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Content Based Image Retrieval: A Study

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Abstract: Content Based Image Retrieval (CBIR) is the today's most active area in information retrieval and image processing. An image contain various visual information that is difficult to extract manually, the CBIR system aims at finding the most appropriate image from image database by matching the various visual contents of image. In this paper, several methods for image retrieval using the CBIR system are described that take consideration of image features like color, shape and texture to find efficient results. In modern internet based life, there is large development of social networking medium; the digital image uploading rate is very high. So, to access this large collection of image data new and fast techniques are needed. These techniques will ease the database handling as well as it will help user to adequately search the required resulting image. This research is very useful to solve many real world problems.

Keywords: Content Based Visual Information Retrieval System, Query By Image Content**,** MARS or Multimedia Analysis and Retrieval System, Visual Information Processing for Enhanced Retrieval.

I. INTRODUCTION

Today's world is developing towards digitalize system, considering this fact number of images are created in every field from medicine, military, crime prevention, architecture, art up to academic. This collection of images contains photographs, diagrams, drawings, paintings, and prints. There are two drawbacks of text based image retrieval that manual image annotation is time consuming and therefore costly and another drawback is human annotation is subjective that is some images could not be annotated because it is difficult to describe their content with words. CBIR system was originated in 1980 by the scientist T. Kato when he was dealing with the experiment for retrieval of image from database by using the visual features of the image [1]. The CBIR system involves tools, techniques and algorithms for color extraction, shape reorganization, pattern matching, query formation, similarity comparison and relevance ranking. There are different kinds of existing system but CBIR is capable to finding the image with specified characteristics or contents in target image collection according to the description of image contents. The fusion of color, shape and texture uses the combination of color, shape and texture features of image to compare with other image features for finding the specified images.

A. Applications of CBIR system are[1]-

- The advantages of such systems range from simple users searching a particular image on the web.
- Various types of professionals like police force for picture recognition in crime prevention.
- Medicine diagnosis Example-CT, MRI, Diagnostic
- Architectural and engineering design
- Fashion and publishing
- Geographical information and remote sensing systems
- General Image Collections for Licensing.
- Scientific Databases Example:-Earth Sciences
- Art Collections Example: - Fine Arts Museum of San Francisco

II. QUERY BY IMAGE CONTENT (QBIC)[2]

Query by Image Content is the first commercial content based retrieval system. It is also called as Content Based Visual Information Retrieval System (CBVIR). This system was developed at the IBM Almaden Research Center. It works on principle of extracting several features from each image, namely color, texture, shape, size, position features. This gives ability to graphically pose and refine queries based on multiple visual properties such as color, texture and shape. It supports queries based on input images, user-constructed sketches, photos, etc. It is being used in IBM's Multimedia Manager in OS/2, and in DB2 Extenders.

QBIR consider two main factors as-

- It uses computable properties of image and videos like color, shape, texture, motion of object and other graphical information in the query.
- It is a Graphical Query Languages which implies the query by drawing, selecting and retrieving the graphical features of digital image.

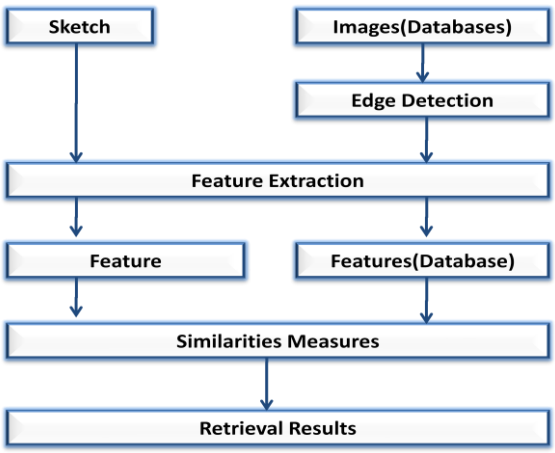

Fig 1: Flowchart of Query by Image (Sketch) Retrieval System [2]

