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Vision-based robot sorting system

Zhang Yawan[1], **Cheng Wei**[1]

[1] College of Mechanical and Electrical Engineering, Huali College of Guangdong University of Technology, Guangdong, Guangzhou, 511320, China

*Corresponding author's e-mail: zywan155@163.com

Abstract. In view of the problems of inefficiency, quite expensively traditional manual sorting in the existing logistics industry, a vision-based robot sorting system is proposed. At the same time, in intelligent logistics, the use of machine vision for intelligent sorting tasks becomes more and more obvious. . The automatic sorting robot uses vision to identify the target, locate the target, grab the target, and sort the target. After the robot vision technology is combined, the sorting is more efficient, stable and safe. The lack of sorting exists. Therefore, the vision-based robot sorting system has high application value. In this paper, for the hardware and software parts, STM32F4 is used as the main controller, and the CCD image sensor is used to establish the plane vision coordinate system. The experimental results show that the feasibility of the system is verified. The sorting system realizes the automatic sorting function of the object and has a good application prospect.

1. The first section in your paper

In recent years, with the rapid development of social economy and the continuous popularization of automation technology, human requirements for the production of small bosses and quality of products have gradually increased. In order to comply with the development of the times, many companies have introduced robots into a variety of automated production lines. And in the era of artificial intelligence, machine vision has developed rapidly, and robots have gradually become an important part of the social development field. For example, industrial container handling, painting operations in the automotive industry, sorting of express goods, etc. Because industrial robots have the characteristics of high work efficiency, low cost and low error rate. Therefore, the replacement of manual labor by industrial robots in the future is a major trend of the times. The use of industrial robots is conducive to improving the level of social productivity, which is of great significance to traditional production methods.[1-3]

In the logistics industry, there are problems such as low efficiency, high cost and high cost of traditional manual sorting operations. At the same time, in intelligent logistics, the use of machine vision for intelligent sorting tasks becomes more and more obvious. Aiming at the above problems, a vision-based robot sorting system is proposed, which mainly divides the video of the object to be sorted into multi-frame images, locates the position in the target object in each frame of image, and then performs target grabbing. During the whole operation process, the system which compensates for the shortage of manual sorting, provides the sorting efficiency of the factory and reduces the production cost of the factory, make the work efficient and orderly.

2. Vision-based robot sorting system

The architecture of the vision-based robot sorting system proposed in this paper is shown in Figure 1. It consists of two major modules: the mechanical part and the control part. [4]

The mechanical part consists mainly of sorting devices and conveyor belts and conveyor tracks. The speed of the conveyor belt affects the quality of the picture taken by the vision unit, so the servo drive is used to power the conveyor.

The control system consists of a programmable controller, a vision unit, and a servo drive unit. The visual unit is the core of the entire sorting system. The vision-based target tracking technology is the premise of sorting the target by the sorting system. [5]The main purpose is to subdivide the video of the target to be sorted into multi-frame images, by positioning each The position in the target object in the frame image is then captured by the target to complete the entire operation process. The overall workflow is shown in the figure below. [6-7]

3. Machine vision based target recognition technology

The iterative method is based on the idea of approximation, and its steps are as follows: 1. It should find the maximum gray value and the minimum gray value of the image, ZMAX and ZMIN are respectively recorded, so that the initial threshold T0 = (ZMAX + ZMIN) / 2; According to the threshold TK, the image is divided into a foreground and a background, and the average gray values ZO and ZB of the two are respectively obtained; Find the new threshold TK+1=(ZO+ZB)/2; 4. If TK=TK+1, the result is the threshold; otherwise, it is 2, iterative calculation.

The image of the threshold segmentation obtained by the iteration works well. The iterative-based threshold can distinguish the foreground of the image and the main area of the background, and has good applicability.

4. Target Recognition

In order to study the robot vision sorting technology based on machine vision, this paper designed two experiments, one is camera still - the target sorting in the target stationary state, and the other is the camera stationary - the target sorting in the case of the target uniform linear motion . In the former case, two methods of matching and clustering based on the invariant features of gray histograms are used to achieve static target sorting. In one case, template matching is used to realize the classification of moving targets. [8-10]

This paper adopts VC++6.0 software development under Windows system. Image acquisition and robot control call external library functions. These library functions can be directly used for environment variable setting in VC++6.0. Image acquisition uses image acquisition card. The drive function IFC is provided to control, the robot control uses the MOTOCOM32 dynamic link library, or the C-means classification method is used, and the fifth figure is the mean target recognition block diagram.

