Matching of small packages of traditional Chinese medicine based on improved RANSAC algorithm

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Abstract. The vision system model of small package sorting of traditional Chinese medicine was constructed, and the chessboard calibration method was used to calibrate the binocular camera. Surf algorithm and orb algorithm are analyzed by experiments, and orb algorithm with high real-time performance is used to extract feature points. The fast nearest neighbor FLANN algorithm is used to quickly match the feature points, and the matched feature points are screened according to Lowe's algorithm and v-axis coordinate consistency principle, to solve the problem of false matching points. The method of selecting feature points based on matching quality ranking to calculate the homography matrix is designed, which solves the random sampling problem of the RANSAC algorithm and effectively shortens the time of feature matching.

Keywords: Feature matching, RANSAC algorithm, Traditional Chinese medicine.

1 Introduction

With the development of automated pharmacies, automated equipment is used more and more widely in pharmacies. At present, most automated drug distribution systems are researched on boxed drugs with packaging rules. The grabbing of small packages of traditional Chinese medicines still needs to be done manually, which greatly affects the work efficiency of traditional Chinese medicine pharmacies. The machine vision imaging control system designed by Zhejiang University [1] adopts the classic binocular stereo vision principle to realize accurate posture information detection of mechanical devices with a non-single degree of freedom. Xu Bo of the University of Chinese Academy of Sciences [2] designed a visual-aided navigation system for blind people based on the Android system based on the principle of binocular vision. The binocular stereo vision measurement method has many advantages such as simple system structure, high measurement efficiency, and high measurement accuracy, and is suitable for online non-contact measurement. In this paper, aiming at the current situation that there are small packages of traditional Chinese medicine by hand, a binocular vision positioning system is designed to realize the positioning of small packages of Chinese medicine.

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2 System platform construction and image processing

2.1 Visual platform construction

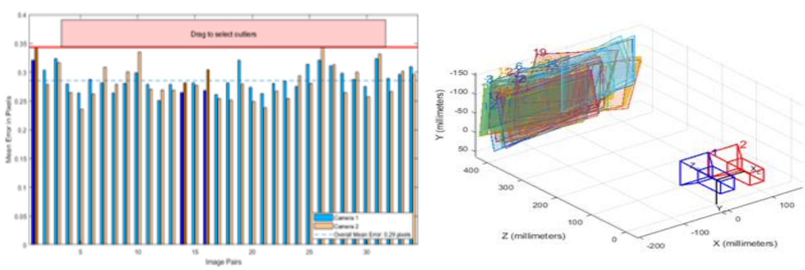
This paper builds a binocular vision platform, uses binocular cameras to collect pictures, matches the corresponding points through a matching algorithm, and then according to the principle of binocular parallax, three-dimensional reconstruction of the center point of the identified small Chinese medicine package is performed to obtain the position of the small Chinese medicine package, The algorithm flow is shown in Fig 1.

2.2 Camera calibration

Use camera calibration to obtain distortion matrix and camera internal and external parameters. The lens distortion coefficient and magnification factor from the center point of the optical axis to the image coordinates represent internal parameters. The conversion matrix between the relative positional relationship of the left and right cameras in the binocular camera system is the external parameters of the cameras.

This article uses Zhang Zhengyou's calibration method [3], which is encapsulated and used in tools such as Matlab. Zhang's calibration method adopts checkerboard calibration, and its calibration method is simple, high-precision, and easy to use. This method is widely used.

This article uses the stereo camera calibration module in Matlab for calibration. After the calibration is completed, the final result is stable at 0.2-pixel error. The calibration result is shown in Fig. 2



a) Pixel error map b) Camera imaging model

Fig. 2. Matlab camera calibration results.

The internal and external parameters of the camera obtained by the checkerboard calibration method are shown in Table 1.

Table 1. Calibration results.

