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A Study and usage of Visual Features in Content Based Image Retrieval Systems

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Abstract: Image retrieval is a prominent area of digital image processing. Images can be retrieved from a large collection of databaseimages on the basis of text, color and structure. Content-based image retrieval uses the visual content ofimages such as color, shape, texture and spatial layout for representing and indexing the images. In a typical CBIR system, thevisual content of the images in the database are extracted and displayed by multi-dimensional feature vectors. Thefeature vector of the images in the database is a feature database. To retrieve the images, users provide theretrieval system with query images. The system then changes query into its internal representation offeature vectors for both query and database images .In this paper we present introduction and literaturereview on various content based image retrieval techniques.

Keywords: CBIR, Content based Image Retrieval, Image Retrieval.

INTRODUCTION

Images play a very crucial role in any visual information Systems and Multimedia. There are a huge number of applications of such information systems in the areas like entertainment, business, art, engineering, and sciences. These kinds ofapplications often involve huge collections of images, so that efficient and effective searching for images is an important operation needed. Image is defines as data representing a two dimensional scene. A digital image is composed of pixels arranged in a rectangular array which have a certain height and width. Each pixel in an image may consist of one or more bits of information, which represents the brightness of the image at that point and it may possibly include color information encoded in as RGB triples. Picture isa visual representation of an object or scene or person or abstraction which is produced on a surface. Image collection is increasing rapidly with the enhancement in various image capturing devices like phone cameras, scanners,digital cameras, mobile cameras and increased use of multimedia data on internet. In order to deal with this huge collection of images an efficient and effective browsing, searching and retrieval tools are required. An image retrieval system is a computer system for browsing, searching and retrieving images from a large database of digital images. .This area of research is very active research since the 1970s. The purpose of an image database is to store and retrieve an image or image sequences that are relevant to a query. There are a variety of domains such as information retrieval, computer graphics, database management and user behavior which have evolved separately but are interrelated and provide a valuable contribution to this research subject. Various Image retrieval systems are developed which are text based image retrieval and content based image retrieval.

Image retrieval get thrust from two major research communities which are database management and computer vision. These two communities see it from two different angles one being text based and other is visual based. Text based system faced many problems and to overcome them research communities have focused on searching based on content of image. This means instead of manually annotating the image by using text based words it has to be represented by its own contents which are color and texture. Image retrieval based on contents is most desirable in most of the applications so there is requirement to extract automatically primitive visual features from the images and then to retrieve those images based on these features. And as humans use color shape and texture to understand mostly so it is natural to use these features for image retrieval. In image retrieval color feature is most widely used feature. Content based image retrieval is to be employed for fast search of image in large scale image collection and to get perfect results.

Informationretrievalis a process which convert request for information to meaningful set of references. As with the advent of time both the memories internal and external are becoming less expensive and as processors are becoming more powerful large image databases have become firm reality. Image databases exist for medical data, satellite images and general collection of photographs. General collection can be searched and accessed by the illustrators who are looking for the right picture for the article or any book. The domain of this application is thought to be enormous as one might be looking for images of sunset, horses or any abstract concept like love. Image databases are very huge which contains hundreds of thousands of millions of images. Image database examples are: IBM QBIC project database. This is a kind of research system which led IBM to develop and sold products. In this images are retrieved based on the visual content and it includes properties like color percentage, color layout and texture.

IMAGE RETRIEVAL APPROACHES

During this era the world is moving very fast because of internet, so we need to develop efficient and effective methodologies to manage large image databases for retrieval. For this purpose there are many general purpose image retrieval systems,which are as follows:

1. Text Based image retrieval.
2. Content Based image retrieval.

TEXT BASED IMAGE RETRIEVAL

Text based Image retrieval is currently used in almost all general purpose web image retrieval systems. Traditionally various textual features such as caption, filename and keywords were being used to annotate and retrieve images. There are many problems found with this method. At first

human intervention is required to describe any contents of image and tag them in terms of some words.

