# An Efficient Sketch Based Image Retrieval with Particle Swarm Optimization

**Y.Jhansi**
Research Scholar,
ANU College of Engineering,
**Acharaya Nagarjuna University**, India
janu.yellapu@gmail.com

**Dr.E.Sreenivasa Reddy**
Professor &Principal ,
ANU College of Engineering,
**Acharaya Nagarjuna University**
esreddy67@gmail.com

**Abstract:**
Image retrieval is a system for browsing, searching the query image and retrieving similar images from large databases. A wide range of features can be used for image retrieval. In the last decades has observed the research interest in the field of Sketch based image retrieval (SBIR).It examines the visual content and detects image in the database according to query sketch. In this work, extensive robust features were extracted from the images database and then stored in the feature repository. This feature set is composed of Histogram of oriented gradients (HOG) and Edge Histogram Descriptor (EHD). Where, features are extracted from the given Query sketch in the similar fashion. Consequently, a novel similarity evaluation using a meta-heuristic algorithm called particle swarm optimization is achieved between the features of the Query sketch and the features of the database images. Our proposed SBIR system is assessed by searching number of images (from the test dataset) and the efficiency of the system is evaluated by calculating precision-recall value for the results. The results were superior to other models like Genetic Algorithm (GA) and Fish swarm Optimization (FSO) in SBIR systems in regard to precision.

***Keywords:*** *SBIR*, *HOG*, *EHD*, *PSO*, *GA*, *FSO*

## 1. INTRODUCTION

Information retrieval is attractive with the massive needs of multimedia data processing to evaluate the real-time data. Thus image retrieval is progressively becoming familiar and recognized. It is essential to implement and develop the tools of image retrieval in order to search or browse images on the internet easily and efficiently. The conventional and general image retrieval which is based on keyword search has many drawbacks, such as the high demand of manual work and the dependency on the personal perception which results in incorrect results. To handle the above drawbacks CBIR was applied. This approach involves a set of methods and algorithms that concentrates on low level image features, for example texture measurements, shape and color signature to retrieve images from database of images depending on the query image (QI) given by the user[1].

Even though, Content Based Image Retrieval (CBIR) is implemented for the concept of retrieval using visual similarity i.e by means of Query by Image, it is implemented using the mechanism of indexing using the Lucene Indexed Retreival Engine( LIRE ) approach, but this method of CBIR is not working for the sketch images, For the retrieval process, as per its approach it is retrieving the similar results only by means of visual similar features It could not present the expected relevant images for query sketch. As a study of CBIR includes, the approach of Query by Text, Query by Image and Query by hand drawn sketches, the concept of Query by Sketch can be used for the retrieval of crime investigations, social security, medical investigations, face identification.

In this paper sketch based image retrieval with Particle Swarm Optimization (PSO) is used since a wide variety of SBIR algorithms has been proposed but most of them concentrate only on finding the similarities between the query image and the database image. So to achieve the better approximation to the information needed for the user, PSO is applied in similarity evaluation which gives images in the database that are most interest to the user.

The content of this paper is organized as follows. In section 2 literature reviews about previous work in SBIR are discussed. In Section 3, an operation performed to extract from the image using proposed methodology. The experimental results and comparison between existing works are illustrated in section 4. The conclusion is shown in section 5.

## 2. RELATED WORK

QBIC **[2]** is one such method with functionality for sketched based retrieval. Sketched based image retrieval offers a number of advantages for searching large image databases. Most of the systems require the user to search by an example image; this image needs to have visual similarity to the image which the user wishes to locate. Finding such a visually similar image can often become time consuming and in the inferior case decrease the task of finding the desired image down to the difficult task of

browsing the database **[3]**. Furthermore should database access be across the internet then slow or busy networks could make the task of browsing the database very time consuming. In this case a sketched based system would allow the user to simply input a sketch representing the image or images which they wish to retrieve,

Query by visual example [4] is one of the earliest approaches that address SBIR .IBM Corporation adapts a modified version of approach in its QBIC system. It defines a pictorial index for each image, including query and database images. The QVE method performs image retrieval method by computing the correlation between the corresponding indexes extracted from the original image and sketched Query.

