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Content Based Image Retrieval Using Data Compression Technique

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Abstract: Content based image retrieval (CBIR) is a technique of retrieving similar images to that of query image from a collection of dataset. CBIR system uses visual features of image to retrieve the similar images from dataset. Over the past years, many researches were applied for developing efficient image feature descriptors. This study presents a technique for improving image retrieval by utilizing a data compression method called ordered dither block truncation coding (ODBTC). Image content descriptors are generated from ODBTC compressed data stream. The ODBTC produces two color quantizers and a single bitmap image. Two image features, namely Color co-occurrence Feature (CCF) and Bit Pattern Feature (BPF) are generated from the output of ODBTC. The similarities between two images are measured from their CCF and BPF features. The proposed method is implemented on Raspberry Pi3 model B in OpenCV-Python platform. Experimental results show that the data compression method described in this paper can be used for image retrieval applications also.

Keywords: CBIR, ODBTC, CCF, BPF, OpenCV-Python, Raspberry Pi3 Model B

I. INTRODUCTION

Digital technology is advancing at a very rapid pace and we require efficient information retrieval systems. Most of our day to day activities involve the usage of images. Multimedia data processing is becoming an inevitable part of human life. Real-time data processing is a new challenge in the digital world. Thus image retrieval is increasingly becoming common and recognized. The electronic format of images found useful in many fields such as photography, art, entertainment, medical imaging etc. As many applications need to search and retrieve images from large datasets, it is necessary to develop simple and efficient algorithms and tools for image search and retrieval. The ultimate goal is to provide an easy and effective system for image retrieval. The traditional method of image retrieval is using keywords, which are not efficient as it sounds. The main drawbacks are the high amount of manual works and the high dependency on personal perceptions. These will lead to wrong results. To overcome these problems content-based image retrieval (CBIR) was introduced.

CBIR is a technique of finding similar images from the dataset by extracting low-level features like color, shape or texture both from the query image and dataset. Image retrieval approaches can be classified into three classes namely, text based image retrieval, semantic based image retrieval and content based image retrieval. Text based image retrieval is the common and conventional method of image search and retrieval in which a description of the image to be retrieved is given. Low level image features are image characteristics that are captured by computers for the purpose of recognition and classification (such as pixel intensity, pixel gradient orientation and color). Semantic image features are used to achieve higher semantic performance that combines the low-level features of images with high-level features which contain perceptual information for human beings [13]. Traditional image retrieval systems index images using low level features which in most cases do not correlate to the semantic features. This creates a gap known as the semantic gap. It says the disadvantage of retrieval system to understand and react to high level features.

II. BACKGROUND

G. Qiu et.al [1] presented a new application of an image compression technique, namely block truncation coding (BTC). It is shown that BTC can also be conveniently used for content-based image retrieval from image databases. Block color co-occurrence matrix (BCCM) and block pattern histogram (BPH) are used to derive feature from the image. BCCM and BPH are used to compute the feature extraction and similarity measures of images for content-based image

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retrieval applications.

M. R. Gahroudi et.al [2] proposed a new method for retrieval of images compressed by BTC. This method has been examined on a database consisting of 9983 images with different contents and its results have been compared with similar methods. In this method, two techniques Color Histogram and Block Pattern Histogram are used as compound and are checked on a big dataset. The results of recall rate and precision rate have been better than other methods. It is also shown that methods based on texture images can be used effectively on non-texture images.

P. W. Huang et.al [3] exploits new techniques for image retrieval by texture similarity. Two major issues have been discussed: (1) how to extract and represent texture features for effective image discrimination, (2) how to speed up the process of image retrieval while still retaining high efficiency of retrieval. System can achieve 93.20% efficiency in exhaustive image retrieval.

Y. D. Chun et.al [4] proposed a content based image retrieval method based on an efficient combination of multiresolution color and texture features. As its color features, color autocorrelograms are used. The hue and saturation components in HSV color space are taken to consideration. Block difference of inverse probabilities and block variation of local correlation coefficients of the image are taken. The color and texture features are extracted in multi-resolution wavelet domain and combined. The dimension of the combined feature vector is determined at a point where the retrieval accuracy becomes saturated. Experimental results show that the proposed study gives higher retrieval accuracy when compared with earlier methods. But complexity is very high.

