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Improving The Advanced Content Based Image Retrieval using Gravitational Search Algorithm

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ABSTRACT

Digital image libraries and other multimedia databases have been dramatically expanded in recent years. Semantic gap that between the visual features and human semantics has become very important area of research known as content based image retrieval (CBIR). In order to effectively and precisely retrieve the desired images from a large image database, the development of a content -based image retrieval (CBIR) system has become an important research issue. The need for improving the retrieval accuracy of image retrieval systems and narrowing down the semantic gap is high in view of the fast growing need of image retrieval. In this paper we proposed, a user-oriented technique for CBIR method based on low level visual features and gravitational search algorithm (GSA). Before applying the visuality features we have divided the images into kxk blocks and a block wise comparison has been done. Color attributes like the mean value, the standard deviation, and the image bitmap of a color image are used as the features for retrieval. In addition, the entropy based on the gray level co-occurrence matrix considered as the texture features and the Canny edge detection technique for image can be considered as edge features. Finally, some future research directions and problems of image retrieval are presented.

Keywords:—*Semantic gap, content based image retrieval, visual features, gravitational search algorithm (GSA).*

I. INTRODUCTION

In ancient times, images were seen mostly in the form of building plans and maps. The need and use of images grew with the time, particularly with the advent of photography around the sixteenth century. In the twentieth century, introduction of computer and advances in science and technology gave birth to low cost and efficient digital storage devices and the World Wide Web, which in turn became the catalyst for increasing acquisition of digital information in the form of images [1].

We often need to efficiently store and retrieve image data to perform assigned tasks and to make a decision. Therefore, developing proper tools for the image retrieval on the basis of image content from large image database is challenging. Generally there are two different types of approaches (1) text based retrieval (2) content based retrieval, are usually adopted in image retrieval. In the text-based system, the images are manually annotated by text descriptors and then used by a database management system to perform image retrieval. However, there are two limitations of using keywords to achieve image retrieval: the large works have to do for manual image annotation and the task of describing image content is highly subjective. The perspective of textual descriptions given by an annotator could be different from the perspective of a user. In other words, there are inconsistencies between user textual queries and image annotations or descriptions. The image retrieval is carried out according to the image contents. This technique is so-called content-based image retrieval (CBIR). The primary goal of the CBIR system is to construct meaningful descriptions of physical attributes from images to facilitate efficient and effective retrieval [2, 3].

CBIR has become an active and fast-advancing research area in image retrieval in the last decade. A huge research activities in CBIR have progressed in following areas (1) region-level features based (2) global image properties based (3) relevance feedback and (4) semantic based image retrieval. Initially, developed algorithms exploit the low-level features of the image such as color, texture, and shape of an object to help retrieve images. It's much easier to implements and perform well for images that are either simple or contain few semantic contents. However, the semantics of an image are difficult to be revealed by the visual features, and these algorithms have many limitations when dealing with broad content image database. Therefore, in order to improve the efficiency and retrieval accuracy of CBIR systems, region based image retrieval methods using initial low level segmentation were introduced. These methods attempt to overcome the drawbacks of global features by representing images at object presents in the image obtained by combining the low level features, which is intended to be close to the perception of human visual system. However, the performance of these methods is mainly based on efficiency of initial segmentation and extraction technique. The difference between the user's information need and the image representation is called the semantic gap in CBIR systems. The major problem in the retrieval accuracy of images is central base of retrieval systems which is essentially due to the inherent semantic gap. To reduce and fill up the gap, the interactive relevance feedback is introduced into CBIR. The subjectivity of human perception is one of the key motivating reasons to make use of interaction model and specifically relevance feedback in CBIR systems. Human perception subjectivity can be appeared at the different level of subjectivity. For instance, people under different circumstances may recognize the same image content in a different way.

The basic idea behind relevance feedback is to incorporate human perception subjectivity into the query process and provide users with the opportunity to evaluate the retrieval results. There are different types of similarity measures those are automatically refined on the basis of these evaluations. However, although relevance feedback can significantly improve the retrieval performance, its applicability still suffers from a few drawbacks [3]. The semantic-based image retrieval methods try to discover the real semantic meaning of an image and use it to retrieve on the basis of similarity measures and GA approach to find relevant images. However, understanding and discovering the semantic-based image retrieval are high level cognitive tasks and thus hard to automate.

