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Image Retrieval by Content Using Descriptors

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Abstract

Image retrieval from large databases has become easier nowadays through the digitization of images. One such methodology which is widely used forms the image retrieval by its content. CBIR enhances the technique of retrieving images from a larger collection. QBIC has achieved its necessity by retrieving the appropriate images by using its features to retrieve the images. Features can be of one of the following- Shape, Color and Texture. This paper makes use of descriptors to retrieve the texture and the color features. Texture feature is extracted by making use of Edge histogram and color feature is extracted by using HMMD color space. The feature extraction phase is applicable for both query image and database images. These features are processed and stored as another database named feature database which is later used to match the query image with the feature database images. Similarity measure is calculated between the images through a distance measure and hence similar images are retrieved that matches the specific criteria.

Keywords: CBIR, MPEG-7, Edge histogram, HMMD.

Introduction

Image retrieval involves various methods. Retrieval process through keyword search is one of the basic techniques but it involves much processing and is time consuming. The other methods of image retrieval did not satisfy the perception level which sounds as an ambiguity. The most successful method of CBIR is the feature extraction technique since it aims at reducing the demerits found in the traditional methods of image retrieval and overcomes the ambiguity by retrieving the images automatically. It mainly diminishes the gap between the perception level of user's interpretation and visual information.

The features in the image can be of either shape or color or it can be the texture of the image. The most commonly used features are texture and color. The feature extraction technique initially determines the feature of the image through processing and saves it in the feature database for future processing. These features are then used to compare the features of the images in the database with that of the target image. Similarity measurement is the phase where the most similar images are retrieved. The advantage of using CBIR is achieved here since the similar images are retrieved automatically by the use of CBIR.

Related Work

[1] used image abstraction technique for which signature bitstrings were used and global color histogram was used for extracting color feature. [2] processed the feature vectors by considering the descriptors locally as well as globally and made use of a novel descriptor through Hough transform. [3] used color averaging technique for as color feature vector and similarity is measured through Euclidean Distance. [4] is an integrated method where the wavelet based search is combined with indexing method. It enabled Multi-class support vector ensemble to organize multi class images. In [5], integrated technique is used for the extraction of color through K-means and B+ database (indexing techniques).
[6] exhibits the retrieval mechanism by combining the techniques of color,edge,color difference and low level features as a whole. In [7], co occurrence matrix is used for generating color and texture feature vector. In [8], color histogram is used for extracting color feature vector and Gabor filter is used for extracting texture feature vector. GA was used for feature discrimination. In [9], wavelet based technique is used for retrieving the images through color and texture. Similarity is given through a distance measure. In [10], color spaces of various techniques were organized to determine the similarity. [11] deals with the various transforms that are used for feature extraction. [12] determined the wavelet based edge detection methods which used daubechies and coiflets for shape extraction. [13] determined the work of applying DCT on the image for retrieval of features. In [14], retrieval of color images based on color moments is incorporated. In [15], a clustering technique and an edge

detection mechanism were combined for shape feature extraction. The clustering technique used K-means clustering and edge detecting method incorporated canny edge detection. [16] rank power measurement is incorporated by using color histogram. In [17], IRM(Integrated Region Matching) and color histogram were used for the retrieval mechanism.[18] used color histogram and Tammura texture for extraction of feature vectors. In [19], color descriptor, pseudo Zernike and steerable filter decomposition were used for shape, color and texture respectively.

Algorithm

This work retrieves similar images from the database by the method of feature extraction which entertains the methods of edge histogram and HMMD for texture and color respectively. The following steps provide the detailed working of the proposed system.

Step 1: Initially, database is built with a collection of images.
Step 2: Query image is considered from the database of images.
Texture:
Step 3: Feature vector for texture is evaluated by using edge histogram
Step 4: For an image, image intensity is determined and edge detection mask is initialized.
Step 5: Edge images are created by performing filtering using the masks
Step 6: Size of each sub image is determined
Step 7: Blocks and histogram are computed
Step 8: Distance between the histogram is computed

Color:
Step 9: Color space descriptor makes use of HMMD
Step 10: It scans the image by 8x8 structuring elements
Step 11: The number of blocks having each color is counted.
Step 12: Color histogram is generated.

Step 13: Similarity measurement phase determines the similarity between the images and retrieves the similar images.

