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Modified Optimization by Artificial Bee Colony (MOABC) for improvement in content-based image retrieval performance

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Abstract:- Artificial Bee Colony(ABC) algorithm based optimization techniques are quite popular and focus for research in fields of Swarm Intelligence. This paper presents an optimization algorithm based on artificial bee colony (ABC) to deal with optimization problems in Content Based Image Retrieval (CBIR) System. We have introduced a modified ABC algorithm which is based on the intelligent scavenging behaviour for content base images. It uses less control parameters, and it can be efficiently used for solving for multi object optimization problems. In the current work, MOABC for discrete variables has been developed and implemented successfully for the multi variable design optimization of composites. The proposed algorithm is applied to Image retrieval section of CBIR system for minimizing the feature vectors and to find the image similar to the queried image. Finally the performance is evaluated in comparison with other nature inspired techniques which includes Particle Swarm Optimization (PSO) and Genetic Algorithm (GA). The performance of MOABC is better as par with that of ABC, PSO and GA for all the loading configurations.

Keywords:- Multi variable optimization, Structural optimization, Artificial Bee Colony (ABC), Feature Extraction.

I. INTRODUCTION

Content-based image retrieval is a method which expenditures visual contents to search images from bulky scale image databases according to users interests it is also known as query by image content. Since 1900s Content-based image retrieval has been an active and fast advancing research area. [1][5] CBIR comes to picture when many applications with large image database, traditional methods of image indexing have recognized to be unsatisfactory. Finger print scanning system, Automatic face recognition system, Medical image database, Trademark image registration are the application of Content-based image retrieval (CBIR). [6][7] The process of CBIR consists of three stages namely Image acquisition, Feature Extraction and Similarity Matching. In CBIR first of all query image undergoes the three stages as mentioned above. The query image is then compared with the images in the image database. All the images in the database undergo feature extraction so that the resultant feature vector can be compared with the feature vector of the query image. The closest image in comparison with the query image from the feature database is returned [8][10].

Multivariable optimization is defined as a problem of finding a vector of decision variables which fulfils constraints and enhances a vector function whose element characterizes the objective functions and these functions form a mathematical description of performance criteria which are usually in clash with each other [9] [11]. The biggest problem for CBIR system is to incorporate useful techniques so as to procedure images of expanded features and types. There are numerous methods for processing of low level cues are distinguished by the characteristics of domain-images.[14] The performance of these methods is tested by various issues like image resolution, intra-image illumination variations, non-homogeneity of intra-region and inter-region textures, multiple and occluded objects etc. [4] [15] The other key trouble, is a gap between inferred understanding semantics by pixel domain processing using low level cues and human perceptions of visual cues of given image[16]. The content based image retrieval system comprises of multiple inter-dependent tasks performed by various phases and Inter-tuning of all these phases of the content based retrieval system is unavoidable for over all good results. The diversity in the images and semantic-gap generally enforce parameter tuning & threshold-value specification suiting to the requirements [17].

In 2005 Karaboga proposed the artificial bee colony algorithm (ABC) is an optimization algorithm based on the intelligent foraging behaviour of honey bee swarm [18]. In ABC model, the colony consists of three groups of bees namely employed bees, onlookers and scouts. In this model it is assumed that there is only one artificial employed bee for each food source [19]. Employed bees go to their food source and come back to hive and dance on this area. The employed bee whose food source has been abandoned becomes a scout and starts to search for finding a new food source [2]. Onlookers watch the dances of employed bees and choose

food sources depending on dances. Optimal multi-level thresholding, MR brain image classification, cluster analysis, face pose estimation and 2D protein folding etc. these are the applications of ABC [20].

II. RELATED RESEARCHES: A REVIEW

Despite a plenty of works available in the literature, a handful of significant research works are reviewed here.

Chih-Chin Lai*et.al* [21] have discussed about a user-oriented mechanism for CBIR method and in this paper we used interactive genetic algorithm. IGA is a branch of evolutionary computation. 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. Through repeated rounds of content generation and fitness assignment, IGA enables unique content to evolve that suits the user's preferences. Based on this reason, IGA can be used to solve problems that are difficult or impossible to formulate a computational fitness function, for example, evolving images, music, various artistic designs, and forms to fit a user's aesthetic preferences. In this paper IGA is employed to help the users identify the images that are most satisfied to the users' need.

