Content Based Image Retrieval for Visual Entity Identification

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Abstract: Content based image retrieval from large resources has become an area of wide interest now a days in many applications. The enormous development in various types of images over internet, it becomes a challenging task to identify the visual entity from the large database. The application of CBIR systems can be found in many areas such as a web-based product search, surveillance, Digitally acquainted Libraries, Prevention of crimes, Identification of Fingerprints, Information Systems of Biodiversity, Medical, Research of Historical places & many others. Content based image retrieval gives solution to the problem of visual entity identification as it uses visual image contents or features such as color, shape, texture unlike only focusing on keywords deals with particular image. In this work the color features, shape features, texture features of the image are considered and studied accordingly. The color features are computed using HSV Histogram and Color Moments. For the shape features the sobel edge detection algorithm because its performance is unaffected by the presence of noise in the image. And for the texture features, gabor wavelet and wavelet transform are considered due to their strong time-frequency representation capabilities. Overall in this report we discuss various image retrieval techniques and a platform to implement the content based image retrieval for visual entity identification.

Index Terms - HSV Histogram, Color Moments, Content based image retrieval, Gabor wavelet.

I. INTRODUCTION

Due to vast development in digital technology and explosion of inexpensive storage media, the digital data production has been tremendously increased. Over the years large amount of images and other data is increasing drastically. Such a huge amount of digital data creates difficulty in finding related data manually. Users upload thousands of images every day on Google. Although tremendous online and offline data is existing but precise image retrieval technique is still not there. Therefore to resolve these challenges intelligent method for searching, filtering and retrieving related data is strongly needed [1].

With a rapid growth and advances in data storage, it becomes very challenging task to handle a big image data. The stated problem can be resolved using image retrieval. Any image retrieval systems can be divided into two groups one is text-based and other is content based. Keyword is the base for retrieval of images in text-based methods. Design of these systems is easy and due to which they are well known. The major drawback of text based method is its quite difficult to have annotation for such a large number of images. In addition, text-based methods are unsuccessful to retrieve visually identical images. Another type of image retrieval falls under the category of content-based methods. Content based method retrieves the images as per the presence of features in the image. Without doing annotation manually CBIR retrieves images which are visually similar. A process of efficient image retrieval on the basis of similarity is termed as content base image retrieval. The accuracy of retrieval depends on appropriate extraction of such contents which exactly describes the image. Moreover, CBIR should be associated with query, match, index and search techniques.

The meaning of "Content-based" is that the search identifies the image contents than data. Data includes description, tags of a particular image. The content might refer to shapes, color or texture or combination of all that can be grasped from the image itself. Having human to manually annotate images might be very time consuming as it require manually entering keywords in a large dataset and might even not capture keywords desired to describe the image. Thus CBIR is need for today's trend as it is dependent on annotation quality and completeness [2]

II. SURVEY OF LITERATURE

In this section a systematic review of existing methodologies has been presented. The review has been carried out to identify the inadequacy and outperforming element of past techniques.

In [3] the color feature has been extracted and stored in the form of feature vector. Author has used the naïve Bayesian classifier to classify the extracted features. Author claimed to have high classification accuracy even with highly complex nature of data. Author in [4] proposed use of DWT for extraction of color and texture features. The similarity metric used was Euclidian distance and testing has been done on Wang database. In [5] author has partitioned image into sub-blocks of equal size. Color features are extracted from each sub-block though quantification of HSV color space into non-equal intervals. The color features are represented using cumulative histogram. Gray level co-occurrence matrix was used to extract the texture feature of each sub-block. Point to point matching algorithm was used for comparative analysis of the query and target image.

Author in [6] applied Gabor wavelet and Discrete Cosine Transform to extract the color and texture feature whereas Manhattan distance was used as similarity metric. [7] adopted color histogram and color moment for extraction of color features. Similar to [8] gabor wavelet has been used for texture feature while the extracted features were classified using support vector machine. Author has presented survey on various methodologies developed on the basis of types of features such as color, texture and shape. The

methods based on Tamura Texture, Gabor Feature and Color Histogram has been implemented and their performance has been measured on the basis of Precision value, Accuracy and Recall value.

