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Automatic sorting system based on CORE XY structure

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Abstract

This design aims to complete the automatic sorting and collation of twelve out-of-order blocks. Through this design scheme, the courier sorting work is simulated, and a design scheme for express sorting is proposed. The designed mechanical structure of the robot is mainly composed of stepper motors and pneumatic components. The image recognition processing of this design adopts the OpenMV camera module to complete the image processing and send it to the single-chip microcomputer through the serial port. The designed control device uses STM32 to complete the communication with the camera. And finishing the control strategy, drive the drive board and solenoid valve with GRBL firmware library to complete the entire sequencing operation. The article introduces the mechanical design ideas, serial communication process, image processing, and the functions and principles of various parts of the hardware circuit. This design can be used in areas such as warehouse management, package sorting, etc., and has practical value. At the same time, the suction cups at the bottom of the cylinder can be replaced to achieve the gripping of different objects.

Keywords

Industrial robot；Electrical mixing；Automatic sorting；Image Identification；STM32.

1. Introduction

According to a study released by the International Federation of Robotics (IFR), the global supply of industrial robots was 69,000 units in 1998, and by 2013 the global supply of industrial robots had risen to 175,000 units. According to the "2014-2018 China Industrial Robot Industry Production and Demand Forecast and Transformation and Upgrade Analysis Report", in 2013, the Chinese market sold 36,560 industrial robots, accounting for one-fifth of global sales, up 60% year-on-year, replacing Japan. The world's largest industrial robot market[1]. In today's society, both domestic and foreign, the quantity and quality of industrial robots are one of the important criteria for measuring the level of industrial automation in a country.

In recent years, e-commerce has grown and continues to grow. Online shopping has become an important part of people's lives. Especially in China, e-commerce has changed the status quo of people's lives. Product classification packaging, express parcel finishing and warehouse cargo management are indispensable parts of the industry chain. In these links, we often face the task of reordering. Due to the complexity of the finishing work, we can only adopt the manual finishing method. The manual finishing has the characteristics of low efficiency, high error rate and large uncontrollable factors[2]. The automatic finishing of robots not only contributes to the optimization of the structure of processing industrial products, but also plays an important role in ensuring personal safety, improving the working environment, reducing labor intensity, increasing labor productivity and reducing production costs[3].

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Compared with the traditional classification structure, the sorting system adopts the Corexy structure, which has obvious advantages in sorting speed, degree of freedom and precision. The principle of the CoreXY structure is to control the movement of XY by two motors at the same time. When the left and right motors are at the same speed, the arm moves along the X axis. When the two motors reverse the same speed, the arm moves along the Y axis; When the left and right motor speeds are different, by controlling the speed difference, the arm can move in any direction of the four quadrants of the XY axis. The simultaneous action of the two motors is more stable than the single motor control and the control accuracy is higher.

It has more advantages than the moving parts based on Cartesian motion. The two conveyor belts of the machine also look very interesting. They look like intersecting, actually on two planes and one on the other. . Two stepping motors are mounted on the carriage moving in the X and Y directions, making the carriage movement more precise and stable.

2. System structure

This design adopts CoreXY mechanical mechanism. The motion mode consists of motor motion and cylinder motion. The camera completes image acquisition and image processing. The processed information is sent to the STM32 MCU through the wireless serial port. The MCU analyzes the data and decides the most. Good sorting method, send G code to control the movement of the stepper motor, and also control the cylinder and vacuum pump to complete the whole sorting action.

