

Face Retrieval Using Image Moments and Genetic Algorithm

Wathiq Najah Abdullah

Computer Science Department, University of Technology/ Baghdad

Email:Wathiq79@gmail.com

Dr. Yossra Hussain Ali

Computer Science Department , University of Technology/ Baghdad

Email:yossra_1@yahoo.com

Received on: 16/9/2015 & Accepted on:17/12/2015

ABSTRACT

Content-based image retrieval has been developed in numerous fields. This provides more active management and retrieval of images than the keyword-based method. So the content based image retrieval becomes one of the liveliest researches in the past few years. In a given set of objects, the retrieval of information suggests solutions to search for those in response to a particular description. The set of objects which can be considered are documents, images, videos, or sounds.

Moments can be viewed as powerful image descriptors that capture global characteristics of an image. The magnitude of the moment coefficients is said to be invariant under geometrical transformations like rotation which makes them suitable for most of the recognition applications.

This paper presents a method to retrieve a multi-view face from a large face database according to face image moments and genetic algorithm.

The GA is preferred for its power and because it can be used without any specific information of the domain.

The experimental results concludes that using GA gives a good performance and it decreases the average search time to (56.44 milliseconds) compared with (891.6 milliseconds) for traditional search.

Keywords: Face Retrieval, Genetic Algorithm, Invariants Moments, Wavelet.

إسترجاع الوجوه باستعمال العزوم والخوارزمية الجينية

الخلاصة

استخدمت عمليات استرجاع الصور اعتمادا على محتواها في العديد من المجالات اذ انها وفرت ادارة اكثر فعالية في استرجاع الصور من الطرق القائمة على الاسترجاع اعتمادا على الكلمات المفتاحية. لذلك اصبحت عملية استرجاع الصور بناءا على محتوى الصور من اكثر الابحاث حيوية في السنوات القليلة الماضية.

تقترح عمليات استرجاع المعلومات حلولا للبحث في مجموعة من الكائنات التي تعكس وصفا معينا. في كثير من الاحيان هذه الكائنات هي وثائق، ولكن في احيان اخرى قد تكون صورا او ملفات صوتية او ملفات فيديو.

تعد العزوم اداة وصف قوية للصور وتعطي وصفا كليا لخصائص الصورة، اهمية كميات العزوم تأتي من عدم تأثرها بالتحويلات الهندسية مقل التدوير مما يجعلها مناسبة لاغلب تطبيقات التمييز.

يقترح هذا البحث طريقة استرجاع صور وجوه -بزوايا دوران متعددة- من قاعدة بيانات كبيرة تحوي صورا لوجوه بالاعتماد على العزوم الثابتة.

الى جانب الطرق الاحصائية، نماذج الذكاء الاصطناعي تمثل نموذجا جيدا لتحسين الأداء في أنظمة الأشعة تحت الحمراء، والخوارزمية الجينية تمثل واحدة من هذه النماذج. تم اختيار الخوارزمية الجينية وذلك لقوتها ولانه يمكن تطبيقها على المشكلة دون اي معرفة خاصة عن مجال المشكلة.

خلصت النتائج التجريبية الى ان استعمال الخوارزمية الجينية يعطي أداء جيدا ويقال من متوسط وقت الاسترجاع الى (56.44 ملي ثانية) مقارنة بـ (891.6 ملي ثانية) الوقت الذي يستغرقه البحث التقليدي.

INTRODUCTION

Contemporary multimedia technology leads to the increasing needs of image and video applications in education, entertainment, remote sensing, medicine, and security [22]. As the technology improves, the use of internet and new progressive digital image sensor technologies increases and a very large database of image are being created by scientific, industrial, medical and educational presentations. There is a great need to professionally retrieve and store image data to perform assigned tasks and to produce a result. Hence, the development of an appropriate tool for image retrieving from huge image gathering is a challenge task.

The two different kinds of approaches generally adopted in image retrieval are: text and content based. In the text-based system, the images are manually marked by text descriptors and then they used by a database management system for accomplishing image retrieval. Though, the using of keywords has two limitations to accomplish image retrieval: the enormous labor necessary in manual image footnote and the description task of the content of image is extremely subjective. On the other hand, the viewpoint of textual descriptions specified by an annotator differs from the viewpoint of a user. That is, there are conflicts between user textual queries and image annotations. To reduce the problem of incompatibility, the image retrieval is performed depending on the contents of the image. This strategy is the referred to as Content-Based Image Retrieval (CBIR) [12].

The principal target of CBIR system is to gather relevant descriptions of visible attributes of images to simplify effective and valuable retrieval [1, 12].

