Content Based Image Retrieval using Color, Multi-Dimensional Texture and Edge Orientation

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Abstract

Many image retrieval systems use global features to retrieve images such as color and texture. But the previous results provide too many false positives while using these global features to search for similar images. Content-based image retrieval system works with the entire image and searching is based on comparison of the query image with image database. CBIR uses the visual information of an image such as color, texture and edge to represent and index the image. These contents can be obtained by applying color, texture and edge based techniques. These techniques are applied on both query image and database to get an image from the database more accurately. Color images are indexed by error diffusion block truncation coding (EDBTC). To improve the accuracy of color histogram based matching YCbCr color space is added into EDBTC indexing scheme. Texture analysis is more important because it is used to improve the discriminatory ability of the extracted image features. The speed of edge based retrieval and texture based retrieval can be enhanced by using canny edge detection and gray level co-occurrence matrix. GLCM is used to extract second order statistical texture feature of image. These proposed techniques are used to improve the accuracy of the result.

Keywords: Content based image retrieval (CBIR), Gray level co-occurrence matrix (GLCM), feature extraction

I. INTRODUCTION

Image processing is a type of signal dispensation in which input is image (video frame or photograph) and output may be image or feature associated with that image.

Image retrieval system is used for searching and retrieving images from a large scale database. To extract images an efficient image retrieval methods are used by the content and metadata based system. But most of the image retrieval systems use global features like color, shape and texture. While using those global features to search for similar images, the previous results will return more false positives. Hence the novel image retrieval system uses both content and metadata to retrieve images. The use of metadata such as keywords or descriptions to the images stored in the database along with the images or the low level feature extracted from the image like shape, color, texture etc have been used for the image retrieval from the existing search engine.

CBIR system can be classified as two phases: indexing and searching. In the indexing phase, each image of the database is represented by a set of attribute features color, texture and shape. In searching phase, when the user selects a query image, a query vector feature is computed. Using similarity distance measure well know Euclidian distance, the query vector compared to the feature vectors in the feature database and retrieve to the user the images that most close or similar to the query image. CBIR is the process of retrieving images from a database or library of digital images according to the visual content of the images. In other words, it is the retrieving of images that have similar content of colors, textures or shapes. Images make the communication process more interesting, illustrative, elaborate, understandable and transparent.

In CBIR system, it is usual to group the image features in three main classes; color, texture and edge. Ideally, these features should be integrated to provide better discrimination in the comparison process. Color is by far the most common visual feature used in CBIR, primarily because of the simplicity of extracting color information from images. To extract information about edge and texture feature are much more complex and costly tasks, usually performed after the initial filtering provided by color.

For example, a user may wish to retrieve all images similar to a given image from a large scale image database. Color histogram describes the gray-level or color distribution for a given image and its computation is more efficient. Color histograms also have some limitations. A color histogram provides no spatial information; it merely describes which colors are present in the image, and in what quantities. In addition, color histograms are sensitive to both compression artifacts and changes in overall image brightness. A digital image in this context is a set of pixels. Each pixel represents a color. Colors can be represented using different color spaces depending on the standards used by the researcher or depending on the application such as Red-Green-Blue (RGB), Hue-Saturation-Value (HSV), YCbCr. In image processing, the features used to represent color, texture and edge
information and the measures adopted to compute similarity between the features of query image and images in the image database.

This paper is organized as follows: Section 2 describes related work. Section 3 presents the proposed work. Section 4 discusses experimental results. Section 5 gives conclusions and future scope of the work.

II. RELATED WORK

Image retrieval in CBIR based on the visual features such as texture, color and edge. Generally texture analysis is a very time-consuming process. Research in texture analysis is very important, because that is used to improve the discriminatory ability of the extracted image features.

The color features are the most widely used visual features in image retrieval because they are easier to extract compared with texture and shape information. Color feature is relatively robust to background complication and independent of image size and orientation. Xue and Wanjun [11] proposed a method in which to extract the color feature the feature extraction methods of color histograms and color moments are integrated. They reported that the recall and precision had been improved and the index sorting was better.

Choras and Andrysiak et al. [2] proposed an integrated color, texture and shape feature extraction method. In which Gabor filtering technique is used to determine the total number of regions of interest (ROIs). They calculate texture and color features from the ROIs based on threshold Gabor features, color moments in YUV space. Here shape features are calculated based on Zernike moments. When determining similarity between images, the features presented proved to be an efficient.

