

IMPLEMENTING SKETCH-BASED IMAGE RETRIEVAL SYSTEM USING EDGE DETECTION AND SIFT ALGORITHM



AHMED SHIHAB AHMED

Department of Basic Sciences, College of Nursing, University of Baghdad, Baghdad, Iraq

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ABSTRACT

Throughout the past few years, several researchers have introduced various methods and various algorithms for a precise and dependable sketch-based image retrieval system. In this paper, a proposed sketch-based image retrieval system is introduced. The framework goes over two phases: creating the sketch dataset phase and implementing SIFT (scale invariant feature transform) algorithm. The sketch dataset was created by selecting 100 colored image passed through canny edge detection operator. The system tends to enter a line-based/hand-drawing sketch and applies the SIFT algorithm to match between the input sketch and all sketches in the dataset. SIFT is one of the main efficient algorithms that are used to make description and matching, since it works on large keypoints. This system retrieves images depending on sketch image, and the result of matching will retrieve images that are approximate the entered sketch. The proposed system is assessed according to the measures that are utilized in detection, description and matching grounds, which are precision, recall and accuracy measures. The system showed (96 %) accuracy for line based sketches and (84%) for hand drawing where the detection was identical.

1. INTRODUCTION:

Content-Based Image Retrieval (CBIR) utilizes image contents for representing and accessing the image. An ordinary CBIR system is categorized as on-line image retrieving and offline property extracting. In the offline phase, the system performs an automatic extraction of the visual features (texture, shape, color and spatial information) for each image in the database according to its pixel values. Furthermore, the system stores those features in another database in the system known as the feature data-base.

The feature data, for every visual attribute of every image is far lesser in scope compared to the image data, therefore, the feature database includes an abstract form of the images in the database of images. The Scale-Invariant Feature Transform (SIFT) is an algorithm in computer vision that detects and describes local features in images [1]. In online image retrieval, the user has the ability of submitting a query instance to the retrieval system searching for relevant images. The system represents this instance as a vector of features.

The distances (in other words, the similarities)

among the feature vectors of the query example and the ones of the media in the feature data-base are afterwards calculated and ranked. Retrieving is directed via applying an indexing method for providing a sufficient way to search the image database. Lastly, the system levels the outcomes of the searches and after that return the outcomes, which are of the highest similarity to the query instance. In the case where the users are not satisfied with the results of the searches, they may give a relevant feedback to the retrieving system that includes an approach for learning the needs of the user information [1].

In CBIR, images are required as inputs. Those images have to express the things that users are looking for; however, the users frequently do not have proper images for that drive. Moreover, the nonappearance of like query images is the common cause of the search. A simple method for expressing the user's query is by utilizing a line-based-hand-drawing (sketch), resulting in Sketch-Based Image Retrieval (SBIR) [2].

In details, a sketch is the natural means of making a query in applications such as CAD or 3-D model retrieving. Some researchers have discussed image retrieval based on sketches, depending on canny edge detection, soble edge detection and Edge Histogram Descriptor (EHD)[2].

* Corresponding author at: Department of Basic Sciences, College of Nursing, University of Baghdad, Baghdad, Iraq
Iraq.E-mail address: ahmedshihabinfo@conursing.uobaghdad.edu.iq

This paper concentrates on entering a simple sketch that uses line-based/Hand-Drawing sketch as a query, and then it proposes a system trend to retrieve the related images. An image retrieval system can be defined as a software system for searching, browsing and retrieving images from large digital image databases. The majority of the conventional and widely known approaches of image retrieving use additions of meta-data, like caption, keywords, or descriptions of the images in a way that enable retrieval images to consider the annotation words. Manual image annotations take quite a long time to perform, they are also laborious and expensive; for solving this issue, many researchers have conducted automatic image annotations. Moreover, the growth of social web applications and semantic web gave the inspiration for developing a number of web-based image annotation tools [3]. Sketches represent the structural components of basic geometric elements of an object. The absence of color and texture information in a sketch often makes the retrieval process too intricate. Thus, the techniques for regular images retrieval are not applicable to sketches. This paper expresses some theoretical concepts in the field of image retrieval and the techniques, which are employed in the proposed sketch-based image retrieval system; such as edge detection filters and some algorithms for feature extraction and matching [4].

