Comparion and Study of Classic Feature Point Detection Algorithm

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***Abstract*—Detection base on feature points contains the characteristics of the whole image, this method is widely used in the field of computer vision.Several popular feature points detection algorithms are discussed, including SIFT feature points detection method and the corner detection methods like Forstner, Harris and SUSAN. In this paper, SIFT, Forstner, Harris and SUSAN are compared by a number of experiments that the invariance to scale, rotation and illumination and the anti-noise ability to Gaussian. We can compare the resules of feature point extraction and analysis of the stability and anti-noise ability of the feature point extraction algorithm on image.**

Keywords-component; Feature points detection, SIFT, Forstner, Harris,SUSAN

I. INTRODUCTION

Image matching methods are various, but all include the following two basic steps: feature extraction and feature matching[1]. Feature extraction is the basis for image matching. There are two main methods: the region-based extraction and feature-based extraction. The former mainly considers the impact of the edge. It is widely used in medical care, and the latter has important applications in the field of computer vision and pattern recognition, for example, Biometrics and Digital Watermarking. So far, there have been a variety of image feature points extraction methods, such as SIFT algorithm, Forstner algorithm, Harris algorithm and SUSAN algorithm, etc. Professor David G. Lowe of Columbia University proposed a algorithm called SIFT in 2004[2] [3]. The algorithm can always get good results in dealing with translation, rotation, scaling, brightness change, partial occlusion, and perspective transformation, and was successfully applied to target identification [4], image restoration [5], image mosaic [6] and other fields. The core idea of the forstner algorithm calculate each pixel Robert's gradient gray level co-variance matrix of pixel in local area to find the corresponding error ellipse as close as possible to the point of the circle as feature points[7].The harris feature point extraction algorithm is very sensitive to scale changes of the image and affine transformation, the algorithm only detects corner in a single scale [8]. In some special corners, there will be deviations of corner locating [9]. In 1995, Smith of Oxford University first proposed the SUSAN algorithm, a gray-scale image edge detection and corner point method [10].

II. EXPERIMENTS OF FEATURE POINT EXTRACTION EFFICIENCY

In this paper,we use Forstner、Harris、SUSAN and SIFT feature extraction algorithm to extract feature points of a standard test images,1000 video frame images and 1000 Gaussian noise images.

A. Feature points detection of the standard image

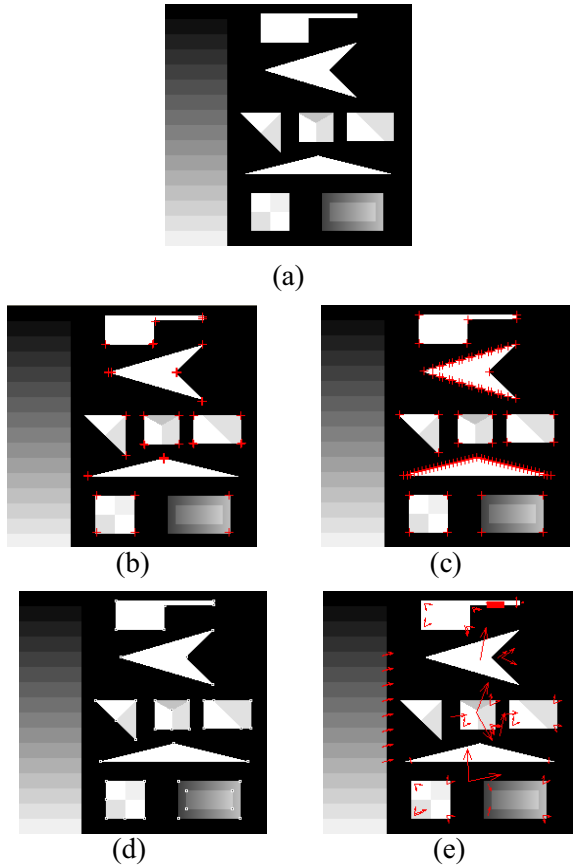

Fig.1 Feature detection results of the normal image of feature points detection.

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We use four algorithms to detect the feature points of the normal image in Fig 1.

The (a) is the a standard test images of feature point detection, The (b), (c), (d) and (e) show respectively the results of feature extraction that use of Forstner, Harris, SUSAN and SIFT algorithm.

