"Feature Extraction in Content Based Image Retrieval: A Review"

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ABSTRACT
Due to the rapid growth of image databases in almost every field like medical science, multimedia, geographical information system, photography, Journalism, etc., a effective and efficient technique is required to process the image .Content-based image retrieval is a technique which is used to extract the images on the basis of their content such as texture, color, shape and spatial layout. However it's very difficult to retrieve the image due to the semantic gap between the user's high level concepts and low-level features of the image. In order to minimize this gap many concepts was introduced. Moreover, Images can be stored and extracted based on various features and one of the prominent feature is Texture.

Keyword - **Content Based Image Retrieval, Fuzzy Logic, Neural Network, Relevance Feedback, Color, Texture, Shape, Semantics.**

1. INTRODUCTION

With the advancement of technology, computational power and reduction in the price of memory, there is a need to switch from the traditional approach to the new advancements. Maintenance of large database is very crucial and especially when large collection of digital images need to be maintained. In many areas where digitized images are required like Journalism, Hospitals, academia, multimedia, geographical information system, crime prevention, pattern recognition, statistics, fashion, architecture and many more. Thus over the decade the volume of digital image is increasing very exponentially. Thus several companies and researchers are working on it to maintain the voluminous and varied amount of database.

Traditional approach of searching the image was by indexing or simply by browsing. Problem with the historical approach leads to another way of accessing the image on the basis of their content or feature. Thus Content Based Image Retrieval (CBIR) is defined as a process of searching a digital image from the large 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. This reduces the semantic gap between the low level visual features and high level semantic features. Image database is different from the traditional approach. It is a two-step process:

a. *Image Extraction*: In this step image is extracted based on the image feature, every image is based on its pixel values.
b. *Matching Step*: In this step, the features extracted from the query are matched with the features of the images stored in the database and identify the visually similar images.

Various algorithms were proposed for the extraction of similar images on the basis of features of the images using various techniques.

2. CONVENTIONAL APPROACH

2.1. Growth of Digitized Images

From the ancient times, the use of the images is very common. They tells us who we are and where we come from. Images are the best way to memorize the time that we spent with our loved ones. Also, images are more eye-catchy then the raw data. Thus now a day's images play a very crucial role in every field. With the advancement in technology, everything becomes digitized which provides ease to the user in every aspects. World Wide Web is the real example for the enormous storage of the digitized images. It contains millions or trillions of images in their databases.

2.2. Need for maintenance for image database

Digitization not only makes the process to store the images in an easy manner but also provide you to search it an efficient manner. Many researchers

have found that visual data all over the world is increasing day by day at very fast speed.

3. WHAT IS CBIR

Content Based Image Retrieval is an application of computer vision where digitally similar images are retrieved from the large database on the basis of their content. Content in this context refer to the Information that describes the image like color, texture, and shapes. The detailed survey on content based image retrieval can be referred [1, 2, 22].

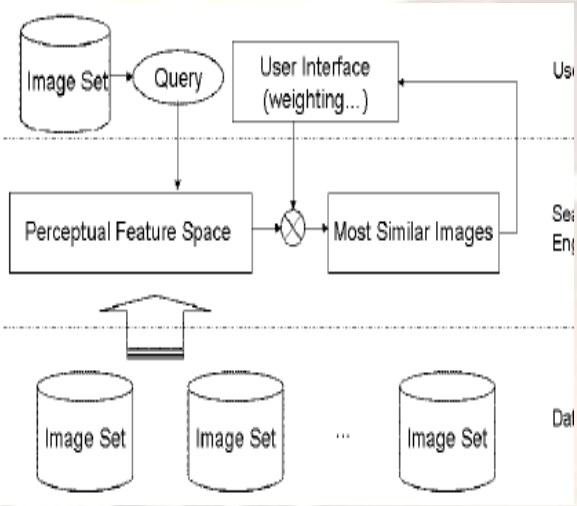

Figure 1: Generic CBIR System

3.1. *Color Based Retrieval*: The Basic technique which is used 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, various color spaces: HSV, grayscale, HSL, Lab, Luv, HMMD, and YCbCr.

3.2. *Texture Based Retrieval*: This is a very important characteristic of an image because it is able to distinguish two images with same color and shape. Variety of techniques has been proposed for matching the texture similarity. Tamura et al. [12], proposed a texture representation on 6 statistical features, including, coarseness, contrast, directionality, line-likeness, regularity, and roughness. These features were considered to be the most visually meaningful. Various techniques designed for texture feature extractions are: statistical parameters, entropy measures, transformed spaces and Markov Hidden Fields algorithms.