2. RELATED WORK:

Many researches have focused on image retrieval and sketch retrieval systems. Some of these researches include:

R. Ethan, V. Rabaud, K. Konolige, G. R. Bradski, [5], (2011), who reported that feature matching is at the center of several computer vision issues, for example object recognition or structure from motion. Now days, techniques depend on pricy descriptors to detect and match. The study introduced an incredibly fast binary descriptor founded on BRIEF, named ORB, that is rotation invariant and resistant to noise. They demonstrated through tests, in what way ORB is at two orders of magnitude that is quicker than SIFT, although performing well in many situations. The efficiency is experienced on various real-world applications, counting object detection plus patch-tracking on a smart phone.

L.Bin, M.S. Yeganeh, [6], (2012), performed a comparison among various types of standard algorithms of edge detection, for instance Roberts, LOG, Canny, Sobel and Prewitt. 1-D operator Roberts, Sobel plus

Prewitt can handle treatment impact of images of more grey-scale gradient and noise. They concluded that canny is the optimal edge detection algorithm.

R. Hua, J. Collomossea, [7], (2013), are presented an image retrieval system for interactive search of image groups utilizing free-hand sketches that depict shape, and they described Gradient Field HOG (GF-HOG), which is an adapted type of the HOG descriptor appropriate for Sketch Based Image Retrieval (SBIR). They compared GF-HOG with classic descriptors using public distance measurements plus language models to image retrieval. They also explored the way that affine deformations of sketch may impact the search performances. The results have shown that GF-HOG consistently outperforms retrieval versus Shape Context, Structure Tensor, SIFT, multi-resolution HOG, and Self-Similarity. Moreover, they have incorporated semantic keywords in their system for permitting the utilization of annotated sketches aimed at image search.

A. Sravanthi, B. H. Reddy, [8], (2014), have introduced the issues and challenges in the way of creating CBIR system that is founded on a free hand sketch. Implementing the existing approaches, which stated that the presented method is better than the already existing ones, as is capable of handling the information gap between a sketch and a colored image. In general, the results showed that the sketch based systems allowed users an intuitive access to search-tools. They said that the growing of data storages and the internet evolution had changed the world. The performance of search in an information set is a point of view, which is highly important.

A.I. Doush, A.B. Sahar, [9], (2016), explained that Banknote recognition means classifying the currency (coin and paper) to the correct class. In this research, they developed a dataset for Jordanian currency. After that they applied automatic mobile recognition system using a smartphone on the dataset that uses a scale-invariant feature transform (SIFT) algorithm. This is the first attempt, to the best of the authors' knowledge, of recognizing both coins and paper banknotes on a smartphone using SIFT algorithm. SIFT has been developed to be the most robust and efficient local invariant feature descriptor.

3.SKETCH -BASED IMAGE RETRIEVAL (SBIR):

SBIR is an effective and significant technique in which an extreme ability to draw the query sketch is not required. Sketch-based image retrieval (SBIR) is a

related means of querying huge image databases. Exclusively, researchers focus on the way to resolve the issue of matching between the sketch and the image. (SBIR) has the aim to return similar images to a sketch drawn by a user (usually a simple collection of drawing lines) [10]. It is specifically adapted in cases where the users have a mental image of the thing they are searching for. In this case, a sketch image is useful specifically when the image dataset is not annotated, and the user does not have similar example image to be used as a query input. There are two important issues in Sketch-based image retrieval: (a) detecting a useful visual content representation, which is associated to a similarity measurement allowing efficient comparison to a query which is not an image, but instead, a sketch drawn by a user that in some cases is not that skillful, and (b) making retrieving scalable to large image datasets via the producing a suitable index model capable of better exploiting the content representation and similarity measurement. In the situation where a sufficient key must be found, it is considered that these challenges must not be separately solved. The aim is retrieving in large datasets all images, which are visually identical to the form of the objects of the query sketch at identical scale, location and rotation [10].

3.1 CANNY EDGE DETECTION:

With all the edge detection approaches formed till now, Canny edge detection algorithm is considered to be one of the utmost firmly well-defined approaches which provide effective plus dependable detection [11]. Due to the ideal to cross the three standards for the edge detection plus the easiness of procedure for the employment, it's now a wide known algorithm for edge detection. Canny's method is founded upon three essential purposes [13].

