BIOSENSORFUSION : NEW INTERFACES FOR INTERACTIVE MULTIMEDIA ART

Yoichi Nagashima

Laboratories of Image Information Science and Technology
1-1-8, ShinsenriNishi-machi, Toyonaka, Osaka, 565-0083 JAPAN
(nagasm@computer.org)

Abstract: This paper is intended as an investigation of some new interfaces for computer music and interactive multimedia art. We have been producing many sensors, interfaces and interactive systems for computer music, composing many works and presenting some performances as applications of our research. Now in this study the main stress falls on "soft connections" with human performers, not using mechanical sensors, switches and tight contacts with human body. We will report and demonstrate bio-sensors, optical sensor and electrostatic sensor. We do not only use these sensors alone but also use "sensor-fusion" technique to detect the information of human performers, and it is important to construct good "human touch" relations. We will discuss about the problems and techniques of this approach.

1. Introduction

Our research called PEGASUS project (Performing Environment of Granulation, Automata, Succession, and Unified-Synchronism) had produced many experimental systems of real-time performance with many original sensors and have composed and performed many works. The recent step of this project was aimed "multimedia interactive art" by the collaboration with CG artists, dancers and poets [Nagashima95a] [Nagashima95b]. Now in this step the main stress falls on "soft connections" with human performers, not using mechanical sensors, switches and tight contacts with human body [Nagashima98]. We report and demonstrate bio-sensors, optical sensor and electrostatic sensor in this paper.

2. MiniBioMuse

The first interface is "MiniBioMuse" sensor that detects human muscle pulses. The famous "BioMuse" is a good sensor system to detect human bio-information, but it is very expensive, big and heavy. Our original "MiniBioMuse" sensor (Fig.1) costs about one hundredth, small like VHS-tape, very light and portable with battery.

Fig.1 MiniBioMuse

This system contains: (1) analog sensing OP-amp circuit with noise reduction, (2) direct noise output buffer to use the natural bio-noise for music, (3) A/D converter, (4) compact CPU card to manage the A/D signal, to reduce the noises and to convert for MIDI information.

The front-end sensing circuit of this interface (Fig.2) was designed by our collaborator Mr. Masaki Teruoka (Kyoto, Japan). The high-gain differential amp detects human muscle pulses, and cancels the "common mode noises" with the signal of ground contact. There are two inputs for muscle signals and one input for ground to cancel the noises.

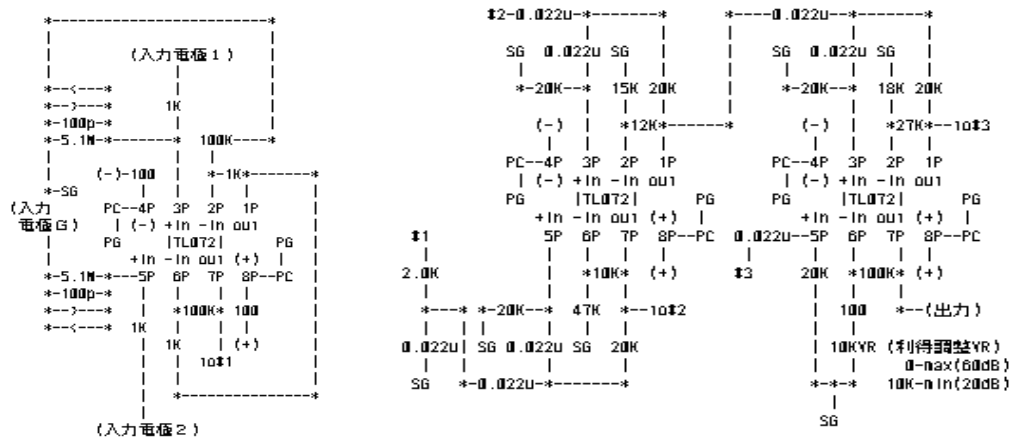

Fig.2. The sensing circuit for "MiniBioMuse" (designed by Mr.Masaki Teruoka)

When we use the "BioMuse" we must use the contact belt with contacting jell, but it is not necessary to use any jell with our "MiniBioMuse". We use simple wrist belts which are used to discharge the electrostatic attack to SIMM memory with cutting the internal resistor (Fig.3). This sensor detects the muscle pulses between the contacts.

Fig.3 The contacts of MiniBioMuse

Fig.4 The performance using the "MiniBioMuse"

This sensor was used for the work called "Brikish Heart Rock" (1997), live computer music for two performers: a flute player and a sensors' player. In this piece, the MIDI output of it was not used, the audio output was only used. The sensor player might move both arms and hands as an improvisational performance. The analog output of the sensor was the noise signal of muscles, so the sounds were real-time processing with the effector. The duration of this piece was not fixed because the two performers and an operator of the computer might continue any scenes, and might repeat any BREAK patterns with their improvisation (Fig.4).

3. HeartBeat Sensor

This sensor was produced for the project "Audible Distance" created by Akitsugu Maebayashi. This work won the second Grand-Prix at the 1st Biennale of ICC (Intercommunication Center) in 1997, and is presented as regular installation of interactive multimedia installation with virtual reality. Three participants called "players" walk around in the dark room with HMD and headphone for 3D-CG and 3D-sound. One player watches other 2 players' CG images and listens to other 2 players' sounds synchronized to each heart-beats. The system detects each player's points, distances and directions with CCD camera in real-time. The system generates images and sounds concerned with the distances and directions of each other, so players experience the "audible" distances. We tested some ways to detect the heart-beat, and finally we use a pair of LED and Phoro-TR unit attaching the ear (Fig.5).

