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Electronic Music Glove using Sound Card

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Abstract: We developed an electronic music glove (EMG) system that could play musical scores in real time processing. The EMG system interfaces with the signal coming from the controller to the sound card in the computer. The computer, according to the status of the finger and foot switches, generates the signals to the speaker systems using the application C++ program by making use of MIDI message. The EMG systems can control up to several octave notes and duration of sound, and several musical performance expressions such as chorus, reverberation, rhythm, and volume. Finally, our EMG could play the performance of simple music depending on the choice of any kind of musical instruments in the sound card in computer systems.

1. Introduction

We continue to invent new ways to play electronic sounds live, ways to sense and transduce our movements and turn them into sounds. The most common form factors of electronic music controllers grew out of those in standard instruments, such as keyboards, guitars and wind instruments[1]. But new technology has freed instrumentalists from the parameters of standard instruments. With new controllers people can play synthesizers by leaping through the air and swinging their arms. Synthesizers communicate with controllers (and with other sound-producing electronics) via the Musical Instrument Digital Interface (MIDI) standard. In the past, the evolution of musical instruments was coupled to their specific capabilities to generate sound. Today, advances in electronic synthesis occur independently of the development of new playing interfaces[2].

Now using MIDI and a microcontroller system, we can simply generate a great variety of sounds. Using these technologies, we developed an electronic music glove (EMG) system that could play musical scores in real-time processing through sensory acception of the movements of finger joints. Any MIDI musical instrument can be played with our EMG system.

We developed an electronic music glove (EMG) system that could play musical scores in real time processing. The EMG system consists of ten flex sensors embedded in the gloves that allow real time analysis of the movements of finger joints and several foot switches for additional inputs, and the control systems interfacing with multimedia computer system. The movements of finger joints cause the change of resistance in each flex sensor attached to gloves and it is converted to the voltage signals. We designed the controller including the microcontroller system that could deliver the signal coming from the EMG to the computer.

By analyzing these data, the computer recognizes which fingers are bended and sends a music signal to the speaker through the sound card by making use of MIDI messages. The designed EMG can control up to several octave notes using foot switches and duration of note and several musical performance expression such as chorus, reverberation rhythm, and volume using MIDI messages. So, our EMG could play the simple music depending on the choice of any kind of musical instruments in sound card in computer systems according to the combination of movements of finger joints and the status of foot switches.

2. System Design

2.1 Hardware Description

The system consists of a PIC16C74 microcontroller (PIC), flex sensors, analog multiplexers, and a voltage converter. Figure 1 shows the block diagram of the EMG system.

The PIC has several A/D converters and TX/RX port that can transmit or receive data through 8-bit data bus using RS-232C serial communication protocol and large number of ports used for latched input and output. The flex sensor is a variable resistance. It is shaped like a thin bar and has a variable resistance value when it is bended inside or outside. A voltage converter is used for RS-232C communication between the EMG system and the computer because two systems use different voltage levels. The PIC microcontroller has five ports for A/D converting but we have ten flex sensors to connect. So we used time-sharing method to read ten flex sensors using two analog multiplexers.

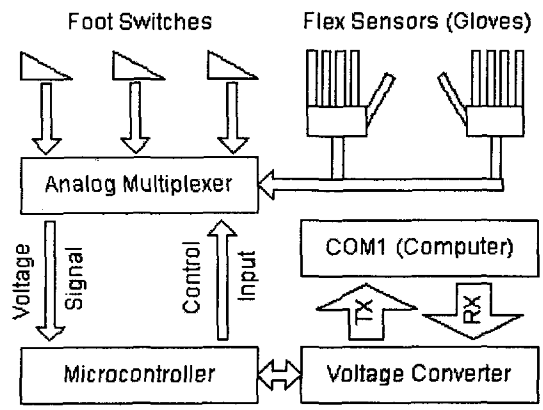

Figure 1. Block Diagram of EMG

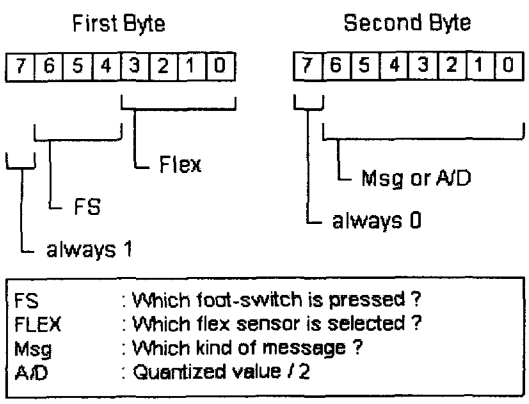

Figure 2. Data format between EMG and computer

The PIC microcontroller sends control signals to the analog multiplexers to select one of the flex sensors and then reads the voltage value of the selected flex sensor through the port. If then converts the voltage signal to 8-bit digital data using internal A/D converter. Then these data is manipulated according to the data format as shown in Figure 2. After the bit-level manipulation, these data is sent to the COM port of the computer through the RS232 protocol, and then the computer analyzes these data and plays a note using sound card and MIDI protocol. MIDI (Musical Instrument Digital Interface) has been standardized to mutually convey real-time musical performance information between electronic musical instruments. The MIDI standard defines hardware (transmitter, receiver) and data formats. A state is expressed by the "message" which divides into a channel message and a system message. The former includes the MIDI channel. Each musical instrument is optionally allocated to a channel. For example, the piano is assigned to channel 1, the flute channel 2, and so on. The system message is the common message shared by the whole system.

At this time, all sound cards support MIDI and have a variety of sound source. Some of the sound cards support extra instruments and special sound sources including the MIDI instruments. So we can play any kind of instruments that the sound card in the computer supports.

