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Global Descriptor Attributes Based Content Based Image Retrieval of Query Images

Jaykrishna Joshi*, Dattatray Bade**
*(Department of Electronics and Telecommunication, Mumbai University, Mumbai-421 601)
** (Department of Electronics and Telecommunication, Mumbai University, Mumbai-400 037)

ABSTRACT
The need for efficient content-based image retrieval system has increased hugely. Efficient and effective retrieval techniques of images are desired because of the explosive growth of digital images. Content based image retrieval (CBIR) is a promising approach because of its automatic indexing retrieval based on their semantic features and visual appearance. In this proposed system we investigate method for describing the contents of images which characterizes images by global descriptor attributes, where global features are extracted to make system more efficient by using color features which are color expectancy, color variance, skewness and texture feature correlation.

Keywords **-** Content based image retrieval (CBIR), Retrieval, Query Image, Global Descriptor Attributes and Color Histogram

I. INTRODUCTION

With the advances in computer technologies and the advent of the World Wide Web, there has been an explosion in the amount and complexity of digital data being generated, stored, transmitted, analyzed, and accessed. Much of this information is multimedia in nature, including digital images, video, audio, graphics, and text data[1]. In order to make use of this vast amount of data, efficient and effective techniques to retrieve multimedia information based on its content need to be developed. Among the various media types, images are of prime importance.

An image retrieval system is a computer system for browsing, searching and retrieving images from a large database of digital images. Most traditional and common methods of image retrieval utilize some method of adding metadata such as captioning, keywords, or descriptions to the images so that retrieval can be performed over the annotation words. The reason behind research on multimedia systems and content-based image retrieval (CBIR) is the fact that multimedia databases deal with text, audio, video and image data which could provide enormous amount of information and which has affected life style of human for the better.

CBIR is the application of computer vision to the image retrieval problem, that is, the problem of searching for digital images in large databases[2]. Content-based image retrieval also known as query by image content (QBIC) and content-based visual information retrieval (CBVIR). "Content-based" means that the search will analyze the actual contents of the image. The term 'content' in this context might refer colors, shapes, textures, or any other information that can be derived from the image itself. There are some types of feature used for Image retrieval such as color retrieval, textual retrieval, shape retrieval and so on. Figure 1 show diagram fundamental of content-based image retrieval system.

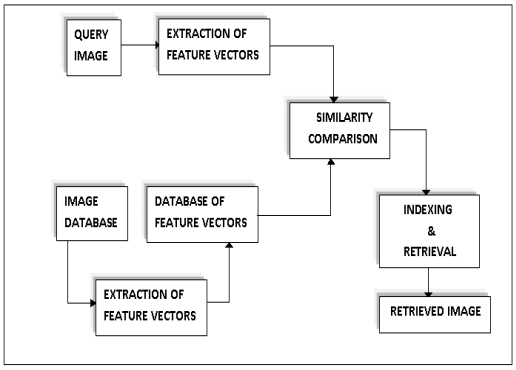

Figure.1 Block Diagram of Basic Content Based Image Retrieval System

II. CONTENT-BASED IMAGE RETRIEVAL (CBIR)

Content-based image retrieval (CBIR) has become one of the most active research areas in the past few years. Thus, many visual feature representations have been explored and many CBIR systems have been built. However, there are several problems and challenges need to be consider in attempt to apply CBIR systems. Firstly, the gap between high-level semantic concept and low-level visual features is great. In the CBIR context, an image is represented by a set of low-level visual features which are the features have no direct correlation with high-level semantic concept[3]. Human prefer to retrieve images according to the

"semantic" or "concept" of an image. But, CBIR depends on the absolute distance of image features to retrieve similar images Thereby, appear the gap between high-level concepts and low-level features which is the major difficulty that hinders further development of CBIR systems. In other sentence, the semantic gap problem is the lack of coincidence between the image representation and the human interpretation for an image.

There are many existing feature selection techniques such as distribution based approaches, Kullback-Leibler divergence (K-LD), boosting manner, discriminant analysis (DA) method and others. However, these feature selection techniques remains a challenging problem for image retrieval. In recent year, there are a lot of discriminant analysis method had been proposed and used as a feature selection method to improve relevance feedback. These methods included multiple discriminant analysis (MDA), biased discriminant analysis (BDA), kernel-biased discriminant analysis (KBDA) and nonparametric discriminant analysis (NDA). The goal of discriminant analysis is to find a weight matrix such that the distances between the two scatter class matrixes are maximized.