3.3. *Shape Based Retrieval*: This is a well defined term, which refers to the shape of the image. This is feature which naturally distinguishes the images. 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, radiuses, skeleton, statistics moments, form signature, Fourier and Hough contour signature.

4. APPLICATIONS

a) Scientific Databases.
b) Art Museum.
c) Medical Science databases.
d) Collection of Photographs.
e) Retail Market Catalogs.
f) Crime Detection & Prevention.
g) The military.
h) Historical Research.
i) Publishing & advertising.
j) Fashion & Graphic Design.
k) Remote sensing.
l) Education & Training.
m) Geometrical Information Systems.
n) Architectural & engineering design.
o) World Wide Web, etc.

5. AVAILABLE SOFTWARE

5.1. *QBIC*: IBM QBIC (Query by Image Content) System [20] was the first commercial system that offers color, texture, shape, layout and keyword based image retrieval. This system serves as the base for the development of new research. To achieve this functionality, QBIC has two main components: database population (collection of still images and videos) and database query. The online demo of QBIC is available at www.qbic.almaden.ibm.com/.

5.2. *Virage*: This is another well known commercial organization from Virage. Inc. allowing web

surfer to find the image on the basis of content. Virage support visual queries based on color, texture, shape, color layout and keyword based image retrieval. This is one step forward to QBIC system. It supports arbitrary combination of above four atomic queries. The online demo of Virage is available at http://www.virage.com/products/vir-irw.html.

5.3. *Blobworld*: Here images are segmented on the basis of their color, plus texture. Then according to the selected region the matching algorithm will return the images from the database. Querying is based on the attributes of one or two regions of interest. Blobworld works really very well for Tiger and zebras. The online demo of Virage is available at http://elib.cs.berkeley.edu/photos/blobworld/start.html.

5.4. There is much more available software in market like Excalibur, Ditto, Photobook, Visualseek and Websek, Netra, MARS, and Retrieval Ware etc.

6. FUZZY LOGIC BASED APPROACH

There are various algorithms was proposed to implement the content based image retrieval. Most of the designing of the system is based on the concept of fuzziness of the image. As human perception vary from one to another it's very vague to describe the content of the image thus fuzzy is best suitable to implement CBIR. Even more, fuzzy takes the crisp decision at the end. Initially, in [6] 1976 William B. Thompson proposed the method for texture boundary analysis on the basis of dissimilarity of region based on various textural properties. It applies the textural boundary operator to various patterns and then constructs the edge map that identifies the boundaries within the image based on the textural difference.

After that in 1999, Swarup Medasani et.al, [8] designed a Java based system that represent the images using Fuzzy Attributed Relational Graphs. These FARG are stored in the database in groups (clusters) using graph clustering algorithm(LCA FARG) to increase the retrieval speed , where each cluster is represented by a leader FARG such that every element in a cluster is within a distance T of a leader. A total of 149 images are collected from the Vistex database of MIT Media Lab and 500 images are used from NETRA database and the test is conducted on these images. This method also introduced the relevance feedback concept. This method also has some limitations that the segmentation of images is done manually; further relevance feedback concept was only introduced but has not been integrated with it.

In [3], proposed the fuzzy logic approach using the Tamura features for texture feature based extraction of image. Tamura is based on Psychological studies of human perception. They defined six different meaningful properties of texture – coarseness, contrast, directionality, line-likeness, regularity, and roughness. Here, coarseness measures the texture scale; contrast measure vividness of the texture, directionality gives the main direction of the image texture.

With the help of fuzzy clustering, the term set is generated where each tamura feature is represented in linguistic terms. Here, query can be framed as a logic combination of the natural language terms & tamura feature values.

In [4], fuzzy logic based approach was used to reduce the semantic gap between low-level features to high level textures. It uses unsupervised fuzzy clustering approach to represent the tamura features in term set which is represented in natural language. User query is framed as a logic combination of the natural language terms & tamura feature values. Min-max composition rules are used to calculate the distance between user query and the images from the database.

Herba & Neamat [5] provides a new approach for graph matching that resembles the human thinking process. Each image is represented by Fuzzy Attributed Relational Graph (FRAG) that describes each object in the image by all its attribute and spatial relation. This approach used to extract features of texture and color both and successfully implemented the Human Vision System (HSV) model.

In 2008, Wu Kai-xing and Xu Qiang [16], proposed Fuzzy color histogram based on L*a*b* color space component. Here L* stands for luminance, a* stands for relative greenness-redness and b* represents relative blueness-yellowness.