C-H Lin et.al [5] proposed three image features for image retrieval. A feature selection technique is also used to select optimal features. The feature used in this study maximizes the detection rate and also simplify the computation complexity of image retrieval. The first and second image features are according to color and texture features respectively. First one is called color co-occurrence matrix and second is the difference between pixels of scan pattern. The third image visual feature is using color, named as color histogram for K-mean. The experimental results indicate that through feature selection, computation of image retrieval from any type of image databases can be effectively reduced.

T. C. Lu et.al [6] this paper uses the color distributions, the mean value and the standard deviation, to represent the global characteristics of the image. Moreover, the image bitmap is used to represent the local characteristics of the image for increasing the accuracy of the retrieval system. As the experimental results indicated, the proposed technique indeed outperforms other schemes in terms of retrieval accuracy and category retrieval ability.

M. J. Swain et.al [7] introduces color histograms of multi-colored objects. It provides a robust, efficient method for finding images into a large database. The study shows that color histograms are efficient object representation technique. This will give a good result in the presence of occlusion. Thus it can be differentiated among a large number of objects. It introduces a technique called histogram Intersection. For solving the location problem it introduces an algorithm called histogram backprojection, which performs this task efficiently in crowded scenes.

J. Huang et.al [8] proposed a new image feature called the color correlogram and used it for image indexing and comparison. This feature tells about the spatial correlation of colors, and is both accurate and inexpensive for content-based image retrieval. The correlogram is a good method to identify large variations in contour and shape. It can also detect changes in viewing positions, etc. Experimental study suggested that this new feature is better than color histogram method and also have a greater effect than the histogram refinement methods for image retrieval.

D. Zhang et.al [9] Gabor wavelet proves to be very useful texture. In this paper an image retrieval method based on Gabor filter is proposed and the texture features are found by calculating the mean and variation of the Gabor filtered image. To have same dominant direction for all images rotation normalization is realized by a circular shift of the feature elements. The method is applied on textured images and natural images.

Yildizer et.al [10] studied another CBIR system which made use of Multiple Support Vector Machines Ensemble for generating block diagram for database. Daubechies wavelet transformation is used for extracting the feature from the images. This method not only improved the efficiency of the CBIR systems, but they also improved the accuracy of the overall process. The goal of this project was to develop a general purpose CBIR technique that can handle large image databases and can be smoothly embedded into different image retrieval systems.

Wang et.al [11] proposed content-based image retrieval for automatic identification of insect species from images. Content-based image retrieval (CBIR) is applied because of its capacity for mass processing and operability. A series of shape, color and texture features was developed. This draw allows the identification of butterfly images to the taxonomic scale of family.

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Vailaya et.al [12] presented a hierarchical algorithm based on binary Bayesian classification. They used a hierarchical structure in which natural scene images are categorized into indoor and outdoor. Outdoor images are also divided into city and landscape. In the lowest level, subsets of landscape images are classified into sunset, forest, and mountain. They concluded high accuracy in classification on a specific database including 6931 images. They also mentioned that the accuracy of algorithm depends on selected features, the number of training sets, and the learning ability of classifier in true decision boundary. The limitation of this approach is that classification is under constraint. That is, test image should be selected from one of the classes.

In this study, a new method for content-based image retrieval is proposed using ODBTC compression method. The query image will be already in compressed format. This image is taken to ODBTC module and the outputs available are color quantizers and a bitmap image. For feature extraction color co-occurrence feature and bit pattern feature is used and applied to the output of ODBTC. There is a use of codebook in ODBTC.

The rest of this paper is organized as follows. In section III details of proposed method is described. Section IV gives the results of the proposed method. Finally, the conclusion is drawn in Section V.

III. PROPOSED METHOD

The process of retrieving stored images from a large image database by means of the image supplied as a query is the principle of content-based image retrieval. This can be done by proper feature extraction and querying process. Image search can be done using content-based on color texture or shape which has been taken as the property for searching the image from a large collection.

Query image is fed into the system for generation of features for the image. The final result is compared with the database image by using similarity measurement. At last, we get similar images corresponding to our query image. The block diagram of proposed method is given in Fig.1. The block diagram consists of feature extraction module, similarity matching module.

