Research and Design of Writing Robot Based on Attitude Information

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Abstract. With the development of artificial intelligence, autonomous learning writing robot has been a hot research topic. In this paper, the development of using cheap chip design suitable for low-end market need to write the low cost of robots, solve the traditional writing robot based on vision is higher requirements for image processing cost the problem. RBF neural network was optimized to learn and classify the pre-processed eigenvalues in the classifier, and its parallel broadcasting ability in Arduino 101 development board was used to make it learn, which improved the recognition rate and the performance of the writing robot.

1. Introduction to relevant theories

1.1. RBF neural network
RBF neural network [1](radial basis function neural network) classifier is a classification algorithm in Arduino 101 development board cuire. This design uses it to classify and identify data. Its structure is shown in Figure 1.

Figure 1. Structure of RBF neural network.
1.2. KNN algorithm
K-Nearest Neighbor algorithm [2] is also an Arduino101 development board classification algorithm. The basic idea of this algorithm is that a sample is most similar to k samples in the data set, and if most of the k samples belong to a certain category, the sample also belongs to this category [3].

2. System design and implementation of writing robot based on attitude recognition
The main steps of writing robot system design are as follows: first of all, obtain data; next in importance, preprocess algorithm normalizes the characteristic values [4]; then, use RBF classifier [5] for classification and learning; finally, transfer the classification results to the lower computer controller to drive the mechanical arm to write characters. Due to space limitation, this paper only introduces the key contents of this design: classifier module and robot arm module. Figure 2 is the overall frame diagram of this design.

![Figure 2. Overall design framework.](image)

2.1. Implementation of RBF neural network classifier
The first step of RBF classification is data acquisition. This design uses Arduino 101 to develop the 6-axis accelerometer to obtain data. The second step is to extract the eigenvalue with the data preprocessing algorithm. The specific steps include posture fragment extraction, time axis normalization, amplitude normalization, elimination of gravity deviation, mean filtering, and extraction of the eigenvalue. The third step is the learning and classification of classifiers, in which the specific steps include vector broadcasting, vector learning and vector classification. Figure 3 shows a flow chart of vector classification.

![Figure 3. Vector classification flow chart.](image)

2.2. Robot arm module
2.2.1. Control principle of mechanical arm. The recognition result of the classifier is transmitted to the controller of the lower computer, and then the controller transmits the instruction to drive the mechanical arm to write characters. Main control board is the core of the special control of steering
gear, this experiment selects the STM32 controller [6], when the Arduino 101 development board to accept a posture action instruction, through protocols transmit information to the servo controller, servo controller receiving orders to the next bit machine controller, depending on the corresponding instructions to perform an action. The principle is shown in Figure 4.

![Figure 4. Schematic diagram of mechanical arm.](image)

2.2.2. Hardware design of mechanical arm. The robot arm is composed of the controller of the lower computer, the steering engine, and the program of the upper computer. In this paper, the industrial steering engine is adopted, which has the characteristics of large torque and large torque, small virtual position, small dead zone, small noise, fast speed and so on.

(1) Design of steering gear

The steering gear is judged by the IC on the circuit, and the rotation angle ranges from 0° to 270°. Generally speaking, there are three kinds of steering gear wires, which are signal wire, ground wire and positive pole wire of the power supply. Signal line is analog interface, using PWM control technology conversion. The servo motor commonly used in the market for this experiment has a rotation angle of 0° to 270°.

(2) Controller design

In this paper, the Arduino 101 development board is selected as the data classifier, and the results are returned and transmitted to the controller of the lower machine, STM32 steering gear controller, so as to drive the character writing of the mechanical arm.

STM32 is an embedded development board commonly used in recent years. The chip selected in this paper is STM32F103CST6, which has high-power voltage regulator module, bluetooth WiFi module, 8M Flash onboard, CH340 chip, 6-channel PWM steering gear connection port, 3.3v voltage regulator output, 6 transient current protection, and adjustable voltage regulator resistance.

The results classified by the Arduino101 development board are transmitted to STM32 through serial ports, and then STM32 controls the rotation of the steering engine. The two are connected with each other through TX, RX, GND and GND, and data can be transmitted to each other.

The results of the Arduino 101 development board are transmitted to STM32, which can drive a six-degree-of-freedom robotic arm to write characters.

3. Optimization experiment of RBF classification algorithm

This section illustrates the comparison of the recognition accuracy before and after the optimization of RBF through experiments. This experiment adopts the control variable method, and each sample to be tested is tested in 6000 groups. In the experiment, RBF neural network learning classification and RBF neural network learning classification combined with KNN classification were compared to observe the recognition accuracy. Since the classification of RBF neural network is cross, but KNN is not cross, the experimental results obtained are shown in Table 1.
Table 1. Accuracy comparison table.

| Sample data | Classification of RBF neural network | RBF and KNN algorithm classification |
|-------------|-------------------------------------|-------------------------------------|
| A           | 5913/6000                           | 5995/6000                           |
| B           | 5795/6000                           | 5894/6000                           |
| C           | 5854/6000                           | 5947/6000                           |
| D           | 5846/6000                           | 5956/6000                           |
| E           | 5708/6000                           | 5788/6000                           |
| F           | 5745/6000                           | 5796/6000                           |
| G           | 5600/6000                           | 5820/6000                           |
| H           | 5721/6000                           | 5858/6000                           |
| I           | 5784/6000                           | 5847/6000                           |

It can be seen from Table 1 that the classification result of RBF neural network is less accurate than that of combining RBF and KNN algorithm. Therefore, RBF neural network should be used to learn classification and KNN algorithm should be used to classify, so that the accuracy of recognition will be greatly improved.

4. Experimental verification and result analysis

In order to analyze the experimental results, a number of groups of simple characters and complex character writing were collected. The details of the experiment are as follows:

Collect complex characters and simple characters for comparison, and collect some simple characters, such as Numbers and letters, for comparison and analysis of their recognition accuracy. The line chart of writing rate is shown in Figure 5.

![Figure 5. Broken line diagram of writing success rate.](image)

According to the experimental results, the average recognition rate of simple characters is significantly higher than that of complex characters, and the B and I recognition error rate of complex characters is significantly higher than that of other characters. It can be known from the investigation that the writing of characters B and I is similar to Numbers 8 and 1, so the recognition rate is reduced, and the recognition accuracy of these characters needs to be further improved.

5. Conclusion

This paper mainly designs classifier module and robot arm module by exploring the writing characters of robot arm. Six axis accelerometer is used to acquire attitude information, classifier learning and classification, and finally character writing is realized. It USES six-axis sensor to acquire attitude information for character writing, which makes up for the deficiency of traditional writing robot relying on coordinate information and image information, and improves the recognition rate of the system. With Arduino 101 development board controller, the classification and learning effect can be achieved, reducing the cost of hardware.
References
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