values of sections of the image are collected and used as further indicative features. 16 symmetric blocks (4x4) of the image contributing to 256 features each, with a total of 4096, constitute our set of determining comparative features. This layout makes for efficient use of database and computational time required. We further incorporate statistical means of measurement including inter-quartile range, mean absolute deviation, and with the elemental features-mean, median and mode, to get an effective sample of the feature set. The above set is then used in the analysis and matching of the sample set of image data.

IQR or interquartile range can be calculated as follows:

$$Q_1 = (\sigma * z_{-1}) + X$$

$$Q_3 = (\sigma * z_3) + X$$

Where, $\text{mean}=\bar{X}$ and standard deviation= σ , for P population.

MAD or mean absolute deviation is calculated as follows:

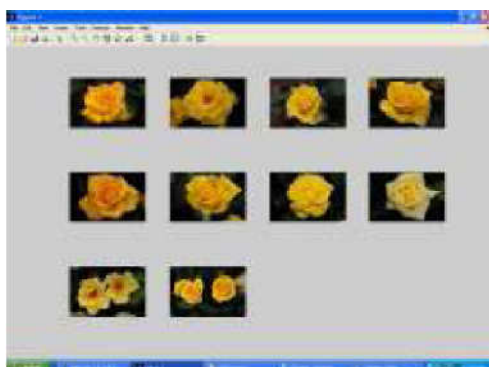
$$Y = \text{mean}(\text{abs}(X - \text{mean}(X)))$$

Features of the query image are extracted and the corresponding differences between this image and the sample data set are then tabulated. Images corresponding to the minimal distances are displayed.

V. RESULTS AND DISCUSSION

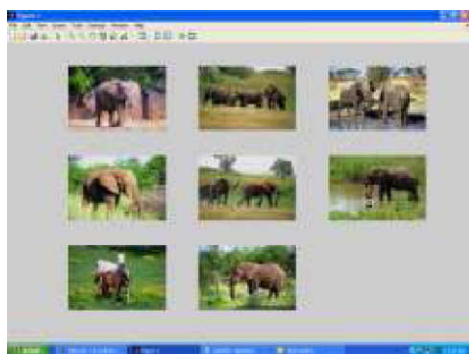
The method proposed here, combining the selected histogram features along with the statistical variables achieves an over all relevancy, improving on the previous matching methods like the one based on dominant color [1]. Taking into consideration the above features, the improvement observable in accuracy is significant. Our test image set consisting of 500 images are categorized into classes of elephants, buses, flowers, horses and dinosaurs.

Below are the test cases we worked on. Using a yellow flower as the query image, we obtain the following output:



For flowers an accuracy of 100% is observed.

The proposed technique shows better performance, retrieving more number of relevant images compared to existing technique



Using an elephant as the query image, an accuracy of 87.5% is observed

The accuracy of retrieval is measured by the relation:

$$\text{Accuracy} = \frac{\text{Total number of relevant images retrieved}}{\text{Total number of images retrieved}}$$

By relevant images, we mean images that belong to the same class as the query image. The effective retrieval system has the highest accuracy. The performance of the proposed technique of using histogram values and statistical variables together with the dominant colors as compared to the existing dominant color based retrieval approach is shown in the table below.

Sample Images	Existing Accuracy	Proposed Accuracy
Class 1-Bus	0.39	0.60
Class 1	0.23	0.79
Class 1	0.39	0.70
Class 2- Dinosaur	0.59	1
Class 2	0.44	0.95
Class 2	0.50	1
Class 3- Elephant	0.56	0.79
Class 3	0.59	0.69
Class 4- Horse	0.42	0.80
Class 4	0.51	0.92
Class 5- Flower	0.39	1
Class 5	0.38	1

VI. CONCLUSION

The proposed technique of image retrieval using histogram values with statistical features along with dominant color identification is a meaningful technique. This method is semantically more accurate as opposed to the existing dominant region color indexing in which the foreground color is used as the only criterion for comparison [1]. The number of relevant images matched is considerably more than that of existing methods. To further improve the efficiency of retrieval, shape and texture features can be incorporated [6]. Limiting to only color based methods, Relevance feedback is another technique that can iteratively improve the efficiency of the search.

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