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Intelligent Gloves Design Based on Arduino System

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***Abstract*— *Hand is an important human organ for human interaction with the outside world. Music is a well-known medium for expressing emotions and ideas. Learning temperament is one of the most effective ways to develop intelligence. In view of the high requirement of equipment and capital investment in temperament training, this paper designs a glove which can practice temperament music score without external equipment. This glove involves Arduino programming, sensors, music and other knowledge. This paper belongs to the development of intelligent teaching aids, which has good educational and social value. In this paper, the overall structure, key design and entity design of the intelligent glove are described. The whole structure is a complete Arduino control board. After wearing gloves, the practitioner can make corresponding sound just according to the bending state of fingers, so as to achieve the purpose of practicing temperament. The main structure is an Arduino control board connected with five bending sensors, through the five bending sensors to make the buzzer on the control board sound. The key design includes function design, appearance design, interaction mode and power supply mode. The solid design includes components, Arduino controller, bending sensor and loudspeaker. The main function of the program design is that when a finger is bent, the speaker will send out the corresponding tone.*

***Keywords*— *Buzzer, Arduino microcontroller; bending senso.*

I. INTRODUCTION

In our daily life, the hand is a very important human organ for human interaction with the outside world. People use their hands to get objects, so as to express their thoughts and perceive the outside world. In today's society, with the continuous progress of science and technology, a variety of gloves also emerge in endlessly, among which data gloves are often used to collect people's hand information. In 1977, Thomas Defanti invented the first data glove, Sayre Glove. It is based on the principle of flexible optical fiber sensor, which uses a light source at one end of the optical fiber and a photoelectric receiver at the other end. When the measurement starts, the luminous flux received by the photoelectric receiver will change when the bending sensor bends, so that the purpose of detecting finger movements can be achieved. In 1981, Gary Grimes of Bell Lab designed a new type of data glove to replace the traditional keyboard. It uses proximity sensors, inertial sensors, bending sensors and other sensors. The proximity sensor detects whether the operating thumb contacts other parts of the hand or fingers, and sends data information to the computer when contact occurs; The joint bending sensor detects the bending degree of the finger; Inertial sensors measure the posture of the forearm and wrist. This kind of data glove can be used to detect the gesture of hand hitting the keyboard, thus providing a data basis for gesture correction.

Main research content: This paper designs a smart glove that can perform simple rhythm training. The main function is that after the user wears the glove, he/she bends his/her fingers and starts from the thumb to issue five tones in turn, so as to achieve the purpose of rhythm training.

Problems to be solved: This paper mainly aims to solve the following key technical problems.

1: Learning to use Arduino for programming requires a certain foundation in SCM and C language. I have learned to use SCM and C language proficiently in my undergraduate course.

2: The bending sensor and the temperature sensor are different from the familiar sensors, which need to be studied separately.

3: Only passive buzzer can be selected, because only passive buzzer can receive different frequencies and make different sounds.

Expected results: After wearing gloves, users can achieve simple music practice by bending different fingers.

II. OVERALL DESIGN SCHEME

Through the analysis of the research status of intelligent music gloves, the audience scope and technical cost of gloves are considered. This paper designs an intelligent music glove that controls five different tones with five fingers. The five fingers can make the sound emitted by the buzzer correspond to five tones respectively, namely, Do, Ray, Mi, Fa and Sou.

A. Design schemet

Based on Arduino's smart music gloves, the initial design goal is to enable users to carry out music practice by wearing the gloves and bending different fingers. Each finger is sleeved at the finger joint of each finger and connected with a bending sensor. The bending sensor senses bending by bending the finger, so as to transmit information to the Arduino control board, which then transmits the information to the buzzer on my control board, so that the buzzer can emit different tones, so as to achieve the goal of simple practice of rhythm. This design uses Arduino for programming. The input module is five flex2.2 bending sensors, the data processing module is the Arduino control board, and the output module is a passive buzzer.

The software flow chart is shown in Figure 1 below.

B. Technology roadmap

Step 1: Get familiar with the bending sensor, learn relevant knowledge, and list the main ideas for design.

Step 2: learn about Arduino, Arduino IDE, and get familiar with the functions of related ports.

