A Comparative Analysis of SIFT, SURF and ORB on Sketch and Paint based images

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A Comparative Analysis of SIFT, SURF and ORB on Sketch and Paint based images

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Abstract*: *Image retrieval has been one of the most interesting and emergent research areas in the field of computer vision. Content-based image retrieval (CBIR) systems are used in order to automatically index, search, retrieve and browse images from the databases. Content-based image retrieval system consider colour and texture features of the image, however those features are different in transformed images even though it is the toughest challenge for the CBIR to understand the image. Human perspective that has been based on input is essential for any retrieval system. Hand drawing images and painting images are considered as a query image for this retrieval system. Occluded images are also considered as an input. This paper has explored few eminent feature extraction techniques like SIFT, SURF and ORB as well as the performances of these techniques for sketch and paint based images. The suitable extraction technique is identified by this examination, the significance of SIFT, SURF and ORB features are listed.

Index Terms*: *CBIR, KNN, ORB, SIFT, SURF.

I. INTRODUCTION

The image retrieval problems are solved by Content-based image retrieval (CBIR) system. It is one of the major applications of computer vision technique. One of the image retrieval problems is to search digital images from the large databases. 'Content-based' is defined the metadata of the image such as keywords, tags, or descriptions associated with the image.

CBIR system mostly needs user friendly interfaces; hence the research community concentrates to provide user approachable environment for image based searching. In this context, sketch images are making search easier than the photo images. The painting images are different in texture and contour features but in content based image retrieval, those features are playing vital role to identify images. Mostly researcher's concentrate on photographic image based retrieval. [Peng Lu et al., 2018]. For this study the sketch images were mainly used for all experiments.

In many applications humans would like to give their hand drawing image as a query image. For example, in the Forensic department the hand drawing of criminal images is the query image, and in this context the retrieval system is highly responsible for retrieving appropriate images. This paper mainly considers sketch and paint images for the input.

II. RELATED WORKS

Ebtsam Adel, Mohammed Elmogy et al., (2014) in this survey paper they deliberated on different feature extraction technique. A feature of the image is established by the points, lines, edges, or other geometric entities in it. The strong characteristic detectors have the talent to find the invariance of image noise, scale invariance, translation invariance, and rotation transformations. There are many feature detector techniques, such as Harris, SIFT, SURF and ORB techniques. It also discusses about merits and demerits of the extraction techniques.

Hae-Yeoun Lee, In Koo Kang et al.,(2005) water marking images are input and the proposed system is to prevent system against Geometric distortion attacks. The scale invariant keypoint extractor showed acceptable performance for watermarking images. The input database had noisy images, rotated images and translated images. The Harris corner detector is used to computes moment matrix from the image gradients then eigen values are added finally it

computes the corner strength.

Aomei Li, Wanli Jiang et al., (2017) the proposed system is FAST+SURF feature extractions performed well in occlusion images. Harris method has no scale and rotation invariant but Speeded Up Robust Features (SURF) algorithm, proved to be the best performance algorithm for rotational invariant and affine invariant. SURF extracted feature points less and there are more errors but it is more robust than the FAST method.

Feng-Cheng Huang, Shi-Yu Huang, et al., (2012) Hardware acceleration is needed in many computer vision applications due to its high computational complexity and Scale Invariant Feature Transform (SIFT) hardware acceleration to handle real time images. The SIFT features are invariant to scale, rotation, and illumination. Those features are essential for robot navigation object detection, and recognition. Practically for Graphics Processing Unit (GPU) based system SIFT is perfect technique for handling real time images.

A.V.Kulkarni, J.S.Jagtap, V.K.Harpale (2013) this researchers used Oriented FAST and Rotated BRIEF (ORB) for object recognition but via implementation they compared speed up performance for SURF, SIFT, and ORB. Computer vision kind of applications demands high performance and low complexity solution for this kind of situation as ORB provides better solution to it. ORB features are rotational invariance, and resistant to noise leading to better performance with low coast. Authors have tested the efficiency of ORB on several real-world applications, including object detection and patch-tracking on a smart phone. From the experiment ORB is at two orders of degree faster than SIFT and another advantage is that consumes less memory.

III. OVERVIEW OF FEATURE EXTRACTION TECHNIQUES

A. SURF

Speeded Up Robust Features (SURF) descriptor is intended to be scale invariant and rotationally invariant. It uses to find descriptor and detector. The purpose of a descriptor is to offer a unique description of an image feature, for example, describing the intensity distribution of the pixels within the neighborhood of the point of interest.

Descriptor is sampled over a window that is related to window size so it could avoid descriptor scale, in this way the scaled feature is identified for another image that descriptor feature will be sampled for the same relative area.