Further, a* and b* was further divided into 5 different regions and L* was also divided into three regions:

a* = [Green, Greenish, Middle, Reddish, Red]

b* = [Blue, Bluish, Middle, Yellowish, Yellow]

L* = [Black, Grey, White]

Now, Fuzzification method is applied using membership function applied on L*a*b*. The output of these membership functions are combined through aggregation operator and then defuzzification is applied.

The similarity ratio is calculated for identifying the similarity between the query image and images stored in the feature database. The precision of this method comes out to be 95% i.e. more accurate and robust approach.

A new image retrieval approach was proposed by Dr. B. Prabhakara Rao. et.al [9]. Using the three features named dynamic dominant color (DDC), Motif co-occurrence matrix (MCM) and difference between pixels of scan pattern (DBPSP) a high precision technique was proposed.

Dynamic dominant color is used because in a given color image, the number of actual color occupies very small proportion of the total color image. Thus dominant color descriptor (DCD) increases the precision. The algorithm used for selection of color space is based on RGB approach which is effective and simple.

Motif Co-occurrence matrix (MCM) is used to calculate the probability of the occurrence of same pixel color between each pixel and its adjacent ones in each image. Using the proposed method, this method is able to consider total 49 number of MCM attributes.

Further MCM specifies the direction of texture but not the complexity of the texture, thus DBSP approach is integrated with MCM to improve texture description.

The performance of the proposed method was evaluated on the image set consists of 1000 images where 10 clusters are formed based on the similarity and around 90 % precision was achieved.

Another approach was proposed by Wang Xiaoling et.al [10], which extracts the color and shape of the image of around 500 images. The experiment includes two parts: Firstly, color feature extraction using Average Area Histogram (AAH); secondly, shape feature extraction using fuzzy image retrieval.

Average area Histogram is an improvement over traditional histogram approach as it reflects the real color distribution over traditional histogram. Basically, traditional histogram is able to identifies the total number of pixel of each color but unable to identify the variations within the same color. Thus, Average area histogram (AAH) is used which uses the area feature of the regions formed by each image color.

In second phase, shape of an image can be identified by various methods. Here Wang Xiaoling et.al uses the moment invariants to describe a region.

Further, image similarity based on fuzzy logic can be identified using the different fuzzy rules that will reflect around 41 % precision i.e., good robustness.

Refer to [17], used the concept of Fuzzy hamming distance (FHD) for retrieving the image based on its content. The proposed system consists of three modules:

6.1. *Preprocessing module*: It basically extracts the information from the image. Then it segments the image and finally represents them in color histogram.
6.2. *Similarity module*: It takes the query image and tries to identify the similarity between them with the help of FHD concept. This method is able to distinguish the images with same color histogram but different semantic content.
6.3. *Ranking module*: It returns the result on the basis of raking arranged in decreasing order.

7. NEURAL NETWORK BASED APPROACH

In [13], proposed content based image retrieval using feed forward neural network approach. To implement this concept, images are clustered together with the help of K-means clustering algorithm and heuristic approach known as differential evaluation. Differential evaluation is a heuristic approach used to identify the value of cluster size i.e., k.

To retrieve the query image from the database images, Gaussian function is applied on the hidden layer of RBF neural network model. With the help of Genetic algorithm, weights are adjusted iteratively for optimization. Further, hierarchical clustering is applied to filter most of the images.

Ionut Mironica and Radu Dogaru in [14] investigated and compare the various clustering based methods used for Content Based Image Retrieval. On this basis, best method is selected in terms of performance.

It covered four different classification methods, Decision Trees, Naïve Bayes, Support Vector Machines (SVM) and Radial Basis Function (RBF-M).

For the implementation and evaluation three different types of databases was maintained: Medical images (320 images), texture database (900 images) and natural database (2700 images).

In overall study, Naïve Bayes classification algorithm is more appropriate than other methods.

8. NEURO-FUZZY BASED APPROACH

The Samuel et.al. [7], proposed a fuzzy combined short-term and long term learning method to construct relevance feedback-based content based image retrieval. Firstly, applies fuzzy support vector machine (FSVM) based short-term learning technique. Here it uses the MPEG-7 150-bin edge histogram descriptor (EHD) and the 64-bin HSV-based scaled color descriptor (SCD) to extract the global low level features with the help of Euclidean distance method. Further it has divided the images into 5 different blocks and then applies the algorithm to identify the relevant and irrelevant blocks. Secondly, in long-term based high level image retrieval, clustering technique to group the images of same semantics and finally, we merge the result to compactly store the memorized feedback information using predictive algorithm to improve the retrieval result.

In [11] proposed an efficient approach for CBIR in order to remove the semantic gap between the low level and high level semantic for image. Rushikesh Borse et.al designed a framework for the implementation of CBIR using the feed forward neural network approach. This framework has been divided into two phases: Firstly, in offline processing all the images are stored with their features and in second phase i.e., online processing query image is processed with user feedback.

