Image Retrieval by Content using Color, Shape, Texture, and Relevance Feedback

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Abstract— Content based image retrieval is a technique used for getting similar type of images to an input image given by a user. Content based image retrieval is used in several areas like medical, biodiversity information system, digital libraries, intellectual properties, crime prevention, security check, remote sensing, engineering and architectural design, publishing and fashion etc. The CBIR manages to provide these applications by using visual features extraction for color, shape and texture features of the images. To provide good quality of results, appropriate features comparison and matching techniques are required. CBIR is the technique of providing similar and accurate results for a query image given by the user. CBIR assumes that all the resulted images on the output screen will be the same as the query image at any instant of time but sometimes it gives false resulted images. So, we can say that the performance of an image retrieval system also depends on the image extraction techniques and the type of images. Most of the existing techniques only consider either the individual features or combined form of features. In this paper, the image retrieval technique uses the best feature extraction technique for the individual feature first and then combined them in a hybrid form and this technique improves the overall precision value of the existing technique by 4%.

Key words: CBIR, TBIR, BIS, LBP, CDH, QBIC

I. INTRODUCTION

Content based image Retrieval is a technique which provides the similar images to a given image through an interface of an image retrieval system [2]. Initially, several image retrieval systems had been developed like TBIR (Text Based Image Retrieval) - extraction of similar images based on text given by user on the interface of the system and CBIR (Content Based Image Retrieval) – extraction of similar images based on the visual features [4]. One of very first systems was the QBIC-Query by image content, in which user gave hint by explaining about the contents or visual features of the digital images for similar image retrieval [1]. Usually, CBIR (the latest image retrieval system) does not apply all identified features; as we know that it includes huge amount of data [8] and increase the required computing time. As an alternative, a set of features [7] which are suitable to the given task is generally selected, but it is tough to evaluate features which are proper for which task [6]. The basic idea of the CBIR approach is to produce image description automatically from the image content by evaluating the content of the images [3]. Image retrieval system is a computer system for searching, browsing, and retrieving images from a large database of digital images.

II. RELATED WORK

Nowadays technology enables us to acquire, manipulate, transmit, and store large collection of online images. But the searching methods used to find out information related to user query are still limited due to challenging and undeveloped research problems [5]. In 2013, Guang Hai Liu and Jing Yu Yang developed "Content-based image retrieval using color difference histogram". This technique presents an ovel image feature representation method, namely color difference histograms (CDH), for image retrieval. The method was considered as an oval visual attribute descriptor combining edge orientation, color, and perceptually uniform color difference, as well as takes the spatial layout into account without any image segmentation or clustering implementation. In 2015, Kommineni Jenni et al. developed Content Based Image Retrieval Using Color Strings Comparison. It basically uses the string codes of features for extraction [12]. Content-Based Image Retrieval (CBIR) is a technique that enables a user to extract an image based on a query from a database containing a large collection of images. A very fundamental problem in designing a content-based image retrieval system is to select the image features that best describe the image contents in a database. In 2016, Mounika B. et al. developed Content Based Image Retrieval using Color. In this technique, for color feature extraction "Hue Saturation Value" (HSV) color space model and co-occurrence matrix (CCM) for texture feature extraction were used. By using quantification of hue saturation, value color model, co-occurrence matrix, gray-level co-occurrence matrix, and color features are combined using the concept of normalized Euclidean distance classifier. In 2016, Bhagyashri Amrutkar and Lokesh Singh developed Efficient Content-Based Image Retrieval Using Combination of Dominant-Color, Shape, and Texture Features. In this technique, an efficient content-based image retrieval framework is presented by extracting the dominant color, texture, and edge features by clustering features of the available database. Dominant color extraction is applied by using color-quantization method. In the initial phase, the image is divided into eight partitions by using the color quantization algorithm and then eight dominant colors are obtained from each partition. For shape feature extraction "Sobel Color Edge Detection" technique is used. And "Local Binary Pattern" (LBP) technique is applied on the gray scale images for extracting the texture feature [9]. At the end, all the features of the image are combined in order to get a single feature vector. And K-means clustering is applied [14] over the feature vector of database images.

