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Content Based Image Retrieval: Feature Extraction, Current Techniques, Promising Directions

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Abstract— The revolutionary Internet and digital technologies have bounden a need to have a system to form abundantly available digital images for easy and accurate retrieval. In this scenario, it is necessary to develop appropriate information systems for efficiently manage these collections .The most common approaches use which is called Content-Based Image Retrieval (CBIR) systems. This Retrieval methods based on color, texture, and shape image are discussed, analyzed and compared[1]. The semantic-based image retrieval is a better way to solve the "semantic gap" problem. One of the main benefits of the CBIR approach is the possibility of an automatic retrieval process, alternatively the traditional keyword-based approach, which usually requires very laborious and time-consuming previous annotation of database images .This paper aims to introduce the problems and challenges concerned with the creation of CBIR systems, for describe the existing solutions and applications and to present the state of the art of the existing research in this area.

Keywords— Content-based image retrieval; Semantic gap; color space;color histograms,color feature; texture feature shape feature

I. INTRODUCTION

The idea behind content-based retrieval is to retrieve, from a database, media item such as images, video and audio those are relevant to a given query. Relevance is judged based on the content of media items[2]. Traditional approach of searching the image was by indexing or simply by browsing. Main problem with the historical approach is to another way of accessing the image on the basis of their content or feature. Therefor Content Based Image Retrieval is defined as a process of searching a digital image from the big database on the basis of their visual features like shape, color and texture. Now there is no need to apply the indexing and images can be fetched in an effective and efficient manner[6]. This method reduces the semantic gap between the low level visual features and high level semantic features.

Several steps are needed retrieving images from a large database. Firstly the features from the media items are extracted and their values and in dices are saved in to database. Then the index structure is used to filter out all irrelevant items by checking attributes with the user's query shown in fig1. At last finally, attributes of the relevant items are compared according to some similarity/dissimilarity measure to the attributes of the query and retrieved items are ranked in order of similarity.

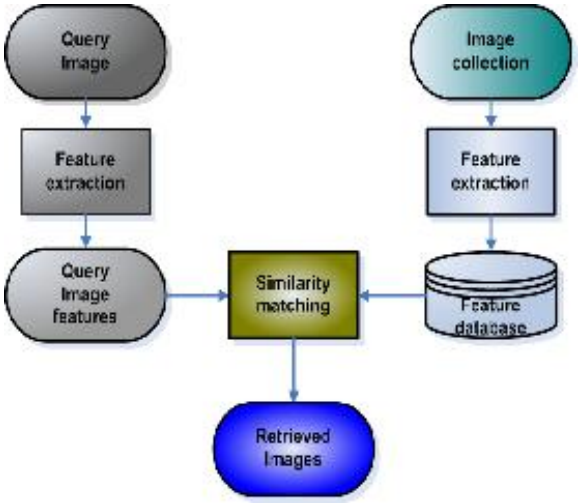

Fig1.Content based image Retrieval

CBIR is in demand because searches that rely purely on meta data are interdependent on annotation quality and completeness. Most of the web-search-engines retrieve similar images by searching and matching textual metadata associated with digital images.

II. FEATURE EXTRACTION

Visual feature extraction is the based on any of content-based image retrieval technique. In a broad sense, features may include both text-based features like key words, annotations and visual features like color, texture, shape, etc[7]. Within the visual feature scope, the features can be classified in to low- level features and high-level features. The selection of the this features to represent an image is one of the keys of a CBIR system. Because of representation subjectivity and the complex composition of visual data, there does not exist a single best representation for any given visual feature. Multiple approaches are been introduced for each of these visual features and each of them characterizes the feature from a different perspective.

A. Color Based Retrieval

Color is a perception which is depends on the outcome of the human visual system to light and the interaction of light with objects. The main issues in color feature extraction include the color space, color quantization, and the choice of similarity function[4]. Different studies of color perception and color spaces have been proposed. Each pixel of the image can be represented as a point in a 3D color space. If we want to describe an image by its color features, we have to firstly determine the color space to use. There exist different space models such as RGB, HSV, CIE L*a*b*, CIE L*u*v* or opponent color.

Color space

A range of colors can be created by the primary colors of pigment and then these colors are define a specific color space[3]. Color space, also known as the color model (or color system), is an mathematical model which simply describes the range of colors as group of numbers, typically as 3 or 4 values or color components which is RGB. Basically speaking, color space is an elaboration of the coordinate system and sub-space. Each color in the system is described by a single dot. A color space is a useful method for users to understand the color capabilities of a particular digital device or file. It shows what a camera can see, a monitor can display or a printer can print, and etc. There are a variety of color spaces, such as RGB, CMY, HSV, HIS. Some of those are explain in this paper.

Hexadecimal Color

Hexadecimal color are used on web pages to specify colors. Hexadecimal color codes always start with a hash (#). Different combinations can produce different color. Such as color blue, the color code is #0000FF, which is '0'red, '0'green and '255' blue. These color codes can be used to change the color of background, tables and text.

RGB Color Model

*RGB (R=Red, G=Gr*een, B=Blue) is a kind of color space which uses red, green and blue to elaborate color model. An RGB color space can be simply interpreted as "all possible colors" which can be made from three colors which is red, green and blue. each pixel of an image is assigned a range of 0 to 255 intensity values of RGB components. Therefore , using only these three colors, there can be 16,777,216 colors on the screen by different mixing ratios.

CMYK Color Model

The CMYK color model is a subtractive color model, is also called process color or four colors. It is used for Color printing which typically uses ink of four colors: cyan, magenta, yellow, and key (black)[5].In order to save money on ink, and to produce deeper black tones, unsaturated and dark colors are produced by using black ink instead of the combination of cyan, magenta and yellow.

