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PROGRAMMABLE METRONOME FOR PERCUSSION INSTRUMENTS AND AN APPLICATION

Hasan Selçuk Selek

Science Institute Sakarya University, Esentepe Campus Sakarya Turkey

Kocaeli Vocational School Kocaeli University, Kullar Campus Kocaeli Turkey

E-mail: hsselek@hotmail.com

Abstract*: Applications of electronics in the music industry have been increasing continuosly. Develpoments in electro music and electro music instruments make this possible. Although it is known that the majority of musicians are against the digital music and techniques, researches show that it would be very benefical for teaching and learning of playing music intruments.*

This study shows that, music and electronic applications can be useable with together in the same projects. With this equipment people can practice on their own percussion studies. System designed as, speed and hit force in case of faulty users can be warned by program. Warning can be reailized as a visual with LED and also can be done with sound.

In this study, at the same time shows that, without using physical metronome, metronome software and designed card can use at applications is may be possible. Based on the study is a software metronome and its card which can be used for all musical intruments. Designed metronome was tested for a electronic drum with a compare circuit. PIC-C compiler was used in order to get the designed card to work compatible with PIC.

The circuit designed for the metronome is integrated with compare circuit and has been tested together.

Key Words: *Metronome, PIC-C compiler, musical instrument, piezofilm sensor*

1. INTRODUCTION

At the first look electrical-electronics can't be associated with the music. But both are have same basis which is laws of physics. In the book of " The Physics of Music" by Ayhan Zeren; "music and physics words and their pronunciations and sounds much alike in terms of adaption the each other, it is thought in the memory of the society that they are very opposite things to each other in the terms of basic features"[1].

From tuning to working all musical instruments, can be explained by one or more elecrical-elctronics rules. Several studies to explain electronics musical instruments working, their modelling, also in order to evaluation and simulation of instruments have been carried out at home and abroad.

Like all musical instruments, electro-drum which is kind of percussion instrument, for modelling and analysing is needed metronome. Metronome is an essential instrument for adjusting the frequency of hits. It is the most important assistant for many musicians, while they are composing and/or playing, also teaching people to play it. In this study, designed metronome is accelerated and controlled learning degree. At the same time metronome program can be used as a good tool for evaluation.

In this study, instead of using physical metronome, a card designed and used which is controlled by the PIC and a program written in C programming. Program and card are described in article.

This circuit is added to all cards without the need for physical metronome. This circuit also can be used for interpretation of the analog signal inputs of electronic instruments.

2. METRONOME

Musical instruments needs a tool, which helps to play at a certain speed and same tempo and that tool can produce sounds at a certain tempo. It is named as metronome. Metronome was invented by Dietrich Nikolay Winkel in 1812 in Amsterdam [2].

J. N. Malzel from Regensburg, got letters patent of this tool, which is invented by Winkel and called as metronome in 1816 in Paris. Famous composer Ludwig Van Beethoven was the one of pioneers who used meronome in music[3].

There are two types of metronome, mechanical and digital shown below Figure1.a [4] and 1.b [5]. But generally mechanic one is prefered for artistic performances, because the sound of digital one's is very shrill.

Figure 1.a: Mechanical metronom

Figure 1.b: Digital metronom

Since it was invented mechanical metronome design has not been changed much. It works like; moved by a spring and regular oscillations of the rat-tat-tat sound that consist of a pendulum rod. Period adjust by little weigt on pendulum rod which is moved up and down. Tempo scale begins 40 hits up to 208 hits per minute.

Quartz crystal is used in digital metronomes. Quartz crystals generally used in wrist watches. There is a very large number of functions and derivatives of metronomes are at various price range. Also electronic music keyboard has the characteristics of the metronome. At Table 1 there are metronome numbers of tempos [6].

Table 1 Tempos-Metronom numbers

Tempos	Metronome Numbers
largo	40 – 52
adagio	48 – 66
andante	60 – 88
moderato	84 – 108
allegretto	104 – 120
allegro	120 – 144
vivace	138 – 168
presto	160 – 200
prestissimo	200 – 208

By many musicians mean that if using the metronome is continuously, an artistic expression is incompatible. But the educational value of this instrument and it has great importance in playing the music. In addition, metronome is used as the program at computer. Although there are several programs available that can be used as a metronome, for specific applications and music instruments specific designs need to be done. The reason for this; each program is unique, and doesn't support other musical instruments and the metronome speeds.

Program and designed card described in this study can easily be used with any electronic instrument. The important thing is, transport musical instruments sound to analog input of matching card and benchmarking program to detect signals coming metronome program works correctly.

This study has benchmarking program. Cards designed with the PIC and circuit is worked by the program written in C Programming.This program is required to have a PIC-C Compiler. For this purpose ready commercially available programs can used. Described circuit and card were improved for the electro drums and tested. As a result of the tests results have been successful.

