Analysis of Content Based Image Retrieval

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Abstract- **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 methods of adding metadata such as captioning, keywords, or descriptions to the images so that retrieval can be performed over the annotation words. The aim of this paper is to review the current state of the art in content-based image retrieval (CBIR), a technique for retrieving images on the basis of automatically-derived features such as color, texture and shape. Matching of query image features with database image features is performed using various distance measures. The performance of various distance measures is also compared to find the suitability of particular method for image retrieval. The results of retrieval are expressed and compared for various distance measures in terms of Time and Accuracy.**

Keywords – CBIR, Metadata, Distance measures, Matching, Time, Accuracy.

I. Introduction

Content-based image retrieval (CBIR), also known as query by image content (QBIC) and content-based visual information retrieval (CBVIR) is the application of computer vision techniques to the image retrieval problem, that is, the problem of searching for digital images in large databases. "Content-based" means that the search analyzes the contents of the image rather than the metadata, such as keywords, tags, or descriptions associated with the image [1]. The term "content" in this context might refer to colors, shapes, textures, or any other information that can be derived from the image itself. CBIR is desirable because most web-based image search engines rely purely on metadata.

The term "content-based image retrieval" seems to have originated in 1992 when it was used by T. Kato to describe experiments into automatic retrieval of images from a database, based on the colour and shapes present. Since then, the term has been used to describe the process of retrieving desired images from a large collection on the basis of syntactical image features. The techniques, tools, and algorithms that are used originate from fields such as statistics, pattern recognition, signal processing, and computer vision.

There is a growing interest in CBIR because of the limitations inherent in metadata-based systems, as well as the large range of possible uses for efficient image retrieval. Textual information about images can be easily searched using existing technology, but this requires humans to manually describe each image in the database. This is impractical for very large databases or for images that are generated automatically, e.g. those from surveillance cameras. It is also possible to miss images that use different synonyms in their descriptions. Systems based on categorizing images in semantic classes like "hut" as a subclass of "house" avoid this problem but still face the same scaling issues.

Several CBIR systems currently exist, and are being constantly developed [2]. The work proposed in [3] compares several feature extraction techniques to see their effectiveness in retrieving medical images based on the application to CT brain images. The goal of this paper is to help medical experts in their diagnosis such as retrieving similar kind of disease and patient’s progress monitoring. The scheme as presented in [4] is the mixture of color, texture and edge density for MPEG-7 standards. Another scheme, as reported in [5] explains a similar kind of approach based on color texture analysis by using different color spaces.

CBIR systems are involved and required in various fields like architectural and engineering designs, art collections, crime prevention, geographical information and remote sensing, intellectual property, medical diagnosis, military, photograph archives, retail catalogs etc.

II. CBIR METHOD

CBIR system, as shown in figure1 extracts visual attributes (color, shape, texture and spatial information) of each image in the database and stores in a different database within the system called feature database. The users present query image to the system. The system automatically extract the visual attributes of the query image in the same mode as it does for each database image, and then identifies images in the database whose feature vectors match those of the query image, and sorts the best similar objects according to their similarity value.

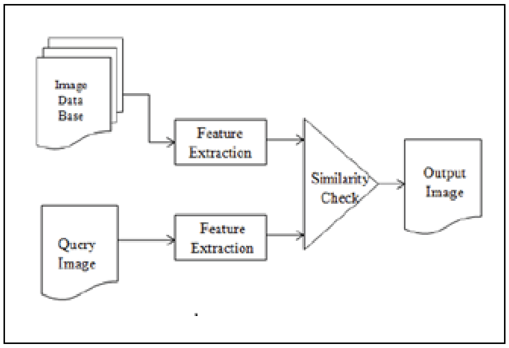

Figure1. CBIR Process

IV. CBIR TECHNIQUES

Many CBIR systems have been developed, but the problem of retrieving images on the basis of their pixel content remains largely unsolved.

A. Query Techniques –

Different implementations of CBIR make use of different types of user queries. Query technique that involves providing the CBIR system with an example image that it will then base its search upon. The underlying search algorithms may vary depending on the application, but result images should all share common elements with the provided example.

Options for providing example images to the system include:

- It may be supplied by the user or chosen from a random set of preexisting image.
- The user draws a rough approximation of the image they are looking for, for example with blobs of color or general shapes.