	Left camera	**Right camera**
Internal reference	$\begin{bmatrix} 357.9493 & 0 & 0 \\ 0 & 358.9134 & 0 \\ 327.0552 & 219.9866 & 1 \end{bmatrix}$	$\begin{bmatrix} 356.9105 & 0 & 0 \\ 0 & 357.6981 & 0 \\ 322.4776 & 230.2176 & 1 \end{bmatrix}$
Distortion	$[k_1 \quad k_2] = [0.0701 \quad -0.0322]$	$[k_1 \quad k_2] = [0.0946 \quad -0.1091]$
External reference	$R = \begin{bmatrix} 1 & -0.0008 & -0.0005 \\ 0.0008 & 1 & 0.0093 \\ 0.0005 & -0.0093 & 1 \end{bmatrix}$	$T = [-63.8760 \quad 0.1461 \quad -1.0065]$

The first parameter of T represents the distance between the binocular cameras, and the actual distance between the two cameras is 60mm.

2.3 Image feature point detection

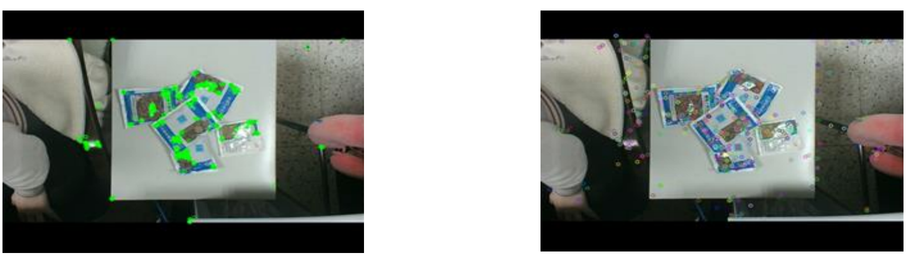
At present, the mainstream matching methods are all feature-based image matching methods. First, the feature points of the image are extracted, and then the image matching is performed according to the similarity between the image feature descriptors. This article compares the existing image matching algorithms. Table 2 shows the performance of some of the algorithms.

Table 2. Feature matching algorithm analysis.

Matching algorithm	Scale robustness	Rotation robustness	Fuzzy robustness	Time
SIFT	Better	common	common	common
SURF	Best	better	better	better
ORB	common	common	common	best

It can be seen from Table 2 that the SURF algorithm has better performance in terms of performance, and ORB is the fastest in time calculation. This article makes a comprehensive comparison between the SURT algorithm and the ORB algorithm to choose the algorithm that is suitable for this article.

This section is aimed at the SURF algorithm and the ORB algorithm for feature points extraction experiments. The feature point extraction results are shown in Fig. 3.



a) ORB feature point detection b) SURF feature point detection

Fig. 3. Feature point extraction.

It can be seen from Fig. 3 that the feature points of the SURF algorithm are relatively scattered, so the SURF algorithm also has a good detection effect in low-texture areas. The feature points detected by the ORB algorithm are relatively concentrated, and they are mostly scattered in the small packaging area of traditional Chinese medicine. In terms of the efficiency of the algorithm, the ORB algorithm has an efficiency advantage, and the matching speed is faster than the SURF algorithm. Considering that the feature points detected by the ORB algorithm are more clustered near the small Chinese medicine package, and the ORB algorithm is more real-time, this paper chooses the ORB algorithm to match the feature points

2.4 Image feature point matching

After the binocular camera is calibrated, it is necessary to use the ORB algorithm to extract the feature points of the left and right imaging images and calculate the homography matrix. The homography matrix can be used to calculate the corresponding point coordinates of a point in the left image in the right image, and then the depth information of the medicine packet can be calculated, and the three-dimensional coordinates of the medicine packet can be obtained. If you want to calculate the three-dimensional coordinates of the center point of the drug pack, you need to find the pixels of the corresponding points in the left and right pictures. This section mainly studies the known point in the left image and maps it to the right image through the homography matrix to get its pixel coordinates in the right image.

The commonly used feature matching method is to measure the distance between two feature vectors and calculate the similarity of two feature descriptors to match similar feature points in a certain feature point search and registration image, and in the feature point matching process, The problem of mismatching points is prone to occur, so it is necessary to select the corresponding algorithm to eliminate the mismatched feature points and improve the accuracy of the matching algorithm. Commonly used feature matching algorithms and algorithms for removing mismatched points include the nearest neighbor algorithm, Lowe's algorithm, and RANSAC algorithm [4].