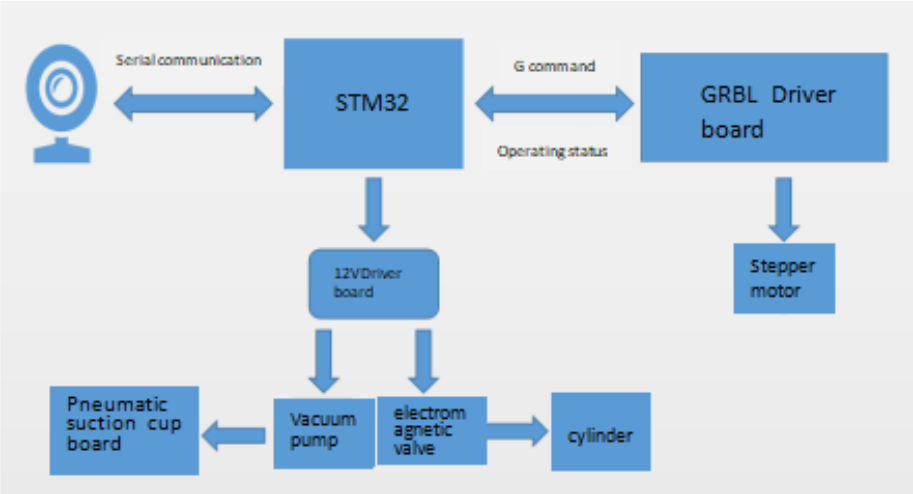

Fig.2.1 System block diagram

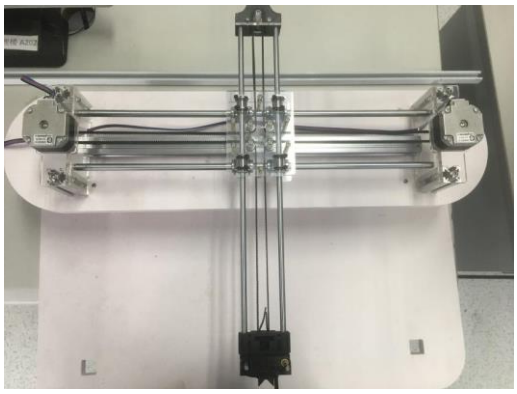

Fig.2.2 CoreXY Robot arm structure

3. Motion control strategy

The OpenMV camera can serially transmit the position information of the current block. After receiving the information, the STM32 microprocessor analyzes the current block position information and makes the most reasonable sorting decision. The algorithm simulates the human mind mode for

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decision making. Whether the block placed in one position is correct, if it is correct, it looks for the second position, the way of thinking when people think, this way of thinking is very rapid in the human brain, So that people can hardly detect this process, and think it is a very normal process. It needs to be written line by line in programming[4]. It seems that it seems too long, but the calculation speed of calculation is abnormally fast, even the low end. The single-chip microcomputer, 12MHZ crystal oscillator, only needs 10ns for each execution of an instruction, which means that as long as the logic is written, even if the number of lines of code is too long, the computer can be executed in a very short time. We don't have to completely pursue the execution efficiency of the code. As long as the logic is correct, we can get the desired output very quickly. Compared with the efficiency of code execution, it is more worthwhile to pursue the portability of the code.

The microprocessor receives the location information of the block from the serial port and needs to complete two things. The first thing is to get the block placed at all positions; the second thing is to get the location of all the blocks. When human beings face this problem, the information obtained by visual observation is the block placed at all positions, but it is very difficult to answer the whole set of motion without using moving blocks. Humans often think in their minds when I Moved this block, how do I observe the block? The two information obtained by the micro-processing is actually performing this derivation process. The control strategy needs to move one step and then rely on the position information of the block and the position information of the block to refresh and move the information after a block. Each time a block is moved, the information needs to be refreshed.

The decision-making process is as follows: First, observe whether there are objects in the temporarily placed area, and each block is still placed. There are two cases. The first case is that the block is sorted, and the second is that the block is not sorted. carry out. Therefore, it is necessary to check the first block by checking whether the correct block is placed in each position. When it is found that the block at a position is not in the correct position, the block is placed in the temporary placement area[5]. At this point, a space will appear in the placement area. According to the location information of the object block, it can quickly find which block needs to be placed in the empty area, and this is always done. Until there are no blocks in the temporary placement area, repeat the steps to start, so that the pieces can be sorted[6].