A wide variety of methods have been recommended in order to make this form of retrieval possible. These methods require the extraction of visual information from the database images and the sketched image for similarity. Within an image the human visual system is capable of perceiving a huge quantity of data and it is this data that needs to be classify and represented in a compact manor. The data stored within an image can be separated into color, texture and shape information **[5]**, all of which have numerous possible representations, all of which can be used for the similarity of sketched images to images within a database.

To easily construct the index structure, a binary similarity map (a hit map)is used as an alternative of the distance map [6]. For each input sketch, N hit maps are created, which correspond to the N orientations. They also designed a simple hit function. Specifically, if a point falls in the valid region on a hit map in the same channel, it is considered as one hit. The sum of all the hits is the similarity between the image D (represented by its contours) and the query sketch Q. Then, they build an edgel index structure for fast retrieval.

A interactive genetic algorithm for calculating a high number of selective features then comparing of related images for these features are proposed for image retrieval[7]. The approach was tested on a group of 10,000 general images to prove the efficiency of the proposed approach.

An approach for image retrieval with Heuristic particle swarm optimization [8], PSO is used to RGB color space and mean and a standard deviation is used to extract the color feature of the image and to calculate the region of the image a region-based method is used to extract the region of the image. An efficient retrieval method to recover sketch based images with the help of soft computing method is projected in [9]. 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 Fish Swarm Optimization based Score level fusion.

## 3.PROPOSED METHODOLOGY

From the query sketch the features HOG and EHD are extracted. These two features are combined to a single score using score level fusion [12]. In the offline process, features like HOG and EHD are extracted and stored in a feature vector for images in the database. A heuristic approach along with PSO is used to compute the similarity between the Query sketch and images from the database and the resultant images are retrieved. The architecture of the proposed system is depicted in fig.1.

### 3.1 Histogram of Oriented Gradients

The HOG descriptor is commonly applied in object recognition, and human detection tasks [10]. The HOG descriptor technique counts occurrences of gradient orientation in localized portions of an image - detection window. After preprocessing, HOG features are extracted and these features are used for similarity measure.

Algorithm implementation of HOG descriptor:

1. Divide the image into small connected regions called cells, and for each cell compute a histogram of gradient directions or edge orientations for the pixels within the cell.
2. Separate each cell into angular bins according to the gradient orientation.
3. Each cell's pixel contributes weighted gradient to its corresponding angular bin.
4. Group of adjacent cells are considered as spatial regions called blocks. The grouping of cells into a block is the basis for grouping and normalization of histograms.
5. Normalized group of histograms represents the block histogram. The set of these block histograms represents the descriptor.

