Volume 3, Issue 11, November 2013 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

An approach used for user Oriented Content Based Image Retrieval using Interactive Genetic Algorithm

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Abstract— A content based image retrieval has become very popular system now a days. As previously used text based system founds very tedious and as a difficult task for image retrieval. But the CBIR is the method where there are many methodologies are available and the task of image retrieval becomes effectively easier. Here we use different feature descriptors such as, color ,texture and shape descriptors to represent low level features of image. There are the techniques called a'trous wavelet transform (AWT) and Julesz's texton elements are used to generate the texton image. Also the multi texton histogram (MTH) is one of the method for this task. It integrates the advantages of co-occurrence matrix and histogram by representing the attributes of co-occurrence matrix using histogram. Here, the user directed mechanism for CBIR using an interactive genetic algorithm (IGA) is proposed and implemented. The color attributes like the mean value, standard deviation and image bitmap of a color image are used as a features for retrieval.

Keywords— CBIR, fitness function, IGA, population, crossover, mutation.

I. INTRODUCTION

With the advancement of technology, the use of internet and new digital image sensor technologies increases at a huge level in various fields of education and scientific research. It is always necessary to find and process the images in that huge database, for this purpose the retrieval of accurate image is required. But the previously used the Text Based approach was so much tedious and difficult for image retrieval. Therefore the automatic and effective method named Content Based Image Retrieval (CBIR) is most effectively applied for this task. This method uses the visual features of image such as, color , texture and shape to search the images from large database. Here the technique proposed and adopted based on HSV for color features which contributes for the task. We here proposed the IGA and with this made the use of some features like mean value, standard deviation and image bitmap of colors. Also for texture GLCM and edge histogram is considered.

II. RELATED WORKS

For this CBIR technique, it is required to extract several low level features like color, texture and shape or edge from the image. The texture & color are important features, the texture contains the information about the structural arrangement of surface & their relationship to the surroundings. For texture, Haralick et al [2] suggested the use of (GLCM) also with this the wavelet transform provides a multi-resolution approach to texture analysis. Manjunath & Ma [12] suggested to use the combination of multi resolution analysis and color correlation histogram where then some computations are made with the use of wavelet coefficients. Then this advances by M. Saadatmand-Tarzjan [13] using OQCM. Gonde et al [1] used technique where more concentration was put on the texture, the color also played a role for CBIR. Guung-Hai Liu et al [5] introduced a technique of multi-texton Histogram. Here we proposed the IGA for CBIR [6] we also evaluated the performance of IGA based image retrieval system that uses wavelet coefficient to represent physical features of images[7].A. B. Gonde , R. P. Maheshwari, R. Balasubramanium [1] proposed the use of texton co-occurrence matrix for CBIR, here proposed the use of AWT & Julesz's texton elements to generate the texton image. Here in this paper the image retrieval is to be made with IGA, here some features like mean value, standard deviation & image bitmap of color image are used[6]. For texture features the entropy based on the gray level co-occurrence matrix & edge histogram of an image are considered[6]. By using this method, here it has been proposed that it is easy to infer which images in the database would be of the most interest to the user. Here the main properties are,

1) Low-level image features, from the Hue, Saturation, Value (HSV) color space, as well as texture & edge descriptors are adopted here.
2) The query by example strategy as a search technique.

III. METHODOLOGY

In this for effective execution of the task we considered the visual features from images, the color descriptor and texture descriptor are helpful for performing the task of image retrieval.

Color Descriptor: The human eyes cannot distinguish the colors very efficiently. The colors can be divided into 8 parts and saturation and intensity into 3 parts separately. As per the quantization levels, the HSV three dimensional feature vector for different values of with different weight to form one-dimensional feature vector named G[7]:

G=QsQvH+QvS+V.

Where Qs is quantified series of S.

Qv is quantified series of V. We can set Qs=Qv=3 , G=9H+3S+V.

$$H=\begin{cases} 0 \text{ if } h\in[316,20] \\ 1 \text{ if } h\in[21,40] \\ 2 \text{ if } h\in[41,75] \\ 3 \text{ if } h\in[76,155] \\ 4 \text{ if } h\in[156,190] \\ 5 \text{ if } h\in[191,270] \\ 6 \text{ if } h\in[271,295] \\ 7 \text{ if } h\in[296,315] \end{cases}$$

$$S=\begin{cases} 0 \text{ if } s\in[0,0.2] \\ 1 \text{ if } s\in[0.2,0.7] \\ 2 \text{ if } s\in[0.7,1] \end{cases}$$

$$V=\begin{cases} 0 \text{ if } v\in[0,0.2] \\ 1 \text{ if } v\in[0.2,0.7] \\ 2 \text{ if } v\in[0.7,1] \end{cases}$$