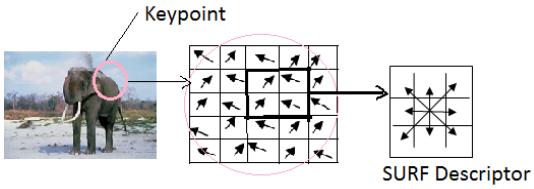

Fig 3.1 SURF feature Extraction

From the description of the image features, the detector helps to find the meaningful or useful features. The SURF feature detector works on the basis of applying an approximate Gaussian second derivative mask to an image at many scales.[Wanli Jiang et al., 2017]

Laplacian is used for edge detection and Gaussian is used for smoothening for combining both features Laplacian of Gaussian (LoG) is used in SURF. The LoG cannot handle corners of image properly so only 45 degree rotation taken place for each axis achieves more robust to rotation. [Ebtsam Adel et al.,2014].

B. SIFT

SIFT is a rotation invariant feature extractor. For every pixel, it provides a set of “features” that “characterize/describe” a small image region around the point. These features are invariant to rotation and scale.

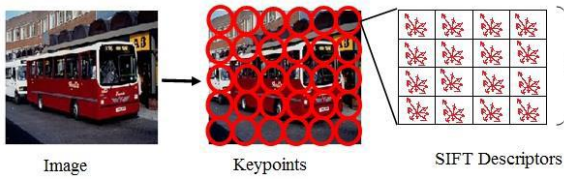

Fig 3.2 SIFT feature Extraction

SIFT keys are used in a nearest-neighbors approach to identify possible objects in an image. Due to the large number of SIFT keys in an image of an object, typically a 500x500 pixel image will generate in the region of 2000 features, substantial levels of occlusion are possible while the image is still recognized by this technique.[Ethan Rublee., 2011]

Steps of SIFT algorithm

- Determine approximate location and scale of salient feature point.
- Refine their location and scale
- Determine orientation(s) for each keypoint.
- Determine descriptors for each keypoint

C. ORB

Oriented FAST and Rotated BRIEF (ORB). It builds on the well-known FAST keypoint detector and the BRIEF descriptor. Both of these techniques are attractive because of their good performance and low cost. It uses multi scale keypoint detector and occlusion descriptor. This descriptor shows rotational invariant and scale invariant. ORB performs faster than SIFT.[A.V. Kulkarni et al., 2013].

IV. IMPLEMENTATION

We measure the performance of SURF, SIFT, ORB with the help of Wang dataset. The data set contains thousand images along with ten different classes.

Name of the Class	Sample Input Data
Bus	

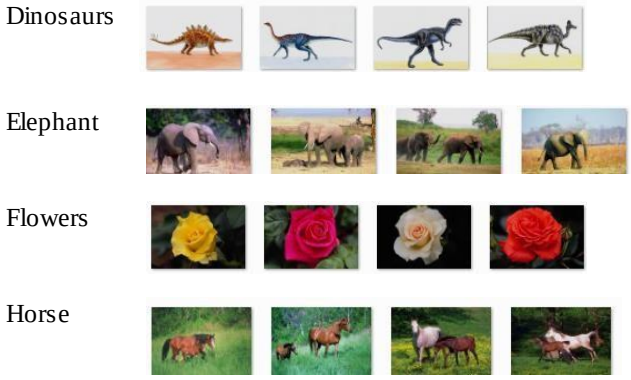

Fig 4.1 Wang Dataset (Photographic Image)

The above all images were read one by one and features will be extracted. The stored features are classified using K nearest neighbor (KNN) algorithm.

The features are trained and labeled. Next the test image features are extracted and matched with the trained classes. The nearest pixel pair images were displayed as the retrieval result.

Here the features are playing essential role. The number of maximum accurate features is very helpful to identify the image.

By the experiment conducted on both photo image and sketch image. 50% paint and sketch images are added for each class and make a new dataset. The new dataset will be the input of SBIR.

Name of the Class	Sample Input Data
Bus	
Dinosaurs	
Elephant	
Flowers	
Horse	

Fig 4.2 Sketch and Paint Images

V. SIMULATION RESULTS

In order to verify the effectiveness of the feature extracting algorithm, the input is given at random and the best result is considered for analysis. In this paper, experiment is carried out with two types of images namely photographic image & sketch and paint images.

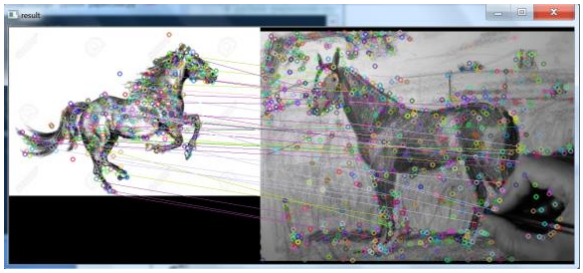

Fig 5.1 Matching result using SURF

Figure 5.1 color lines are denoted as matching features of two different images. 669 number of feature matches are found by SURF technique for two different paint images.