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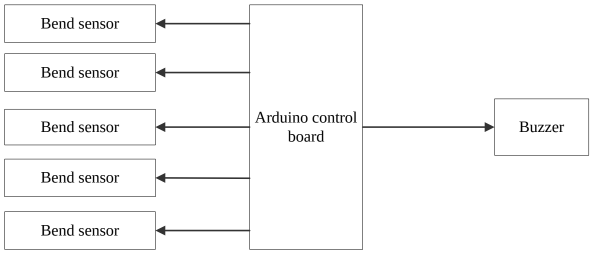

Fig. 1. Flow Chart of Intelligent Glove Software.

The third step is to be familiar with the learning of the two software ALTIUM DESINGER and Arduino IDE, so as to lay a foundation for later circuit diagrams and programming.

The fourth step is to purchase relevant components and understand the relevant functions of the required components.

Step 5: program Arduino and draw the circuit diagram.

Step 6: weld the Arduino control board, burn the program, and test whether bending different fingers can produce corresponding tones.

Step 7: integrate the whole system for debugging, complete the debugging of the functions required by the design, and realize the normal work of each module.

III. HARDWARE DESIGN OF INTELLIGENT GLOVES BASED ON ARDUINO

A. Bend sensor

Selection of bending sensor

Five flex2.2 bending sensors are selected in this design. When the metal of the sensor bends outward, the resistance value of the sensor will change, so that the bending can be detected. Non bending resistance: 90002 ohms, 90 degree bending resistance: 14000 ohms, 180 degree bending resistance: 22000 ohms. In the laboratory, a 10K22 resistor is connected to the bending sensor, which is connected to the Arduino Nano. The bending sensor is an analog sensor. The function corresponding to the reading of the sensor value is analogRead(), and the corresponding value range is 0-1023. This work uses five bending sensors. The connection between the sensor and ArduinoNano is shown in Figure 2. When the metal surface of the bending sensor is bent, the resistance value of the bending sensor will change, so as to detect whether the corresponding finger joint is bent.

Wiring diagram of bending sensor

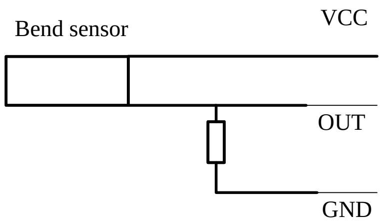

Fig. 2. Wiring diagram of bending sensor.

B. Buzzer

This design selects a passive buzzer speaker module, which is equivalent to a passive buzzer. The buzzer is divided into active buzzer and passive buzzer. The active buzzer has internal vibration and drive circuit, which can sound when power is added. The advantage is that it is easy to use. The disadvantage is that the frequency is fixed and there is only one single tone. The sound frequency of the passive buzzer is controllable, which can make the effect of "Duolaimi hair rope". Common functions include tone (), and noTone (). In the arrangement process, we selected "Dorami Fusuo", a total of 5 notes.

TABLE I. Loudspeaker and Arduino Nano Wiring Table.

Loudspeaker	Pin1	Pin2
Arduino Nano	D7	GND

Note: There is no difference between Pin1 and Pin2

TABLE II. Corresponding tone of loudspeaker.

Tone	Duo	Lai	Mi	Fa	Suo	La	Xi	Duo(high)
Tone value	294	330	350	393	441	495	556	589

C. Switch control USB to TTL

The function of USB to TTL module is to convert the level into signals that can be recognized by both parties for communication. The level logic of the communication interface of the MCU is different from that of the PC communication interface. The communication interface on the PC has USB interface, and the corresponding level logic follows USB related principles. The serial communication of the single chip microcomputer passes through the RXD, TXD, VCC and GND four pins on the single chip microcomputer, wherein RXD and TXD are used to transmit data, and the corresponding level logic follows the TTL principle.

IV. SOFTWARE DESIGN OF INTELLIGENT GLOVE DESIGN SYSTEM BASED ON ARDUINO

A. System program block diagram

This program uses Arduino programming and program initialization. Five flex2.2 bending sensors as input modules feel fingers bending, and the analog digital conversion is used to Arduino. The Arduino control board is used as the data processing module for data processing. After processing, the digital analog conversion is used to passive buzzer, and the passive buzzer sends out the corresponding tone.