When matching the detected feature points, once the viewing angle changes or an area that is not in the image appears, mismatching is easy to occur. When the left and right cameras are used to collect pictures in this article, the left part of the left imaging picture and the right part of the right imaging picture is likely to be mismatched during the matching process. This paper first uses the FLANN algorithm to quickly match the feature points extracted by the ORB algorithm and uses Lowe's algorithm to eliminate some mismatched pairs of the feature points obtained by the matching. Although Lowe's algorithm can remove some mismatch points, there are still mismatches. In this paper, we need to use the RANSAC algorithm to remove the mismatched points and calculate the homography matrix, so that the center point of the medicine bag can be matched subsequently.

3 Improved RANSAC algorithm

From Section 4, we can know that when the probability $z > 95\%$ that the randomly selected points are all interior points, stop the iteration to calculate the accurate homography matrix. If the proportion of interior points in the matching point set P is small, and the FLANN algorithm has a poor matching result, it takes multiple iterations to calculate the correct homography matrix, which greatly increases the calculation time of the algorithm. The sample data extracted from the feature contains correct data and abnormal data. If the calculated homography matrix has a large error, the subsequent center point coordinates will be offset when the homography matrix is used for conversion. Therefore, this paper designs a method to remove mismatch points and proposes an improved RANSAC algorithm, which can quickly calculate the homography matrix.

(1) For the binocular vision system built in this paper, the images to be matched are roughly parallel. Theoretically, the value of the matched feature points in the V axis direction in the (U, V) coordinate system is equal, but due to camera distortion and installation Error, the value of the matching point pair in the V axis direction is not completely equal and is roughly within an error range. If the two feature points are matched, according to the principle of a binocular parallel system, the V-axis coordinates of the two points should be similar; if the V-axis coordinates of the two points are too different, there is a high probability that they are mismatched, so Checking whether the matching point pairs are consistent on the V axis can reduce these mismatched pairs and improve the matching accuracy and speed of the initial homography matrix.

(2) In the RANSAC algorithm, 4 points are randomly selected to calculate the homography matrix, and the homography matrix is used to determine the points in the set as interior points and exterior points. The probability of selecting four points randomly as interior points is greater than 95%, The correct homography matrix is constructed, otherwise, it is necessary to continue to iteratively calculate the homography matrix. The increase in the

number of iterations will affect the computational efficiency of the RANSAC algorithm, so this article draws on the idea of PROSAC to improve and optimize the RANSAC algorithm.

The PROSAC algorithm sorts the matching quality, and the matching points with high matching quality are used to calculate the homography matrix. So that the calculated homography matrix can calculate the inner and outer points of the algorithm faster, and effectively accelerate the calculation speed of the algorithm.

When performing feature matching, Lowe's algorithm filters out mismatched points by calculating the ratio of the nearest neighbor distance to the next neighbor distance. If (T is a set threshold), it is considered a correct match point. When using Lowe's algorithm, we want the ratio of the two to be smaller. When measuring the matching quality, we think that if the two feature points match, then the distance r of the feature vector extracted by the ORB algorithm should be very small, Therefore, this article combines the two as the basis of matching quality, and defines the matching quality E as shown in formula (1):

$$E = \gamma * r \tag{1}$$

First, according to the matching quality E, the feature point pairs are sorted in ascending order to form a feature point pair matching set. Secondly, the four points with the smallest E value are selected to initialize the homography matrix, and then four points are selected from the ordered feature point sets for calculation. The homography matrix H. If the number of interior points calculated by using the homography matrix is greater than m, then H is considered to be the optimal homography matrix, $m = \alpha N$, α Is the ratio of the number of interior points to the total number of feature points， This article takes 0.8. The flow chart of the improved RANSAC algorithm is shown in Fig. 4

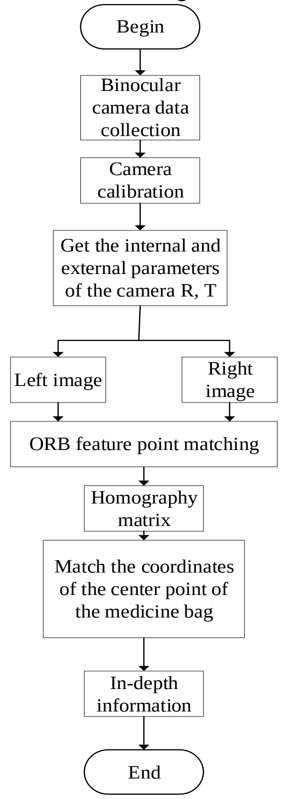


Fig. 1. Flow chart for calculating the depth of the center point of the medicine bag.