In 2002, Shih and Chen proposed color retrieval method based on the primitives of color moments [10]. After dividing an image into several blocks, a fast non-iterative clustering algorithm will be applied. Based on this algorithm the color moments are extracted from the entire blocks and these are clustered into several classes. The mean vector of each class will be calculated and they are considered as primitives of the image and all primitives are used as feature vectors. Two test databases from Corel were used and the performance of the proposed method is compared with other existing methods. The experimental result says that the proposed method is better than others.

In 2010, Jun Yue, Zhenbo Li, and Zetian Fu, [4] Proposed a method for content-based image retrieval by extracting color and texture features of the images more quickly. First RGB color space is converted into HSV color space and then it will be quantified rationally. Color histogram technique is used for color feature extraction and a gray-level co-occurrence matrix is used for texture features extraction. These features are fused by constructing weights of feature vectors. The experimental result says that the mixed features retrieval brings better visuals than the single feature retrieval.

In 2012, Nishant et al. [8] proposed one picture recovery method. It recovers comparative pictures in diverse stages. The photos are at first recuperated in perspective of their shading segment similarity. The significance of the recouped pictures is then further improved by planning their surface and shape highlights independently. Generally CBIR contrast request pictures highlight vector and every image in the database. This decreases the precision of the system as the interest incorporates the whole database which contains a wide grouping of pictures. Moreover accomplishment of shape develop CBIR depends as for exactness of Segmentation framework used. Deplorably it has been exhibited that correct division is still an open issue. Present procedure wipes out the dependence over precise division framework to some degree by narrowing down the chase range at each stage.

When users specify the query “content” or “objects” of their interest and their only wish is to retrieve images containing relevant objects or contents, while ignoring irrelevant contents of the image such as the background. This process usually requires more complicated segmentation of the object from the background. Kumar et al. [5] proposed a model in which the user can select “object of user’s interest” of various shapes; non homogenous texture includes different colors based on many objects present in the same image using various tools such as polygonal, rectangle, circle selector tools. Here, two state procedures are used to query the image from the image database. In first state, to narrow down the search space, they integrate global color feature and texture feature vectors and in the next state they process using local features. As color and texture features, they used color moments and sub-band statistics of wavelet decomposition. They reported that objects with non uniform color and non-homogenous regions can be found effectively.

In 2014, Choudhary et al. [9] proposed a substance based picture recuperation composed technique which isolates both the shading and surface segment. Shading minute (CM) is used on shading pictures to partition the shading segment and neighborhood twofold illustration (LBP) is performed on the Grayscale picture to remove the surface component. By then both shading and organization highlight of picture are joined to shape a singular part vector. Finally likeness organizing is performed by Euclidian division which differentiations highlight vector of database pictures and question pictures. LBP essentially used for face affirmation. Regardless, LBP is used for basic pictures. This joined strategy gives definite, profitable, less bewildering recuperation structure.

In 2012, Mangijiao Singh [6] proposed a new content-based image retrieval technique which combines color histogram and texture features. The discriminating power of color indexing process will be improved by encoding a small amount of spatial information in the color index. Based on this proposed method color feature of an image will be divided (horizontally) into three equal non-overlapping regions. First three moments of the color distribution is extracted from each region in the image and each color channel. Finally, they will be stored in the index for a HSV color space. Gabor texture descriptors are adopted for its texture feature. This approach assign weights to each and every feature respectively and it use Canberra distance as similarity
measure to calculate the similarity of color and texture features. Experimental results proved that the proposed method can provide higher retrieval accuracy than other conventional methods, they combining color histogram and texture features. But it cannot provide more accurate images to the query image.

Texture segmentation is concerned with automatically determining the boundaries between various textured regions in an image [7]. In order to accurately capture the textural characteristics of an image, texture analysis algorithms use filter banks or co-occurrence gray level matrices (GLCMs) have to consider multiple orientations and scales.

A multi feature model for the Content Based Image Retrieval System is proposed in [3] by combining the Color Histogram, color Moment, texture, and edge Histogram descriptor features. Users were given options to select the appropriate feature extraction method for best results. They report the results are quite good for most of the query images and it is possible to further improve by fine tuning the threshold and adding relevance feedback.

