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An Efficient Image Retrieval Scheme for Sketches using Fish Swarm Optimization with the Aid of Optimal Score Level Fusion

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Abstract

Objectives: Image retrieval is system software for browsing, examining and retrieving images from a large database of images. Images and sketches do not share numerous common modalities. Hence, Sketch to Image Retrieval is a tedious task in image processing. Sketch image retrieval focuses on the hand-drawn query and retrieves the similar images from a large database which is useful for further processing.**Methods/Statistical Analysis:**In the, most of the traditional/conventional image processing techniques considered edges and outlines for image retrieval. In this paper, a new methodology is developed by fusion of Edge Histogram Descriptors, Histogram of oriented gradients, Scale Invariant Feature Transform (SIFT) and Speeded up Robust Features (SURF). In the proposed model first feature Extraction is carried out and Euclidian distance is calculated amongst the query sketch and innovative image. Formerly the feature vectors are provided to the score level fusion stage, and then they obtained results are optimized. For optimization, Fish Swarm Optimization (FSO) is employed in the proposed method. **Findings:** The performance of the proposed method is evaluated through Benchmark sketch image database. Also, the attained results are compared with the existing evolutionary algorithm Genetic Algorithm (GA). **Application/ Improvement:** The experimental results showed that the projected method with FSO yields better results than GA.

Keywords: EHD, Fish Swarm Optimization, Genetic Algorithm, HOG, Score Level Fusion,SIFT, SURF

1. Introduction

At the time of the last few years, retrieval of images has become a very appropriate area in computer science owing primarily to the improvements in imaging technology that has eased capturing and storing images. A laidback manner to direct the consumer inquiry is utilizing a line-based hand-drawing, a sketch, foremost to the sketch-to image retrieval[1]. Sketch to image retrieval has turn into a progressively protuberant research topic in current years. Though, to date the chief emphasis has been on recovering images of the similar category, supervising imperative possessions of sketches they can detention fine-grained dissimilarities of objects namely, pose and iconic pattern[2]. The usual mechanism of text-based querying could be vague owing to extensive demographic variations, and it surfaces the problem of availability, legitimacy and vagueness in the tag and text data nearby an image[3]. The fast growth of multimedia implementations trailed by the advent of large-scale image assortments has brought about the need for effective approaches for storage, indexing, browsing, and retrieval of images[4]. Images and binary sketches do not share numerous common modalities. Images comprise rich data in domains namely color and texture, though sketches can be labeled only using their shape and spatial configuration. Consequently, customary CBIR means depending on texture and color cannot be inbred in SBIR[5]. CBIR goals at evading the usage of textual metaphors and in its place retrieve images on the basis of similarities in their innards (textures, colors, shapes etc.) to a user-supplied query image or user-specified image features[6,7].SBIR is a system majorly focusing on displaying

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patrons inquiry based on hand drawn sketches. SBIR is an efficient mechanism in expressing the patrons illustrated inquiry using via boundary. But in CBIR the retrieval of an image depends on the existing text and similarities in images. The SBIR scheme involves various kinds of fresh hand writing stylesand dissimilarsuppleness to the inquiry patrons[8,9]. A sketch is a quickly skilled freehand picture that aids numerous drives, it might trace approximately that the artist envisages, it might trace or upsurge a notion for later usage or it force also be utilized as a quick means of explicitly on behalf of a clue and an image[10]. In Human-Computer Interaction (HCI) schemes SBIR is extensively utilized because Outlining a sketch is a easy manner for user to display notions instinctively. In computer vision, sketch acknowledgment is a significant yet challenging issue. Meanwhile, a sketch is dissimilar from both binary shape and natural image, does not comprise textual data and has great variation in shape. Sketch recognition is valuable in actual numerous implementations[11]. Utilizing a sketch based scheme can be much Significant and effectual in numerous arenas of the life. In few cases, we can recollect our minds by figures or drawing. The SBIR schemes have a large implication in the criminal exploration. The empathy of unsubstantial images, tattoos and Graff it is can be reinforced by these schemes[12]. Inorder to sketch the key feature lines of shape or scene SBIR scheme is utilized because of its simplicity. Generally, the humans visual perception depends on object boundaries appeared in the image. In current scenario consumers are using various smart devices like touch screens or touch padto draw binary sketches effectively.SBIR is contrasting in finding defective set of alphabets, where as it is similar in recognition of hand written sketches[13]. The reimbursements of SBIR are becoming noticeable with the progress of touch-screen devices namely tablets&smart phones. SBIR presentation cannot meet the necessities of practical implementation, though that drives the essential for further development[14]. The improvement of Content based image retrieval is recovered by a sketch in usually utilized databases. The consumer draws the sketch region where he uses to characterize those sketches that are the support of the recovery procedure. Using a sketch based scheme can be very significant and well-organized in numerous parts of the time. In few situations, we can repeat our brainpower by figures or drawing[15].