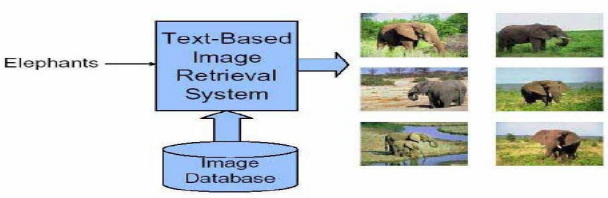

Fig.1Text-Based image retrieval

As shown in Fig. 1 this approach uses the text associated with an image to determine what the image contains. Google, Yahoo Image Search engines are examples of systems using this type of approach. The problem occurs because in most of the cases in an image there are several objects which can be referenced and each object has its own set of attributes..However these search engines are fast and robust but sometimes they fail to retrieve relevant images. There are various advantages along with disadvantages of such systems. Advantages are :-They are easy to implement and perform Fast retrieval. Disadvantages are: Manual annotation is impossible for a large database, manual annotation is not accurate, polysemy problem which means more than one object can be refer by the same word, surrounding text may not describe the image. As size of the image grows it becomes difficult and complex to represent the image content. If we need to share the image database globally the linguistic barrier may make annotation ineffective. To overcome all such problems a new image retrieval system is designed.

CONTENT BASED IMAGE RETRIEVAL (CBIR)

In late 1990's, Content-based image retrieval was introduced by T. Kato. IBM was the first, who take an initiative by proposing query-by image content (QBIC).CBIR involves the following four parts in system realization: data collection, build up feature database, search in the database, arrange the order and results of the retrieval. Features employed by the image retrieval systems include color, texture, shape and spatial are retrieve automatically and similarities of images are based on the distances between features .Result of content based query will be most similar to desired image as shown in Fig 2.If user is searching for a particular object like horse then for sure he is going to get images similar to it.

TYPES OF CONTENT BASED IMAGE RETRIEVAL

a). REGION BASED: In it during retrieval, a user is provided with segmented regions of the query image, and is required to assign several properties, such as the regions to be matched, the features of the regions, and even the weights of different features .

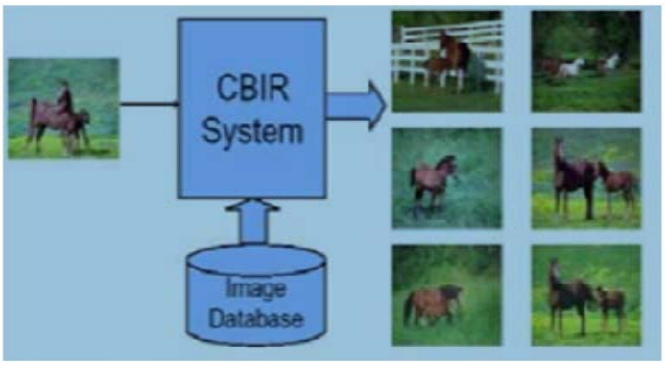

Fig 2 Content Based Image Retrieval[1]

b)OBJECT BASED: It retrieve mages from a database based on the appearance of physical objects in those images. These objects can be elephants, stop signs, helicopters, buildings, faces, or any other object that the user wishes to find. Such image retrieval systems are generally successful for objects that can be easily separated from the background and that have distinctive colors or textures

c). EXAMPLE BASED: Users give a sample image, or portion of an image, that the system uses as a base for the search.The system then finds images that are similar to the base image.

d) FEEDBACK BASED: System shows user a sample of pictures and asks for rating from the user. Using these ratings, system re-queries and repeats until the right image is found.

1.2 Framework of a CBIR System

The working framework of a CBIR System is shown in figure The main steps that need to be addressed in CBIR approach are the following:

1. Image Acquisition: Image is acquired using digital devices and image database is created.
2. Image Preprocessing:Images are preprocessed before the retrieval process to enhance the images so that more similar images could be retrieved. It involves enhancement, noise removal, segmentation etc.
3. Feature Extraction:In this feature like texture, color or shape is obtained from images and a feature vector database is created. Features can be broadly classified into low level and high level features. These FV databases are used for measuring the similarity between querying image and database images.
4. Similarity Matching:Similarity matching techniques are used for acquiring percentage of similarity between the queried image and images existing in the database.
5. Output/ Retrieved Images:These are the final outcomes after the whole process is done by matching.
6. User Interaction/Feedback:User can communicate with the system for classifying the images whether they are relevant or not. This process goes on until the user gets satisfied.