Lei Wu *et.al* [22] have proposed a method on Tag Completion for Image Retrieval, the proposed method falls into the category of semi-supervised learning in that both tagged images and untagged images were exploited to find the optimal tag matrix. In this proposed method also evaluated tag completion by performing two sets of experiments, i.e., automatic image annotation and tag based image retrieval. In this proposed method, they focus on a study the problem of tag completion where the goal was to automatically fill in the missing tags as well as correct noisy tags for given images.

Yingying Wang *et.al* [23] have proposed a model image classification as a Multiple Instance Learning (MIL) problem, by regarding each image as a bag composed of different regions/patches. In this proposed method rate distortion multiple instance learning (RDMIL) to take advantage of witnesses to improve the performance of MIL for image classification task. The objective function of RDMIL was decomposed into two convex sub-problems, which can be solved by alternating technique. Especially they design a sequential method to effectively optimize the RD sub problem. Experimental results on two real-world datasets demonstrate the proposed RDMIL algorithm was effective and promising. That approached well illustrates the generative process of witnesses and measures the diverse importance of instances in a probabilistic approach.

H. B Kekre *et.al* [24] have proposed a method on the selection of suitable similarity measure for content based image retrieval. It contains the analysis done after the application of similarity measure named Minkowski Distance from order first to fifth. It was also explains the effective use of similarity measure named correlation distance in the form of angle 'cosθ' between two vectors. In this proposed method the 'Bins Approach' explained the terms of computational complexity for feature extraction. It was based on histogram partitioning of three colour planes. As histogram was partitioned into 3 parts, they could form 27 bins out of it. These bins were directed to extract the features of images in the form of four statistical moments namely Mean, Standard Deviation, Skewness and Kurtosis.

Ramadass Sudhir *et.al* [25] proposed an algorithm image retrieval technique, which used YUV colour space and wavelet transform approach for feature extraction. Firstly, the colour space was quantified in non-equal intervals, then constructed one dimension feature vector and represented the colour feature. Similarly, the texture feature extraction was obtained by using wavelet. Finally, colour feature and texture feature were combined based on wavelet transform. Based on the colour feature, the rich colour images, such as the type of landscape images or planes, the colour characteristics of the use of regular search colours can be similar to the image. The use of colour and texture features of wavelet transform was more suitable for segmentation of objects and classification of related image from thousands of images. In which the retrieved images were much similar when the YUV is used and the retrieval time is also less when comparing with the previous RGB and HSV methods.

B.Ramamurthy *et.al* [26] have proposed to retrieve the medical images from huge volume of medical databases. This requires the pre-processing, feature extraction, classification, retrieval and indexing steps in order to develop an efficient medical image retrieval system. In this proposed work, for pre-processing step, the image segmentation method have been carried out, for feature extraction, basic shape feature has been extracted using canny edge detection algorithm, and for classification, K-means classification algorithm has been used. They have realize that Canny Edge Detection and K-means clustering algorithms are quite useful for retrieval of relevant images from image database. The results of this proposed indicate that the proposed approach offers significant performance improvements in retrieval of medical images. Further, by fine tuning of shape feature extraction and using other shape feature extraction methods, performance of the retrieval process can be improved more.

This paper is organised as follows: basics of multi-objective problems in CBIR are presented in Section 3. Details of the problem and its formulation are explained in Section 4. The numerical results and discussions are presented in Section 5. Finally, the comparison of nature inspired techniques and conclusions are given in Sections 6.

III. PROPOSED METHODOLOGY USING ARTIFICIAL BEE COLONY ALGORITHM FOR CONTENT BASED IMAGE RETRIEVAL:

In this paper, we have introduced an optimization technique by using the ABC. The proposed ABC algorithm is performing as neighbourhood search model that fine tunes the neighbourhood search property from employed and onlooker bees that helps to converge faster than conventional PSO and GA. This optimization algorithm is giving the benchmark model.

