MANTECH Publications
Recent Trends in Computer Science and Software Technology
Volume 4, Issue 3, September-December 2019

Sketch Based Image Retrieval and Indexing Using Chamfer Distance

K. Gayathri Devi, Dr. L. Latha
Department of Computer Science and Engineering,
Kumaraguru College of Technology, Coimbatore, Tamilnadu, India.
Corresponding Authors' E-mail: *Kg3devi@gmail.com, Latha.l.cse@kct.ac.in*

Abstract

Sketch based image retrieval (SBIR) is one of the emerging research areas in image retrieval that includes retrieval of image based upon sketch given by the user. The sketch is the outline of an original image that at times may be a hand drawn image or edge detected image. This paper discusses about such a retrieval task based upon sketches as input query followed by indexing of the image by similarity ranking. This paper highlights the approaches involved in SBIR for retrieving images and also the results of image retrieval and indexing based on similarity ranking.

Keywords: *Sketch Based Image Retrieval (Sbir), Sketch, Indexing, Retrieval, Content Based Image Retrieval, Chamfer*

INTRODUCTION

There are different ways of image retrieval based on user needs. These include text based image retrieval and context based image retrieval. Text based image retrieval is dependent on the keyword of an image. Content based image retrieval is based on the contents of an image rather than metadata, as in the case of text based image retrieval. Content of the image may be any information that describes the image itself, such as color of an image, texture of an image or shape of an image.

Content based image retrieval based upon color of an image is by computing distance measures on color similarity, which is achieved by making use of color histogram. Retrieval based on color does

Page 97-105 © MANTECH PUBLIATIONS 2019. All Rights Reserved

not consider size or orientation of the image. Retrieval based on textures considers visual patterns present in the image. Identification of texture in an image is made by modeling the texture as a two-dimensional gray level variation. Classification of textures includes various methods such as co-occurrence matrix, wavelet transform, orthogonal transform, laws texture energy etc.., content based image retrieval based upon shapes include shape of a particular region but not an entire image. A shape is obtained by applying segmentation or edge detection to an image.

Sketch based image retrieval is similar to content based image retrieval where the shape of an image represents the sketch. Difference between sketch and content based image retrieval is that in sketch based image retrieval, the outline sketch of an entire image is considered, whereas content based image retrieval based on shape does not consider an entire image outline but only the outline shape of a particular region.

Sketch based image retrieval can be implemented by making use of two approaches, either by using global technique or by using local technique. Local techniques make use of feature vectors for retrieval. Some techniques involve use of shape context, structure local approach etc. Global techniques include edge histogram descriptor, angular partitioning of abstract images, histogram of edge local orientation etc.

Content based image retrieval requires image as an input in order to perform retrieval task. But at times, the user may not have the exact image they require. They may have only the idea of an image but not the exact image. Hence, in such situations the user can make use of sketch based image retrieval, in which the user can give the hand drawn image as an input which represents the shape of the image they desired to retrieve. Based on the user's hand drawn input, the exact image will be retrieved from the database of images.

In this paper, Section II discusses about the survey on sketch based image retrieval, section III describes the methodology implemented. Further sections IV and V deal with results and conclusion.

RELATED WORK

Sketch based image retrieval by Jose M. Saavedra. Benjaminbustos [2], their proposed system consists of three stages that includes key shape detection, local

Page 97-105 © MANTECH PUBLIATIONS 2019. All Rights Reserved

descriptor computation and finally, descriptor matching. Key shape is a geometric shape that may be a circle, line or a square. In the first stage, the sketch representation of the image is obtained by canny edge detection procedure. By using a scaling factor of α=0.3, the canny operator is applied. Then the image is down sampled by a factor of 0.5 in an iterative manner until the resulting image reaches a pixel value around 200 pixels in one of its dimensions. The query image being a sketch, it does not require any edge detection operation. It involves only a thinning operation, and after this the abstract representation of an image is obtained to detect simple shapes. They decompose the sketches into strokes. For the purpose of decomposing, they identify the edge links. Strokes may be a combination of one or more key shapes. Finally at the end of this stage, they classify six predefined key shapes on performing stroke decomposition.