However, these methods have their own drawback that must be solved to improve the performance of CBIR[4]. Basic single Gaussian assumption which proposed by MDA and BDA usually doesn't hold, since the few training samples are always scattered in the high dimensional feature space, and their effectiveness will be suffer. Moreover, single Gaussian distribution means all positive samples should be similar with similar view angle and similar illumination, which are not the case for CBIR. To overcome the problem of single Gaussian distribution assumption, KBDA had been introduced. But, this kernel based method has two major drawbacks which is regularization approach is often unstable and it is rely on parameter tuning. Then, NDA had been proposed to solve the problem in MDA, BDA and also KBDA. This approach can only barely match the accuracy performance of KBDA. As a conclusion, many feature selection methods can not satisfy the requirements in CBIR even though there are many method has been apply in content-based image retrieval[5].

III. METHODOLOGY

The term Content-based image retrieval [CBIR] describes the process of retrieving desired images from a large collection on the basis of features (such as colour, texture and shape) that can be automatically extracted from the images themselves.Content-based image retrieval, also known as query by image content and content-based visual information retrieval is the application of computer vision to the image retrieval problem, that is, the problem of searching for digital images in large databases. 'CONTENT BASED' means that the search makes use of the contents of the images themselves, rather than relying on human-input metadata such as captions or keywords. The surrounding world is composed of images.

There are different models for color image representation. In the seventeen century Sir Isaac Newton showed that a beam of sunlight passing through a glass prism comes into view as a rainbow of colors. Therefore, he first understood that white light is composed of many colors[6]. Typically, the computer screen can display 2^8 or 256 different shades of gray. For color images this makes 2^ (3x8) = 16,777,216 different colors. Clerk Maxwell showed in the late nineteen century that every color image cough be created using three images – Red, green and Blue image. A mix of these three images can produce every color. This model, named RGB model, is primarily used in image representation. The RGB image could be presented as a triple(R, G, B) where usually R, G, and B take values in the range [0, 255]. Another color model is YIQ model (lamination (Y), phase (I), quadrature phase (Q)). It is the base for the color television standard. Images are presented in computers as a matrix of pixels. They have finite area. If we decrease the pixel dimension the pixel brightness will become close to the real brightness. A content-based image retrieval system (CBIR) is a piece of software that implements CBIR. In CBIR, each image that is stored in the database has its features extracted and compared to the features of the query image[7].

Searching and browsing image collections have become important and active research fields in the last decade. There are two approaches to image retrieval: Text-Based approach and Content- Based approach. Querying by image content is one of most promising search techniques where users try to find relevant images based on the given query image. Color, texture, and shape are the low level features that are usually preferred in content-based image retrieval (CBIR) systems. Among these methods, color histogram is the simplest, yet an effective visual feature commonly used in color image retrieval[8]. The aim of query-by-color is to find images, whose color features are similar to the color features of query image. Although color histograms are commonly used in computer vision and have the computational advantages, it is a fact that they are also very sensitive to small illumination changes and quantization errors. In proposed method, firstly we investigate two methods for describing the contents of the images where first one characterizes images by global descriptor attributes. Feature vectors based on color and texture features are called Global Descriptor Attributes[9].

IV. DESIGN STEPS

Step-1: Feature Extraction:

First step in the proposed method is to extract the image features to a distinguishable extinguishable extent. Feature extraction is most critical stage. The end result of feature extraction is a set of features called feature vector; which constitutes the representation of image (features such as color, shape, texture etc. are used to describe the content of image).

Global Descriptor Attributes:

1. Color

Color is the most extensively used visual content for image retrieval. Color feature is one of the most significant features of image retrieval. Its three-dimensional values make its discrimination potentiality superior to the single dimensional gray values of images.

Extraction of color feature is done using

i. Color moment and
ii. Color Histogram

i. Color moment

Sticker and Orengo who propose the method of color moment consider that the color information focus on the low-level color moment of the image, and they mainly do statistics for the first order, second-order and third-order moment of each color component. For image retrieval, the color moment is a simple and effective representative method of color features. Such color moment as first-order (mean) and second (variance) and third-order (Skewness), is proved to be very effective in presenting color distribution of images. The three color moments are defined with formulas as follows:

a) Color Expectancy: It is defined as the average color.

$$\text{Color Expectancy}(\mathbf{E_1}) = \frac{1}{N} * \left(\sum_{j=1}^{N} \mathbf{P_{ij}}\right)$$

b) Color Variance: It is defined as the dispersion of color values from average.

$$\text{Color Variance}(\boldsymbol{\rho_1}) = \sqrt{\left(\frac{1}{N} * \left(\sum_{j=1}^{N} \left(\mathbf{P_{ij}} * \mathbf{E_1}\right)^2\right)\right)}$$

c) Color Skewness: It is defined as symmetry of color distribution on the whole image.

$$\text{Color Skewness}(\boldsymbol{\sigma_1}) = \sqrt[3]{\left(\frac{1}{N} * \left(\sum_{j=1}^{N} \left(\mathbf{P_{ij}} * \mathbf{E_1}\right)^3\right)\right)}$$

Where N represents number of pixels in an image & in an i × j matrix $\mathbf{P_{ij}}$ represents the ij^{th} pixel value.

ii. Color Histogram:

An image histogram is a chart that shows the distribution of intensities in an indexed or intensity image. The CCH of an image indicates the frequency of occurrence of every color in an image. The approach more frequently adopted for CBIR systems is based on the conventional color histogram (CCH), which contains occurrences of each color obtained counting all image pixel shaving that color.