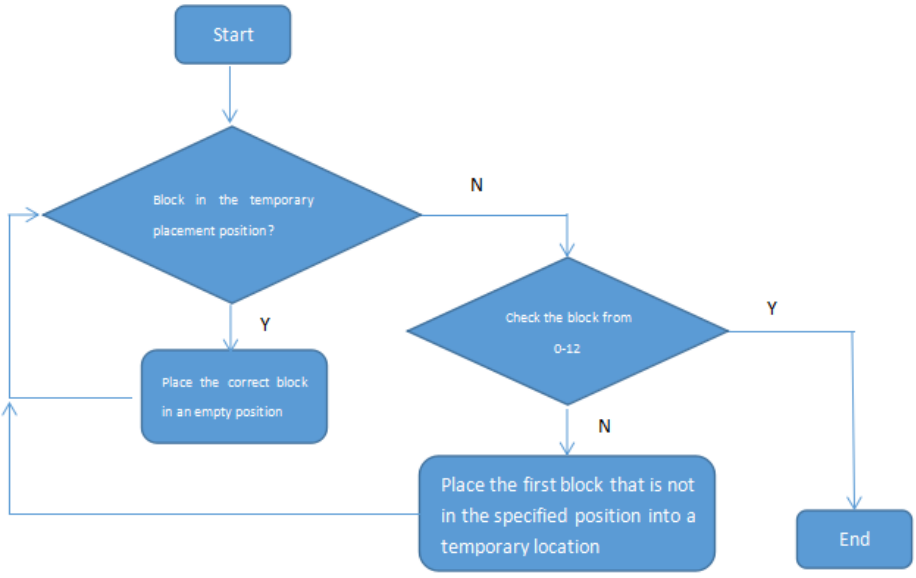

Fig3.1 Sorting decision

After the decision is made, STM32 controls the movement of the X and Y axes of the robot according to the decision, the movement of the cylinder, the sucking and the movement of the suction block. The grabbing action is similar to the placing action flow. The difference lies in the switch of the vacuum pump, because the GRBL library can look ahead. 16-20 actions, so the motion is controlled by delay, and the motion state of GRBL needs to be continuously queried. The G code sends a “?”

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command to query its motion state, and GRBL returns idle to represent inactive state and Run. Represents the state of motion. After sending a coordinate instruction, the motion state is always queried until the returned value is Idel. When the next control action is performed, the time of querying the state will affect the speed of the whole motion, and should not be too large. A very long vacuum period should not be too small. If it is too small, it will make it impossible to control its movement. This design selects 200ms as the interval to query the motion state. In the actual test, the whole movement process is smoother. The crawling action flow is as follows:

