Binocular Stereo Vision Positioning System Based on Improved SURF Algorithm

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Abstract

Binocular stereoscopic vision system is mainly composed of camera calibration, feature point extraction, feature point matching and three-dimensional coordinate acquisition. The traditional SURF algorithm has real advantage and robustness and running time than SIFT has certain advantages, but can not accurately extract the target object accurate contour information. Therefore, a binocular stereoscopic vision system based on the SURF algorithm combined with Snake model is proposed. The experimental results show that the algorithm can accurately find the contour of the target object on the basis of shortening the computation time.

Keywords

Binocular stereoscopic vision; feature extraction; SURF algorithm; Snake model; target location.

1. Introduction

Binocular stereoscopic vision is to simulate the human eye to observe the object method, through two cameras to simulate the human eye were two left and right images, after a series of operations processing, the greatest degree of reduction of the human eye recognition process[1]. In the binocular vision system, the feature extraction and matching is a key to complete the target location. The algorithm that implements this process is the most representative of the SURF algorithm proposed by Bay et al., Compared with the SIFT algorithm, the SURF algorithm adopts Hessian Based on the above problem, this paper proposes a SURF algorithm based on the Snake model[2]-[5]. Firstly, the feature information of the target is extracted according to the SURF algorithm, and then the snake model is combined with the snake model, which can be used to extract the target contour information. An initial energy function curve is defined, and under constant constraints of energy, the curve eventually converges to the contour of the graph[6].

2. System Framework of Binocular Stereo Vision Positioning System Based on SURF Algorithm Combining Snake Model

Binocular stereoscopic vision system mainly contains camera calibration, feature point extraction, feature point matching, three-dimensional coordinates of the process, the whole process can be described as: through the camera around the two cameras to collect a few different angles of the image, and then the camera calibration , Using the SURF algorithm to extract the feature points, combined with the Snake model to find the exact boundary information of the target object, complete the feature matching, through the three-dimensional coordinates to achieve the positioning of the object.The system block diagram is shown in Fig 1:

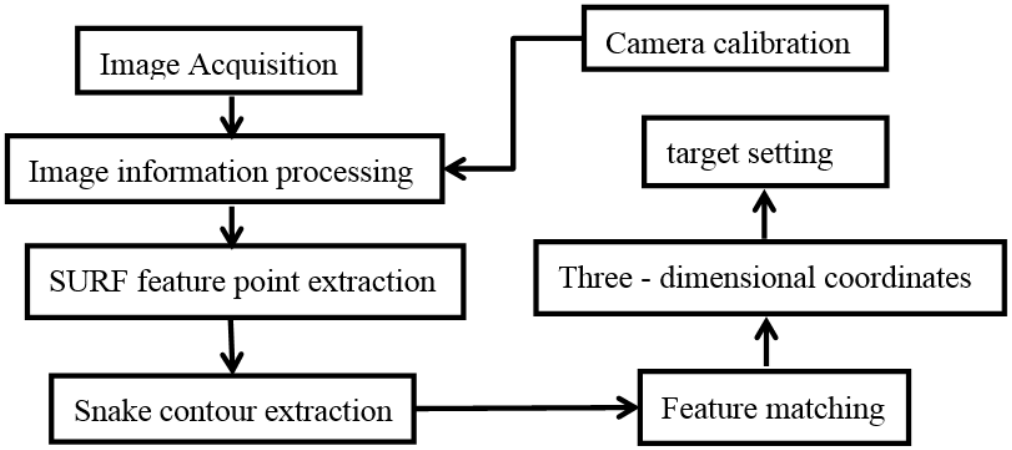

Fig.1 The system block diagram

2.1 Camera calibration based on OpenCV

Based on OpenCV camera calibration both traditional calibration method and automatic calibration method of the advantages of two calibration methods, the specific process of the calibration process for the film from different angles using cv Find Chessboard Corners () function to get all the corners of the template , and then use the cv Find Corner Sub Pix () function to get the coordinates of the corner, use the cv Draw Chessboard Corners () function to get the corner coordinates drawn on the template image, and then get the corner information to be encapsulated[7].

2.2 Feature extraction

The feature extraction is to obtain the similarity of the matching elements based on the similarity attributes between the matching primitives. In order to find the range and similarity of the search, the matching points of the binocular images are obtained [8].