Face retrieval technology is needed for searching the certain people in the surveillance video automatically. The goal of face retrieval is to retrieve the face images of certain people given a query face image. Such work could be used in various applications of different areas, such as in the security field, searching a criminal from the surveillance video. Face retrieval is performed based on feature representation extracted from images [19].

Feature extraction of faces plays an important role in security access control systems, law enforcement forensic investigation, and low bit video coding.

The features of a color image used here are the image moments. Many important geometric features of an image can be determined from its moments. Among these are its mass, spread and center of inertia. These moment invariants are simple functions of moments and independent of scaling, translation and rotation. They have been used in separating between shapes of aircrafts, character recognition and scene-matching applications. Moments have been widely used in image analysis, pattern recognition and low-level computer vision [18].

The typical task of searching for the features is mathematically expensive, and hence genetic algorithm (GA) is used as a search algorithm. GA has several advantages that make it more convenient than traditional search algorithms [22].

This paper presented a system that uses the genetic algorithm (GA) to deduce which images in the databases would be most significant to the user.

The Proposed System

The proposed system constitutes of several components. These begin with entering a face image to be identified. Then, a sequence of processes is applied on the query image. These processes are: image transformation, features extraction, similarity matching, and classification. The flowchart of the general steps of this system is shown in Figure (1).

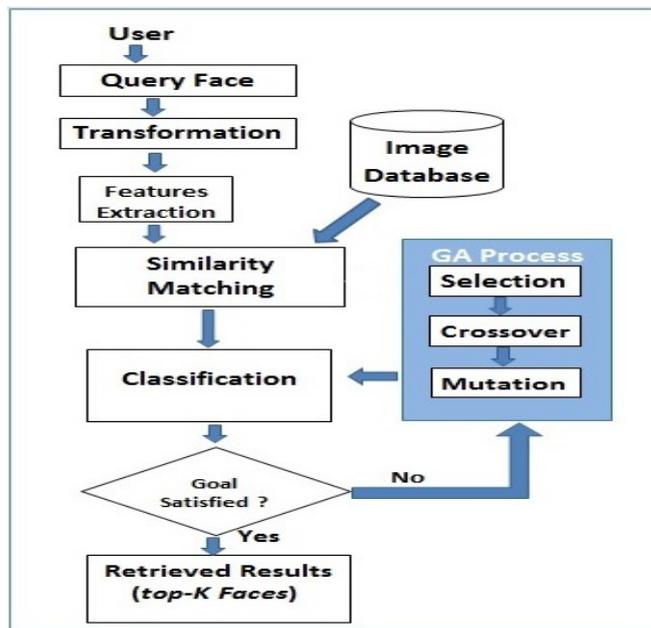


Figure (1): The Proposed System Flowchart

The proposed algorithm is given as follows:

Algorithm:

Input: Query Face Image

Output: Retrieved Face Images.

Step 1: Change Image Color Space To YUV.

Step 2: Apply a Wavelet Transformation.

Step 3: Extract The Image Features Using Invariants Moments.

Step 4: Apply The Genetic Algorithm to find the Best Matched Face:

- i- Selection: Select two chromosomes randomly according to their fitness.
- ii- Crossover: Apply crossover operator on the selected chromosomes.
- iii- Mutation: Mutate a randomly selected chromosome.
- iv- Stopping Criteria: Checking for goal found or maximum generation reached.

Step 5: Evaluate the Resulted Faces.

Step 6: End.

The details description of its steps is presented in the following sections:

Features Vector Extraction

Color images can be represented by using three primaries of a color space [23]. The RGB space does not correspond to the perceiving colors by the human and does not isolated the component of luminance from the chrominance components [4]. The YUV color space is used in the proposed system to represent the face images. The YUV color space can be considered to be similar to human eye’s retina, while the main channel – luminance (denoted as Y channel) or "luma" describes the intensity of light. In the YUV color space, two additional channels – chrominance components called "U" and "V" – carry the color information. There are many formulas to convert from RGB to YUV [11].The equations that used in the proposed system are as follows [10]:

$$\begin{aligned}
 Y &= 0.299 * R + 0.587 * G + 0.114 * B \\
 U &= (-0.147 * R - 0.289 * G + 0.436 * B) + 128 \\
 V &= (0.498 * R - 0.417 * G - 0.081 * B) + 128
 \end{aligned}
 \dots\dots (1)$$

Powerful feature extraction of image, frequently considered as a serious module in multimedia information processing, is not suitably paid attention. Developing an algorithm for

extracting image feature efficiently and effectively can profit majorly to emerging imagery applications like medical diagnosis, biometric and geographical information system [22].