In [9] the concept of Fast Feature Extraction, Multi-codebook Approach and Multi-core Support vector machine. The major drawback of proposed method is it does not support large database. It includes design of an image database and retrieval of specific features using color histogram and the Euclidian distance as similarity measurement. In this method feature combination was not considered [10]. The semantic subspace learning (SSL) method has been proposed that exploit the RF log data with contextual information for retrieval of an image. Improvement in the low dimensional semantic concept subspace has been observed [11]. Image is divided uniformly into 8 coarse partitions; the centroid of each partition is selected dominant color. Texture features are obtained using gray level Co-Occurrence matrix (GLCM) and partial shape matching technique is used to derive the shape features. Gradient vector flow method was used to capture the shape information where invariant moments were computed to extract shape features. The texture and shape feature combination has given robust representation of image that helped to enhance the retrieval accuracy [12].

III. Overview and Performance Measures

This study proposes an improved method for visual similarity search in content-based image retrieval. In this method features such as color, shape and texture are extracted from query image and these features are compared with the feature vectors of database images using some similarity metrics. Color histogram is used to represent the color feature of image and color moment, under certain a color space like Hue Saturation Value (HSV). The Shape features like the outer edge and inner edge of an image would be analyzed through gabor wavelet method. Lastly the texture feature is also going to be used in retrieving the similar image. On applying HSV and color moment methods, ultimately we will get the edge gradient feature. Various proximity functions would be used that can effectively measure distance/similarity between images like Euclidean distance, Manhattan distance, standardized L2, Mahalanobis, Cityblock, Minkowski, Chebychev, Cosine, Correlation, Sperman, Normalized L2, Relative Deviation. The outcome would be a set of precision values. Performance of proposed system is calculated in terms of precision and recall. Recall is the system ability to retrieve all models whereas precision is nothing but the ability to retrieve relevant models only. The proposed method is implemented on MATLAB platform and tested on a standard database consisting of images. The search would be based on similarity rather than the exact match.

The standard architecture of content based image retrieval is shown in figure 3.1.

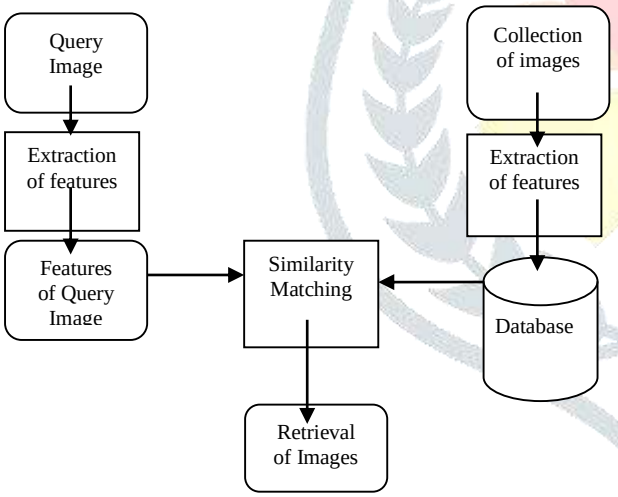


Fig 3.1: Standard Architecture of CBIR

First the data acquisition process comes into picture i.e. the collection of images in the database. Next the various features of images are extracted by using color, shape and texture features and saved in the feature vectors. The user input the query image and again the color, shape and texture features of the query images are extracted and saved. The matching of features is carried out between the feature database and query image feature. The image features that get matched are displayed in an ascending order and thus the similar images were retrieved.

A. Feature Extraction

Feature extraction is a means of extracting compact but semantically valuable information from images. This information is used as a signature for the image. Similar images should have similar signatures. If we look at the figure shown in 3.2, the white color and texture of the building are the characteristics properties. In a similar way sky can be described by its blue color. And we can take the size of the image in the picture into account.

Fig 3.2: Example of image properties

Feature extraction of the image in the database is typically conducted off-line so computation complexity is not a significant issue. This section introduces three features: texture, shape, and color, which are used most often to extract the features of an image.