There are different approach of CBIR algorithms has been proposed, but most of them focus on the similarity computation phase to find effectively and efficiently a desired image or a group of images that are similar to the given query. To achieve better results of the user's choice information need for the following search in the image database, involving user's interaction is necessary for a CBIR system. In this paper, we proposed a user-oriented CBIR method which uses the Gravitational Search Algorithm (GSA) to infer which images in the databases would be of most interest to the user. Three visual features, color, texture, and shape, of an image are utilized in our approach. GSA provides an interactive mechanism to better capture user's intention. There are very few CBIR systems considering machine learning, but [5] is the representative one. They considered the red, green, and blue (RGB) as well as HSV, YCbCr color model.

II. Related work

An image is worth more than ten thousand words. Human beings are able to explain a narrative from an image on the basis of observations and specifically their background knowledge. One important question that arises is whether it can be develop an intelligent model to learn image concepts like human. There is no doubt that the ambitious efforts have been made to develop an intelligent model in the past decade. The most straightforward form of image retrieval systems, simply asks the user to specify one or more relevant images. To improve the query results, some systems allow the user to manually change the weight of image feature [2]. This gives higher weights to features in which example images are similar and gives lower weights to those features where the images differ. Some systems allow the users to specify irrelevant images as negative examples. This approach, however, introduces undesirable side effects because it tries to cluster negative examples into one class. In actuality, negative examples can be many classes of images in the database.

There are some literatures that survey the most important CBIR systems [6]. Also, there are some papers that overview and compare the current techniques in this area [7]. Since the early studies on CBIR, various color descriptors have been adopted. Yoo et. al. [8] proposed a signature-based color-spatial image retrieval system. Different type of color spaces and its spatial distribution within the image are used for the features. In [9], a CBIR scheme based on the global and local color distributions in an image is presented. Vadivel et. al. [10] have introduced an integrated approach for capturing spatial variation of both color and intensity levels and shown its usefulness in image retrieval applications.

Like color, texture is also an important visual feature in defining high level semantics for image retrieval purposes. Wavelet based texture evaluation using sub-bands by bit-plane extractions in texture image retrieval were presented in [11]. An effective and efficient characterization to overcome some limitations, such as computational expensive approaches or poor retrieval accuracy, in a few texture based image retrieval methods, Kokare et. al. [12] concentrated on the problem of finding good texture features for CBIR. Pi and Li [13] combined fractal parameters and collage error to propose a set of new statistical fractal signatures. These signatures effectively extract the statistical properties intrinsic in texture images to enhance retrieval rate. Liapis and Tziritas [14] explored image retrieval mechanisms based on a combination of texture and color features. Texture features are extracted using discrete wavelet frame analysis. One or two dimensional histograms of the CIE Lab chromaticity coordinates are used as color features. Chun et al. [15] proposed a CBIR method based on an efficient combination of multiresolution color and texture features. As its color features, color autocorrelograms of the hue and saturation component images in HSV color space are used.

The color and texture features are extracted in multiresolution wavelet domain and then combined. In order to well model the high-level concepts in an image and user's subjectivity, recent approaches introduce human computer interaction into CBIR. Takagi et. al. [4] evaluated the performance of the similarity based GA-based image retrieval system that uses wavelet coefficients to represent physical features of images. Cho et. al. [16] applied GA to solve the problems of emotion based image retrieval. He used wavelet transform to extract image features and IGA to search the image that the user has in mind. When the user gives appropriate fitness to what he or she wants, the system provides the images selected based on the user's evaluation. In [17], a new GA framework incorporating relevance feedback for image retrieval was proposed. Some technique combines an GA with an extended nearest neighbor approach to reduce the existing gap between the high-level semantic contents of images and the information provided by their low level descriptors. Shi et al. [22] proposed GA-based approach which incorporates an adjust function and a SVM. Their method can prevent the optimal solution from losing, accelerate the convergence of GA, and raise retrieval performance. To reduce the gap between the retrieval results and the users' expectation, the IGA [19] is employed to help the users identify the images that are most satisfied to the users' need.

