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Implementation and Comparison of Feature Detection Methods in Image Mosaicing

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Abstract: *The method of joining two images to make a panorama is image mosaicing. Accuracy of registered image is based on accurate feature detection and matching. Feature extraction is one of the most important step for image processing. Feature detection is a low-level image processing operation. According to proposed method different feature extraction techniques can be used for image mosaicing. The work compares two robust methods Scale Invariant Feature Transform (SIFT) and Speeded Up Robust Features (SURF). It also gives a way to extract distinctive invariant features from images that can be used to perform matching between different views of a scene or object.*
Keywords: *Sift, surf, feature extraction*

I. Introduction

Recently image mosaicing has been an important role in image processing field. Image mosaicing is the process of assembling a series of images to form a single image. The task of finding similarities between two images has become a challenging problem nowadays. Image mosaicing can enhance image resolution. Image mosaicing is the major research field in computer vision, computer graphics and video processing.

Image registration mainly consists of four steps:
1) Feature detection: It detects salient and distinctive objects in both sensed and reference image.
2) Feature matching: All the features that have been matched.
3) Transform model estimation: Aligning the sensed image with reference image.
4) Image resampling and transformation: The sensed image are transformed

Feature extraction and matching is the base for many computer vision problems. There are also many other feature detection methods: edge detection, corner detection etc. Feature correspondences the images is needed to adjust and blend the images.

II. Overview of Methods

2.1 Surf overview

SURF (Speed Up Robust Features) is a robust algorithm technique for object recognition, image registration. Surf method uses detection, description and matching. To detect interest points SURF uses determinant of Hessian blob detector, which can be computed with 3 integer operation using precomputed integral images. In the first stage Laplacian of Gaussian images of box filter is used to allow the fast computation time. The computational cost applying the box filter is independent of size of the filter because of integral image representation. Determinants of Hessian matrix are used to detect keypoints.

2.1.1 Orientation Assignment

Inorder to be invariant to rotation orientation for the interest points are introduced .For this Haar wavelet responses in x and y directions. At high scale the size of the wavelet is big. Therefore integral image is again use for fast filtering. Six operations are needed to compute the responses. Wavelet responses are calculated and weighted with Gaussian centered at the interest points. The responses are represented as a vectors in a space. The horizontal and vertical response are get summed and these two summed vectors get a new vector. Small size dominating wavelet responses large size yield maxima in vector length.

2.1.2 Descriptor Components

For the extraction of descriptors, the first step consists of constructing a square region centered around the interest points. The region is splits up regularly into 4x4 square sub regions. For each sub region we compute a simple features 5x5 regularly spaced sample points .To increase the robustness towards geometric deformation and localisation errors, the response dx and dy are first weighted with Gaussian centered at the interest points.

Then, wavelet responses dx and dy summed up over each sub-region and form a first set of entries to the feature vector. Hence each sub region has a four dimensional descriptor vector **v.** This results in a descriptor vector for all 4x4 sub-regions of length 64.
Fig:1 shows the properties of the descriptor for three distinctively different image intensity patterns within a sub-regions

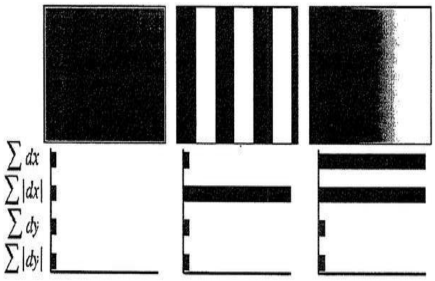


Fig.1 The descriptor entries of a sub-region represent the nature of the underlying intensity pattern. Left: In case of a homogeneous region, all values are relatively low. Middle: In presence of frequencies in x direction, the value of |dx| is high, but all others remain low. If the intensity is gradually increasing in x direction, both values dx and |dx| are high.