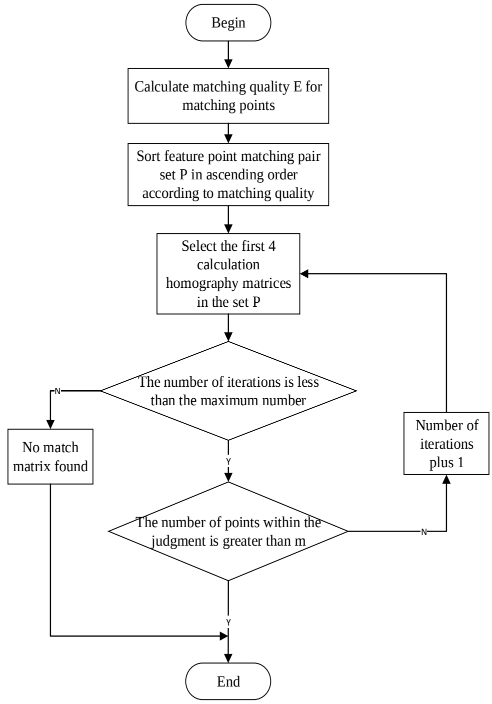
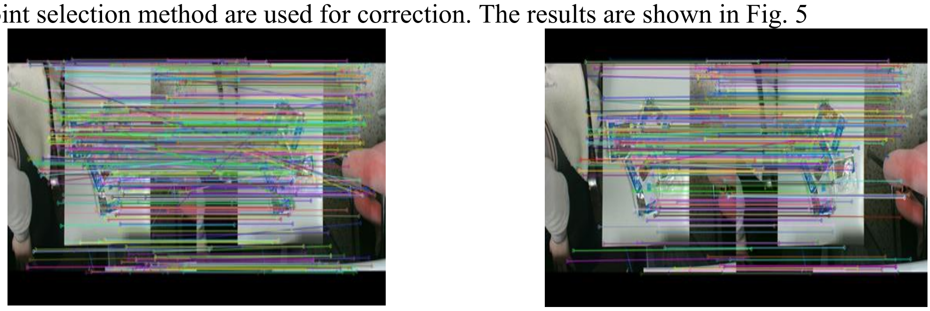


Fig. 4. Improved RANSAC algorithm flow char.

4 Feature matching experiment results

4.1 Filter out mismatched points

Aiming at the feature points extracted by the ORB algorithm, this article first uses the FLANN algorithm for fast matching. A small number of errors will still occur after the feature points of the FLANN algorithm are matched. Lowe's algorithm and the V-axis coordinate point selection method are used for correction. The results are shown in Fig. 5



a) FLANN feature matching results

b) Feature matching results after removing mismatched points

Fig. 5. Feature point matching.

It can be seen from Fig. 5 that after FLANN matching, when the same parameters are set, there will be a small number of mismatched feature points in feature point matching at different times, and there will be a large number of feature points. After Lowe's algorithm and V-axis coordinate point screening, the mismatched points of intersection are removed, and the matching effect is better.

4.2 Comparison of improved RANSAC experiment results

This paper conducts experiments on the improved RANSAC algorithm and finds that the matching effect of the feature points is small, but in terms of running time, the number of iterations of the improved RANSAC algorithm is significantly reduced, and the running time is less. The running results are shown in Table 3 Shown.

Table 3. Before and after the improvement of the RANSAC algorithm.

	Number of original iterations	**Improve the number of iterations**	**Initial running time**	**Improve running time**
1	4	1	0.0284	0.0124
2	5	2	0.0326	0.0157
3	1	1	0.0204	0.0181

5 Summary

This article focuses on the SURF algorithm and the ORB algorithm, and uses these two algorithms to match, compares the characteristics of the two algorithms, and finally chooses the ORB algorithm as the feature matching algorithm in this article. To solve the problem of ORB algorithm mismatch, first, use Lowe's algorithm and V-axis coordinate characteristics for preliminary screening, then use the improved RANSAC algorithm to remove mismatches and finally calculate the position of a point in the left image in the right image based on the homography matrix. Coordinate. The results show that the improved RANSAC algorithm can obtain an accurate homography matrix in one calculation, and it runs faster than the original algorithm.

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