Interactive Genetic Algorithm for Image Retrieval

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Abstract- This paper presents (CBIR) content-based image retrieval system by extracting the image features like heuristic variance, wavelet transform, entropy, skew, kurtosis, relative smoothness and uniformity. In this work, the above mentioned features are computed for all the images present in database by evaluating the proposed algorithm and then the extracted features were compared to the same features of the input query image. The results in the experiment have shown an improved performance i.e., with higher precision rate when compared with other CBIR methods.
Keywords- Image Retrieval, Wavelet transform, entropy, heuristic variance, skew, kurtosis, uniformity, relative smoothness.

I. INTRODUCTION

To search the images from database, the CBIR (Content-based image retrieval) method uses visual contents such as texture, color and shapes. it has been an active and fast advancing research area since the 1990s.

The two major tasks of CBIR system are: The similarity i.e., distances measurement among the feature extracted vectors of the input query image and the feature extraction of visual contents of all the images in the database. As per the methods used in CBIR, the features can be classified as search features and low-level. We have represented images using two types of features such as color information features and texture features extracted by wavelet network.

Texture is an important feature of natural images. Texture models can be divided into the following classes:

- Model-based methods
- Geometric methods
- Statistical methods.
- Filtering methods

One of the most widely used visual content for image retrieval is Color. However, there would be disappointing results in image retrieval using color features because, in many of the cases, similar content may not be present for similar colors.

In recent years, wavelet network is used as an alternative for image feature extraction. Along with the characteristics of neural networks studied, the Wavelet Networks topologies are attempted to combine the properties of wavelet decomposition. Wavelet Networks had a wide range of applications in computer science or biology and engineering. These may range from classification, to approximation of complex nonlinear functions or feature extraction.

The theme of this work is to propose a new approach to extract a set of image features, based on wavelet which is the main contribution of this work. The reminder of this paper is organized as follows. In Section II the wavelet transform is discussed in short. The section III provides a complete algorithmic approach of interactive genetic algorithm. Results in tabular forms, graphs and in images are presented in section IV. The conclusion is given in the sections V.

II. WAVELET TRANSFORM

The introduction to the concept of Wavelet transform (WT) has been recently in mathematics. Though many essential ideas which lead to the development of wavelets were around for many years. It is a simple linear transformation, which is just similar to the concept of Fourier transform; however the time localization is allowed for the various frequency components for a given signal. The analyzing functions are called as wavelets, in case of the wavelet transform. Wavelets are mathematical functions that divide data into different frequency components, and later analyses each component with a resolution matched to its scale. They have many advantages over Fourier methods in analyzing mathematical and physical situations, even if the signal contains discontinuities and sharp spikes.

III. INTERACTIVE GENETIC ALGORITHM

Consider the Image database consists of 94 Natural sceneries. Every image is truncated to the standard size 200x200. The feature vector for the particular image is computed as described below.

The image in database is divided into sub blocks of size 50x50 with overlapping size of 8x8.The first feature namely variance of the histogram of the hue content, are computed for the all the overlapping sub blocks of the image. This is treated as first part of the feature vector corresponding to the image.

Similarly other features are computed for all the overlapping sub blocks of the image to obtain other parts of the feature vector. All the parts belonging to the individual features are combined to obtain the feature vector corresponding to that particular image.

Thus feature vectors are computed for all the images in the data base.

List of low level features computed in every sub blocks of the image:

1. Variance of the histogram of the hue content of the particular sub-block is computed.
2. Measurement of uniformity:

   $p(z_i)$ is the probability of gray value z_i in the particular sub block of the image. The uniformity of sub block of the image is measured using the formula given below.

$$U = \sum_{i=1}^{n} p^2(z_i)$$

3. Measurement of Average Entropy:

   Average entropy is computed as described below

$$e = -\sum_{i=0}^{L-1} p(z_i) \log_2 p(z_i)$$

4. Measurement of Relative smoothness:

$$R = 1 - \frac{1}{1 + \sigma^2(z)}$$

Where, σ (z) is the standard deviation of the gray values z in the particular sub block of the image.