III. PROPOSED WORK

Content-based image retrieval (CBIR) is a novel method for finding images from large scale image database. In CBIR, images are indexed by low-level features, such as color, texture, and edge that can be derived from the visual information of the image. Here an efficient approach for image retrieval based on color, texture and edge descriptor features. These features are extracted in an offline process. In this work, a query image will be submitted and find similar images to that query based on a feature comparison criterion. This work first starts with feature extraction. Figure1 represents proposed system architecture. Firstly a database is prepared by importing different type of images. After this, analysis is performed on each and every image in the database. Analysis represents assessment of different descriptors used in this approach. Database is indexed according to values of different images. Finally the database is arranged on the basis of measures. When a user query is submitted for similarity matching the steps of analysis and feature selection is repeated as performed with image database. Now the value of query image is compared with the values of different images stored in database. As a result, the images having closest values compared to query image color, texture and edge values are ranked and extracted from database.

A. EDBTC Compression

The EDBTC compresses an image in an effective way by incorporating the error diffusion kernel to generate a bitmap image [1]. Simultaneously, it produces two extreme quantizers, namely, minimum and maximum quantizers. The EDBTC scheme offers a great advantage in its low computational complexity in the bitmap image and two extreme quantizers generation. In addition, EDBTC scheme produces better image quality compared with the classical Block truncation coding (BTC) approaches.

For each image block, the EDBTC produces a single bitmap image and two extreme (color) quantizers. The bitmap image size is identical to that of the original image size. EDBTC employs the error kernel to generate the representative bitmap image. The EDBTC exploits the dithering property of the error diffusion to overcome the false contour problem normally occurred in BTC compression.

![Fig. 1: System Architecture](image-url)
B. Color Histogram Feature

Color histogram feature represents the combination of pixel brightness and color distribution in an image. Mainly, the color histogram approach counts the number of occurrences of each unique color on a sample image. Since an image is composed of pixels and each pixel has a color, the color histogram of an image can be computed easily by visiting every pixel once. By examining the color histogram of an image, the colors existing on the image can be identified with their corresponding areas as the number of pixels.

Histogram search characterizes an image by its color distribution, or histogram. Many histogram distances have been used to define the similarity of two color histogram representations. Y’CbCr color space is used to retrieving this feature and this color space is used for encoding RGB information. The actual color will be displayed based on the actual RGB primaries. Therefore standard RGB primary chromaticity is used to express YCbCr is predictable. In YCbCr, color is represented as brightness and two color difference signals where Y is the single component (brightness), Cb indicates the difference between the blue component and a reference value and Cr indicates the difference between the red component and a reference value. But in RGB color will be represented as red, green and blue. This process includes following steps:
1) Convert RGB color space image into YCbCr using rgb2ycbcr function.
2) Color quantization is carried out using color histogram by assigning the data ranges. Here the range for Y is [16, 235], and the range for Cb , Cr is [16, 240].
3) The normalized histogram is obtained by dividing with the total number of pixels.
4) Repeat step1 to step3 on an image in the database. Calculate the similarity matrix of query image and the image present in the database.
5) Repeat the steps from 4 to 5 for all the images in the database.
6) Retrieve the images.

C. Texture Feature

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). Gray level co-occurrence matrix is formulated to obtain statistical texture features. A number of texture features may be extracted from the GLCM. Only four second order features namely angular second moment, correlation, inverse difference moment, and entropy are computed. These four measures provide high discrimination accuracy.
1) Angular second moment
Angular Second Moment (Uniformity or Energy) is the sum of squares of entries in the GLCM. It measures the image homogeneity and ASM is high when image has very good homogeneity or when pixels are very similar.
2) Inverse different moment
Inverse Difference Moment (IDM) is the local homogeneity. If local gray level is uniform and inverse GLCM is high then it is also high. IDM weight value is the inverse of the Contrast weight.
3) Correlation
Correlation measures the linear dependency of grey levels of neighboring pixels. Digital Image Correlation is an optical method that employs tracking & image registration techniques for accuracy 2D and 3D measurements of changes in images.
4) Entropy
Entropy shows the amount of information of the image that is needed for the image compression. Entropy measures the loss of information or message in a transmitted signal.
All the texture features are real numbers. Real numbers cannot be displayed using waveforms which show only bits as outputs. So bits are converted to real numbers for feature extraction.