One of the essential problems in image databases querying by resemblance is how to choose related image descriptors and relative resemblance degrees [3].

The process of feature extraction is responsible for making up a feature vector that is well enough to depict the face image. The feature vector is generated using the Haar wavelet of color values.

It is common that, as the complication of a classifier increases quickly with the number of dimensions of the pattern space, it is essential to make decisions only on the most important, known as discriminatory information, which is carried by the extracted features. So, we encounter the need of dimensionality reduction. Each matrix of the seven wavelet coefficients contains information concerning the texture of the face. An effective technique of reducing dimensionality and distinguishing textural information is to calculate a group of measures [8].

Thus, image moments are extracted from each sub-band. No doubt the moments are one of the most important and most frequently used shape descriptors. They frequently serve as a reference method for evaluation of the performance of other shape descriptors [6].

Regarding the image retrieval, moment-based chromaticity distribution descriptors [21] have been applied. Another advantage of moment invariants is their ability to produce small-sized compact feature vectors with minimum information redundancy. Moment invariants originated mainly from a well-established area of mathematics called algebraic invariants [8].

The approach using invariant features appears to be the most promising and has been used extensively. Its basic idea is to describe the objects by a set of measurable quantities called invariants that are insensitive to particular deformations and that provide enough discrimination power to distinguish objects belonging to different classes [6].

Mathematical Description of Moments

Moments are scalar quantities used to characterize a function and to capture its significant features. From the mathematical point of view, moments are “projections” of a function onto a polynomial basis. Depending on the polynomial basis used, various systems of moments can be recognized.

From a mathematical point of view, invariant I is a functional defined on the space of all admissible image functions that does not change its value under degradation operator D , i.e. that satisfies the condition $I(f) = I(D(f))$ for any image function f . This property is called invariance. Another desirable property of I , as important as invariance, is discriminability. For objects belonging to different classes, I must have significantly different values.

Usually, one invariant does not provide enough discrimination power and several invariants I_1, \dots, I_n must be used simultaneously. This will lead to having an invariant vector. In this way, each object is represented by n-dimensional vector space called feature space or invariant space. The mathematical basis of the adopted method is described below.

If the image can have nonzero values only in the finite part of xy -plane, then moments exist. Geometric moment (also called raw moment) of order $(p+q)$ for a two dimensional discrete function is computed using (2) [24].

$$m_{pq} = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} x^p y^q f(x, y) \quad \dots \dots \dots (2)$$

Where: $f(x, y)$ is the image function,
 $p, q = 0, 1, 2, \dots,$ and
 M, N are image dimensions.

In the case of geometric moments, we have the so-called *central* geometric moments [24]. The central moments μ are usually used in real applications to replace the raw moment [25].

$$\mu_{pq} = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} (x - \bar{x})^p (y - \bar{y})^q f(x, y) \quad \dots \dots \dots (3)$$

$m_{00} = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x, y)$	$\mu_{11} = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} (x - \bar{x})(y - \bar{y}) f(x, y)$
$m_{10} = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} x f(x, y)$	$\mu_{12} = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} (x - \bar{x})(y - \bar{y})^2 f(x, y)$
$m_{01} = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} y f(x, y)$	$\mu_{21} = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} (x - \bar{x})^2 (y - \bar{y}) f(x, y)$
	$\mu_{22} = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} (x - \bar{x})^2 (y - \bar{y})^2 f(x, y)$
	$\mu_{30} = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} (x - \bar{x})^3 f(x, y)$
	$\mu_{03} = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} (y - \bar{y})^3 f(x, y)$

... (4)

In this work, *nine* different moments are considered, where *three* of them are geometric moments [m_{00}, m_{10}, m_{01}] and the rest are *six* central geometric moments [$\mu_{11}, \mu_{12}, \mu_{21}, \mu_{22}, \mu_{30}, \mu_{03}$], [24] given by the following:

Central moments can be extended to be both translational and scale invariant, by being divided by the scaled (00)-th moment. The results are called *normalized central moment* [30]:

$$\mu_{pq} = \mu_{pq} / \mu_{00}^{(p+m)/2+1} \quad \dots \dots \dots (5)$$

To enable invariance to rotation, above moments require reformulation. The results of the theory of algebraic invariants to the rotation of 2-D objects are given below [5]:

$$\begin{aligned} \Phi_1 &= \mu_{20} + \mu_{02} \\ \Phi_2 &= (\mu_{20} - \mu_{02})^2 + 4\mu_{11}^2 \\ \Phi_3 &= (\mu_{30} - 3\mu_{12})^2 + (3\mu_{21} - \mu_{03})^2 \\ \Phi_4 &= (\mu_{30} - \mu_{12})^2 + (\mu_{21} - \mu_{03})^2 \\ \Phi_5 &= (\mu_{30} - 3\mu_{12})(\mu_{30} + \mu_{12})((\mu_{30} - \mu_{12})^2 - 3(\mu_{21} - \mu_{03})^2) \\ &\quad + (3\mu_{21} + \mu_{03})(\mu_{21} + \mu_{03}) \times (3(\mu_{30} - \mu_{12})^2 - (\mu_{21} - \mu_{03})^2) \quad \dots \dots \dots (6) \\ \Phi_6 &= (\mu_{20} - \mu_{02})((\mu_{30} + \mu_{12})^2 - (\mu_{21} + \mu_{03})^2) \\ \Phi_7 &= (3\mu_{21} + \mu_{03})(\mu_{30} + \mu_{12})((\mu_{30} + \mu_{12})^2 - 3(\mu_{21} + \mu_{03})^2) \\ &\quad - (\mu_{30} + 3\mu_{21})(\mu_{21} + \mu_{03}) \times (3(\mu_{30} - \mu_{12})^2 - (\mu_{21} - \mu_{03})^2) \end{aligned}$$

The set of moments has been selected taking into consideration two main factors: (1) the feature set size and (2) the complexity of the specific moment invariants calculation. Small feature set size and low complexity in calculating moments ensures faster descriptor extraction [8].

Similarity Measures and Distance:

The feature vector is designed to describe the face image and classify it. We need techniques to compare two feature vectors in order to implement the classification. The essential techniques are to either evaluate the similarity, or the difference between the two. Two vectors which are almost associated will have a high similarity and a little difference. The measure of a distance in the feature space with n-dimensional can be used as the difference; the lower the distance between two vectors, the larger the similarity.

The most conventional metric of evaluating the distance between two vectors is Euclidean distance, and is calculated by the square root of the total of squares of the differences between vector components. The Euclidean distance between two vectors X and Y, each has n components, is calculated as:

$$d_E(X, Y) = \sqrt{\sum_{i=1}^n (x_i - y_i)^2} \dots \dots \dots (7)$$

Another distance metric, referred to as the *city block* or *absolute value metric*, is given by:

$$d_{CB}(X, Y) = \sum_{i=1}^n |x_i - y_i| \dots \dots \dots (8)$$

This metric gives similar results, and it is computationally faster than the Euclidean distance. The *city block* or *absolute value metric* is used in the proposed system [16].

Hence, the distance measure between images (a query face image and a face image in the images database) is defined as

$$d_{CB}(Qf, Df) = \sum_{i=1}^n |(Qf_i - Df_i)| \dots \dots \dots (9)$$

Where:

Qf is the query face image,

Df is an image in the images database,

Qf_i is the feature number (i) in the query face image,

Df_i is the feature number (i) in the image in the database, and

n is the number of features.

e

Genetic Algorithm

Genetic algorithm, called "only the fittest to survive", is the most famous for its ability to search efficiently big areas and has been shown to be strong. Genetic algorithm seems to be an extremely well-chosen as a search policy for choosing and creating of new vectors for using in image retrieval systems [20].

Genetic algorithms (GAs) are stochastic search algorithms on the basis of biological and evolutionary operations that allow organisms to adjust further to their environment. They are concerned with problem in science, engineering, and business [9]. GA works on a group of potential solutions, which is referred to as the population.

A Genetic Algorithm encodes a promise solution for solving a particular problem on data structures represent chromosomes, then employs recombination operator to the specified structures in a way that maintains crucial information.

Reproduction chances are employed in a manner which produces those chromosomes that represent a better solution to the objective problem further opportunities for reproducing than chromosomes representing worse solutions. GA is a hopeful heuristic strategy to identify semi-optimal solutions in a huge search space [7].

A GA is typically consists of two basic problem dependent elements: the *encoding problem* and the *evaluation function*. The *encoding problem* implies the generation of an encoding system for representing the candidate solutions of the problem of optimization. In this paper, an image index in the database of face images represents an encoded candidate solution (i.e., a chromosome).

The *evaluation function* evaluates the specific solution's quality. A fitness value is associated with each chromosome, which in this case is the measure of distance between the candidate solution and the input image. According to this case, the lowest of the distance represents the better solution.

Through consecutive iterations, known as generations chromosomes evolve. At the creation of next generation, the new chromosomes, known as offspring, are produced by (a) selecting chromosomes to be combined (b) combining two chromosomes from the current population with each other by a crossover operator (c) altering a chromosome by a mutation operator [15].