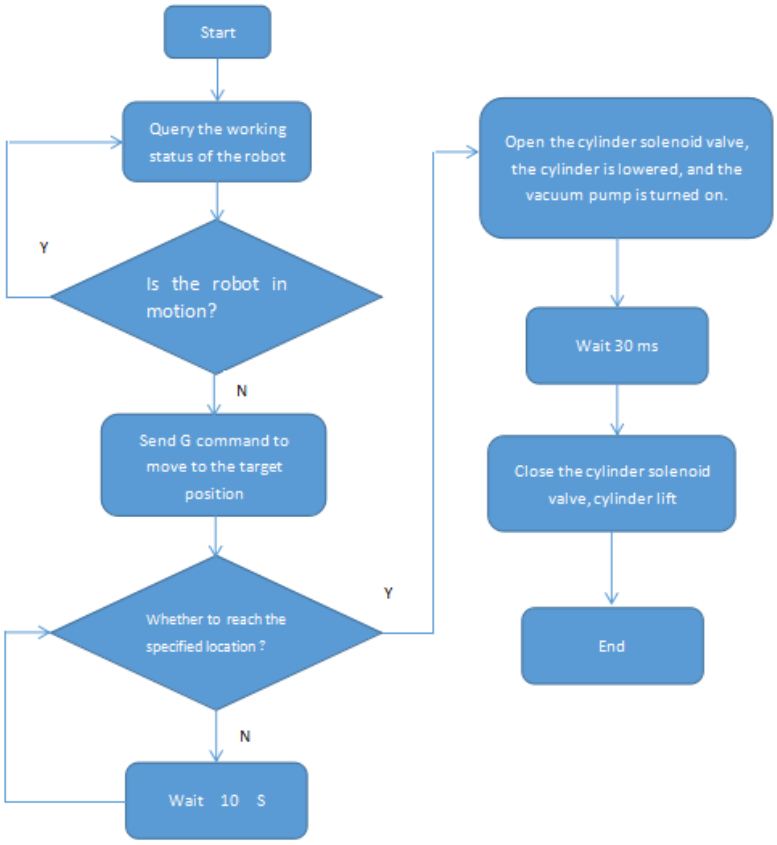

Fig3.2 Grab the block process

4. Image Processing

The OpenMV camera gives the entire machine vision, and the task that the camera needs to accomplish is color recognition to distinguish between different pieces. The image captured by the camera is an RGB image. The RGB color mode is a color standard in the industry. It is a change of the three color channels of red (R), green (G), and blue (B) and their mutual Superimposed to get a variety of colors, RGB is the color of the three channels of red, green and blue. This standard includes almost all colors that human vision can perceive. It is one of the most widely used color systems. . This design needs to be identified in three colors, red, green and yellow.

Since the camera needs to be placed on site, if the placement position is incorrect, the recognition fails. Therefore, the position of the camera is calibrated with a marker point. When the left border of the image coincides with the marker point, it indicates that the camera is correctly placed. The task is completed with minimal effort. The setting area selects the location of the area through the OpenMV observation window.

The OpenMV camera can call the function to determine the main color of the region of interest, and can return the value of RGB. When the main color of the region of interest is red, the numerical characteristics of the RGB three components are R component > B component > G component; When the main color of the region of interest is green, the numerical characteristics of the RGB three components are R component > G component > B component; when the main color of the region of

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interest is yellow, the numerical characteristics of the RGB three components are B component versus R component. The G component is quite small. Therefore, according to this idea, the color is identified, and the flow is as follows:

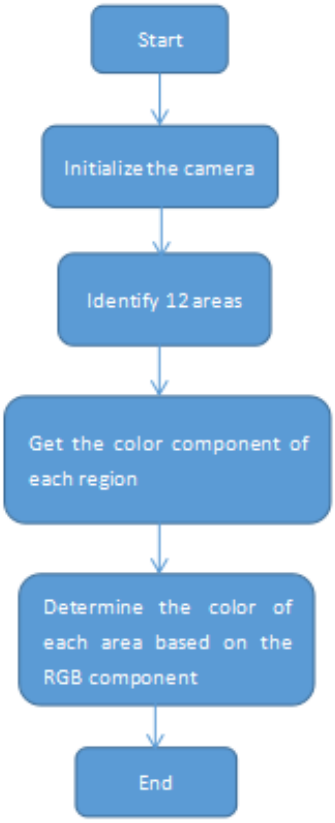

Fig4.1 Image processing flow

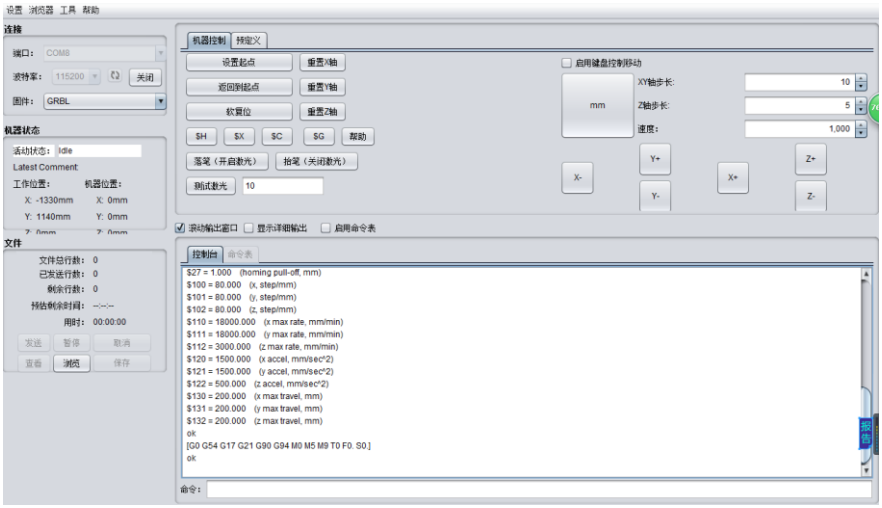

Fig5.1 GRBL PC software interface

5. Analysis of results

5.1 Motion positioning

The block and the console have an absolute position, which means that an accurate grip can be accomplished as long as the position of the position relative to the arm is determined. GRBL driver board can be directly controlled by the host computer software, the interface is simple, easy to operate, and can modify the relevant parameters in the GRBL firmware library, such as step value, step speed

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of x, y axis, acceleration and other parameters, image operation The interface facilitates the positioning of each target.