Amethodical tactic that bonds the appearance gap for SBIR[16] have familiarized a robust line segment-based descriptor Home Location Register HLR to designate the sketches and abstracted boundaries by considering them as a set of line segments, laying the substance for improved sketch/extracted edge explanation and noise impact lessening. To decrease the influence of noisy boundaries which is a problem for SBIR they have proposed an algorithm for object boundary selection. A debauched technique was pragmatic to detect the result for the object boundary selection algorithm professionally. They have projected the spatial constraint and coherent restraint to decrease the fake matches as that fake match could damage retrieval presentation. The new solutions have revealed that their HLR descriptor outdoes them, combined with the object boundary assortment algorithm, their outline suggestively recovers SBIR performance.

Sketch-based image retrieval frequently requires enhancing the trade-off between efficacy and precision.To comprehend effectual retrievals Index features are characteristically implemented to large databases. Though, the efficiency can be exaggerated by errors, the abstruseness of consumer given instances may also damage the efficiency if associated with existing methods of image retrieval. Sketch to image retrieval schemes that saves the index structure are stimulating that utilizes initial result grouping, re-ranking through visual verification, and a significance feedback scheme to search for more comparable images[17]. The initial solution grouping aids our scheme detects more pertinent images for the relevance feedback. Their RVFV method filters out immaterial images to recover the relevance feedback and to detect more relevant images for the top-ranked images. The projected CBRF more deeply discovers pertinent images, to detect those that were not established in the original SBIR. These schemes work well if related to other approaches, and could detect numerous pertinent images if the initial solutions were adequate.

Sketch to image retrieval goals at recovering the most similar sketches from a large database on the basis ofa sketch query. The efficient search technique system uses sketch strokes as features and for effective retrieval they used codebooks[18]. From the sketch, stroke features were considered on stroke lines with critical corners as anchor points, from those local gradients were improved and defined using a quantized histogram of gradients. A codebook was prearranged in a hierarchical tree that continues structural data of visual words and permits effective retrieval in sub-linear time. Investigational solutions on three data information set established that the

anticipated algorithm achieves constructively against other traditional approaches for sketch retrieval.

From the past one decade numerous researchers focused on optimization. The Optimization is a field, which contains nature inspired algorithms called evolutionary algorithms. The usage of these evolutionary algorithms is increasing day by day in real life situations. A method for estimating the parameters of software reliability growth models were developed to estimate the parameters they used Logistic exponential testing effort function and then the results are optimized using Evolutionary algorithms namely, Artificial Bee Colony (ABC) optimization and Genetic Algorithm (GA)[19]. In their investigation, the attained results proved that the optimization yields result merely.

The complex features of sketch based image are Distortion, Fraudulent and pigmentation.These are very difficult to understand to retrieve the appropriate SBIR. Hence, there is an ever demanding challenge to propose and develop methodologies that can overcome these disadvantages. Hence, this paper aims to propose a method which helps to overcome some of the challenges as cited above. In the proposed methodology the features of the image extracted through HOG, EHD, SIFT, SURF are considered which restores the originality of the image and hence aims at better retrieval accuracy. The proposed method is tested by providing benchmark database which contains 31 different sketches, with 40 related images of each sketch. The attained results are compared with traditional score level fusion method and GA.

Remaining of the paper is organized as follows: section 2 elucidates the proposed methodology, Section 3 shows the results and the comparisons and section 4 closes with concluding remarks.

