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Jewels Originality Using SIFT and SURF

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Abstract: Copyrights is considered the most important issue that the most of the jewelry designers and jewelry companies worries about and any other art designers, each designer have his own style and local features that is built in the jewels, each feature is unique and cannot be faked by global brands counterfeit. This study propose a jewels features recognition method, Speeded up Robust Feature (SURF) algorithm or Scale Invariant Feature Transform (SIFT) are used for allowing the proper detection of watermarks, even in the case where the features in image have been partially altered or rotated. For the recognition of the chosen object area after geometrical distortions, jewels features using SURF or SIFT are estimated and stored prior to the process for usage throughout the procedure of detection. In the step of detection, the SURF/SIFT features of the jewels image are obtained then they undergo matching against the stored images. From the results of matching, SURF/SIFT properties are utilized for computing the affine-transformation parameters and the object area is then recovered.

Key words: Speeded up Robust Feature (SURF), Scale Invariant Feature Transform (SIFT), parameters, jewelry designers, copyrights, recognition method

INTRODUCTION

SIFT algorithm in image processing used for features description and detection in images, in any image region of interest in any object have many features that can be extracted and described for this object. This feature can be used for object matching or recognition of objects in images that contain different objects, the feature extracted from image can be matched in different situation in scale, rotation, illumination and view point.

The positions of feature saved in the system have fixed position between these features and should not change in image and from one image to other (Girshick *et al*., 2014).

In this system, the SIFT algorithm is used for showing the originality of jewels, the genuine jewelry have its own feature that can be saved and any fake jewelry the feature is not exactly the same in (i.e., distance between feature is not the same and other features) (Lowe, 1999).

Scale Invariant Feature Transform (SIFT): Mainly the proper use of image features that is extracted from that image and saved in system database usually considered difficult and complicated in application of computer vision and image processing.

Different image situation and complex environment that the system can work with the image (scaling, illuminating, rotating and viewing) the SIFT still can perform the identification and matching correctly (Lowe, 2004).

SIFT algorithm (Otero, 2015)

Scale space construction: The SIFT start with generating scale space that is used later for the scaling of features invariance (Fig. 1).

Laplacian of Gaussian: Identifying the keypoints by many mathematical steps (Fig. 2 and 3) (Paganelli *et al*., 2012).

Fasting approximate keypoints finding: both maximum and minimum operation is applied to the keypoints. (Fig. 4) (Ke and Sukthankar, 2004).