Proposed Work

This work of retrieval system makes use of standardized descriptors for image retrieval by content through a multimedia standard named MPEG 7 which improves the retrieval of images by content. It also makes use of histogram which is a commonly used feature for image retrieval. Functional key elements of MPEG 7 are as follows:

- Description definition language
- Description schemes
- A/V descriptors
-

Low level visual features are
- Color
- Shape
- Texture
- Motion
- Face

Importance of using content descriptive method is that it manages to overcome the difficulties of searching and organizing contents. The main of objective of using descriptive content is that because of its fast and effective content filtering technique, providing several aspects of the content, applicability for large range of applications.
The proposed system is shown in figure 1

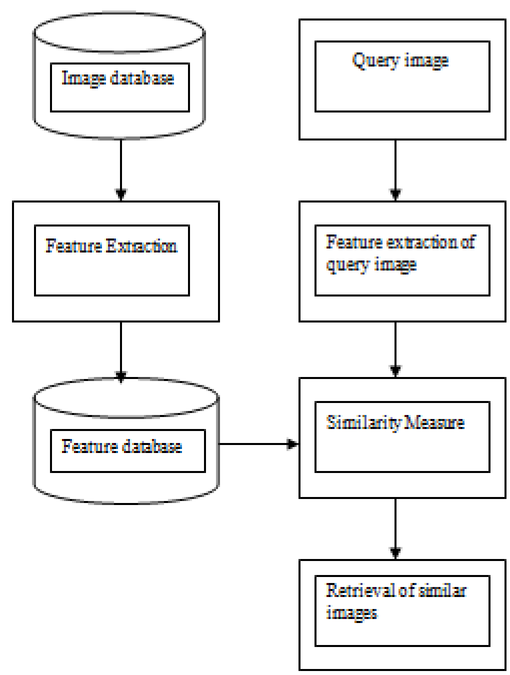

Figure 1: CBIR system

1. Database

The collection of images for processing is stored in the database. Images from the database are considered as query image.

2. Feature Extraction

This phase of proposed work aims at extracting the features from the images. Here visual features of color and texture are extracted and stored in the feature database. For extracting the above said features, HMMD color space shown in figure 4 and Edge histogram descriptor are used respectively.

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2.1 Color Space Descriptor-HMMD

It is a color space descriptor and it specifies a color point. It also allows color space selection. The description makes use of the selected color space. It provides scalar quantization for image retrieval. The color quantization descriptor associated with this divides the color space into bins.

The process flow of HMMD shown in figure 5,which initially scans the image by 8x8 structuring element. It then counts the number of blocks having each color. Finally a color histogram is generated.

Color space descriptor extraction is shown in figure 2 & 3 which describes the structuring elements for images with resolutions 320x240, 640x480.

If, W, H -- width and height of image respectively
E x E – structuring element's spatial extent
K – Sub-sampling factor

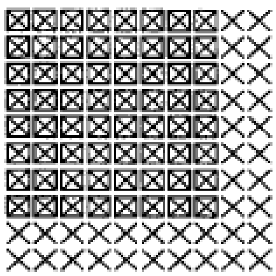

Figure 2: Structuring element with resolution 320x240

Sub sampling factor,
$p = \max \{0, \text{round } (0.5 \log_2 WH-8)\}$ (1)
$K = 2^P$, E=8K