2. Proposed Method

Sketch-based image retrieval (SBIR) has developed a progressively protuberant investigation topic in current years. SBIR is a system majorly focusing on displaying patrons inquiry based on hand drawn sketches. SBIR is an efficient mechanism in expressing the patrons illustrated inquiry using via boundary. But in CBIR the retrieval of an image depends on the existing text and similaritiesin images. Images and sketches do not part numerous common modalities. Images comprise rich data such as color, texture etc., while sketches can be designated only using their shape and spatial conformation. The projected scheme gives an exclusive pattern for Content-based Image Retrieval by sketches.Sketch retrieval boxes at retrieving images from a great database on the basis of one hand drawn query. A user can drawa sketch easier and faster than color depiction of the scene.The architecture of the projected scheme is given in Figure1.

In our projected scheme an effectual image retrieval technique for sketches using fusion of scoresis achieved. The main intention of the projected technique has four chief stages such as (i) Preprocessing, (ii) Feature extraction, (iii) Score level fusion and (iii) Image retrieval. Primarily, input sketch based image is designated from the image database. In this scheme the search was performed by the free hand sketches as an input then the anticipated colored images were regained from the database as the output. At first, the input image is nourished to the preprocessing stage. Subsequent the features are abstracted by Edge Histogram Descriptor, Histogram of Gradients, SIFT and SURF features. After the feature extraction, we detect the Euclidian distance amongst the query sketch and original image. Then the feature vectors are provided to the score level fusion stage, for refining the function of retrieval procedure the score level fusion is joined with

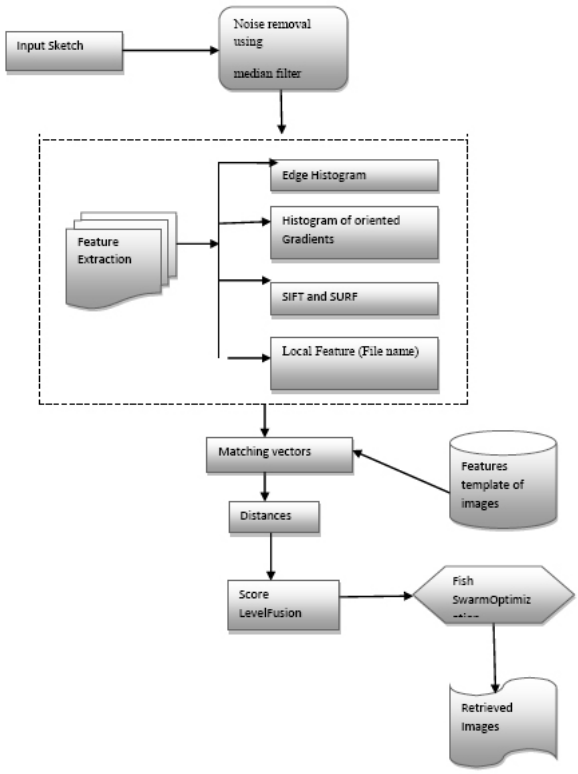

Figure 1. Block diagram for proposed sketch-based image retrieval technique.

the optimization method. At this time, we use Fish Swarm Optimization (FSO) algorithm for optimized retrieval. From that optimal score value, the projected technique retrieves the analogous images from the database. Sketch query is a key feature in image retrieval and produces the similar results as hand drawn sketches.

2.1 Noise Removal using Median Filter - Preprocessing

Noise suppression or noise removal is a significant mission in image processing. In our projected technique we use the median filter for the noise removal. The median filter is frequently implemented to gray value images because of its property of edge preserving smoothing. In the median filtering operation, the pixel values in the neighborhood window are graded rendering to intensity, and the median becomes the output value for the pixel under assessment. Thus subsequent stages were utilized to eradicate the noise from images,

In median filtering, the neighboring pixels are ordered conferring to brightness, and the median value develops the novel value of the central pixel. Median filters can do an outstanding job of rejecting assured kinds of noise, in specific, "shot" or impulse noise in that some separate pixels have new values. The overall expression for the median filter is provided as per the eqn1,

$$M_f(a_1, a_2 \ldots\ldots a_N) = MIN(\sum_{i=1}^{N} \|a_1 - a_i\|, \ldots\ldots \sum_{i=1}^{N} \|a_N - a_i\| \quad (1)$$

where,

M_f -Median Filtered output

$a_1, a_2 \ldots\ldots a_N$ - Number of pixels under evaluation

N - Number of pixels

With the help of Eqn 1, the median filtering is accomplished to eliminate the noise from the assimilated image. Once the noise removal is completed, the subsequent stage in our projected technique is the feature extraction procedure.