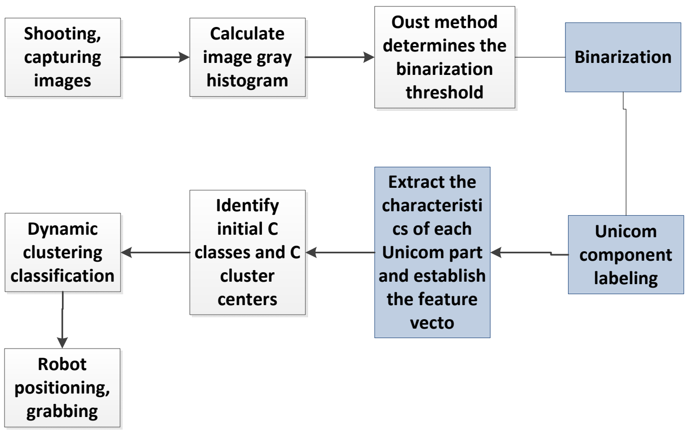

Figure 1 Mean Target Recognition Block Diagram

The above solves the problem of target sorting when the target is stationary. In the actual production process, in many cases, the object is constantly moving, which requires detection of the moving target. This paper studies the motion of the object on the conveyor belt, that is, the object makes a uniform linear motion. The system flow chart is shown in Figure 7. When the program starts, take a picture of a moving object without a moving target. Set this photo as the background and set the timer. A scene graph is taken every 0.5s (the data processing time is 0.1~0.3 in the experiment), the moving target is extracted by the background difference method, and the extracted target is classified by template matching, so as to solve the traditional template matching time-consuming The disadvantage of this paper is that Kalman filtering is used to predict the centroid coordinates of the target at the next moment. The coordinates of this prediction are centered in the range of 80*80 pixels, which reduces the calculation of matching, and can basically move in real time. The target is sorted, and the nearest neighbor method is used for data association of multi-target tracking to ensure the accuracy of tracking.

4.1. Stationary target sorting test

The system can classify different objects at rest, and use the methods of matching and clustering based on the invariant features of gray histograms to realize classification. According to the result of calculating the calibration of the camera, the position of the target in the robot coordinate system is calculated, and MOTOCOM32 is called. The provided library function controls the robot to place different types of targets in the specified positions, and the specific positions can be set on the program interface.

The sorting objects in this experiment are five different types of standard squares with widths of 70mm, 65mm, 60mm, 55mm and 50mm and thickness of 1mm. The program designed in this paper can distinguish the squares with diameter difference >=10mm, the diameter Blocks with a difference of 5 mm sometimes cause mis-grabbing operations (the washers that the machine considers to have a diameter difference of 5 mm are treated as washers of the same type)

4.2. Moving target sorting test

Different types of targets on the conveyor belt for uniform linear motion are sorted, the background difference method is used to extract the moving targets, and the template matching method is used to classify the targets. In order to reduce the matching time, a prediction mechanism is introduced, and kalman filtering is used for prediction. Multitarget tracking by using the nearest neighbor method for data correlation, and finally controlling the robot crawling with the results of camera calibration.

Kalman filtering is used for prediction. For multi-target tracking, the nearest neighbor method is used for data correlation, and then the results of camera calibration are combined to control the robot's capture.

This phenomenon occurs for the following reasons:

1. The camera used in this experiment is a black and white camera with a pixel of 30w (648*492). The camera's pixels are low, and it is not easy to photograph the details of the object;

2. The camera is installed on the large flower board of the laboratory, which is far away from the area where the gasket is placed, which is easily affected by external conditions;

3. Due to the limitations of the value segmentation algorithm, it is greatly affected by light, and the shadow may be regarded as part of the object.

5. Experiment and analysis

The static and dynamic targets are grouped and compared with the system by using literature technology. The experimental data is as follows.

Table 1 Experimental data

	data	Document system	System of this paper
Static	time /s	3	1.5
	Accuracy	45%	63%

dynamic	time /s	6.5	5
	Accuracy	31%	58%

In the same situation, the success rate of grabbing static blocks is higher than the success rate of dynamic capture. Therefore, to improve the accuracy of the capture, it is possible to improve the selection of a high-pixel camera, the use of some algorithms that are less affected by external conditions, and the installation position of the camera as a target recognition algorithm as close as possible to the scene, so that the details of the target can be photographed. Accurately identify targets.

When the moving target speed on the conveyor belt is less than 0.5m/s, the system can capture the moving target very well. The main reason for the fast speed and the inability to grasp is that the target recognition algorithm uses the template matching algorithm. The method is time consuming. Although this paper adopts a simplified method, the prediction mechanism is introduced on the basis of traditional template matching, which reduces the range of matching and shortens the calculation time, but it cannot completely solve this problem. Subsequent research can be based on feature points. The target matching algorithm, which takes less time and enables faster target tracking.

6. Conclusion

Development trend of robot sorting technology based on machine vision In addition to the above application of robot sorting technology in various fields, the current research on machine vision has made great progress. However, due to many deficiencies in environmental variability, software and hardware development, etc., further research is needed. This paper introduces the software and hardware components of the automatic sorting control system, describes the image processing algorithm of the visual unit, and solves the shortcomings such as low target recognition efficiency and low accuracy through deep learning convolution algorithm. It is suitable for small and medium-sized companies. The demand for sorting is low and has good promotion value.

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