2.1.3 SURF Algorithm
The algorithm consists of
1) Feature point testing
2) Feature point description

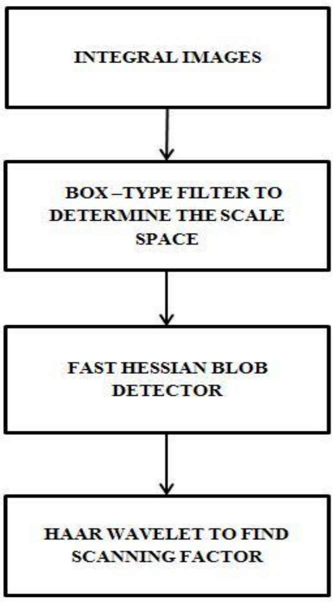


Fig. 2 SURF Algorithm

For a point *X* of the image *I*, the coordinate is (*x*, *y*) , the point's value *I* (*X*) S is sum of point *X* and the origin of the rectangular region formed by all points of the pixel values shown in equation (1):

I∑(X) =∑∑ I (I, j) (1)

Pixels sum within the rectangular area in fig.2 obtained by equation (2) :

∑=A-B-C+D (2)

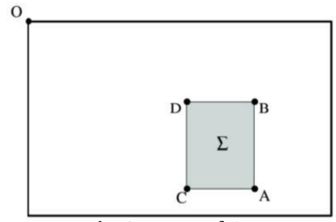


Fig.3 Integral image

In SURF algorithm the scale space is constructed from box filters. Figure 4, when the image of the smallest scale was formed, the box-type filter grew gradually to 6 pixels, the pixel values of the convolution with the original image formed the image pyramid

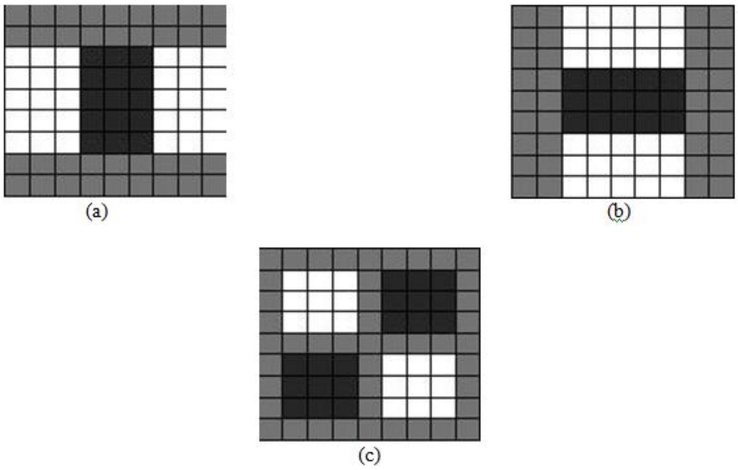


Fig.4 Box filters with 9×9 pixels

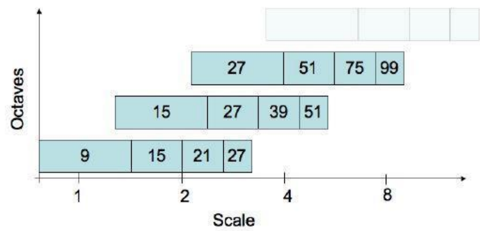


Fig.5 Size of box filter in a scale pace

The filter size is calculated by

$$\text{Filter size} = 3\times(2^{\text{Octave}}\times\text{interval}+1) \tag{3}$$

SURF uses a blob detector based on hessian matrix to find point of interest. SURF also uses the determinant of the Hessian for selecting the scale. Given a point p=(x, y) in an image I, the Hessian matrix H(p, σ) at point p and scale σ, is:

$$\mathbf{H}(\mathbf{x}, \sigma) = \begin{bmatrix} Lxx(x,6) & Lxy(x,6) \\ Lyx(x,6) & Lyy(x,6) \end{bmatrix} \tag{4}$$

2.2 Sift algorithm

SIFT (Scale Invariant Feature Transform) algorithm proposed by Lowe in 2004 [6] to solve the image rotation, scaling, and affine deformation, viewpoint change, noise, illumination changes, also has strong robustness.

