

## A simplified and novel technique to retrieve color images from hand-drawn sketch by human

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### ABSTRACT

With the increasing adoption of human-computer interaction, there is a growing trend of extracting the image through hand-drawn sketches by humans to find out correlated objects from the storage unit. A review of the existing system shows the dominant use of sophisticated and complex mechanisms where the focus is more on accuracy and less on system efficiency. Hence, this proposed system introduces a simplified extraction of the related image using an attribution clustering process and a cost-effective training scheme. The proposed method uses K-means clustering and bag-of-attributes to extract essential information from the sketch. The proposed system also introduces a unique indexing scheme that makes the retrieval process faster and results in retrieving the highest-ranked images. Implemented in MATLAB, the study outcome shows the proposed system offers better accuracy and processing time than the existing feature extraction technique.

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## 1. INTRODUCTION

The adoption of the sketching technique that is drawn by hand is mainly meant for extracting certain significant information from the image in the form of particular features. In such case, extracting a unique feature is the sole criteria for the successful recognition process when any queried image of sketch is being given with respect to accuracy and processing time [1]. At present, there are many forms of studies being carried out feature extraction where the prominent one of by integrating spatial correlation information with the color distribution of an image in highly structured mode [1]. Existing methods have been reported to testify this fact using TRECVID 2005 dataset that consists of different forms of multimedia clips sourced from multiple language-based programs. Such techniques are reported to offer better information in the form of auto-correlogram with respect to edge information and individual color information. Apart from conventional file format of multimedia, there is also an increasing popularity of advance multi-dimensional framework that are found to be used in wider scope of application e.g. show business, designing mechanical products, augmented virtual reality, and computer-aided medical procedures. Some of the reported studies have adopted standard dataset of Purdue benchmarking dataset as well as Princeton dataset which basically deals with shape-based information associated with multi-dimensional models [2]. They also offer better form of geometric pattern-based information which could be mechanized in multiple modelling perspective. The popular search engine are also reported to use two dimensional sketch-based image retrieval mechanism

where extended dimensionality of an image could be retrieved using a user-friendly interface [2]. The voxel model can be developed by a user using freehand drawing in the form of query image while it can be assessed with respect to multiple number of image database that consist of benchmarked multi-dimensional images at same time. Irrespective of such beneficial functionalities, the prime issues in existing studies are associated with selection mechanism within the domain of multiple dimensionalities. The problems also reside in bridging the research gap as well as taking care of all the prominent indicators to normalize the smoothening curves of sketch. Further, feedback of user is also deployed to ascertain the conclusive remark of query outcome [3]. Hence, existing system offers various commercial available tools to do this task but at the cost of inferior accuracy and hence user quality of experience is affected [4]. There is certain standard existing technique that make use of invariant features, histogram-based features, and edge-based features which is claimed to offer high end performance towards analyzing any image and extract potential information that contributes towards accuracy. Assessment of such schemes are witnessed to be used for image forensics as well as varied investigation for various photo sharing applications [5]. At present, there is also an increasing trend of evolution of dataset in order to facilitate various forms of research work but they are still connected with various pitfalls and drawback which are mainly connected with non-inclusion of artifacts in the computational model. Therefore, there is a critical trade-off in the demand and the applicability of the existing solution [6]–[10]. Researchers are consistently attempting to evolve up with a concrete solution associated with retrieval process of sketch, however, there is no reported work yet to confirm full fledged solution towards existing problems in this regard. Hence, this problem is addressed in proposed system where a novel computational framework is developed in order to carry out extraction of information associated with sketch. The remaining sections of this paper are organized as follows: section 2 presents system design, and procedure, while section 3 discusses implementation method, section 4 discusses result analysis and section 5 discusses conclusion.

