

The Design of Automatic Performance Experiment Equipment of Xylophone based on HMI Technology

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Abstract

With the improvement of living standards and the rapid development of science and technology, more and more musical instruments have been widely viewed. As the simplest and most common instrument, the existing instruments are developing towards electronic direction. It is of great research significance and value to design a device that can automatically play the real object of the xylophone. Using HMI visualization technology and MCU control technology, this paper designs a device which can play the xylophone automatically. The device can simulate the way of playing the xylophone and automatically complete the automatic playing of various pieces. The device uses HMI visual interface to increase the human-computer interaction function, improve the diversity and operability of the automatic xylophone, and can be widely used in teaching popular science equipment such as language programming and music demonstration teaching. Finally, the feasibility and validity of the device designed in this paper are verified by the analysis of experimental data.

Keywords

Experiment equipment, Xylophone, Automatic playing, HMI technology.

1. Introduction

According to the survey, many people will read or listen to music in their spare time, and the people who listen to music are far more than those who read, because reading is a "heavy appreciation" activity, heavy appreciation is easy to make people feel tired, while music is different, listening to music is "light appreciation", people can listen to music while doing other things, music is also conducive to adjusting the atmosphere and alleviating Mood, the fast pace of modern life makes many people have no leisure time to develop their hobbies. Most people like to use music to add some mood to their boring work or study life, but there are not many people who can operate the instrument[1-2]. Maybe everyone wants to learn and master the playing method of one or several instruments, but they have no choice but to work or study Things on the schedule are full of people's schedules, which makes people feel more than they can do. Some people who prefer rhythm are not very familiar with the operation of musical instruments. In addition, they don't have enough free time to practice[3]. Most of the ordinary people also don't have the energy and money to watch music concerts and performances, so they can't "see" the "real face" of the sounds played by musical instruments. They can only listen to M The sound recorded in P3 or MP4; in addition, it's really difficult for a friend's birthday to buy a gift that is affordable, novel and not low-level; there are also many primary and secondary school students' lack of learning about their interests and hobbies, and the monotony of the course can't drive their learning enthusiasm[4-5]. The automatic performance of the xylophone device completely solves the above problems.

This design enables people to understand SCM, C language, CAD drawing, circuit design, 3D printing and other technologies. It can help children learn xylophone and develop their hobbies. C language is used for control and adjustment to realize automatic performance of melody. In this paper, HMI visualization technology and MCU control technology are used to design a device that can automatically play the xylophone. The device can realize the way of simulating people playing the xylophone, and automatically complete the automatic playing of various tracks. The device uses HMI visual interface, increases human-computer interaction function, improves the diversity and operability of the automatic xylophone, and can be widely used in language programming, music demonstration teaching and other teaching popular science equipment. Finally, the feasibility and effectiveness of the device designed in this paper are verified by the experimental test data analysis.

The Experiment equipment designed in the paper can be used in the following aspects:

- Educational equipment for children to learn to play xylophone
- Teaching of C programming
- Used to adjust the atmosphere (such as birthday party, art performance, etc.)
- For enjoying music and relaxing in leisure time
- As a gift to family or friends

2. The Design Background and Purpose

2.1 The Design background

With the improvement of living standards, many people have a certain understanding of music, more and more people listen to music, now more and more creators, all kinds of songs are emerging in an endless stream, people choose more and more new songs, but the songs that can really be sung are not as good as the songs of the last century[6,7].

With the fire of folk music, it has led to another climax of various famous musical instruments. African hand drum, guitar, xylophone, drum and other musical instruments have once again entered the field of vision of people who love music. Nowadays, the pace of life is speeding up. Although many people yearn for such slow-paced cities as Lijiang, Dali, there are only a few people who can really break away from the fast-paced and enter the slow-paced life. Many people love music, but music is not their own profession after all, and they can only become a good lover. There is no time to practice musical instruments so that those who love music can only listen to the sound in MP3 and MP4. In addition Nowadays, with the reform of education system, many children begin to receive all kinds of interest education from childhood, but what kind of things can attract the children's attention is a very important issue. The education mode based on the book has become the past, which needs the injection of new life; selecting dolls in boutiques to send friends is a fashionable choice for the post-90s young people, and now technology is developing rapidly Choosing the right gift is also a big problem.

2.2 Design purpose

- Let people know more about musical instruments and melody, relax themselves after a day's intense work, relieve tired body and mind, add fun to life and broaden their interests and hobbies.
- Let people know SCM, C language, CAD drawing, circuit design, 3D printing and other technologies.
- It can help children learn xylophone and develop their hobbies.
- Which can be given as a gift to others.
- C language is used for control and adjustment to realize automatic performance of melody.
- The polymer lithium battery is used as energy source, which is environmentally friendly and durable.
- Safe and reliable, 3D printing materials are light and colorful, which are easy to attract children's attention and play an educational role.

- The improved version will add the communication module between the computer and the computer to further meet the needs of users.
- Using science and technology instead of manual high-precision operation, energy saving and emission reduction meet the requirements of contemporary society.

