IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 18, Issue 6, Ver. IV (Nov.-Dec. 2016), PP 144-146
www.iosrjournals.org

Digital Image Forgery Detection Using SURF

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Abstract: *Digital images are widely used today. One of the principal problems in image forensics is determining if a particular image is authentic or not. This can be a crucial task when images are used as basic evidence to influence judgment like, for example, in a court of law .Copy-move tampering is a common type of image synthesizing, where a part of an image is copied and pasted to another place. In this paper, an efficient algorithm based on the SURF is proposed . Results of experiments indicate that the proposed method is valid in detecting the image region duplication and quite robust to additive noise and blurring.*
Keywords: *Image forensic, Copy-move forgery, SURF.*

I. Introduction

Digital crime , together with constantly emerging technologies, is growing at a rate that far surpasses defensive measures. Sometimes a digital image or a video is incontrovertible evidence of a crime or the proof of a malevolent action. By looking at digital content as a digital clue, multimedia forensics aims to introduce novel methodologies to support clue analysis and to provide an aid for making a decision about a crime .Even though tampering with photograph is not new, during the past few years, doctored images are appearing with growing frequency and sophistication. This is mainly due to the availability of low-cost hardware and photo editing software which makes it easy to manipulate and alter digital images without leaving any obvious trace.

II. Proposed Method

Copy-Move Forgery Detection has five steps

2.1 Pre-Processing

Here the image is converted from its RGB to Gray representation

2.2 Feature Extraction

The features can be extracted by using SURF (Speeded Up Robust Features) method. SURF is the
robust local feature detector. It is based in sums of 2D Haar Wavelet responses and makes an efficient use of integral images. SURF features can be extracted using the following steps:

- Integral Image
- Keypoint Detection
- Orientation Assignment
- Feature Descriptor Generation

2.2.1 Integral Image:

Integral Image increases the computation speed as well as the performance, its value is calculated from an upright rectangular area, the sum of all pixel intensities is calculated. Which is in the rectangular area whose vertices are A, B,C and D. It allows for fast computation of box type convolution filters. Suppose an input image I and a point(x, y) is given. The integral image $I\Sigma$ is calculated by the sum of the values between the point and the origin.

2.2.2 Keypoint Detection:

This step requires scale space generation for the extraction of keypoints. To detect the blob- like structures at locations where the determinant is maximum. In SURF Laplacian of Gaussian is approximated with a box filter. Convolution is applied to an image with varying size box filter for creating the scale space. After constructing the scale space, determinant of the Hessian matrix is calculated for detecting the extremum point. If determinant of the Hessian matrix is positive that means, both the Eigen values are of the same sign either both are negative or both are positive. In case of the positive response, points will be taken as extrema otherwise it will be discarded .Hessian matrix is represented.

Where, $L_{xx}(x, \sigma)$ is the convolution of the Gaussian second order derivative with the image I in point x, and similarly $L_{xy}(x, \sigma)$ and $L_{yy}(x, \sigma)$. These derivatives are called as Laplacian of Gaussian. The 9×9 box filters are approximation of the Gaussian and represent lowest scale for computing the blob response maps. The approximate determinant of the Hessian matrix is calculated .Where 0.9 represents the weights applied to the rectangular regions are simple for computational efficiency. The relative weight of the filter responses is used to balance the expression for the Hessian's determinant. The approximated determinant of the Hessian represents the blob response in the image at the specified location. These responses are stored in a blob response map over different scales, and local maxima are detected

2.2.3 Orientation Assignment:

At first a circular area is constructed around the keypoints. Then Haar wavelets are used for the orientation assignment. It also increases the robustness and decreases the computational cost. Haar wavelet responses are calculated within a circular neighbourhood of some radius around the interest point. Haar wavelets are filters that detect the gradients in x and y directions. In order to make rotation invariant, a reproducibleorientation for the interest point is identified.