A learning-based model is used by Zhang *et al.* [11] to perform the identification of sketches using a sophisticated method. Bhattacharjee *et al.* [12] have used an adaptive technique using sub-graph formulation to increase the flow. The representation learning method towards addressing the convergence issue for image retrieval is carried out by Xu *et al.* [13]. Existing techniques have also witnessed Weng and Zhu's hashing method [14] using supervised learning schemes and semantics. Adopting the deep neural network is seen in Dai *et al.* [15], while Setumin and Suandi [16] also carry out a nearly similar approach. The histogram is used for gradient mechanism implementation of a matching set of images. Adopting a learning framework is seen in Zhou *et al.* [17] for image retrieval. The work of Wang *et al.* [18] uses a histogram-based descriptor for feature extraction. Adopting the deep neural network towards optimizing the retrieval process is seen in Huo *et al.* [19], where semantics has also been used to better its performance. The re-ranking and relevance feedback process is seen in Qian *et al.* [20], where semantics have been used for processing queries. Choi *et al.* [21] carried out a predictive operation for the sketch retrieval process using shadow strokes over the canvas. Zhang *et al.* [22] have used a supervised approach for assessing the similarity between sketch and image. Adopting reinforcement learning and salient contours are also reported in this study towards the development of unique descriptors. A user-defined mechanism to the retrieved embodiment is witnessed in model presented by Wang *et al.* [23], where gradient-domain is used for preventing visible seam and extracting foreground objects only. The trade-off between sketch and image is reported to be bridged in the work of Li *et al.* [24], where subspaces are used to align this gap. Song *et al.* [25] have presented a training-based method towards similar domain of sketch-based retrieval using natural images as the case study. Another unique method is presented by Polsley *et al.* [26] has discussed about similar concept where the accuracy is found to be better over higher number of images. Further, the framework implemented by Li *et al.* [27] have reported the adoption of feature extraction using semantics in order to identify ambiguity over facial sketches. The work carried out by Setumin, and Saundi [28] has used a learning-based technique using a neural network where the order to strokes are translated using semantics. Pavithra and Kumar [29] developed a model for presenting the index of objects for providing input query sketches. Apart from the above mentioned studies, the contributory work description presented by Hai *et al.* [30]–[35] has highlighted about the significance of method of data transmission over optical network which offers an insight of mechanism that can be used for retrieving images from the network repository.

Therefore, it can be seen that there are various degrees of approach being carried out in the existing system where machine learning of different variants is found to be highly dominant in performing retrieval of sketch images. Various learning techniques have also been experimented with, aiming to achieve accuracy and less emphasis on the sophistication or complexities of internal operation related to training. The following section outlines various research challenges which are extracted from above mentioned existing approaches. The potential issues associated with existing and approaches are as: i) all the analyses in existing approaches are carried out considering standard datasets and not from other sources, which minimizes the applicability scope; ii) the complete focus on implementing existing approaches is mainly towards accuracy and not towards computational complexity associated with sophisticated learning models; iii) the dataset is

directly used, and it does not undergo any form of internal processing, which could be needed to achieve better accuracy performance; and iv) a higher proportion of work uses the conventional descriptor-based approach, which is high cases specific and does not apply if the images change.

Based on the above points, the statement definitive to problem is "developing a cost-effective image retrieval system from sketch-based images using a lightweight training approach to achieve a scalable outcome is quite a challenging processing". The following section outlines the proposed solution used for addressing this problem. The proposed system's prime aim is to design and develop a computationally cost-effective approach that can extract related ranked images from the hand-drawn sketch. The implementation of this mechanism is carried out using an analytical scheme where the idea is to achieve a higher form of accuracy in the least duration of processing time. Figure 1 highlights the proposed architecture adopted towards implementation.