2.3 SURF feature point extraction

SURF constructed pyramid images are very different from SIFT, because these differences have accelerated the speed of their detection. SURF uses the Hessian matrix determinant approximation image. First look at the image of a pixel point Hessian matrix, as follows:

$$H(f(x,y))=\begin{bmatrix}\frac{\partial^2 f}{\partial x^2} & \frac{\partial^2 f}{\partial x \partial y}\\ \frac{\partial^2 f}{\partial x \partial y} & \frac{\partial^2 f}{\partial y^2}\end{bmatrix}$$

Feature points need to have scale independence, so before the Hessian matrix structure, the need for its Gaussian filtering. After filtering, the Hessian matrix of the scale image point I (x, y) is defined as:

$$H_{essian}=\begin{bmatrix}L_{xx}(x,\sigma) & L_{xy}(x,\sigma)\\ L_{yx}(x,\sigma) & L_{yy}(x,\sigma)\end{bmatrix}$$

In the case of the Hessian matrix, the discrete pixels are formed by convolution of the template, the Gaussian Gaussian smoothing, and the second derivative solution are combined together, using a template instead, such as the x and y directions of the second order mixed partial ,the template is as follows in Fig 2:

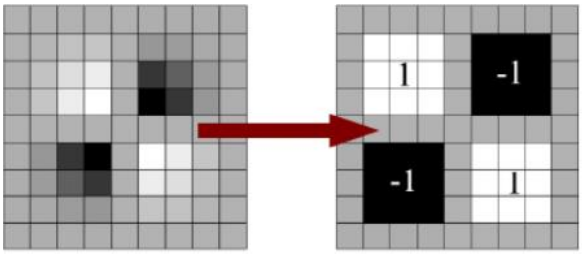

Fig. 2 Second-order mixed partial pilot templates in the x and y directions

The left side of the graph is Gaussian smoothing and then in the x and y direction for the second derivative of the template, in order to speed up the operation with the approximate processing, the results will be simplified to the right. And the right figure can be used to calculate the integral map, greatly speed up the speed. This leads to an approximate hessian determinant.

Using the non-maximal suppression to determine the initial feature points, the hessian matrix processed by each pixel and its three-dimensional field of 26 points to compare the size,if it is the maximum or minimum among the 26 points, then The three-dimensional linear interpolation method is used to obtain the sub-pixel-level feature points, and the points with less than a certain threshold are also removed to realize the precise positioning of the feature points.

2.4 SURF feature matching

The SURF achieves the degree of matching by calculating the euclidean distance between the two feature points. The shorter the distance, the better the matching degree of the two feature points. In the SURF algorithm, if the two feature points have the same direction contrast change, then we are the target of the feature points; if the two feature points in the opposite direction of contrast changes, you can directly exclude. In OpenCV, feature point matching can use the BruteForceMatcher class or the FlannBasedMatcher class match method. Feature extraction based on SURF algorithm as shown in Fig 3.

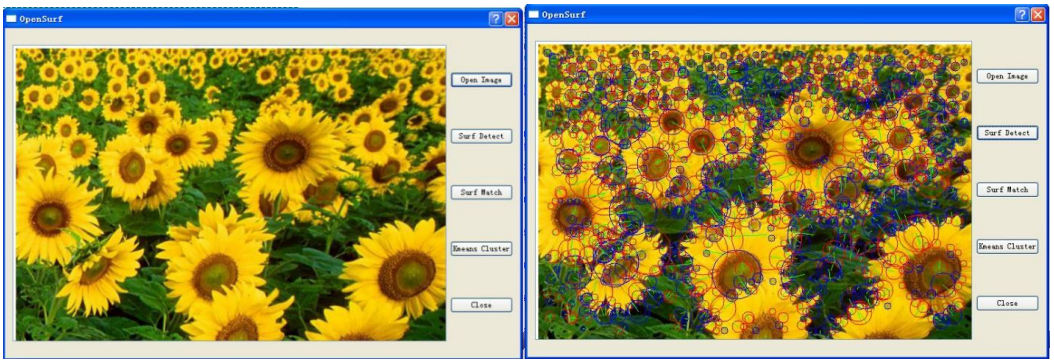

Fig. 3 Feature extraction based on SURF

From the above match, we can see that after the SURF match is completed, the target image and the source image only get the relationship between the corresponding points, and can not get the whole contour of the target object. Therefore, we need to study the algorithm of target contour recognition, In this paper, the SURF algorithm based on the Snake model is proposed to realize the contour information of the target object.