2.2 Feature Extraction

The feature extraction is accomplished once the image is made free from noise. The feature extraction is a significant stage in image processing. The features that are abstracted from the images are answerable for meticulous retrieval of the image from query image. The feature vectors are molded once the numerous features are extracted that is then utilized in further processing. In our projected scheme we extracted two kinds of a feature such as local feature and worldwide features. The local feature is the filename that is abstracted from each image in order to discriminate each image in the database. Subsequent is the worldwide feature. The numerous global features that we extract in our projected system are,

1. Edge Histogram descriptor,
2. Histogram of oriented gradients,
3. SIFT and SURF features.

2.2.1 Edge Histogram Descriptor

The Histogram signifies the most usually utilized worldwide descriptor in any image processing techniques. An edge histogram is a unique feature in an image that signifies the frequency and the directionality of brightness variation in an image[20]. The edge histogram descriptor comprises of some local edge histogram bins. To restrict edge distribution in the image, the image is at first alienated into 4x4 sub images. For each of the sub-image histogram is produced that characterize the edge distribution. There are amount of edge kinds and in order to define each type divide the sub-image into dissimilar image blocks.

Sketch hasfour directional edges than a non-directional edge. The four directional edges consistvertical, 45 degrees, horizontal, and 135-degree diagonal edges. These directional edges are abstracted from the image blocks. If the image block contains a random edge without any directionality, then it is referred as a non-directional edge. we divide an image space into non-overlapping square blocks to extract both directional non-directional edge features and then we can extract edge data from each block. Note that, irrespective of the image size, we split the sub-image into a fixed number of image blocks. i.e., the size of the image block is relative to the size of an original image to the pact with the images with dissimilar resolutions. The size when the image blocks unambiguous by the eqns (2) and (3) is mentioned,

$$A = \sqrt{\frac{x_w \times x_h}{N}} \quad (2)$$

$$B_S = \frac{|A|}{\sqrt{2}} \times 2 \quad (3)$$

where,

x_w - image width

x_h - image height

B_S - block size

A - area

The edge feature is then abstracted from the image blocks. For each edge type, the edge strength is considered using the edge filter values. The maximum edge strength among these edges is obtained and is associated with the threshold value as revealed in expression (4). when the maximum value is superior to the threshold, then the consistent image block is deliberated to have the consistent edge.

$$\max(V_{es}(m,n), H_{es}(m,n), D(45)_{es}(m,n), D(135)_{es}(m,n), Nd_{es}(m,n)) \geq T \quad (4)$$

2.2.2 Histogram of Oriented Gradients

For object recognition, and human detection missions the HOG descriptor is frequently implemented. HOG is a window based descriptor calculated locally to a noticed interest point[21]. The window is centered upon the point of interest and alienated into a steady square grid $n \times n$ within each cell of the grid a frequency histogram is calculated signifying the distribution of edge orientations inside the cell. The edge alignments are calculated and quantized into q bins. The histogram counts are concatenated to custom a $q-D$ vector for each cell that is again concatenated to form and qn^2 - D vector for the window. In numerous applications, numerous windows are experimented in a non-overlapping $w \times w$ grid local to the key-point in addition again computed to output the final descriptor. We calculate the hog descriptors for manifold scales and for secure window size and bin on the basis of values. The HOG descriptors are thus formed an effective feature is recuperating the images on the basis of any queries.

2.2.3 SIFT and SURF Feature

2.2.3.1 SIFT Feature

The Scale-Invariant Feature Transform (SIFT) is a prominent feature that is utilized in image retrieval procedure. The method is accomplished by perceiving the scale-space extrema in the image where we classify the locations and scales in the image[22]. The scale-space of an image $I(a,b)$ is signified by a function $S(a,b,\rho)$ which is given by,

$$S(a,b,\rho) = g(a,b,\rho) * I(a,b) \quad (5)$$

where,

$g(a,b,\rho)$ - Gaussian function that is given by

$$g(a,b,\rho) = \frac{1}{2\Pi\sigma^2} e^{\frac{-(a^2+b^2)}{2\sigma^2}} \quad (6)$$

The SIFT feature vector are thus premeditated by the above expression and these feature values are then utilized for further processing.