3.1. Content Based Image Retrieval with Modified optimization by ABC:

The approach supported retrieving images just like one chosen by the user is named Content based Image Retrieval (CBIR). Each image is represented by Multi variable optimize dimensional feature extra action. During this approach, Image process algorithms square measure accustomed extract feature extraction that represent image properties like color, texture, and shape that square measure the visual features. To retrieve the query image from the database images, a similarity measures are notice to check the likeness between a question image and database images. One among the most sanctifications of the CBIR approach is the possibility of an automatic retrieval process, instead of the traditional keyword-based approach, which usually requires very laborious and time-consuming previous annotation of database images. The CBIR technology has been employed in many applications like fingerprint identification, diverseness data systems, digital libraries, crime interference, medicine, historical analysis etc.

3.2. Feature Extraction:

In this paper, we have presented a Modified Article Bee Colony (MOABC) algorithm to solving the optimization problem in CBIR System. In our algorithm, we use all three type feature extraction, color, texture and shape.

3.2.1. Color Feature Extraction:

A content-based image retrieval system is presented that computes color similarity among images i.e. it supports querying with respect to color. Color is one of the most important features of objects in image. The color histogram of each image is then stored in the database. When the user does the search by specifying the query image, the system registers the proportion of each color of the query image and goes through all images in the database to find those whose color histograms match those of the query most closely. The color histogram is widely used as an important color feature indicating the content of the image, due to its robustness to scaling, orientation, perspective, and occlusion of images. Initially, a smoothening operation is performed over each frame of the shot segmented clips. Anisotropic diffusion is utilized in our proposed CBIR approach for the smoothening of the frames, prior to color histogram. For, a sequence of frames, the anisotropic diffusion is given by

$$\frac{\partial f}{\partial t} = div\left(c(a,b,t)\nabla f\right) \tag{2}$$

Where, $div(\nabla f)$ is the divergence operator, $\frac{\partial f}{\partial t}$ is the diffusion co-efficient and denotes the gradient. a,b,c is followed by a normalization function which converts the three dimensional vector into a single dimensional vector. Thus, the color histogram, another important feature for the proposed CBIR scheme is extracted

3.2.2. Texture Feature Extraction:

Texture is a feature that is quite difficult to describe, and subjected to the difference of human perception, and it is hard to extracted by segmentation, because segmentation unable to extract the whole texture but the texture element. Given a texture vector which is indicated as $X = \{x_1, x_2, \ldots, x_n\}$, where n is the dimension of the feature vector. We model the distribution of all samples by the following formula

$$p(x \mid \lambda) = \sum_{i=1}^{M} \omega_i \, p_i(x) \tag{3}$$

Where $p_i(x)$ is a normal PDF which is a component of the GMM It is parameterized by a mean vector μ_i , and a covariance matrix R_i :

$$p_i(x) = \frac{1}{2\pi \mid R_i \mid^{1/2}} \exp\left[\frac{-1}{2}(x-\mu_i)^T R_i^{-1}(x-\mu_i)\right] \quad (4)$$

ω_i is the weight of the component $p_i(x)$, $0 < \omega_i < 1$ for all components, and $\sum \omega_i = 1$. Mixture model specified in equation (3) is called the Gaussian Mixture Model (GMM).

3.3.3. Shape Feature Extraction:

Shape is also an important low-level feature in image retrieval system; since an object, in most case, can form by a set of shape (e.g. a car is consisted of a few rectangles and a few circles), most similar objects have a high correlation in the set of shapes. Shape-based image retrieval should extract the shapes from images by segmentation, and classify the shape, where each shape should have their own representation and should variant to scaling, rotation, and transition. In shape-based image retrieval the user need to choose an reference image or sketch a desired shape, since the user may not only want the shape that exact matched, so shape based image retrieval should be able to identify similar shapes.