5.2 Communication test

In this design, STM32 uses two serial ports, which communicate with GRBL driver board and camera respectively. With the Jlink online debugging function in Keil software, you can see the received value and debug the communication in this way[7].

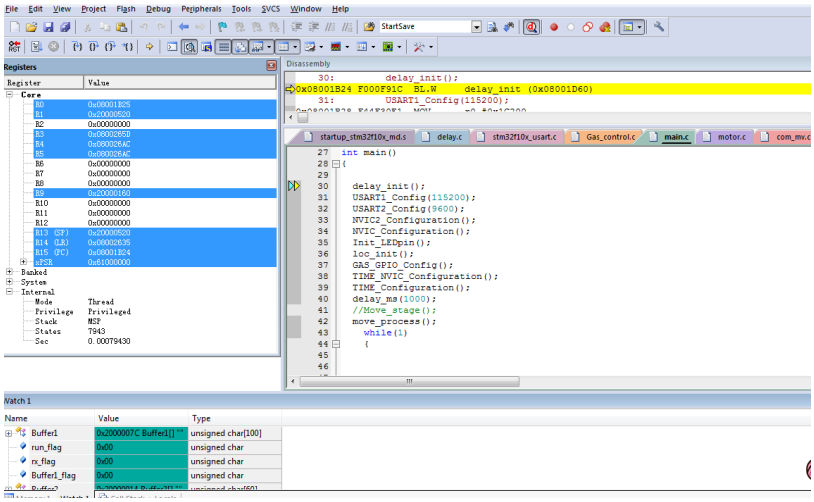

Fig5.2 Jlink online simulation interface

Under the observation window, you can see the changes of each variable and the data received.

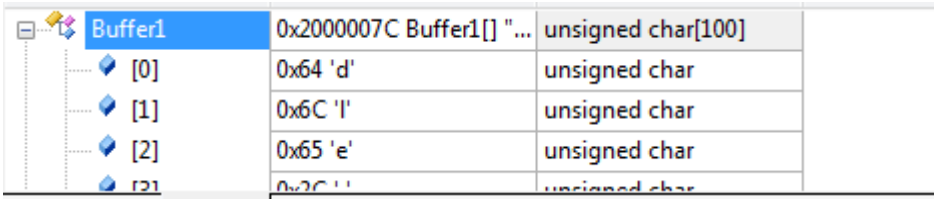

Fig5.3 Data received when the machine stops working

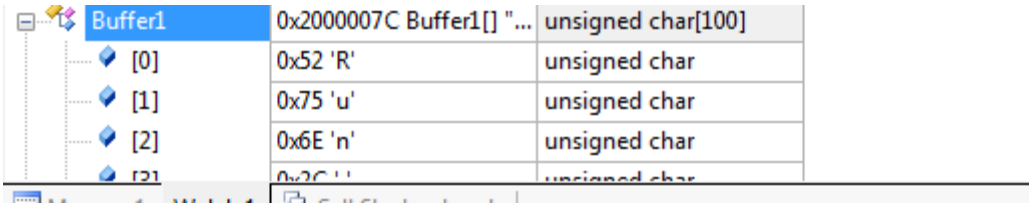

Fig5.4 Data received while the machine is working

6. Conclusion

This design uses the CoreXY structure to complete the movement of the X and Y axes, completes the Z-axis movement through the cylinder movement, and uses the vacuum suction cup to suck the block. The combination of single-chip technology, image processing, pneumatic and electric power has completed the task of rapid sorting. The combination of various technologies allows the robot to think like a human being, be able to perceive objects, and can think and make the most reasonable and fast. Sorting. Delivering boring tasks to the machine can not only reduce labor intensity, but also improve efficiency.

Since the control of this design is open-loop control, there is no feedback, and the initial position is used for movement, which makes it necessary to recalibrate in the new working environment. Later in the design, the design can be made more intelligent by adding sensors. The processors selected in

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this design are all open source code, and can be developed for special tasks, and the development cost is low.

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