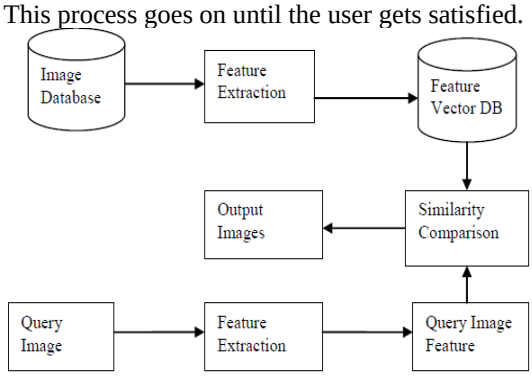

Fig 3: Block Diagram for CBIR Technique

CBIR may address the disadvantages of text-based retrieval systems. CBIR first requires construction or availability of an image database; features are then extracted from the images. A basic CBIR system is composed of two parts. The first contains the visual information contained in image pixels represented as image features and descriptors. Typically, visual components of the image, such as, color, texture, shape, faces, and spatial layout of objects and various geometric shape characteristics and/or a combination of these are utilized as the features. Photometric features exploit color and texture properties, and are derived directly from raw pixel intensities. Geometric features make use of shape-based properties. The feature data set is then built. The second CBIR component assesses similarities. If an image query is given, the feature vectors are extracted, and similarity matching is performed. A group of similar target images are retrieved and presented based on rank similarity matching. In summary, CBIR is a mechanism for describing and recording image content based on pixel and voxel information, and then determining the similarity between the query image and the database image.

LITERATURE REVIEW

The research in content based retrieval system is done initially using inherent features .It make use of representation of the features that are extracted from the images themselves [2].A content Based Image retrieval(CBIR) system first extract the features ,then index those features by using some appropriate structure and then efficiently provide the result to the users query. CBIR provides some flow of work to provide the satisfactory answers to the users query. Firstly a CBIR system takes an RGB image as input then perform feature extraction, perform a similarity computation with the image which is stored at database and then retrieve the output image on the basis of similarity computations.Some basic CBIR system fundamentals are divided into three parts .They are feature extraction, multidimensional indexing and retrieval system architechture[3]From both query image as well as image database features of the image are extracted and then they are matched. If features match then image is retrieved on the basis of matching features as shown in above figure. Features are of two types which are text based and visual based. Text based features are like tags, annotations and keywords. Whereas visual based features are color, texture, shape and spatial information.For general purpose study the extraction of these features are given emphasis.

Color feature is the characteristic of image which is easily perceived. It is generally represented by using histograms.Retrieval using this feature has fast speed and storage space required is modest. This feature is also not susceptible to rotation of the image. Retrieval using color is most important area to search. It is categorized into two ways global color feature search and local color feature search. Color histogram is most commonly used approach with global colors[4].

Swain[5] has used color histogram approach for indexing .The main idea was to count the number of times a color occurs in image array and then color histogram intersection is used to match two images. Histogram intersection algorithm used in this approach matches the query's image color histogram with the histograms of the each image model in the database. If the match value is higher better it is. The technique of Histogram intersection is good to match color histograms. The biggest weakness in this was it loses space information of animage color entirely.As images are characterized using color histograms so there may be case images with little bit different appearance have similar histogram[6].So these images need to be compared before retrieval.

Pass [6] put forward color vector aggregation as a means of image index. He used histogram refinement technique for further put condition on histogram based matching. In this technique pixels of a bucket are split up into classes on the basis of some local features. Local features include texture, orientation, and distance from the nearest edge along with relative brightness.So in this technique if pixels do not belong to same class but are in same bucket they cannot be matched.Pixels which are in same class can be distinguished by any standard methods. Color coherence vectors used in this scheme are more complex form of histogram refinement. The issue of color space information which was withthe technique of Swain is resolved by using aggregate vector. A uniform color space would result in better query results. The issue with this approach is color constancy problem which means an object of same color appear different when counted in different lighting conditions.

Sticker and Orengo propose a new color indexing technique. It is stronger form of color histogram approach. The Paradigm of color indexing into an image database works as follows-when a query image is given, what we want is an image which has color composition similar to color composition of the query image. Color indexing is based on the consideration that often color is used to encode a functionality [7].For example: roads are black, forests are green, sky is blue.An objects color is not major criteria to find its identity.Even Texture and some geometric properties are needed to determine identity.So mere color indexing methods give false results. To overcome this Sticker and Orengo gave two color indexing methods. In first method, the index contains complete color distribution of images in the form of cumulative color histograms. The color distribution are compared by using L infinity metric along with L one and L two metric which were used in earlier technique. The second method proposed by both of them is totally different approach to color indexing. Here we need not to store the complete color distribution but only major features of these.If the choice of features is good it can make retrieval results robust.So only major features are compared in retrieval process which is faster than comparing complete color distribution. Histograms cannot handle noise. They are inefficient in handling noise because they are very sparse or distributed. Noise gets added to the images because of image capturing devices. This noise can be removed by using Filters.[8].