The novelty of the proposed theory is the proposed system follows a top-down architectural form where upper layers of the operations block are implemented first, followed by its lower layers. A practical correlation analysis is carried out for the test (queried) images matched with the images within the trained database. The proposed system offers a higher degree of compactness towards storage optimization. IT also provides a significant reduction in processing time. One of the considerable novelties of the proposed method is that it retains a single-entry record associated with all attributes. If this technique is used, it can facilitate the large-scale retrieval of images over a single machine itself, and hence the degree of scalability factor increases. The crawling mechanism is used in the proposed system to facilitate an initial level of processing directly from the storage unit. It is not required to access the images within the local machine. This is done to map the proposed system with existing cloud-based applications. After formulation of the training data, the clustering of the attributes is carried out, and further extraction of the queried image is carried out, followed by sampling operation and quantization mechanism. In the last stage, the model assesses the accuracy of the retrieved outcome by evaluating the degree of correlation between queried sketch and matched image obtained from the trained dataset. Hence, the proposed system targets to offer higher accuracy using this simplified technique. The following section discusses system design.

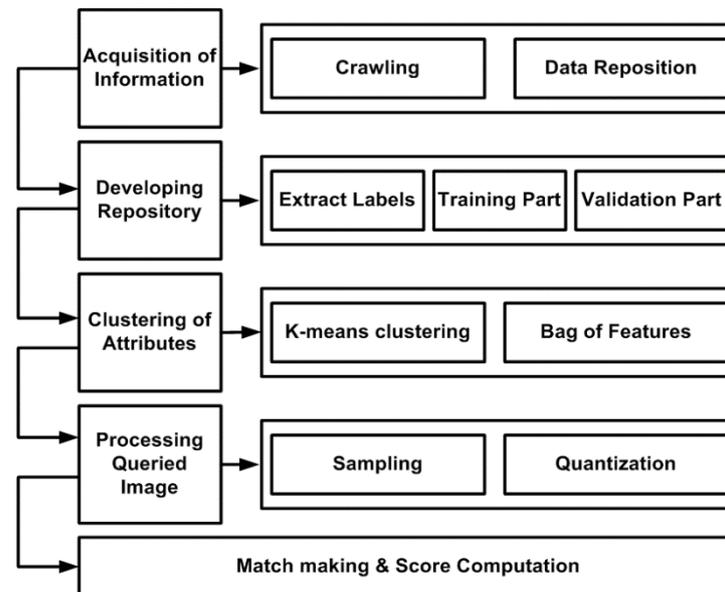


Figure 1. Proposed architecture

## 2. PROPOSED PROCEDURE

This section discusses the design being implemented for the proposed system. The complete design of the proposed method is classified into five essential blocks of operation viz. i) acquisition of information, ii) developing repository, iii) clustering of attributes, iv) correlation assessment, and v) processing queried image. The design and implementation of proposed concept is carried out by emphasizing towards the data preparation using a crawling mechanism. Further, the scheme assists in developing a novel reposition system in highly structured manner for which also facilitates towards effective analysis of attributes. Finally, clustering operation is carried out for all the attributes followed by sampling and processing the input file.

### 2.1. Acquisition of information

Information plays a significant role in the proposed system, which emphasized much of the model's design. The proposed method performs provisioning of the targeted resource for acquiring the live data. The mechanism of acquisition of the information presented is exhibited in Figure 2. It is known that there is an increasing interest in transmission and sharing of an image file which renders the design of the repository of the image is quite a large-scale implementation. However, it is quite a challenging aspect owing to the memory of random access being highly limited. The proposed system considers the image as an input, and while it is subjected to the data repository, it is transformed as an object. The proposed system accesses the image in the runtime that is a highly essential attribute to be functional over the database of a large scale. The study considers a variable  $N$  as the number of image files present in the dataset.