Selection process keeps and eliminates chromosomes in the population on the basis of their corresponding fitness or quality [13]. There are several possible selection strategies. One of them is *Tournament* selection which is adopted in this paper. In *Tournament* selection, s chromosomes are randomly taken, and the best of them is chosen. The less chromosome fitness is the winner of the tournament from s tournament competitors, and it is entered in the mating pool. the tournament winners fill the mating pool. Therefore, it has an average fitness lower than the average fitness of the population [14].

Crossover operation creates viable offspring through the combination of two old chromosomes attributes. Chromosomes are both combined at a predetermined rate of crossover, which can be defined as the proportion of the number of constructed offspring in every generation to the size of population.

Mutation generates random alterations in different chromosomes. Mutation operation presents the crucial role to either replace the missing chromosomes from the population throughout the process of selection or introduce new chromosomes which are not existed in the initial population. The degree at which new chromosomes are initiated in the population is controlled by the rate of mutation [15].

Based on the chromosome model, the individuals are encoded as a n -length string, where each location (locus) holds a gene: $i = (i_1, i_2, \dots, i_n)$. The gene values i_j (called "allele") are often binary [3]. Each individual represents an index in the face database.

The similarity between queries and images is computed using City Block distance. Based on the similarity value with the query, the retrieved images are arranged [3].

The GA has been changed to guarantee its uniformity. If the best fitness value in the old generation is higher than the best fitness value in the new generation, the worse chromosome in the new generation is replaced with the best chromosome in the old generation [3].

The advantages of GAs over traditional search techniques are:

- They operate directly on an encoding of the set of parameter;
- The search operation is executed on a population of candidate solutions.
- Instead of unoriginal or extra knowledge, pay-off information is utilized.
- Instead of deterministic transition rules, probabilistic rules.

Recently, because the computational capabilities of computers became significantly improved, Genetic Algorithm has been utilized extensively in several engineering fields like system identification, signal processing, and the problems of data mining [12].

The following sections give several aspects of the system implementation:

The database

The experiments are performed on test images chosen from UPC Face Database [17] in order to verify the robustness of the algorithm against aspects resulting from lighting conditions, pose change, and partial occlusion. The images database comprises a set of 44 persons with 21 pictures for each person corresponding to various views of pose ($0^\circ, \pm 30^\circ, \pm 45^\circ, \text{and } \pm 60^\circ$)

controlled by three lighting conditions (regular or environment light, bright light source from 45° angle, and a closely frontal mid-bright light source). The images resolution is 240X320 with BMP format. Five training models with five different conditions are shown in Figure (2).

Figure (2): A single person examples from the UPC data base reflecting five face cases.



GA Parameters:

Representation of Solution:

For a given problem In order to apply GA to, it should be a decision for finding a suitable genotype needed by the problem, i.e., the representation of a chromosome. In the proposed system, a chromosome's integer value denotes an index to an image in the image features database.

Initial population:

At the start of the process of GA, an initialization of a population of possible solutions is involved. Typically, the initialization procedure is application-dependent; the random generation of binary strings is adopted as initial candidate faces.

Fitness function:

To measure the value of the chromosomes in a population, the fitness function is utilized. Hence, in our approach, the quality of a chromosome *C* related to the query image *Qf* is defined as:

$$\text{Fitness} (Qf , C) = d_{CB} (Qf , C) \dots\dots\dots(10)$$

Where:

d_{CB} (Qf , C) is the distance measure between images as given in Eq.(9).

Genetic operators:

Selection: the tournament selection method is adopted in this system [2] because of the complexity of its time is low. It can speed up the process of evolution because it does not involve an overall fitness comparison for every individual in the population.

Crossover: the one-point crossover [26] is used in the proposed system. In order to generate quality preserving off-springs, it is swapped portions of two chromosomes selected according to their fitness.

Mutation: In order to increase the variation of the population, the mutation operator is used to create a new chromosome [12]. In mutation, randomly selected position in a chromosome is inverted.

Performance Evaluation

Experiments are run ten to twenty-two times, and the average results are reported. The performance of the adopted face retrieval algorithm is evaluated using two important performance evaluation methods: Retrieval Precision (RP), Recall Rate (RR), and Average Retrieval Time (ART).

Retrieval Precision

Retrieval Precision (RP) is defined as the ratio of number of relevant images retrieved (Nr) to the number of total retrieved images (N_C) [4] as shown in Equation (11) [20].

$$RP = Nr / N_C \dots\dots\dots(11)$$

Recall Rate

Recall Rate (RP) is defined as the ratio of number of relevant images retrieved (Nr) to the total number of relevant images (N_{db}) as shown in Equation (12) [20].

$$RR = Nr / N_{db} \dots\dots\dots(12)$$

Experimental Results:

The experiments are performed on a Pentium 4 computer with CPU of 2.40 GHz and 4.0 GB RAM. Some of images have been chosen as query examples and the original image database is used as test examples for verifying of the retrieval performance.

