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Sketch based Image Retrieval using Information Content of Orientation

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Abstract

Background/Objectives: This paper presents an image retrieval system using hand drawn sketches of images. Sketch is one of the convenient ways to represent the abstract shape of an object. The main objective is to perform retrieval of images using edge content by prioritizing the blocks based on information. **Methods/Statistical Analysis:** Entropy based Histogram of Gradients (HOG) method is proposed to prioritize the block. The method helps to pick the candidate blocks dynamically to compare with database images. **Findings:** The performance of the method has been evaluated using benchmark dataset of Sketch Based Image Retrieval (SBIR) with other methods like Indexable Oriented Chamfer Matching (IOCM), Context Aware Saliency (CAS-IOCM) and Histogram of Gradients (HOG). Comparing to these methods the number of relevant images retrieved is high for our approach.**Application/Improvement:** Knowledge based block selection method improves the performance of the existing method.

Keywords: Entropy, Histogram of Gradients, Performance Evaluation, Sketch Based Image Retrieval

1. Introduction

The most common way to perform searches in search engines is using text/voice. The major challenge in verbal cues (text/speech) is to accommodate the multilingual changes dynamically into the machine. Even in one language the communication patterns depends on the locality and the age group of the people (pronunciation differs between people in different country). Image based search engines can overcome some of these problems to deal with heterogeneous group peoples. The Content Based Image Retrieval (CBIR) system is developed by describing the image content using texture, color, edge etc. Various mathematical, Human Visual System (HVS) measurement[1] and Signature based similarity search[2] are used to evaluate the similarity between query and database images. As per the Human Visual System (HVS) edge is one of the important features that represent the content of an image. Sketches can be used to represent the shape or the edges of an object. Here we present an image retrieval system using hand drawn sketches of images.

Development of such independent interface requires the use of models and techniques different from machine that is used in for specific task. Search engines must deal with heterogeneous group peoples. Barrow et al developed[3] an evaluation method of two dimensional asymmetric distances between two sets of edge points of image. Chamfer matching[4] find the distance between the query sketches to every edge pixel in the database image. Chamfer matching algorithm is a shape sensitive that is the shape of the resulting image should be as close as possible to the users input. The retrieval accuracy increase by Indexable Oriented Chamfer Matching (IOCM)[5] method, where the distance map is calculated from binary similarity map (Hit Map). The disadvantage of this algorithm is less reliable in presence of background clutter. The

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modified IOCM[6] with Context Aware saliency (CAS)[7] has helped to locate the region of interest in a image. The short comparison of various SBIR methods is done by Vishal et al.[8], A patch based retrieval technique that facilitates image retrieval based on sketch in large image databases. The edges are obtained using the canny edge detection[9], instead of exporting a single visual descriptor for every image; an overlapping spatial grid is utilized to generate a pool of patches. Patch similarity[10] is efficiently estimated with second nearest neighbor algorithm[11]. As an extension of previous method, the Histogram Of Gradient (HOG)[12] is build in each patch to estimate the match between the sketch and the database images. In order to minimize the computation time of HOG, six values produced for each non overlapping block (9 blocks) there by giving 54 values for an image. The issue in patch based method is the blocks which are blank or has no object/sketch content is also considered while calculating the closeness of sketch image to database images. Hence, there is a need for method that compares the blocks based on content of edge information.

Our focuses on this work is to develop a method that dynamically operates on edge content of the image. Block based prioritization and selection is done based on information content of an edge image that helps to reduce the number of features in image retrieval without minimizing the retrieval accuracy. We present an entropy based Histogram of Gradients (HOG) method for sketch based image retrieval in which a modification has been done in the existing HOG based algorithms by including entropy.

2. Histogram of Gradient with Entropy

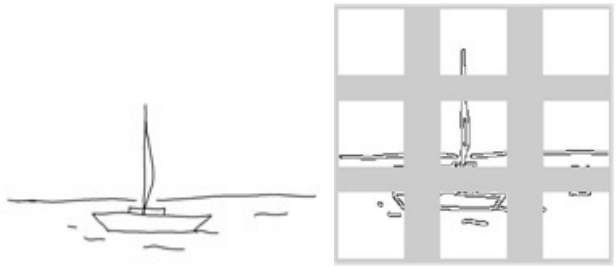
Histogram of Gradient (HOG)[12] is an edge based descriptors used in computer vision and image processing for the purpose of object detection. The image is divided into small regions called cells, then the local appearance and shape of the object is obtained by distribution of intensity gradient and edge directions in HOG descriptors. Since the HOG descriptor operates on localized cells, the method upholds invariance to translation and photometric transformations. As an extension of HOG, Entropy based approach is divided into four step process (i) Partitioning image into blocks and Gradient Computation (ii) Orientation Binning (iii) Prioritizing using entropy (iv) Fast nearest neighbor calculation.