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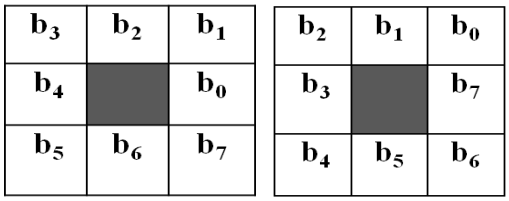
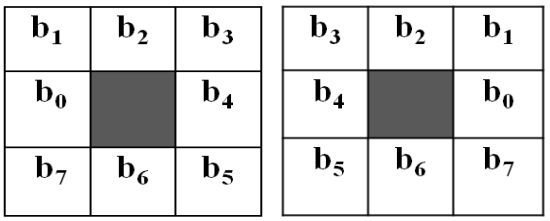
QBIR in Query-by-Sketch Image Retrieval Using Edge Relation Histogram, consider each input image as the sketch. Sketches are drawn as binary line image by user and the feature extraction is applied on it. Feature extraction detects the edge of the sketches in the feature database in advance and the input image when user input the image. The features of sketch images and databases are compared and result is calculated according to the similarity measures.

The edge detection is important in this system and it is achieved by canny edge detection method. The 256*256=65536 dimensional image features are retrieved by using canny method to all edge pixels and normalizing the histogram by the total number of line pixels. This process disables shift-variation and scale variation to be realized. The rotation and symmetry invariant features are easily described by shifting the binary number as shown in below fig 4 and 5. Similarity of input image to databases images are calculated by using the histogram intersection between features of database images and the input image features.



$(b_7b_6b_5b_4b_3b_2b_1b_0)_2$ (a) Before $(b_6b_5b_4b_3b_2b_1b_0b_7)_2$ (b) After

Fig. 2 Rotation Invariance [2]



$(b_7b_6b_5b_4b_3b_2b_1b_0)_2$ (a) Before $(b_5b_6b_7b_0b_1b_2b_3b_4)_2$ (b) After

Fig. 3 Symmetry Invariance [2]

Advantages of QBIR system-

- Very fast.
- Easy to implement.
- Invariant to small changes in camera angle.

Disadvantages of QBIR system-

- Sensitive to illumination changes.
- Sensitive to different levels of gamma correction.
- Doesn't account for location of color.
- Applied only on binary line image.

III.MARS OR MULTIMEDIA ANALYSIS AND RETRIEVAL SYSTEM [3]

MARS is developed by Beckman Institute for Advanced Science and Technology, University of Illinois. This system makes use of color, spatial layout, texture and shape matching. Color is represented by using two dimensional histogram for the HS coordinate values in the HSV color space. Texture is represented by using the two histograms, one for calculating the coarseness and other for measuring the directionality for the image. Also one scalar defines the contrast of each pixel in the image.

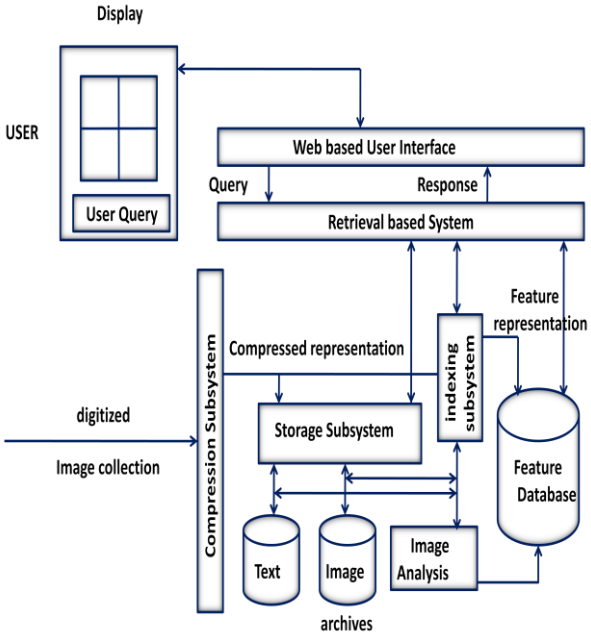


Fig 4: MARS system Components [3]

