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Study on Automatic Yarn Feeding Device in Textile Workshop

Changxin[1] Cao, Weiping[1,2,*] Luo

1School of Mechanical Engineering and Automation, Wuhan Textile University, Wuhan, Hubei 430200, China;

2Hubei Provincial Key Laboratory of Digital Textile Equipment, Wuhan, Hubei 430200, China

Abstract: According to the characteristics of low automation, high labor cost and high labor intensity of bobbin transfer and upper and lower frames in textile workshop, an automatic yarn loading device composed of handling system, rotating platform, image acquisition system and upper and lower frame system is designed. Firstly, the work flow of the four systems in the textile workshop is introduced. Secondly, the image acquisition and processing methods are described in detail. Finally, the circle fitting is mapped to the original image, the fitting circle of the original image is positioned through the binocular vision imaging principle, and finally the yarn is loaded through the upper and lower yarn frame system.

Keywords: Automatic Handling; Image Acquisition and Processing; Binocular Vision Calibration; Automatic Yarn Feeding; Automation

Introduction

Textile industry has a long history and is a basic industry in China. Bobbin is the end product of the textile industry, a lot of manpower is needed in its transfer, upper and lower frame and other operations [1]. Many domestic factories use manpower to transfer the bobbin to the frame next to the hydraulic forklift, and then put the bobbin on the cartridge spindle one by one with the help of workers [2]. In recent years, with the continuous improvement of China's economic strength and the level of industrial manufacturing, as well as the rise of workers' wages, labor costs are increasing. The textile industry, which is characterized by labor-intensive, has suffered a significant impact, which implies that the way of manual operation is urgently needed to be changed [3][4].

In order to solve the above problems, considering the movement of the whole device and the functions of identifying, handling and feeding the bobbin yarn, a set of devices for identifying the bobbin yarn through stm32 control and machine vision is developed.

1 Composition structure of automatic yarn hanging system

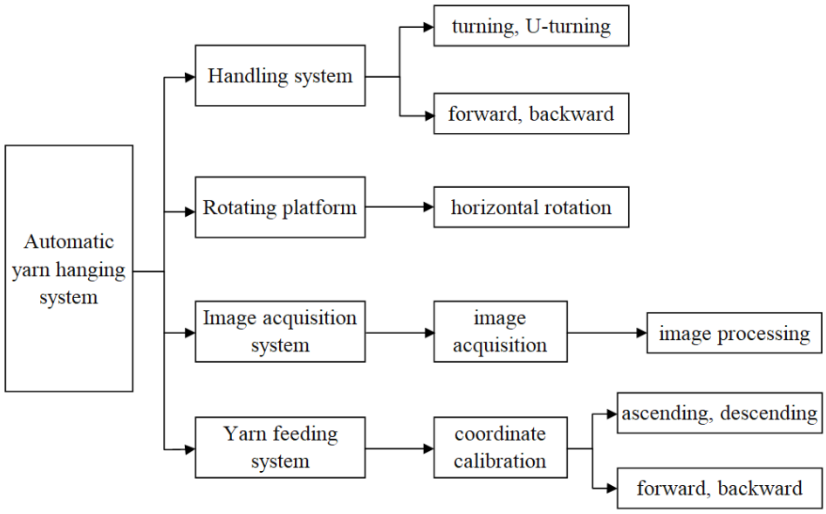

Figure 1 Block diagram of automatic yarn hanging system

Figure 1 is the structure block diagram of the automatic yarn hanging system, mainly composing four parts: the handling system, the rotating platform, the image acquisition system and the yarn feeding system, which can achieve the goals of automatic transportation and feeding of bobbin yarn in the textile workshop. The main functions of each part are as follows:

(1) Handling system: the handling system can realize the function of carrying device and bobbin yarn moving on the designated route, and can perform turning, U-turning, forward, and backward movements;

(2) Rotating platform: the rotating platform is attached to the handling system, in order to save operation time, speed up the progress of the project, and realize the 360 ° free rotation of the feeding system on the horizontal plane.

(3) Image acquisition system: the system mainly includes image acquisition, image processing, coordinate calibration and other functions to realize the positioning of the cartridge spindle.