3. Research on Target Contour Recognition Based on SURF Algorithm Combined with Snake Model

The Snake model is a method of edge detection and contour recognition based on dynamic growth of two-dimensional curve. It can use the local and the whole information to realize the accurate positioning of the boundary and keep the linearity smooth. The model is defined by an initial energy function curve, which is initialized around the contour to be segmented, and finally converges to the graphic contour under the constraints of the minimum value of energy and so on. The Snake model is defined as:

$$v(s)=[x(s),y(s)] \qquad s\in[0,1]$$

Snake model to solve the problem is the initial contour of the problem, from the above description of the SURF algorithm can be found in the matching results, you can get the target image and the source image corresponding to the location of the key points, these key points basically cover the target object in the image of the general range, so as to get a preliminary contour information, the results shown in Fig 4, but can not locate the target object accurate contour information, which in many need to know the target contour information research, the field should be further operation.

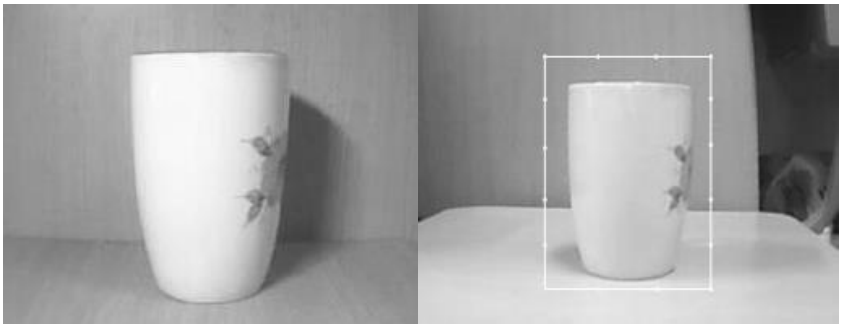

Fig. 4 Through the SURF to get the initial profile

In the above extraction experiment, it can be seen that the key points of the target object and the source image obtained by the SURF algorithm can obtain the area covered by the extraction key, from which the center position coordinates (x_c, y_c) of the target object image can be determined and the width W and the height H of the coverage area are obtained, so that the center of the target object image and the approximate contour information, and then according to the characteristics of the initial shape of the Snake model to create a rectangle of center is (x_c, y_c), width W and height H, take the square on the four The point on the edge is taken as the initial contour point set of the Snake model. Based on the Snake model, the center of the target object and the precise contour information can be obtained by contour recognition of the target object. The results are shown in Fig5.

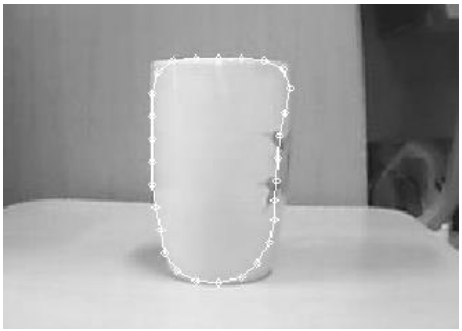

Fig. 5 Combines the Snake model for accurate contours

4. Target positioning experiment

In the experiment, the cup is taken as the identified object, and the feature points of the target object template are extracted. The coordinates of the center position of the target object in the left and right images are (178.651, 316.743), (200.015, 132.706).

SURF algorithm to achieve feature extraction and matching

Image Position	Extract Feature time/s	Extract Feature number	Feature Matching time/s	Feature Point number
Left figure	0.153	318	0.173	8
Right figure	0.149	316	0.181	6

In the binocular stereoscopic vision system, the camera is calibrated, and the image is acquired by the left and right cameras. The corresponding object and the source image are matched by the SURF algorithm. The Snake model is used to extract the target object accurately. Through the Snake model based SURF algorithm can not only achieve the target object positioning, find accurate contour information, and can save a lot of running time, according to many scholars of the experimental results found that through the SIFT algorithm to complete a cup recognition will cost 2.19 s time, using a Snake model based on the SURF algorithm to complete a cup recognition process only takes about 0.33s time.

5. Conclusion

In this paper, based on the combination of Snake model SURF algorithm binocular stereoscopic vision positioning system, first through the camera to collect the left and right images, and then through the SURF algorithm for feature extraction, to achieve the target object and the source image corresponding to each other, get the outline, Snake model and SURF algorithm to find the exact contour information of the target object, according to the matching results to achieve the target object positioning. The experiment results show that the proposed method can accurately find the contour information of the target object, and also save the time of the algorithm running in the matching process and meet the requirements of robustness and real - time. However, there are some shortcomings in this paper, that is not in the real scene to achieve the process of crawling, in future research, will further achieve in the real scene to complete the crawl of the object.

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