2.2 Software Description

We used assembly language for the PIC programming and C++ language for the application program to run our EMG system and computer.

The registers to process the data in the PIC microcontroller are programmed and the state diagram of the EMG system is shown on Figure 3. The PIC controller has 24 ports for input and output grouped by A, B and C. So each group has 8 ports, and should be set up to identify input, output and A/D converting. We used the group A for analog input and group B for analog multiplexers. The time-sharing method is applied to read the state of the flex sensors and foot switches. We need two analog multiplexers for connecting ten flex sensors to PIC

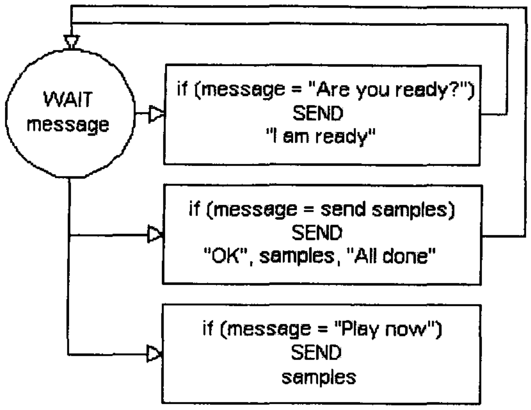

Figure 3. The state diagram of EMG system

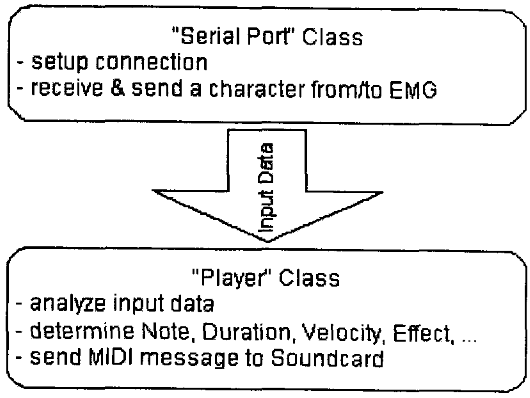

Figure 4. Two classes used in the computer

controller. The PIC controller sends a control signal to the analog multiplexers to select one of ten flex sensors and the PIC controller reads the voltage value of the selected flex sensor through the port A. The port group C in the PIC controller is used to read the state of foot switches and to send the data received to the computer. Using these foot switches we can control the octave of the note. For example, when you press the first switch and the index finger bends, you will hear the C4 sound of selected instrument. When you press the second switch and bend the same finger you will hear the C5 sound of the instrument. The player can adjust these octaves using the program running in the computer. The 7-th bit of group C is allocated for RX (receive) and the 6-th bit for TX (transmit). After setting up the ports, the EMG waits for the message from the computer. The concept of program in the EMG is like a loop.

A player with the EMG executes the program and turns on the EMG system, and then the EMG system waits for the ready message from the computer. The program consists of two parts with SerialPort class and Player class. These parts must be thought of as independent of each other as these are constructed in two separate classes using C++ language. SerialPort class is used to set up connection between the EMG and the computer. It can receive and send a data through the serial port embedded in the computer. The baudrate in the computer is 2400 bytes per second and it is enough to process the data from the EMG system.

Player class analyzes the incoming data and determines an appropriate value of note for the data, the duration of the note, the velocity of the note and the effects for the note. To measure the duration of the note, the program uses system clock. The time between first note and second note is the duration of the first note. We save the performance as a file using database system for replay. The velocity of the note is determined by the variation of the data sequence by movement of the finger. If any finger is bent, its speed could be slow or fast. The program saves ten samples of each finger. We can calculate the velocity of the note by computing the difference of the sequence for 10 samples. The MIDI message made using these results is sent to the internal MIDI synthesizer supported by the sound card.

3. Principle of Operation

The connection between the EMG and the computer allows the player to set up the overall system. In its initial state, the EMG waits for ready message from the computer. The state diagram is shown on Figure 5.

First, the computer sends a "Are you ready?" message to the EMG for identifying the setup of communication. If the communication between EMG and the computer has been set up successfully, the EMG sends a "I am ready" message to the computer. The computer sends a "Send samples" message to the EMG to get sample values from the flex sensors. Then the EMG sends an acknowledge message "OK" and the current data of flex. Then the computer sets up the initial value by averaging ten values of

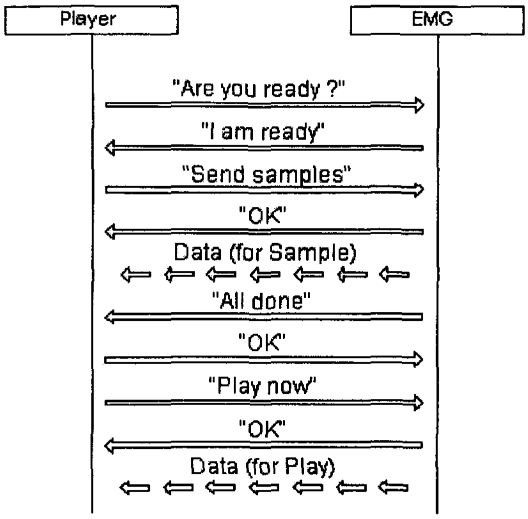

Figure 5. Flow diagram of EMG system

samples. Finally, the EMG sends an "All done" message to the computer. Now the system is ready to play. Before playing the music we should select the instrument to play and the effect for the music. If you want to play the music, just send the "Play" message.

4. Conclusion

We developed the new musical instrument called EMG for real time play. Our EMG system can be used as any type of musical instrument for creating music by dancers and musicians. We can generate the musical notes of 164 other instruments through our EMG systems. In the future, this EMG system should be improved user-friendly.

Acknowledgement

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