The SIFT algorithm has four main steps:

(1) Scale Space Extrema Detection,

(2) Key point Localization and filtering (3)Orientation Assignment and

(4) Description Generation.

The first step is to identify location and scales of key points using scale space extrema in the DoG (Difference-of-Gaussian) functions with different values of σ. Scale space is separated by a constant factor k as in following equation.

$$\mathbf{D(x, y, \ \ ) = (G(x, y, k \ \ ) – G(x, y, \ \ ) \times I(x, y)} \qquad (5)$$

Where, G is the Gaussian function and I is the image. In the keypoint localization step, the low contrast points are rejected and the edge response is eliminated. To compute the principal curvatures Hessian matrix was used and eliminate the keypoints that have a ratio between the principal curvatures that are greater than the ratio. An orientation histogram was formed from the gradient orientations of sample points within a region around the keypoint in order to obtain an orientation assignment .

The descriptor of SIFT that was used is 4 x 4 x 8 = 128 dimensions [4]. The keypoint descriptors are calculated from the local gradient orientation and magnitudes in a certain neighborhood around the identified keypoint. The gradient orientations and magnitudes are combined in a histogram representation from which the descriptor is formed [5].

2.2.1 Construction Of SIFT Descriptor

Fig.6 illustrates the computation of the key point descriptor. First the image gradient magnitudes and orientations are sampled around the key point location, using the scale of the key point to select the level of Gaussian blur for the image [6]. To achieve orientation invariance, the coordinates of the descriptor, then the gradient orientations are rotated relative to the key point orientation. Fig.6 illustrated with small arrows at each sample location on the left side.

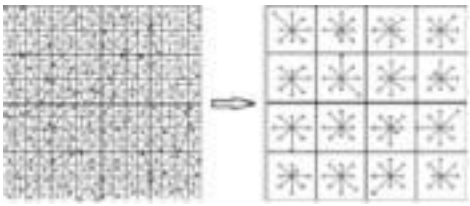


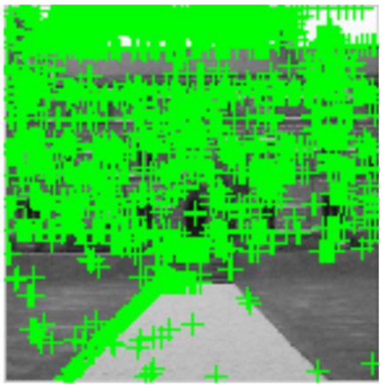
Fig.6 SIFT Descriptor Generation

The key point descriptor is shown on the right side of Figure 6. It allows for significant shift in gradient positions by creating orientation histograms over 4x4 sample regions. The figure shows 8 directions for each orientation histogram , with the length of each arrow corresponding to the magnitude of that histogram entry. A gradient sample on the left can shift up to 4 sample positions while still contributing to the same histogram on the right. So, 4×4 array location grid and 8 orientation bins in each sample. That is 128-element dimension of key point descriptor.

III. Experimental Results

To compare the effectiveness of the algorithm one image are taken as the experimental data to find feature points. The experiments are performed on Intel Core i-3 3210, 2.3 GHz processor and 4 GB RAM with windows 7 as an operating system. Features are detected using both SIFT and SURF algorithm.

(a) Original image



(b) Detected features using SIFT

(b) Original image

(d) Detected features using SURF

While comparing different feature detection algorithm care should be taken for the image dataset used. The accuracy results may vary from image, so, same set of images should be used for each algorithm and such images should be chosen in the dataset that have larger no. of interest points

IV. Conclusions

In this paper, we compared two feature detection methods. Based on the experimental results, it is showed that the SIFT has detected more number of features compared to SURF. The SURF is the fastest algorithm while SIFT performs good performance .

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