2.2.3.2 SURF Feature

The projected method of Sketch-based image retrieval utilizes Speed Up Robust Feature extraction technique (SURF) to extract the features of both sketches and images from the database. SURF extraction method is a scale and rotation invariant feature extraction technique that is faster than extensively utilized feature extracting technique scale invariant feature transform[22]. SURF emphases on the scale and in-plane rotation invariant detectors and descriptors of an image. Integral image is intended from the image and compute sum of pixel intensities in the integral image by the eqn below,

$$h_{\xi}(p,q) = \sum_{a=0}^{a \leq p} \sum_{b=0}^{b \leq q} h(a,b) \quad (7)$$

The Hessian matrix is utilized for decisive the intensity point in SURF feature extraction. The matrix is intended with the help of the expression below,

$$H_m(g,\phi) = \begin{bmatrix} I_{g,g}(g,\phi) & I_{g,h}(g,\phi) \\ I_{g,h}(g,\phi) & I_{h,h}(g,\phi) \end{bmatrix} \quad (8)$$

where,

$I_{g,g}(g,\phi)$ -Convolution of the Gaussian second order derivative.

The sites in the image where the determinant of Hessian matrix is maximum are perceived. Pixel intensities are high where the determinant of Hessian matrix is maximum, so an element of Hessian matrix gives the maximum intensity points in an image. The features of these supreme intensity opinions are abstracted to apply the projected Sketch-based image retrieval scheme.

2.3 Score Level Fusion

Fusion refers to combination of different features extracted from the sketches and images. It improves the retrieval efficiency by combining the feature sets of sketches and images[23]. For the database images all the features are extracted by Edge Histogram Descriptor, Histogram of concerned with gradients, SIFT and SURF features. Similarly, for the sketch query also all the four features were extracted and thenEuclidean distancebetween query features set and image feature set calculates the matching scores corresponding to each feature set. These matching

scores are then normalized by using min-max normalization scheme. By using sum of scores techniquethese matching scores are combined at matching score level fusion and fusion to a single score by the equ 9.

$$\mathbf{S}_{comb} = (\mathbf{S}_1+\mathbf{S}_2+\mathbf{S}_3+\mathbf{S}_4)\ /4 \tag{9}$$

where, S_1, S2, S3, S4 are matching scores of EHD, HOG, SIFT and SURF feature sets. To this obtained fusion score using the distance measures relevant sketches are retrieved.

2.3.1 Fish Swarm Optimization

The Euclidean distance for each query and the database images are designed and the solution is subjected to optimization that aids is real repossession of the image. The optimization used in our projected technique is fish swarm optimization.

In fish swarm optimization (FSO), the fish search the issue atmosphere in their visual on the basis of the behaviors, and then they move in the direction of the target using a random value of their stage. In FSO, the resolve ofinitial values of the stage and visual fundamentally influence the final solution[24]. In fact, the algorithm deeds better in worldwide searches, but after impending the worldwide optimum, it is incompetent of doing a suitable local search since the visual is superior to it must be. Consequently, by large value of the visual, positions with improved fitness are improbable to be found. We have measured the two key parameters in the FSO algorithm in our projected technique such as visual and step parameter. The moment weight is utilized in order to update the visual and the stage values that is provided in below expressions,

$$V_i = m_w \times V_{i-1} \tag{10}$$

$$S_i = m_w \times S_{i-1} \tag{11}$$

where,
V_i -Visual parameter value for i th iteration
S_i - Step parameter value for i th iteration
m_w -moment weight

The moment weight m_w is a positive performance that varies amongst high to low value. It is designed rendering to the current and final iteration. The moment weight m_w value is primarily set as a minimum value and then on the basis of the input it linearly surges by updating procedure and lastly it influences the termination condition that is the maximum value. The expression is provided as,

$$m_{\dot{w}} = m_{w_{\min}} + \frac{i_{\max} - i}{i_{\max}} \times (m_{w_{\max}} - m_{w_{\min}}) \tag{12}$$

On the basis of the above expression the moment weight is considered and for each iteration, the above process is repeated in order to select the best value that resembles the exact retrieval of the images. The flowchart of fish swarm optimization is given in Figure 2.

