

Design of the Multifunctional Writing Robot based on Arduino

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Abstract: To solve the problem that the writing robot cannot write according to strokes, this paper makes a deep analysis on the basic structure and Arduino control system of the writing robot, and introduces a software based on successive comparison interpolation algorithm which is compiled by VB, and uses the path planning program to compute the vectorization of single line fonts. According to the vector data of the path planning and the whole motion equation of the writing robot, the vector path and the whole control plan of the writing robot are carried out. By system testing, the writing robot has high positioning precision, fast writing Chinese characters, which can easily realize the function of changing pen and achieves the expected design goal.

Keywords: Handwriting Robot; Arduino; Point-by-Point Comparison Interpolation Algorithm; Single-line Word

1. INTRODUCTION

Handwriting robot, as one kind of intelligent robot, not only can complete the function of writing, but also can be used in industry, science exhibition and teaching [1]. The control function of handwriting robot is mainly to control the end of the manipulator in a certain way in space, at present, there are many researches on handwriting robot in China. For example, Li Bingyin et al. [2] have discussed the spatial position precision of stepper motor controlling manipulator. Jing Xingbi, Wan Renming et al. [3] used the SCARA robot developed by hualu-863 to make a simple description of the writing system of soft pen calligraphy. Wang Jianguang et al. [4-7] made a detailed analysis of the kinematics simulation, trajectory planning and text contour extraction of the robot. Wang Xiaoli et al. [8] conducted experiments on Chinese character writing by using MOTOMAN robot. Gong xiaobo et al. [9] studied Chinese character rendering with IRB140 robot. Daniel Pérez-Marcos et al. [10] have discussed the human brain-robot interface for remote writing. The system allows a user to select by thought arbitrary words and to send them to a robotic arm, which receives the command via Internet and writes the word on a whiteboard in real time. The analysis of the existing results found that many large printing devices or writing drawing instruments structure is more complex on the current market, needs the professional technical maintenance and has a low performance-price ratio. What's more, the control process is relatively complex, and cannot be carried out in accordance with the strokes of

Chinese characters order to write. Therefore, inventing a cost-effective handwriting robot with simple structure which can write the Chinese characters according to the users' requirements is not only the need of social development, but also has important practical significance and the huge market benefits.

2. OVERALL SCHEME DESIGN

The writing robot consists of path generation module, program execution module, off-line module and two-dimensional writing hardware module, which takes the program execution module as the main control module, the above bit machine and the off-line module as the auxiliary controller to adjust the working starting point of the writing robot. The mechanical structure of the writing robot is composed of four parts of the motor, the supporting shaft, the transmission module and the steering gear. The whole device adopts the way of belt transmission, so it is in a two-dimensional working state. As shown in Fig.1, it is the overall control block diagram of the writing robot.

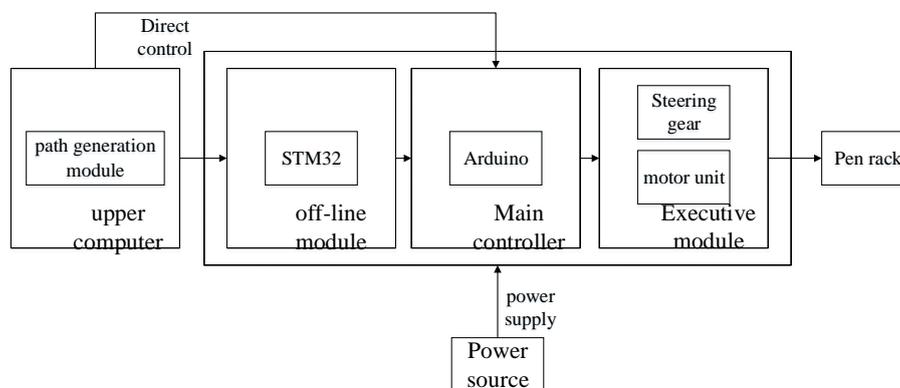


Fig.1 The overall control block diagram for the writing robot

3. CONTROL SYSTEM DESIGN

The overall control system of handwriting robot designed in this paper consists of seven modules, including upper computer, main control board, steering machine, off-line module, motor and battery. This robot uses Arduino as the main controller, the upper computer and off-line module as the auxiliary controller and the execution link consists of motor and steering gear, all parts cooperate with each other to complete the work.

3.1 Main controller

The main controller adopts the Arduino system board, mainly through the serial port to receive the G code sent by the upper machine or offline module, through internal procedure to identify and convert G code, then through the point by point comparison interpolation algorithm and the control program to control motor and steering gear working state. As is shown in Fig.2, it's the Arduino system board.