At the second stage, they define the spatial information for the identified key shapes. They make use of two descriptors, namely key shape angular spatial descriptor and histogram of key shape orientations. In the first descriptor, by considering local information of each slice in an angular way, they form a histogram. In the second descriptor that is based upon key shape orientation, they compute a local histogram.

Finally, they consider local descriptors of key shapes that belong to the same type and match them. Match filtering and Hungarian methods were used to filter out irrelevant matches and to find the set of matches between key shapes.

Sketch based image retrieval based upon angular partitioning was proposed by Abdolahchalechale et.al. [3]. In this paper, we discuss and present the retrieval based upon two stages of image abstraction and angular partitioning. Their proposed method includes complex objects in an inhomogeneous background. Image abstraction is achieved in the following manner: first, edges of an image are obtained by making use of canny operator at α=1 and Gaussian mask size=9, wherein strong edges were retained by making use of threshold values, thus grey image is converted into edge image. Thinning operation is being applied to query image. Abstract image is given as an input to angular partitioning; it is obtained by performing the normalization procedure. By making use of Fourier transform, features were extracted from the image by considering the angular spatial distribution

Page 97-105 © MANTECH PUBLIATIONS 2019. All Rights Reserved

of pixel from abstract image. Finally, Manhattan distance between feature vectors is computed to find the similarity between the images to perform the retrieval task.

An alternative approach for SBIR was proposed by Yang Cao et.al. [1] They designed Mind Finder, a search engine which can be used in real time for mining a large scale database by indexing. For the purpose of image search, they proposed an index structure named edgel index. In this process, first the database images were converted into shape image by making use of edge detection and boundary detection. Chamfer matching was used as a distance measure to conduct the retrieval process. In order to reduce the time complexity, they make use of distance transform map of the query image. In order to overcome some drawbacks of chamfer matching, Indexable Oriented Chamfer Matching (IOCM), which has the ability to tolerate local distortions, was proposed? For performing computation easily, the distance transform map in IOCM is converted into binary map called hit map that takes values either 0 or 1. Based on this hit map, the distance measure is converted into similarity measure.

For indexing, they performed both database to query matching and also two way matching. In the first approach, they make use of sketch and hit map as input. They adopted inverted index strategy to implement IOCM; they built an edgel dictionary in which each entry is a word (x, y, θ). This was done for the entire database. For each entry, they maintain an inverted list of images. A ranking algorithm is designed which ranks the entire database based upon similarity score. In two way matching, since it is difficult to generate hit map for all images in the database that requires more space, they make use of N candidates from database to query matching and store their raw curves instead of distance transform maps for those N images. Thus, by making use of this framework, they build a real time search engine that indexes 2.1 million images. They also proposed a strategy – structure consistent sketch matching which decomposes the query sketch into small sub queries and computing similarity for each query, and finally taking geometric mean for all the computed value after which the similarity score is considered as a final score, which is then used to rank and index the images.

Bag of regions approach for sketch based image retrieval proposed by Rui Hu et.al.

Page 97-105 © MANTECH PUBLIATIONS 2019. All Rights Reserved

[5]. For retrieval based upon sketches, they designed a framework based upon bag of visual words by using multi scale region segmentation. The image is decomposed into regions at multiple scales. They collected the regions from the hierarchical region tree nodes. The contours of region map were extracted that contains details at various levels. GF-HOG is built to capture local structure. A codebook (BoVW) Bag of Visual Words is formed by using k-means clustering, for clustering shape descriptors. Based upon that information, they form histograms that are being used for matching. To encode query sketch, they make use of GF-HOG. Finally in the retrieved image, the sketched object is localized.

