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# A Review of Different Content Based Image Retrieval Techniques

Shristi Jain[1], Dr. Asmita A. Moghe[2]
[1]*School of Information and Technology, RGPV, Gandhi Nagar, Bhopal, India*
[2]*University Institute of Technology, RGPV, Gandhi Nagar, Bhopal, India*

**Abstract— Content-based image retrieval (CBIR) is the application of computer vision techniques to the image retrieval downside, that is, the matter of finding out digital images in massive databases. CBIR applies to techniques for retrieving similar images from image databases based on automated feature extraction methods. In this paper we've analyzed different techniques of content-based image retrieval. The development of CBIR systems involves analysis on databases, image processing and handling problems that vary from storage issues to friendly user interfaces. The accuracy of retrieval has subsequently increased with the use of low level features such as color, texture, shape etc. From many research activities performed on CBIR system shows that low-level image features cannot always describe high-level semantic concepts within the users mind because, using low level features only does not include human perception. If human perception is allowed in the image retrieval system the efficiency can be improved.**

**Keywords— Content-Based Image Retrieval (CBIR), image processing, Semantic gap, Semantic feature extraction.**

## I. INTRODUCTION

With the development of technology more and more image database is been created by various equipment in applications like in the field of crime prevention medicine, fashion and graphic design, architectural and engineering design, publishing and advertising, research, law etc. These images call for image processing tools to handle them. To retrieve an image from a given database requires image retrieval [1]. Thus, many techniques have been developed to meet the requirement. Image retrieval techniques can be classified into three categories: text-based image retrieval (TBIR), content-based image retrieval (CBIR), and semantic-based image retrieval (SBIR).

In the text-based approach, images are usually searched by text descriptors. Its greatest advantage is that when images are recorded correctly, good search results can be achieved. This approach has some limitations such as, a considerable amount of human labour for manual annotation is required, and the entry can be inaccurate due to the subjectivity of human perception. To overcome these drawbacks, CBIR was introduced and it has become the predominant technology. The CBIR term has widely been used to describe the relevant images retrieving process from a large collection of database based on image visual contents, normally called as features (color, shape, texture…etc.) [2] .Whereas, in SBIR low-level features like color, texture, shape etc. of images are used to identify meaningful and interesting regions/objects based on the similar characteristics of the visual features is extracted. Then, the object/region features will go into semantic image extraction process to get the semantics description of images to be stored in database. The semantic mapping process is used to find the best approach to describe the segmented or clustered region/objects based on the low-level features.

The fundamental difference between content-based and text-based retrieval systems is that the human interaction is a crucial part of the latter system. Humans tend to use high-level features, such as keywords, text descriptors, etc., to describe images and measure their similarity. The features automatically extracted using computer vision techniques are mostly low-level features (color, texture, shape, spatial layout, etc.). In general, there is no direct link between the high-level features and the low-level features. The problem of CBIR is the semantic gap between the high-level image and the low-level image i.e., there is a difference between what image features can distinguish and what people perceive from the image.

CBIR has become an active and fast-advancing research area in retrieval of similar images. Through many research activities performed in CBIR, it has progressed into four major directions: semantic based, region level features based, global image properties based, and relevance feedback based [3]. Initially, for image retrieval the developed algorithms extract the low-level features of the image such as color, texture, and shape because they are easy to implement and execute well for images that have few semantic content. However, the semantic content of an image is difficult to be revealed by the visual features, and respective algorithms have many limitations while dealing with broad content image database. Therefore, to improve the accuracy of CBIR systems, region-based image matching methods via image segmentation were introduced. These methods are used to overcome the drawbacks of global features by representing images at an object level, which is meant to be close to the perception of human visual system. However, the performance of those methods mainly depends on the results of segmentation [4].

The difference between the low-level features and high-level features i.e., the user's information need and the image representation is called the semantic gap in CBIR. The limited matching accuracy of images in systems is essentially due to the inherent semantic gap. To reduce the semantic gap, the interactive relevance feedback is introduced into CBIR. The basic idea behind relevance feedback is to incorporate human perception individuality into the query process and to provide users with the opportunity to evaluate the matching results. The similarity measures are automatically refined on the basis of these evaluations. However, relevance feedback can significantly improve the matching performance; its pertinence still suffers from a few drawbacks. The semantic-based image matching methods try to discover the actual semantic meaning of an image and use it to retrieve relevant images. However, determining and understanding the semantics of an object are high-level cognitive tasks and thus hard to be implemented [5].