III. PROPOSED TECHNIQUE

The proposed image retrieval technique improve the accuracy of the existing technique that uses color and texture features individually and then in the hybrid form. Proposed technique uses the available retrieval techniques first for individual features and then combine the best ones for acquiring the better accuracy [13]. First of all a database is created having large number of images and then the image features database is created by applying the image extraction techniques of the color, shape, and texture features [10]. In this way, all the images of the database are processed in order to extract the features of the images. After this phase, the input image is also processed in a similar manner and the features are extracted and saved. The input image features are compared with all the image features in the database and similarity measurements are applied for getting the similar type of images to the user's input image from the database. And the top most similar images are extracted to display. After this measurement, the results of similar images are acquired and displayed to the user.

A. Extraction of color feature

Usually the color feature of the digital images is assumed to be an extraordinary equal feature as it is closer to customer view and visualization structure. In this technique, for color feature assessment, starting from the top left corner of the image and continue from left to right and top to bottom pixel-wise by picking 3×3 neighborhood for every pixel, the maximum and minimum values are obtained by using the following formula:

$$\text{Max} = \max(\text{3x3 neighbuorhood} \quad (1)$$

$$\text{Min} = \min(\text{3x3 neighbourhood}) \quad (2)$$

After getting the values of max, min, the average value of these two terms is calculated. In the same way the average value for all the individual pixels are calculated and finally a single average value is obtained.

After applying the above technique for the color feature, the outcomes obtained are shown in the figure below.

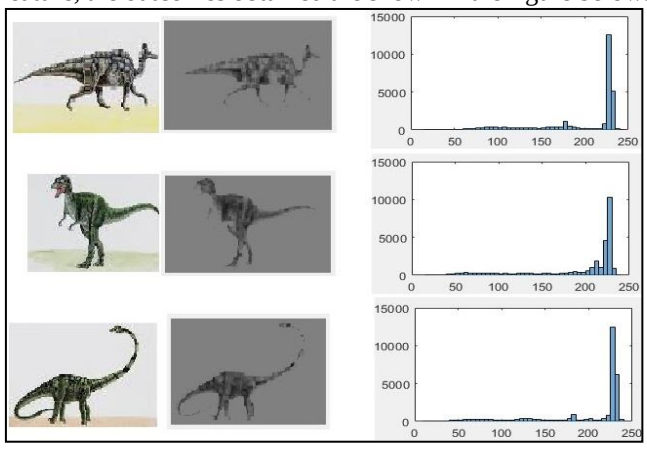

Fig. 1: Outcomes of color feature extraction.

B. Extraction of shape feature

The shape feature of an image is the representation of the range of parts or the whole image. Visual forms also heavily depend on shape assets. Shape features play an essential part in CBIR. In the proposed technique, Weber's local descriptor is applied for the shape feature extraction.

1) Weber's local descriptor (WLD)

Weber's Local Descriptor is said to be effective for shape visual feature during image retrieval and also in the detection process of human faces and other object shapes. The orientation for the pixels of digital images is calculated by using the given block of pixels and the formula:

x_1	x_2	x_3
x_8	x_c	x_4
x_7	x_6	x_5

$$\theta(x_c) = \arctan\left[\frac{x_6 - x_2}{x_8 - x_4}\right] \quad (3)$$

Or

$$\theta(x_c) = \arctan\left[\frac{v_s^{11}}{v_s^{10}}\right] \quad (4)$$

$$C = \arctan(v_s^{11}, v_s^{10}) = \begin{cases} \theta, & v_s^{11} > 0 \text{ and } v_s^{10} > 0 \\ \pi + \theta, & v_s^{11} > 0 \text{ and } v_s^{10} < 0 \\ \theta - \pi, & v_s^{11} < 0 \text{ and } v_s^{10} < 0 \\ \theta, & v_s^{11} < 0 \text{ and } v_s^{10} > 0 \end{cases} \quad (5)$$

And

$$\theta' = C + \pi,$$

$$\text{where } \theta \in [-\pi/2,\ \pi/2] \text{ and } \theta' \in [0, 2\pi] \quad (6)$$

Now the value of quantization function for the pixel of given images is calculated as follows:

$$\Phi_t = \frac{2t}{T}\pi, t = \text{mod}\left(\left\lfloor \frac{\theta'}{2\pi/T} + \frac{1}{2} \right\rfloor, T\right) \quad (7)$$

Here T = 8. Thus, the calculated orientations are separated into T bins.