Here we can thus have 72 bins of one-directional histogram [6]. This reduces the complexity and time computation. The role of color cumulative histogram, in this the color histogram is derived by first quantize colors in the image into a number of bins in a specific color space and counting number of bins in each bin. In this, when characteristics of images should not take over all the values, the statistical histogram will appear in a number of zero values. This may leads to not accurately reflect the color difference between images. Therefore here needs to construct a cumulative histogram of the color characteristics of image after using non-interval HSV quantization for G[6].

Texture Descriptor: Now the texture feature extraction which can be done with the help of GLCM and CCM. The gray level co-occurrence matrix (GLCM) creates a matrix with the directions and distances between pixels and then extracts meaningful statistics from the matrix as texture features. The GLCM composed of probability value given by,

$P(i,j|d,\theta)$ where between two pixels the distance d and direction in θ is taken into account. The element in the matrix are computed as,

$$P(i,j|d,\theta)=\frac{P(i,j|d,\theta)}{\sum_i \sum_j P(i,j|d,\theta)}$$

It gives the texture features as per the correlation of the couple pixels gray level at different positions.

Here four important features described,

1) Entropy
2) Contrast
3) Energy
4) Inverse difference

1) Entropy: It gives the measure of image texture randomness; it achieves minimum value for all values space co-occurrence matrix are equal. But when values of co-occurrence matrix are uneven, its value becomes greater.
   $S=-\sum_x \sum_y P(x,y)\log(x,y)$
2) Contrast: It measures the value of the matrix is distributed and images of local changes in number, it refects the clarity of image and texture of shadow depth. Larger the contrast deeper the texture.
   $I=\Sigma\Sigma(x-y)^2 P(x,y)$.
3) Energy: It gives the distribution of image gray-scale uniformity of weight and texture.
   $E=\sum_x \sum_y P(x,y)^2$.
4) Inverse Difference: It gives the measure of local changes in image texture number.
   $H=\sum_x \sum_y \frac{1}{1+(x-y)2} P(x,y)$.

   Feature extraction based on CCM:

   Dividing image into N x N image sub-block, then calculating and extracting main color image with HSV space to meet some conditions as,

   1. Ci and Cj belongs to same color of magnitude that is the HSV components as,
      hi=hj, si=sj, vi=vj.

2. Ci and Cj doesn't belongs to same color of magnitude, but satisfy si*3+vi=sj*3+vj and $|hi-hj|=1$ or satisfy hi=hj, si=sj and vi,vj$\in\{0,1\}$. Into this the set 's' formed which is corresponds to color-connected region, for each color connected region $\{Ri\}(1\leq i \leq M)$.
   $S=\{Ri\}(1\leq i \leq M)$[6].

IGA: The methodology is mostly depending on the low level feature extraction in an image and then after processing them the application of IGA to it. The use of Genetic Algorithm includes some steps as, making certain set of solutions represented by chromosomes which then called population. Solutions from one population are taken which then forms another population. In this way better population would forms and new desired offspring are also forms as per the fitness functions. The very first thing is to generate the population of n chromosomes ,then evaluation of the of fitness function of each chromosome in the populations. Repeat the process for creation of new population until the new population is complete.

Initialization : Here the individual solutions are to be formed which then forms initial population**.** Nature of problem will decide the size of it, which contains large number of possible solutions. The "seeding" of solution is to be made where the chances of finding the optimal solutions.

Selection: During each successive generation, a part of existing population is used for breeding the newer one. Then proper fitter fitness function is selected. The fitness function is always problem dependent. Further taking Genetic Operators into consideration as,

Crossover and Mutation:

From these crossover and mutation operators the second and likely more population generations would be taken place.

For each new solution to be produced, a pair of parent solution is required which are already selected previously. By producing child solution from crossover and mutation methods, the characteristics of parent would be shared. New parents are selected for each new "child", and the process continues until a new population of solutions of appropriate size is generated[3]. These processes ultimately result in the next generation population of chromosomes that is different from the initial generation. Generally the average fitness will have increased by this procedure for the population, since only the best organisms from the first generation are selected for breeding, along with a small proportion of less fit solutions. These less fit solutions ensure genetic diversity within the genetic pool of the parents and therefore ensure the genetic diversity of the subsequent generation of children.