Forstner angle point algorithm is not sensitive enough to detect the T-corner and corner detection is incomplete. Harris angle point algorithm can detect basically all the corners, but the algorithm need a large amount of calculation and is sensitive to jagged edges. SUSAN angle point algorithm are very good on the Y-corner, T—corner and L-corner detection results, but the complexity of the algorithm is high. SIFT feature detection algorithm estimate the scale, location and direction of the feature points,it show the feature vector with the direction information, This algorithm contains the information of the feature points is a richer, more stable match.

B. Feature detection results of the video frame

We use four algorithms to detect the feature points of 1000 video frame images in Fig 2.

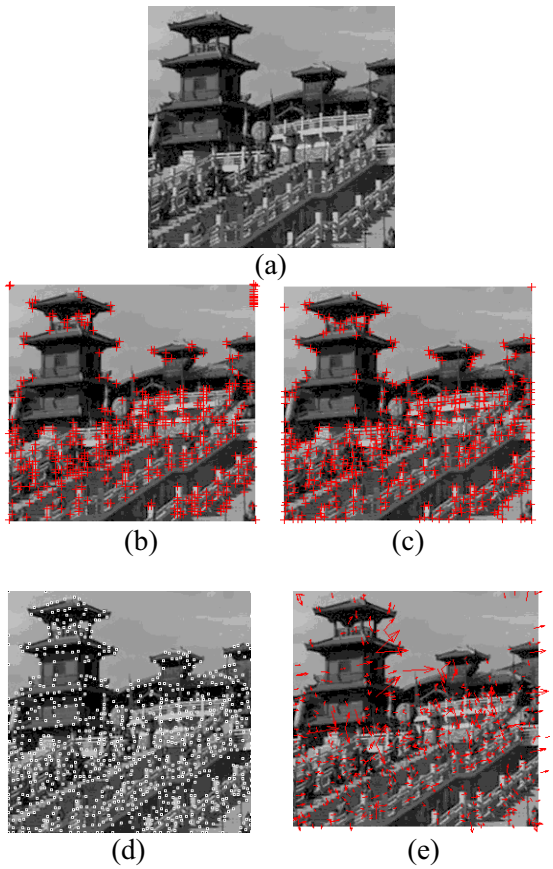

Fig. 2. Feature detection results of the video frame images

The (a) is the video frame images of feature point detection, The (b), (c), (d) and (e) show respectively the video frame images results of feature extraction that use of Forstner, Harris, SUSAN and SIFT algorithm.

The test results of Forstner, Harris and SUSAN corner detection algorithm is not very accurate, there is some redundancy. SIFT feature detection algorithm is more precise.

C. Feature detection of the video frame with white Gaussian noise

We use four algorithms to detect the feature points of 1000 video frame images with white Gaussian noise in Fig 3.

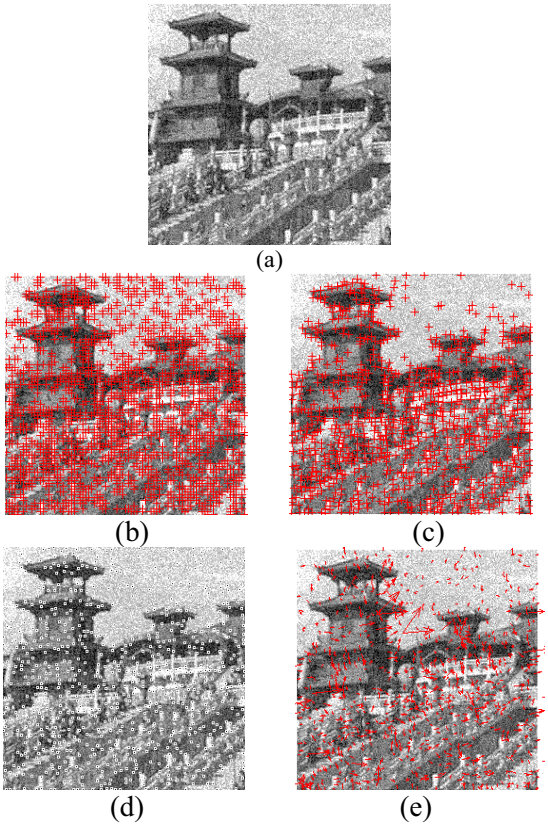

Fig. 3. Feature detection results of the video frame with white Gaussian noise

The anti-noise abilitys of SUSAN corner detection and SIFT feature detection algorithm are better than Forstner and Harris corner detection algorithm.