2.1 Partitioning into Blocks and Gradient Computation

The HOG descriptor is a vector formed from the cell histograms from the entire block regions[12]. Two main block geometries are generally used in image processing techniques, Rectangle(R)-HOG blocks and Circle(C)-HOG blocks. In the Dalal and Triggs[12] human detection experiment, the optimal parameters were found to be for Rectangle with 3x3 blocks appears quite similar to the scale-invariant feature transform descriptors; the resized image is then divided into 9 non overlapping blocks of equal size. Based on observation on the benchmark database images, the number of blocks is fixed as 9 blocks (Figure 1a & Figure 1b) inorder to minimize the contribution of different objects in same cell. Discrete derivative mask 1-D centered is applied on the vertical and horizontal directions to obtain the gradients (edge) of image.

2.2 Orientation Binning

The second step of calculation involves creating the orientation based histogram for each cell. Each edge pixel within the cell at least casts a vote for one histogram channel. The bins of histogram are evenly spread over 0_to180_. The human detection experiment[12], shows that an unsigned gradient used in conjunction with 9 histogram bins performs better than other bin distribution. Studies in psychological experiments proves that the HVS is much responsive to orientations 0_, 45_, 90_and 135_. Hence, the optimal parameter 6 bins are selected in between for distributing the gradient value. The gradient magnitude is used as weight for each vote in each pixel.



(a) (b)

Figure 1. (a) Boat Sketch Image. (b) Partitioned image into 9 blocks.

2.3 HOG Based on Entropy

Entropy[13] is the statistical measure of the randomness that gives the object content present in the image. Information

is a very short message that measures the rare content of edge in this image. Note that, the edge information are said to be decreases as the entropy value decreases. The information content is said to be low simply because it has less edge content in the cell. If the pixels are changing in unexpected ways, however, longer messages are required to communicate this fact and the information is said to increase. This assumption helps to identify all changes in the image that are meaningful. Entropy (E) is calculated by the equation 1,

$$E = -\sum_{i=0}^{n} p_i \log(p_i) \quad (1)$$

Where 'p' contains the probability of histogram count of each bin in a block and 'n' is number of histogram bins. The top five blocks that has higher information content are selected for comparison. The entropy value is classified into high or low based on a threshold value and the method of HOG[10] is carried on those blocks instead of whole image to minimize the computational cost. The HOG features of the selected 5 blocks (Figure 2) are used for comparison with database images. It gives a single information value for each block and the corresponding HOG descriptors with 30 values (5 blocks x 6 bins) are

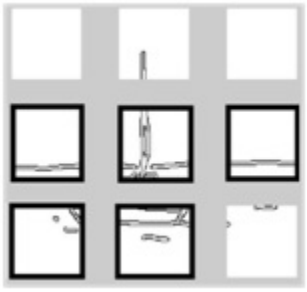


Figure 2a. Partitioned image into 9 blocks.

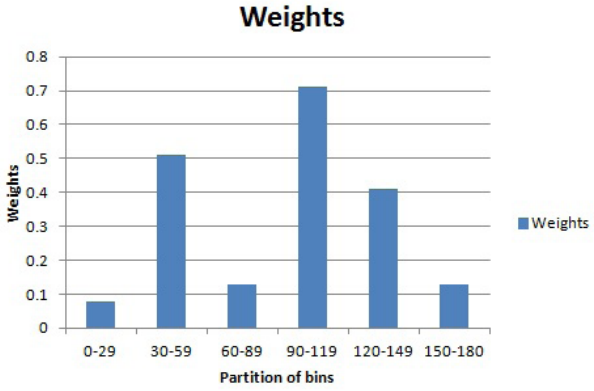


Figure 2b. Selection of 5 blocks.

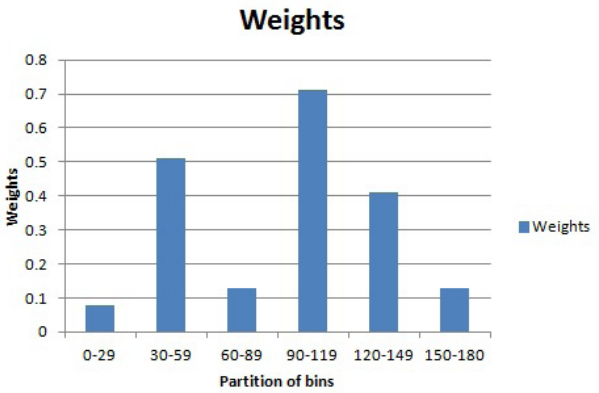


Figure 2c. Histogram for center block.

used for comparison. The number of HOG features are reduced approximately 50% which increases the speed in retrieval.