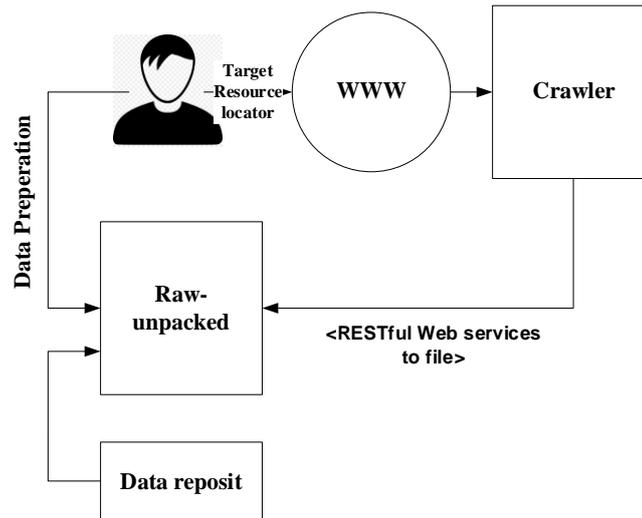


Figure 2. Acquisition of information

### 2.2. Developing repository

To develop an effective training database, it is necessary to ensure the inclusion of a higher scope of an attribute to signify essential information of the object within an image. The proposed system carries out the complete database division arbitrarily considering labels to construct an effective database. The full dataset is classified into a training dataset and a test dataset. The proposed system also uses standard local attribute identification and descriptor, i.e., speeded up robust features (SURF) attributes consisting of all the objects of attributes that are constructed using parallel processing to address all forms of challenges reduce the duration of extraction of potential features.

### 2.3. Clustering of attributes

The proposed system constructs an attribute object ( $A_o$ ) considering multiple sets of the group set where  $A_o = \{\text{group-1, group-2, } \dots, \text{group-}n\}$  followed by the acquisition of an attributes consisting of the large scale of an attribute ( $M$ ) obtained from specific  $h\%$  of images by retaining maximum (80%) of the significant characteristics from each group. The proposed algorithm also targets grouping accuracy where the quantity of attributes is rendered equilibrium with all  $A_o$ . The specific  $i^{\text{th}}$  group that belongs to  $A_o$  has the minimal number of potential features ( $P_a$ ) considered the reference quantity of attributes for the remaining group. The proposed clustering system is developed to construct a dictionary with a massive amount of visual-based details ( $V_a$ ). In this mechanism, a specific set of observational point is noted from the sketch ( $o_1, o_2, \dots, o_n$ ) considering number of real dimensional vector. The prime idea is to partition all the  $n$  number of observation points in a sketch body into specific  $l$  number of observation such that  $l < n$  in order to generate an observational set  $J = \{J_1, J_2, J_3, \dots, J_l\}$  followed by reducing them into variance of it. Hence, the cumulative quantity of attributes ( $C_a$ ) is mathematically expressed as (1).

$$C_a = P_a \cdot A_o \quad (1)$$

The group's center position is initialized for the complete clustering process, and the proposed system performs the computation of the duration consumed for all the iteration. It is explored that it

consumes less time for all the iteration. Therefore, the proposed system carries out an indexing process for the inverted image with groups of attributes and an encoding mechanism. It is also seen that efficient scaling up of the higher number of images in the massive dataset is supported by the proposed system exhibiting better scalability performance.

**2.4. Sampling assessment**

The proposed system makes use of a platform that facilitates sketching by the user. The platform also offers a privilege to perform filtering operations for the images retained with the primary disk storage to extract a digital format of the image queried upon. This is done after the procedure of sampling is accomplished, followed by the quantization process. Figure 3 highlights the mechanism of processing queried images of a sketch by the user.