5. The image is subjected to discrete wavelet transformation (DWT) to obtain approximation co-efficient (app), horizontal detail co-efficient (hor), vertical detail co-efficient (ver) and diagonal (both horizontal and vertical) detail co-efficient(dia) The variance of the approximation co-efficient 'app' is computed and considered as 5th feature.
6. Similarly the variance of the detail co-efficient, horizontal detail co-efficient is considered as the sixth feature.

7. Similarly the variance of the detail co-efficient, vertical detail co-efficient is considered as the 7^{th} feature.

8. And the variance of the detail co-efficient, diagonal detail co-efficient 'dia' is considered as the 8th feature.

9. Skewness:

   The Skewness of the gray values is computed for every sub block of the image as mentioned below.

$$\mu_3(z) = \sum_{i=1}^{L-1} (z_i - m)^3 \, p(z_i)$$

10. Kurtosis:

   The Kurtosis of the gray values is computed for every sub block of the image as mentioned below.

$$\mu_4(z) = \sum_{i=1}^{L-1} (z_i - m)^4 \, p(z_i)$$

Algorithm:

1. Initially read all the images in the database.
2. Extract the features of every individual image in database.
3. The features include

   a. Heuristic variance
   b. Uniformity
   c. Entropy
   d. Relative smoothness
   e. Wavelet transform
   f. Skew

g. Kurtosis

Flow chart:

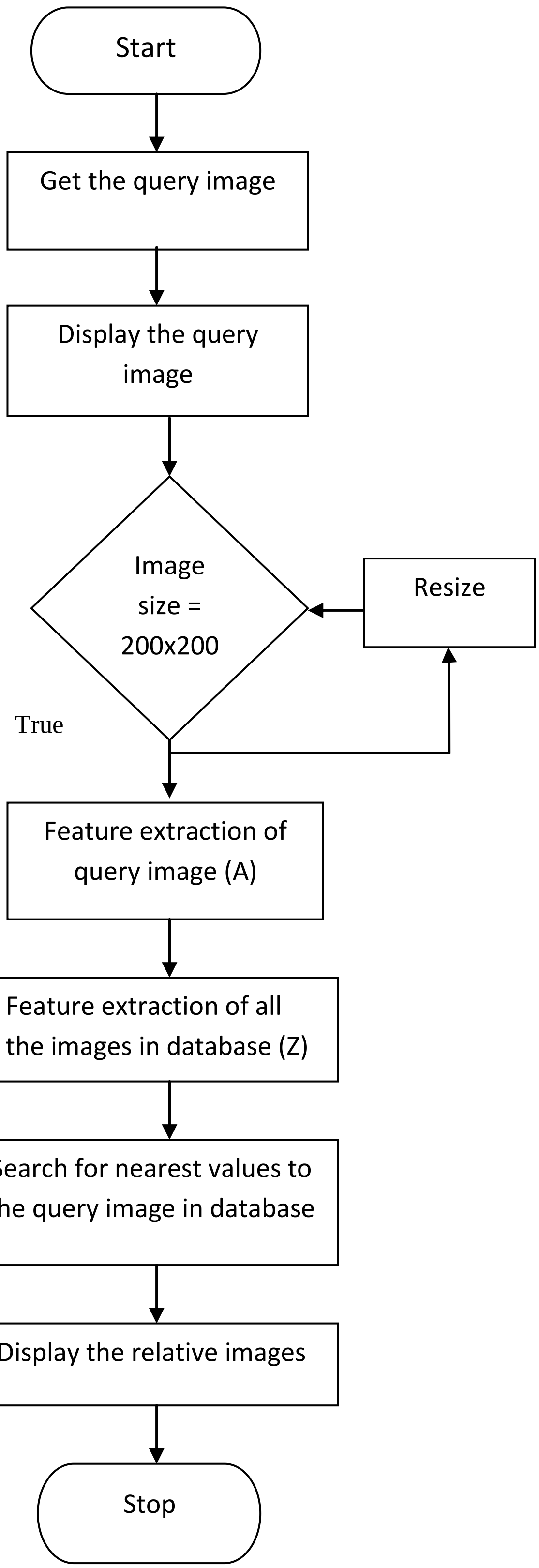

Figure 1: Flow chart of Interactive genetic algorithm

4. Save the extracted features for every individual image in database in seven individual variables respectively and all the variables are saved in a single variable (Z).
5. The complete extracted feature database data is saved in MAT file.
6. Now, take the input query image and extract the features mentioned in point 3 and loaded into a variable (A).
7. Now, load the data from MAT file and compare the features.
8. For comparison, subtract the two variables ‘A’ and ‘Z’ and save the difference.
9. Then calculate the mean square value of difference.
10. Then sort the values in ascending order with their positions respectively.
11. Then display the first least 8 images which have the most similar features which are considered as the output.

For example, the image database consists of 5 different types of images as shown in the figure below with eight in number each. The procedure of obtaining the features of all images in the database is shown below figure. Then to obtain the required similar images in database, a query image is selected and its features extracted and the desired result is obtained by comparing it with the features of images in the database as shown in the figure 2.