We have run several experiments of the program with different genetic parameters as shown in Table (1). So, Table (2) shows the performance evaluation metrics for different experiments of the system implementation.

The experimental results prove that the maximum Average Retrieval Time (ART) throughout all the experiments is much less than the Average Retrieval Time taken by the system when executed without using Genetic Algorithm. The Average Retrieval Time without using Genetic Algorithm is (722.25 milliseconds) which is computed throughout (20) system run. However, by referring to retrieval times given in Table (2) it has shown that shows that using GA decreases the average retrieval time to (60.15 milliseconds). An example of a query image given to the system together with the retrieved images is shown in Figure (3). Also, the results prove that the Retrieval based on GA gives good precision and recall rate. The figures (4-6) show the relation between population size and the performance metrics, the relation between the population size and the average time, and the relation between the population size and both maximum generation and the average time. Figure (7) shows the average time of traditional search and GA search.

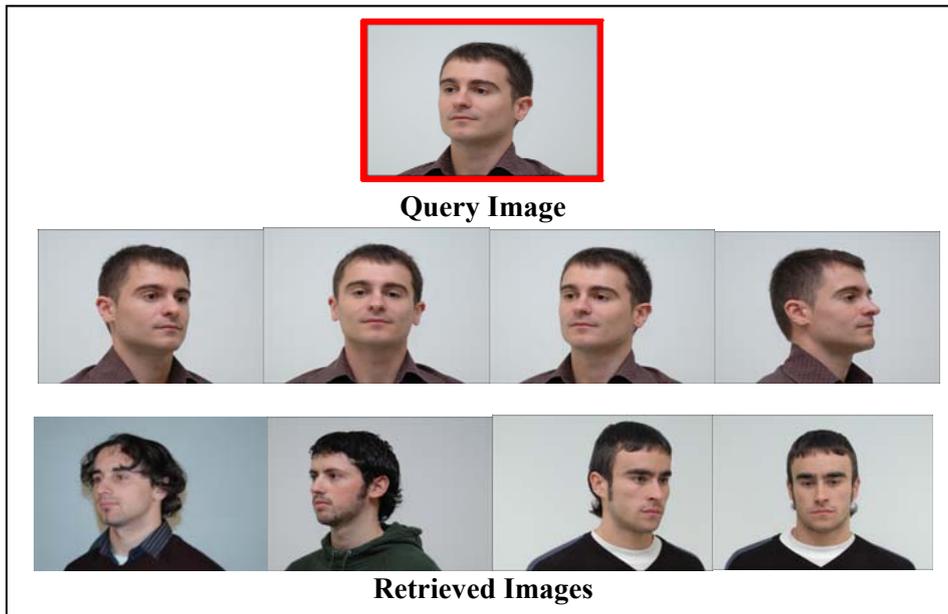
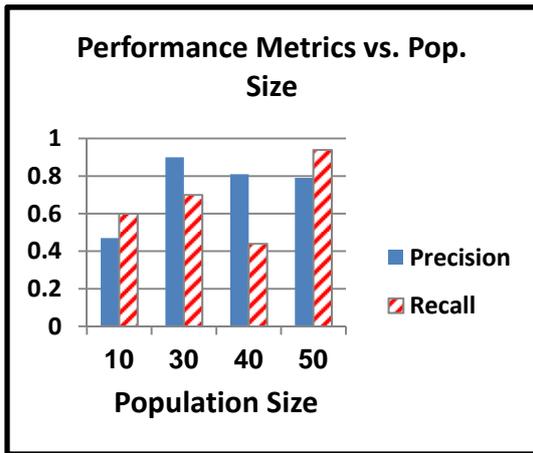
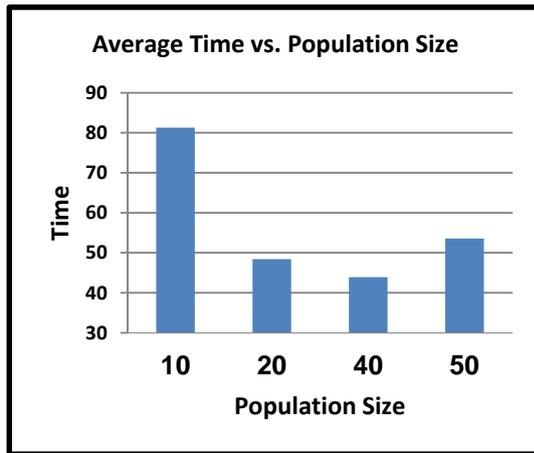