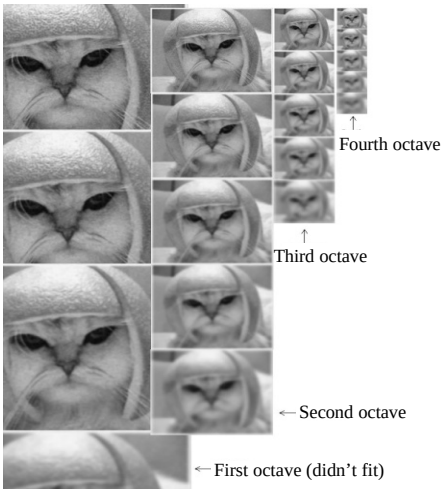

Fig. 1: Scale_space calculation

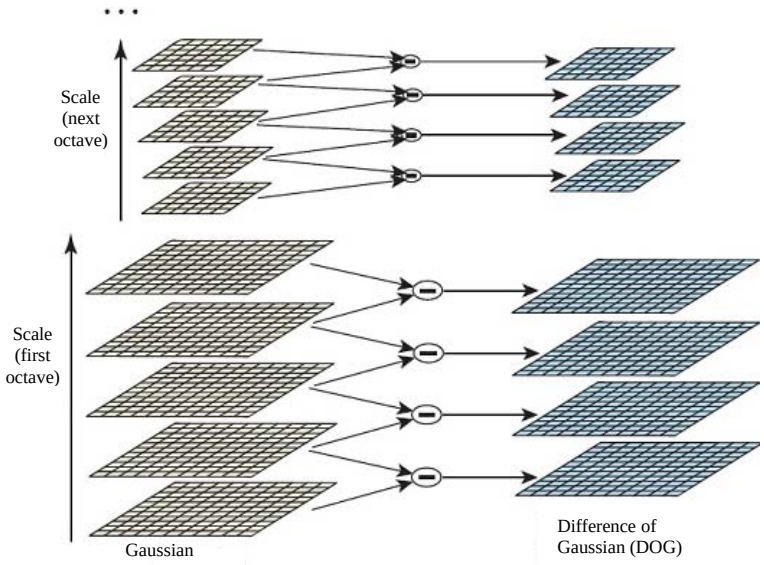

Fig. 2: DOG

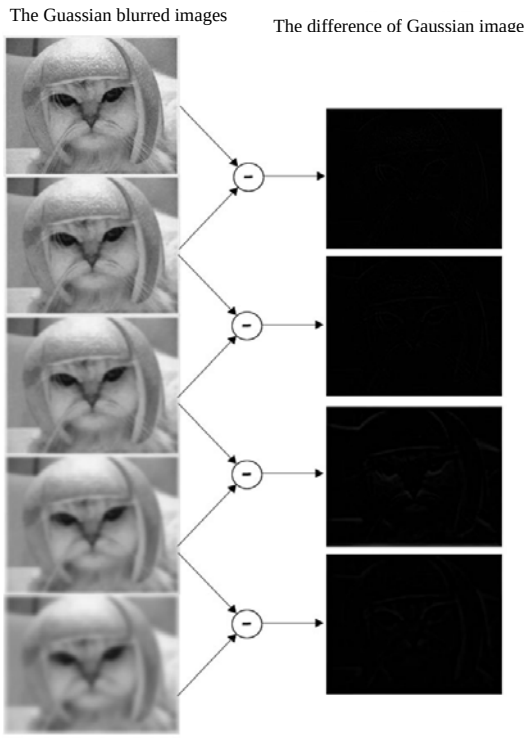

Fig. 3: Calculating DOG

Unstable keypoints eliminating: The eliminating of weak keypoints in the system.

Orientation calculation of keypoints: The rotation of keypoint should not affect the system, since, it is invariant the calculation of orientation is done in this step.

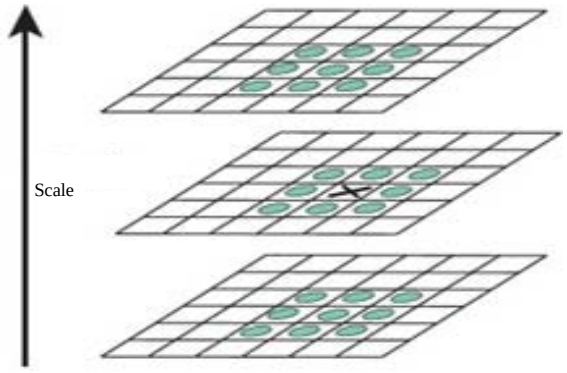

Fig. 4: Identification of keypoints

Feature saving and generation: Generating the feature and extract it and then each feature (unique feature) can be used for feature identification and detection (Wu *et al*., 2013).

SURF algorithm: An important patented local feature detector and descriptor is the SURF which is stand for Speedup robust features. SURF might be utilized for operations like identification of object, classification or three-dimensional reconstruction, image registration. It's partially inspired by the descriptor of SIFT. The standardized version of this algorithm is much faster than the original SIFT and it is claimed by its authors that it is stronger against various image transformations than the SIFT (Bay *et al*., 2006).

For the detection of the points of interest, SURF utilized an integer approximation of the determinant of Hess (blob detector) that may be calculated with three integer processes with the use of a pre-computed integral

image. Its property descriptor is based on the summation of the Haar wavelet responses around the interest point. Those may be calculated using the integral image as well (Bay *et al*., 2006).

The descriptors of SURF have been utilized for locating and recognizing items, individuals or faces, reconstructing three-dimensional scenes, tracking objects and extracting interest points.