Plataniotis worked for noise removing filters for images. He has placed emphasis on filtering algorithms based on fuzzy concepts which allows the use of adaptive weights in filtering structures. Filtering is a process of approximating a signal degraded by additive random noise[9]. Image signal are possessed of flat regional parts and abruptly changing areas like edges that carry information for visual perception. Filters which have good edge and that contain image detail preservation are suitable to image filtering. Here adaptive fuzzy filter used works as double window two stage estimators where we can distinguish between two operations. At first the original signal is filtered to reject possible outliers by using a multichannel median filter in a small processing window then

it is applied to adaptive fuzzy filter to give final estimates. The most common noise encountered in the real time situation is Gaussian, impulsive or a mixture of both.The adaptive fuzzy filter gives near optimal performance for any kind of above noise encountered in any application. In content based image retrieval user's intention to interact with the system is to get the images according to user's desires.

To meet this aim we must bring down the semantic gap among the low level features extracted from image and high level concepts which is human perception and thinking. Aboulmagd[10] purposed new approach to reduce this gap. HSV color space is used in this. Letters H S and V stands for Hue, Saturation and value respectively. Here Hue represents color tone that is red or blue, saturation is the amount of color like pale red or bright red. Component is lightness or intensity means amount of light which is distinction between dark color and light color.Color space has a problem of non-uniformity. As human cannot perceive minor fluctuation of hue when color is of type blue or green but for orange this is not the case.In order to model this non uniformity fuzzy set is used in this approach. Fuzzy attributed relational graph and graph matching algorithm is used. Some of the attributes under testing were size query, contrast, color, hue. In this technique queries based on single attribute provided better answers than the retrieval based on multiple queries combined together. The major drawback of this system was if an object was similar in all the attributes except one then user rates it less similar.

Image retrieval using color feature alone often does not meet user's requirements and provide disappointing results.[11].This is because in most of the cases images having similar colors do not have same contents. It is because global color features does not capture texture or color distribution within an image.Texture is useful in classifying images because texture describes contents of real world images such as trees, clouds in sky, fruits skin, brick etc. Texture is supposed to be repetition of specific pattern of pixels over a spatial domain. And if noise is added to these patterns and its repetitive frequencies may result in an image texture that looks unstructured and random. Texture property is homogenous and it does not result from presence of a single color or intensity.

For some black and white gray scale images to segment the image texture may act as clue. And there may be some images which contain no object. In those scenarios the only way to compare the image is by using texture. In order to retrieve images accurately and efficiently from a database Huang proposed texture based extraction. Texture provides surface characteristics for images. It can be identified by smoothness, coarseness and regularity [12]. Texture can be described by three categories –structural, statistical and spectral. To address retrieval using texture Huang proposed a texture descriptor called CSG vector. And new type of texture signature for images called EDP-string was given. This speeds up the process of image retrieval.In some system image texture is retrieved by using pixel texture property this means small block present in small region. These systems then calculate mean value of texture of all blocks and then use it as region feature. Problems occur in these systems because they cannot define texture for whole region. Manjunath system relies on texture system. System used two characteristics of image. They are image detail feature and coarse feature [13]. Feature image detail serve purpose for image retrieval of desired image and coarse feature for discarding the undesired images.

Gnanaraja presented a texture based segmentation algorithm.Every segmentation algorithm matches any specific features or feature vector which is describing a region[14]. He used a reference image with known texture and a model for classifier is trained. And this model is applied to image of unknown texture. For data extraction different features are calculated and are rated. The features collected this way, best of them are chosen and used to train the classifier. This classifier is then used to segment the images. By Using classifier it is possible to determine the location where that particular text occurs in image. As in this approach an efficient segmentation algorithm was used to form partition or to form regions along with it a region adjacency graph was built for considering spatial relationship among those regions In general only color and spatial information are not sufficient in superior segmentation[15],so including texture gives good results.

