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Texture Extraction Using Speeded Up Robust Features (SURF) Method

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Abstract: **Today, different methods of texture extraction are available which acquire image features depending on image texture. This paper gives an innovative feature extraction technique called Speeded up Robust Features (SURF) method. This method provides descriptive representation of an image by obtaining information in the form of key-points. To detect key-points, SURF uses determinant of Hessian blob detector. SURF method gives excellent performance over earlier methods due to robustness, fast computation and comparison features. This is achieved by using integral image representation and due to its invariant nature to image rotation. In this paper, we have conducted experiments on UMD texture dataset and also calculated Euclidean distance from image feature. The results show strong performance of SURF method in terms of computation and matching.**

Keywords: **Description, Detection, Euclidean distance, Extraction, Key-points, Matching.**

I.INTRODUCTION

Texture is a repeating pattern of variation in pixel intensities. It plays important role in image classification as it describes the appearance of object. If there is an image in which three objects are overlapped, we cannot identify them separately. But the objects can be characterized by using their textures because each image has a specific texture. Many real world applications like rock classification, wood species recognition, face recognition, geographical landscape segmentation, and object detection use the texture information from images. In all these applications, the target object is viewed as a specific type and hence they can be solved using texture extraction [1], [2], [3].

Texture extraction is the process to characterize each texture class in terms of feature measures. There are many texture extraction methods were introduced like gray level co-occurrence matrices (GLCM), Gabor filters, Local Binary Pattern (LBP)[4], wavelet transform methods, and Independent component analysis. All these methods are based on simple computations and take more time for execution. Surf method is superior to all these earlier methods due to having advantages like robustness, fast computation and comparison. SURF technique is also good at handling blurred and rotational images. To speed up the performance, intermediate image representation that is integral image is used [5], [6].

SURF is a texture detector and descriptor method which has application in object recognition, image registration, classification, reconstruction of 3D scenes and tracking objects. To extract features from an image, point of interests are founded by using Hessian blob detector. Further description is obtained for each point of interest. The descriptor is based on sum of Haar wavelet responses around the point of interest. Last stage of SURF method is comparison and matching of descriptors obtained from different images [7].

II.RELATED WORK

Many researchers have developed different texture extraction algorithms which include co-occurrence matrices[8], Markov random field, Gabor filter bank, Local Binary Patterns and Scale Invariant Feature Transform. The key idea behind these methods is to capture information from image. To acquire information Gabor based method uses the response of Gabor Filter banks[9], LBP uses difference of pixel values. In LBP, the information provided by the magnitude of the pixels is ignored which causes loss of captured information about image features [10].

Shokoufandeh et al.,[11] provides more distinctive feature descriptors using wavelet coefficients . Pope and Lowe [12] used features based on the hierarchical grouping of image contours, which are useful for objects lacking detailed texture. Matas et al., [13] have shown that maximally-stable external regions can

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produce large numbers of matching features with good stability. Mikolajczyk et al., [14] have developed a new descriptor that uses local edges while ignoring unrelated nearby edges.

SIFT extracts features that can be invariant to image scale and rotation but it takes much time in computation of results. These techniques fail to achieve fast calculation and matching. David G. Lowe presented paper on distinctive image features from scale invariant key-points method for extracting distinctive invariant features from images that can be used to perform reliable matching between different views of an object or scene [15].

SURF overcomes these problems and speed up the computation with the help of integral images. Hessian matrix determinant is used in SURF to detect the location of interest points and gives stable performance as compared to other detectors like Harris detector. SURF features are extracted in terms of key-points which are found by describing the intensity distribution of pixels [16].

III. Texture Extraction

In this section we present our approach. First input image is taken from UMD dataset and then SURF features are extracted from it. Simplified block diagram of this method is shown below:

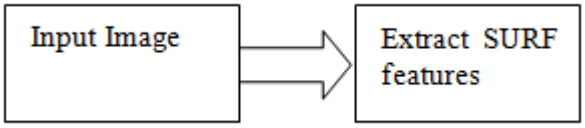

Fig.1. SURF feature extraction

UMD dataset contains 25 different texture classes with 40 images in each class. The size of images is 1280x960. Each class in the dataset consists of viewpoint changes and scale differences. The textures include images of fruits, shelves of bottles and buckets, various plants and floor textures. SURF algorithm is carried out in following parts-

A. Integral image computation-

Integral image representation is necessary to boost the performance of SURF method. The integral image is computed for each input image and is used to speed up the calculation of any upright rectangular area. If input image and a point with coordinates X and Y are given then integral image is calculated by the sum of the values between the point and the origin. Calculation of integral image is shown in following figure-