Sketch based manga retrieval proposed by Tushi Jing et.al. [4] makes use of fine multi scale edge orientation histogram (FMEOH). Their proposed method comprises of three steps namely labeling margin areas, feature description of FMEOH, and binary embedding. In their proposed method, they define the spatial area in multi scale sliding window. Squares were used to represent the regions of FMEOH features. Features of database and query image is used in matching for performing retrieval. The square region is divided into cells of size 8x8, and they were quantized into bins of 4 orientations and normalized. Finally, the entire vector is renormalized. To save memory and to make efficient computing, the features were converted into binary strings. Those binary strings were taken and hamming distance was computed for those strings which are used in comparison. Manga images comprise of a series of frames, hence exclusion of margin is made for efficient searching, and it is made by erosion.

Sketch based 3D model retrieval proposed by Changquingzou et.al. [6] is based on multi feature fusion. They used local statistical structure and joint description of global spatial features for the retrieval of 3D models based on sketches. They constructed a Histogram of Spatial Orientations (HSO) in which local structural features were defined. To improve the retrieval performance, they made use of Bag of Features approach and relevance feedback scheme. Bag of Features approach is used for the purpose of visual word representation. Usually, Histogram of Oriented Gradients (HOG) method was designed for grey scale images. But the author had modified the same for binary sketch in his approach by making use of shape points. Shape context is used to extract Global features of

Page 97-105 © MANTECH PUBLIATIONS 2019. All Rights Reserved

sketches. In Bag of Features, step with the help of k means clustering the form local and global vocabulary of visual words. Based on these visual words, histograms were constructed and they were used in matching. The relevance feedback step proposed by them helps users to interact with the system efficiently. This is achieved by labeling the 3D models as relevant or irrelevant. Weight balancing and user query modification is allowed in this relevance feedback to improve retrieval performance.

For the purpose of face photo retrieval, Xing gao et.al. [8] proposed sketch photo synthesis. They proposed retrieval algorithm based upon sparse representation. The sketch photo synthesis proposed by them was an automatic approach that comprises of two stages, namely sparse neighbor representation (SNS) and sparse representation based enhancement (SRE). In SNS step, an estimate for pseudo image is generated initially, followed by SNS in SRE. Photo patches and sketch is mapped by making use of patch-derivative based sparse representation. Based on this strategy, they proposed an algorithm called sparse-representation- based face recognition algorithm for the purpose of retrieval task.

For the purpose of Object recognition, authors Serge Belongie et.al. [7] proposed an approach which depends upon shape matching and shape contexts. Correspondences between the points on the shapes were analyzed to know about similarity. Usually shape context will be same for the same shapes. Shape context and descriptors were attached to each reference points which help to solve the problem of correspondence. These correspondence were used to align the transform. Reference point that holds shape context information helps in describing the remaining points. Finally, nearest neighbor classification is used for the purpose of object recognition. This is made by finding stored prototype at the maximum level of which the image is matched.

METHODOLOGY

1. Sketch based image retrieval requires outline sketch of an image to retrieve it from the database of images for which edge detection procedure is required. We apply canny edge detection to the query image for comparing the image with the database image. The same canny operator is applied to the database images too, in order to make comparison easy for retrieval task. Oriented Chamfer Matching performs well for the purpose of

Page 97-105 © MANTECH PUBLIATIONS 2019. All Rights Reserved

comparing contours of object, hence chamfer distance is taken as a distance measure and it is calculated as given in Eq.1

$$Dist_{(D->Q)} = \sum_{p \varepsilon D} \min_{q \varepsilon Q} || X_p - X_q||_2 / |D| \quad (1)$$

Where D represents a set of edgels, position of edgel $p \varepsilon D$ is denoted $x_p = (x_p, y_p)$. Gradient orientation is denoted by Θp. Considering orientation in computing chamfer distance, it is calculated using Eq.2

$$Dist_{D->Q} = \sum_{\Theta \varepsilon T} \sum_{p \varepsilon D \& \Theta p = \Theta} \min_{q \varepsilon Q \& \Theta q = \Theta} || X_p - X_q||_2 / |D| \quad (2)$$

Where T represents quantified orientations.