The SURF algorithm is based on the general ideas and phases as the original SIFT algorithm, however, the details in every one of the steps are different. The approach has 3 basic parts: the detection of the point of interest, the description of the local neighborhood and matching (Bay *et al*., 2008).

Detection: This algorithm utilizes square-shaped filters as an approximate of Gauss smoothing. (While the cascaded filters utilizes in SIFT algorithm for the detection of the scale invariant property points where the computation of difference of Gaussians is done in a progressive manner on re-scaled images). The operation of image filtering by using a square is usually faster in the case where the integral image is utilized (Rublee *et al*., 2011):

$$S(x, y) = \sum_{i=0}^{x}\sum_{j=0}^{y} I(i, j)$$

Input image summation inside a rectangle may evaluated quickly with the use of the integral image which requires evaluations at all 4 rectangle corners.

SURF utilizes a blob detector which is dependent on the Hess matrix for finding the interest points. The determinant of the Hess matrix is utilized in a form of a measurement of the local variation that is detected around this specified point and other points are selected where the determinant usually is maximum. As opposed to the Hess-Laplace detector, this algorithm utilizes the determinant of the Hess for choosing the scale interest (Rublee *et al*., 2011).

Considering:

- Point p = (x, y) in image I
- The Hess matrix H (p, σ) at point p

Scale σ is as follows:

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

Scale-space representation and location of points of interest (Dreuw *et al*., 2009): Points of interest may be detected by using different scales, partially due to the fact that the search for correspondences need images seen at different scales and requires comparison these images. In other property detecting methods, the scale space is typically realized usually as an image pyramid. Images are smoothed repeatedly with the Gauss filter, then the next higher pyramid degree calculated by the smoothed images are sub sampled. Thus, many stairs or floors with various measures of the masks can be calculated:

$$\sigma_{approx.} = \text{Current filter size} \times \left(\frac{\text{Base filter scale}}{\text{Base filter size}} \right)$$

Descriptor (Badrinath *et al*., 2011): The objective of a descriptor is providing an individual and strong description of image features, for example, via. the description of the pixels intensity distribution of in the surrounding of point of interest. The descriptors majority is therefore, calculated locally, therefore, a description is reached for each of the interest points that have been previously identified.

The descriptor dimensionality plays a direct role in matching point's robustness/precision and each of its computational complexity. A short descriptor can be stronger in the face of appearance changes, however, it may not provide efficient distinguishing and therefore, give a big number of false positives.

The initial phase is made up of fixing a re-producible direction according to the data from a circular area that surrounds the point interest. Then, the task is constructing a squared area that is aligned to the chosen direction and the SURF will extract from it.

Assigning orientations (Jun-Wei *et al*., 2014): For the sake of achieving invariance in rotation, the direction of the interest point must be computed. The Haar wavelet responses in each of x and y direction in radius that surrounds the point of interest with circular neighborhood of are calculated. The responses that are resulted are then weighted via. a Gauss function which has its center at the interest point, afterwards plotted as points in a 2D plane, with the vertical response in the ordinate and the horizontal one in the abscissa. The dominant direction could be founded via. the calculation of the summation of all of the responses in a sliding orientational window that has the size "π/3". The horizontal response and the vertical response in the window undergo the summation. Both of the summed responses afterwards result in a local vector of orientation. The longest of those vectors generally selects the direction of the interest point. A parameter which represents the sliding window size is

which must be selected carefully for the sake of achieving the wanted balance between angular resolution and robustness.

Descriptors based on Haar wavelet responses (summation) (Jun-Wei *et al.*, 2014): A squared area is obtained for describing the area which surrounds the point and the following steps are done:

- The point of interest centered and directed along the orientation
- The area of interest is divided into smaller squared sub-areas (4×4 smaller sub-images)
- For every one of them, the Haar wavelet responses are obtained at 5×5 regularly spaced sample points
- The responses are weighted with Gauss (for the sake of offering more robustness for distortions, translation and noise)

Matching operation (Bao *et al.*, 2011): Through the comparison of the descriptors that have been extracted from various images, pairs matching may be detected.