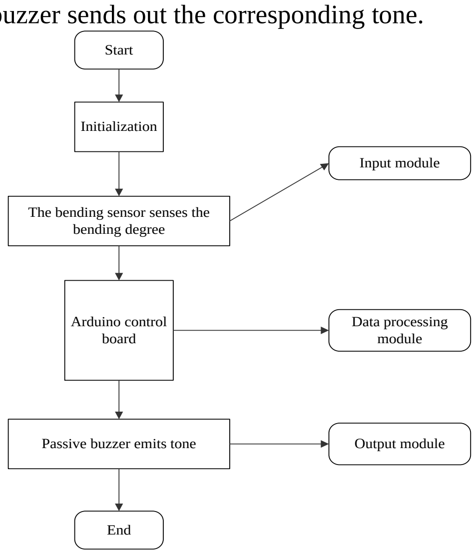

Fig. 3. Program Block Diagram of Intelligent Glove System.

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B. Software development environment

The programming development environment used in this article is Arduino IDE, which can be downloaded for free on the official website（http://www.arduino.cc）. The current software version is 1.8.1.

C. Partial procedures

Initialization function

Enter the bending sensor into the program:

```
int PotBuffer1 = 0;   // AD Read Data Cache Variables.
#define NOTE_D1 262
#define NOTE_D2 293
#define NOTE_D3 329
#define NOTE_D4 349
#define NOTE_D5 392
#define NOTE_D6 440
#define NOTE_D7 494
int tune[] =
{NOTE_D1,NOTE_D2,NOTE_D3,NOTE_D4,NOTE_D5,
NOTE_D6,NOTE_D7};
float duration[]={1,1,1,1,1,1,1};
int length;
int tonePin=11;
```

Set the buzzer to output:

```
void setup()
{
  Serial.begin(115200);     // Initialize the serial port baud rate to 9600.
  //Serial.println("ASDAsd");
  pinMode(2,OUTPUT);
  pinMode(3,OUTPUT);
  pinMode(4,OUTPUT);
  pinMode(5,OUTPUT);
  pinMode(6,OUTPUT);
  pinMode(A0,INPUT_PULLUP);
  pinMode(A1,INPUT_PULLUP);
  pinMode(A2,INPUT_PULLUP);
  pinMode(A3,INPUT_PULLUP);
  pinMode(A4,INPUT_PULLUP);
  pinMode(tonePin,OUTPUT);// Set the pin of the buzzer as the output mode.
```

Set a sizeof function to find out how many notes are in the tone sequence:

```
length = sizeof(tune)/sizeof(tune[0]);
void loop()
{
  String ss;
  int PotBuffer0 = analogRead(A0);
  int PotBuffer1 = analogRead(A1);  // Read AD value.
  int PotBuffer2 = analogRead(A2);
  int PotBuffer3 = analogRead(A3);
  int PotBuffer4 = analogRead(A4);
 ss=String(PotBuffer0)+","+String(PotBuffer1)+","+String(
PotBuffer2)+","+String(PotBuffer3)+","+String(PotBuffer4)+
",";
 Serial.println(ss);
  if(PotBuffer0<600)
  {
   tone(tonePin,tune[0]);
   delay(400*duration[0]);
   noTone(tonePin);
  }
  if(PotBuffer1<600)
  {
   tone(tonePin,tune[1]);
   delay(400*duration[1]);
   noTone(tonePin);
  }
  if(PotBuffer2<600)
  {
   tone(tonePin,tune[2]);
   delay(400*duration[2]);
   noTone(tonePin);
  }
  if(PotBuffer3<600)
  {
   tone(tonePin,tune[3]);
   delay(400*duration[3]);
   noTone(tonePin);
  }
  if(PotBuffer4<600)
  {
   tone(tonePin,tune[4]);
   delay(400*duration[4]);
   noTone(tonePin);
  }
}
```

