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An Improved Image Registration Algorithm based on SURF

Yujuan Zou[1,*], Yong Chen[2]

[1] College of Information Technology, Jiangsu Maritime Institute, Jiangsu Nanjing, 211170, China

[2] Nanjing Longyuan Microelectronic Company Limited, Jiangsu Nanjing 211106, China

[*] 54552046@qq.com

Abstract

Image stitching has become an important part of image processing and an increasingly popular research direction. Image registration is the core of image stitching. In order to overcome the performance imbalance of traditional algorithms, an improved image registration algorithm is proposed in this paper. Firstly, the algorithm detects the feature points based on Hessian matrix, and then describes the feature points by rBRIEF method. Finally, in the matching stage, the nearest neighbor ratio and next nearest neighbor algorithm are used for a rough matching, and the RANSAC algorithm is used to confirm the rough matching point pairs to eliminate false matching. The test results show that the improved surf image registration algorithm has certain efficiency and robustness.

Keywords

Computer Vision, Image Stitching, Image Registration, Hessian Matrix, Speeded Up Robust Features (SURF).

1. Introduction

Image stitching refers to the technology of stitching the images with overlapping areas into a seamless and high-definition image, so as to ensure the high resolution of the image while obtaining a large viewing angle. Image stitching is an increasingly popular research direction and has become a hot spot in the field of image research [1-2]. Researchers at home and abroad have proposed a variety of stitching algorithms. In the night vision imaging technology of military domain network, 360-degree circular pictures are realized through image stitching, so that the observer can observe all the surrounding conditions [3]. In the navigation of binocular robot, the image stitching technology is used to splice the images collected by binocular to expand the field of vision of the robot [4].

The quality of image stitching mainly depends on the degree of image registration, so image registration is the core and key of stitching algorithm. In the aspect of image registration, from the initial violent matching of image gray information to feature-based matching, the image quality is greatly improved; Sift, as an image registration algorithm based on speckle feature, once became a classic of image registration technology with high quality. Surf algorithm improves SIFT algorithm and successfully reduces the computational complexity of image registration. Corner detection techniques such as Harris corner, SUSAN operator and Moravec operator are applied to image registration to improve the registration accuracy. The proposal of orb algorithm further improves the processing speed of image registration technology and is widely used in various real-time scenes. At present, many scholars are exploring the image registration technology based on mutual information.

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2. Feature Point Detection

A determinant Gaussian filter matrix operator based on Gaussian matrix is defined as DoH. A Gaussian filter matrix operator based on is defined as LoG (Gaussian Laplace operator) [5]. Spots in the target image can be detected by the extreme values of the two filters. The Gaussian Laplace operator is used to perform convolution differential operation on an image with a local differential structure in image processing or make the calculated image highly similar to the Gaussian Laplace operator. Therefore, a local differential structure similar to it in an image may directly obtain the strong reflection response of the image filter, Positive and negative log responses correspond to dark and bright spots in the image respectively.

Based on SURF algorithm, this algorithm uses the response approximation of box filter instead of solving the Gaussian second-order partial derivative of the image. In this way, the scale space can be obtained by integral calculation of the image, so that each pixel in the overlapping region is calculated only once, so that the speed of detecting feature points can be improved. As shown in the figure below, the frame filter is weighted, and the weighted values are different in different directions. Calculate the approximate value of Hessian matrix.

$$det(H) = D_{xx}D_{yy} - (kD_{xy})^2 \tag{1}$$

3. Feature Point Description

The brief descriptor is mainly used to describe the change trend of pixel gray value around each feature point. If two feature points have the same description word or number, it can be considered that both feature points are the characteristics of the same pixel. Brief's description only randomly compares the gray values of two pixels P and Q around a feature point according to a certain distribution law. 1 indicates that the gray value of P far exceeds the gray value of Q, and 0 indicates that the gray value of P far exceeds the gray value of Q. By randomly comparing the binary gray values around 128 pairs of pixels with the gray values of 128 object points, the binary descriptor composed of 128 zeros or 1 is obtained, so as to realize the distribution and characteristic description of the gray values around the object points. Although the BREF descriptor does not have rotation invariance, the BREF descriptor can be calculated in combination with the direction of the key points, Thus, the directions of feature points describing words are linked together to increase rotation invariance.

$$\tau(I,x,y) = \begin{cases} 1 & I(x) > I(y) \\ -1 & I(x) < I(y) \\ 0 & I(x) = I(y) \end{cases} \tag{2}$$

$$f_n = \sum_{1 \le i \le n} 2^{i-1}\, \tau(I, x_i, y_i) \tag{3}$$

4. Image Registration

The improved algorithm uses the quadratic matching algorithm for calibration. Firstly, the nearest neighbor ratio and next nearest neighbor algorithm are used for rough matching, and then the random sampling consistency algorithm is used for secondary matching.