MATERIALS AND METHODS

Proposed system: The proposed system algorithm is given below.

Step 1: Start
Step 2: By using camera or mobile camera the jewels picture acquisition is done
Step 3: Preprocessing for image is applied to remove noise and unwanted information
Step 4: ROI (Region of Interest) is detected and bordered using SIFTS or SURF
Step 5: Jewels features calculated and extracted and saved in system
Step 6: Matching operation is done for features saved in the system and features from new image
Step 7: Obtain results
Step 8: End

Main steps applied in our system

Image acquisition: Jewelry acquisition is done by using any photographic method (camera, smartphone camera, image scanner or monitoring camera) the obtained image is go through many steps:

- Image preprocessing
- Smoothing
- Noise removal

Detection of edges: Since, two descriptors methods applied in our system the edge detector is treated as an internal operation inside SIFT or SURF and the edge usually, since, it have more information than the other places in the jewelry images and by using the variation in intensity which is changing rapidly the specification of the ROI could be done in this step.

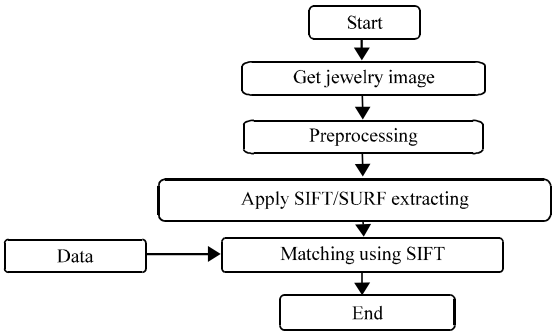

Fig. 5: Proposed system

Image segmentation: This operation is an internal step in both SIFT and SURF several levels of segmentation is applied to help in identifying the Region of Interest (ROI) The jewelry image entered the system segmented several times to identify the region of interest and match it which can be done easily by subdividing the ROI (Region of Interest) this operation is done internally inside SIFT.

Feature extraction: The features inside any jewelry image is extracted which can be used later for matching and recognition nevertheless the orientation and the side view of the jewelry image the result will be the same and feature is extracted anyway only SIFT family and SURF can provide such attribute.

Matching operation: The result obtained from the system by applying the matching is done in this step and decision about the genuinely of the jewelry mark detected and shown by using the feature obtained (extracted features) from the Jewelry image which can be match with feature that is saved inside database for the original jewelry design image (Fig. 5).

RESULTS AND DISCUSSION

The jewelry design image is rich with features that is unique and can be done for matching and checking the originality of the jewelry each company has its own local features that cannot be found in any other faked one as shown in Fig. 6.

Figure 7 shows the matching operation using SIFT which is applied for both images, the first image represent the original design of jewerly (left jewels) which is processed by SIFT and the feature obtained from this design is saved in the system database, the second image represent the market jewels image which is need to be checked for orginality (right jewels), general shape of both jewels is the same, since, both of them is made by similer raw materials and done by same machine or art jewelry industry experts and by the same company the featured

Fig. 6: Sample jewels design and design feature

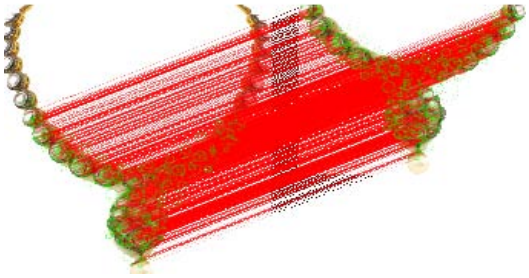

Fig. 7: Genuine design matching using SIFT

obtaind from it will be the same and will be matched correctly and the system will identify it as a genuine.

Figure 7 shows the matching operation using SURF which is applied for both images, the first image represent the original design of jewerly (left jewels) which is processed by SURF and the feature obtained from this design is saved in the system database, the second image represent the market jewels image which is need to be checked for orginality (right jewels), general shape of both jewels is the same, since, both of them is made by similer raw materials and done by same machine or art jewelry industry experts and by the same company the featured obtaind from it will be the same and will be matched correctly and the system will identify it as a genuine (Fig. 8).