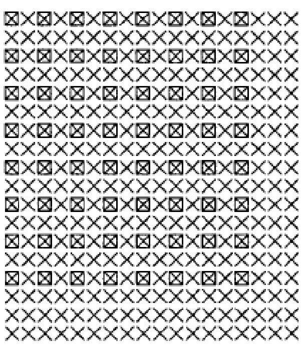

Figure 3: Structuring element with resolution 640x480

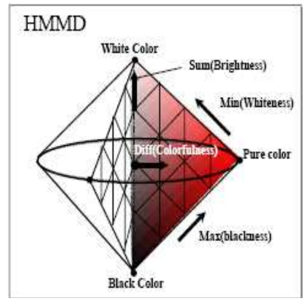

Figure 4: HMMD color space

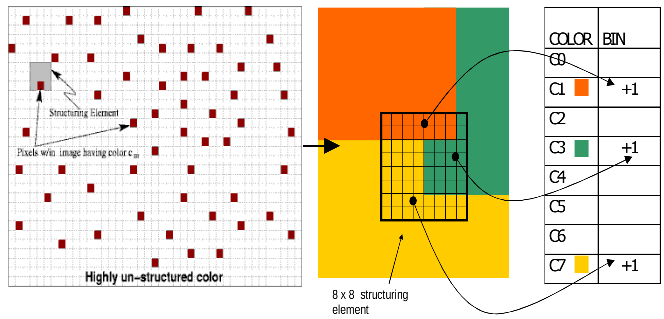

Figure 5: HMMD process flow

The color space extraction procedure is shown in figure 6

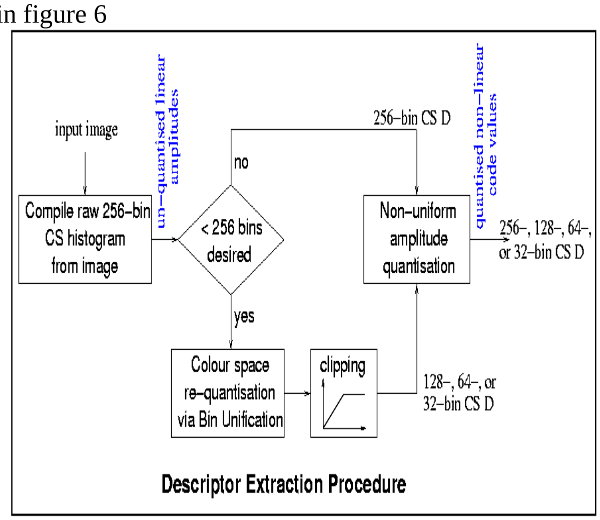

Figure 6: CSD Extraction

Four components of HMMD color space are hue, min, max, and diff. Other than these, fifth component of HMMD is sum. Four non-uniform quantization of HMMD are denoted in MPEG-7. These quantization partition the space into 256, 128, 64, 32.

The relationship between RGB and HMMD is given by,

- Max = max(R, G, B)
- Min = min(R, G, B)
- Diff = Max-Min
- Sum = (Max + Min) /2

2.2 Edge histogram descriptor

A descriptor for image matching used in MPEG 7 standard is edge histogram descriptor. It represents the local edge distribution in an image. Edge recognized an important feature in an image. It is sensitive in the view of human interpretation.

Types:
There exist five types of edges described by edge histogram descriptor. In that, four are directional and one non directional edge. The last edge figure without any direction is termed as non- directional edge shown in figure 7

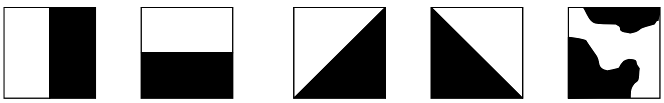

Figure 7: Edge Types

Initial step in EHD is partitioning. It divides the image space into 4x4 sub images. The sub image edge distribution is represented by generating an edge histogram for the same. Image blocks are generated from sub images that are found as square blocks as shown in figure 8.

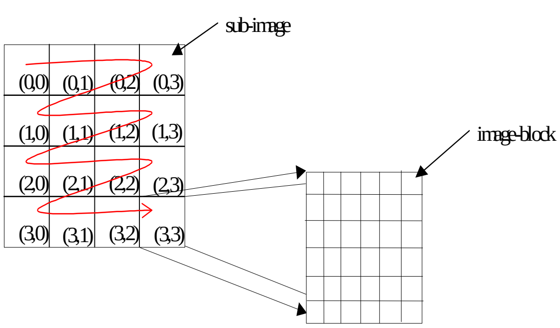

Figure 8: Partitioning of EHD

Edge feature extraction is encountered from the image block. Further division of image block into four sub blocks as shown in figure 9. The average values of sub blocks and a filter convolution is used to obtain the edge magnitudes.

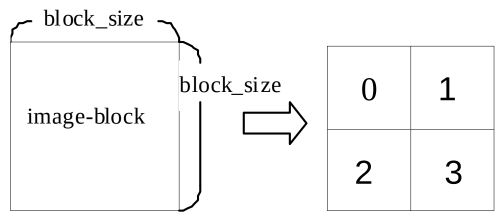

Figure 9: Edge feature extraction

The standard of MPEG-7 is designed in such a way that it supports local edge distribution with only 80 bins (standard semantics) shown in table 1. The generation of 80 bins can be explained as follows:

There exist five types of edges which generates five histogram bins for each sub image. The image space is partitioned into 4x4 sub images= 16 sub images. Now, total number of bins = total number of sub images x histogram bins for each sub image. (i.e.) 16x5 = 80 bins for edge histogram.

