A Comparative Review and Optimization of Surf, Brisk and Freak Feature Descriptors

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Abstract— The concept of feature detection is a method to compute abstraction of image information at every point of an image and making local decision at that particular point that there is a feature in an image or not under image processing and computer vision. An interesting part of an image can be called as feature. In this paper I have done the comparison between three keypoint descriptors and have proposed a new combined approach to detect the keypoints present in an image. One of the descriptor is well known as SURF descriptor and other two are new in the fields which are called BRISK and FREAK. In this paper comparison is done between the three descriptor in terms of the Number of Features detected and Time Taken by each of the descriptors to do so. Thus by dividing the time by the number of feature we can calculate the average time taken for a single feature lesser the number greater is Descriptor in terms of speed and lesser computation power. In the end I have made a flow chart of new proposed methodology which I will work to implement that proposed methodology and compare them with the other descriptor in my future work.

Key words: Interest Point, Features, Features Detection, Feature Description. Feature Extraction

I. INTRODUCTION

The concept of feature detection is a method to compute abstraction of image information at every point of an image and making local decision at that particular point that there is a feature in an image or not under image processing and computer vision. An image patch near the features found can be produces after successful detection of the features. A high amount of image processing would be needed in this process of extraction whose result is called feature vector also known as feature descriptor. Local histogram and Njets can be mentioned among one of the methods to detect features. The step of feature detection itself can add some additional attributes such as strength of blob and polarity under blob detection and gradient magnitude, edge orientation under edge detection. Features thus extracted are in form of connecting regions, isolated points and continuous curves. Subset of the image domain is resulting features. [1]

A feature definition changes according to the application type, feature of an image can't be bound to an exact or universal definition. An interesting part of an image can be called as feature. Many computer vision algorithms uses feature as starting point thus whole success of these algorithms depends on how good is the feature detector. Repeatability is necessary property for feature detector between two or more different images of same types to detect that they have same features or not. [1]

The focus of this paper is to perform the evaluation between these descriptor so it may help future researcher which tends to exceed in the field of keypoint description, detection and matching. Which is a key area in the computer vision which serves as a base for many of applications such as object reorganization in fields of robotics and other applications, smile detection in cameras for smart phones, face detection in all digital cameras, panorama shots and many more others, The code of all three descriptors that are SURF, BRISK and FREAK has been implemented in MATLAB version 2015a. In my knowledge under the date of writing this paper no comparison under the MATLAB code has not been done till date and all the implementation has been done in the OpenCV.

II. TECHNIQUES

A. SURF

SURF stand for Speeded Up Robust Features first described by Herbert Bay in May 2006. It is basically inspired from SIFT but having some improvements over it It is a local feature detection which robust in nature meaning it has some extent of fault tolerance. Hessian blob detector are determined by the use of an integer approximation, with the integral image i.e. three integer operations can be processed very quickly. For detection of features around the point of interest response of Haar wavelet is summed up. For detection of features around the point of interest response of Haar wavelet is summed up. Once again computation of these could be done with the help of an integral image. 3D reconstruction and object recognition are main applications of SURF. [2]

B. BRISK

BRISK stands for Binary Robust Invariant Scalable Keypoints. BRISK is equipped with a mechanism for orientation compensation; by trying to estimate the orientation of the keypoint and rotation the sampling pattern by that orientation, BRISK becomes somewhat invariant to rotation.