This ear sensor is connected to the interface module. It contains: (1) digital input of the sensor, (2) compact CPU card to manage the input as interpolation of each heart-beat event and to send the massage via microwave (Fig.6). The receiver converts this message to MIDI information.

Fig.5 Ear Sensor for Heart-Beat

Fig.6 Interface Module

4. Harp Sensor

The third interface is "Harp Sensor" using optical fiber sensors of factory automation. This interface has a wooden rectangular frame which has 2-dimensional optical "strings": 13 vertical strings and 3 horizontal strings in the frame (Fig 7).

Fig.7 The "Harp Sensor"

Fig.8 Performance of "Harp Sensor"

As the default, the output MIDI messages of this sensor are mapped like a classical Harp. Performer can play vertical 13 strings chromatically with 3 octave changes by horizontal 3 strings. This sensor was used for the work called "Atom Hard Mothers" (1997), live computer music with live graphics for two performers and the work called "Atom" (1998), live computer music for Kyma and solo performer. In these pieces, the MIDI output of this sensor acted as a harp with chromatic strings, as a percussion with 6 gongs and as 3 bells or single plate for performances with the live control of MAX (Fig.8).

5. ElectroStatic Pad

The fourth interface is "ElectroStatic Pad" sensor with internal graphical display system. The human performer's soft touches with 5 metal pads generate several types of MIDI outputs and several patterns of 80 LEDs display on the panel. We use this interface not only as musical instrument but also as controller and display of multimedia installation (Fig.9).

Fig.9 The "ElectroStatic Pad" sensor

Fig.10 Performance of "ElectroStatic Pad"

This system contains: (1) electrostatic noise sensing circuits with controllable threshold levels, (2) compact CPU card to manage this information and generate 5 mode phrases to MIDI messages. This sensor was used for the work called "Brikish Heart Rock" (1997), live computer music for two performers and the work called "*TEN nimo noboru samusa desu*" (1997), live computer music with live graphics for four performers. In these pieces, the MIDI output of this sensor was used as a "soft-touch" percussion part (Fig.10).

6. Sensor Fusion Technique

We use these sensors not only as solo instrument of music but also as a part of "sensor fusion" system.

For example, Fig.11 shows the system block diagram of the work "Atom Hard Mothers". In this piece, there are 3 special sensors to detect performances and these messages are merged to MAX patch which works as "pattern matcher", "system controller" and "algorithmic composer". The important point is the filtering of MIDI message, because the traffic of live sensors is heavy in some cases. Thus we produced many equipments for performance: MIDI merger with programmable message filter, and so on.

Fig.11 shows that our original sensors, interfaces and systems use normal MIDI protocol with other commercial MIDI equipments. So we define special information in MIDI message. For example, almost musical instruments do not accept "An mm pp" message (polyphonic pressure), so we use "AF mm pp" (16ch) for each defined protocol.

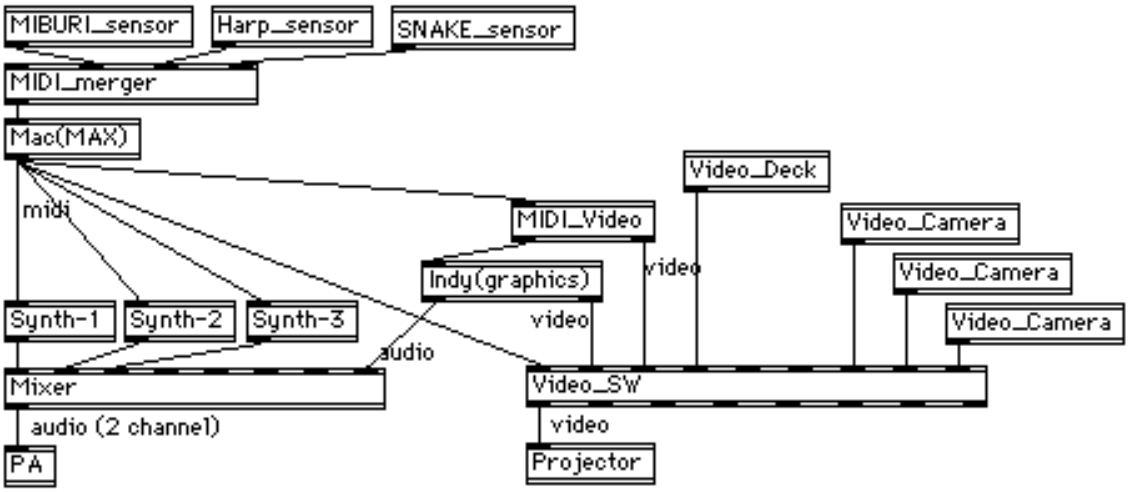

Fig.11 System Block Diagram of "Atom Hard Mothers"

7. Summary

We have reported 4 examples of our research in this paper. The sensor technology may apply not only for music but also human interface systems. We will continue this research both with another sensors for music and with human interface applications.

REFERENCES

[Nagashima95a] Nagashima, Y. Multimedia Interactive Art : System Design and Artistic Concept of Real Time Performance with Computer Graphics and Computer Music. *Proceedings of Sixth International Conference on Human Computer Interactio* .Elsevier, Yokohama Japan, 1995.

[Nagashima95b] Nagashima, Y., Katayose, H., Inokuchi, S. A Compositional Environment with Interaction and Intersection between Musical Model and Graphical Model --- "Listen to the Graphics, Watch the Music" ---. *Proceedings of 1995 International Computer Music Conference*. International Computer Music Association, Banff Canada.

[Nagashima98] Nagashima, Y. Real-time Interactive Performance with Computer Graphics and Computer Music. *Proceedings of IFAC Man-Machine Systems International Conference*. Elsevier, Kyoto Japan, 1998.