Histogram bins	Semantics
Local_Edge[0]	Vertical edge of sub-image at (0,0)
Local_Edge[1]	Horizontal edge of sub-image at (0,0)
Local_Edge[2]	45degree edge of sub image at (0,0)
Local_Edge[3]	135degree edge of sub-image at (0,0)
Local_Edge[4]	Non-directional edge of sub-image at (0,0)
Local_Edge[5]	Vertical edge of sub-image at (0,1)
:	:
:	:
:	:
Local_Edge[74]	Non-directional edge of sub-image at (3,2)
Local_Edge[75]	Vertical edge of sub-image at (3,3)
Local_Edge[76]	Horizontal edge of sub-image at (3,3)
Local_Edge[77]	45degree edge of sub-image at (3,3)
Local_Edge[78]	135degree edge of sub-image at (3,3)
Local_Edge[79]	Non-directional edge of sub-image at (3,3)

Table 1: Histogram bins and its associated semantics

Similarity Measure

Similarity measure is given with respect to L2 norm of distance measure to ensure the collation between the images in the database in parity with the query image.L2 norm of distance measure is found to be the most commonly used distance measure namely Euclidean distance in image retrieval by content. It compares the feature vectors of the images in the feature database and the target image and retrieves the most concurrent images from the database in affinity with the query image. The Euclidean distance measure is given by,

$$D_{QI} = \sqrt{\sum_{i=0}^{79} (FQ_i - FI_i)^2} \quad (2)$$

Since the descriptor contains 80 bins, i vary from 0 to 79. Here D represents the distance measure to

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identify the similarity, FQ represents the feature vector obtained from the query image and FI represents the feature vector obtained from the feature database.

Results and Discussion

Figure 10 shows the sample database used in the proposed work. Three different query images are chosen for processing which is shown in figure 11. Figure 13, 14, 15 represents the retrieval of images from the database based on the query images.