2. Texture:

Texture is that innate property of all surfaces that describes visual patters, and that contain important information about the structural arrangement of the surface and its relationship to the surrounding environment**.** Texture is another important property of images. Various texture representations have been investigated in pattern recognition and computer vision.

Step-2: Normalization:

If the image energy varies with position, matching using cross correlation can fail. For example, the correlation between the feature and an exactly matching region in the image may be less than the correlation between the feature and a bright spot. The range of correlation is dependent on the size of the feature. Normalization is performed so that all images have a fixed dimension in order to allow comparisons.

Step-3: Inputting Query Image:

To retrieve images, users provide the retrieval system with example images or sketched figures (Query image). The system then changes these examples into its internal representation of feature vectors.

Step-4: Matching:

The similarities /distances between the Global Descriptor Attributes (GDA)of the query example or sketch and those of the images in the database are then calculated. This step involves matching these Global Descriptor Attributes (GDA) to yield result that are visually similar. If the Euclidean distance between the query image and the images in the database is small enough the corresponding image in the database is considered as the match to the Query image. Formula for Euclidean distance is given below

$$\mathbf{ED} = \sqrt[z]{\left((\boldsymbol{R_2} - \boldsymbol{R_1})^2{}_1 + \cdots\cdots + (\boldsymbol{R_2} - \boldsymbol{R_1})^2{}_i\right)}$$

Where

ED= Euclidean Distances

$\mathbf{R_1}$= Visual features of image query

$\mathbf{R_2}$= Visual features of images in database

i = Feature in which i start with i=1

Step-5: Simulation:

Instead of exact matching, content-based image retrieval calculates visual similarities between a query image and images in a database. Accordingly,

the retrieval result is not a single image but a list of images ranked by their similarities with the query image. Many similarity measures have been developed for image retrieval based on empirical estimates of the distribution of features in recent years. Different similarity/distance measures will affect retrieval performances of an image retrieval system significantly. In the proposed method this step involves sorting the images based on their Euclidean distance values and ranking them in ascending order. After this calculate the Match Percentile (MP) by using the formula

$$\text{Match Percentile (MP)} = \frac{(N-R)}{(N-1)}$$

Where N= number of images in the database, R = Rank of the image

Step-6: Applying Conventional Color Histogram(CCH):

The CCH is constructed by counting the number of pixels of each color. Histogram based search method is investigated in RGB color space only on filtered databases. A higher successful rate is retrieving target image is obtained.

peppers.png **dog.png** **guitar.png** **flower.png** **Gantrycrane**
seq nos → 1 2 3 4 5

balloon.png **fabric.png** **pepper_1.png** **pepper_2.png** **pepper_3.png**
seq nos → 6 7 8 9 10

Figure 2: Results

Peppers.png **Pepper_1.png** **Pepper_2.png** **Pepper_3.png** **Fabric.png**

Figure 3: Top Five Sorted Images

V. RESULTS

The first image is the query image Peppers.png. The eighth image which is Pepper_1 is rotated (180 degree) image of the query image. The ninth and the tenth image Pepper_2 and Pepper_3 respectively are developed by doing some changes in illumination and brightness to the query image. These images are included in the database to show and represent the accuracy of the proposed algorithm.

Next step involves sorting of images in descending order and extracting top five relevant images (with respect to the given query image) from the database based on their Average match percentile value as shown in Figure 3.

Table.3 Histogram Error of top 5 sorted images

Rank	Image name	AMP	Histogram error
1	**Peppers.png**	**1.0000**	**0**
2	Pepper_1.png	0.8929	0.0425
3	Pepper_2.png	0.8810	0.0469
4	Pepper_3.png	0.8095	0.0451
5	Fabric.png	0.7857	0.0547

The Table.3 shows the top five extracted similar images which are sorted with respect to the average match percentile value. After applying CCH on the five extracted images, histogram error is calculated between the query image and the top five images. As seen in the Table.3 above, the histogram error is zero for the Peppers.png image which is the query image.

A histogram error of zero indicates a perfect match. Thus the retrieved image is same as the query image.

VI. CONCLUSION

The need to find a desired image from a collection is shared by many professional groups, including journalists, design engineers and art historians. While the requirements of image users can vary considerably, it can be useful to characterize image queries into three levels of abstraction: primitive features such as color or texture, logical features such as the identity of objects shown and abstract attributes such as the significance of the scenes depicted. While CBIR systems currently operate effectively only at the lowest of these levels, most users demand higher levels of retrieval. Due to the use of global descriptor values to extract images the process of retrieval method is much faster than the conventional approach of retrieval of images.

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