2.4 Fast Nearest Neighbor

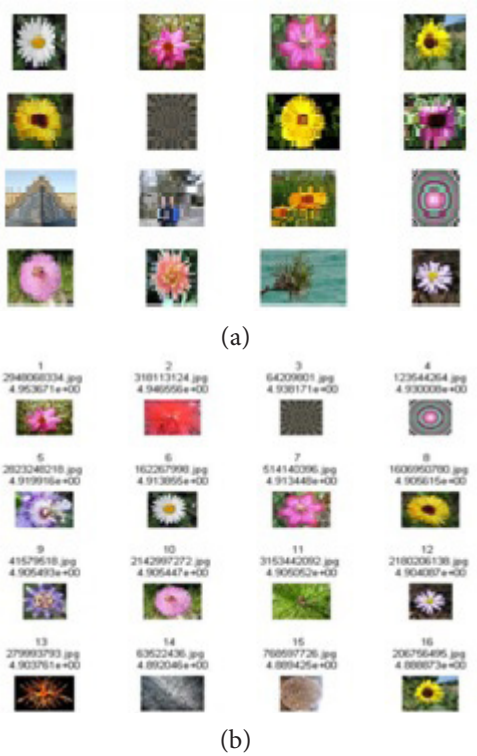
HOG descriptor in the hand drawn sketch is matched by identifying its nearest neighbor key point in the database images. The minimum Euclidean distance helps to identify the nearest neighbor image[3] from the sketch descriptor vector. The ratio of distance from the closest neighbor to the distance of the second closest determines the probability of correct matches. In optimal situations, it is better to reject all matches in which the distance ratio is greater than 0.8, which eliminates 90% of the false matches while discarding less than 5% of the correct matches.

3. Experiment Result

The methods were tested using a standard input benchmark dataset[14] and the system configuration of operating system windows 7 platform with the hardware capacity as i3 processor, 1 GB ram. The Figure 3 depicts the sample input of flower sketch image and its corresponding output is given in Figure 4. In Figure 4(a) on an average of 12-14 images are retrieved using HOG in the top 16 images. The main issue of HOG is the block that are compared has high possibility not containing relevant information i.e. a boat image can match with the moon image because both the images have sky as their background. In order to overcome this drawback entropy based HOG is applied to eliminate the blocks with low information content for better matching process. This method retrieves (Figure 4(b)) on an average of 14-16 images correctly in the top 16 results.

Figure 3. Flower sketch image.

The proposed method is compared with other methods such as IOCM[5], CAS-IOCM[6] and HOG .The stem chart shows the result of various methods for 4 benchmark sketches of boat, buildings, flower and cave with the number of relevant images retrieved in 16 images is given in Figure 5. Indexable Oriented Chamfer Matching (IOCM), generates the distance map which is multi valued is converted to binary similarity map (Hit Map) between sketch image to target image. Context Aware Saliency based IOCM (CAS-IOCM) is an extension of IOCM method, detects the salient regions that are distinctive with respect to both their local and global surroundings for reducing the background information. As shown in Figure 5 the HOG with entropy give better results for most of the cases, but in buildings sketch the IOCM and Entropy based HOG yields almost same result. Information in the building category images are distributed across all the cells .Since the dynamic selection on number of blocks is required then the static number of blocks to increase the accuracy.



(a)

(b)

Figure 4. (a) Results obtained by HOG. (b) Results obtained using entropy based HOG.

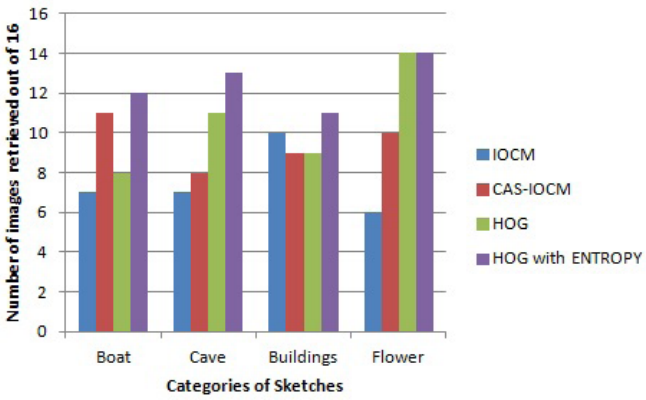


Figure 5. Comparison between various methods.

4. Conclusion

This work involves in designing of an image search engine using sketch based image retrieval. A modification has been done in the existing HOG based SBIR algorithms by including entropy. The results shown in this model can produce the improvement of retrieval for image search engines. Further studies have to be carried out to make this system scale and rotation invariant technique. Dynamically varying the block size depending on the scale of the object and knowledge based block selection method can improve the result of proposed method.

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