IV. Modified Optimization by Artificial Bee Colony (MOABC) Algorithm for CBIR Systems:

In the ABC algorithm, the colony of artificial bees is classified into three categories: employed bees, onlookers, and scouts. Employed bees are associated with a particular food source that they are currently exploiting or are "employed" at. They carry with them information about this particular source and share the information to onlookers. Onlooker bees are those bees that are waiting on the dance area in the hive for the information to be shared by the employed bees about their food sources and then make decision to choose a food source. A bee carrying out random search is called a scout. In the ABC algorithm, the first half of the colony consists of the employed artificial bees, and the second half includes the onlookers. For every food source, there is only one employed bee. Onlookers are placed on the food sources by using a probability-based selection process. As the nectar amount of a food source increases, the probability value with which the food source is preferred by onlookers increases.

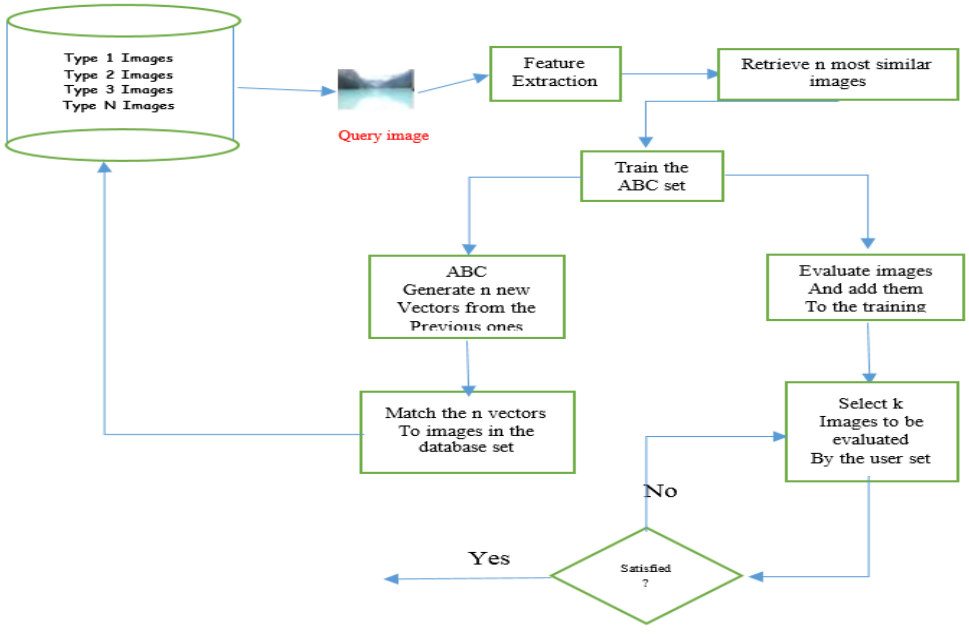


Figure 1: Proposed Diagram of Multi variable optimization technique with ABC

In our proposed algorithm, we have used an optimization concept with ABC and archive strategy to make the algorithm converge to the PSO and GA. The best advantage of MOABC is that it could use less control parameters to get the most competitive performance. In order to demonstrate the performance of the MOABC algorithm, we have compared the performance of the MOABC with those of GA, PSO optimization algorithms on several Variables.

In the initialization phase, the ABC algorithm generates randomly distributed initial food source positions $F(x)$ of solutions, $F(x)$ where denotes the size of employed bees or onlooker bees. Each

solution $F(x)=(f_1(x), f_2(x), ..., f_n(x))$ is a n -dimensional vector. Here, n is the number of optimization parameters. And then evaluate each nectar amount. In the ABC algorithm, nectar amount is the value of benchmark function.

Employed Bees' Phase:

In the employed bees' phase, each employed bee finds a new food source V_i in the neighbourhood of its current source x_i. The new food source is calculated using the following expression:

$$V_{ij} = x_{ij} + \Phi_{ij}(x_{ij} - x_{kj}) \tag{8}$$

where $k \in (1,2,3...m)$ and $j \in (1,2,3...n)$ are randomly chosen indexes and $k \neq i.\Phi_{ij}$ k is a random number between [-1, 1]. It controls the production of a neighbour food source position around x_{ij} . Then employed bee compares the new one against the current solution and memorizes the better one by means of a greedy selection mechanism.