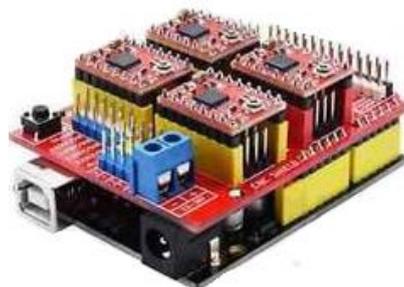


Fig.2 The Arduino system board

3.2 Steering Gear

Steering gear control line is connected to the Arduino, through the Arduino system board output G code to control clockwise and counterclockwise rotation of the steering gear to change the steering front blade angle, so as to appear displacement difference in the vertical direction to make the pen rack raise. When blade clockwise, the support of pen rack disappear, and then through the rubber band to slide pen rack down. That is to control the rise and fall of the pen. The steering gear choose SG90 classic steering gear.

3.3 Motor

This device has two motors, through a serial port to receive the G code sent by upper machine or offline module, after identification and transformation of the output pulse signal to control the positive and negative rotation of the motor. Two motor's reversion drives the coupling action, in this way, the pen at the end of robot can rotate and move forward and backward, left and right. For each control pulse output in practice, the stepper motors step forward or backward, thereby giving impetus to the movement of fixed track so as to achieve the purpose of moving around pen rack. 42BYGH40 stepper motor is selected for this motor.

3.4 Offline module

The offline module takes STM32 as the main control chip, through the design of circuit and program, it can explicitly read and write the NC files saved in the SD card on the LCD screen. The buttons on the offline module choose different NC files, then transmit the code information via RS232 communication protocol to program execution module. And the start-stop can be controlled by two buttons of the offline module to adjust the pen rack work starting point. The STM32 schematic diagram is shown in Fig.3.

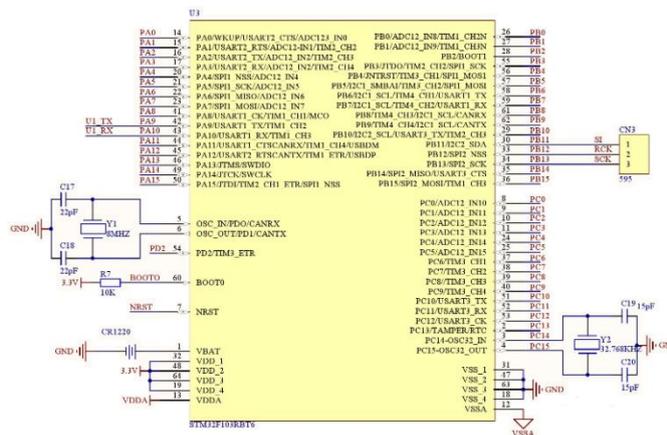


Fig.3 The STM32 schematic diagram

4. SOFTWARE DESIGN

4.1 Point-by-point comparison interpolation algorithm

The basic idea of point-by-point comparison interpolation algorithm is that each step must be compared with the theoretical trajectory when the controlled object moves according to the required trajectory. According to the comparison results to determine the next move direction, the cutting tool starts from the starting point and determines the feeding direction according to the principle of closing to the curve and pointing to the end point, and controls the tool feeding successively until they are the terminal interpolation curve. The workflow is shown in Fig.4.

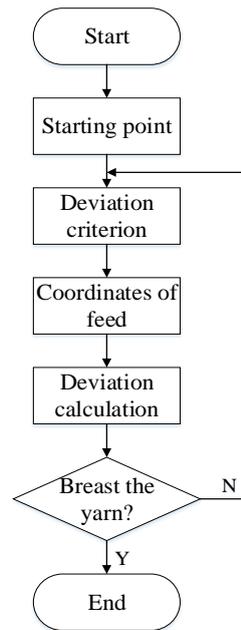


Fig.4 The work flow of point-by-point comparison interpolation algorithm

4.2 Single-line Word

When the machine is processing Chinese characters, it is scanned as a picture, and there are general contours, which is not beautiful when using machine, so it is necessary to handle the characters in single line. The idea is first to perform a scan operation from the top down, when the black spots are scanned, first of all, determine whether the dots near the pixels are black, meet the conditions to remove the center of these black spots, the other part of the white, and then carry out from left to right scan operation. The whole process is similar to the judgment from top to bottom of and performs a scan operation all the time. If the corresponding black dots can no longer be found, the algorithm ends. By this algorithm, the strokes of all characters will become single line, thus constructing a single word.

4.3 Software development

This paper uses VB to write a new software based on interpolation algorithm to meet the needs of different fonts. According to this software, users can describe Chinese characters in a specific part, generate G code and simplify the G code through the algorithm, so as to generate single-line words that can be written by the machine. The software allows users to customize font and character size selection, set machine writing speed and so on. The software interface developed based on VB is shown in Fig.5.