- **Minimum error rate:** The capability to determine and mark all the real edges, i.e. no edge is missed.
- **Edge points should be fine localized:** Space among the actual edge and edge pixels which found via the detector have to be as small as possible.
- **Single edge point response:** The detector should return just single point to very correct edge point. So, the detector has to be marked each edge once[12].

The steps of applying canny edge detection may be described below:

- **Convolving the image $f(r, c)$ with a Gauss function for getting smooth image.**

- **Operating first difference gradient operator for calculating edge strength later edge magnitude plus direction (applying soble edge detection).**
- **Utilizing non-maximal or serious suppression to the gradient magnitude.**
- **Utilizing double threshold to the non-maximal suppression image.**

4. SIFT (SCALE INVARIANT FEATURE TRANSFORM):

SIFT computer vision method is designed for detecting and describing local image properties. For any image object, the points of interest on the object may be obtained for providing object "feature descriptions". The method was proposed by D. Lowe in 1999. In this section, a review and description is presented about the way SIFT obtains image properties which have several features making them relevant for matching different images of an object or scene [14].

4.1 STAGES OF COMPUTATION IN SIFT:

- **Generating a scale space:** which is the initial preparation. This step creates internal representations of the initial image for ensuring scale invariance, which is performed via the generation of a "scale space" [15].
- **Laplace of Gauss Approximation:** The LoG is optimal to find points of interest (i.e. keypoints). However, it is computationally expensive. To overcome this, it is possible to approximate it with the use of the representation that has been generated previously.
- **Keypoint Detection:** using the high speed approximation, the task of this stage is to detect keypoints. Those are the Difference of Gaussians (DoG) image maxima and minima that were calculated in step2 [16]
- **Eliminate bad keypoints:** Edges and areas of low contrast are considered as bad keypoints. Getting rid of them makes the algorithm effective and robust. A method, which is similar to the Harris Corner Detector has been utilized here[17].
- **Orientation Assignment:** An orientation is computed for every keypoint. All following computations are performed depending on those orientations. This efficiently gets rid of the impact of orientation, turning it invariant to rotations.
- **Generation of SIFT Properties:** while maintaining scale and rotation invariance, one more representation is produced, which aids in the unique identification of

properties. Assuming to have 10,000 properties. With this representation, it is possible to easily identify the desired property (such as a specific eye, or a sign board), [18][19][20][21].

5. THE PROPOSED SYSTEM MODEL:

In this paper, the proposed system begins with sketch (line-based sketch - hand-drawing sketch) keyed in by the user for matching to retrieve relevant images. On the other hand, the proposal builds a modest dataset that contains amount of images which are processed using canny edge detection operator to extract their sketches for corresponding dataset of sketches. In the end, the input sketch is analyzed and matched using SIFT algorithm with all sketches in the dataset. The results of matching are retrieved images that approximate the input sketch as shown in figure(1).