Preselected pairs are to be used in the BRISK. Thus in the end we get a binary descriptor which works in the hamming distance in place of Euclidean distances. It is a 512 bit binary descriptor which calculates the average weighted Gaussian near the keypoints over a select pattern of points. The comparison of the values is done over a specific Gaussian window pairs depending on the greater window value present in the pair it leads either to a 0 or a 1. The BRISK descriptor is different from the descriptors we talked about earlier, BRIEF and ORB, by having a hand-crafted sampling pattern. BRISK sampling pattern is composed out of concentric rings. [3]

C. FREAK

FREAKS stands for Fast Retina Keypoint. Measurement of orientation is done similarly in FREAK as done in the BRISK the only difference is that FREAK uses a set of

predefined 45 sampling pairs which are symmetric. . Orientation is measures of all the keypoints and rotation of the sampling pairs by the measured angles are done to somehow compensate the changes added due to rotation. It is also the type of binary descriptor that uses the method of pair selection and a sampling pattern as used by the BRISK descriptor. Coarse-to-fine structure is an advantage in this method for speeding up the matching process by using an approach of cascading between the two descriptors. First, when the matching between the two keypoints is done in FREAK only first 128 bits is compared. Candidates more than 90% are discarded as a result of the selection of first 128 bits that results in the acceleration even on further in the matching process as comparison is performed as a cascading operation. [4]