Onlooker Bees' Phase:

In the onlooker bees' phase, each onlooker chooses a food source with a probability, which is related to the nectar amount (fitness) of a food source shared by employed bees. Probability is calculated using the following expression:

$$fit_i = \frac{1}{1+f_i} \tag{9}$$

Here f_i is fitness function and fit_i is the fitness after a transformation.

Scout Bee Phase:

In the scout bee phase, if a food source cannot be improved through a predetermined cycles, called "limit", it is removed from the population, and the employed bee of that food source becomes scout. The scout bee finds a new random food source position using

$$P_i = \frac{fit_i}{\sum_{i=1}^{M} fit_i} \tag{10}$$

Here M is the number of food source and f_i is fitness function of the i^{th} food source. Finally, chose a candidate solution based on the section probability by "roulette wheel section", method. The best ones then get quite the same selection probability as the others and the algorithm stops progressing.

Pseudo code of MOABC algorithm:

1. **Step 1:** Generates randomly distributed initial food source in cycle = 1
2. **Step 2:** Initialize the food source positions (solutions)
3. **Step 3:** Evaluate the nectar amount (fitness function) of food sources
4. repeat
5. **Step 4:** Employed Bees' Phase
6. For each employed bee
7. Produce new food source positions
8. Calculate the value
9. If new position better than previous position
10. Then memorizes the new position and forgets the old one.
11. End For.
12. **Step 5:** Calculate the values for the solution.
13. **Step 6:** Go to 2nd Phase (Onlooker Bees)
14. For each onlooker bee
15. Chooses a food source depending on
16. Produce new food source positions
17. Calculate the value
18. If new position better than previous position

19. Then memorizes the new position and forgets the old one.
20. End For
21. **Step 7:** Go to 2nd Phase (Scout Bee Phase)
22. If there is an employed bee becomes scout
23. Then replace it with a new random source positions
24. **Step 8:** Memorize the best solution achieved so far
25. **Step 9:** Cycle = cycle + 1.
26. **Step 10:** until cycle = Maximum Cycle Number
27. Evaluate each particle in the size of home
28. **Step 11:** Perform the optimal solution check for all the particles:
29. if the Calculated value is best *xi* is dominated by the new solution, then *xi* is replaced by the new solution.

Table 1: Pseudo code of MOABC algorithm

After Step 10.The proposed algorithm performance of the approach is based on the precision; recall and F-measure cross over points. After evaluating Euclidean distance of the query image, the precision and recall values are generated using the following equations (8), (9) and (10) in[27].

$$precision = \frac{No.of\ relevant\ images\ retreived}{Total\ no.of\ images\ retrivd} \quad (8)$$

$$recall = \frac{No.of\ relevant\ images\ retreived}{Total\ no.of\ relevant\ images\ in\ database} \quad (9)$$

$$F = 2\frac{precision * recall}{precision + recall} \quad (10)$$

V. EXPERIMENTAL RESULT

We will introduce performance measures. For every algorithm, we will give the parameter settings. The propose technique is tested on the image database of 500 variable images includes five categories as some different types of butterflies and flowers with 200 images for each datasets. The precision, recall and F-measure are calculated for the sample query images for each category using Eq. (8), (9) and (10). These measures are the important parameters to judge the performance of the algorithms. Precision is the fraction of the relevant images which has been retrieved, checks the completeness of the algorithm. Recall is the fraction of the relevant images which has been retrieved, checks the accuracy of the algorithm. After that we compare with the proposed result with single object optimization technique of ABC, PSO and GA.

Table 2: Total number of Retrieved dataset 1 images for MOABC, ABC, PSO and GA

	MOABC	ABC	PSO	GA
Precision	0.74	0.68	0.62	0.53
Recall	0.70	0.62	0.58	0.47
F-score	0.66	0.59	0.48	0.45

Table 3: Total number of Retrieved dataset 2 images for MOABC, ABC, PSO and GA

	MOABC	ABC	PSO	GA
Precision	0.80	0.78	0.29	0.24
Recall	0.64	0.67	0.48	0.15
F-score	0.57	0.51	0.38	0.17

Table 4: Total number of Retrieved dataset 3 images for MOABC, ABC, PSO and GA

	MOABC	ABC	PSO	GA
Precision	0.69	0.70	0.56	0.45
Recall	0.70	0.38	0.51	0.57
F-score	0.63	0.21	0.44	0.50