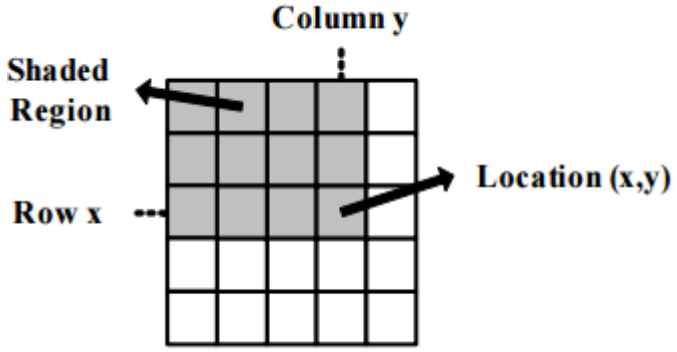

Fig.2 Calculation of integral image

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If i is an input image then integral image ii is given by following formula at location (x,y)

$$ii(x,y) = \sum_{x' \le x,\, y' \le y} i(x',y')$$

B. **Interest point detection-**

To detect interest points, SURF uses Hessian blob detector which is computed by using integral image. Determinant of Hessian matrix is used to measure the local change around the point of interest and points are chosen where this determinant is maximum. If we have given a point P(x,y) in an image I then Hessian matrix H(ρ,σ) is given by,

$$H(p,\sigma) = \begin{pmatrix} L_{xx}(p,\sigma) & L_{xy}(p,\sigma) \\ L_{yx}(p,\sigma) & L_{yy}(p,\sigma) \end{pmatrix}$$

Where $L_{xx}(\rho,\sigma)$, $L_{xy}(\rho,\sigma)$, $L_{yx}(\rho,\sigma)$ and $L_{yy}(\rho,\sigma)$ are second order derivatives of gray scale image.

C. **Description-**

Descriptor is used to provide a unique and robust description of an image feature by describing the intensity distribution of pixels within the point of interests. This descriptor is based on Haar wavelet responses which are computed in X and Y direction around the point of interest. Description is obtained for every point of interest identified previously.

D. **Matching-**

In the matching stage, matching pairs are found by comparing the descriptors obtained from different images. We compare features if they have same type of contrast.

IV. Experiments and Results

To analyze the performance of the proposed method, we conduct experiments on six images from UMD dataset.

Result of SURF feature extraction of test input image is shown below-

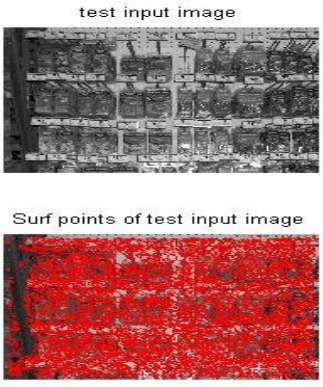

Fig.3 SURF feature extraction of test input image

Results of SURF extraction features of other images from dataset are obtained by comparing features with test input image as below-

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Result of comparing SURF features of test input image with image 1:

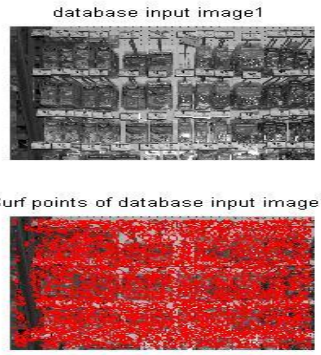


Fig.4 SURF feature extraction of image 1

Result of comparing SURF features of test input image with image 2:

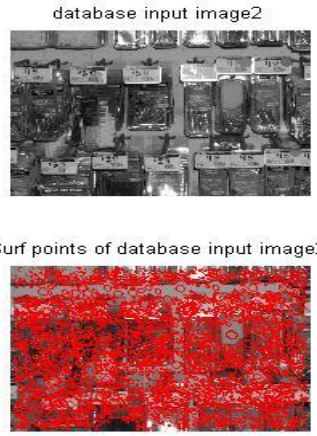
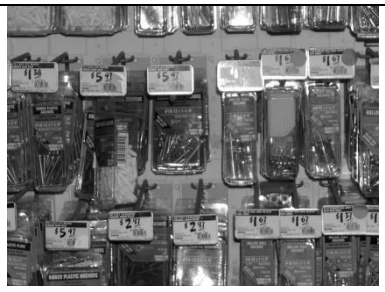


Fig.5 SURF feature extraction of image 2

The experimental result of all six input images are summarized in following table-

Serial Number	Images	Key-points	Euclidean distance by compairing with test input image
1.		6575	0

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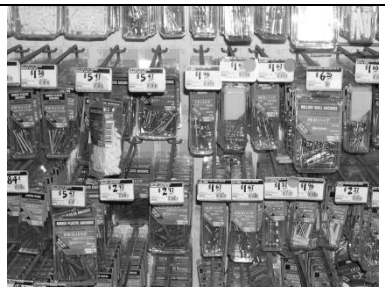
2.		5714	0.4896
3.		6671	0.5463
4.		7201	0.6480
5.		6306	0.7403
6.		6428	0.8645

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7.		6276	0.9139

Above table shows experimental results of six dataset images by comparing with the test input image. Here key-points and Euclidean distances of each input image are plotted. Euclidean distance of first image is zero because we have compared first image with image itself likewise other euclidean distances are also computed.

V .CONCLUSION

We have proposed SURF feature extraction techniques in which SURF feature are extracted by obtaining key-points and description is given for each detected point of interest. We have also calculated Euclidean distance between SURF features of input images. From its results, we can say that the images having quite similar texture have less Euclidean distance as compared to the images with dissimilar textures.

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