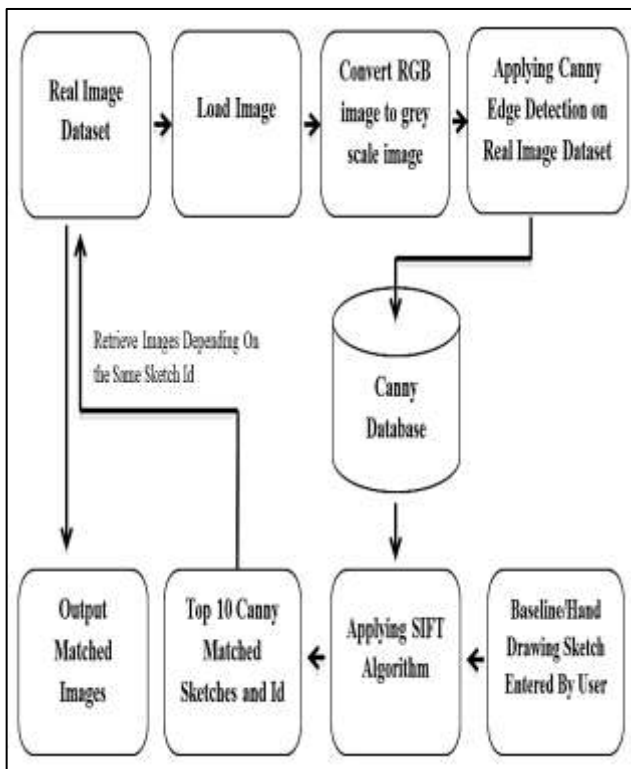


Figure 1 – Proposed system diagram

5.1 DATASET:

In this paper, the proposed system includes tow datasets. The first one is 100 colored images collected from different sources, stored in a folder, classified into 10 types of images. Each one of these types contains 10 images, these types are (Eiffel Tower, Japanese Houses, Arc triumph in France, Egyptian Pyramids, Iraq’s Free Monument, Saint Basil’s Cathedral in Russia, Mercedes-Benz Sign, Steve Jobs, the Dark is Rising Sequence (novel series) and Colosseum Amphitheatre in Italy) as showing in figure (2). The second dataset is created by passing all images in the first dataset through canny edge detection operator.



Figure 2 – Colored Dataset

5.2 ALGORITHM OF THE PROPOSED SYSTEM:

general implementation of the proposed system
Input: based line / hand drawing sketch.
Output: images that are approximate to the entered sketch.
Begin
Step 1: Creating Dataset of Sketches by applying canny edge detection.
Step 1.1: converting all colored images in dataset to grayscale images.
Step 1.2: Smoothing using Gaussian filter mask.
Step 1.3 : Finding intensity gradients by applying soble edge detection
Step 1.4: applying Non-maximum suppression to convert blurring edge to sharp edge.
Step 1.5: Doubling thresholding to discern between edges if they are true edge or caused by

noise or color variations.

Step 1.6: Edge tracking by hysteresis algorithm to check if they are connected to a strong edge. If they are connected, They will remain , but if they are not, they will be removed.

Step 1.7 saving all of canny sketches in a file.

Step 2 SIFT Implementing & Sketch Matching

Step 2.1: Calculate the Gaussian scale-space .

Step 2.2: Calculate the Difference of Gaussians (DoG),

Step 2.3: Discover candidate keypoints (3d discrete extrema of DoG)

Step 2.4: Refine candidate keypoints location with sub-pixel precision.

Step 2.5: Filter unstable keypoints due to noise.

Step 2.6: Filter unstable keypoints laying on edges.

Step 2.7: Allocate a reference orientation to every keypoint..

Step 2.8: Construct the keypoints descriptor.

Step 2.9: match the keypoints among the entered sketch and all the sketches in the dataset, retrieve the top 10 images that belong to top 10 sketches.

End

Now apply some technical details about the implementation and how the system matches using SIFT algorithm. The Figures (3) and (4) shows how the match between hand drawing sketch and sketch dataset is applied, while figures (5) and (6) show the result of matching between based-line sketch and sketch dataset.

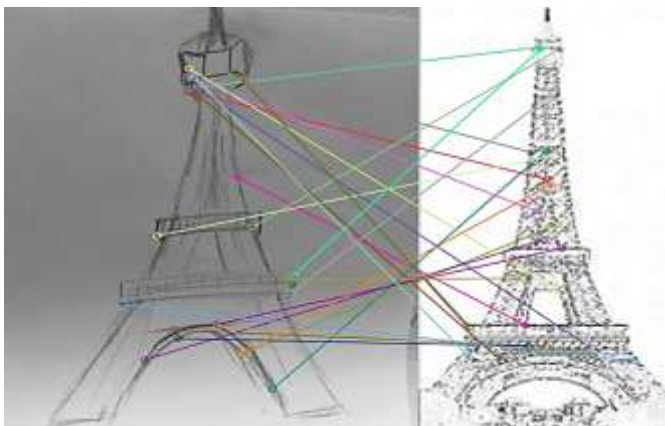


Figure 3 – match result of applying the proposed system using hand drawing sketch as an input

