PREDICTING OPTIMAL FEATURES IN THE CONTEXT OF MEDICAL IMAGE RETRIEVAL WITH THE AID OF SUPPORT VECTOR MACHINE (SVM)

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Abstract- **The aim of this work is to enhance the retrieving performance of medical images by incorporating optimization techniques. This includes four different medical images such as brain, lung, mammogram and ultrasound. This RGB images change into grey scale images then given for feature extraction.Features are shape, color and texture (Grey-Level Co-occurrence Matrix (GLCM) and Grey-Level Run Length Matrix (GLRLM) for image retrieval. The extracted features optimized using Genetic Algorithm (GA) and Crow Search Optimization (CSO) algorithm. From this, CSO performed better and attain optimal features. Then Support Vector Machine (SVM) classification technique is implemented. The results obtained the performance of precision, recall and f-measure for brain, lung, mammogram and ultrasound images and then retrieve images for given query image.**

Keywords: **Medical Images, Grey-Level Co-occurrence Matrix (GLCM), Grey-Level Run Length Matrix (GLRLM), Crow Search Optimization (CSO) and Support Vector Machine (SVM).**

I. INTRODUCTION

Recently collection of images has rapidly grown and continues to increase in future due to widespread use of internet. To access these large databases, efficient method is required for querying the indexed image database. It is difficult to locate the relevant information from such a huge database [1]. Image retrieval techniques can be commonly classified into two categories: the method based on global features and, the methods based on local features. It is worth noting that, whether global features or local features, the extraction of the primary visual features is one of the key issues in image retrieval [2]. Efficient image searching, browsing and retrieval tools are necessary by users from various domains, including remote sensing, fashion, crime prevention, publishing, medicine, architecture, etc[3].The feature extraction plays an important role in CBIR whose effectiveness depends upon the method accepted for extracting features from given images [4].The feature vectors encode image properties, such as color, texture and shape. The similarity between two images is computed as a function of the distance between their feature vectors [5].Searching, browsing and retrieving images from a huge database are unrealistic and unsuitable problems [6].Colour texture analysis relates the chromatic and textural properties of images. The approaches combining colour and texture can be grouped into parallel, sequential and integrative. The parallel approach joins the grey level texture features of the image to colour ones, and they are mainly used for image retrieval applications [7].The shape features of the images are collected after the images have been segmented into regions or objects. Some of features used for morphological shape decomposition are presented [8].Texture measures the characteristics of images with respect to changes in certain directions and scales [9].In order to overcome the problems brought by using single feature and improve the retrieval accuracy, an image retrieval method which fuses color , texture and shape these three basic features is proposed, users can finally get satisfied query results according to the relevant feedback results [10].The support vector machine is a classifier specially using multiclass SVM in this technique for improved performances. The new technique of SVM classifier is suitable for binary classification tasks [11].This trained when presented with a query image retrieves and displays the images which are relevant and similar to query from the database. The results show a considerable improvement in terms of precision and recall of image retrieval [12].

II. LITERATURE REVIEW

Soumya Prakash Rana et al. [13] 2019, had anticipated an image was inconceivable by a single feature. Thus, the research addresses that point for content based image retrieval (CBIR) by fusing parametric color and shape features with nonparametric texture feature. Finally, a hypothesis test was carried out to establish the significance of the proposed work which infers evaluated precision and recall values are true and accepted for the all image database.

M.Vanitha [14] 2016, had proposed a Content Based Image Retrieval was a system where more number of images was retrieved from a large database collection. To improve better Content Based Image Retrieval system, it was necessary to find comparatively a better technique for image retrieval. That paper deals with a review on how Neural Network takes an important place in Content Based Image Retrieval Techniques.

KommineniJenni et al. [15] 2015, had suggested method mainly concentrated on database classification and efficient image representation. They present a method for content based image retrieval based on support vector machine classifier. This CBIR approach has significantly increased the accuracy in obtaining results for image retrieval.

VrushaliYashwantErande and P.R.Badadapure [16] 2013, had planned of image retrieval using text are proven to be insufficient for the large image database.CBIR or Content Based Image Retrieval was the retrieval of images based on visual features such as color, texture and shape. In their project DML and ANN algorithms are used to measure the similarity between images. The experiment also indicates that the new algorithm (ANN) was more effective and more efficient than alternative algorithm.