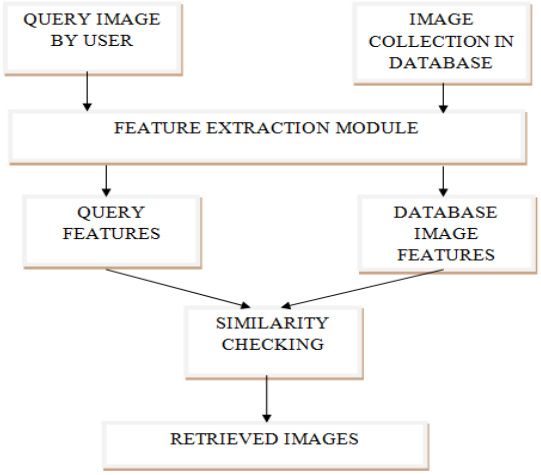

Fig. 1 Block diagram of proposed CBIR system

A. Ordered Dither Block Truncation Coding

A frame of a digital image can be visualized as an orderly arrangement of 'picture elements' (pixels) arranged in horizontal lines and many such lines are stacked one below the other. It may also be visualized as a matrix of pixels arranged in rows and columns. Any color can be represented as a mixture of three primary colors namely red, green and blue. In digital processors, each of the R, G, B signals are represented by 8 bits, corresponding to 256 quantization levels, starting from zero intensity to full intensity. In ODBTC, first the original RGB image is divided into image blocks after decomposing to three different color channels R, G and B. The original image is again converted to the grayscale image for calculation bitmap image. The earlier BTC method performs the thresholding by comparing the mean of each block with the pixel values. If the pixel value is smaller compared to threshold values the turned to 0 otherwise 1. In ODBTC dither array is calculated using the minimum and maximum values of the image. The thresholding is done by comparing pixel value to the sum of block value and dither array value. The end results of ODBTC are two quantizers and a bitmap image. The advantage of ODBTC is that the reconstructed image with less blocking effect and false contour.

B. Feature Extraction

For feature extraction, two image features are used namely Color Co-occurrence Feature (CCF) and Bit pattern Feature (BPF) are used. CCF is derived from the two color quantizers and BPF are from the bitmap image. Color is one of the low-level features used commonly in CBIR systems. Here color co-occurrence feature is obtained from the color

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co-occurrence matrix. The quantizer values of ODBTC are indexed with color codebook to obtain color co-occurrence matrix. Indexing is done by considering the closest match between the minimum and maximum quantizers and the codebook generated by the minimum and maximum quantizers respectively. Thus we get the CCF matrix. To further reduce complexity CCF matrix is downscaled to 1D image feature descriptor.

Bit pattern feature consists of shape, edge and image contents. The bitmap codebook is generated at ODBTC stage. The indexing is done by checking the similarity between this codebook and bitmap image of the query. BPF is derived by looking the probability of occurrence of the bitmap image to each codeword. BPF is a very simple method and does not require complicated calculations.

C. Feature Matching

The similarity matching of the query image and dataset images is done using distance measure. All the image feature extraction methods are done both for the query image and dataset images. For dataset images, this is needed to calculate only once. A collection of images are retrieved from dataset after executing similarity matching. The similarity check is done using the Equ. (1)

$$\sum \left(CCF(query) - CCF(target)\right) + \left(BPF(query) - BPF(target)\right) \quad (1)$$

IV. Result and Discussion

The experiments in this study employed the Corel dataset [17] which contains 990 different images with each. As such, the outcomes were reported utilizing the ten semantic sets with every comprising of 100 images. These datasets are in the groups of Food, Buses, Elephants, Mountains, Beach, Buildings, Flowers, Africa, Horses and Dinosaurs. Each category in dataset is having different image sizes.

The proposed system is implemented on Raspberry Pi3 model B. The usage of OpenCV-Python platform made the system to give efficient result. Python version 2.7 and OpenCV version 3 are used. Numpy is a highly optimized library for numerical operations. Besides that, several other libraries like SciPy, Matplotlib which supports Numpy can be used with this. So OpenCV-Python is an appropriate tool for fast prototyping of computer vision problems.