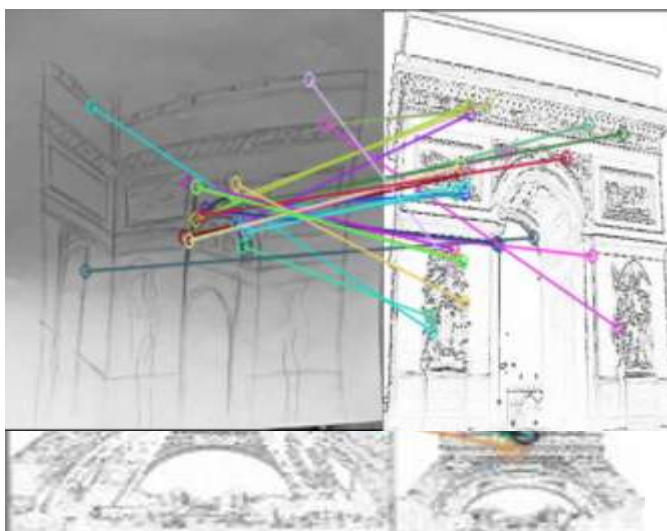


Figure 4 – another match result of applying the proposed system using hand drawing sketch as an input

Figure 5 –match result of applying the proposed system using based-line sketch as an input








Figure 6 – another match result of applying the proposed system using based-line sketch as an input















6. RESULTS:

The proposed system implemented the SIFT algorithm on the Canny dataset using two types of sketches, the line based sketch and the hand drawing sketches. The experimental results show that the SIFT gives very good results when it works on some types of sketches more than some others, such as the images that contain monument or spatial sign. When it is used on a sketch that contains many symbols such as the Iraq Free Monument or Japanese Houses sketches, the SIFT gives 96% and 92% accuracy respectively. This can be the result of the fact that the SIFT technique works by locating keypoints and then Match between them. The result analyzing shows that if the image contain many symbols, the SIFT will locate many matched keypoints, and thus will return good results. In Mercedes-Benz sign and Eiffel Tower sketches, the SIFT gives 92% and 94% accuracy respectively because all the sketches contain the same single symbol with different sizes and angles. The SIFT is thought to be effective in such a situation. There are two weakness points in SIFT technique. The first one is face recognition, when the proposed system uses face sketches (Steve Jobs), the result was not good.

This is because, for example, if the SIFT works on human face keypoints, it cannot distinguish if this keypoint is an eye or ear, and may consider it a simple circle and match it with any other circle found in any other sketch. Consequently, it is not fit with face recognition. The second reason is the number of objects. If the system is used to match between two sketches of Egyptian Pyramid, one of them contains two pyramids and the second contains only one pyramid, in this situation the system will return a few matched keypoints between the two sketches. Moreover, there is a possibility that it would prefer dissimilar sketches. The experimental results show that the size of image is a very effective element in the work of a sketch retrieval system. Hence, the size between the two matched sketches must be too close. The system has all types of sketches in the dataset, so the line-based sketches produced better results than the hand drawing sketches. See Table 1 below.

Table 1. Result of applying the proposal system

Image Name	Image	Results						
		Precision	Recall	Accuracy (in %)	TP	TN	FP	FN
Line Based Eiffel Tower Sketch		0.7	0.7	94%	7	87	3	3
Hand Drawing Eiffel Tower Sketch		0.4	0.4	88%	4	84	6	6
Line Based Japanese House Sketch		0.6	0.6	92%	6	86	4	4
Hand Drawing Japanese House Sketch		0.3	0.4	86%	3	84	7	7
Line Based Arc Triomphe Sketch		0.5	0.5	90%	5	85	5	5

Hand Drawing arc Triomphe Sketch		0.3	0.3	86%	3	83	7	7
Line Based Pyramids Sketch		0.5	0.5	90%	5	85	5	5
Hand Drawing Pyramids Sketch		0.3	0.3	86%	3	83	7	7
Line Based Iraq Free Monument Sketch		0.8	0.8	96%	8	88	2	2
Hand drawing Iraq Free Monument Sketch		0.7	0.7	94%	7	87	3	3
Line Based Cathedral Sketch		0.5	0.5	90%	5	85	5	5
Hand Drawing Cathedral Sketch		0.3	0.3	86%	3	83	7	7
Line Based Benz sign Sketch		0.6	0.6	92%	6	86	4	4
Hand Drawing Benz sign Sketch		0.4	0.4	88%	4	84	6	6
Line Based Steve Jobs Sketch		0.3	0.3	86%	3	83	7	7
Hand Drawing Steve Jobs Sketch		0.2	0.2	84%	2	82	8	8
Line Based Novel Series Sketch		0.5	0.5	90%	5	85	5	5
Hand Drawing Novel Series Sketch		0.3	0.3	86%	3	83	7	7
Line Based Colosseum Sketch		0.5	0.5	90%	5	85	5	5

