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3D Color Feature Extraction in Content-Based Image Retrieval

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ABSTRACT
Content-based Image Retrieval (CBIR) consists of retrieving the most visually similar images to a given query image from a database of images. "Content-based" means that the search will analyze the actual contents of the image rather than the metadata such as keywords, tags, and/or descriptions associated with the image. The term 'content' in this context might refer to colours, 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 and this produces a lot of garbage in the results. Also having humans manually enter keywords for images in a large database can be inefficient, expensive and may not capture every keyword that describes the image. Thus a system that can filter images based on their content would provide better indexing and return more accurate results. This paper proposes 3D colour feature extraction for comparing the contents.

KEYWORDS
QBIC (Query by Image Content), CBVIR (Content Based Visual Information Retrieval), Color Space, Texture, Conventional Color Histogram , CMY, HSV.

I. INTRODUCTION

The term CBIR seems to have originated in 1992, when it was used by T.Kato to describe experiments into automatic retrieval of images from an image database. Content-based image retrieval (CBIR) is a technique for retrieving images on the basis of automatically-derived features such as color, texture and shape. CBIR also known as QBIC (Query By Image Content) or CBVIR (Content Based Visual Information Retrieval). "Content-based" means that the search will analyze the actual contents of the image. The term 'content' in this context might refer colors, shapes, textures, or any other information that can be derived from the image itself.

Image Retrieval and classification is often solved by associating keywords or other textual annotations to the data. Manual annotation is expensive, slow and often inconsistent. CBIR operates on a totally different principle to retrieve stored images from a collection by comparing features automatically extracted from the image (Figure - 1) . The commonest features used are mathematical measures of color, texture, or shape. CBIR involves the following steps.

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1) Feature Extraction: Process of extracting image features to a distinguishable extent. The basic features of Image are
   a. Primitive Features (Mean Color, Color Histogram)
   b. Semantic Features (Color Layout, Texture)
   c. Domain Specific Features (Face Recognisation , Finger print Matching)
2) Feature Matching: Process of matching the features extracted by Database Images and Query image that yield to a result, that is visually similar.

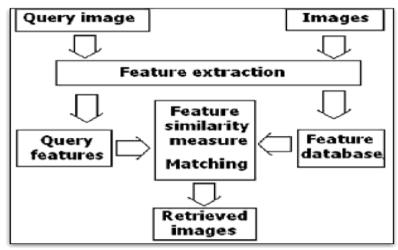

Figure-1 : Block Diagram for CBIR

In typical Content-based image retrieval systems the visual contents of the images in the database are extracted and described by multi-dimensional feature vectors. The feature vectors of the images in the database form a feature database. To retrieve images, users provide the retrieval system with example images or sketched figures. The system then changes these examples into its internal representation of feature vectors. The similarities /distances between the feature vectors of the query example or sketch and those of the images in the database are then calculated and retrieval is performed with the aid of an indexing scheme. The indexing scheme provides an efficient way to search for the image database.

II.COLOR SPACE

A Color space is defined as a model for representing color in terms of intensity values. Each pixel of the image can be represented as a point in a 3D color space. Commonly used color space for image retrieval include RGB (Figure -2), Munsell, CIE L*a*b*, CIE L*u*v*, HSV), and opponent color space. There is no agreement on which is the best. However, one of the desirable characteristics of an appropriate color space for image retrieval is its uniformity. Uniformity means that two color pairs that are equal in similarity distance in a color space are perceived as equal by viewers.

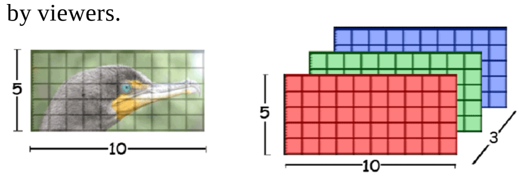

Figure - 2

RGB space is a widely used color space for image display. It is composed of three color components red, green, and blue. These components are called "additive primaries" since a color in RGB space is produced by adding them together. In contrast, CMY space is a color space primarily used for printing. The three color components are cyan, magenta, and yellow. These three components are called "subtractive primaries" since a color in CMY space is produced through light absorption. Both RGB and CMY space are device-dependent and perceptually non-uniform.

The CIE L*a*b* and CIE L*u*v* spaces are device independent and considered to be perceptually uniform. They consist of a luminance or lightness component (L) and two chromatic components a and b or u and v. CIE L*a*b* is designed to deal with subtractive colorant mixtures, while CIE L*u*v* is designed to deal with additive colorant mixtures.

III. PRINCIPLES OF RETRIEVING

Color Retrieval : Several methods for retrieving images on the basis of color similarity have been described in the literature, but most are variations on the same basic idea. Each image added to the collection is analyzed to compute a color histogram which shows the proportion of pixels of each color within the image. The color histogram for each image is then stored in the database. At search time, the user can either specify the desired proportion of each color, or submit an example image from which a color histogram is calculated.

The approach more frequently adopted for CBIR systems is based on the conventional color histogram (CCH), which contains occurrences of each color obtained counting all image pixels having that color. Each pixel is associated to a specific histogram bin only on the basis of its own color, and color similarity across different bins or color dissimilarity in the same bin are not taken into account.

Since any pixel in the image can be described by three components in a certain color space (for instance, red, green and blue components in RGB space or hue, saturation and value in HSV space), a histogram, i.e., the distribution of the number of pixels for each quantized bin, can be defined for each component. Clearly, the more bins a color histogram contains the more discrimination power it has. However, a histogram with large number of bins will not only increase the computational cost, but will also be in appropriate for building efficient indexes for image data base.