It is worth tuning parameters such as the mutation probability, crossover probability and population size to find reasonable settings for the problem class being worked on. If mutation rate is small then leads to genetic drift. If mutation rate is too high may lead to loss of good solutions unless there is elitist selection .If recombination rate is too high then it leads to premature convergence of the genetic algorithm.

Termination: This generational process is repeated until a termination condition has been reached. There might be some conditions for this.

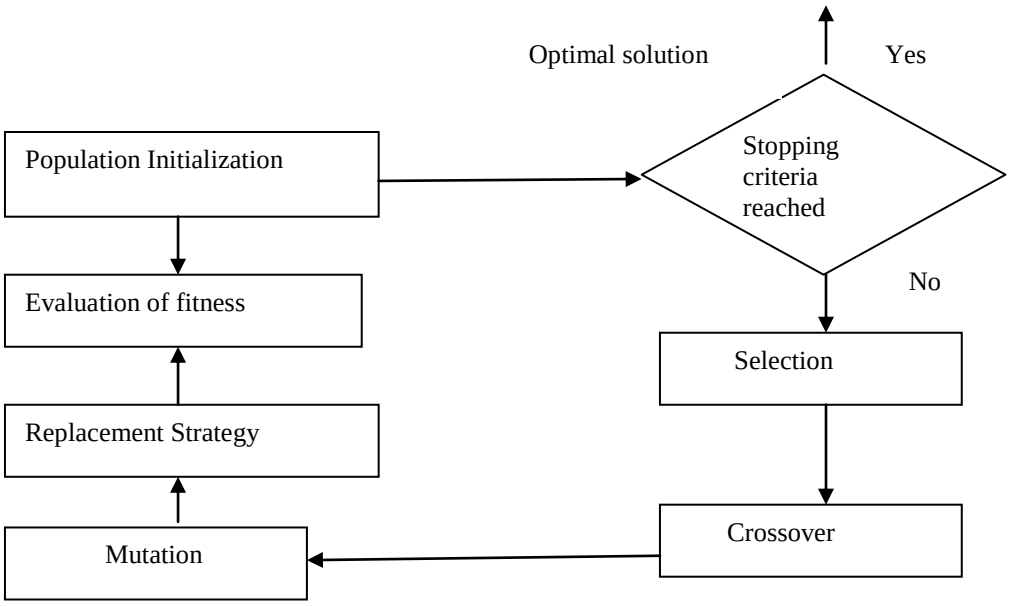


Fig 1. Overview of Genetic Algorithm

There are the steps for genetic algorithm which are explained earlier and also shown in the flowchart above fig 1.

Now the system flowchart is also shown below where the query image can be drawn from database and also its feature extraction would be done. After extracting the features from image the GA to be applied, but instead of that the novel approach of IGA is preferred[4]. The main difference between IGA and GA is the construction of the fitness function, i.e., the fitness is determined by the user's evaluation and not by the predefined mathematical formula.

A user can interactively determine which members of the population will reproduce, and IGA automatically generates the next generation of content based on the user's input. By repeating content generation and fitness assignment, IGA enables unique content to evolve that suits the user's preferences.

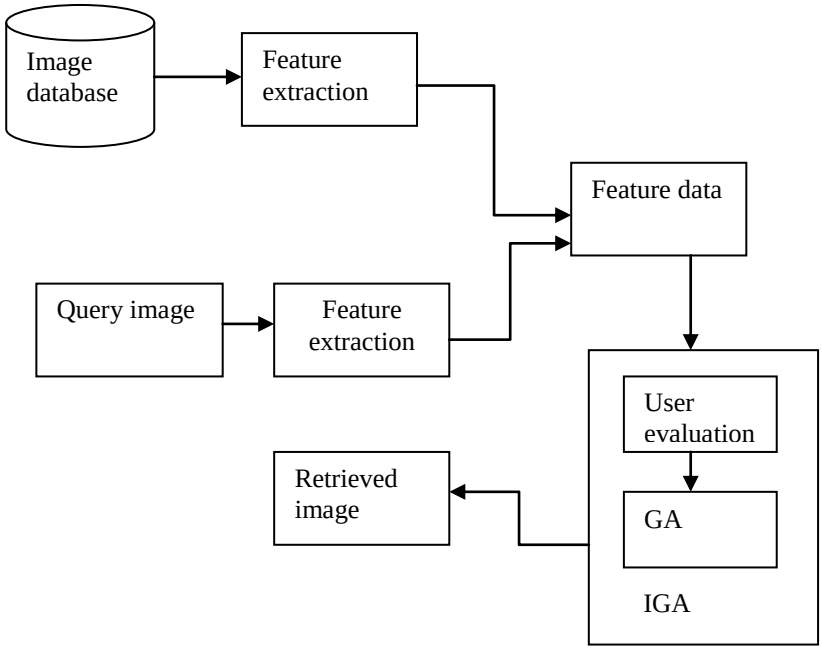


Fig 2. System flowchart

IV. **Experimental Result**

The effectiveness of this system is shown here with retrieval of the images, for this a suitable database is selected. In this we selected a database which covers a wide range of images; we are having 5 – 6 categories of images which are differing from each others. The sample images are given in fig 3.