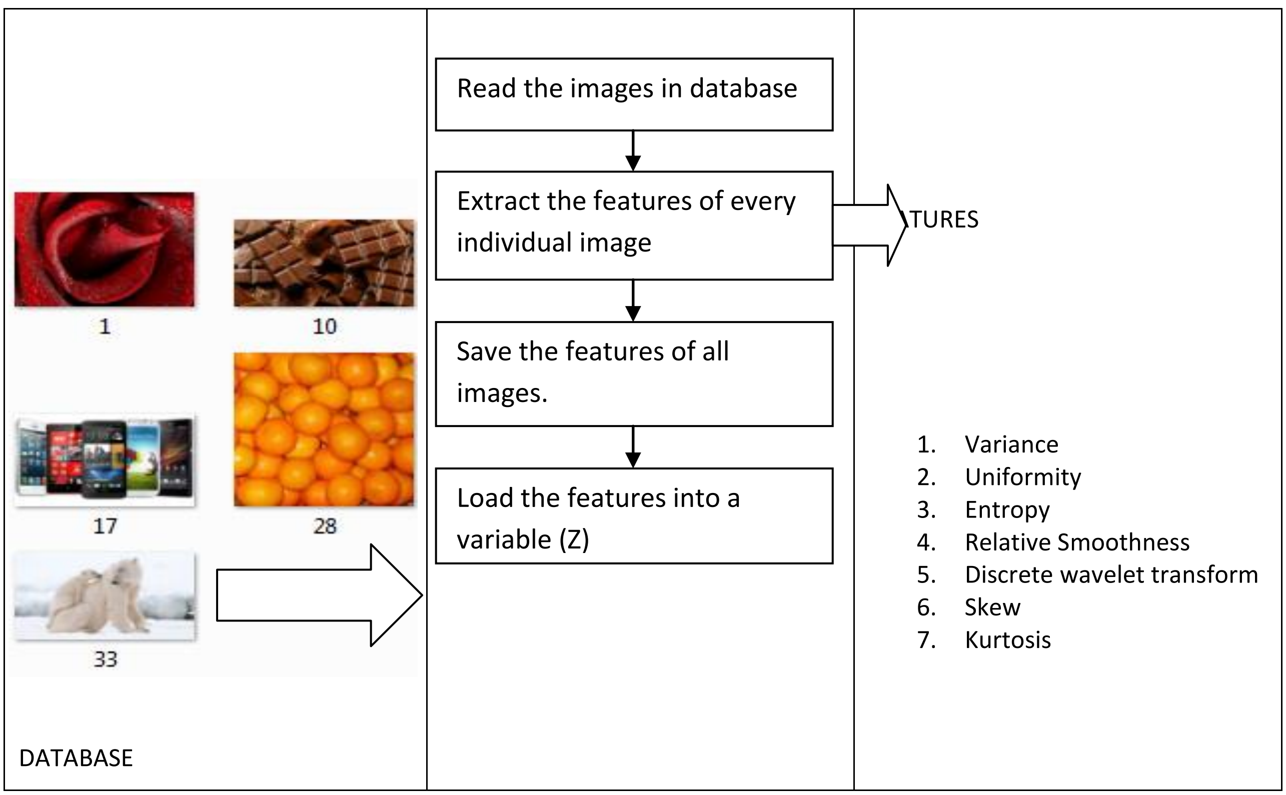

Figure 2: Features of images created

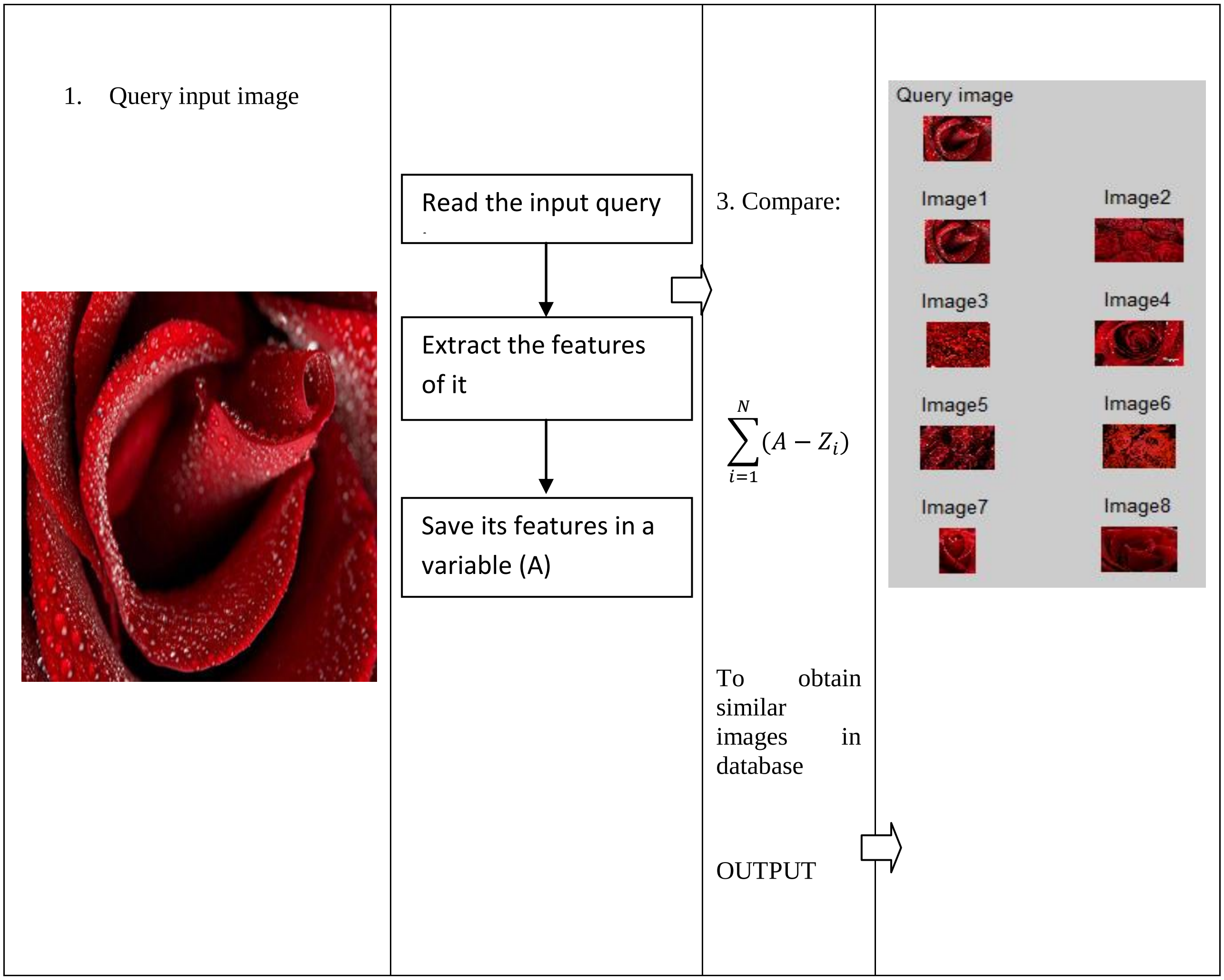

Figure 3: Output image attained from database

IV. RESULTS & ANALYSIS

We have considered image database with 5 different images, each of 8 in number and shuffled them as shown in figure 4. From the database or if we would like to search the type of image required , then we applied the input image for which the analysis is done as shown in figure 2 and figure 3. The output images attained were shown in figure 5. Table 1 shows the amount of image retrieval