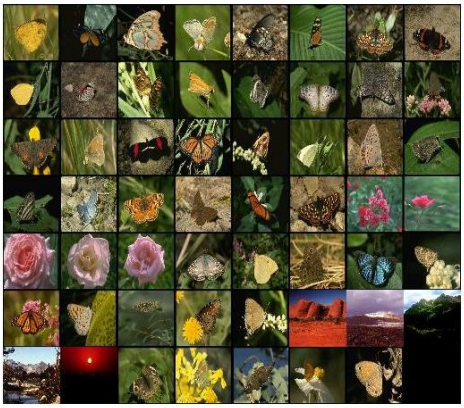
Table 5: Total number of Retrieved dataset4 images for MOABC, ABC, PSO and GA

	MOABC	ABC	PSO	GA
Precision	0.55	0.51	0.47	0.51
Recall	0.60	0.44	0.43	0.24
F-score	0.49	0.29	0.39	0.28

Table 6: Total number of Retrieved dataset 5 images for MOABC, ABC, PSO and GA

	MOABC	ABC	PSO	GA
Precision	0.71	0.69	0.45	0.29
Recall	0.47	0.57	0.57	0.48
F-score	0.88	0.62	0.50	0.38

(a)



(b)

Figure. 2: a) query image, b) Result of the Color Feature

(a)

(b)

Figure 3 a) query image, b) Result of the Shape Feature

(a)

(b)

Figure 4: a) query image, b) Result of the Texture Feature

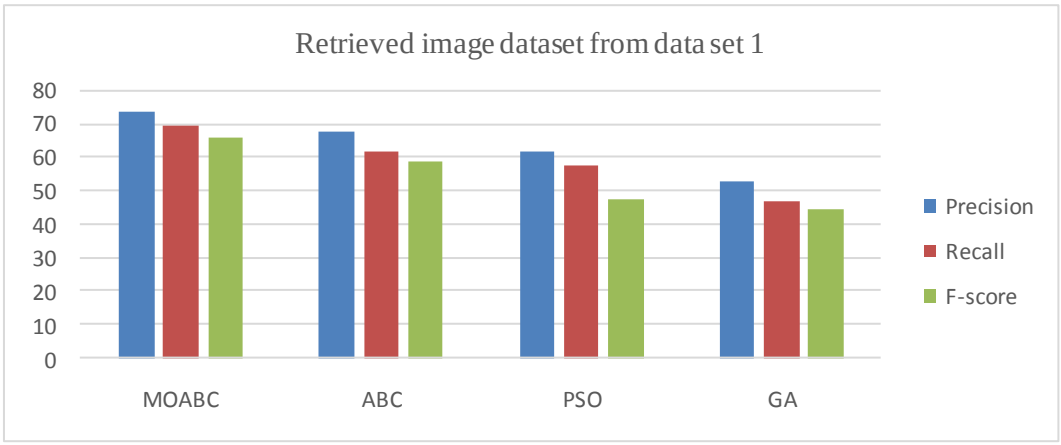


Figure 5: Precision, recall and F-measure values for MOABC, ABC, PSO and GA of dataset 1