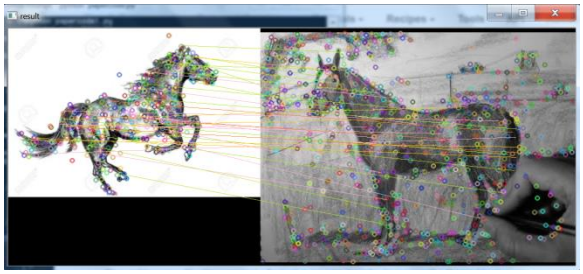

Fig 5.2 Matching result using SIFT

Fig 5.2 shows 896 features are matched for both sketch image while using SIFT technique.

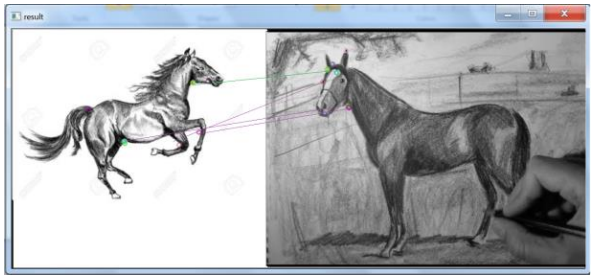

Fig 5.3 Matching result using ORB

Fig 5.3 shows 230 features are matched for both sketch image while using ORB technique .

Table 5.1 Comparative study for existing feature matching technique.

Author and year	**Name of the Algorithm**	**No of features matching**
Shaharyar Ahmed Khan Tareen., et al., iCoMET 2018	SIFT SURF ORB	384 319 854
Ebrahim Karami., et al., Published in ArXiv 2017	SIFT SURF ORB	183 119 168

The above table shows the existing feature matching results for the photo image. From the Table 5.1 author Shaharyar and Ebrahim explained SIFT , SURF and ORB techniques are used to extracted the features and their experiment had showed the number of features matched between two photo images.

Here we use the same experiment with the help of sketch images. From the figure 5.1, 5.2, 5.3 SIFT offers the best feature matching rate for sketch images.

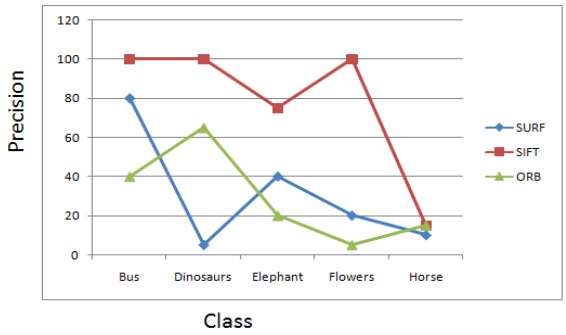

Fig 5.4 Comparative analysis for three technique using photo image dataset

SURF, SIFT, ORB techniques are examined by using Wang dataset. The retrieval rate is calculated using precision formula. From fig 5.4 SIFT offers good retrieval response for three different class. The above result was obtained only for the photo image.

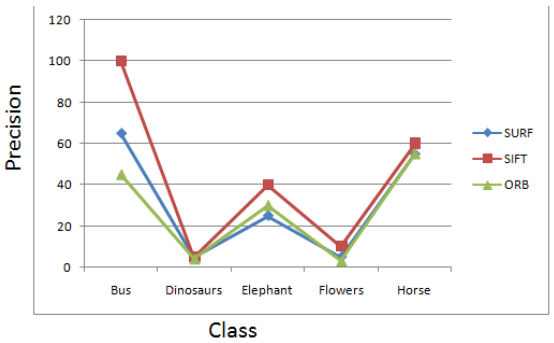

Fig 5.5 Comparative analysis for three technique using sketch image dataset

Next the same feature extraction techniques were examined by using sketch images.

From the fig 5.5 the result obtained from the three different techniques for sketch image dataset but the obtained results were not benchmark standards even though SIFT offers notable performance for sketch images.

The experiment has two phases, training phase and testing phase. In the training phase we input the feature descriptors details into KNN classification. Features are classified and labeled properly. Next the testing phases the query image details were compared to existing labeled features. The Euclidean distance was adopted to measure the similarity of features. The goal of each SBIR task is to find the nearest neighbors (NN) images from the sketch image database or photo image database. The resultant photos or sketches ranked in the top K results.

VI. CONCLUSION

Experimental results have shown the feature extractions performance for sketch and painting images. This demonstration shows SIFT making better results for sketch and paint images. The current work opens a new direction for the researchers in the paint and sketch based images in the CBIR field, and can possibly be applied in numerous vision based applications.

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