Main program preparation

```
int PotBuffer1 = 0;   // AD Read Data Cache Variables.
#define NOTE_D1 262
#define NOTE_D2 293
#define NOTE_D3 329
#define NOTE_D4 349
#define NOTE_D5 392
#define NOTE_D6 440
#define NOTE_D7 494
int tune[] =
{NOTE_D1,NOTE_D2,NOTE_D3,NOTE_D4,NOTE_D5,
NOTE_D6,NOTE_D7};
float duration[]={1,1,1,1,1,1,1};
int length;
int tonePin=11;
void setup()
{
  Serial.begin(115200);     // Initialize the serial port baud rate to 9600.
  //Serial.println("ASDAsd");
  pinMode(2,OUTPUT);
  pinMode(3,OUTPUT);
  pinMode(4,OUTPUT);
  pinMode(5,OUTPUT);
  pinMode(6,OUTPUT);
  pinMode(A0,INPUT_PULLUP);
  pinMode(A1,INPUT_PULLUP);
  pinMode(A2,INPUT_PULLUP);
  pinMode(A3,INPUT_PULLUP);
```


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```
  pinMode(A4,INPUT_PULLUP);
pinMode(tonePin,OUTPUT);// Set the pin of the buzzer as the output mode.
length = sizeof(tune)/sizeof(tune[0]);// A sizeof function is used here to find out how many notes are in the tone sequence.
}
void loop()
{
  String ss;
  int PotBuffer0 = analogRead(A0);
  int PotBuffer1 = analogRead(A1);  // Read AD value.
  int PotBuffer2 = analogRead(A2);
  int PotBuffer3 = analogRead(A3);
  int PotBuffer4 = analogRead(A4);
ss=String(PotBuffer0)+","+String(PotBuffer1)+","+String(PotBuffer2)+","+String(PotBuffer3)+","+String(PotBuffer4)+",";
  Serial.println(ss);
  if(PotBuffer0<600)
  {
   tone(tonePin,tune[0]);
   delay(400*duration[0]);
   noTone(tonePin);
  }
  if(PotBuffer1<600)
  {
   tone(tonePin,tune[1]);
   delay(400*duration[1]);
   noTone(tonePin);
  }
  if(PotBuffer2<600)
  {
   tone(tonePin,tune[2]);
   delay(400*duration[2]);
   noTone(tonePin);
  }
  if(PotBuffer3<600)
  {
   tone(tonePin,tune[3]);
   delay(400*duration[3]);
   noTone(tonePin);
  }
  if(PotBuffer4<600)
  {
   tone(tonePin,tune[4]);
   delay(400*duration[4]);
   noTone(tonePin);
  }
}
```

V. FUNCTION REALIZATION, TEST RESULTS AND IMPROVEMENT

A. *Function realization*

Bend sensor module detection

After bending the bending sensor, its internal resistance will change, so that the bending can be detected. The connection between the bending sensor and the Arduino control board is shown in Figure 4 below.

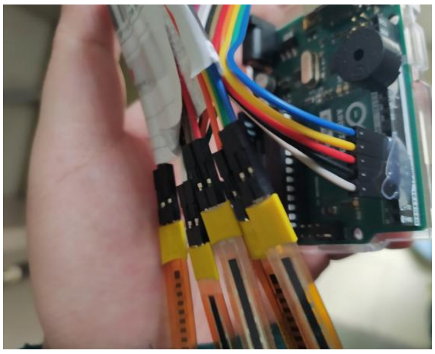

Fig. 4. Physical connection diagram of bending sensor and control board.

Buzzer module detection

The passive buzzer is selected in this design. Compared with the active buzzer, the passive buzzer can receive more frequencies and emit different tones, which is also the reason for choosing the passive buzzer. After the power supply is connected, the bending sensor and the passive buzzer can emit tones, which indicates that the passive buzzer is well connected with the Arduino control board. The connection between the passive buzzer and the Arduino control board is shown in Figure 5.

Fig. 5. Wiring diagram of buzzer and control board.

Fig. 6. Overall physical picture of intelligent gloves.

Overall inspection

The overall design of intelligent gloves based on Arduino includes three parts: bending sensor, Arduino control board and buzzer. When bending different fingers, that is, bending different bending sensors, the passive buzzer will emit five different tones. Starting from the thumb, the tone is in turn Duo Laimi's instigation. The overall physical connection of the smart gloves is shown in Figure 6.

B. Test results and improvement

All the functions required by this design have been realized. Bending five different flex2.2 sensors can hear five different sounds from the passive buzzer, corresponding to the five tones of Do, Re, Mi, Fa and Sou respectively. Through the tone, you can play simple music similar to two tigers, so as to achieve the purpose of practicing music and intelligence. There is still a lot of room for improvement in this experiment. First, the tone is too single to meet the more complex music practice, which needs to be improved. Second, it is not very convenient to wear gloves. I hope there will be a more integrated control board to replace the Arduino control board in the future, which will make it more convenient and truly achieve the goal of practicing music anytime and anywhere.