4.1. Rough Matching based on K- Nearest Neighbor

The K-Nearest neighbor algorithm is mainly used to classify targets [6]. Its main idea is somewhat similar to the way humans judge things. When it is necessary to classify a target, the target is often compared with objects of known species. For example, to judge whether a ball is

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football or basketball, the ball to be classified will be compared with football and basketball respectively. If the ball is more similar to football, I think this ball is football. The k-nearest neighbor algorithm compares the data to be classified with the data of known types to find the most similar data. If there are more types of a in the N data, the data to be classified is considered to belong to class A.

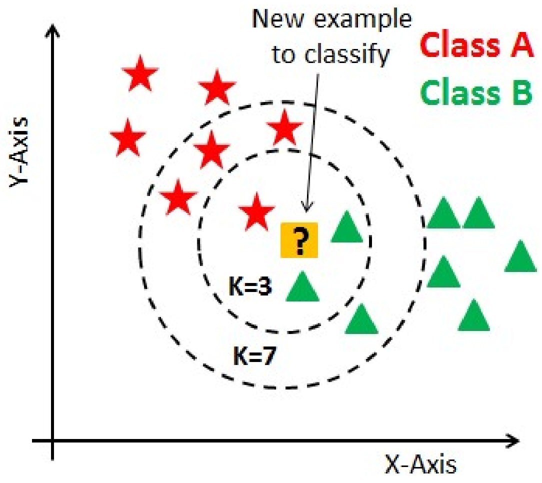

Figure 1. K-nearest neighbor classification

The improved algorithm adopts the algorithm of nearest neighbor ratio and next nearest neighbor, which is a rough matching algorithm. The nearest matching point and the second nearest matching point are obtained by calculating the Euclidean distance, and then the ratio is calculated to pass through an appropriate threshold and determine whether it is used as the matching point. The Euclidean distance is calculated as follows.

$$d(R_i, S_j) = \sqrt{\sum_{j=1}^{n}(r_{ij} - s_{ij})^2} \quad (4)$$

The similarity can be calculated by using a point area of the vector, which greatly reduces the amount of calculation and performs fast matching.

$$R_i \cdot S_j = |R_i| \cdot S_j \, cos(\theta) \quad (5)$$

4.2. Secondary Registration based on RANSAC

RANSAC is the abbreviation of random sample consensus. It is an algorithm to calculate the mathematical model parameters of data and obtain effective sample data according to a set of sample data sets containing abnormal data [7]. The improved algorithm which is based on RANSAC uses the random sampling consistency algorithm, which can obtain a more robust estimation matrix and effectively eliminate a large number of wrong matching pairs. The algorithm consists of two steps of iterative calculation.

Step 1: randomly select 4 corresponding feature sub nodes from the results after each matching and use them to calculate the same unit element application sub matrix respectively.

Step 2: according to the application of the element and the formula of the matrix method, a coordinate in the point of the projected image of the first frame can be calculated to impact the coordinate of the projected point of the second frame. The more important method is to

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calculate the average distance between the coordinate of the projected point and the correctly matched coordinate eigenvalue and the point projection coordinate, If the projection coordinate distance is less than a certain value under the visual threshold, it is directly regarded as the coordinate is correct and has matched the feature points, otherwise it is directly regarded as the wrong matching, and the number of correct matching point pairs is recorded.

Repeat these two steps for many times, count the number of correct matching point pairs after the cycle, take the maximum number of correct matching point pairs as the final result, eliminate the wrong matching, and output the correct matching point pairs, so as to realize the matching screening and screening of feature points.

4.3. Experimental Analysis

The Parallax standard atlas is registered by the improved algorithm and SURF algorithm. Comparing the registration time of each algorithm, it is verified that the improved algorithm has high timeliness. The timeliness of the improved algorithm is slightly one order of magnitude faster than that of the algorithm, and has good timeliness.

5. Conclusion

Image stitching technology is still popular in the current computing field, which is of great help to solve various display problems. The main content of this paper focuses on the key technology image registration algorithm in image stitching. After comprehensively analyzing the advantages and disadvantages of existing feature point algorithms, this paper focuses on an algorithm flow from feature point extraction to image matching. Through the continuous improvement of image registration algorithm, the requirements of image registration technology for feature point processing, registration method and fusion effect are higher and higher, so the requirements for input image are lower and lower. This technology can improve the quality of image stitching in more directions.

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