Resolution system based on Image processing Technology Applied to Logistics system

Jiabao Liu[1], Yang Fu[2], Bin Wang[3]

[1]School of Mechanical Engineering, Hebei University of Technology, Tianjin, China

[2]School of Computer and Software Engineering, Xihua University, Chengdu, China

[3]School of Information and Computer Engineering, Northeast Forestry University, Harbin, China

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Abstract: The automatic identification technology of goods in intelligent three-dimensional warehouse has the problems of high cost of RFID electronic tag and low recognition rate of goods image recognition technology. This paper presents an automatic cargo image recognition method based on the combination of feature matching and template matching. Firstly, the minimum container rectangle (MBR) in the image is extracted as the template for image matching. Secondly, the scale-invariant feature transform (SIFT) algorithm is used for rough matching of cargo images. Finally, the deformable multiple similarity measure (DDIS) method was used to match accurately. Experimental results show that the proposed method has high recognition accuracy and relatively fast recognition speed, and has certain practical value.

1. Introduction

At present, there are many automatic identification technologies used in intelligent three-dimensional warehouse, such as bar code identification technology, magnetic card (bar) identification technology, RFID radio frequency identification technology, machine vision image recognition technology and so on. However, the paper label is easy to damage and obscure, while the electronic label is expensive, the stability of system integration is poor, and there is no unified domestic standard. at the same time, the label is not the inherent attribute of the goods. Therefore, this paper uses the machine vision image recognition technology, according to the inherent attributes of the goods, through the image matching method to extract the characteristic information of the goods in the image, and automatically identify the goods into storage. A series of problems caused by labeling can be effectively avoided.

Some researches have applied machine vision image recognition technology to intelligent stereo warehouse, which is mainly divided into automatic image matching recognition technology based on template [1-2] and feature [3].However, these methods only consider the shape of goods or carry out simple number recognition in image matching, which cannot meet the high complexity of real goods image. In recent years, due to the emergence of 3D depth sensors, researchers have proposed a 3D object recognition and location method based on point-pair feature descriptor [4]. However, this method has high cost and requires high hardware conditions. This article through to the goods images to extract the minimum circumscribed rectangle [5], highlight the scope of image recognition and use characteristics of coarse matching scale invariant feature transform [6] and deformable template fine matching similarity measure algorithm [7] for complex image matching of goods.

2. Proposed method

In this paper, a method combining feature matching and template matching is proposed to reduce the recognition accuracy due to too few or the same feature points in matching images. Firstly, the image of goods to be matched in the warehouse is collected and preprocessed. Secondly, the cargo MBR in the image is extracted as the template of image matching. Then, the optimized SIFT

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algorithm is used to carry out the rough matching of the cargo images, and the matching feature point pairs are judged. If there are more than 2 pairs and only one image has the largest number of feature points, the match is successful. Finally, template matching is adopted for the cargo images which cannot be recognized by feature matching, and the optimized DDIS algorithm is used for fine matching.

2.1 MBR extraction of image target

The traditional feature matching method only preprocesses the image before the target matching, such as grayscale and binarization, which leads to the low accuracy of image matching. In this paper, the target MBR extraction method is used to extract the target from the preprocessed image to obtain a more accurate target object. In this way, the impact of the background in the cargo image on the cargo recognition is avoided, and the image area required to be calculated during image matching is reduced, thus shortening the running time. The extraction method of image target MBR in this paper adopts the spindle finding method [8] with very fast operation speed, and the obtained image target MBR is clipped out as the template image during image matching. The specific steps are as follows:

Step 1: Target MBR extraction. In this paper, the target MBR of image is obtained by using the method of finding the principal axis. This method is easy to determine the rectangular edge, has fewer rotation times and fast operation speed.