Hand Drawing Colosseum Sketch		0.3	0.3	86%	3	83	7	7
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7. Conclusion:

As a tourist or a resident, one needs to detect crammers depending on their sketches and match them with black list dataset to retrieve the crammer image. The sketch based image retrieval, as opposed to text-based retrieval, is easier to express the orientation, and pose in the query sketch to find the required image if compared to specifying these characteristics in a text. The main challenge in sketch based image retrieval system is that it requires understanding of both sketch and image domain and then do a comparison. Traditional approaches have depended on hand designed features, which used the gradients or edges as features generally invariant across both the image and the sketch domains. However, such techniques can be improved a lot. The aim of this system is to retrieve an image depending on image sketch with high efficiency (good accuracy and good time). The proposed system begins by entering a simple sketch (line-based image or hand-drawing image) that are keyed in by the user for matching and introducing relevant images. On the other hand, the proposal builds a modest dataset that contains 100 colored images, which are processed using canny edge detection to extract their sketches for corresponding dataset of sketches. Finally, the input sketch is matched and analyzed using SIFT with all dataset of sketches. The result of matching will retrieve top 10 images that are approximately similar to the entered sketch. Several conclusions have been derived from the test results of this study. Of them is that shows the SIFT algorithm as very effective when it is used for matching between two sketches because of its

ability to create a lot of keypoints, and match between them. The line-based sketch is better than the hand-drawing sketch when it matched with canny sketch Using SIFT algorithm. For the SIFT to work well, the size of the two matched sketches must be the same or too close to get better results. As long as the sketches in the dataset focus on the object only, they do not contain a lot of unwanted details, and thus the proposed system will return better results. The work percentage in this paper achieved high accuracy rate for the Heritage places, spatial signs and book covers sketches. Consequently, it can be applied in the field of sketch search. On the other hand, the work percentage achieved low accuracy rate for the face sketches.

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أحمد شهاب أحمد

قسم العلوم الأساسية/ كلية التمريض / جامعة بغداد/ بغداد/ العراق

E-mail ahmedshahinfo@conursing.uobaghdad.edu.iq

المستخلص:

من خلال السنوات الماضية قدم الباحثين تقنيات وخوارزميات مختلفة لنظام استرجاع الصور بدقة وموثوقية بالاعتماد على المخططات. في هذا البحث تم تقديم نظام مقترح لاسترجاع الصور. آلية العمل تمر عبر مرحلتين: مرحلة تكوين قاعده بيانات المخطط ومرحلة تنفيذ خوارزمية الـ SIFT (Scale Invariant Feature Transform). يتم انشاء مرحلة تكوين قاعده البيانات عن طريق اختيار 100 صورة ملونة يتم ادخالها جميعا في مرحلة وحده المعالجة الاولى والتي تتضمن تطبيق خوارزميه الـ Canny Edge Detection. اما مرحلة الاختيار تتضمن ادخال مخطط باستخدام الحاسوب / مخطط برسم اليد وتطبيق خوارزمية الـ SIFT للمطابقة بين المخطط المدخل ومخططات الناتجة من عملية المعالجة الاولى. الـ SIFT هي واحدة من الخوارزميات الاساسية والفعالة في التحقق ووصف المخطط لانها تعمل على مقدار واسع من النقاط المفتاحيه في المخطط. الهدف من هذا النظام المقترح هو استرجاع صورة بالاعتماد على مخطط وبالنتيجة سوف يسترجع النظام صور مقارنة للمخطط المدخل.

النظام المقترح قد تم تقييمه من خلال المقاييس الاساسية لاسترجاع الصور والتي تتضمن (الضبط، استرداد، دقة) والنظام المقترح قد حقق دقة تتراوح بين 96% عند ادخال رسمة باستخدام الحاسوب الى 84% عند ادخال رسمة باستخدام اليد، ايضا النظام المقترح قلل الوقت المطلوب الذي تستغرقه الخوارزمية في المطابقة والوصف.