Further, in order to reduce computational complexity, distance transform is computed. Even though computing distance between two contours using chamfer matching is easy, it does not provide good indexing. To make indexing strategy efficient, distance transform map is converted into Hit map that comprises of only 0's and 1's. Hit value is computed by making use of Eq.3

$$Hit = \begin{cases} 1 & (|| x_p - x_q|| <= r \;\&\&\; \Theta_p = \Theta_q) \\ 0 & \text{otherwise} \end{cases} \quad (3)$$

Where r represents tolerance radius.

Similarity is computed based upon this hit map. It is calculated by using Eq.4 and Eq.5

$$Sim\ D -> Q = \sum p \varepsilon D\ hit / |D| \quad (4)$$

$$Sim\ Q,D = (sim\ Q->D.simD->Q) \quad (5)$$

Finally, we rank the database image based on this similarity score.

2. Alternatively, there may be some situations where users draw multiple strokes to find images. To fix such problems, the image is divided into strokes and similarity is computed for each stroke piece of an image and by taking geometric mean of similarity scores from all these strokes as final similarity score.

3. Finally, a combination of the above two procedures is used in order to perform efficient retrieval task. Here, we perform scaling and rotation of an image before giving it as an input to the algorithm. Canny operator is applied above this rotated image, and previous procedure is repeated.

Page 97-105 © MANTECH PUBLIATIONS 2019. All Rights Reserved

RESULTS AND DISCUSSION

Input image is scaled and rotated and given as an input to the algorithm and results were shown below:

A. Image retrieval based upon distance measure

After input of the query image, the image sketch is obtained by applying canny operator to the image. The retrieval task is then further proceeded, but only based on the edge detected sketch image. Chamfer distance is the distance measure that is being used to compare the query image along with the database image for retrieval. In order to make the retrieval simpler and reduce time complexity, distance transform map of a query sketch is generated. The above algorithm is implemented in MATLAB that uses some inbuilt functions that help in exact retrieval of an image based upon sketch. The algorithm makes uses of inbuilt function 'edge' to find the edges of an image and 'bwdist' function to compute the distance from pixel. Similarly, the same procedure is applied to the database images. On comparing the distance measure of query and database image, the exact image is retrieved. The implementation is made and the results were shown below