Quantization in terms of color histograms refers to the process of reducing the number of bins by taking colors that are very similar to each other and putting them in the same bin. By default the maximum number of bins one can obtain using the histogram function in MatLab is 256. For the purpose of saving time when trying to compare color histograms, one can quantize the number of bins. Obviously quantization reduces the information regarding the content of images but as was mentioned this is the tradeoff when one wants to reduce processing time.

Texture Retrieval: Texture is that innate property all surfaces, that describes visual patterns and that contains important information about the structural arrangement of the surface and it's relationship to the surrounding environment, Example: Clouds, Trees, Bricks(Figure -3). The ability to retrieve images on the basis of texture similarity may not seem very useful. But the ability to match on texture similarity can often be useful in distinguishing between areas of images with similar color (such as sky and sea, or leaves and grass).

A variety of techniques has been used for measuring texture similarity. Calculate the relative brightness of selected pairs of pixels from each image. From these it is possible to calculate measures of image texture such as the degree of contrast, coarseness, directionality and regularity, or periodicity, directionality and randomness

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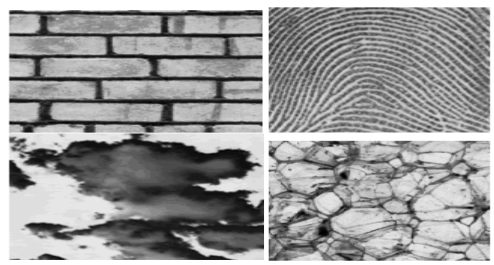

Figure - 3

Shape Retrieval: The ability to retrieve by shape is perhaps the most obvious requirement at the primitive level. Unlike texture, shape is a fairly well-defined concept - and there is considerable evidence that natural objects are primarily recognized by their shape (Figure - 4). A number of features characteristic of object shape (but independent of size or orientation) are computed for every object identified within each stored image. Queries are then answered by computing the same set of features for the query image, and retrieving those stored images whose features most closely match those of the query.

Two main types of shape feature are commonly used - global features such as aspect ratio, circularity and moment invariants and local features such as sets of consecutive boundary segments Queries to shape retrieval systems are formulated either by identifying an example image to act as the query, or as a user-drawn sketch.

Figure - 4

IV. FEATURE COMPARISON

Once the features vectors are created, the matching process becomes the measuring of a metric distance between the features vectors. The nearest matching database images with the query image has the least distance metric. The exact match is the one with zero distance metric. The following are existing algorithms to distance for various features.

- Manhattan Distance
- Euclidean Distance
- Correlation Distance
- Cosine Similarity Distance
- Gabor filter and ICA for Texture information retrieval

V.ADVANTAGES OF CBIR

The following are some of the advantages of CBIR systems:

- Visual features such as color, texture and shape information of images are extracted automatically.
- Similarity of images are based on the distances between features
- No barrier on language
- No Human Intervention
- Accurate

VI.CURRENT CBIR SYSTEMS

The following are some current CBIR systems:

- QBIC from IBM
- VisualSeek from Columbia University
- Photobook from Media Laboratory, Massachusetts Institute of Technology (MIT).

VII .PROPOSED SYSTEM

The proposed system is “3 Dimensional Color array feature extraction” using RGB Color space. In color image, pixel is represented with red, green, and blue components. We can uniquely identify each color by mixing these component values for each pixel.

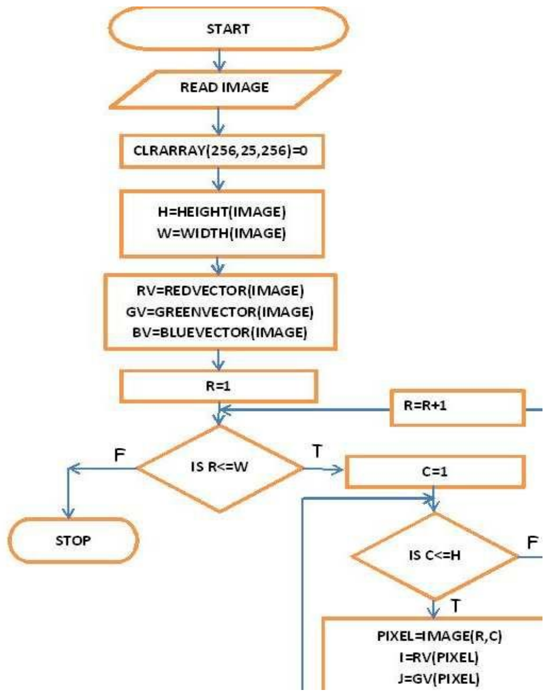

Figure -5 (Flowchart for the building Feature table)

Proposed system creates a 3 Dimensional color array to represent each color uniquely. First step is to read the query image, calculate the number of occurrences of each color value and build 3D color table (Figure – 5). Similarly build the 3D color table for database Image. Now find the distance between color values from 3D color tables using the formula (Figure - 6)

$$D = \sum_{i,j,k=1}^{256} \left| DBIMGARR_{I,J,K} - QRYIMGARR_{I,J,K} \right|$$

Figure – 6

Here D is sum of all distances between two color point occurrences from Database Image DBIMGARR and QRYIMGARR. The least distance value is most appropriate match of query image with database image and exact match is with value zero.

VIII. CONCLUSIONS

CBIR is the one good tool for various applications to retrieve the visual information in various areas. The dramatic rise in the sizes of image database has stirred the development of effective and efficient retrieval systems. CBIR is still developing science. As image compression, digital image processing, and image feature extraction techniques become more developed, CBIR maintains a steady pace of development in the research field.

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