This query technique removes the difficulties that can arise when trying to describe images with words

B. Semantic Retrieval –

The ideal CBIR system from a user perspective would involve what is referred to as semantic retrieval, where the user makes a request like "find pictures of Abraham Lincoln". This type of open-ended task is very difficult for computers to perform - pictures of Chihuahuas and Great Danes look very different, and Lincoln may not always be facing the camera or in the same pose. Current CBIR systems therefore generally make use of lower-level features like texture, colour, and shape, although some systems take advantage of very common higher-level features like faces (see facial recognition system). Not every CBIR system is generic. Some systems are designed for a specific domain, e.g. shape matching can be used for finding parts inside a CAD-CAM database.

C. Other Query Methods –

Other query methods include browsing for example images, navigating customized/hierarchical categories, querying by image region (rather than the entire image), querying by multiple example images, querying by visual sketch, querying by direct specification of image features, and multimodal queries (e.g. combining touch, voice, etc.)

CBIR systems can also make use of relevance feedback, where the user progressively refines the search results by marking images in the results as "relevant", "not relevant", or "neutral" to the search query, then repeating the search with the new information.

D. Content Based Comparison of Images –

The most common method for comparing two images in content-based image retrieval (typically an example image and an image from the database) is using an image distance measure. An image distance measure compares the similarity of two images in various dimensions such as colour, 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 intuitively 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. A long list of distance measures can be found in.

(1) Color

Computing distance measures based on colour similarity is achieved by computing a colour histogram for each image that identifies the proportion of pixels within an image holding specific values (that humans express as colours). Current research is attempting to segment colour proportion by region and by spatial relationship among several colour regions. Examining images based on the colours they contain is one of the most widely used techniques because it does not depend on image size or orientation. Colour searches will usually involve comparing colour histograms, though this is not the only technique in practice.

To overcome the quantization effects of the color histogram, Stricker and Orengo [23] used the color moments as feature vectors for image retrieval. Since any color distribution can be characterized by its moments and most information is concentrated on the low-order moments, only the first moment (mean), the second moment (variance) and the third moment (skewness) are taken as the feature vectors. The similarity between two color moments is measured by the Euclidean distance. Two similar images will have high similarity. However, if two images have only a similar sub-region, their corresponding moments will be different and the similarity measure will be low.

(2) Texture

Texture measures look for visual patterns in images and how they are spatially defined. Textures are represented by texels which are then placed into a number of sets, depending on how many textures are detected in the image. These sets not only define the texture, but also where in the image the texture is located.

Texture is a difficult concept to represent. The identification of specific textures in an image is achieved primarily by modelling texture as a two-dimensional gray level variation. The relative brightness of pairs of pixels is computed such that degree of contrast, regularity, coarseness and directionality may be estimated (Tamura, Mori & Yamawaki, 1978). However, the problem is in identifying patterns of co-pixel variation and associating them with particular classes of textures such as silky, or rough.

(3) Shape

Shape does not refer to the shape of an image but to the shape of a particular region that is being sought out. Shapes will often be determined first applying segmentation or edge detection to an image. Other methods like [Tushabe and Wilkinson 2008] use shape filters to identify given shapes of an image. In some case accurate shape detection will require human intervention because methods like segmentation are very difficult to completely automate.

III. IMPLEMENTATION OF CBIR

The various steps involved in implementation of content based image retrieval are as follows.

Take any image from the database as a query image

1) Extract the features of query image.
2) Load the database and read the image.
3) Extract the any feature from the image load in step 3 for example shape.
4) If the feature matches the database in step 3.
5) If yes then extract the other feature like histogram otherwise read another image form step 3.
6) After extracting all the features the best matching
   Image will be represented as an output image.

In this paper, for comparing and matching various features of query image with database image features, variety of distance measures are utilized to get more efficient system as follows:

A. L2 Norm.

L2 Norm measures the Euclidian distance between the pixels of the original and the corrected image. Formula for the L2 norm is:

$$\sum (img_{originali} - img_{corrected})^{2} \qquad \text{---- (1)}$$

Where the summation index i goes over all the pixels in the image. A noteworthy feature of L2 Norm is that the contribution of a specific pixel grows quadratic ally as its distance to the corresponding pixel grows.

B. L1 Norm.

Norm measures the absolute distance between the pixels of the original and the corrected image. Formula for the L1 norm is:

$$\sum (abs\,(img_{originali\,-}\; img_{correctedi})) \qquad \text{---- (2)}$$

Where the summation index i goes over all the pixels in the image. Unlike in L2 norm, the contribution of a distance between two pixels grows linearly with the distance. So, L1 norm "punishes" relatively more for smaller distances than L2 norm.

C. Chebyshev Distance

Chebyshev distance (or **Tchebychev distance**), is a metric defined on a vector space where the distance between two vectors is the greatest of their differences along any coordinate dimension. It is named after Pafnuty Chebyshev.