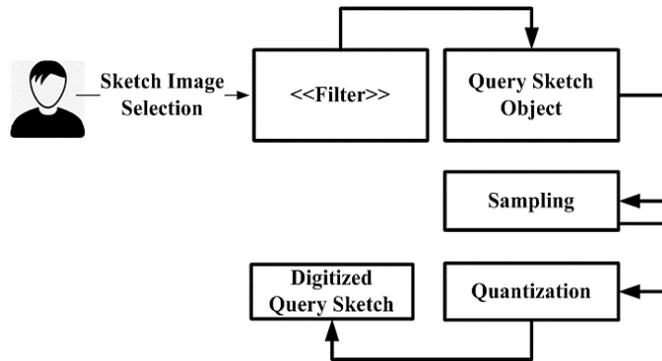


Figure 3. Flow of the processing of sketch image

**2.5. Processing queried image**

The proposed algorithm is mainly split into two main operations towards achieving research goal. The first algorithm assists in indexing the stage image which directly facilitates towards better query processing. The second algorithm assists in computing the correlated score. The algorithmic steps of both are shown as following Table 1.

The proposed system computes the similarity score in the form of correlation maintained in the form of an  $N \times 1$  dimensional matrix where the outcome consists of the score equivalent to the obtained image with respective identity. The correlation score is evaluated with the aid of cosine similarity using a probability range [0 1]. The proposed system then progresses towards the extraction of the correlated image. The proposed method compares the input sketch image and the original images of the objects maintained in the repository to obtain a better-correlated score. The implementation exhibits a series of multiple operations towards emphasizing the clustering mechanism followed by the indexing operation. The idea of this part of the operation is to ease off the means of clustering, which is very much different from any conventional approach with a hypothesis that the proposed simplified mechanism of clustering could potentially assist in an efficient correlation at the end. The proposed indexing mechanism will also contribute towards an efficient form of precision and accuracy over the existing mechanism. The proposed system further implements two algorithms to carry out the indexing mechanism of an image, as well as it also carries out the evaluation process of the correlation score.

Table 1. Proposed algorithm

| Algorithm to index sketch image        | Algorithm for computing correlated score         |
|--|--|
| Input: $d_s$ (data store)              | Input: $q_s$ (query sketch)                      |
| Output: $T_{in}$ (target index)        | Output: score (matching score)                   |
| Start                                  | Start  |
| 1. For $i=1: d_s$                      | 1. For $i=1: q_s$                                |
| 2. select $I_{ran}$                    | 2. $dig_s \rightarrow read(i)$                   |
| 3. If $t_r=true$                       | 3. $[ID \ score] \rightarrow f_4(dig_s, T_{in})$ |
| 4. $t_s \rightarrow f_1(I)$            | 4. End   |
| 5. $c_{bag} \rightarrow f_2(t_s)$      | End  |
| 6. End                                 |  |
| 7. $T_{in} \leftarrow f_3(I, c_{bag})$ |  |
| End                                    |  |

### 3. METHOD

The implementation of the proposed scheme is carried out considering analytical research methodology. The discussion of this section is carried out with respect to method for indexing the sketch image followed by computing correlated score. The adoption of proposed methodology is carried out in sequential manner to accomplish the identified research goal.

#### 3.1. Discussion of algorithm to index sketch image

This algorithm is mainly responsible for performing an indexing mechanism for all the sketch-based images, emphasizing the potential attributes. The algorithm takes the input of data store  $d_s$  that carry out a series of operations to target the target index  $T_{in}$ . The primary steps of the proposed system's operational process are directed towards extracting all the sketch-based images from the origination point of datastore  $d_s$ . The study considers that the datastore consists of all the sketch images in a highly classified manner concerning multiple image groups. The algorithm obtains an I object by converting entire sketch images in the form of objects. The algorithm then selects Iran's arbitrary image, followed by implementing a grouping of the attributes. The next part of implementation is applying training operation towards the sketch-based image. A specific function  $f_1(x)$  is designed to carry out training operation  $t_r$ , which considers I like an image object for this purpose. A unique operation of splitting is carried out in the proposed system considering all the labels connected with an image object using the  $f_1(x)$  function to carry out the classification of an image. For a better inference system, the proposed study uses bag-of-attributes to collect all the potential attributes. The proposed bag-of-attributes' implementation is carried out based on the conventional framework of bag-of-words frequently used in mining operations. A nearly similar principle is applied in the presented case of image objects. The algorithm constructs another function,  $f_2(x)$ , that carries out the extraction of all the potential attributes, which is further followed by the implementation of a learning operation associated with the visual-based objects' framework. The implementation of quantization of attributes follows this process. The image is represented in the next part of the process so that the proposed mechanism leads to the extraction of essential attributes, i.e.,  $c_{bag}$ . After the algorithm successfully extracts all the characteristics for the target image, the proposed algorithm carries out an indexing mechanism for the specific sketch-based image. To carry out the indexing operation of an image object, the proposed system implements a function  $f_3(x)$  for both the image object and attributes extracted this process of implementation results in the object of a target image,  $T_{in}$ . Further, the indexed attribute's result is utilized to assess the correlation with the queried object of sketch image concerning different images already present in the repository.