III. EXPERIMENTS OF FEATURE POINT STABILITY

In this paper,we carry out the experiment to Forstner、Harris、SUSAN and SIFT feature extraction algorithm to compare and analyze its stability.To extract 200 feature points of the original video frame, we use the above four algorithms to detect the feature points of 900 video frame images in scale, viewing angle, illumination changes. Some experimental results are shown in Table 1, Table 2 and Table 3, Where N denotes the total number of feature points of the original video frame, and C denotes matching feature points with the original video frame 200 feature points under different conditions, R indicates the matching rate.

Table 1. Matching results under different scales

video	Forstner			Harris		
frame	N	C	R	N	C	R
1	200	173	87%	200	159	80%
2	200	182	91%	200	168	84%
3	200	177	89%	200	164	82%
video	SUSAN			SIFT		
frame	N	C	R	N	C	R
1	200	167	84%	200	184	92%
2	200	174	87%	200	191	96%
3	200	171	86%	200	186	93%

Table 2. Matching results under different orientation

video	Forstner			Harris		
frame	N	C	R	N	C	R
1	200	153	77%	200	162	81%
2	200	166	83%	200	169	85%
3	200	158	79%	200	163	82%
video	SUSAN			SIFT		
frame	N	C	R	N	C	R
1	200	168	84%	200	183	91%
2	200	176	88%	200	189	95%
3	200	171	86%	200	184	92%

Table 3. Matching results under different illumination

video	Forstner			Harris		
frame	N	C	R	N	C	R
1	200	165	83%	200	167	84%
2	200	171	86%	200	177	88%
3	200	169	85%	200	178	89%
video	SUSAN			SIFT		
frame	N	C	R	N	C	R
1	200	172	86%	200	186	93%
2	200	178	89%	200	193	97%
3	200	175	88%	200	187	94%

IV. CONCLUSION

In summary, Forstner corner detection algorithm is simple, but influenced by the image contrast, and sensitive to the Gaussian noise. Harris corner detection algorithm is sensitive to scale and affine changes of image, and the feature points accuracy is not high on the Gaussian noise. SUSAN corner detection algorithm have strong noise immunity, scaling and rotation invariance, but the complexity of the algorithm is higher. SIFT feature detection algorithm feature location is more accurate, noise immunity, good stability.

REFERENCE

[1] Liyong Ma, Yude Sun, Naizhang Feng, Zheng Liu. Image Fast Template Matching Algorithm Based on Projection and Sequential Similarity Detecting. IEEE Computer Society, 2009, 957-960

[2] DAVID G.LOWE. Object Recognition from Local Scale-invariant Features. International Conference on Computer Vision, 1999: 1150-1157

[3] DAVID G.LOWE. Distinctive Image Features from Scale-Invariant Key-points. International Journal of Computer Vision, 2004, 60(2): 91-110

[4] MAO WENGE, ZHANG TIANWEN, WANG LI. Detection of Text in Images using SUSAN Edge Detector. Journal of Harbin Institute of Technology (New Series), 2005, 12(1): 34-40

[5] Haitao Li, Peiliang Wu, Lingfu Kong. Combining ODCS and SIFT for Fast Color Object Identification. Computer Science, 2009, 36(12): 257-258

[6] YAN KE, RAHUL SUKTHANKAR. PCA-SIFT: A more Distinctive Representation for Local Image Descriptors. Proceedings of the Conference on Computer Vision and Pattern Recognition, Washington, USA, 2004: 511- 517

[7] LI YANFANG, WANG YARNING, HUANG WENQING, ZHANG ZUOLI. Automatic Image Stitching using SIFT. ICALIP 2008-2008 International Conference on Audio, Language and Image Processing, Proceedings, 2008: 568-571

[8] LAPTEV I., LINDEBERG T.. Space-time interest points[C] . Proceedings of Ninth IEEE International Conference on Digital Object Identifier, 2003,1: 432-439

[9] MARCO LOOG, FRANÇOIS LAUZE. The Improbability of Harris Interest Points. IEEE Transactions on Pattern Analysis and Machine Intelligence, 2010, 32(6): 1141-1147

[10] Xiaohong Zhang, Bo Li, Dan Yang. A Novel Harris Multi-scale Corner Detection Algorithm. Journal of Electronics & Information Technology, 2007, 29(7): 1735-1738

[11] Li Yang, Hong Zhang, Yushan Li. Rapid Adaptive RSUSAN Algorithm of Corner Detection. Computer Science, 2004, 31(5): 198-200