(4) Feeding system: it mainly realizes the function of placing the bobbin yarn on the cartridge spindle, and has the ability to ascend and descend, advance and retract;

2 Image processing system

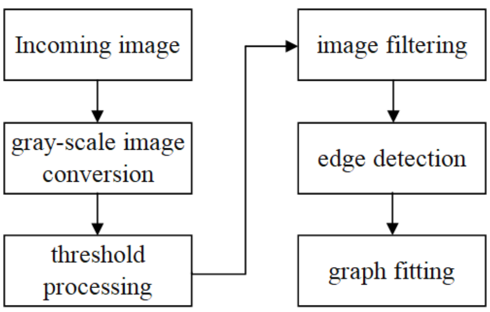

Figure 2 Image processing flowchart

Fig. 2 shows the image processing flow of the image processing system. The fitting circle of the cartridge spindle is obtained by processing the image, which is convenient for locating.

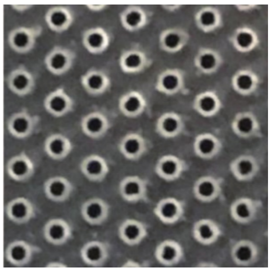

Fig. 3 Gray value image of cartridge spindle

Figure 3 is the image of the original image of the cartridge spindle after gray value conversion. The gray value conversion of the original image helps to reduce the pixel channel of the image, reduce the amount of original image data, and avoid all processing the three components of RGB, thereby facilitating the subsequent processing flow.

The final image obtained by threshold processing, filtering, edge detection and circle fitting after gray value conversion is:

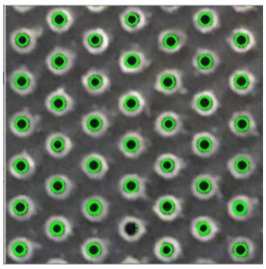

Figure 4 Final fitting effect diagram

According to Fig. 4, although all contours can be circle-fitted on the processed image, when it is finally mapped to the original image, there are very few contours that do not complete circle fitting because of the noise interference between the images. After completing 50 circle fitting tests, it is concluded that the probability of circle fitting for all contours is 4%.

3 Feeding system

Based on the camera calibration, the binocular vision imaging is carried out and the reciprocating motion of the linear sliding table is controlled, and the yarn feeding project is completed.

Specifically, the process of establishing the camera imaging geometric model can be understood as the transformation of the four coordinate systems in the camera model, as shown in Fig.5. First, the world coordinate system is transformed into the camera coordinate system by rigid body transformation, then the camera coordinate system is transformed into the image coordinate system by perspective projection, and finally the image coordinate system is transformed into the pixel coordinate system by affine transformation.

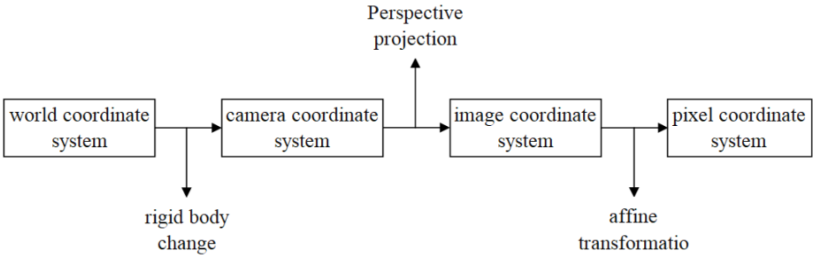

Figure 5 Camera imaging coordinate system conversion

The information of an object in three-dimensional space is pushed from a two-dimensional image. In order to derive the specific position information of the object in three-dimensional space, in addition to the image itself, the parameters of the camera are also very important, indicating that camera calibration is a key step in the application of visual imaging. There are two methods of camera calibration, the traditional photogrammetry and self-calibration method, and the device adopts Zhang Zhengyou calibration method. This method is between traditional photogrammetry and self-calibration measurement, and it is faster, more accurate and more stable. It is worth noting that the purpose of camera calibration is to obtain the internal parameter matrix, external parameter matrix and distortion parameters of the camera.