3. REALIZING THE METRONOME WITH PIC

In this study, firstly card designed on computer using PIC and Proteus program. Card tested and controlled visualy. In Figure 2, the card designed for metronome and carried out by using proteus program.

PIC 18F628A and LCD panel were used in the circuit. Two LEDs are put in order to output. If the desired number of hits are the same with the number of hits made by user the outputs are active, LEDs are on. If not LEDs are passive, off.

There are three buttons in the circuit (Up, Down and OK) for to set the number of hits. LCD screen is used to guide and inform.

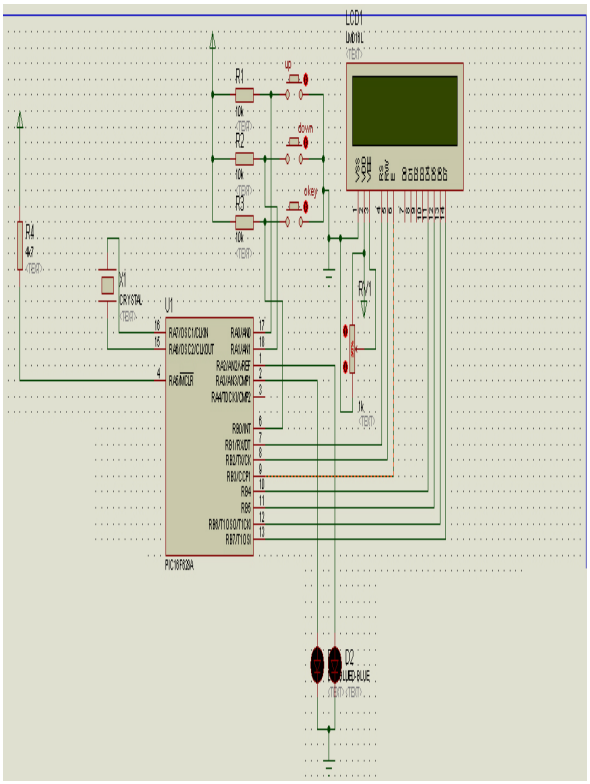

Figure 2: Metronome circuit

Program works as follows;

- First name of the program appears on the LCD screen (HSS2011),
- Reference of 110 hits per minute stated. This is the most widely used number of hits,
- If needed, the buttons (Up, Down and OK) are used to adjust desired value and shown on the screen.

The number of hits can change as follows;

- To enter the Set Up menu by pressing "Up" and "Down" buttons at the same time,
- If you want to set hits number less than 110, press "Down" button until which number you want,
- If you want to set hits number more than 110, press "Up" button until which number you want,
- Check the LCD screen while numbers on the screen increasing and decreasing,
- When you reach the wanted,desired number press "OK" button and it records number then exit Set Up menu.

4. METRONOME PROGRAM

The program written for metronome was "C Programming Language"and "PIC-C Compiler CCS PCWHD 4.093 Full Portable" is used for to work together harmoniously with PIC on computer.

The program named "HSS2011". Using this compiler the program also checked on the computer screen at the same time the accuracy of the simulation done with help of the program. The selectable numbers of hit are between 40 and 240, for to be appropriate for physical metronome.

Messages on the LCD screen are active for 1500 ms and LEDs (used at output) are active for 100 ms. If times want to change; it is possible with the program changing. This program can be changed to decrease or increase the time.

The metronome circuit, which is tested on the computer and checked whether it works correctly is shown below figure 3. For electro drums, this circuit provides analysis of hits severity and speed.

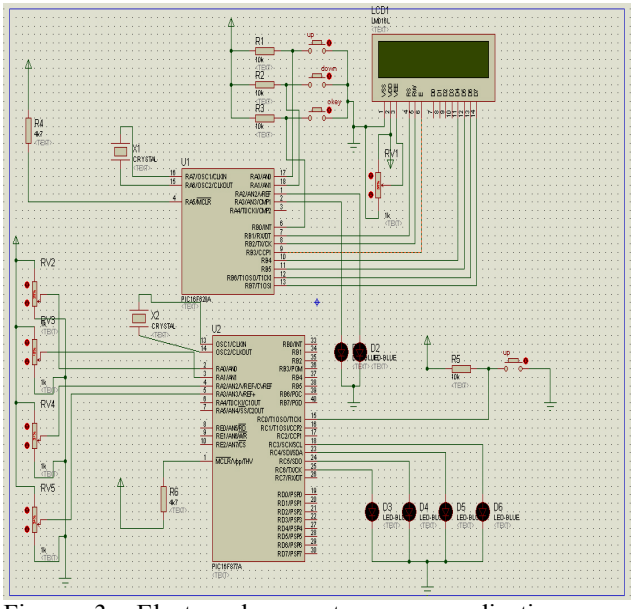

Figure 3: Electro drum-metronome application circuit

Hits on the drums defined as "tuse". In this study; tuses detected with piezofilm sensors, then signal digitized and after that the desired number of hits whether realized or not is determined.