Quellec*et al* [17] 2010, had proposed content-based image retrieval (CBIR) method for diagnosis aid in medical fields. Images are indexed in a generic fashion, without extracting domain-specific features: a signature was built for each image from its wavelet transform. Results are promising: a mean precision of 56.50%, 70.91% and 96.10% is achieved for these three databases, when five images are returned by the system.

III. PROPOSED METHODOLOGY

This research includes medical image features (shape, color and texture) for image retrieval. The color contains 256 features, shape contains 200 features, the texture contains two different features namely GLCM (22 features) and GLRLM (7 features) are extracted. From this evaluation the time has been calculated, but the number of features are large based on that computation time is also high. To overcome this problem doesn't compensate the performance and choose the feature by using optimization technique. The extracted features optimized using GA and CSO optimization algorithm from this CSO performed better and attain optimal features then given to SVM classification technique. The performance of precision, recall and f-measure are calculated by grouping the number of retrieved images sorted according to classification of database images.

A Preprocessing

The basic convergence of the pre-processing part is presented for the change of the image quality to adjust it sensible for additional processing in order to deal with free of or downsizing the isolated and additional segments in the setting of the input images. Following to the preprocessing capacity, the preprocessed image is prepared to the progressive technique. The RGB colour image is an additional colour image in which red, green and blue light are incorporated into various ways to deal an expansive exhibit of colours. RGB value does not characterize a comparative colour crosswise over gadgets without some kind of colour administration. Gray scale is a scope of shades of gray without obvious colour. Gray scale is a scope of shades of gray without obvious colour.

B Feature extraction

The images subsequent to preprocessing, the feature extracted by a method for adjusting shape (morphological), color (Histogram equalization), texture (GLCM and GLRLM) in the feature extraction process.

a. Shape Feature Extraction

Shape is main source of information which is used for object recognition. Without shape visual content object cannot be recognize properly. Image is incomplete without recognizing shape. The two objects cannot have exact same shape but by using various algorithms we can recognize similar shape easily. In this mathematical morphology technique is used and it provides an approach to the processing of digital images which is based on shape. Appropriately used, Mathematical morphological operations tend to extract their essential shape characteristics and to eliminate irrelevancies.

b. Color Feature Extraction

Color space represents thecolor in the form of intensity value. We can specify, visualize and create the color by using color space method. There are different color feature extraction methods.

c. Color Histogram

Color histogram represents the image from different perspective. The image in which color bins of frequency distribution are represented by color histogram and it counts the pixels which are similar and store it. Color histogram analyses every statistical color frequency in an image. The change occurred in the translation, rotation and angle of view these problems are solved by color histogram and also it focuses on individual parts of an image. The computation of local color histogram is easy and it is resistant to minor variations in the image so for indexing and retrieval of image database it is very important.

d. Texture Feature Extraction

Texture contains significant information about the basic arrangement of the surface that is clouds, leaves, bricks, fabric etc. It also defines surface with environment relationship. Texture feature also describes the physical composition of surface. There are different methods of texture feature extraction

e.Grey *Level Co-occurrence Matrix (GLCM)*

A GLCM ceaselessly speaks to a matrix in which quantity of rows and columns are proportionate to the number of gray levels, *G*, in the image. The matrix element $(u,v/d_1,d_2)$ symbolizes the indistinguishable segregated by a pixel partition (d1 and d2). The GLCMs are prepared for get-together sufficient estimations from them by technique for the grey co-props function, which outfit the insights with respect to the breast cancer of an image, which can be sorted as Autocorrelation, Contrast, Correlation number 1, Correlation number 2, Cluster prominence, Cluster shade, Dissimilarity, Energy, Entropy, Homogeneity 1, Homogeneity 2, Maximum probability, Sum of squares, Sum average, Sum variance, Sum entropy, Difference variance, Difference entropy, Inverse difference normalized, Inverse difference moment normalized, Information measure of correlation number 1 and Information measure of correlation number 2based on this the equations explained below.