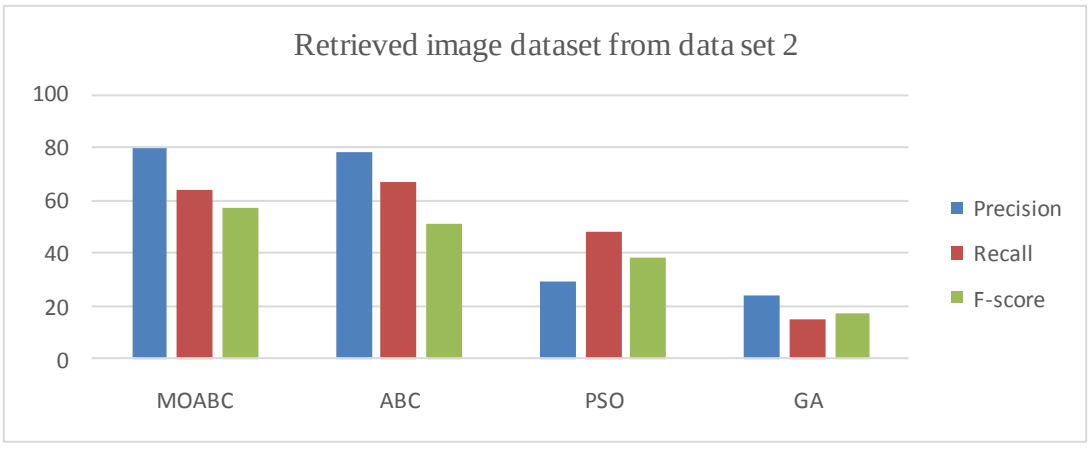


Figure 6: Precision, recall and F-measure values for MOABC, ABC, PSO and GA of dataset 2

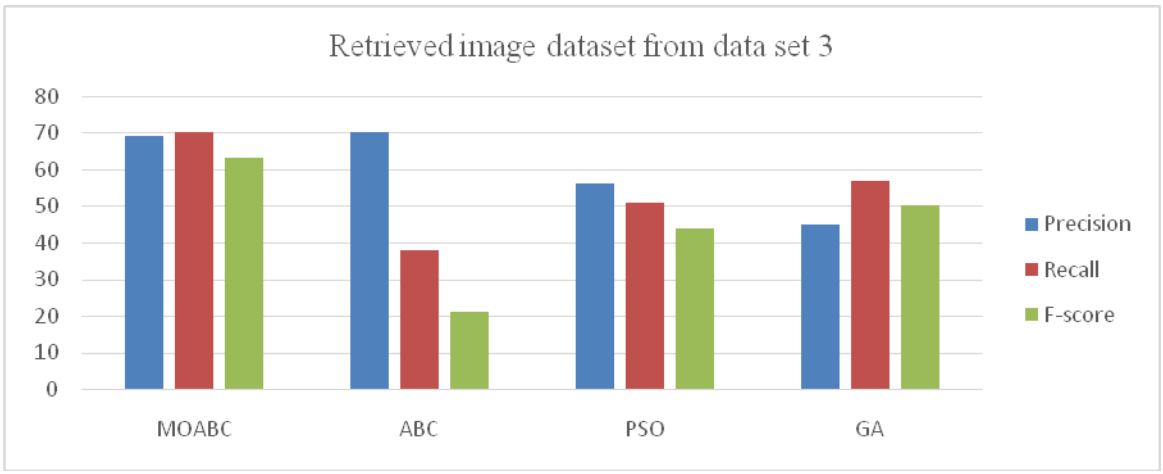


Figure7: Precision, recall and F-measure values for MOABC, ABC, PSO and GA of dataset 3