3. Design Requirements

The automatic performance xylophone device is made by programming, CAD drawing and 3D printing. Every one has literature to look up, which is convenient for the owner to use and learn. The following is a brief introduction of the technology used.

3.1 C program design

C language is a general computer programming language, which is widely used. The design goal of C language is to provide a programming language that can compile and process low-level memory in a simple way, generate a small amount of machine code and run without any support of running environment [8].

3.2 AVR single chip microcomputer

Single chip microcomputer is a typical embedded microcontroller unit, which is composed of arithmetic unit, controller, memory, input and output equipment, and is equivalent to a microcomputer [9]. Compared with general-purpose microprocessors used in personal computers, it emphasizes self supply (no external hardware) and cost saving. Its biggest advantage is its small size.

3.3 Automatic control technology

Automation control is a kind of integrated automation control technology and theory in modern industry, manufacturing and other production fields.

3.4 3D printing technology

3D printing (3DP) is a kind of rapid prototyping technology. It is a technology based on digital model file, which uses powder like metal or plastic and other adhesive materials to construct objects by layer printing [10].

3.5 CAD drawing technology

CAD (Computer Aided Design) is a kind of software which uses computer and its graphic equipment to help designers to design [11]. In engineering and product design, computer can help designers to take charge of calculation, information storage and drawing.

3.6 Electronic Technology

Electronic technology is the follow-up practical teaching material of analog electronic technology and digital electronic technology [12]. Aiming at improving electronic technology, especially the application and engineering practice skills of modern electronic design, this paper introduces electronic design automation technology with a large number of applications, and summarizes the traditional electronic design methods and common basic integrated circuits.

3.7 Servo control technology

Servo control, that is to meet a certain purpose, the movement of the generated and the movement of the object control of human activities. The so-called servo control refers to the effective control of the position, speed, acceleration and other changes of the object movement [13]. This kind of control has been popularized in various fields. Servo control system refers to the feedback control system used to follow or reproduce a process accurately.

3.8 HMI human machine interface technology

HMI is the abbreviation of human machine interface, "human machine interface", also known as human machine interface. Human computer interface (also known as user interface or user interface) is the medium of interaction and information exchange between system and user, it realizes the

transformation between the internal form of information and the form that human can accept. There are human-computer interfaces in the field of human-computer information exchange.

4. The Hardware Design

4.1 Design drawing

Automatic performance of xylophone requires high stability. The appearance design is shown in Figure 1.

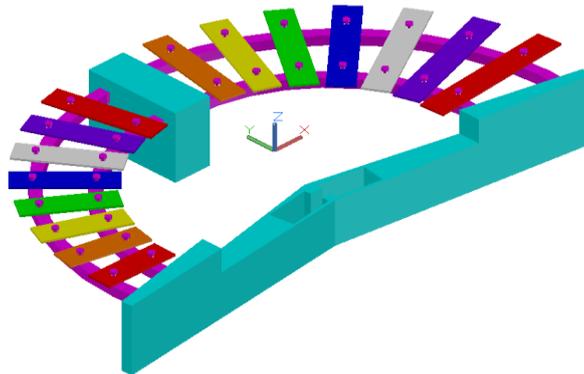


Figure 1. The CAD drawing 3D view of automatic playing xylophone

4.2 Display part of structure diagram

The 3D print of the display structure needs to be made according to the screen size and closely fit with the screen, as shown in Figure 2 and figure 3:



Figure 2. The CAD drawing of display structure 3D view

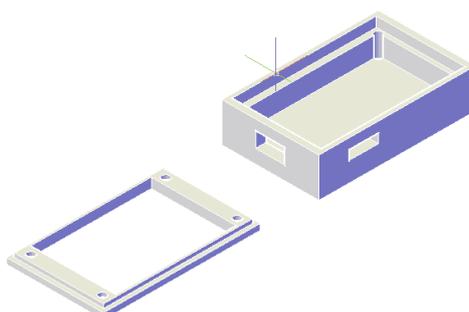


Figure 3. The 3D printing of display structure

4.3 Part of program content

The main program of the experimental device of automatic playing xylophone is written in the C language of single chip microcomputer. The contents of the main program are as follows.

```
#include <reg51.h>
#define uchar unsigned char
#define uint unsigned int
#define ulong unsigned long
sbit dj=P1^0;
sbit dj1=P1^1;
sbit dj2=P1^2;
sbit dj3=P1^3;
bit ds=0;
bit zt=0;
void InitTimer0(void)
{
    TMOD = 0x01;
    TH0 = 0x0B8;
    TL0 = 0x00;
    EA = 1;
    ET0 = 1;
    TR0 = 1;
}
void delaysms(uint x) //error -0.651041666667us
{
    uint i,j;
    for(i=0;i<x;i++)
        for(j=0;j<112;j++);
}
void delayus(uchar s) //error -0.149305555556us
{
    //2000us/180=11.111
    unsigned char a,b,i;
    for(b=91;b>0;b--)
        for(a=1;a>0;a--);
    for(i=0;i<s;i++)
    {
        for(b=1;b>0;b--) for(a=1;a>0;a--);
    }
}
```

5. The Experiment and Analysis

After a series of experiments and tests, the automatic playing device can play the music completely and correctly according to the requirements. The moment when the music is finished represents that the automatic playing device has been made successfully. The physical figure of the device is shown in Figure 4.