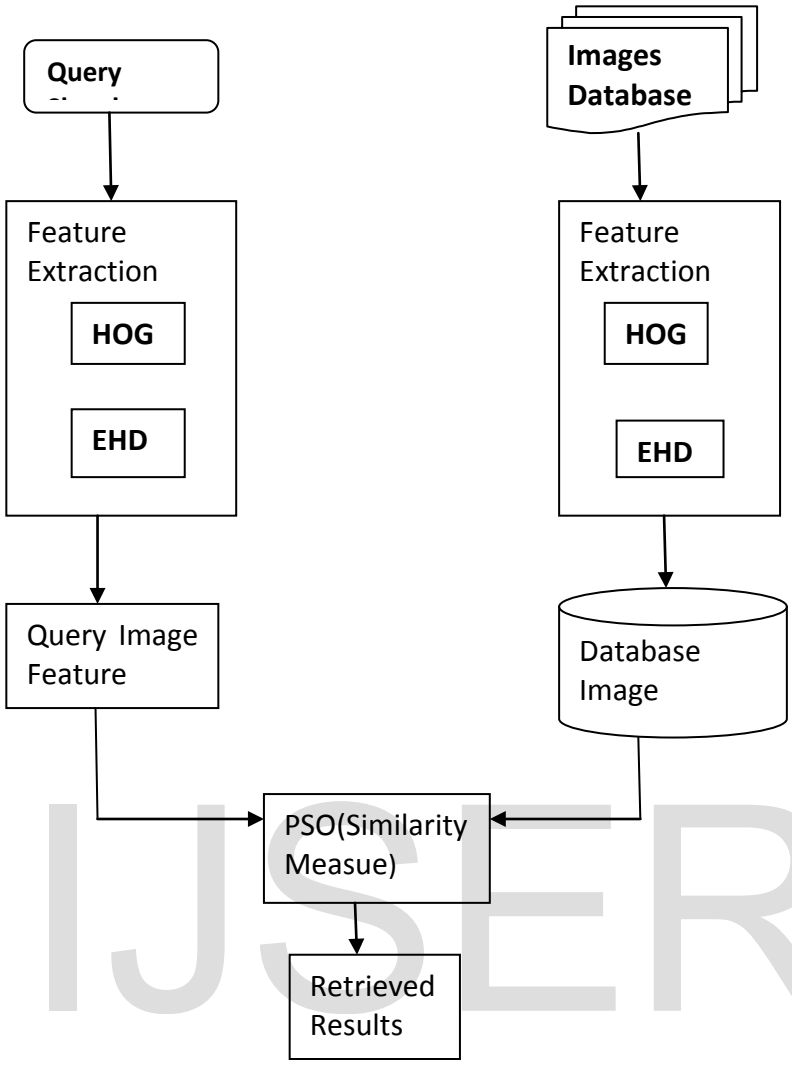





**Fig.1 Architecture of proposed System**

### 3.2 Edge Histogram Descriptor

The Histogram represents the most commonly used global descriptor in any image processing techniques [11]. An edge histogram represents the frequency and the directionality of brightness variation in an image which is a unique feature in an image. The edge histogram descriptor consists of number of local edge histogram bins. To localize edge distribution in image, the image is first divided into 4x4 sub images. For each of the sub image histogram is generated which represent the edge distribution. There are number of edge types and inorder to define each type we divide the sub image into different image blocks. They are four directional edges and a non directional edge. Four directional edges include vertical, horizontal, 45 degree, and 135 degree diagonal edges. These directional edges are extracted from the image-blocks. If the image-block contains an arbitrary edge without any directionality, then it is classified as a non-directional edge. The steps are used in EHD to calculate histogram is given below:

*1)* First, the RGB image converting into the gray image.
*2)* Now the gray scale image is divided into 4x4 sub-image.
*3)* Now each sub-image is divided into nonoverlapping small blocks.
*4)* For each image blocks edge is defined by five types which are- vertical, horizontal, $45^0$- diagonal, $135^0$- diagonal and nondirectional edges.
*5)* Calculate the Local as well as the global histogram for all sub-images with relative frequency occurrence of five types of edges in each sub-image.
*6)* After calculating histogram for each sub image bin values are normalized for a total number of blocks in a sub-image. And then these normalized bins are quantized.

### 3.3 Particle Swarm Optimization

Particle Swarm Optimization is initially recognized in 1995 by Kennedy, Eberhart [13]. It is also identified as global best search optimization. It is dependent on the bird flocking problem that signify the group of particles travels around the best solution for the problem space that is explored by the negotiator. If X be the decision vector in a cost function f (X) then it must be minimize in the optimization problem. In the PSO algorithm, all particles have random coordinates in n dimensional space. For each particle, pbest and gbest are the best coordinates each particle and the best coordinates among overall particles, respectively that the particles move based on pbest and gbest. To develop particle swarm optimization, where the position of negotiator is x, y and velocity are $v_x$ (for x-axis), $v_y$ (for y-axis).

The algorithm steps are given as follows:

**Step 1- Initialization**

Choose some random values from the feature vector of image dataset and assign these value to initial particle position as X[ ][ ].

**Step 2- Determines the local best position**

Initially, assign the initial particle position as local best position P[ ][ ] = X[ ][ ] and initial velocity of each particle as V[ ][ ] = 0.

Then calculate the difference between X[ ][ ] and P[ ][ ].

**Step 3- Determines the global best position**

Assign the fitness function and choose the minimum value from the group of particles, assign it as a global best value.

**Step 4- Update the position and velocity**

Choose two random number according to some criteria and assign new particle position NX[ ][ ] and new velocity NV[ ][ ].

Replace initial position to new position and initial velocity to new velocity as X[ ][ ] = NX[ ][ ] and V[ ][ ] = NV[ ][ ].

**Step 5 Termination**

Optimization process stops while the process reaches to the highest number of iterations or if global best value remains same till 25 iterations.