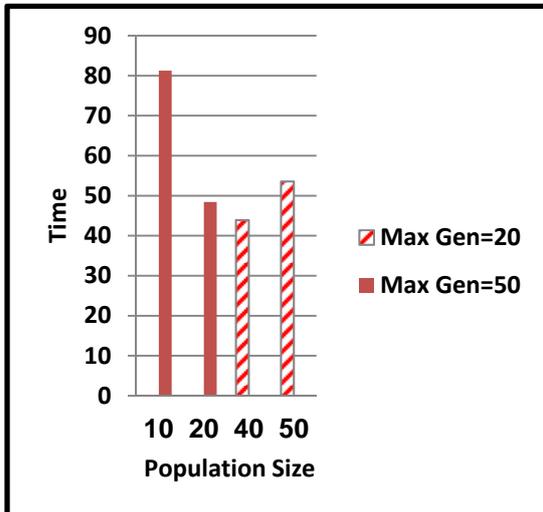
Figure (3) : An Example of a query image and retrieved images



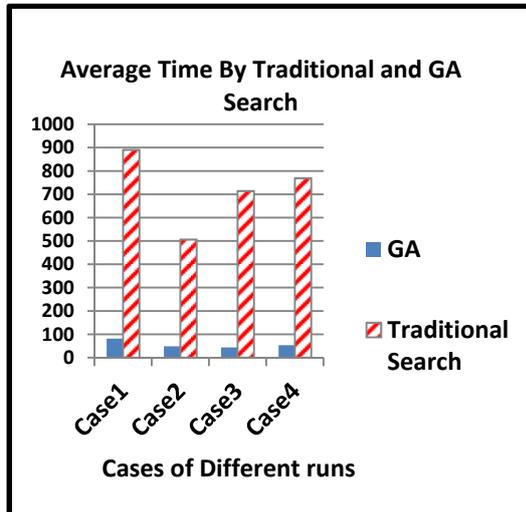
Figure(4):Performance Metrics Vs Pop. Size



Figure(5):Average Time Vs Pop. Size



Figure(6): Average Time Vs Pop Size



Figure(7): Average Time for Traditional & GA Search

Table (1): GA Parameters Used in the Experiments

Experiment No.	Pop. Size	Max Gen.	Pc	Pm
1	20	50	0.8	0.1
2	50	20	0.7	0.05
3	10	50	0.8	0.05
4	40	20	0.8	0.05

Table(2): Performance Evaluation Metrics

Experiment No.	RP (%)	RR (%)	Average Retrieval Time (in millisecond)	Average of Convergence Gen No.
1	95	75	41.73755	8
2	93	81	50.83967	5
3	80	75	78.1989	32
4	86	94	54.99973	5

CONCLUSIONS:

In this System, a new technique for face Retrieval is presented that exploits the statistical characteristics of an image by the virtue of moments invariants. The technique is based on using the genetic algorithm (GA). The face image is represented using YUV color space and is transformed by two-level wavelet transformation.

Moments invariants offer robustness against variability due to the changes in regions of the objects. The features used in moments analysis are less sensitive to illumination changes, easier for estimating the rotations and have less computational burden.

GA which is a hopeful heuristic approach for determining near-optimal solutions in large search spaces is adopted to find the best match face image to the query face image. The genetic chromosome is represented by a string of binary numbers that represents an index to the image database. several experiments have been run on the system. These experiments are executed with different genetic parameters.

From the experimental results it can be concluded that the application of GA in information retrieval can be successful, and the GA gives a better performance compared with traditional image search. From the results of the simulation, it can be demonstrated that the features of faces are extracted effectively. GA was capable of searching successfully and decreasing calculative complication, and consequently decrease the time of search. The results show, also, that the adopted method is relatively strong to various facial constraints.

On the other hand, three evaluation metrics are used to measure the retrieval performance and calculative complication of the system: Retrieval Precision (RP), Recall Rate (RR), and Average Retrieval Time (ART).