Once the wavelet responses are calculated and weighted with the Gaussian centered at the interest points, the responses are represented as points in a space with the horizontal response strength and the vertical response strength. The dominant orientation is estimated by calculating the sum of all responses within a slidingorientation window. The horizontal and vertical responses within the window are summed. The two summed responses then yield a local orientation vector. The longest such vector over all windows defines the orientation of the interest point. A circle segment of 600 is rotated around the interest point. The maximum value is chosen as a dominant orientation for that particular point.

2.2.4 Feature Descriptor Generation:

For generating the descriptors, first construct a square region around an interest point, where interest point is taken as the center point. This square area is again divided into 4 × 4 smaller subareas. For each of this cell Haar wavelet responses are calculated. Here dx, termed as horizontal response and dy, as vertical response. Horizontal and vertical response represents the selected interest point orientation. The wavelet responses dx and dy are summed up over each sub-region and form a first set of entries in the feature vector. And then extract the sum of the absolute values of the responses | dx | and | dy |. For each of this sub region 4 responses are collected. So each sub region contributes 4 values. Therefore the descriptor is calculated as 4 × 4 × 4 = 64.

2.2.5 SURF feature descriptors matching:

Keypoints match is done between two images typically. Given a pair of images i**I** , j**I** with their respective interest points and feature descriptors, for every interest point in the first image Ii, we calculate the Euclidian distance to all feature descriptors in the second image i**I** . If the ratio of the nearest neighbor and the second-nearest neighbor is smaller than a predefined threshold, which is discussed in the experiment, a match is assumed to be correct and is therefore added to the list of putative matches. In our paper, the matchprocess of keypoints is done by matching between two subsets of the keypoints set of the test image, as described in follows:

(1) Given a keypoints set of test image as S , randomly divide the set into two subsets as $_1S$, $_2$ S , $_{12}S$ *S =S .

(2) Find the nearest neighbors in $_1S$, $_2S$, and save the matching records.

(3) Applying step (1), (2) to $_1S$, $_2S$ respectively and repeatedly until $_1S$, $_2S$ only contains one element. By using the above matching method, the keypoints matches can be found, and the duplication can be further determined.

III. Experiment

3.1 Experiment Setup

The SURF algorithm implemented by Herbert Bay et al. is used to detect the keypoints and get the descriptors. The experiment environment is as follows, the operation system is based on the Linux2.6.32-22 kernel, GCC 4, 64 bit. In the experiment, we use the extended descriptor mode to get the128d SURF descriptors. The test images are chosen from the UCID: Uncompressed Color Images Database, and edited using the GIMP software.

3.2 Experiment Results and Analysis

As shown in Fig.1(a) is the original images 'car' and , (b) is the faked image of copy-move forgery .In the latter one the car was copied and pasted on its right side. The proposed detection method is used to detect duplicate regions in them. SURF keypoints features are extracted by first, and their descriptors are matched within each other with a threshold ω. A larger threshold means more match points, thus tends to come with more false matches, while a smaller one will get more accurate matches with less match points. In this paper, it is empirically set to be 0.35, within all the test images, to strike a balance between numbers of correct matches and total numbers of matches.

The detection results are displayed in the image with lines between two matched keypoints. By observing the detection results, the duplication regions can be figured out. The robustness of the proposed method to scaling, rotation, blurring and noise are further tested. Images are copied and pasted with operations such as, scaling, rotation, blurring and additive noise. We can find the proposed method can reliably detect the duplicated regions, and can stand the operations of scaling, rotation, noise and so on

Fig. 1(a) Original Image

Fig.1(b) Example of a copy move forgery image

IV. Conclusion

Detecting and extracting the robust SURF interest points and their descriptors by first, the possible duplicated regions in test images can be found by matching the descriptors vectors. Experiment result indicate that this method can detect the copy-move forgery quickly, and can stand certain transformations and post processing such as, scaling, rotation, noise blurring and so on. However, further investigation is still needed to automatic locate the tampered region and its boundary.

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