C. Texture feature extraction

Local binary patterns (LBP) method is an effective texture feature-based method, and it has been applied in some of the wide spread regions of research such as human face identification, digital image retrieval, and object tracing etc. In this method, LBP value is calculated for a 3x3 subpart of digital image by associating the grey value of the centre pixel with its neighbouring pixels as shown in the following figure:

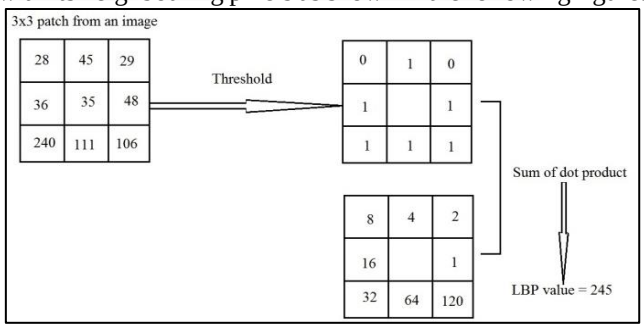

Fig. 2: An example LBP value calculation.

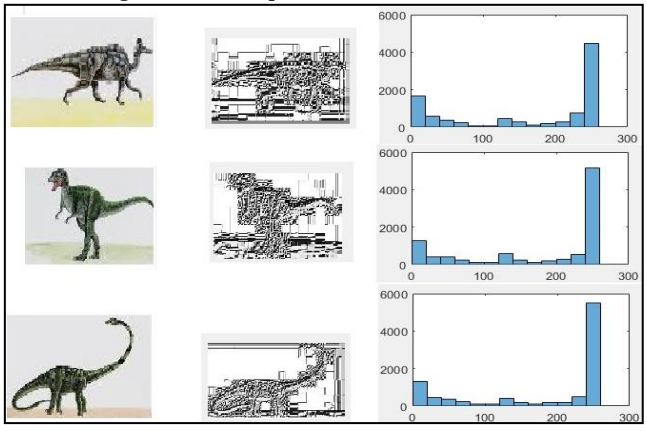

Fig. 3: Outcomes of texture feature extraction.

By using the 3x3 neighborhood for each pixel, the respective LBP values are calculated by choosing the center pixel of the 3x3neighborhood as the threshold value. If pixel value is greater than or equal to the threshold value then replace with 1 otherwise with 0.

D. Relevance Feedback

In the physical world representation, one identifies that giving surveys from the users in a web development or in a web implementation process is often inconvenient for the users. Generally the user overlooks such type of questions and even in case where they are persuaded to response, they do not feel comfortable many times with such type of applications. Keeping this in observance, a new technique for recording user replies and responses has been presented in this proposed technique. So that, when a user clicks on an image from the stored images, a record is preserved automatically for the input query images. Based on these records or feedbacks, the system can be represented according to the user involvement in image retrieval process [11]. Furthermore, when a user clicks on an image, it is measured to be a positive image example, all the images from this class are represented to the user in less time.

IV. SIMILARITY MEASURE

When an input query image is presented to the image retrieval system, extraction of image features is implemented. On these extracted features of input query image and of stored images of database, a similarity measurement is applied. With this measurement, the key distance between the query image and the resident image is calculated by using the Euclidean distance measurement.

Let the input query image is denoted by X_i and the trained image is denoted by Y_i. Euclidean distance can be computed by using the following formula:

$$Euclidean\ Distance = d = \sqrt{\sum_{i=1}^{N}(Xi - Yi)^2} \quad (8)$$

V. DATABASE USED

For implementing the proposed technique, a database of 750 images of different categories like animals, food, flowers, buildings etc. is used. Each of the category consists different number of images. In this technique, CORAL database is used. There are 8 classes of images in the database.