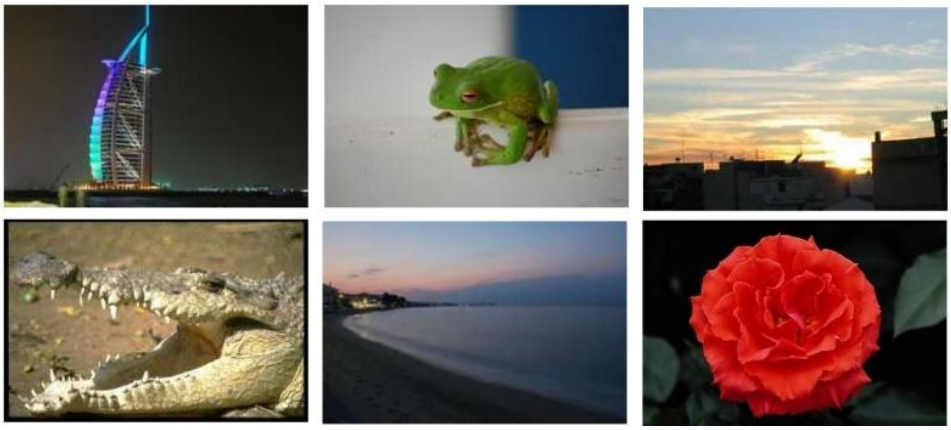
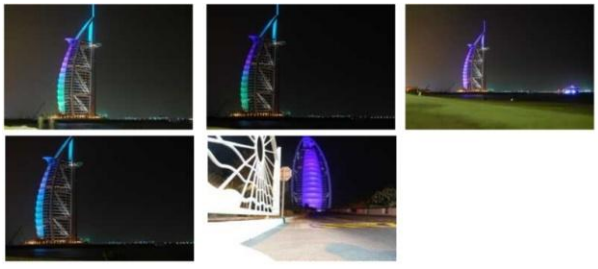


Fig 3. Sample images

The figure below shows the retrieved results after application of the IGA to the system. The effectiveness of the system will be definitely clear from the accurately precisely retrieval. The fig 4 shows the retrieval of images from the selected database.



a)

b)

c)

Fig 4. Retrieved images, a) building) frog, c) flower.

For effective retrieval of images, there are two important factors are responsible as, precision and recall rates. For defining these parameters, for a query image relevant images are consider and for this they have to be belong to same category as the query image.

$$\text{Precision} = NA(q) / NR(q)$$
$$\text{Recall} = NA(q) / Nt$$

Where *NA*(*q*) denotes the number of relevant images similar to the query, *NR*(*q*) indicates the number of images retrieved
by the system in response to the query, and *Nt* represents the total number of relevant images available in the database. When each precision and recall for ten images are obtained, we discard the best value and the worst one and then averaged these values to obtain the average precision and average recall.

Table 1. Precision and recall values

Sr. No.	Category	Precision (%)	Recall (%)	Precision (%)	Recall (%)
		With IGA		Without IGA	
1	Frog	60	42	40	22
2	Building	60	37	38	33
3	River	40	25	34	22
4	Crocodile	66	28	33	25
5	Flower	33	22	50	33
6	Sunset	50	30	38	30
7	Average Values	51.5	30.66	38.8	27.5

V. CONCLUSION

This paper gives one of the effective retrieval method in CBIR, where the use of IGA gives efficient and accurate results in contrast to the conventional approaches that are based on visual features, the IGA method provides an interactive mechanism to bridge the gap between visual features & human perception. The color information of an image & entropy in addition with texture descriptor using GLCM gives vital help in characterizing the image. As these features & performances of IGA approach to image retrieval lifts up a task of CBIR at more significant level.

ACKNOWLEDGEMENT

The authors are thankful to all the reviewers who made a significant work in the area of CBIR and this made a great help in the improvement of performance of this paper.

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