In order to effectively retrieve color and texture features of image, image is divided into 5*5 sub-images. For each sub-images the color histogram is calculated and for the texture retrieval a vector based on wavelet coefficients is used. The segmentation is used to detect the object in two phases, first the K-means clustering method is applied on color-texture space calculated from given image, and then the attraction based method is applied to detect and group the different regions in the image. This technique involves choosing a number of attracted regions and associating each region with the attractor that has the largest attraction to it. The MARS uses the five attractors, one for each corner of the image called background attractor and one for the center of image called object attractor. This consists of the fact that their database contains images of single object. The shape of the boundary of the extracted object is represented by means of Fourier Descriptors (FD). Boolean operators are used to formulate the complex queries. The desired features of image can be specified by pointing an image database that has such property or by directly choosing the color from given palette and texture from available set of pattern in the database.

The similarity between input image and database image is calculated from histogram intersection. The similarity of texture feature of two images is determined by a weighted sum of the Euclidean distance between contrast and histogram intersection distances. The 5*5 color-texture weighted sum is used for similarities comparison for the color-texture layout distance between two images.

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IV. VISUAL INFORMATION PROCESSING FOR ENHANCED RETRIEVAL(VIPER) [4]

It was developed at the Computer Vision Group, University of Geneva. It supports color and texture matching. This system retrieves images based on color and texture matching.

VIPER is now the plug-in part of the GIFT (GNU Image-Finding Tool) architecture, which brows using the text with the help of 80000 feature index in the document. From the each image up to 1000 features are extracted, which are further divided into color features and texture feature groups. For color feature extraction VIPER technology uses the HSV color space. The extracted HSV color values are quantized into bins. Each bin is represented as a image feature using the histogram. Gabor filters are used for texture feature extraction. For the user interface, the VIR provide different set of GUI tools. These include facilities for image query, image insertion, weight adjustment for re-query, inclusion of keywords, and support for several popular image file formats. Another technique it can allow is the query by sketch, in which user can draw a sketch by using different drawing tools and colors from color palette. In this way queries can be form using different user defined primitives. Further the comparison is performed between the input images with the database images. The similarity score is computed by using the distance function defined in the primitive.

V. FUSION OF COLOR, SHAPE AND TEXTURE FEATURES FOR CONTENT BASED IMAGE RETRIEVAL [5]

The CBIR system is consist of several components as follow:

- Color features extraction
- Shape features extraction
- Texture feature extraction
- Combination of three extracted features
- Similarity measures

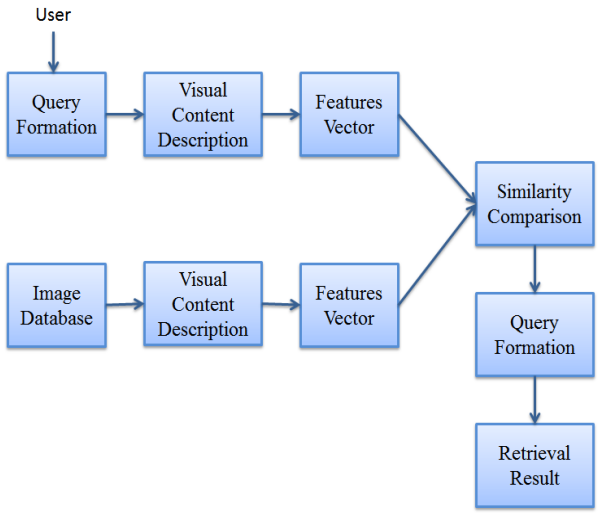

Fig 5: System architecture of CBIR [5]

A. Color feature extraction

Color is simplest and most effective feature of image. Color space is used to represent the three-dimensional color coordinate system. To retrieve the color feature the HSV color scheme is used. HSV schema uses the hue, saturation and color value of image. The RGB color space is represented as linear combination of red, green and blue color values from 0 to 255 so it require to store those values quantized with the same precision. In HSV color schema pixel is represented as angle around the central vertical axis called Hue with the values ranges from 0 to 360, the distance from central vertical access is called Saturation with values ranges from 0 to 1 and the Value represent the intensity of the color ranges from 0 to 1. Hence this color scheme is more close to human visual perception.

