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# A Novel Approach of Color-Texture based CBIR Using Fuzzy Logic

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***Abstract***

*Image retrieval is an emerging research area for multimedia database. It is the basic requirement task in the present scenario. In this paper we propose a novel CBIR approach using Fuzzy clustering. The proposed method firstly clusters the images based on RGB components, using Fuzzy clustering algorithm, secondly the image retrieval is performed based on texture element in the clustered database.*

*The performance of the system is evaluated on the most common evaluation method namely Precision and Recall method. The proposed method achieves higher efficiency than the texture based retrieval techniques.*

***Keywords:*** *CBIR, Feature Extraction, Texture, Fuzzy clustering, Similarity measurement*

## 1. Introduction

In past few decays, the number of image collections available has increased due to ease of capturing images by different acquisition systems and transmitting them through network. The storage format of image data is relatively standardized however the effective retrieval of images from such databases remains a significant challenge. In case of small collection of images, it is feasible to identify a desired image simply by using browsing and indexing, but in many large image databases, traditional methods of image indexing have proven to be insufficient and time consuming.

Content-based image retrieval (CBIR) [1] is an emerging research topic for multimedia databases and digital libraries. Figure 1 shows the Content-based Image Retrieval model. Using Content based Image Retrieval techniques [2]; a user can query an image database by content of interest such as colors, textures, shapes and visual example [3] like sketch.

The Database images that satisfy the similarity measures are retrieved from database as a result [4]. There are four important feature components for content-based image retrieval: color [5, 6], texture [8], shape [9], and spatial relationship. Among these features, Texture contains the most attractive visual information for human perception.

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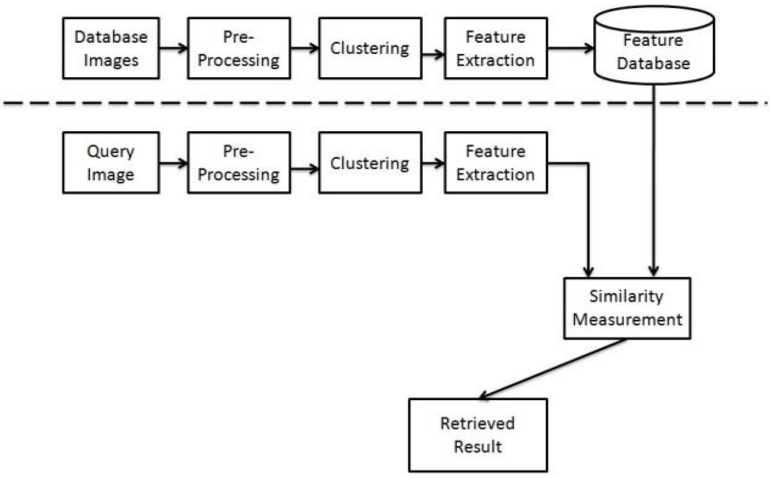


**Figure 1. Content Based Image Retrieval Model**

Color histogram is the most widely used feature for image retrieval [11]. But image retrieval techniques using only color feature do not give encouraging result because the color histogram do not contain textural information. Texture is the property of all surface that describes visual patterns, each having properties of homogeneity [8]. Texture measures look for visual patterns in images [9].

In this paper we propose a new approach of CBIR. In our work we use Fuzzy clustering algorithm to represent color clusters of image; the features are extracted based on texture.

## 2. Image Color Content Representation

In color based image retrieval [13, 14], relevant images are retrieved using the RGB color model. Color images are normally in three dimensional. In proposed method RGB color component are taken from each and every image. Then mean value of Red, Green and Blue component in target images are calculated and stored in database.

$$Red\ Average = \frac{\text{Sum of all the Red pixels in the image R(P)}}{\text{No. of pixels in the image}}$$

$$Green\ Average = \frac{\text{Sum of all the Green pixels in the image G(P)}}{\text{No. of pixels in the image}}$$

$$Blue\ Average = \frac{\text{Sum of all the Blue pixels in the image B(P)}}{\text{No. of pixels in the image}}$$

Where, R(P) = Red Component Pixels,

G(P) = Green Component Pixels,

B(P) = Blue Component Pixels,

## 3. Fuzzy Clustering

Clustering algorithm can offer superior organization of multidimensional data for effective retrieval clustering algorithm allows nearest neighbour search to be efficiently performed. Using fuzzy algorithm the term set can be generated and the degree of appearance for each color feature can be interpreted as five natural language terms for example Figure 2 shows the term set for one color component that are Very Low, Low, Medium, High, Very High.