The test data of note performance of automatic xylophone playing device is shown in Table 1 and table 2. The test times of each note are 10 times. It can be seen from the table that the completion rate of each note is 100%, which can meet the performance requirements of automatic xylophone playing device.

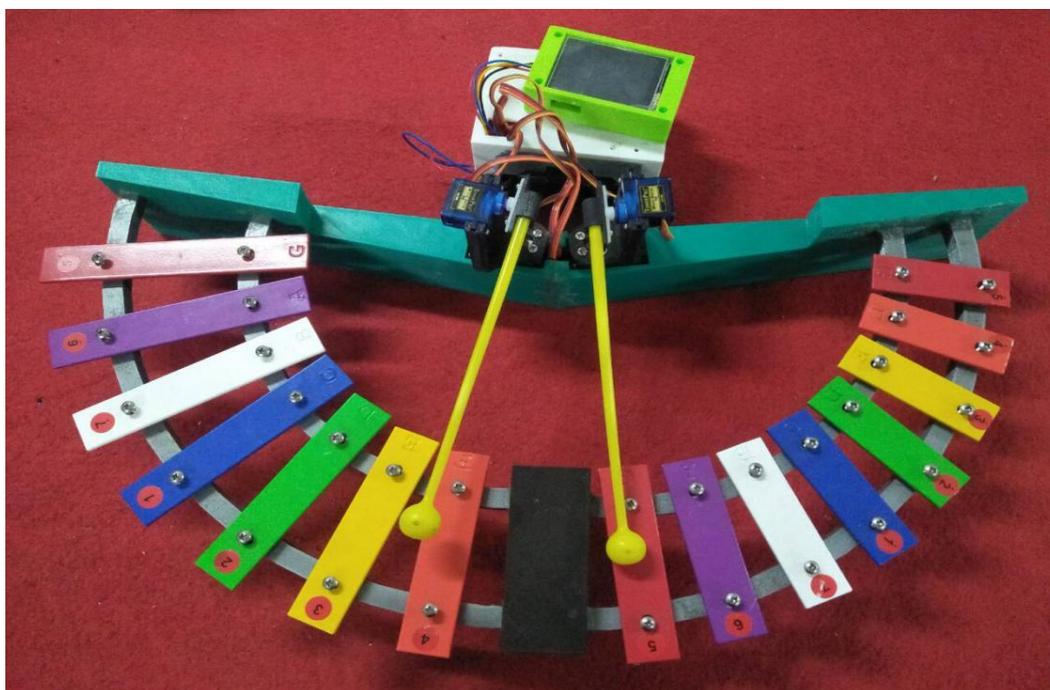


Figure 4. The physical picture of automatic playing xylophone device

Table 1. The single note test data 1

Musical note	1	2	3	4	5	6	7
Number of tests	10	10	10	10	10	10	10
Completion rate	100%	100%	100%	100%	100%	100%	100%

Table 2. The single note test data 2

Musical note	1	2	3	4	5	6	7
Number of tests	10	10	10	10	10	10	10
Completion rate	100%	100%	100%	100%	100%	100%	100%

In order to verify the performance of the xylophone designed in this paper to play different difficulty tracks, 11 tracks of different difficulty are selected here for testing, and the number of tests for each track is 10. The test data of the automatic performance of the tracks of the xylophone device is shown in Table 3. It can be seen from table 3 that the completion degree of automatic playing for easier tracks is basically 100%; with the increase of difficulty, the completion rate gradually drops to 90%, which is also within the reasonable design range. For the more difficult tracks, the completion degree is reduced by 60%. To some extent, it can not achieve the continuous repetition of the song name, which is mainly limited by the stability of the equipment.

Table 3. The test data of track auto play

Track title	Difficulty degree	Number of tests	Number of completions	Completion rate
Little star	easy	10	10	100%
City of sky	middle	10	9	90%
Flying insects	easy	10	10	100%
Catch loach	easy	10	10	100%
The story of time	middle	10	10	100%
Little rabbit	easy	10	10	100%
Mimi Panda	middle	10	10	100%
The moon represents my heart	Hard	10	9	90%
You're the wind	Hard	10	9	90%
Turkey March	More difficult	10	6	60%
The funeral of roses	More difficult	10	7	70%

6. Conclusion

With the improvement of living standards and the rapid development of science and technology, more and more musical instruments have carried out the public vision. As the most simple and common musical instrument, the existing musical instruments are developing towards the electronic direction. It is of great significance and value to design a device that can automatically perform the real object of the xylophone. In this paper, HMI visualization technology and MCU control technology are used to design a device that can automatically play the xylophone. The device can realize the way of simulating people playing the xylophone, and automatically complete the automatic playing of various tracks. The device uses HMI visual interface, increases human-computer interaction function, improves the diversity and operability of the automatic xylophone, and can be widely used in language programming, music demonstration teaching and other teaching popular science equipment. Finally, the feasibility and effectiveness of the device designed in this paper are verified by the experimental test data analysis.

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