$$Autocorrelation = \sum_q \sum_r qrp(q,r) \quad (1)$$

$$Contrast = \sum_q \sum_r (q-r)^2 \; p(q,r) \quad (2)$$

$$Correlation1 = \sum_q \sum_r \frac{(q-\alpha_q)(r-\alpha_r)p(q,r)}{\sigma_q \sigma_r} \quad (3)$$

$$Correlation2 = \sum_q \sum_r \frac{(qrp(q,r)-\alpha_q \alpha_r)}{\sigma_q \sigma_r} \quad (4)$$

$$Cluster\ Prominence = \sum_q \sum_r ((q-\alpha_q)+(r-\alpha_r))^4 \, p(q,r) \quad (5)$$

$$Cluster\ Shade = \sum_{q,r} ((q-\alpha_q)+(r-\alpha_r))^3 T(q,r) \quad (6)$$

$$Dissimilarity = \sum_q \sum_r |q-r|\, p(q,r) \quad (7)$$

$$Energy = \sum_{q,r} p(q,r)^2 \quad (8)$$

$$Entropy = \sum_{q,r} p(q,r) \log(p(q,r)) \quad (9)$$

$$Homogeneity1 = \sum_q \sum_r \frac{p(q,r)}{1+|q-r|} \quad (10)$$

$$Homogeneity\ 2 = \sum_{q,r} \frac{P(q,r)}{[1+(q-r)^2]} \quad (11)$$

$$Maximum\ probability = \max(p(q,r)) \quad (12)$$

$$SumOfSquares = \sum_q \sum_r (q - mean(p(q,r)))^2\, p(q,r) \quad (13)$$

$$SumAverage = \sum_{\alpha=2}^{2N_g} p_{q+r}(\alpha) \quad (14)$$

$$SumVariance = \sum_{\alpha=2}^{2N_g} (\alpha - f_8)^2\, p_{q+r}(\alpha) \quad (15)$$

$$SumEntropy = -\sum_{m=2}^{2N_g} p_{x+y}(m) \log\{p_{x+y}(m)\} \quad (16)$$

$$DifferenceVariance = \sum_{\alpha=0}^{N_g-1} (\alpha)^2\, p_{q-r}(\alpha) \quad (17)$$

$$DifferenceEntropy = -\sum_{\alpha=0}^{N_g-1} p_{q-r}(\alpha) \log\{p_{q-r}(\alpha)\} \quad (18)$$

$$Inverse\ DifferenceNomalised = \sum_q \sum_r \frac{p(q,r)}{1+\left(\frac{|q-r|}{N}\right)} \quad (19)$$

$$Inverse\ Difference\ Moment\ Nomalised = \sum_q \sum_r \frac{p(q,r)}{1+\left(\frac{q-r}{N}\right)^2} \quad (20)$$

$$Information\ Measure\ of\ Correlation1 = \frac{Hqr - Hqr1}{\max\{Hq, Hr\}} \quad (21)$$

$$Information\ Measure\ of\ Correlation\ 2 = (1-\exp[-2(Hqr2 - Hqr)])^{\frac{1}{2}} \quad (22)$$

f. Grey-level run-length matrix (GLRLM)

Texture features based on this GLRL matrix, namely: Shot Runs Emphasis (SRE), Long Run Emphasis (LRE), Gray Level Non-uniformity (GLN), Run Length Non-uniformity (RLN), and Run Percentage (RP).

Short Run Emphasis (SRE):

$$SRE = \frac{1}{n} \sum_{q,r} \frac{p(q,r)}{r^2} \quad (23)$$

Long Run Emphasis (LRE):

$$LRE = \frac{1}{n} \sum_{q,r} r^2 * p(q,r) \quad (24)$$

Gray Level Non-uniformity (GLN):

$$GLN = \frac{1}{n} \sum_q \left(\sum_r p(q,r) \right)^2 \quad (25)$$

Run Length Non-uniformity (RLN):

$$RLN = \frac{1}{n} \sum_q \left(\sum_u p(q,r) \right)^2 \quad (26)$$

Run Percentage (RP):

$$RP = \sum_{q,r} \frac{n}{p(q,r)*r} \quad (27)$$

C. Optimal feature

Based on above mention process attain485 features from this for finding optimal features the Genetic algorithm (GA) and Crow Search Optimization (CSO) algorithms are utilized. The optimal features are obtained from CSO algorithm which is given to SVM for classification.

a. Crow Search Optimization algorithm (CSO)

In this area, a general depiction of the standard CSO is exhibited. CSO is an ongoing metaheuristic algorithm created by Askarzadeh, which is inspired on the knowledge behaviour of crows. In nature, crows proof cleverness behaviours such as self-awareness, utilizing apparatuses, recognizing faces, warn the flock of possibly unfriendly ones, refined communication ways and reviewing the food's hidden place after a while. Every one of these behaviours connected to the way that the brain-body ratio of the crows is marginally lower than the human brain have made it recognized as a standout amongst the most intelligent birds in nature.