HSL and HSV Color Model

HSL and HSV are the two most common cylindrical-coordinate on behalf of points in an RGB color model, which rearrange the geometry of RGB trying to be more intuitive. HSL also called HLS stands for hue, saturation, and lightness, which is founded by Alvy Ray Smith in 1978. HSV also called HSB, B for brightness stands for hue, saturation, and value. HSI is a third model, common in computer vision applications, which stands for hue, saturation, and intensity.

YUV color space

The black-and-white system used only luma (Y) information; color information (U and V) was added in such a way that a black-and-white receiver would still display a normal black-and-white picture. Color receivers decoded the additional color information to display a color picture. RGB to YUV conversion is shown in below formula.

$$\begin{pmatrix} Y \\ U \\ V \end{pmatrix} = \begin{pmatrix} 0.299 & 0.587 & 0.114 \\ -0.14713 & -0.28886 & 0.436 \\ 0.615 & -0.51499 & -0.10001 \end{pmatrix} \begin{pmatrix} R \\ G \\ B \end{pmatrix}$$

*Color Histogram:-B*asic technique which is based on the technique of color histogram. Color Histogram of each image is calculated and then stored in the database which represents the proportion of pixel of each color within the image. Then matching algorithm will extract those images from the databases whose color histogram matches with the required one. There are various types of histograms: normal,weighted, dominant, and fuzzy.

B. Shape Based Retrieval:

Two major steps are involved in shape feature extraction. They are object segmentation and shape representation. Once objects are segmented, their shape features can be represented and indexed. In general, shape representations can be divided into two categories, boundary-based and region-based. There are two main features of the shape: Global feature (like aspect ratio) and local feature (like boundary segments). Shape of an image can be represented using area, perimeter, radius, skeleton, statistics moments, form signature, Fourier and Hough contour signature.

C. Texture Based Retrieval

This is a very essential characteristic of an image because it is able to distinguish two images with same color and shape. A lot of techniques has been proposed for matching the texture similarity. Texture representation on 6 statistical features, including, coarseness, contrast, directionality, line likeness, regularity, and roughness. Various techniques designed for texture feature extractions are: statistical parameters, entropy measures, transformed spaces and Markov Hidden Fields algorithms .There are some major issues in texture analysis:

a.Feature extraction: to compute a characteristic of a digital image able to numerically describe its texture properties.

b.Texture discrimination: to partition a textured image into regions, each corresponding to a perceptually homogeneous texture .

c.Texture classification: to determine to which of a finite number of physically defined classes for example normal and abnormal tissue, a homogeneous texture region belongs

d.Shape from texture: to reconstruct 3D surface geometry from texture information.

Approaches to texture analysis are usually categorized into structural, statistical, model-based and transform.

III. SIMILARITY MEASUREMENT

Determining similarities among data objects is a difficult task of content-based multimedia retrieval systems. The purpose of a measure of similarity is to compare two lists of numbers and compute a single number which evaluates their similarity. The most common method for comparing two images in content-based image retrieval is using an image distance measure. An image distance measure compares the similarity of two images in various dimensions like color, texture, shape, and others. For example a distance of 0 signifies an exact match with the query, with respect to the dimensions that were considered. As one may gather, a value greater than 0 indicates various degrees of similarities between the images. Search results then can be sorted based on their distance to the queried image.

The basis of many measures of similarity and dissimilarity is euclidean distance. The distance between vectors X and Y is defined as follows:

$$d(x,y) = \sqrt{\sum_{i}^{n} (x_i - y_i)^2}$$

In other words, euclidean distance is the square root of the sum of squared differences between corresponding elements of the two vectors. Note that the formula treats the values of X and Y seriously: no adjustment is made for differences in scale. Euclidean distance is only appropriate for data measured on the same scale. As you will see in the section on correlation, the correlation coefficient is (inversely) related to the euclidean distance between standardized versions of the data Correlation

The correlation between vectors X and Y are defined as follows:

$$r(X,Y) = \frac{\frac{1}{n}\sum_{i} x_i y_i - \mu_X \mu_Y}{\sigma_X \sigma_Y}$$

where μX and μY are the means of X and Y respectively, and σX and σY are the standard deviations of X and Y. The numerator of the equation is called the covariance of X and Y, and is the difference between the mean of the product of X and Y subtracted from the product of the means

IV. INDEXING

When the number of images in the database is increasing, there is a need for indexing visual information to avoid sequential scanning for saving time. Index structures ideally filter out all irrelevant images by checking image attributes with the user's query. Therefore, only relevant images has to be analyzed more carefully. Some examples of indexing methods used in content-based image retrieval are given here. They include k-d Trees, different types of R-Trees and SS-Trees. K-d Trees are binary trees in which during searching, the value of one of the k features is checked at each node, to determine the appropriate sub tree. Different types of R-Trees are suitable for feature vectors of higher dimensions than k-d Trees, since they partition feature space in higher dimensional rectangles. Insertion in SS-Trees is more effective than in R-Trees. Even more effective queries for high-dimensional data can be performed using the Pyramid Technique.

V. CONCLUSION

The goal of this paper has been to give an overview of the content-based retrieval process while focusing mainly on color,shape and texture attributes .Finding the right image is not always easy.There are many millions of digital images available on the Web. Research in content-based image retrieval (CBIR) in the past has been focused on image

processing, low-level feature extraction, etc. Extensive experiments on CBIR systems demonstrate that low-level image features cannot always describe high-level semantic concepts in the users' mind. It is believed that CBIR systems should provide maximum support in bridging the 'semantic gap' between low-level visual features and the richness of human semantics we surveyed the field of content-based image retrieval, by presenting an overview of the most important aspects of images. We compare various methods used in the CBIR techniques using different feature extraction techniques.

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