Along with the HSV, color quantization is used. Color quantization gives ability to store the same color values in the same bin which reduce the storage space. The 14 bin quantization uses 8 bins for storing hue, 3 bins for storing saturation and 3 bins for intensity value. Quantization decreases computation time as non-quantization needs to compare large amount of colors.

B. Shape feature extraction

There are various methods for extracting the shape of image on the bases of region based shape extraction, boundary based shape extraction, and contour based shape extraction. Shape extraction is quite complicated as compared to other features extraction as it required various transformations like scaling, shifting, rotating, etc to apply on image to capture the exact shape of image.

The chain code method is used to determine the boundary of an image by identifying the corners in the image. Shape is a key attribute of segmented image regions, and its efficient and robust representation plays an important role in retrieval. Synonymous with shape representation is the way in which such representations are matched with each other. Horizontal distance vector describes the variance of the shape of the object from top to bottom, where vertical distance vector describe the variation of the shape of object from left to right.

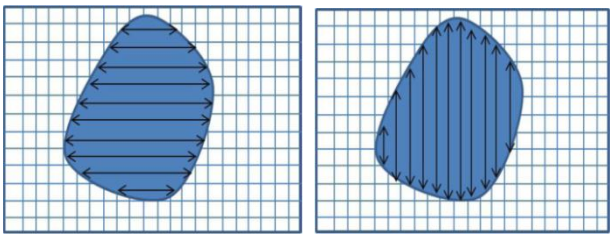

Fig 6: Horizontal and vertical distance calculation [5]

C. Texture feature extraction

The ability to retrieve images based on the texture may not seem very useful but it can often be useful to distinguish between areas of images with similar color, such as sky and sea, or leaves and grass. There are several measures in texture feature comparison such as the degree of contrast, coarseness, directionality and regularity, or periodicity, directionality and randomness.

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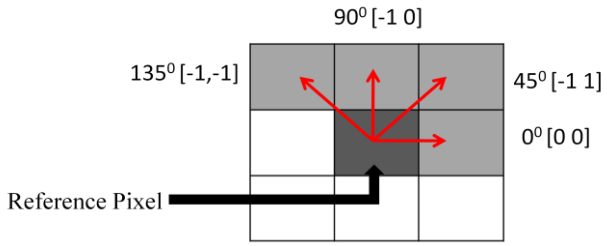
Texture features are intended to capture the granularity and repetitive patterns of surfaces in a picture. For instance, grassland, brick walls, teddy bears, and flower petals differ in texture, by smoothness as well as patterns. The notion of texture generally refers to the presence of a spatial pattern that has some properties of homogeneity. Directional features are extracted to capture image texture information.

A statistical approach is the Grey Level Co-occurrence Matrix. This method characterizes texture by generating statistics of the distribution of intensity values as well as position and orientation of similar valued pixels. A structural approach to texture representation is characterized by generating complex texture patterns from lower level texture primitives, similar to how regular languages are generated by finite state automata.

Formula to calculate grey level co-occurrence for single pixel [5]-

$$M_{CO} = \sum_{x=1}^{K}\sum_{y=1}^{K} \begin{cases} 1, \text{if } I(x,y) = i \text{ and } I(x+d_x, y+d_y) = j \\ 0, \text{Otherwise} \end{cases}$$

Example [5]-



VI. CONCLUSION

Content based Image retrieval is growing technique in image processing from various decades. There are various different techniques in CBIR to retrieve appropriate images from large database. The CBIR techniques those uses shape and layout along with color and texture achieves the best results.
The selection of features is important aspect of image retrieval to capture the most relevant image to user interest.

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