Figure 1 shows a block diagram for CBIR [6]. In typical content-based image retrieval systems, the visual contents of the images in the database are extracted first and then described by multi-dimensional feature vectors. The feature vectors of the images in the database are stored in a feature database. To retrieve relevant images, users provide the retrieval system with a query image. The system then changes the query image into its internal representation of feature vectors. The similarities /distances comparison between the feature vectors of the query image and those of the images in the database is performed with the aid of an indexing scheme.

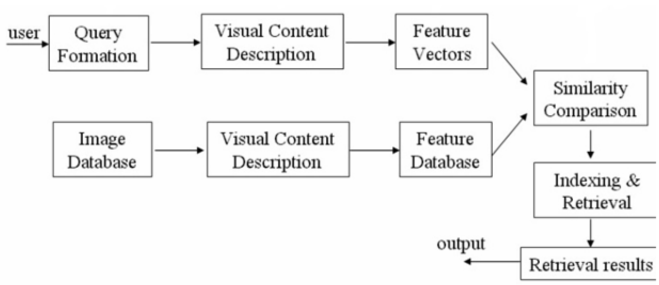


Fig.1. Diagram for content-based image retrieval system

Section II gives the literature reviewed for various CBIR techniques.

## II. LITERATURE SURVEY

A really massive database of images is being created by scientific, industrial, medical and academic applications. As the technology advances, the utilization of web and new advanced digital image sensing element technology will grow. Due to the massive database thus created, the task of image retrieval is becoming very tedious. As in earlier days the text based approach was most popular wherever the text was first annotated with image, however currently the database is extremely huge and this method can't be helpful or reliable. Therefore, an efficient and automatic procedure is needed for assortment, retrieving and indexing from database. Since the text based approach is cumbersome and expensive, the solution is use of "Content based Image Retrieval (CBIR)".This method uses visual contents of image like color, shape, texture, etc. to explore images from huge databases.

Kashif Iqbal et.al used the color histogram, texture and shape features controlled by fuzzy heuristics in image retrieval approach for biometric security purposes [7]. The color histogram is used to extract the color features, the Gabor filter is used to extract the texture features and the Hue moment invariant algorithm is used to extract shape features of an image. The use of these three feature extraction algorithms ensures that the proposed image retrieval approach produces results which are highly relevant to the content of an image query. Euclidean distance is used to calculate the similarity between two feature vectors and Fuzzy heuristics is used to measure similarity between the query image and the images in the database in order to retrieve and display relevant results to the user query. To evaluate the effectiveness of the proposed method the standard precision and recall measures are used and the results are compared with the well-known existing approaches. The results demonstrate that the effectiveness of the proposed approach and the potential of their approach in the area of biometric security.

In [8], authors present region-based image retrieval tool, finding region in the picture (FRIP) that is able to accommodate to the extent possible, region scaling, rotation, and translation. In the proposed method features of each region are extracted. Adaptive circular filters are used for semantic image segmentation, which are based on Bayes' theorem as well as texture distribution of an image and to decrease the computational complexity without losing the accuracy of the search results, they have extracted optimal feature vectors from segmented regions and applied them to step-wise Boolean AND matching scheme. The experimental results show that the FRIP system can indeed improve retrieval performance when compared to global property-based or Region of Interest-based method.

In [9] the authors introduced a novel technique for image indexing. Content-based image retrieval systems operate in two phases. First is the indexing phase, in which for each image in the database, a feature vector is computed and stored in a database. Second is the searching phase, in which when a user makes a query, a feature vector for that query is computed and then by using a similarity criterion, this vector is compared to the vectors in the feature database and the images most relevant or similar to the query image are returned to the user. In this technique, the image is divided into 4 x 4 blocks and the intensity gradient for each block is calculated. The image blocks, based on their intensity gradient are classified into uniform or non-uniform block. Each uniform block is labeled by its average color. The histogram of uni-color blocks is then generated to show the color distribution of the image. Whereas, each non-uniform block is segmented into dark and light regions and is classified by two average colors of those regions. The histogram of bi-color blocks is then constructed to show the distribution of local color adjacency in the image.