3. Results and Discussion

The projected procedure is applied in the working platform of MATLAB (2015a). The sketch-based image retrieval is performed on the Benchmark sketch database[25]. The images are endangered to numerous methods such as preprocessing, feature extraction and score level fusion in order to recover the exact images. The sketch image is provided as input, and then the relevant images are recovered. The solutions that we attain using the projected scheme is illustrated in the Figure 3 and Figure 4.

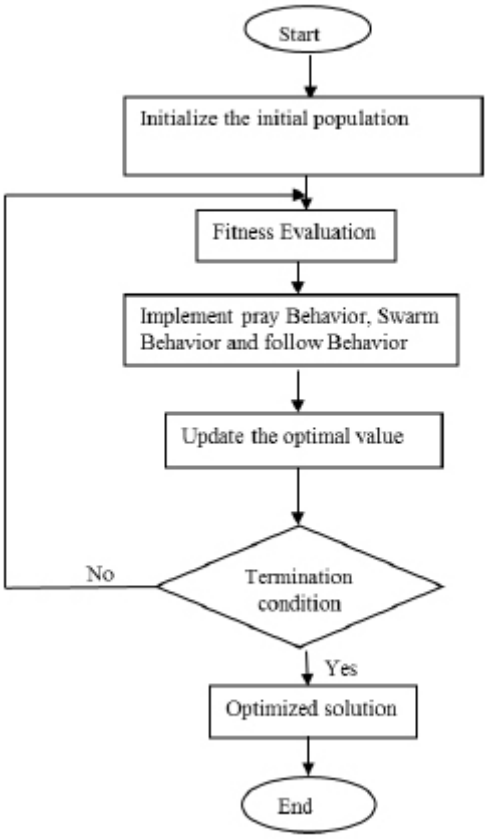

Figure 2. Flowchart of fish swarm optimization.

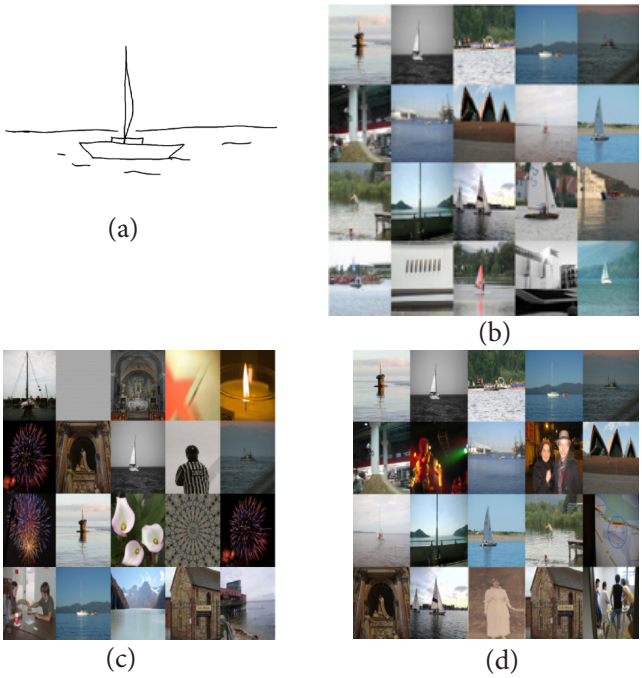

Figure 3. (a) Input image 1 (b) Retrieved images using FSO-score level fusion (c) Retrieved output using GA (d) Retrieved output using score level fusion.