Step 2: Rotate the target image. MBR obtained by most target objects is not upright, which affects the cutting effect. Therefore, the image is rotated in this paper. Assuming that the rectangle starts from the upper left corner, and the four clockwise vertices are $A(x_1, y_1), B(x_2, y_2), C(x_3, y_3), D(x_4, y_4)$, according to the obtained target MBR, the image of the upright rectangle can be obtained by rotating the image counterclockwise by θ degree. Rotation Angle θ is:

$$\theta = \arcsin\left(\frac{x_1 - x_4}{\sqrt{(x_1 - x_4)^2 + (y_1 - y_4)^2}}\right)$$

Step 3: Cut out the target image. Cut out the target image according to the vertex $A(x_1, y_1)$ of the rectangle and the length of two adjacent sides of the rectangle $h = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}, w = \sqrt{(x_2 - x_3)^2 + (y_2 - y_3)^2}$, and get the template image matched by SIFT algorithm.

2.2 Optimized SIFT algorithm

Because it is necessary to consider the lighting environment and the placement form of goods in the three-dimensional warehouse, when extracting the features of goods images, it is required to maintain invariance to rotation and brightness, and to maintain a certain degree of stability to the change of viewing angle, affine transformation and noise, so this paper chooses SIFT feature, which is a very stable local feature. Sift algorithm has two parts: feature detection and feature matching. In this paper, the matching image target before feature detection of SIFT algorithm is extracted to avoid the interference of background to feature detection and reduce irrelevant feature points.

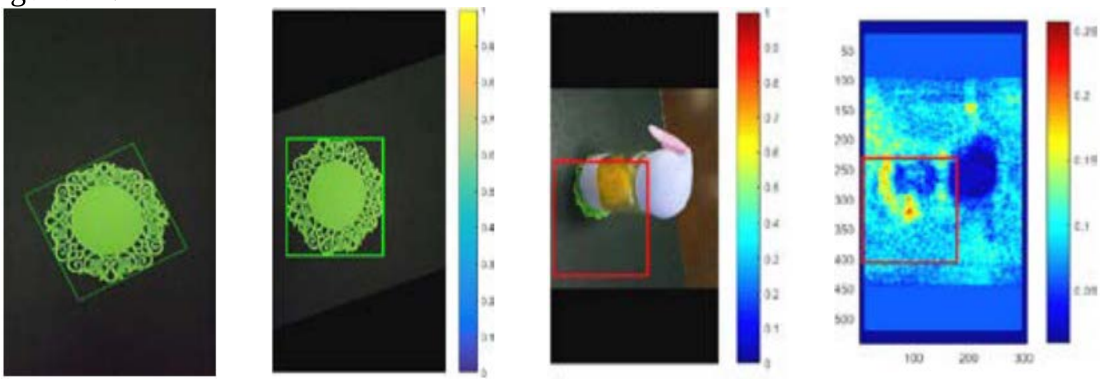
In the feature matching part, the two feature points closest to each feature point of the reference image are found in the image to be matched. If the nearest distance divided by the second nearest distance is less than a fixed threshold, the pair of matching points with the closest distance is selected as the matching pair. Assumes that the reference images of SIFT descriptor $R_i = (r_{i1}, r_{i2}, \cdots, r_{i128})$, to match the image of SIFT descriptor $Si = (s_{i1}, s_{i2}, \cdots, s_{i128})$, then describe the Euclidean distance of two feature points as follows:

$$d(R_i, S_i) = \sqrt{\sum_{j=1}^{128} \left(r_{ij} - s_{ij}\right)^2}$$

In this paper, the image matching distance threshold is modified, and the threshold selected by Lowe[6] is 0.8. The experiment in this paper finds that when the threshold is selected too high, the matching logarithm of the target object will be greatly reduced, which is not conducive to the final image recognition, so the threshold selected in this paper is 0.7.