The originality of non-genuine jewels will be checked by using same concept with low number of matched features the jewels will consider unoriginal, since, the data obtained from both images are not the same due to differences in raw material and manufacturing method (Fig. 9).

The feature of jewels image are not the same and it is different every time the image is captured using camera or mobile camera and the matching operation still can be performed, since, the SIFT and SURF can be work with different rotation and illumination and lighting conditions.

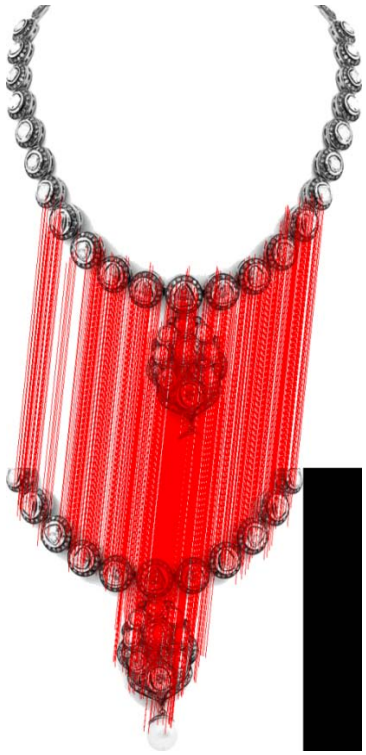

Fig. 8: Genuine design matching using SURF

Fig. 9: Fake design unmatched

Figure 10 shows the internal operation inside SIFT where DOG discrete extrema calculated, Fig. 11 DOG discrete extrema with thresholding will be applied, Fig. 12 the candidate keypoints after refinement is applied which is lead to the final keypoint which can be defined as in Fig. 13 and SURF descriptor of the key point is applied as in Fig. 14.

Fig. 10: DOG discrete extrema

Fig. 11: DOG discrete extrema with thresholding

Fig. 12: Candidate keypoints after refinement

Fig. 13: Final keypoints

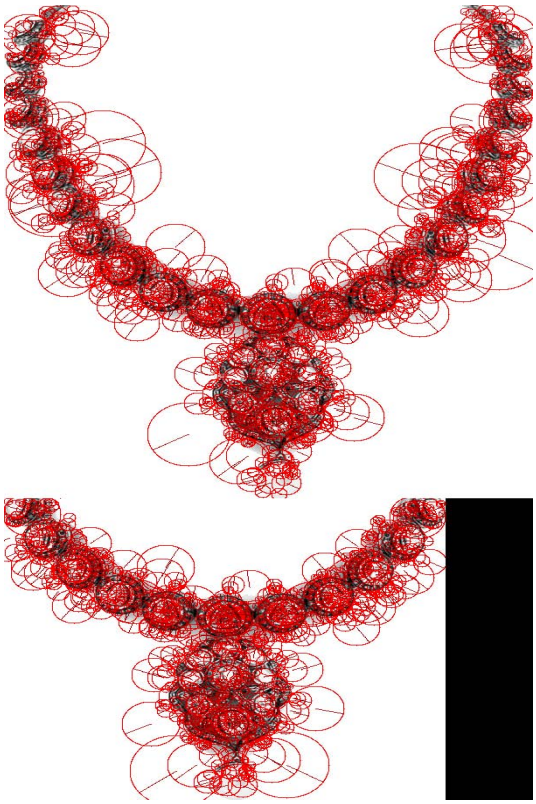

Fig. 14: SURF descriptor

CONCLUSION

SIFT and SURF algorithms have been used to analyze external features of an image by various researchers in the past. The jewels originality detection is the application of image analysis in which SIFT and SURF algorithms have been applied to analyze external features of the checking the originality of jewels notes. In the present research, method using SIFT and SURF algorithms has been proposed for checking the originality of jewels notes. SIFT and SURF algorithms are compared to validate the proposed system. The results confirmed that the original jewels show matching with high number of detected features when flse one show limited number of matched values.

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