VI. OBSERVATIONS RECORDED

Basically, in image retrieval techniques, mainly two parameters are used to observe the accuracy of the results in the system. These two parameters are precision and recall.

A. Precision

Precision calculates the ratio of relevant images to the intended images to be retrieved. Precision is calculated based on the following formula:

$$\text{Precision} = \frac{O}{P} \quad (9)$$

Where O = Total relevant images
P = Total images intended to be retrieved

B. Recall

Recall calculates the ratio between relevant images retrieved to the total number of images in the category to which the input image belongs. The Recall is calculated based on the following formula

$$\text{Recall} = \frac{O}{Q} \quad (6.2)$$

Where O = Total relevant images
Q = Total images in the category or in the database

VII. RESULTS

The results of the proposed scheme are given in the table below.

S. NO	*Category*	*Proposed Approach*	*Previous Approach*
1	Africa	0.95	1
2	Buildings	0.82	0.8
3	Buses	0.9	1
4	Dianosaurs	1	1
5	Elephants	0.86	0.6
6	Flowers	0.82	1
7	Horses	0.97	0.95
8	Food	0.9	0.55
Overall Accuracy		0.90	0.86

Table 1**:** Precision values of Proposed and Previous Approach

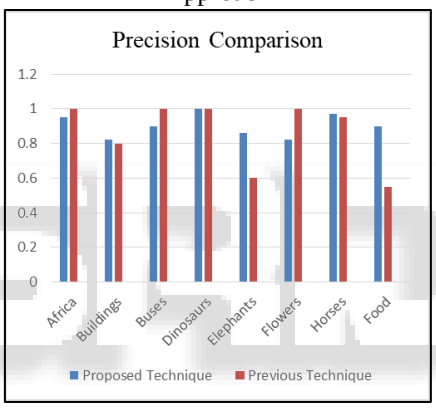

Fig. 4: Precision comparison.

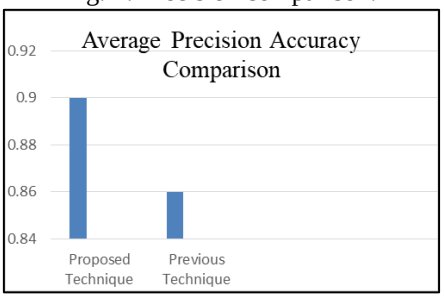

Fig. 5: Average Precision Accuracy Comparison

Serial no.	Category	Proposed Approach
1	Africa	0.255
2	Buildings	0.176
3	Buses	0.174
4	Dinosaurs	0.253
5	Elephants	0.178
6	Flowers	0.261
7	Horses	0.215
8	Food	0.316
	Overall accuracy	0.228

Table 2: Recall values of the proposed technique

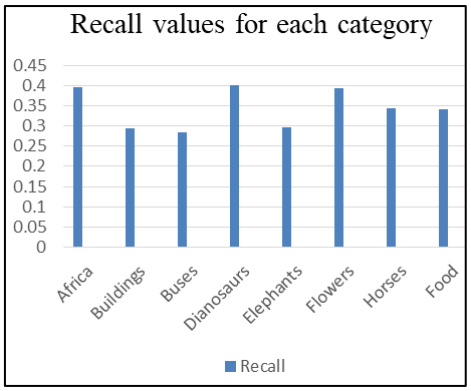

Fig. 6: Recall values for each category

VIII. Conclusion and Future Work

As we know, in image retrieval system, the content-based image retrieval is the most emerging technique for the large database system. Even though this area has been explored for decades, still there is a huge scope for achieving the accuracy of human visual observation in distinctive images. The CBIR system can be enhanced by improving the indexing, retrieval design, and feature extraction mechanism. In the proposed technique, a combination of visual features is used. One more feature of relevance feedback is used, which basically stores the feedback from the user's responses. It reduces the response time for the query image. The overall results and accuracy of the proposed technique gives better results than the previous technique's but in order to improve the accuracy for all the classes of images, some more research work is still required.

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