2.3 DDIS algorithm

Since the SIFT feature points found in the image are always limited and few, it is possible to fail to match the target image, or to match several images with the same number of feature points. Before matching with DDIS algorithm, the template image and the target rectangular frame of the matching image need to be marked manually, that is, the rectangle size and position information need to be calculated in advance, which is convenient for direct call during image matching. However, this method requires a lot of preliminary work. In order to solve this problem, this paper automatically calculates the size and position of the rectangular box through the MBR of the image target during the matching process, as shown in Fig. 1-a and b. Figure 1-a is a template image with the MBR of the image target as the template frame. Since the obtained rectangular frame is in an oblique state, it is difficult to be used for template matching, so the image is rotated to obtain an upright MBR template block diagram (as shown in Figure 1-b), and Figure 1-c and Figure 1-d are the matching result of DDIS algorithm.



a b c d

Figure 1 DDIS algorithm matching

3. Experimental results and analysis

In this experiment, the host computer with 4.2GHz Intel i3-7350K CPU processor, 16 GB memory and window10 64bit operating system was simulated by VS2015 and MA TLAB R2016b.

3.1 Image acquisition and preprocessing

The images used in this paper are taken by mobile phone devices instead of the special camera of the warehouse, and the images are taken and obtained by imitating the warehouse environment. There are 7 kinds of cargo images in the sample image library. Each cargo has at least 3 images with different angles, backgrounds and lighting, so there are 36 images in the image library, as shown in Figure 2.The same collection method is adopted for images of goods to be matched, including 12 images, as shown in Figure 3.In order to facilitate the follow-up work, the image is clipping, grayscale and binarization.

Figure 2 Part of the cargo image library

pair0001 pair0002 pair0003 pair0004 pair0005 pair0006 Pair0007 pair0008 pair0009 pair0010 pair0011 pair0012

Figure 3 Image of goods to be matched

The experimental results show that the Harris+ VL_SIFT method correctly identifies 6 of the 12 images to be matched, and the recognition accuracy is 50%.The original SIFT, VL_SIFT and SIFT+RANSACS methods correctly identified 9 images, and the recognition accuracy was 75%.The method in this paper correctly identified 11 images, with a recognition accuracy of 91.7%, as shown in Table 1.Therefore, the recognition accuracy of the proposed algorithm is higher than that of other methods.

Table 2 shows the matching speed of each algorithm. The method in this paper takes about 1min to identify a cargo, which is faster than the original SIFT method and SIFT+RANSACS method. This is because the method in this paper extracts MBR from the image of the matched cargo before image matching, so as to avoid background interference and reduce the detection range of features. Slower than the method using VLFEAT algorithm library, this paper improves the identification accuracy rate by increasing the time. The identification accuracy rate of goods identification module in the intelligent three-dimensional warehouse has a higher priority than the identification speed, so the time is also within the acceptable range.

Table 1 Comparison of recognition accuracy of various algorithms

Algorithm type	Recognition accuracy /%
Original SIFT	75
vl_SIFT	75
Harris+vl_SIFT	50
SIFT+ RANSACS	75
The method of this paper	91.5

Table 2 Comparison of average recognition speed of various algorithms

Algorithm type	Recognition accuracy /%
Original SIFT	91
vl_SIFT	4.5
Harris+vl_SIFT	4
SIFT+ RANSACS	87
The method of this paper	62

4. Conclusion

In this paper, in order to solve the problem that the label is not the inherent attribute of the goods in the intelligent three-dimensional warehouse, and the matching accuracy of other image matching methods is low, a cargo image recognition method based on the combination of feature matching and template matching is proposed. Firstly, the target MBR of the matching image is extracted as the matching template image, then the optimized SIFT algorithm is used for rough matching, and the cargo image which can not be recognized by feature matching is filtered. Finally, the optimized DDIS template matching method is used to find the matching image. The experimental results show that the recognition accuracy of this method is improved in the range of acceptable recognition time, and has a certain practical value. In view of the shortcomings of this method, real-time should be considered in the follow-up research. We can refer to the method of VLFeat algorithm library to improve the recognition speed of the algorithm, so as to meet the requirements of high real-time and high accuracy of intelligent stereo warehouse.

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