### 3.4 Proposed Algorithm

**Input:** Sketch image for query and digital image dataset.

**Output:** Retrieved n number of digital images that is similar to the query sketch.

Step 1- Select the digital image from a database.

Step 2- Pre-process the image by resizing all images into 256*256.

Step 3- Apply HOG on images in database to extract the gradient information of the image.

Step 4- Apply Edge Histogram Descriptor and Calculate local as well as a global histogram of edges.

Step 5- Combine all features in a single multidimensional feature vector and store it in the database.

Step 6- Repeat all the step from 1 to 5 for all the images of the dataset and combine all the feature vectors and store in the database.

Step 7- Input an MxN dimensional sketch as a query image.

Step 8- Apply all the steps from 2 to 5.

Step 9- apply particle swarm optimization to get an optimal solution.

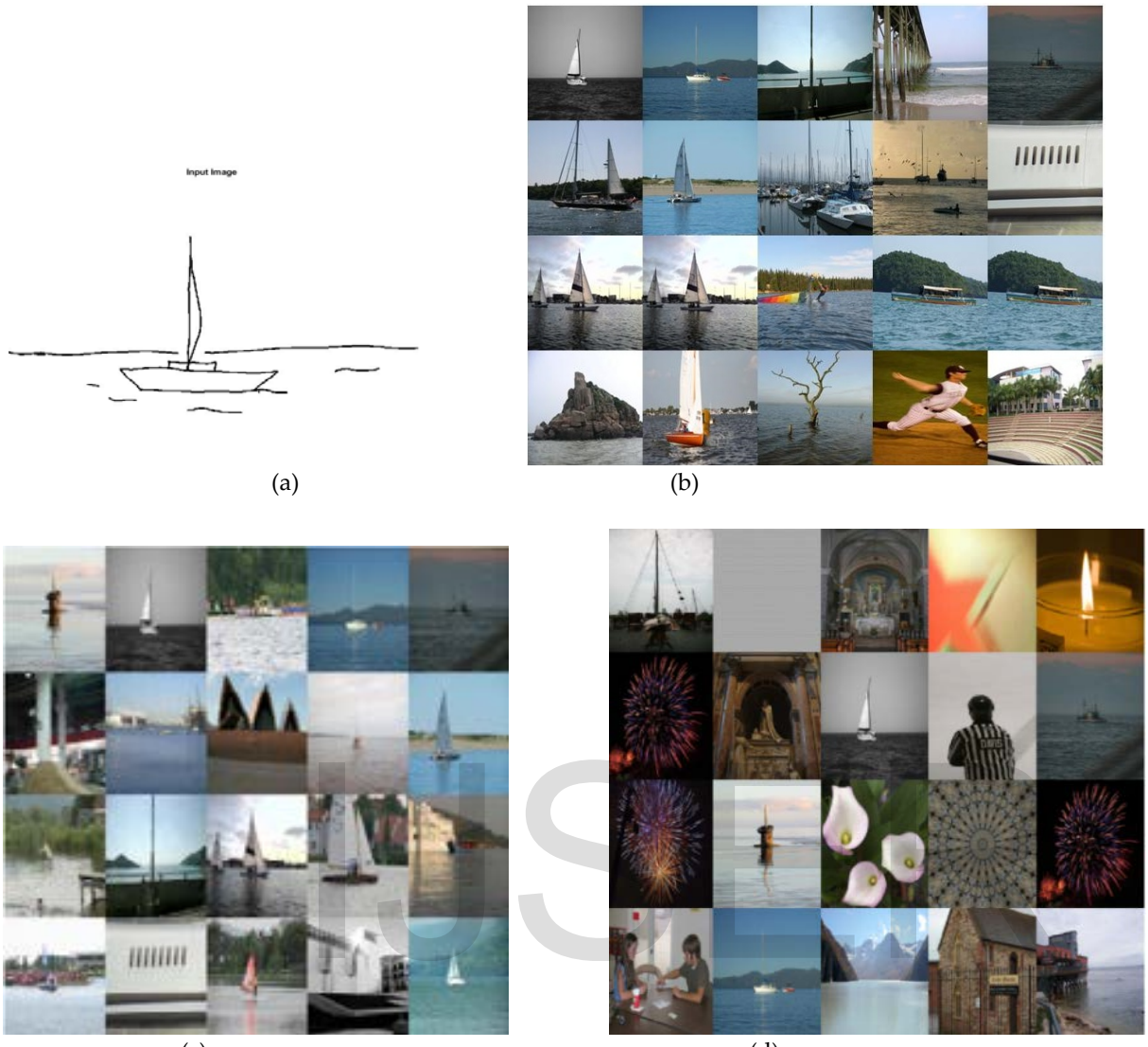
Step 10- Retrieved top n images for a given sketch and calculate precision and recall of retrieved images.