The CSA evolutionary procedure emulates the behaviour conducted by crows of hiding and recovering the additional food. As an algorithm dependent on population, the size of the flock is accommodated by *N* individuals (crows) which are of n-dimensional with *n* as the issue dimension. The position $Y_{i,k}$ of the crow i in a specific iteration k is portrayed in Equation (28) and represents a possible solution for the issue:

$$Y_{i,k} = \left[y^1_{i,k}, y^2_{i,k}, \ldots\ldots, y^n_{i,k} \right]; i = 1,2,\ldots N,\ k = 1,2,\ldots\ldots,\max Iter \quad (28)$$

Where *max Iter* is the maximum of iterations in the procedure. Each crow (individual) is expected to have the ability of remember the best visited area $M_{i,k}$ to hide food until the present iteration Equation (29):

$$M_{i,k} = \left[m^1_{i,k}, m^2_{i,k}, \ldots\ldots, m^n_{i,k} \right] \quad (29)$$

The position of each is adjusted by two behaviours: Pursuit and evasion.

Pursuit: A crow j pursues crow i with the reason to find its hidden place. The crow i does not see the nearness of the other crow, as outcome the reason of crow j is accomplish.

Evasion: The crow i thinks about the nearness of crow j and in order to secure its food, crow i deliberately take a random trajectory. This behaviour is simulated in CSA through the implementation of a random movement.

The sort of behaviour considered by each crow i is determinate by an awareness probability (AP).

In this manner, a random value r_i consistently circulated between 0 and 1 is sampled. In the event that r_i is greater or equal than AP, behaviour 1 is applied, generally situation two is selected. This operation can be summarized in the accompanying model:

$$Y_{i,k+1} = \begin{cases} Y_{i,k} + r_i \cdot fl_{i,k} \cdot \left(M_{j,k} - Y_{i,k}\right) & r_i \geq AP \\ random & otherwise \end{cases} \quad (30)$$

The flight length $fl_{i,k}$ parameter shows the magnitude of movement from crow $Y_{i,k}$ towards the best position $M_{j,k}$ of crow j, the r_i is a random number with uniform distribution in the range [0, 1].

Once the crows are modified, their position is assessed and the memory vector is updated as pursues:

$$M_{i,k+1} = \begin{cases} F\left(Y_{i,k+1}\right) & F\left(Y_{i,k+1}\right) < F\left(M_{i,k}\right) \\ M_{i,k} & otherwise \end{cases} \quad (31)$$

Where the F(·) represents the objective function to be minimized.

D. Classification using SVM

The SVM approach seeks to find the optimal separating hyper plane between the classes by focusing on the training cases that are placed at the edge of the class descriptors. These training cases are called the support vectors. The training cases other than the support vectors are the discarded vectors. By this way not only is an optimal hyper plane fitted but also the less training samples are more effectively used and thereby high classification accuracy is achieved using rather small training sets.

SVM has confirmed its competence over the neural networks and the RBF (Radial Basis Function) classifiers. Unlike neural networks, this model builds and does not require hypothesizing number of neurons in the middle layer or defining the centre of Gaussian functions in RBF. The SVM employs an optimum linear separating hyper plane to divide the two sets of data in a feature space. By maximizing the minimum margin between the two sets the relative optimum hyper plane is generated. As a result, the resulting hyper plane will only be relied on the border training patterns called the support vectors. The support vector machine functions on two mathematical operations such as the Nonlinear mapping of an input vector into a high-dimensional feature space that is unseen from both the input and output and Construction of an optimal hyper plane for detaching the features.

IV. RESULT AND DISCUSSION

The intention of retrieving images for a given query image evaluate with following investigations. The investigation includes four different medical images such as brain, lung, mammogram and ultrasound shown in table-1, the performance of each query image evaluates with three standard measures precision (P) recall (R) and f measures (Fm) for GA and CSO, represent in performance graphs.