REFERENCES

- [1] Antonelli, M., Dellepiane, S. G., and Goccia, M., "Design and implementation of Web based systems for image segmentation and CBIR," *IEEE Trans. Instrum. Meas.*, vol. 55, no. 6, pp. 1869–1877, 2006.
- [2] Chun, Y. D., Kim, N. C., and Jang, I. H., "Content-based image retrieval using multiresolution color and texture features," *IEEE Trans. Multimedia*, vol. 10, no. 6, pp. 1073–1084, 2008.
- [3] Dana, V., *Genetic Algorithms in Information Retrieval*, 2000.
- [4] Dass, M. V., Ali, M. R., and Ali, M. M., "Image Retrieval Using Interactive Genetic Algorithm", *IEEE, International Conference on Computational Science and Computational Intelligence*, 2014.
- [5] Flusser, J., On the independence of rotation moment invariants, *The Journal of The Pattern Recognition Society*, 33, pp.1405-1410, 2000.
- [6] Flusser, J. and Suk, T., "Rotation moment invariants for recognition of symmetric objects," *IEEE Transactions on Image Processing*, vol. 15, no. 12, pp. 3784-90, 2006.
- [7] Goldberg, D. E., "Genetic and Evolutionary Algorithms Come of Age", *Communication of the ACM*, 37(3): 113-119, March, 1994.
- [8] Karakasis, E.G., Amanatiadis A., Gasteratos, A., and Chatzichristofis, S.A., Image moment invariants as local features for content based image retrieval using the Bag-of-Visual-Words model, *Pattern Recognition Letters* 55, pp. 22–27, 2015.

- [9] Lazea, Gh. and Lupu, As. E., Aspects on path planning for mobile robots, 1996.
- [10] Parekh, R., "Principles of Multimedia", 2nd ed., 2013.
- [11] Podpora, M., Korba's, G. P., and Kawala-Janik, A., "YUV vs RGB – Choosing a Color Space for Human-Machine Interaction", the Federated Conference on Computer Science and Information Systems pp. 29–34, Vol. 3, 2014.
- [12] Rao , S. S., Kumar, K. R., Devi, G. L., "Texture Based Image retrieval using Human interactive Genetic Algorithm", International Journal of Science Engineering and Advance Technology, IJSEAT, Vol. 1, Issue 6, 2013.
- [13] Selvi, R. Muthu , Rajaram, R., "Effect of Cross Over Operation in Genetic Algorithms on Anticipatory Scheduling", 24th, International Symposium on Automation & Robotics in Construction, 2007.
- [14] Sharma, A. , Mehta, A., " Review Paper of Various Selection Methods in Genetic Algorithm ", International Journal of Advanced Research in Computer Science and Software Engineering , Volume 3, Issue 7, 2013.
- [15] Sumathi, S. , Hamsapriya, T. , Surekha, P. , "Evolutionary Intelligence: An Introduction To Theory and Applications with Matlab, Springer-Verlag, 2008.
- [16] Umbaugh, Scott E. ,digital image processing and analysis: Human and Computer Vision Applications with CVIP tools, Second Edition, CRC Press, 2010.
- [17] UPC Face Database, Web Site: [http://gps-tsc.upc.es/ GTAV/Research Areas/ UPC Face Database/ GTAV Face Database.htm](http://gps-tsc.upc.es/GTAV/Research Areas/ UPC Face Database/ GTAV Face Database.htm)
- [18] Wu, C., Horng, S., Wen, and C. Wang, Y., Fast and scalable computations of 2D image moments, Image and Vision Computing 26, pp. 799–811, 2008.
- [19] Xiao-ma, X., Ming-tao, P., "Multiview face retrieval in surveillance video by active training sample collection", 10th International Conference on Computational Intelligence and Security, 2014.
- [20] Xie, Y., Setia, L. and Burkhardt, H., Block DCT Vectors Construction for Face Retrieval Based on Genetic Algorithm, IEEE Third International Conference on Natural Computation, 2007.
- [21] Yap, P.T., and Paramesran, R., Content-based image retrieval using legendre chromaticity distribution moments, IEE Proc. Vis. Image Signal Process. 153(1), pp. 17–24, 2006.
- [22] Yen, G. G. and Nithianandan, N., " Facial Feature Extraction Using Genetic Algorithm", Oklahoma State University, Stillwater, USA, 2002.
- [23] Yoo, H. W., Park, H. S., and Jang, D. S., "Expert system for color image retrieval," Expert Syst. Appl., vol. 28, no. 2, pp. 347–357, Feb. 2005.
- [24] Zaeri, N. and Baker, F., Thermal Face Recognition using Moments Invariants, International Journal of Signal Processing Systems Vol. 3, No. 2, 2015.
- [25] Zhanga, Y., Wanga, S., Sunc, P., and Phillips, P., Pathological brain detection based on wavelet entropy and Hu moment invariants, 2015.
- [26] Zhou, X. S. and Huang, T. S., "Relevance Feedback in content-based image retrieval: Some recent advances," Inf. Sci., vol. 148, no. 1–4, pp. 129–137, Dec., 2002.