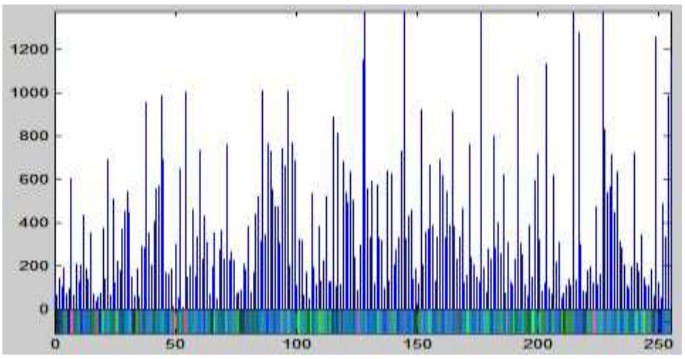
B. Color

One of the most important feature visually recognized by humans in images is color. Color is a powerful descriptor that simplifies the object identification, and is one of the most frequently used visual features for CBIR. Several color descriptors have been developed from various representation schemes, such as color histogram[1], color moments[1], color edge[1], color texture[1], and color correlograms.

- *Color Histogram*

The most commonly used method to represent color feature of an image is the color histogram. A color histogram is a type of bar graph, where the height of each bar represents an amount of particular color of the color space being used in the image. The bars in a color histogram are named as bins and they represent the x-axis. The number of bins depends on the number of colors there are in an image. The number of pixels in each bin denotes y-axis, which shows how many pixels in an image are of a particular color. An example of a color histogram in the HSV color space can be seen with the image in figure 3.3

a. Sample Image



b. Corresponding Color Histogram

Fig 3.3: Sample Image and its Corresponding Color Histogram

- *Texture*

In the field of computer vision and image processing, there is no clear-cut definition of texture. This is because available texture definitions are based on texture analysis methods and the features extracted from the image. However, texture can be thought of as repeated patterns of pixels over a spatial domain, of which the addition of noise to the patterns and their repetition frequencies results in textures that can appear to be random and unstructured. Texture properties are the visual patterns in an image that have properties of homogeneity that do not result from the presence of only a single color or intensity.

- *Shape*

One of the common used features in CBIR systems is the shape. Shape of an object is the characteristic surface configuration as represented by the outline or contour. Shape recognition is one of the modes through which human perception of the environment is executed. It is important in CBIR because it corresponds to region of interests in images. Shape feature representations are categorized according to the techniques used. They are boundary-based and region-based . In region based techniques, all the pixels within a shape are taken into account to obtain the shape representation.

IV. SYSTEM DEVELOPMENT

The proposed systems consist of two phases as follows:

Training Phase:
Feature extraction applied for image database is a backend process which is independent from user extraction. The extracted features are smaller than actual image and then they are stored as feature database in the form of matrix for similarity measures later on. The collection of feature vectors is termed as feature database of the images in database.

Testing Phase:
This phase is also known as front end starts when user gives a specific query request by giving an example image. Then, features of query image are also extracted in same manner as database image features are extracted and stored as a feature vector. Then similarity is measured based on chosen distance metrics based on least distance set of most similar images is obtained as result.

The proposed algorithm is presented below:

i. Read image from the database.
ii. Quantize the image into Hue, Saturation and Value (HSV) into 8x3x3 value.
iii. Compute the HSV Histogram.
iv. Extract three color moments from Red, Green, Blue Plane of images.
v. Convert image to Gray Scale image.
vi. Apply Gabor Wavelet (no. of scales = 4 and no. of orientation = 6) to calculate mean squared energy and mean amplitude.
vii. Apply Wavelet moment to calculate first 2 moments of wavelet coefficients i.e. mean coefficient and standard variation coefficient.
viii. Apply edge gradient using sobel edge detection to calculate gradient magnitude or edge strength.
ix. Apply 1 to 7 on all images stored in a database and store features as feature database.