for different images in database. In figure 6 and I figure 7 the graphical comparison has been made, which the accuracy of different images.

Image database:

Figure 4: Image database taken

Output:

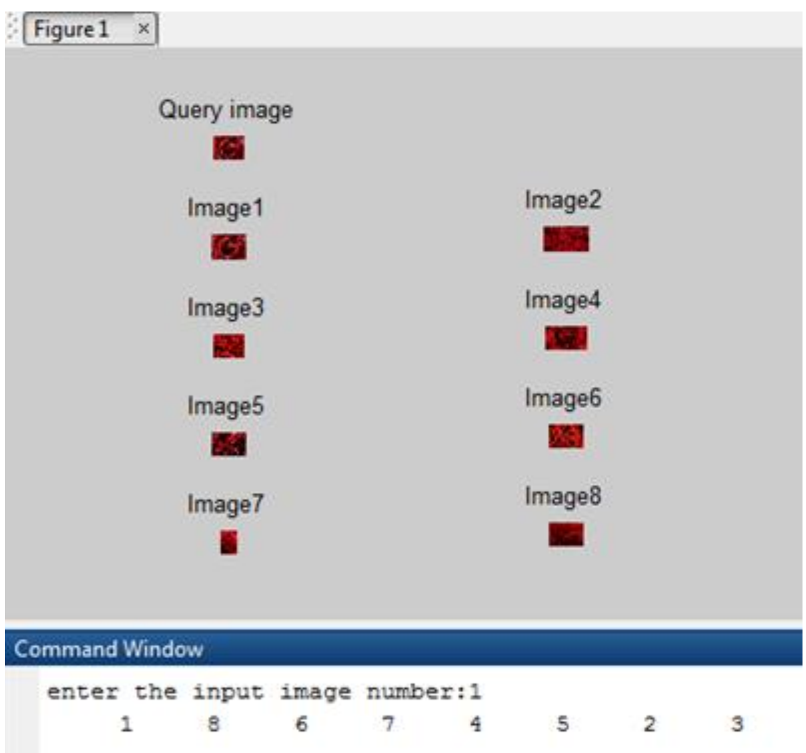

Figure 5: Roses retrieved from the database

Table 1: Percentage retrieval of different input images

Sl. No.	Image type	No. of images in database	No. of images retrieved	% of retrieval
1	Roses	8	8	100 %
2	Chocolates	8	8	100 %
3	Mobiles	8	6	75 %
4	Oranges	8	6	75 %
5	Polar bears	8	5	62.5 %
Total number of images		40	Average retrieval	82.5 %