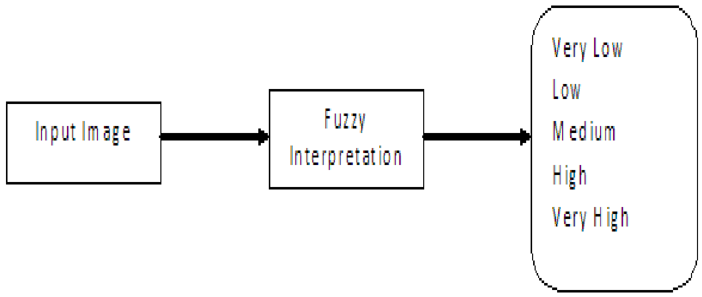


**Figure 2. Fuzzy Interpretation for One Color Component**

Algorithm used for Fuzzy Clustering [3]

Input. Data sequence x1, x2, x3… xn

Where

xi denotes a color feature of i'th image and n is the number of images

Output. Five membership functions of the color features.

Step 1. Let c0 =min{x1, x2, . . . ,xn} and c6 =max{x1,x2,. . .,xn} compute c1, c2 ,. . . , c5 as follows

$$c_j = c_0 + \frac{j}{6} \times (c_6 - c_0)$$

Step 2. U=0. For each xj , update each element uij using one of the following rules,

Where,

Uij , $1 \le i \le 5$ and 1$\le j \le n$ is the membership value of xj in i'th linguistic term

Rule 1. If $x_i \le c_1$ then ui,1=1 and $u_{i,j\neq 1} = 0$

Rule 2. If $c_j < x_i \le c_{j+1}$ compute uij =(cj+1 - xi)/(cj+1 - cj),

Ui,j+1=1 - uij and $u_{i,k\neq j,j+1} = 0$

Rule 3. If xi<c5 , $u_{i,k\neq 5} = 0$ and ui,5=1

Step 3. Compute c1, c2 ,. . . , c5 using the following equation:

$$c_j = \frac{\sum_{j=1}^{n} u_{ij} x_j}{\sum_{j=1}^{n} u_{ij}}$$

If c1, c2,. . . , c5 are unchanged, the algorithm stops; otherwise go to step 2.

In proposed algorithm each linguistic term is a fuzzy set and represented as a triangular membership function. Five evenly distributed triangular membership functions are used as initial membership functions of a color feature. Figure 3 c0 and c6 denotes the minimum and maximum of the input data and c1, c2 ,. . . , c5 denotes the class centres of the five membership functions.

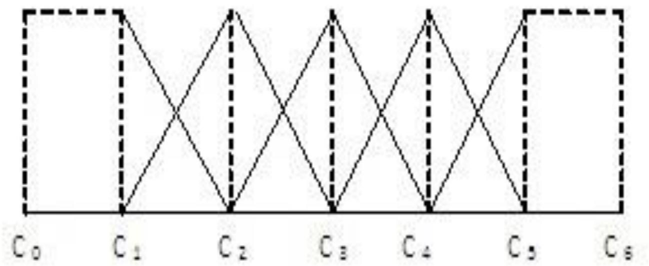


**Figure 3. Membership Function for a Color Feature**

In proposed methodology firstly the color contents of each color is extracted from each database image and then the database images are clustered using fuzzy clustering algorithm. For each color content, five clusters are formed for example for red color the clusters formed will be Very Low Red, Low Red, Medium Red, High Red and Very High Red. For an extracted color component of database images, step 1 of algorithm generates five clusters and c2 ,. . . , c5 as the centres for each class. The membership function value of each database image for all these classes is calculated in step 2. Again in step3 the values for c2 ,. . . , c5 are recalculated using these membership values and classes are reformed. The process continues until there is no change in centres of classes. The centres of classes and the membership values of each database image for the classes are stored in database as feature vector.

## 4. Image Texture Content Representation

Textures are represented by Texel's 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 an important characteristic for the analysis of many types of the images including natural scenes, remotely sensed data and biomedical modalities [7].Tamura et al. proposed six statistical features which correspond to visual pattern [8]. Texture properties of an image include Coarseness, Contrast, Directionality, Line-likeness, Regularity, Roughness, Entropy and Energy. Table 1 shows the Texture Feature and their Representation.

**Table 1. Texture Features and their Representation**

| Name of The Texture Feature | Representation |
|---|---|
| Coarseness | Texture Granularity |
| Contrast | The difference in intensities among neighbouring pixels |
| Directionality | The placement of the texture primitives |
| Line-likeness | The shape of texture primitives |
| Regularity | Variations of texture-primitive placement |
| Roughness | Variations of physical surface |

The Texture features under consideration are Energy, Entropy and Contrast [7].