The Chebyshev distance between two vectors or points' *p* and *q*, with standard coordinates p_i and qi, respectively, is

$$D_{chebyshev}\,(p, q) := max_i\,(|p_i - q_i|) \qquad \text{---- (3)}$$

It is also known as **chessboard distance**, since in the game of chess the minimum number of moves needed by a king to go from one square on a chessboard to another equals the Chebyshev distance between the centres of the squares, if the squares have side length one, as represented in 2-D spatial coordinates with axes aligned to the edges of the board.

D. Minkowski Distance

The Minkowski distance is a metric of Euclidean space which can be considered as a generalization of both the Euclidean distance and the Manhattan distance.

$$D_{ij} = \{|x_i - x_j|^n + |y_i - y_j|^n\}^{1/n} \qquad \text{---- (4)}$$

When n=1, it becomes city-block distance. Chebyshev distance is a special case of Minkowski distance with n=100 taking limit.

IV. RESULTS

For the implementation we have created a database of approx 107 images and the coding has been performed on MATLAB software.

Now the result for the various methods are shown as follows in which the first image we have taken as the query image, second image being the most matched image from the database and number of images retrieved for every method is specifically given 10.

A. L2 Norm

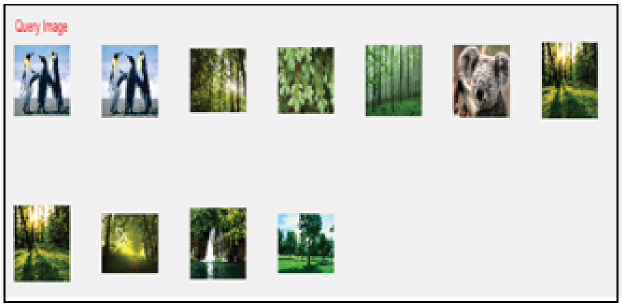

Figure2. L2 Norm –Images Retrieved.

B. LI norm

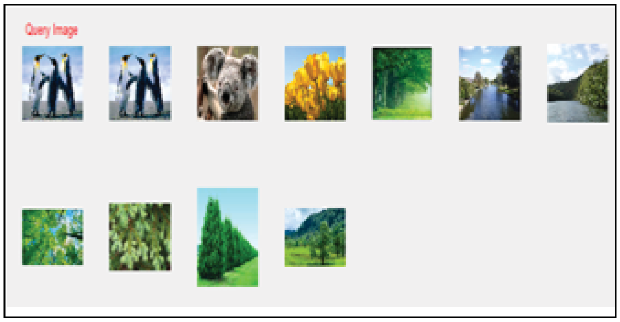

Figure3. L1 Norm –Images Retrieved.

C. Chebychev

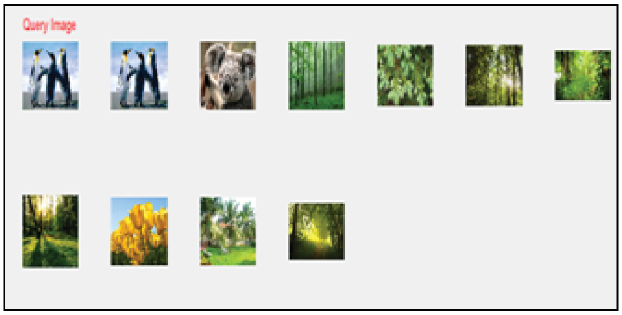

Figure4. Chebyshev –Images Retrieved.

D. Minkowski distance

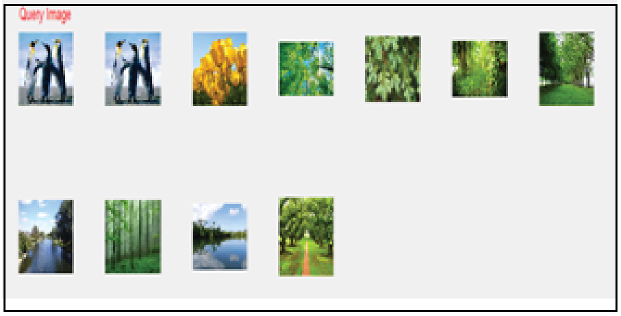

Figure5. Minkowski –Images Retrieved.

Table below shows the comparison of all the methods with respect to their time and accuracy.

Table -1 Experiment Result

Sr. No.	Methods	No. of images retrieved	Time	Accuracy (%)
1.	L1 Norm	10	0,000031	83
2.	L2 Norm	10	0.000027	86
3.	Chebyshev	10	0.000030	89
4.	Minkowski	10	0.000029	85

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