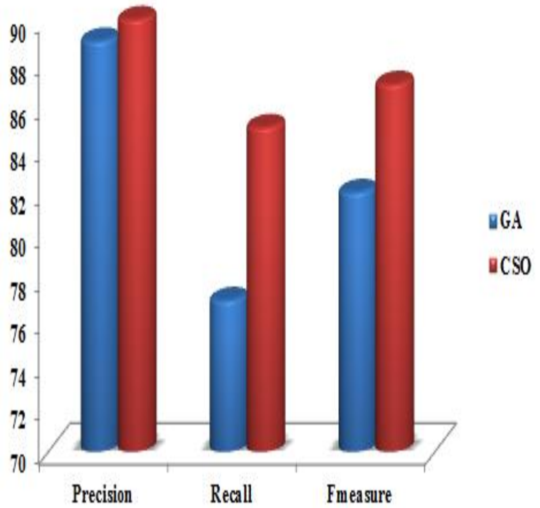


Figure.3Performance graph for brain image

This figure 3 exhibits average performance measures of a set of given query images from different optimization techniques. In the context of retrieving specific images for a given brain query images the performance of proposed techniques achieve precision, recall and f-measure. Whereas in GA the precision is 89, GA the recall is 77 and GA the f-measure is 82 respectively, in CSO the precision is 90, CSO the recall is 85 and CSO the f-measure is 87 respectively.

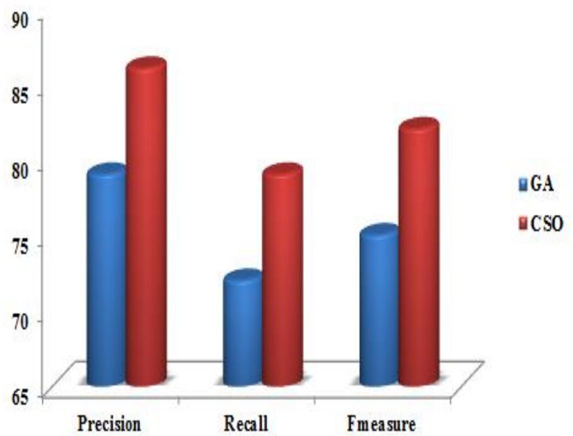
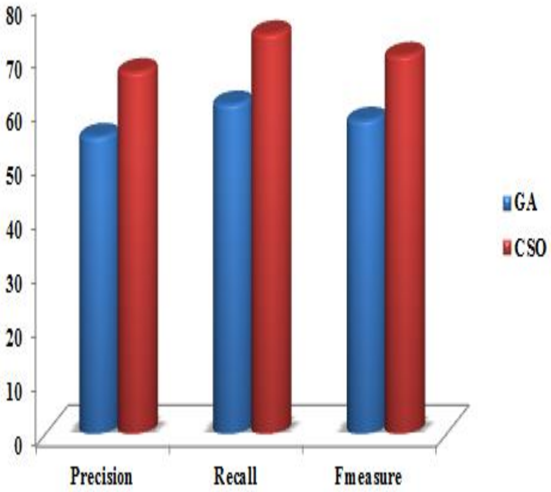


Figure.4 Performance graph for lung image

This figure 4 exhibits average performance measures of a set of given query images from different optimization techniques. In the context of retrieving specific images for a given lung query images the performance of proposed techniques achieve precision, recall and f-measure. Whereas in GA the precision is 79, GA the recall is 72 and GA the f-measure is 75 respectively, in CSO the precision is 86, CSO the recall is 79 and CSO the f-measure is 82 respectively.



This figure 5 exhibits average performance measures of a set of given query images from different optimization techniques. In the context of retrieving specific images for a given mammogram query images the performance of proposed techniques achieve precision, recall and f-measure. Whereas in GA the precision is 55, GA the recall is 61 and GA the f-measure is 58 respectively, in CSO the precision is 67, CSO the recall is 74 and CSO the f-measure is 70 respectively.