Shape of an object in image is configuration which is represented by an outline. Shape recognition is a mode by which human perception of environment is seen. It is important in CBIR because it represent the region of interest in an image. Reshmaproposedan algorithm for shape retrieval .She presented speed of retrieval can be enhanced by using approximate shape for retrieval rather than exact shape[16].To get the approximate information about the shape of an object, she used automatic segmentation process in her shape retrieval system. In the system, depending on the brightness, image is segmented into five classes. Then the attributes such as mass, centroid and dispersion for each class is calculated. This information is stored in shape vector. And for retrieval purpose shape vector of both image query and database images are compared. The images which will match most are returned as result. This methodology have improved accuracy of the content based image retrieval systems by giving more images which are similar to query image.

Quoc worked on improving retrieval of images using image region matching. The technique used is SCF or spatial and color based image retrieval. The system composed of two modules preprocessing and retrieval. First module preprocessing performs the function of extracting appropriate features from images and storing them in database.[17].The retrieval module extract the feature vector from the query pattern and apply any metric such as Euclidean distance for evaluating matching similarity between database image and query image. It ranks database image in decreasing order of similarity with the query image and provide result as most similar images.In images for the classification of objects, images can be classified into two types-foreground and background regions[18].Regions are extracted by using some segmentation algorithm. Wavelet transformis used then to extract shape based texture feature from images. Objects in images are automatically classified. Neural network is another method to classify objects. As by focusing on some salient parts in images it becomes easy to understand them, a CBIR system is also focused on this by confining to selective portion and rest of part is irrelevant.

Guoyong combined all three features in his research and showed their advantages.He made use of an algorithm which can reduce the influence of the background. Algorithm used an interactive segmentation algorithm (image is divided into different partition of different size) to generate a hard partition. Then to acquire ideal segmentation around the hard partition it use border matting[19]. Improvements are made in the areas

like to use Gaussian Mixture Model to replace the histogram and extending grey level images to color images.For color feature extraction he has used HSV by converting values of RGB to it. For shape feature at first color image is converted to gray level image. He proposed seven moments for translation, scaling and rotation. Then eigenvector of shape is formed which is automatically stored in feature library. His experiments has shown increased precision which means number of images associated with the example in the result to the number of images to the number of images returned for the query. The problem with this approach is it has long response time.

Heller and Zoubin specified a simple Bayesian network for content based image retrieval in which distribution of texture and color features are modeled[20].As a user first specify query ,set of images are extracted by system. Then a Bayesian score is computed for each image by distribution of color and texture features in a large unlabeled collection of images.All unlabeled images weregiven ranks using Bayesian score and topmost images are returned. This paper has shown that it is advantageous to use set of images for retrieval other than using a single image or plaintext. Relevance feedback mechanism can be combined in it for searching specific target images.

In order to give fast retrieval and clarity in images segmentation process can be applied to retrieval. Mustafa proposed a segmentation approach to address above issue. He included low level features like color, texture and spatial information. He used earlier developed mean shift algorithm. This algorithm was giving good results for color and spatial information. But in some cases only these features are not sufficient. So he included texture descriptor as additional feature. He used wavelet frames that give translation invariant results. Wavelet transformation is used to decompose the image into sub bands. Most of the texture information is stored in some of those bands. For each sub band K-mean clustering algorithm is used to specify the values of energy in two classes. And same algorithm is used to generate the result. The results were robust and accurate as compared to mean shift algorithm. For taking into account characteristics of relevant and irrelevant images neural networks can be used for classification of images.Shereena did experiments by classifying images using neural networks. And results showed that methods which are based on hybrid combination of features such as color and texture give higher accuracy than the methods which are based on retrieval using single feature extraction. It is difficult to say one feature is superior to other[21].She showed Texture feature combined with color histogram give better results. Neural network classification improved recall rate and retrieval time.

CONCLUSION

With time multimedia technology is becoming more popular and users are not satisfied with the traditional information retrieval technique. Content based image retrieval is becoming source of fast and exact retrieval. The applications of CBIR are in dermatology and blood cell detection etc. Image has features like color, texture and shape. Various techniques are employed by researchers to extract images from database by using single feature as well making combination of those features. When features are combined it gives more accurate and exact results. Combining all three features give fast results as well accuracy is improved by this approach of image retrieval.

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