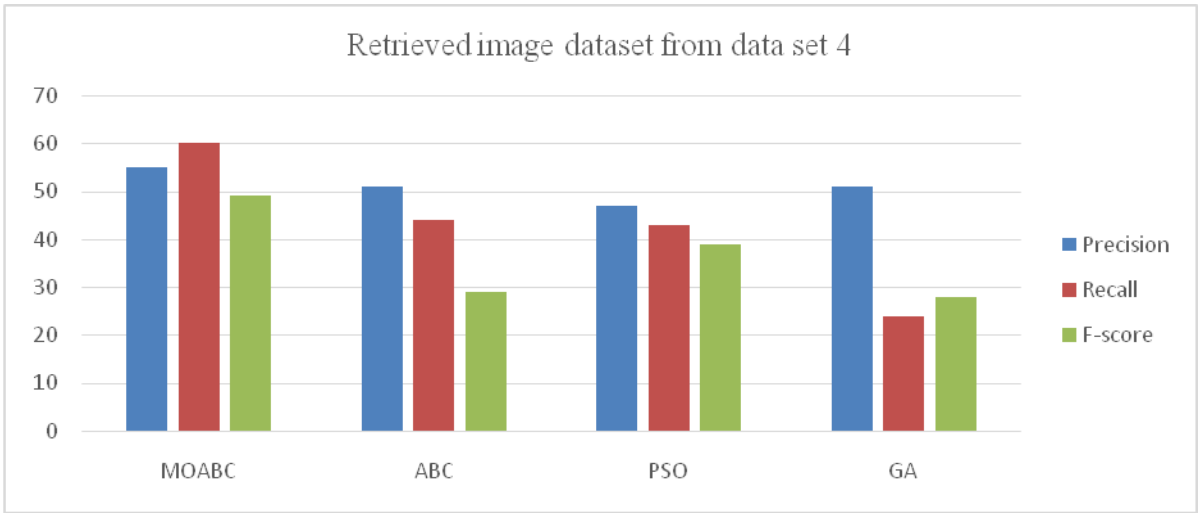


Figure 8: Precision, recall and F-measure values for MOABC, ABC, PSO and GA of dataset 4

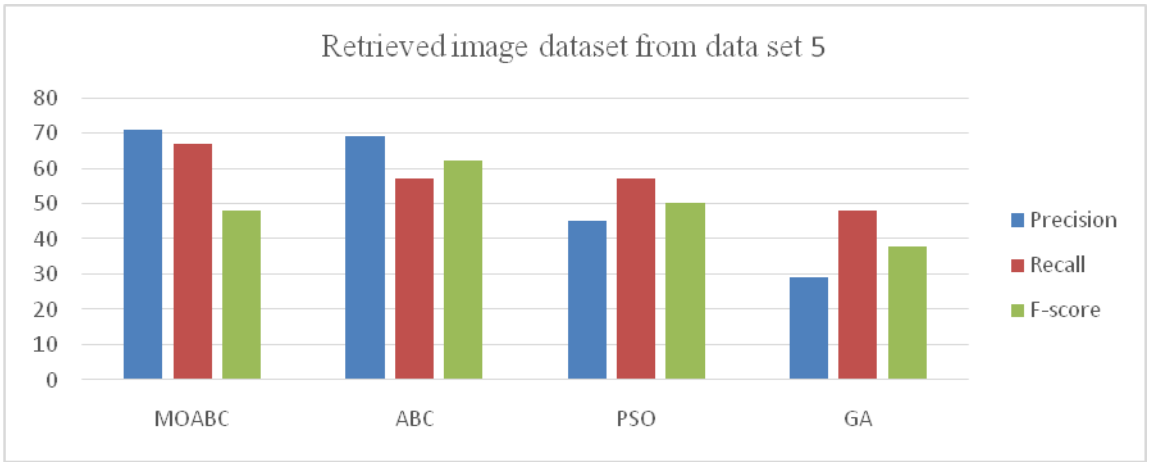


Figure 9: Precision, recall and F-measure values for MOABC, ABC, PSO and GA of dataset 5

Compared to other optimization technique, our proposed work has produced better results. Our proposed work has performed satisfactorily when its color, texture and shape feature was tested on the five different databases. From the fig 5 to fig. 9 is observed that the propose MOABC has the precision rate as 78% and recall rate 70%, but the other three algorithms have lesser and also F-measure of the MOABC is also better than the individual ABC, PSO and GA algorithms. After the inclusion of the feature extraction, based on the given query image, the retrieved color, texture and shape feature from images.

In the all five different dataset retrieval were performed by querying five different images and for every dataset we get precision, recall and F-score values is determined. The precision and recall value comparison between the proposed extensive algorithms features extraction based on multi-variable optimization systems shows that the performance of the proposed system is best over that of the existing systems. Thus the comparisons are made using multiple features such as color, texture, shape that the proposed MOABC algorithm performs better than the individual ABC, PSO and GA.

VI. CONCLUSION

In this paper the new method (MOABC) is introducing multi variable updation in ABC algorithm, PSO and GA instead of single optimization Search. Here it is implemented in MATLAB and is tested by using different evaluation functions. The parameter position is optimized for multiple object and the values of the propposed method is compared with single object ABC, PSO and GA algorithm. In the proposed method the fitness values are seems to be better for the Precision Recall and F-score value found to be better in all single evaluationary algorithems. From the above results it is clear that the MOABC is the better optimization technique while comparing to ABC, PSO and GA.

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