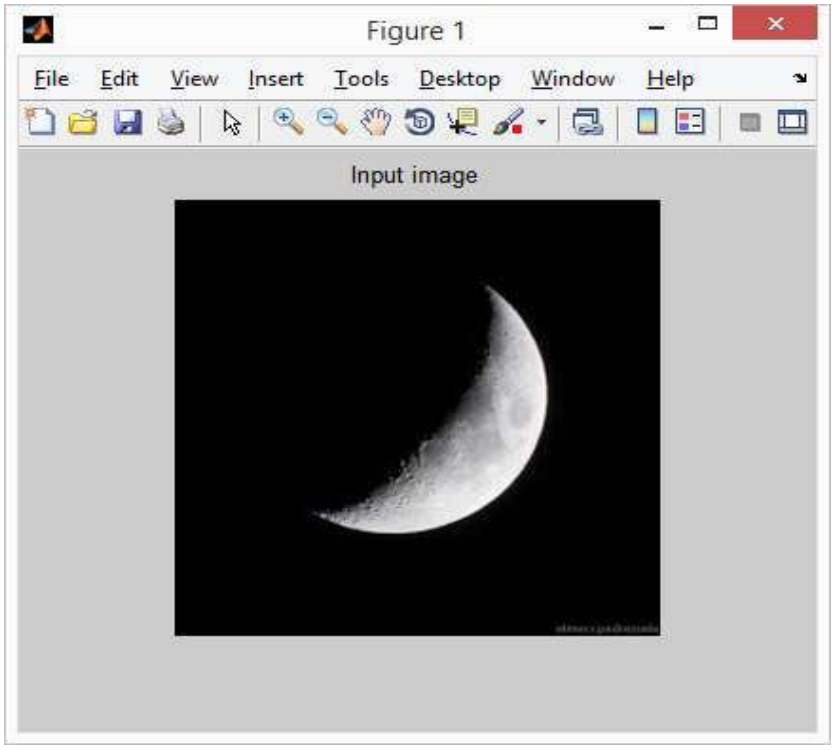


Fig.1. Input image

Page 97-105 © MANTECH PUBLIATIONS 2019. All Rights Reserved

B. Indexing of database images

Query sketch and hit map is given as an input and based upon these inputs, the images are ranked. Hit map is a binary map that holds only two values, either 0 or 1. The hit value is 1 when the difference between the pixel values of the query and the database image is less than a particular tolerance radius, say here the tolerance radius r=6. It also checks for the condition, whether the orientation of each pixel in database and query image are equal only then the hit value will be 1. Otherwise, the hit value would be 0. Similarity measure is computed on the basis of this hit value. Then the similarity value is sorted to rank the images in the database. The similarity score remains zero for the images that has exact match. The image that has the exact match is ranked first. Indexing of the image here means ranking of the image database. The similarity score keeps on increasing if the dissimilarity between the images increases. Fig 8, shows the results of indexed images in which the first image (from left) is the exact matched image according to the user given query, hence the similarity score is 0, whereas in other images the similarity score differs and they are ordered from low to high, which represents the ranking of the image.