A variation in the use of color as a feature is made by Jean-Pierre Braquelaire and Luc Brun [10] who have used color image quantization which is a process of reducing the number of colors in a digital color image and it has been widely studied for the last 15 years. This work also focuses on the different steps of clustering methods. The methods are compared step by step and some optimizations of the algorithms and data structures are given. A low-cost quantization scheme is proposed and a new color space called H1H2H3 which improves quantization heuristics is proposed.

The authors have presented a new top-down quantization method based on the color space H1H2H3. This method splits each cluster along the axis H1, H2, or H3 of greatest variance. Finally a new data structure which allows us to manipulate the 3D histogram of an image is proposed. According to experimental results, the method is seen as an intermediate method between a fast but poor method i.e. most of the time this intermediate method produces quantized images with a quality almost equal to better but slower methods.

Among other low level features, corners and edges were also used as features for CBIR in [11]. To generate image regions containing texture and isolated features, a combined corner and edge detector is used which is based on the local auto-correlation function and it is shown to perform with good consistency on natural imagery. Consistency of image edge filtering is most important for 3D interpretation of image sequences using feature tracking algorithms.

Hybrid interactive genetic algorithm in which an evolutionary algorithm attempts to solve a problem applying Darwin's basic principles of evolution is also applied on a population of trial solutions to a problem, called individuals. Genetic algorithms are a class of evolutionary algorithms, which place a special priority on the application of genetic operators, such as mutation and crossover. They use an encoding method to represent possible solutions to a problem, and a fitness function that allows a quantitative evaluation of each candidate according to how close it is to an ideal optimal solution. In [12] a CBIR algorithm is designed in which relevance feedback, evolutionary computation concepts and distance-based learning are combined to reduce the existing semantic gap between the high level semantic content of the images and the information provided by their low-level features.

Use of multiple features is made in [13] for CBIR. Here the authors have used color histogram, color mean and color structure descriptor, for feature extraction. The feature matching procedure relies on their Euclidean distance. From the above method it is concluded that multiple features can give better performance than the single feature. Thus selection of feature is one of the important issues in image retrieval. The system is supposed to be efficient if there is minimum semantic gap.

Anita Nanasaheb Ligade & Manisha R. Patil have used both implicit and explicit feedback technique along with genetic algorithm to minimize semantic gap. Genetic algorithm utilizes the principle of survival of the fittest to operate on a population of probable solutions to produce better and better approximations to a solution. In relevance feedback technique for retrieval of images, user's feedback is taken since user's judgment improves the results of CBIR extremely. The authors have created two tier architecture of implicit and explicit feedback as combination of implicit and explicit feedback in CBIR system gives better result than solely explicit feedback. However, the location of an image in retrieval result reflects directly its similarity to query image [14].

Hybrid Content Based Image Retrieval which combines a multi-objective interactive genetic algorithm (IGA), allowing a trade-off between image features and user evaluations, and a support vector machine to learn the user relevance feedback is also proposed in [15]. It has been seen that the hybrid method outperforms previous works, retrieving faster the relevant images present in the database with respect to image query provided by the user while requiring less user interactions.

In order to effectively and precisely retrieve the relevant images from a large image database a user-oriented mechanism for CBIR method based on IGA is proposed in [16]. Color attributes like the mean value, the standard deviation, and the image bitmap of a color image are used as the features for retrieval. In addition, the entropy based on the gray level co-occurrence matrix and also the edge histogram of an image is considered as the texture features. In contrast to conventional approaches that are based on visual features, this method provides an interactive mechanism to bridge the gap between the visual features and the human perception. But the retrieval only considers the low-level features, so some of the irrelevant images are also retrieved.

In [17] a CBIR system is implemented using different features of images. The images are analyzed on the basis of color moments and color auto-correlogram. Gabor wavelet is also used as to calculate the mean squared energy which acts as the primary image content identifying feature. For classification of extracted features SVM technique is used. It's been concluded that the existing image retrieval systems are either text-based or image-based queries, but not both. Hence, a system with integrated methods is highly needed. CBIR is clearly a technology with very high potential and needs to be manipulated with help of high efficiency algorithms.

Clustering and image mining technique for fast retrieval of images is also proposed by A.Kannan et.al. Unlike other image processing techniques, Image mining does not aim at finding a specific pattern in images. It focuses rather on identifying and finding image patterns and deriving the knowledge from images within an image set based on the low-level (pixel) information. The images are clustered by using Fuzzy C mean algorithm and entropy is used to compare the images with some threshold constraints [18].