It tries to extract the color, texture and shape of the image. The color feature of the image is extracted using color histogram. Texture is calculated using Co-occurrence matrix and Wavelet Transform. Finally description of shape of the image is extracted using the erosion morph feature extraction technique.

Further, in order to reduce the semantic gap, it uses neural network approach using linguistic expression based image description (LEBID) framework as in Fig 2.

Refer to [21], proposed a technique based on fuzzy logic and neural network. The paper has proposed a novel approach to retrieve the features of the image including texture, color and shape with the help of natural language queries, fuzzy mapping of image database and fuzzy similarity distance. The Neural network approach is proposed to learn the meaning of fuzzy queries.

For conducting the experiment, images from various websites and images and for texture images are extracted from Brodatz album. This proposed method achieved 82% of the recall and 87% precision.

9. OTHER TECHNIQUES

In [15], proposed a technique for CBIR texture feature extraction using statistical texture features. Firstly it converts the RGB color image into gray scale single component image in order to reduce the computation. Further, grayscale image is divided into blocks like 2*2, 4*4, 8*8, 16*16, and 32*32.

Now statistical texture features including mean, standard deviation, skewness, flatness, energy, entropy and smoothness are calculated for each block and store these features into feature database. Now, the query image statistical features are calculated with the images stored in the feature database with the help of distance between them.

They used 1000 images, and average precision obtained as 61 and recall as 76.

Refer to [18], presents the concept of multiresolution multigrid framework. It extracts the local color and texture feature of the image by partioning the image into equal sized non-overlapping tiles. Now, features was drawn using conditional co-occurrence histograms computed using the image and its complement in RGB color space. An integrated matching scheme based on most significant highest priority (MSHP) principle, and adjacency matrix of a bipartite graph constructed between images tiles, is implemented for image similarity.

Shape of an image is extracted using the Gradient vector flow field (GVF). Invariant moments are used to represent the shape features. The experimental result shows 96% precision.

With reference to [19], proposed architecture to develop a distributed multimedia retrieval system named as CMRS. Timo Ojala et.al tries to develop an application which supports media independent platform and addition of new media type to the system. To achieve this, Timo Ojala et.al encapsulates the data, operation and user interface related to a particular media type or query entity into a single unit.

With the help of Self Organizing Map (SOM), we can efficiently visualize the database in a 2-dimensional view.

10. MAIN CHALLENGES TO CBIR

There are various issues that are still challenging in the field of CBIR.

- High Dimensionality of the system is required so to incorporate versatile techniques.
- The ultimate end user of the system is Human, so to make the front-end according to the user so that human is become able to specify the content of the image.
- Still there is a semantic gap between the High level concept and low level features. Because it is very difficult to identify the user Physiology, perception, emotions, etc.
- Customization of the search and image interpretation is a big challenge to achieve.
- Today, the databases are not specifically designed to store the images. They all are generally designed by keeping in mind for non-image data. So again it's a challenge to design the suitable databases.
- Designing the system that will enhance the performance of the CBIR system.

11. CONCLUSION

Content Based Image retrieval System is immature and a research area. Initially it started with the indexing approach and then move towards the extraction of the image based on the content. Still lots of researches are going on in this field and many organizations like yahoo. Inc. and Google. Inc. is working independently on this research field to make it a success.

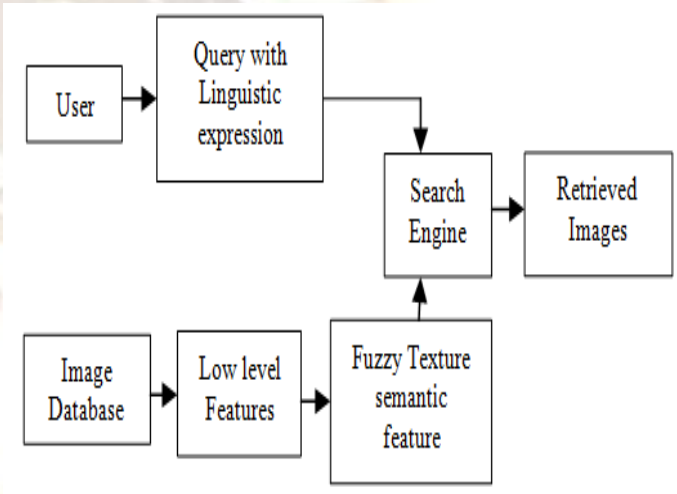

Figure 2: Block Diagram for semantic based image retrieval.

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