Figure.5 Performance graph for mammogram image

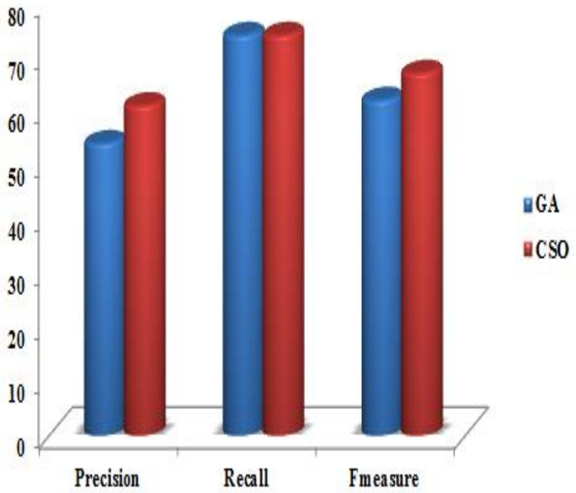
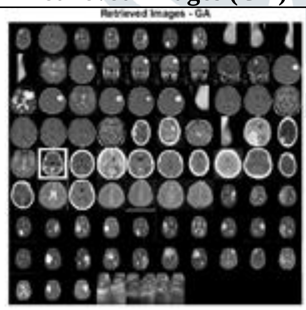
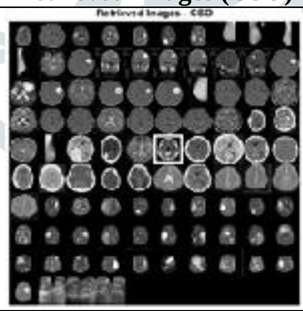
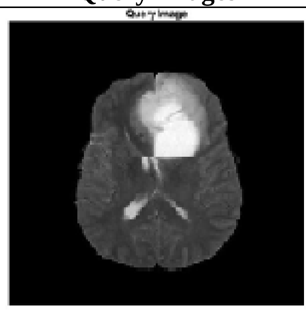
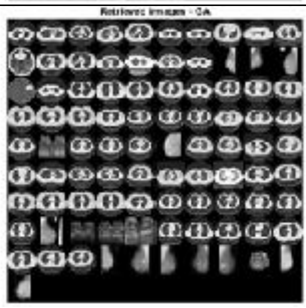
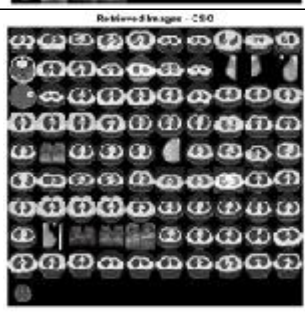
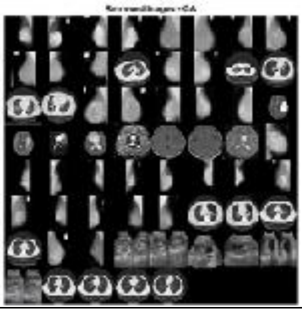
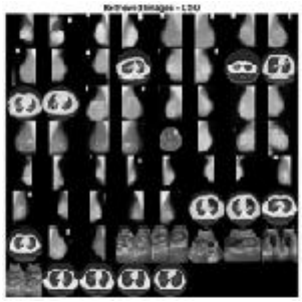
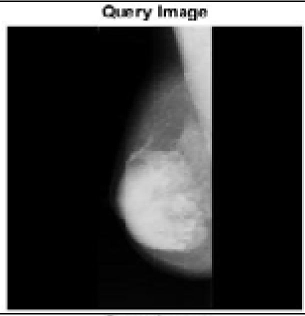
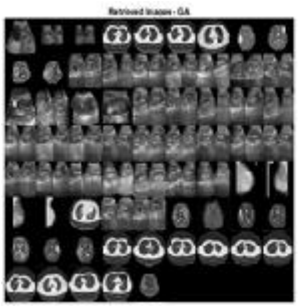
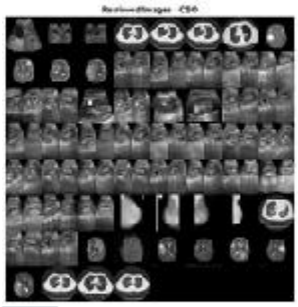


Figure.6 Performance graph for ultrasound image

This figure 6 exhibits average performance measures of a set of given query images from different optimization techniques. In the context of retrieving specific images for a given ultrasound query images the performance of proposed techniques achieve precision, recall and f-measure. Whereas in GA the precision is 54, GA the recall is 74 and GA the f-measure is 62 respectively, in CSO the precision is 61, CSO the recall is 74 and CSO the f-measure is 67 respectively. Table.1 shows the retrieved images for optimization techniques.

Table.1 Retrieved images with query images for optimization techniques

Medical Images	Retrieved Images (GA)	Retrieved Images (CSO)	Query Images
Brain			
Lung			

Mammogram			
Ultra sound			

V. CONCLUSION

This investigation concludes with evident results while implementing SVM associate optimization techniques to retrieve images for given query image. This work exhibits with the superior performances of proposed CSO in the context of retrieving images for given query image. The proposed technique reveals average for brain the precision recall and f-measure as 87%,the proposed technique reveals average for lung the precision recall and f-measure as 82%, the proposed technique reveals average for mammogram the precision recall and f-measure as 70% and the proposed technique reveals average for mammogram the precision recall and f-measure as 67% respectively. In future, the upcoming researcher can put forth their research platform by enhance the performance even more efficient.

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