III. RESULTS

A. *Results for Image One*

Fig. 1: Original Image One

Fig. 2: Results of SURF on Image One

Fig. 3: Results of BRISK on Image One

Fig. 4: Results of BRISK on Image One

Fig. 5: Original Image Two

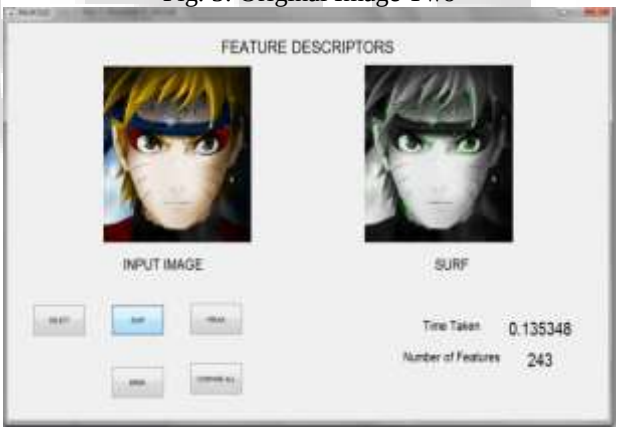

Fig. 6: Results of SURF on Image Two

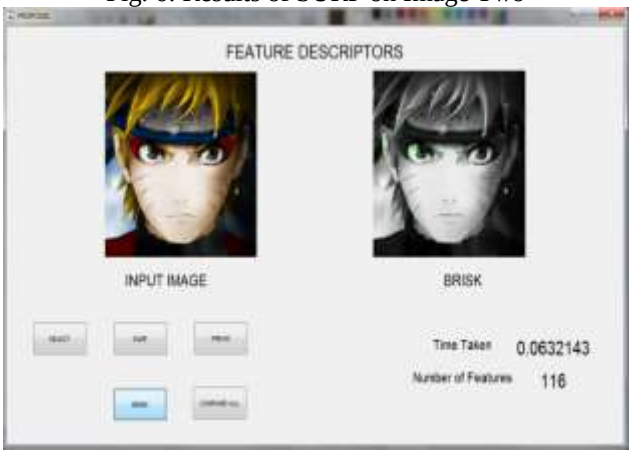

Fig. 7: Results of BRISK on Image Two

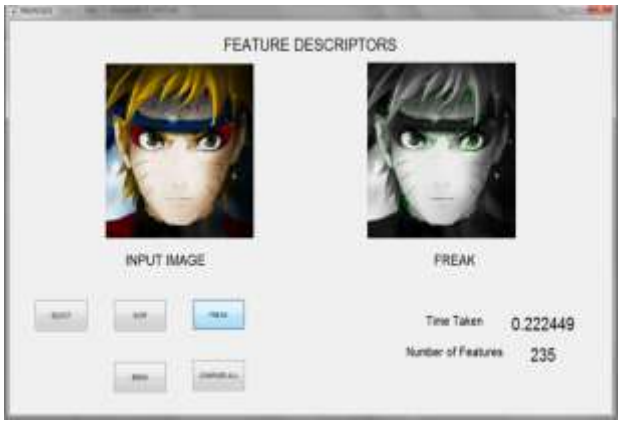

Fig. 8: Results of FREAK on Image Two

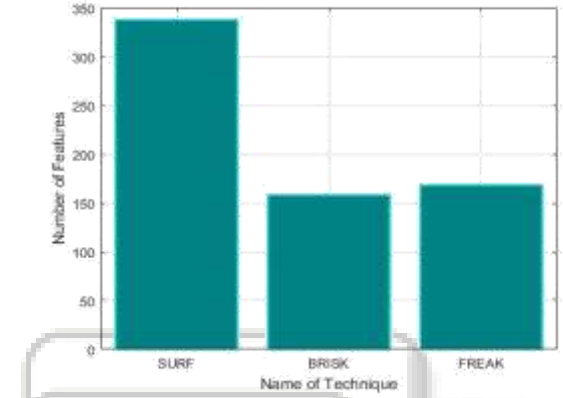

Fig. 9: Bar Graph for Number of Features for Image One

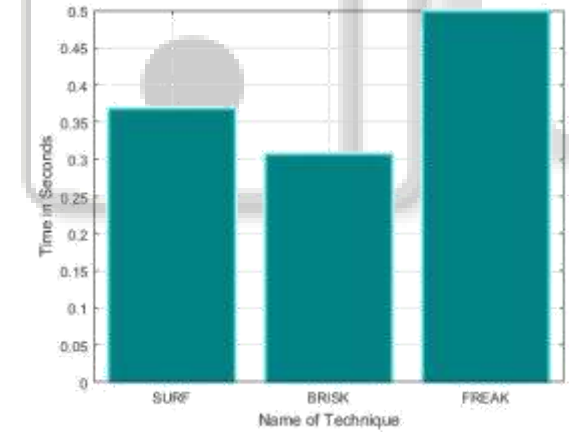

Fig. 10: Bar Graph for Time Taken for Image One

Technique	SURF	BRISK	FREAK
For Image One			
Time	0.148052	0.0665484	0.231741
Features	338	158	330
Avg. Time	$4.408 \times e^{-4}$	$4.211 \times e^{-4}$	$7.022 \times e^{-4}$
For Image Two			
Time	0.135348	0.0632143	0.22449
Features	243	116	235
Avg. Time	$5.567 \times e^{-4}$	$5.449 \times e^{-4}$	$9.552 \times e^{-4}$

Table 1: Comparison of Results

IV. New Proposed Technique

A new technique which combines features SURF, BRISK and FREAK.

As we know that FREAK needs keypoints detected by a detector in its first step. But SURF and BRISK can be used as a detector as well of their own. In this new proposed methodology I intend to use detector feature of BRISK and FREAK as well as the detection capabilities of FAST as first step as well. FAST as its name tells is very fast indeed as compare to other detectors still till this date despite being and old detector. This will provides a certain edge and will not add massive time strains to new method timing. For the time being name of this methodology will be ZEON so that we don't have to use terms PROPOSED or NEW METHODOLOGY again and again. In my future I will try to implement ZEON and I will present a paper with results of SURF, BRISK and FREAK methods and compare them with ZEON methodology.

V. Conclusion

In this paper the main focus was to evaluate the results of three mainstream descriptors under implementation in MATLAB. I found that despite of being old SURF is still both more quick and robust in keypoint detection as compare to both BRISK and FREAK. SURF extracts maximum numbers of features in a very less time every single time. FREAK also extracts good number of features a little less then SURF but takes more time then both but it overcomes this drawback by having maximum accuracy. FREAK takes time may be it need to run a detector first and then FREAK method is applied a single line code for FREAK is yet not available in MATLAB for FREAK as for BRISK and SURF is available. BRISK is lacking behind in terms of number of features but it also takes much lesser time so this makes it number one in terms of average time taken per feature.

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