Figure 10: Sample database

Q1 Q2 Q3

Figure 11: Query Images

Figure 12: Original Image

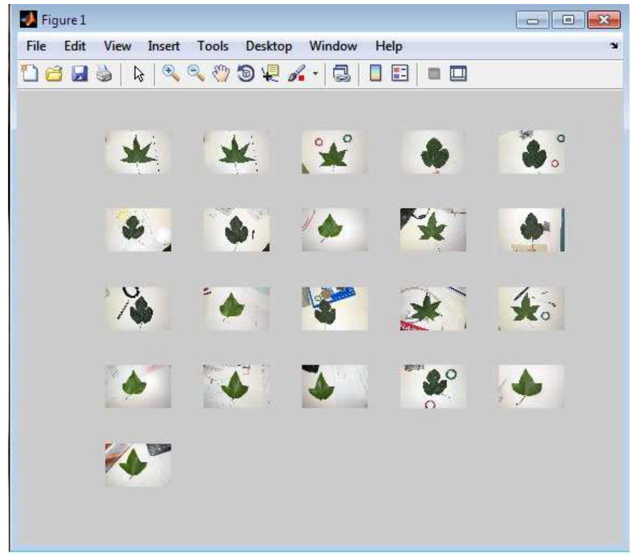

Figure 13: Retrieved concurrent images for Q1

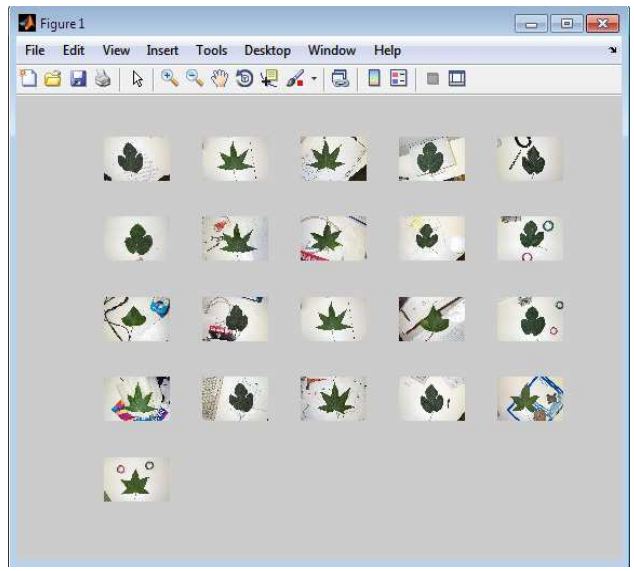

Figure 14: Retrieved concurrent images for Q2

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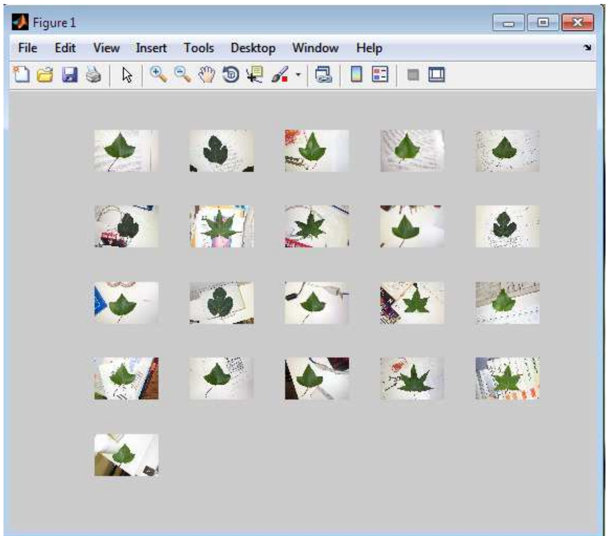

Figure 15: Retrieved concurrent images for Q3

Performance Analysis

Performance of the proposed work is analyzed through the following,

$$\text{Precision} = \frac{\text{Number of relevant images retrieved}}{\text{Total number of images retrieved}} \quad (3)$$

$$\text{Recall} = \frac{\text{Number of relevant images retrieved}}{\text{Total number of relevant images in DB}} \quad (4)$$

Here C1, C2, C3 denotes the three different categories of the images chosen as query images for processing.

Category	C1	C2	C3
Q1	6	8	5
Q2	8	10	4
Q3	7	2	11
Average precision in %	6.5	6.0	7.5
Recall	0.065	0.060	0.075

Table 2: Precision and Recall evaluation

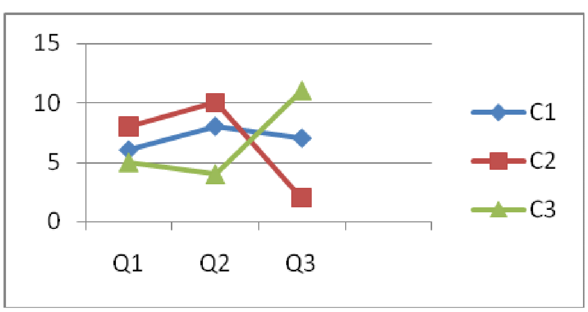

Figure 16: Retrieval performance analysis

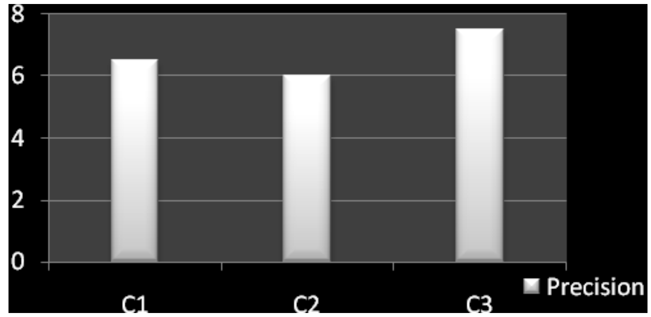

Figure 17: Precision evaluation

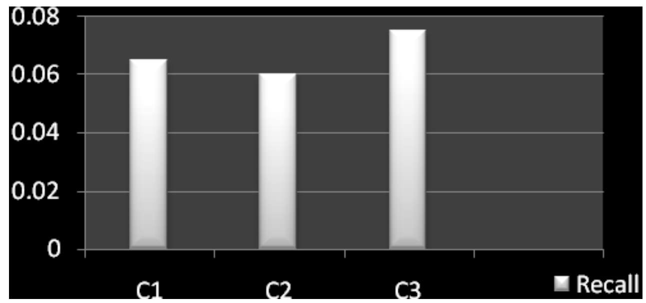

Figure 18: Recall evaluation

Conclusion and Future work

This work uses MPEG 7 standard to choose the feature vectors for feature extraction. It makes use of HMMD color space for color feature extraction and EHD for texture feature extraction. These features are compared to retrieve concurrent images from the database. This work can further be improved by using a different feature extraction technique and by using global descriptors in the place of local descriptor.

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