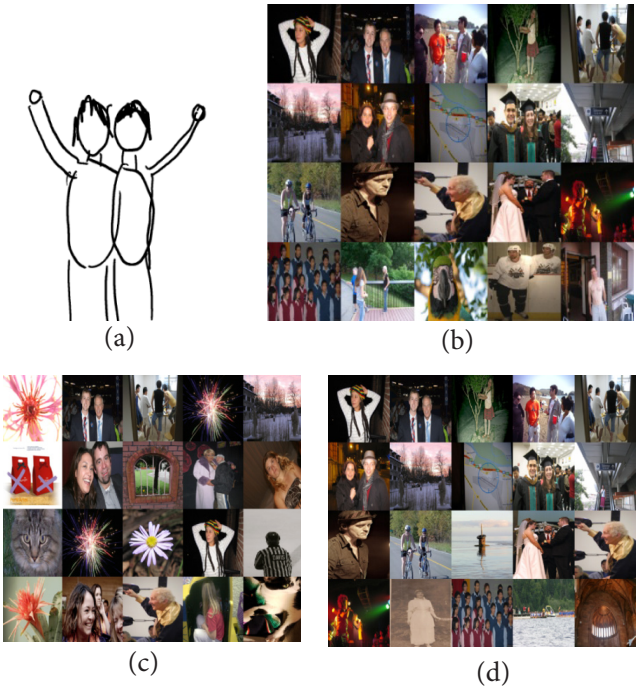

Figure 4. Input image 2(a) Retrieved images using FSO-score level fusion (b) Retrieved output using GA (c) Retrieved output using score level fusion.

Figure 3 illustrates the processed image by our projected scheme. The Figure 3(a)is the input sketch image on the basis of that the retrieval has to be performed. Figure 3(b) displays the retrieved output attained by our projected scheme of FSO based Score level fusion technique. Figure 3(c) shows the retrieved output by GA and Figure 3(d) displays the retrieved outputs obtained by available score level fusion technique. It is evident from the output that our projected scheme has retrieved more precise images if related to available systems. Likewise, for numerous input images, the related process is done to detect the efficiency of the projected scheme and is displayed in Figure 4.

3.1 Performance Evaluation

The performance evaluation of the new methodology is performed by measuring its precision, Recall, F- measure and accuracy. The precision and recall can be attained with the help of the expressions below[26],

$$precision = \frac{Number\ of\ retrieved\ images\ relevant\ to\ the\ query\ image}{Total\ number\ of\ \ images\ retrieved} \quad (13)$$

$$recall = \frac{Number\ of\ retrieved\ images\ relevant\ to\ the\ query\ image}{Total\ number\ of\ relevant\ images\ in\ the\ database} \quad (14)$$

The pragmatic outcome is revealed in the Table1 provided.

Figure 5 appearances the graphical illustration for Accuracy obtained with the help of the projected and prevailing technique. From the graph, it is concluded that our projected scheme has distributed better accuracy value if related to the prevailing scheme.

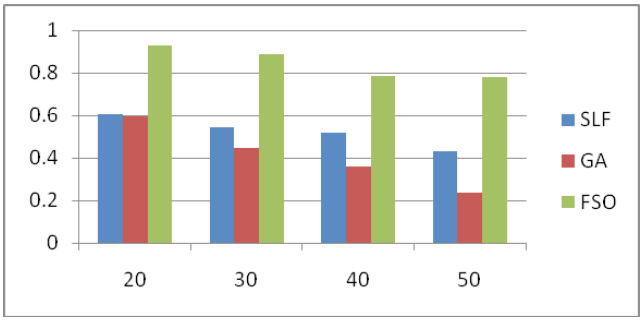

Figure 5. Graphical illustration of accuracy with SLF, GA, and FSO.

Table 1. Comparison of performance metrics of our method (FSO) with GA and SLF

Retrieval Count	Score level fusion				GA				FSO(Proposed method)			
	Precision	Recall	F measure	Accuracy	Precision	Recall	F measure	Accuracy	Precision	Recall	F measure	Accuracy
20	0.9402	0.65	0.6873	0.607	0.6271	0.3298	0.438	0.596	0.9548	0.8910	0.9215	0.9290
30	0.8646	0.4215	0.5765	0.5425	0.5665	0.2781	0.418	0.4438	0.8892	0.8123	0.9303	0.8892
40	0.7969	0.3790	0.5379	0.5091	0.5199	0.2424	0.402	0.3569	0.7822	0.7822	0.8700	0.7822
50	0.7503	0.3790	0.5178	0.4587	0.4315	0.2587	0.3899	0.2361	0.7938	0.7823	0.8439	0.7794

4. Conclusion

In this paper, an efficient retrieval method to recover sketch based images with the help of soft computing method is projected. Primarily, numerous features such as worldwide and local features are abstracted from the image. Subsequently, the images that are applicable to the provided query image are recovered from the database on the basis of these feature values with the help of FSO based Score level fusion. The sketch input image is implemented and on the basis of the feature, values engendered the relevant images are retrieved on the basis of the anticipated method. The solution we acquire displays that the anticipated scheme of FSO – Score level fusion method has distributed better solutions in the name of numerous assessment metrics if associated with the available technique.

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