The results when a dinosaur and rose flower images are given as query is are given in Fig.2 and Fig.3

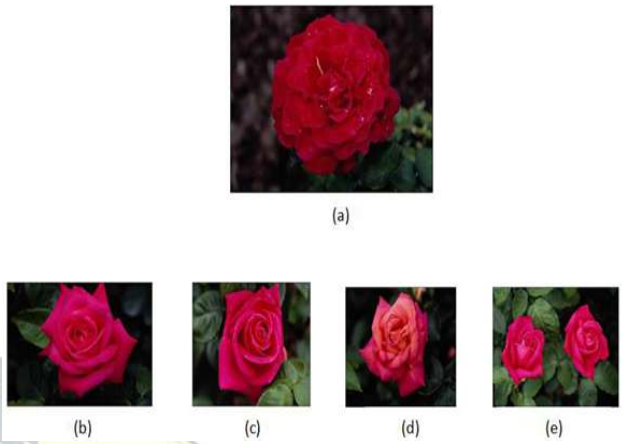

Fig. 2 Result of proposed system when a rose flower (a) is given as query image, (b), (c), (d), (e) are the result

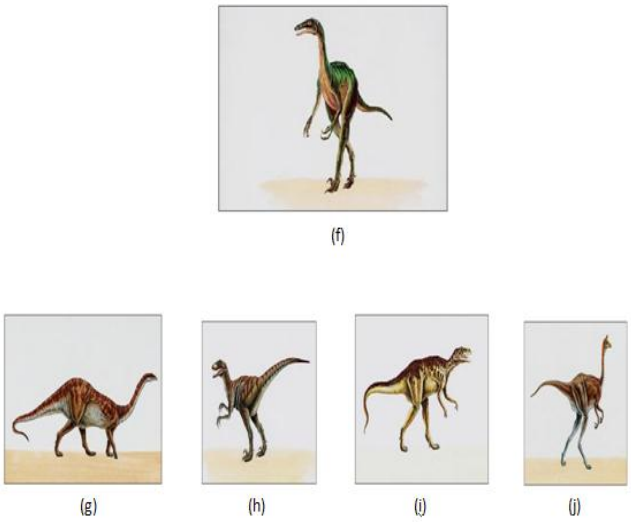

Fig. 3 Result of proposed system when a dinosaur (f) is given as query image, (g), (h), (i), (j) are the results.

Precision refers to a measure of the capacity of the system in retrieving just the images that are similar to the query image. Some images in database are turned as query images and then the precision is computed over all query images along with the number of retrieved images L = 15. The precision calculated for some query image and their retrieved images are presented in Table 1.

Corel database is taken in [10] for finding the classification accuracy. In the below table, the accuracies for each class is given. The average accuracy of the approach in [10] with Corel database is 62% which is good when high

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dimensionality of pictures and number of classes is considered. Only 20% of building images are classified correctly; 50% of building pictures are classified as beach pictures and 40% of food pictures are classified as African people pictures. This is also due to the fact that the centres of these images contain colourful objects with different shapes. When the details are lost, they look very similar [10].

TABLE I
PRECISION MEASUREMENTS

Classes/category in dataset	Precision
Dinosaur	0.93
Buses	0.93
Flower	0.80
Horses	0.667
Elephant	0.53

TABLE III
CLASSIFICATION ACCURACY FOR COREL DATABASE, AS IN [10]

Categories	Accuracy (%)
African people and villages	50
Beaches	70
Buildings	20
Buses	80
Dinosaurs	90
Elephants	60
Flowers	100
Horses	80
Mountains and glaciers	50
Food	20
Average	62

V. APPLICATIONS

Medical Diagnosis: Content Based Image Retrieval (CBIR) system retrieve brain images from that database which are similar to the query image. The goal of diagnostic medical image retrieval is to provide diagnostic support by displaying relevant past cases, along with proven pathologies as ground truth. Crime Prevention: Collect finger prints, shoe prints, hair pattern and face image stored in the database. Whenever a serious crime is committed they can compare evidence from the scene of the crime for its similarity to records in their database. Security Check: Finger print or retina scanning for access privileges. Intellectual Property: Trademark image registration, where a new candidate mark is compared with existing marks to ensure no risk of confusing property ownership. Watermarking can be implemented using this method.

VI. CONCLUSION

CBIR is a developing area. As the size of image dataset increases there is a need of more effective retrieval systems. In this proposed system of CBIR, one of the data compression methods called ODBTC is employed. The result obtained from ODBTC is used to extract feature descriptors using CCF and BPF methods. The experimental result shows that proposed method is giving a better result in terms of color image retrieval applications. In order to have an efficient system the information about dataset and also computer vision is required.

For the further study, the proposed system can be extended to another color space. To increase the retrieval performance another feature can be added based on shape features. In order to help the users retrieve the correct images they seek, relevance feedback techniques have been developed. This involves allowing users to make further selections from the initial lot of images, presented for a query. Need for tools that automatically extract high-level features from images. Algorithms that can support both content-based and text-based retrievals should be developed.

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