V. RESULTS

The proposed system has been tested on wide range of dataset which consist of around 1360 images. The data has been collected from Visual geometry group, Department of engineering science, University of Oxford. The results have been represented in two categories:

A. Qualitative Analysis
B. Quantitative Analysis

C. QUALITATIVE ANALYSIS

We figure out the performance for proposed CBIR using different distance measures as:
First of all we will create the GUI for project in which data set is to be loaded for which the feature extraction is to be done. Then to browse the image form large dataset.

Fig 5.1: GUI without selecting any database or test image

- Database used for the system

This GUI will present the different images or classes of images available in the dataset.

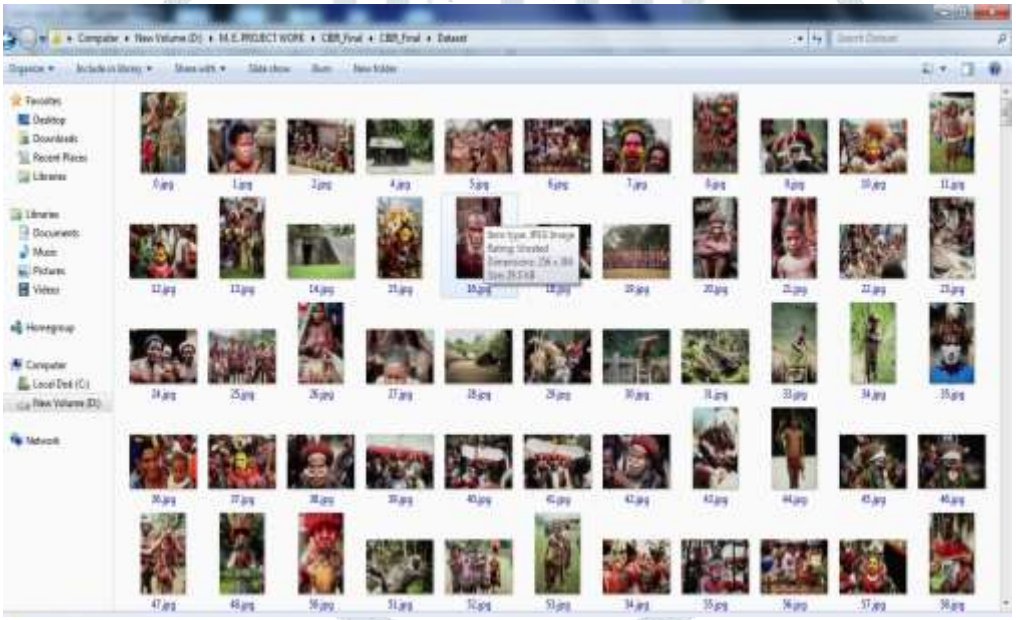


Fig 5.2: Database or test images

- Analysis of query image by using Manhattan as a similarity measure

Fig 5.3: Analysis of query by Manhattan distance

VI. CONCLUSION AND FUTURE SCOPE

In this work, a content based image retrieval technique has been proposed which finds several applications in the field of Biodiversity Information Systems, Digital Libraries, Crime Prevention, Fingerprint Identification, Medicine, Historical Research and many others. The proposed technique of content based image retrieval (CBIR) is based on extraction of color, texture and shape features where the similarity metric such as Euclidian, standard Euclidian, Manhattan, Mahalonobis, Chebyshev and Miniskowi distances were used to retrieve the similar images with reference to input query image.

To extract the color features, various color descriptors like color histogram, color correlogram and color moments were used in this work. For texture features, gabor wavelet and wavelet transform method has been proposed due to their strong time-frequency representation capabilities. For shape based features the sobel edge detection algorithm has been proposed because its performance is unaffected by the presence of noise in the image. Overall this work is an attempt towards designing and development of robust image retrieval algorithm which will provide high retrieval accuracy with low retrieval time.

The further work that needs to be extended is hybrid combination of color, texture and shape features and their testing on standard as well real time dataset to record the performance of developed algorithm. Region based retrieval systems are effective to some extent, but their performance is greatly affected by the segmentation process. Development of an improved image segmentation algorithm is one of the scopes for future work. The retrieval performance can be enhanced by development of automatic pre-classifier which classify the database into different semantic images.

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