D. Edge Detection

Edges in image are represented as areas with strong intensity contrast and major variation in the picture quality can be created by a jump in intensity from one pixel to the next. Main purpose of edge detection is to significantly minimize the amount of data and filters out unimportant information, while preserving the important properties of an image. An edge may contain other edges, but at a certain scale, an edge still has no width. If the edges in an image are identified accurately, almost all the objects are located and their important properties such as area, perimeter and shape can be measured easily. Therefore edges are used for boundary estimation and segmentation in the scene.

The Canny edge detection algorithm is used for edge feature extraction. It runs in 5 separate steps:
1) Smoothening
When images are taken from the camera they will contain some amount of noises and these noises must be reduced to prevent the mistaken for edges. In order to remove the noise Gaussian filter is applied to smooth the image. By using this noise removal method false edge detection will be reduced.
2) Finding gradients
In this step, the intensity gradients of the image will be found. If the gradient of the image has large magnitudes then those edges should be marked.
3) **Non-maximum suppression**

Non-maximum suppression is edge thinning technique. It is applied to thin the edge. In this step, the gradient magnitudes of the “blurred” edges in the image will be converted into “sharp” edges. This is done through preserving all local maxima in the gradient image and deleting all other things. The algorithm for each pixel in the gradient image:

1) First, indicate the gradient direction theta to nearest 45°.
2) A value of the current pixel will be preserved, if and only if the edge strength of the current pixel is large when compared with the other pixels in the image with the same direction (i.e., if the pixel is pointing the y direction, it will be compared to the pixel above and below it in the y axis). Otherwise, the value will be suppressed.

4) **Double thresholding**

This algorithm uses double thresholding. If the edge pixels are stronger than the high threshold then they are marked as strong edge; if the edge pixel is weaker than the low threshold then they are suppressed and edge pixels between the two thresholds are marked as weak edge. The strong edges will only be due to actual edges occurred in the original image. The weak edges can be occurred due to noise/color variations.

5) **Edge tracking by hysteresis**

All the final edges are determined by suppressing the edges that are not connected to a strong edge. When noise responses are unconnected, weak edge pixels are caused from true edges. Edge tracking can be implemented by applying Binary Large Object (BLOB). In which, the edge pixels are divided into connected binary large objects using 8-connected neighbourhood. Binary large objects must contain at least one strong preserved edge pixel, while other BLOB’s are suppressed.

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**Fig. 2: Image sample from the test database. (a) Corel 1000, (b) Vistex database**

**E. SIMILARITY COMPUTATION**

After the extraction of color, texture and edge features of both query image and database, features of the query image will be compared with the feature database. Finally, the matching process retrieves those images whose extracted features match those of the query most closely.

**IV. EXPERIMENTAL RESULTS**

In this section, extensive experiment results are reported to demonstrate the effectiveness of the proposed feature extraction approaches. Several image databases consisting of natural and textural images are utilized in this experiment to have an in-depth investigation of the successfulness of the proposed CBIR system. The proposed image retrieval system extracts the image features from all images in the database using methods mentioned in proposed work. Based on the similarity distance score from the descriptors, the similarity between the query and target image is measured. Based on the similarity distance values a set of ranked images are returned by the system. In this experiment, the retrieval accuracy is measured using the average precision, average recall value over all query images. The higher average precision rate indicates that the system is able to retrieve a set of returned images which has more similar appearance with the query image. Additionally these proposed methods almost always showed performance gain of average retrieval time over the other methods. It is showed in figure 4. In which red dots represents the time consumption for retrieval time consumption of existing system and blue line represents the time consumption for retrieval time consumption of proposed system.
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Here CBIR method has been proposed which uses the combination of dominant color, GLCM texture and canny edge detection for shape. Extracted features covering color, texture and shape proved that the proposed method yielded higher average precision and average recall. By extracting the features of an image by GLCM approach, the image compression time can be greatly reduced in the process of converting RGB to Gray level image when compared to other Techniques. Additionally these methods almost always showed performance gain of average retrieval time over the other methods. An extension of this work can be brought to index video by considering the video as a sequence of images.

V. CONCLUSION AND FUTURE WORK

REFERENCES


Fig. 3: Example of image retrieval result using Corel 1000.

Fig. 4: Performance comparison over the time