VI. CONCLUSION

In this design, Arduino is used as the center of the whole system, and five flex2.2 bending sensors and a passive buzzer are connected to the Arduino control board. After the program is burned into the Arduino control board through USB, five different flex2.2 bending sensors can be bent to make the passive buzzer emit five different tones corresponding to five notes of Dorami, which is very consistent with the expected results. Basically, it has achieved the goal of simply practicing music, cultivating sentiment and exercising intelligence.

After debugging, the finished physical product can achieve the expected function well. Starting from the sensor on the thumb, bend five bending sensors respectively, so that you can hear the passive buzzer emit five tones of dozing. However, the function is relatively simple, and the gloves can only be used to complete some music with low pitch requirements. For more complex music, it can not be well interpreted, so it is not widely used in the market. However, as a music enlightenment for infants, it is very helpful. The finished physical product can emit five different tones, and can play a simple track similar to two tigers, This may be helpful for infants and young children, but for some people who are specialized in music, it is far from meeting the requirements. Through the whole process of this graduation design, I have a deeper understanding of the smart music gloves. It can not only simply bend each finger to make a tone, but also combine multiple fingers to make a tone. For example, this graduation design product can only emit five tones through a passive buzzer. If it can be designed to bend the thumb and middle finger at the same time to emit another tone, it can greatly improve the musical range of the smart gloves to play a more comprehensive music. It can even be coded and pronounced according to the different bending degrees of one finger or several fingers, If so, it can even improve the piano's melody, so that the audience and use can be more extensive.

REFERENCES

[1] Liang Shanlin, “A virtual performance based on visual gesture recognition,” Beijing University of Technology, 2017.

[2] David J. Stunnan,and David ZcltZet, “A Survey of Glov-based Input,” *I.IEEComPuter.Craphics & Applications,* January,1994.

[3] T G. Zimmerman, “A Hand Gesture Interface Device,” *Proc. HumanFactors in Computing System and Graphics Interfice*, ACM Press, New York,April ,1987.

[4] Liu Xianmei, Li Congxin, and Jia Huizhu, *Application Research of Data Glove in Desktop Virtual Reality System*, 2001.

[5] Ma Xiaoming, “Learning Piano and Intelligently Developing Teaching in Forest Areas,” vol. 132, no. 3, pp. 97-98, 2008.

[6] Sun Jiangbo, “The Design and Research of a Humanoid Manipulator for Playing the Piano,” Changchun University of Technology, 2015.

[7] GB/T 16252-1996, Home standard of the People's Republic of China: hand size for adults.

[8] Zuyuan He,Qingwen Liu, and Tomochika Tokunaga, “Ultrahigh resolution fiber-optic quasi-static strain sensors for geophysical research,” *Photonic Sensors,* vol. 4, 2013.

[9] Yi Jiang and Wenhui Ding, “Recent developments in fiber optic spectral white-light interferometry,” *Photonic Sensors*, vol. 1, 2011.

[10] AnSun, YuliyaSemenova, and GeraldFarrell, “A novel highly sensitive optical fiber microphone based on single mode-multimode-single mode structure,” *Microw. Opt. Technol. Lett.* vol. 2, 2010.

[11] Cai Rui, “The Principle and Application of Arduino,” *Electronic Design Engineering*, vol. 20, no. 16, pp. 1-3, 2012.

[12] Meng Hongbing, “Development of wireless monitoring instrument for microclimate of fruit trees,” *Electronic Technology and Software Engineering,* vol. 9, pp. 1-1, 2014.

[13] Cai Zhuofan, “Design of mobile inspection system for classroom based on Arduino and Android,” *Electronic technology*, vol. 27, no. 5, pp. 1-4, 2014.

[14] Tao Ling, “Research and design of interesting interactive device in open system environment,” Wuxi : Jiangnan University, 2008.

[15] Gao Xiansheng, “Introduction and Quick Strategy of AVR Single Chip Microcomputer,” China Machine Press, 2014.