 

### 4.1. Energy

The texture represents the energy content of the images. If the image contains more and high textures, then the energy will be high [15]. In proposed method energy is calculated using following formula:

Texture_energy = sum (Texture_img( : ).^2)/tp;

### 4.2. Entropy

Entropy is a statistical measure of randomness that can be used to characterize the texture of input image [15]. In proposed method entropy is calculated using following formula:

Texture_entropy = entropy (Texture_img);

### 4.3. Contrast:

Contrast is the measurement of vividness of texture pattern in an image [15]; the simple method of varying picture contrast is stretching or shrinking of its grey scale. In proposed method contrast is calculated using following formula:

Texture_contrast = contrast (Texture_img);

## 5. Methodology of the Proposed Work

The architecture of the proposed work is given in Figure 4 which depicts all the processing steps used in this work as following: -

### 5.1. Database of Images

Database consists of the number of images which has universal names and can be recognized using name only.

### 5.2. Algorithm of Proposed Work

Step 1: Input the query image

Iinput=Iquery

Step 2: Find RGB component from the image.

Step 3: Find appropriate cluster, Using Fuzzy Algorithm.

Step 4: Convert the image from RGB to Gray.

Step 5: Extract Feature vector of the image.

FV = [Energy, Entropy, Contrast]

Step 6: Apply similarity measurement algorithm to the extracted feature vector and the features of image database stored in database.

Step 7: Retrieve the relevant image based on similarity measurement.

 

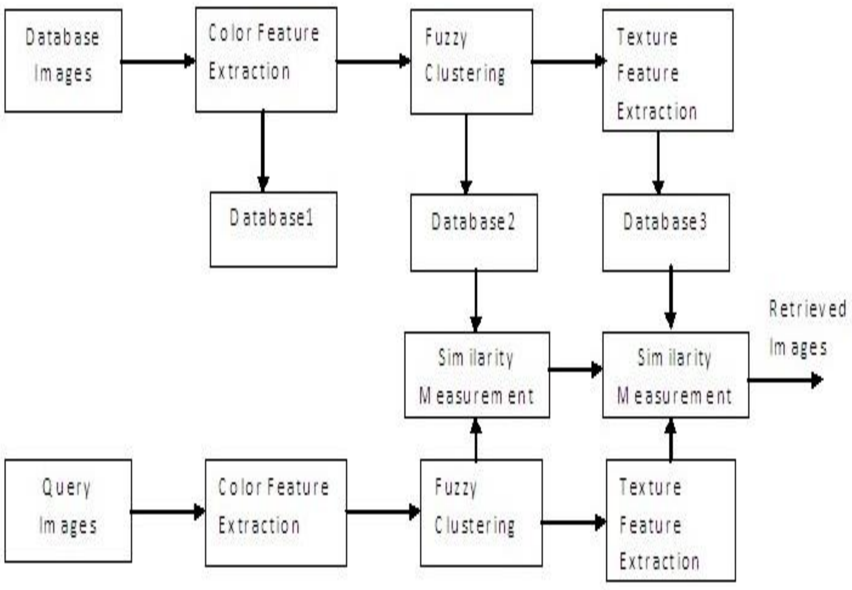


**Figure 4. Architecture of Proposed CBIR System**

## 6. Performance Evaluation

The evaluation of retrieval performance is crucial problem in Content-Based Image Retrieval (CBIR).Many different methods for measuring the performance of a system have been used by researchers. The most common evaluation method namely Precision-Recall method can be used to evaluate the performance of retrieved system.

Precision is defined as ratio of number of relevant image retrieved to the total number of images retrieved.

Recall is defined as ratio of number of relevant image retrieved to the total number of relevant images in database.

With this, the following formulae are used for finding Precision and Recall values:

$$\text{Precision} = \frac{\text{No. of Relevant Images Retrieved}}{\text{Total no. of Images Retrieved}}$$

$$\text{Recall} = \frac{\text{No. of relevant Images Retrieved}}{\text{Total no. of relevant Images in the database}}$$

Total number of images in the database [13] =100

The query image taken is shown in Figure 5 and retrieved relevant images are shown in Figure 6

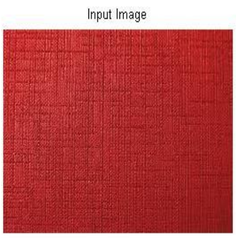


**Figure 5. Query Image**

 


**Figure 6. Retrieved Relevant Images**

Total number of Relevant image retrieved = 4

Total number of image Retrieved = 7

Total number of relevant image in database = 5

**Precision = 0.6 Recall = 0.8**

## 7. Conclusion

The main objective of the proposed image retrieval model is to develop an efficient image retrieval scheme. The proposed method is based on the two steps firstly to cluster the database based on RGB component. Secondly, the retrieval is performed based on texture features.

In proposed method the database is reduced using clustering and the searching of image is performed on the reduced database. This will improve the efficiency of the retrieval system and reduce the search time for relevant images in database.

The proposed method combines the concept of Texture based Image Retrieval system and clustering based on color component. This will increase the speed of retrieval system. The Proposed system has a high efficiency than the Texture Based CBIR and Color Based CBIR.

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