## 4. Experimental Results

The proposed PSO is tested with Eitz *et al.* dataset [14] mainly designed to measure retrieval performance in a large database. The database consists of 31 user drawn sketch queries outlining objects and each sketch query is associated with 40 photos. To measure retrieval effectiveness for an image retrieval system, precision and recall values are calculated. The proposed method is compared with GA and FSO image retrieval methods [9] as shown in table1.

$$precision = \frac{Number\ of\ \text{retrieved images relevant to the query image}}{Total\ number\ of\ \ images\ \text{retrieved}} \quad (1)$$

$$recall = \frac{Number\ of\ \ retrieved\ images\ relevant\ to\ the\ query\ image}{Total\ number\ of\ \ relevant\ images\ in\ the\ database} \quad (2)$$




(a) (b)

(c) (d)

**Figure 2.** (a) Input image (b) Retrieved images using PSO (c) Retrieved output using FSO (d) Retrieved output using GA.

Table 1: Comparison results of performance metrics with GA, FSO, PSO

| | GA | | FSO | | PSO | |
|---|---|---|---|---|---|---|
| **Retrieval Count** | **Precision** | **Recall** | **Precision** | **Recall** | **Precision** | **Recall** |
| 20 | 0.6271 | 0.3298 | 0.9548 | 0.8910 | 0.96 | 0.7910 |
| 30 | 0.5665 | 0.2781 | 0.8892 | 0.8123 | 0.8523 | 0.5423 |
| 40 | 0.5199 | 0.2424 | 0.7822 | 0.7822 | 0.7982 | 0.6522 |
| 50 | 0.4315 | 0.2587 | 0.7938 | 0.7823 | 0.7958 | 0.6625 |

Figure 3 appearances the graphical illustration for precision obtained with the help of the projected and prevailing technique. From the graph, it is concluded that our projected scheme has distributed better precision value if related to the prevailing scheme.

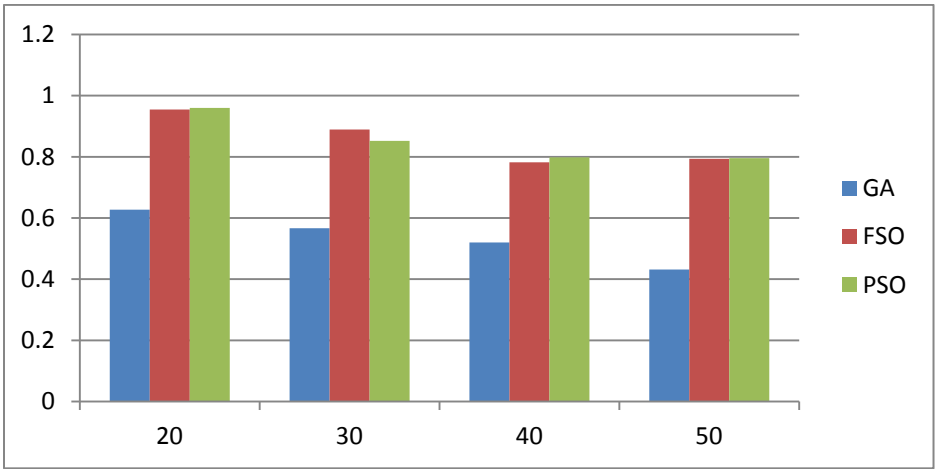



Fig 3**:** Graphical illustration of precision with PSO,GA and FSO

## 5. Conclusion

This study recommended the effective SBIR system employing PSO for the retrieval of images from databases based on a query sketch. EHD and HOG are used to extract edge and gradient information of images respectively. PSO is used to optimize these feature vectors with optimal weights and measure the similarity between images. Experiment result gives better results in comparison to other optimization algorithms like GA and FSO.

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