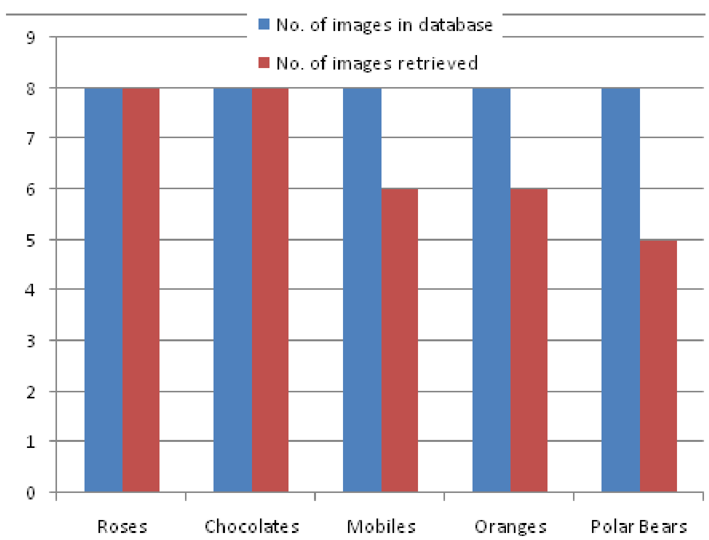

Figure 6: Comparison of number of images in database to number of images retrieved

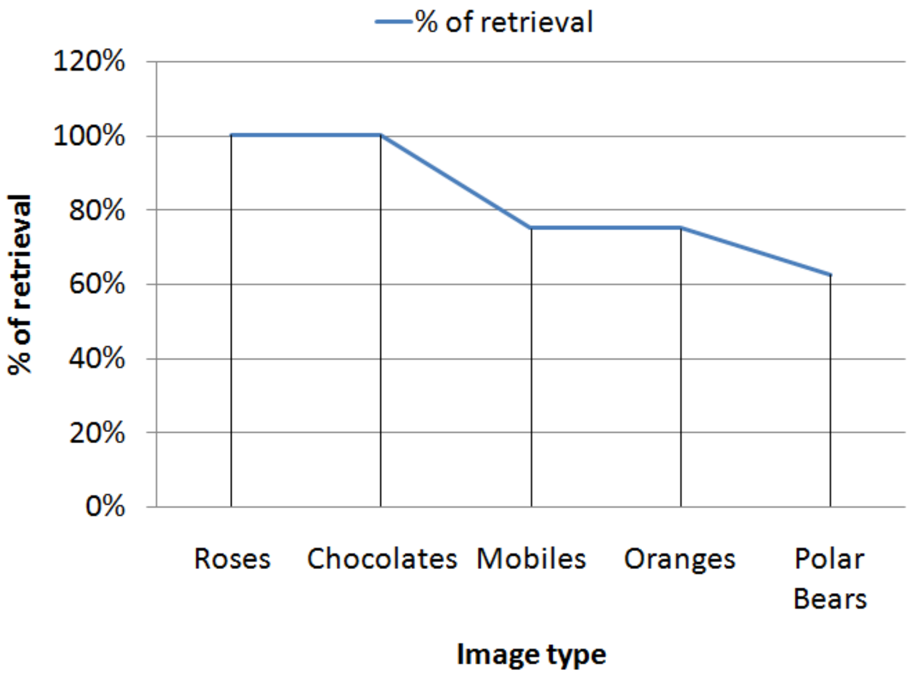

Figure 7: Comparison of different input images retrieved.

V. CONCLUSION

In this paper we would like to conclude that iterative genetic algorithm is very much efficient in order to retrieve the image from the database. From the above shown results the percentage of retrieval was 82.5% on an average which shows the accuracy of the algorithm. As number of features extracted is seven in number, the accuracy level could reach its optimal value. The algorithm is implemented in MATLAB, the database of 100 images is taken out of which 8 images were similar. The images were retrieved successfully based on the input image applied.

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