#### 3.2. Algorithm for computing correlated score

This is the following algorithm mainly concerned with implementing correlation assessment concerning the objects within the repository and the queried image object. This algorithm's input is queried sketch-based image  $q_s$ , where the algorithm gives an outcome of the overall score of correlation. In this algorithm, the proposed system analyzes the multiple numbers of queried images of the sketch in input. The processing of digitization is carried out for all the sketch-based image objects, which are considered queried objects, thereby generating a digitized sketch image  $dig_s$ . This process is followed by applying a function  $f_4(x)$  responsible for carrying out an indexing operation. This function considers processing input arguments associated with the digitized queried object of the sketch  $dig_s$  and image that has been indexed  $T_{in}$ . Finally, an image is retrieved with its connected correlation score as well as its identity.

Therefore, it can be seen that all the essential operational blocks are sequentially connected to carry out the further operation. Thus, the proposed system makes sure that using a progressive scheme and simplified steps of operation results in a better form of image processing approach that can be used for performing analysis of the sketch-based image retrieval system. Therefore, the proposed algorithm provides a simplified approach with higher ranges of flexibility towards the design process.

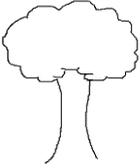
### 4. RESULT AND DISCUSSION

The prior section illustrates the methods and algorithms, whereas the discussion of its implementation is carried out in the form of accomplished outcome in this section towards sketch-based image retrieval. The scripting is carried out in MATLAB while the system adopts Princeton database [36], consisting of 36,000 surface models of polygonal shapes associated with regular objects. The database system consists of a specific group with the inclusion of multiple images within that group. The queried image is given in a sketch specific to different groups of images to assess the proposed study. The idea is to check the similar matched image retrieved from the database. The prime agenda of assessment is to evaluate for both dataset as well as captured images to exhibit the scalability and applicability of proposed logic over different variants of images. Unlike existing approaches, the idea is also to test the computational complexity

of the algorithm with respect to algorithm processing time. Table 2 highlights some visual outcomes to show the retrieved images for queried sketch-based image objects' input.

The outcome of the retrieved images for the proposed system is restricted to 5 correlated images with higher ranks corresponding to the queried sketch image as an input. The outcome of the proposed method is assessed concerning the recall and precision-based performance parameters. The complete assessment has been carried out for 1,000 hand-drawn sketches as a queried image subjected to the proposed algorithm for performing matching. The numerical outcome is obtained by averaging all the results of the scores obtained. The study's result is compared with the existing SURF descriptor concerning the same performance parameters using 1,000 simulation rounds considering processing time and accuracy. Figures 4(a) and 4(b) highlights comparative analysis for accuracy while Figures 4(c) and 4(d) exhibits processing time respectively for both dataset and captured images (images captured outside of the dataset's scope). The quantified outcome of the study exhibits that it offers approximately 9% and 6.9% improved accuracy concerning the dataset and captured image, respectively. The proposed method provides approximately 15.5% and 14.9% of minimized processing time concerning the dataset and captured image. The prime reason for the improved accuracy is the novel indexing policy missing in the SURF approach. On the basis of accomplished outcome, the implemented scheme can be stated offer cost-effective better retrieval of sketch images. Therefore, a better form of technology is implemented, which provides consistency irrespective of any conditions and types of images.