III. Proposed Method

Content based image retrieval system usually provides a graphical user interface for retrieving information and communicating with the user. It collects the required features, including the query image, and also same features from images in the database from the user and displays the retrieval results to him. However, as the images are matched based on low-level visual features, the target or the similar images may be far away from the query in the feature space, and they are not returned in the limited number of retrieved images of the first display. Therefore, in some retrieval systems, there is a relevance feedback from the user, where human and computer can interact to increase retrieval performance.

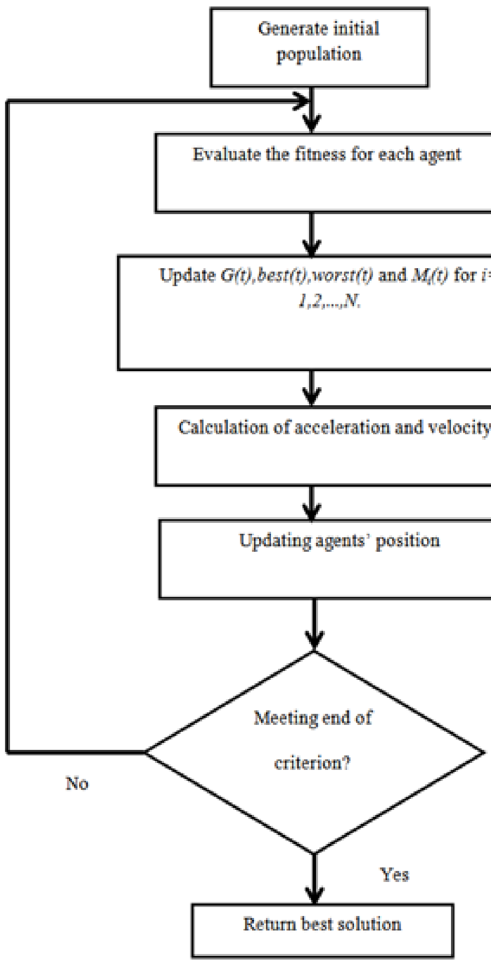

Figure 1: GSA Approach

Before matching of similarity features we have divided the images in KxK blocks to provide the blockwise compression. According to the aforementioned concept, we design a graphical user interface image retrieval system based on GSA, as shown in figure (1). Our technique of operations is explained as:

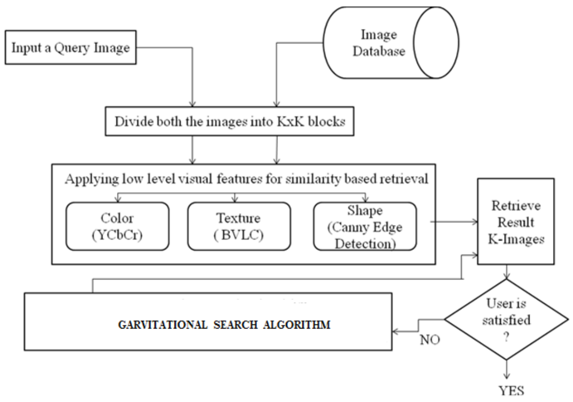

Figure. 2: Improved Content Based Image Retrieval System Using GSA Approach

- Select a query image: The user provides a sample image as the query for the system.
- Divide both query image and the image from database into KxK blocks.
- Calculate similarity features: The system computes the similarity between the query image and the images in the database according to the above mentioned low-level visual features e.g. color, texture and shape.
- Retrieval: The system retrieves k-number of images presents a sequence of ranked in decreasing or increasing order of similarity based matching. As a result, the user is able to find relevant images by getting the top-ranked images first.
- GSA Approach: After obtaining some relevant images from database using above steps (1), (2) and (3), the system provides an interactive mechanism via GSA, which lets the user evaluates the retrieved images those are more or less relevant to the query one, and the system then updates the relevance information to include as many user-desired images as possible in the next retrieval result. are applied.