5 THE SYSTEM JOINT TEST

In this paper, modularized adjustment is adopted for debugging, and the overall performance of the system is optimized. After completing the software design, firstly, debug the motor to control the left and right movement of the writing device, set the motor's moving speed. Then add the pen setting device to test the steering gear angle. The system joint test results are shown in Fig.6.

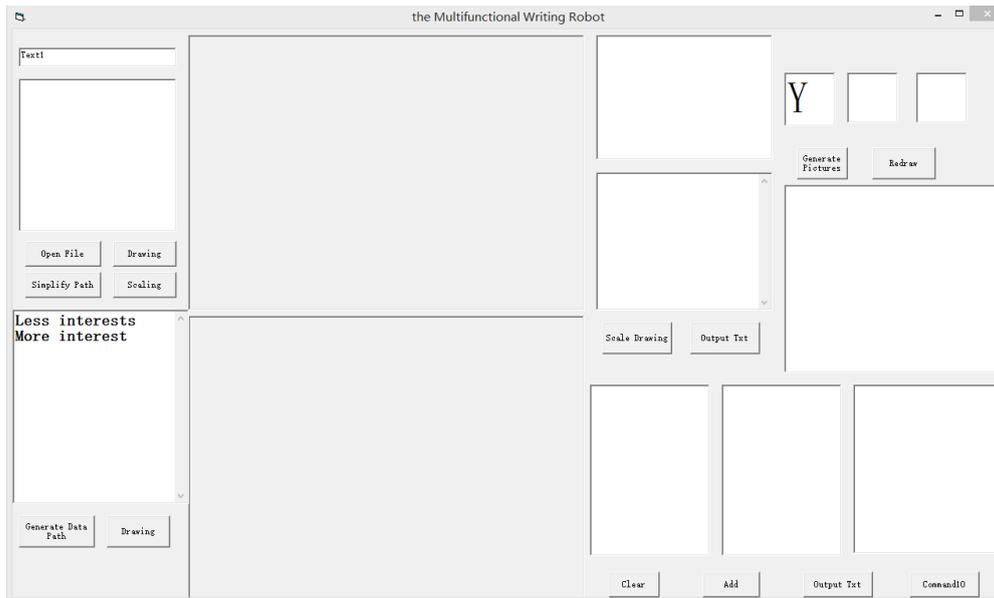


Fig.5 The software interface developed based on VB

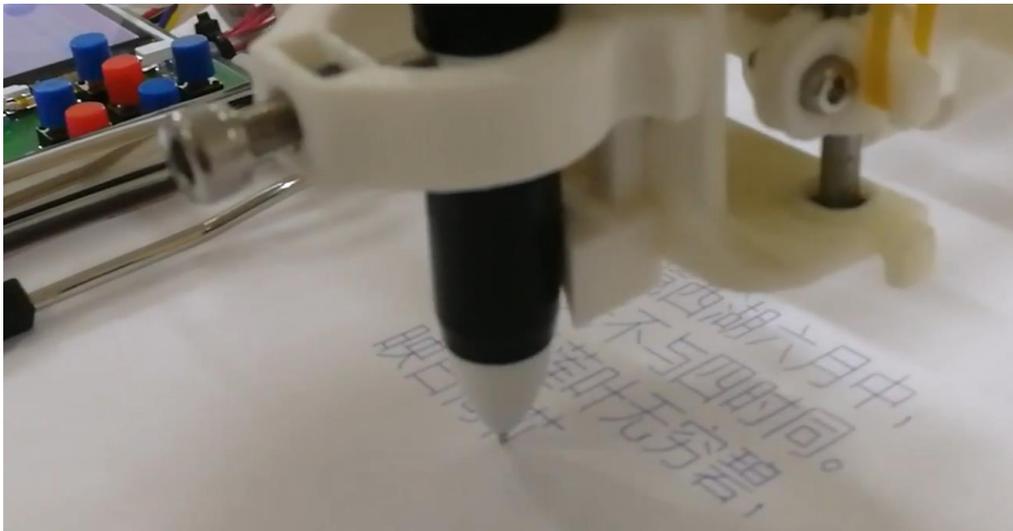


Fig.6 The system joint test results

5. CONCLUSION

The writing robot designed in this paper takes Arduino as the core controller, executes the translation path file and the successive comparison interpolation algorithm, and the controller output pulse signals control two stepper motor to complete the writing task of the end writing pen. The hardware device of the writing robot is easy to install, and the writing robot has a good application foreground in writing and drawing vector graph, especially in teaching practice and advertisement.

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