$$\begin{pmatrix} \frac{1}{dX} & -\frac{\cot\theta}{dX} & u_0 \\ 0 & \frac{1}{dY\sin\theta} & v_0 \\ 0 & 0 & 1 \end{pmatrix}\begin{pmatrix} f & 0 & 0 & 0 \\ 0 & f & 0 & 0 \\ 0 & 0 & 1 & 0 \end{pmatrix} = \begin{pmatrix} \frac{f}{dX} & -\frac{f\cot\theta}{dX} & u_0 & 0 \\ 0 & \frac{f}{dY\sin\theta} & v_0 & 0 \\ 0 & 0 & 1 & 0 \end{pmatrix} \quad (3)$$

$$\begin{pmatrix} R & T \\ 0 & 1 \end{pmatrix} \quad (4)$$

Eq. (3) is the internal reference matrix of the camera. Wherein, f represents the distance between the camera, dX and dY represent the physical length of a pixel in the X and Y directions on the camera's photosensitive plate, respectively. u_0 and v_0 represent the coordinates of the center of the camera plate in the pixel coordinate system, respectively, and θ represents the angle between the vertical and horizontal edges of the plate.

Eq. (4) is the external parameter matrix of the camera. The relative position of the world coordinate system and the camera coordinate system determines the external parameter matrix. Wherein, R represents the rotation matrix and T represents the translation vector.

Suppose that the physical coordinates of a point in the world coordinate system are (U, V, W). This point corresponds to the pixel coordinates in the pixel coordinate system (u, v), and Z represents the scale factor, then the camera imaging model without considering the image distortion is:

$$Z\begin{pmatrix} u \\ v \\ 1 \end{pmatrix} = \begin{pmatrix} \frac{f}{dX} & -\frac{f\cot\theta}{dX} & u_0 & 0 \\ 0 & \frac{f}{dY\sin\theta} & v_0 & 0 \\ 0 & 0 & 1 & 0 \end{pmatrix}\begin{pmatrix} R & T \\ 0 & 1 \end{pmatrix}\begin{pmatrix} U \\ V \\ W \\ 1 \end{pmatrix} \quad (5)$$

4 Sliding table hanging yarn

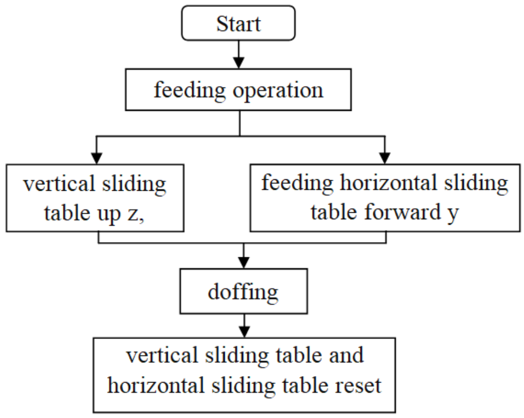

Figure 6 Flow chart of yarn hanging on sliding table

Fig. 6 shows the flow chart of the sliding table hanging yarn. On the basis of binocular vision calibration, the coordinates (x, y, z) of the cartridge spindle corresponding to the bobbin clamping device are obtained, and the rising of the vertical sliding table and the advance of the horizontal sliding table are the feeding operation. That is, on the basis of knowing the corresponding position relationship, the two kinds of sliding tables move at the same time, and the motion distance is their corresponding position relation coordinates. After the completion of the movement, the cartridge spindle is embedded in the middle of the bobbin yarn to complete the drop operation. That is, the vertical sliding table drops slightly, the cartridge spindle perfectly supports the bobbin yarn, and then the two kinds of sliding table devices complete the reset operation.

5 Conclusion

Considering the present situation of yarn hanging in textile workshop, a fully automatic yarn hanging device based on binocular vision technology is designed in this paper. Specifically, it carries the load of the whole device through the AGV trolley, the positioning and identification of the cartridge spindle through binocular vision technology, and the clamping and yarn operation through the collocation of two kinds of linear sliding tables. This device greatly improves the degree of automation of the textile workshop, reduces the safety risk of the textile workshop and reduces the labor cost. In addition, compared with other products in the same period, it is lightweight, highly intelligent, and the price is not expensive, which meets the requirements of domestic textile workshops.

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About the author: Changxin Cao (1996-), male, master student, interested in data processing and machine learning.

Correspondence contact person: Weiping Luo (1967-), female, master, professor, interested in detection technology and intelligent control.

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