Table 2. Queried image and similar images retrieved

| Queried Sketch  | Image-1   | Image-2   | Image-3  | Image-4   |
|---|---|---|--|---|
|   |   |   |   |   |
|  |  |  |  |  |

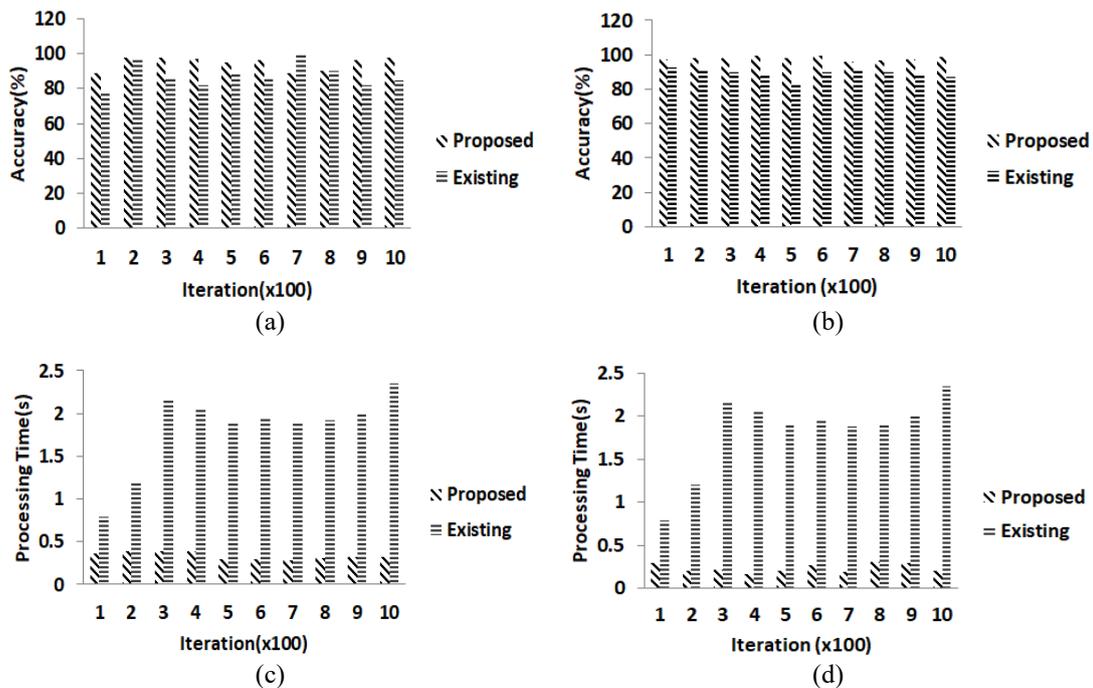


Figure 4. Comparative analysis (a) evaluation of accuracy, (b) evaluation of accuracy for image being captured, (c) evaluation of processing time for dataset, and (d) evaluation of algorithm processing duration

## 5. CONCLUSION

This paper has presented a discussion about a technique that extracts the highest-ranked image from hand-drawn sketches by a human. The proposed study uses a simplified feature clustering approach and bag-of-features to address the associated problems in existing studies. The significant contribution as well as novelty of the proposed system is viz. i) extraction of potential attributes are carried out by simple bag-of-attribute model unlike any existing approach for higher precision, ii) a novel and yet simplified indexing mechanism for accelerating retrieval of image, and iii) the proposed system offers higher adoption in any form of image irrespective of its symmetric and asymmetric shapes. The simulated study outcome using both the standard and captured images shows higher accuracy and lower processing time.

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