In this circuit PIC16F877A is used. If it is necessary it can be used more or less capacity PIC integrates.

Tuses are taken from drummer by piezofilm sensor. Then passes through "Noninverting Amplifier" which is used OP-AMP (Operational Amplifier) as

an ADC (Analog to Digital Converter). This can be transferred to the matching card. The above circuit's input was designed as "Voltega Divider".

Analysis should be done on the basis of the severity of hit. When analysing the severity of hits, four output (LEDs) are used. One of LEDs, will be on according to the severity of hit. The others will remain off.

At the electro drums, a hit accepted must be larger then 200 mV. For the proper operation of the circuit, the signal from the ADC should not be less then 150 mV. The hits which is under this value is not acceptable. The strong hit from the top, should be limited because of preventing damage of integrated, operating voltage should be taken in to account.

According to the value of ADC outputs, using LED the hit severity range is shown in following Table 2 (1: LED is on, 0:LED is off).

Table 2 ADC Output – LED Status

ADC Çıkış (mV)	LED 3	LED 4	LED 5	LED 6
<205	0	0	0	0
>205	1	0	0	0
>410	0	1	0	0
>610	0	0	1	0

5. RESULTS AND CONCLUSION

Research results can be grouped as follows.

This paper presents, a card and programme can be used instead of pysical metronome. For percussion instruments without physical metronome, with using designed circuit a metronome was obtained. The metronome, has been tested by designed circuit. In this article, it is shown that, designed card and programme can be used all musical instruments.

The speed and severity of hits, turn into electrical signal. In the first part of the designed circuit, metronome tapping speed is determined. Then signal received from the input of analog card which is passed through from ADC is digitized. The signal received from benchmarking part of designed card, compared with the severity and speed of hit. Also, it is determined that whether it is true or not.

The circuit was visualized by using LED. Users informed by LCD screen. Not using physical metronome, evaluation of severity and speed of hit with together are separated from other studies. This version of the circuit is open to be improved. This study is important to shed light on other recent studies.

With this circuit, teaching methods can be developed for the music instruments, by preparing beginner and/or advanced level etudes. In this way, users who want to learn electro drum can see and correct their mistakes even if there is not instructor. The subject studies are underway.

Metronome Programme

```
#include <16F628.h>
#use delay(clock=4000000)
#Fuses XT,NOWDT,NOPUT,NOPROTECT
#include <mylcd.c>

#define met_1_out pin_a2
#define met_2_out pin_a3

#define up !input(pin_a0)
#define down !input(pin_a1)
#define ok   !input(pin_b0)
int16 sure=1000;
int vurus =110;
void hesapla()
{
sure=60000/vurus;
}
void ayar()
{
printf(lcd_putc,"\f  UP DOWN ILE \n  DEGER
GIRINIZ");
delay_ms(500);
while(!ok)
{
while(up && down);

       if(up)
       {
         vurus++;
         if(vurus>240) vurus=240;
         printf(lcd_putc,"\fVURUS SAYISI GIR\n
%u",vurus);
         hesapla();
         while(up);
       }
       if(down)
       {
         vurus--;
         if(vurus<40) vurus=40;
         printf(lcd_putc,"\fVURUS SAYISI GIR\n
%u",vurus);
         hesapla();
         while(down);
       }
}
```

```
}

void main()
{
  set_tris_a( 0x02 );
  set_tris_b( 0x01 );
 OUTPUT_B(0x01);
  lcd_init();
  delay_ms(100);
  printf(lcd_putc," METRONOME\n HSS-
2011");
  delay_ms(1500);
  printf(lcd_putc,"\fVURUS SAYISI
GIR\nBUTONLARI KULLAN");
   delay_ms(1500);
   printf(lcd_putc,"\fVURUS SAYISI GIR\n
%u",vurus);
  while(1)
  {
   if (up && down) ayar();

    output_high(met_1_out);
    delay_ms(100);
     output_low(met_1_out);
     delay_ms(sure-100);
     output_high(met_2_out);
    delay_ms(100);
     output_low(met_2_out);
     delay_ms(sure-100);

  }

}
```

6. REFERENCES

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Hasan Selçuk Selek was born in Konya, Turkey in 1970. He received his BS degree in electronic engineering from the Electrical Electronical Engineering Faculty of The Hacettepe University Ankara (Turkey) in 1992, the MS degree from the Arts and Science Institute of The Sakarya University (Turkey) in 1998. He continues to work on the PhD at the Science Institute of The Sakarya University (Turkey). He is currently instructor of Automation Program at Kocaeli Vocational School at The Kocaeli University (Turkey). His research interests include modelling, circuit design, card design and development of electronic materials.