IV. Experimental Results

In Experimental study we have used images from Corel Database which consist near about 10,800 images from the 80 concept groups, e.g., autumn, aviation, bonsai, bus, castle, cloud, frog, elephant, iceberg, primates, ship, stalactite, steam-engine, tiger, train, and waterfall etc.

In Figure. 2 we give an example to illustrate the practicability of our proposed system. A user submits an image containing a frog as the query image into the system, and then, the similarity measurement module of the system compares the query features with those images in the database and finds the most similar images to the query image.

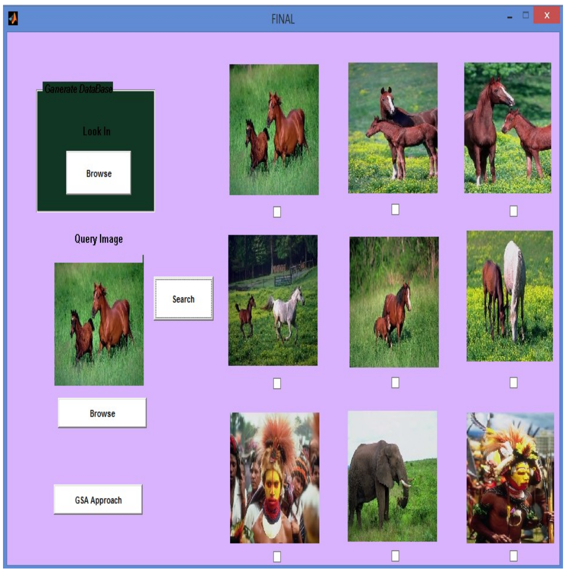

Figure (2): An Example of Query by Image in which a image of frog is chosen as input image and the similar images are obtained.

These images are ranked based on the similarity. Under each image, a check box is attached so that the user can tell the system which images are relevant or irrelevant. After the user evaluates these images, the system adjusts the similarity measure according to the user's point of view and provides refined search results. The user can repeat this process until he/she is satisfied with the retrieval results.

Figure (3.a): An Example of Query by Image in which a image of horse is chosen as input image and the similar images are obtained after GSA

Figure 3.a shows the first display of returned images and the retrieved results after applying the GSA process. The results are ranked in ascending order of similarity to the query image from left to right and then from top to bottom. From the results, we can find that if the retrieval only considers the low-level features, some irrelevant images are retrieved. By adopting user's subjective expectation, the retrieval results are effectively increased in very few generations.

To evaluate the effectiveness of the proposed approach, we examined how many relevant images to the query were re-trieved. The retrieval effectiveness can be defined in terms of precision and recall rates.

PRECISION is the ratio of the number of relevant records retrieved to the total number of irrelevant and relevant records retrieved. It is usually expressed as a percentage. RECALL is the ratio of the number of relevant records retrieved to the total number of relevant records in the database. It is usually expressed as a percentage.

Table 1: Comparison of precision with other methods

Category	L&C [10]	C&T [16]	C&Y [18]	Proposed
Food	45	93	99	100
Buildings	59	26	85	94
Beach	90	93	93	89
Elephants	80	68	80	85
Buses	52	7	71	100
Dinosaurs	100	100	100	100
Flowers	80	88	82	100
Horses	68	26	79	94
Mountains & Glaciers	41	26	56	89
Africa People & Village	50	6	61	100
Average	**74**	**58**	**84**	**95**

V. CONCLUSION

This research paper has presented a user-oriented framework in interactive CBIR system. In contrast to conventional approaches that are based on visual features, our method provides an interactive mechanism to bridge the gap between the visual features and the human perception. The color distributions, the mean value, the standard deviation, and image bitmap are used as color information of an image. In addition, the entropy and edge histogram is considered as texture descriptors to help characterize the images. In particular, the GSA can be considered and used as a semi automated exploration tool with the help of a user that can navigate a complex universe of images. In further, more low-level image descriptors or high-level semantics in the proposed approach can be developed.

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