Cong Jin, Shu-Wei Jin has used automatic image annotation (AIA) which is a task of assigning one or more semantic concepts to a given image and is a promising way to achieve more effective image retrieval and analysis [19]. Image annotation can be viewed as a classification problem, which may be solved by using a classifier. For annotating an image without caption, first, image is represented into a low-level feature vector. Then, the image is classified into a category. Finally, the semantics of the corresponding category to the image is generated.

The unlabeled image may be automatically annotated. The authors have presented a novel AIA scheme based on improved quantum particle swarm optimization (IQPSO) algorithm for selecting visual features and an ensemble stratagem supported boosting technique to enhance performance of image annotation approach.

Junwei Han et.al [20], in their study reported a framework for effective image retrieval by employing a novel idea of memory learning. It forms a knowledge memory model to store the semantic information by simply collecting user-provided interactions. A learning strategy is then applied to predict the semantic relationships among images according to the memorized knowledge. One important advantage of their framework is its ability to annotate images and also generate the keyword annotation from the labeled images to unlabeled images efficiently. However, a limitation of the proposed method is that it somewhat lacks sufficient theoretical justification.

Zs. Robotka et.al [21] gave software which was able to search, cluster and classify huge sets of different images using a low dimensional representation of images to extract relevant images from the database. Images are represented by using Gaussian mixture model (GMMs). Image similarity matching is done by matching the descriptions with a distance measure based on approximation of the Kullback Liebler divergence. The GMMs are estimated using improved Expectation Maximization (EM) algorithm which avoids convergence to the boundary of the parameter space.

To improve the accuracy of CBIR, a fuzzy relevance feedback mechanism (F-RFM) is also implemented in [22] in which a CBIR system based on a new Multi-scale Geometric Analysis (MGA)-tool, called Ripplet Transform (RT) is proposed. For evaluation of features extraction and similarity distance, fuzzy entropy is used at the end of each iteration. The conclusion of the above proposed method is that the retrieval performance might be improved further by using fuzzy based RFM within 2 to 3 iterations.

Sana Fakhfakh, et.al in [23] has tried to create a visual vocabulary from phase extraction of descriptors such as color, texture, interest points. A signature is assigned to each image in collection and the extraction of signature is based on application of Haar wavelet multiscale, Harris interest points and analyzing color histogram. This signature will go through a size reduction step by using the PCA (Principal Component Analysis). The obtained signature of each image passes through a stage of binarization. This binary code obtained needs use of Hamming distance for similarity matching. Experiments are undertaken on four data sets “Caltech101”, “Caltech256”, “ImageCLEF 2013” and “ImageCLEF 2014”.

Asma El Adel, et.al has proposed a new approach for CBIR supported by a parallel aggregation of content based features extraction using fuzzy support decision mechanisms. Shape features are extracted by using Fast Beta Wavelet Network modeling and Hue moments. The texture feature is based on Energy computing at different decomposition levels. A Fuzzy Decision Support System is used for feature aggregation to improve the retrieval performance. But having an index with a huge number of features can increase the complexity of the computational cost algorithm.

Images are particularly complicated to manage besides the volume they occupy; retrieval is an application and context dependent task. It requires the translation of high-level user perceptions into low-level image features. The majority of current techniques are based on low-level feature extraction using CBIR. In [25] multiple methods are used for extracting the features. The methods are wavelet transforms HSV histogram, color auto-correlogram, Gabor wavelet transform, SVM technique and relative deviation. Based on these principles, CBIR system uses color, texture and shape fused features to retrieve the desired image from the large database. High resolution images are taken as database.

## III. CONCLUSION

In this paper we have reviewed various methods of content-based image retrieval. Various types of feature extraction methods and techniques are described. The majority of image retrieval techniques are based on low-level features such as color, texture and shape extraction algorithm. The accuracy of retrieval has subsequently increased with the use of low level features. The development of CBIR systems involves analysis on databases, image processing and handling problems that vary from storage issues to friendly user interfaces. There is a need to improve the precision of image retrieval systems and to reduce the semantic gap in view of the growing need for image retrieval. If human perception is allowed in the image retrieval system the efficiency can be improved.

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