The above algorithm is implemented using MATLAB and the results were shown below



Fig.2. Scaled image

Page 97-105 © MANTECH PUBLIATIONS 2019. All Rights Reserved

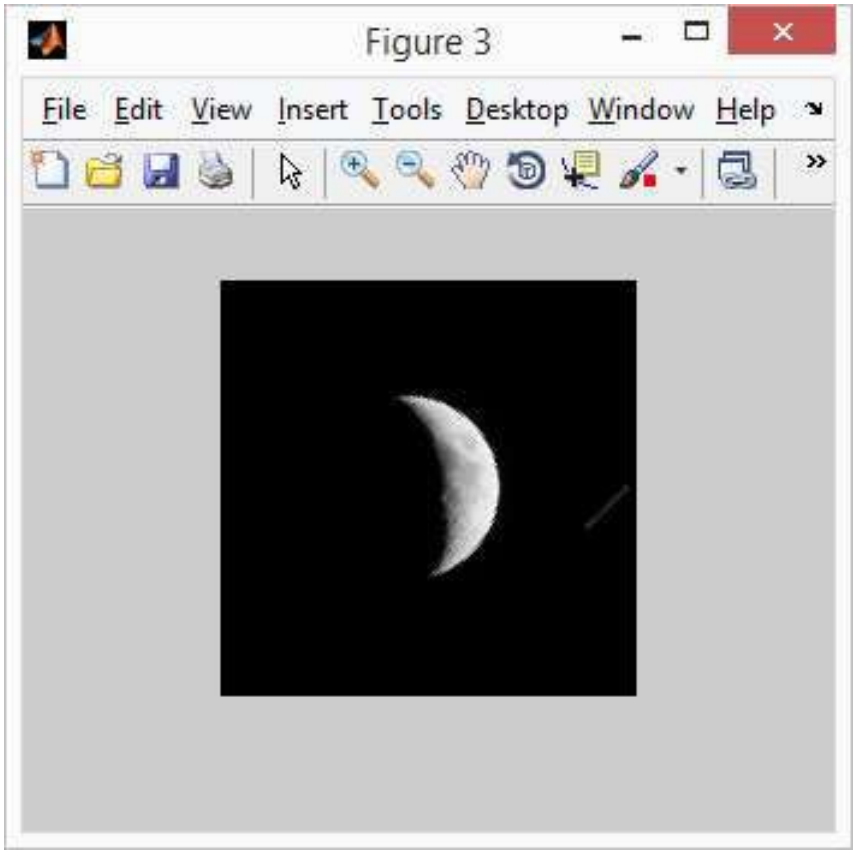


Fig.3. Rotated image

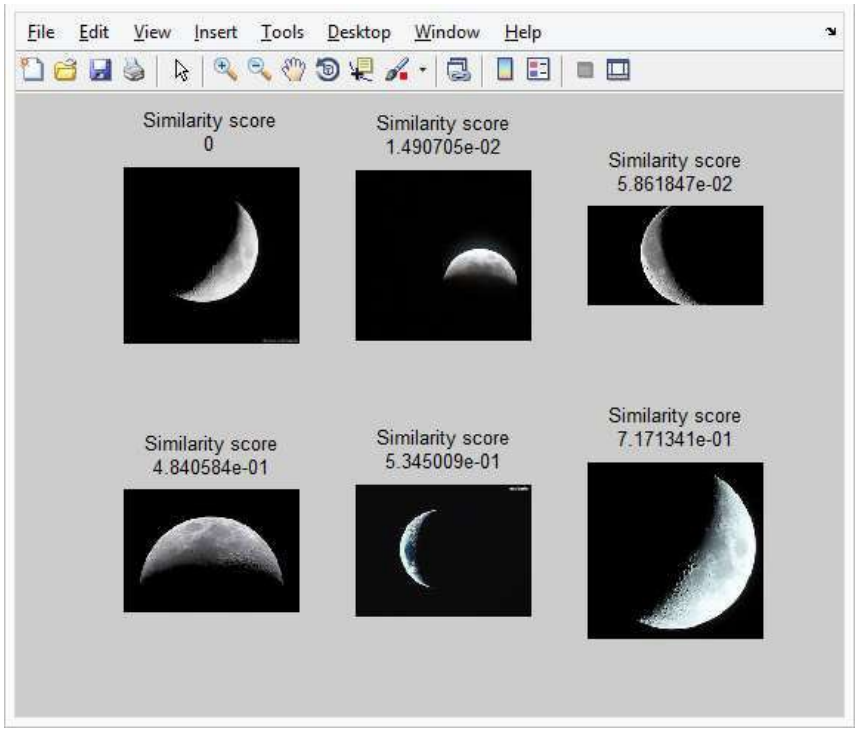


Fig.4. Indexed database images

Page 97-105 © MANTECH PUBLIATIONS 2019. All Rights Reserved

CONCLUSION

The implementation of sketch based image retrieval is made based on distance measure, and indexing of database image is made based on similarity computation, and the results were discussed above. Therefore, instead of considering the edge detected query image from the same image database to perform the retrieval among the database of images, retrieval and indexing for user hand drawn input images will be preferred in the future.

REFERENCES

I. Yang Cao, Changhu Wang, Liqing Zhang and Lei Zhang, "Edgel index for large scale sketch based image search", Proceedings from IEEE conference on computer vision and pattern recognition, IEEE computer Society, pp. 761-768, 2011.

II. AbdolahChalechale, GolshahNaghdy and Alfred Mertins, "Sketch-Based Image Matching Using Angular Partitioning", IEEE Trans. On systems and humans, vol. 35, no. 1, January 2005.

III. Yusuke Matsui, KiyoharuAizawa, Yushi Jing, "Sketh2Manga: sketch based manga retrieval", Tokyo, ICIP, pp. 3097-3101, 2014.

IV. Rui Hu, Tinghuai Wang and John Collomosse, "A bag of regions approach to sketch based image", Proceedings from 18th IEEE international conference on image processing, pp. 3661-3664, 2011.

V. Yafei Wen, ChangqingZou, Jianzhuang Liu, Shuze Du and Shifeng Chen, "Sketch based 3d model retrieval via multi feature fusion", Proceedings from 22nd international conference on pattern recognition, IEEE computer society, pp. 4570- 4575, 2014

VI. SergeBelongie, Jitendra Malik, Jan Puzicha, "Shape matching and object recognition using shape contexts", IEEE Trans.on pattern analysis and machine intelligence, vol. 24, no. 24, April 2002.

VII. XinboGao, Nannan Wang, Dacheng Tao and Xuelong Li, "Face sketch- photo synthesis and retrieval using sparse representation", IEEE Trans. on circuits and systems for video technology, vol. 22, no. 8, August 2012.

Page 97-105 © MANTECH PUBLIATIONS 2019. All Rights Reserved