INTERACTIVE MULTI-MEDIA PERFORMANCE WITH BIO-SENSING AND BIO-FEEDBACK

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ABSTRACT

This is a report of research and some experimental applications of human-computer interaction in multi-media performing arts. The human performer and the computer systems perform computer graphic and computer music interactively in real-time. In general, many sensors are used for the interactive communication as interfaces, and the performer receives the output of the system via graphics, sounds and physical reactions of interfaces like musical instruments. I have produced many types of interfaces, not only with physical/electrical sensors but also with biological/physiological sensors. This paper is intended as an investigation of some special approaches: (1) sensing/reacting with "breathing" in performing arts, (2) 16-channel electromyogram sensor and its application of "muscle performing music", (3) 8-channel electric-feedback system and its experiments of "body-hearing sounds" and "body-listening to music".

1. INTRODUCTION

As the research called PEGASUS project (Performing Environment of Granulation, Automata, Succession, and Unified-Synchronism), I have produced many systems of real-time performance with original sensors, and have composed and performed many experimental works at concerts and festivals. The second step of the project is aimed "multimedia interactive art" by the collaboration with CG artists, dancers and poets.
Fig.1 shows the concept of the keyword: "listen to the graphics, watch the music". The third step of the project is aimed "biological or physiological interaction between human and system". I had produced (1) Heart-beat sensor by optical information at human earlobe, (2) Electrostatic touch sensor with metal contacts, (3) single/dual channel electromyogram sensor with direct muscle noise signals. And now I report the newer sensors in this paper.

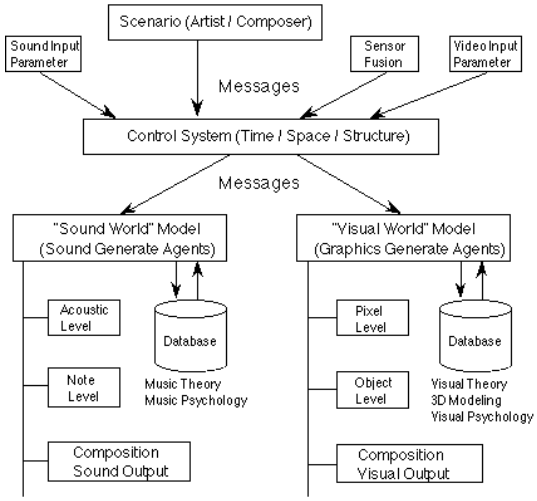

Figure 1. *Conceptual system block diagram of the PEGASUS project, multimedia interactive art.*

2. "BREATHING MEDIA"

In computer music performance, the human performer generates many information which computer system can detect, but "sound" and "image" of performance have fatal problems of its delay. The final sound of the performance and image of the movements of performer are detected just after its generation, and the system has limited conversion time and limited computation time, so the performer feels the delay of response in every time.
Thus I have developed two types of new sensors with which computer system can detect the actions before by sound or by image of the performance.

2.1. Vocal Breath Sensor

Vocal performer acts with heavy breathing, and her(his) breast and belly repeats expansion and contraction. So I used rubber tube sensor which changes its resistance with the tension, and produced the Vocal Breath Sensor system to convert the breathing to MIDI information in real-time (Fig.2). The sensing information is used to change signal processing parameters of her voices and to arrange parameters of real-time computer graphics on stage. The audience can listen to her voice and watch her behavior

with the tight/exaggerated relation effected and generated by the system which detects the changes before the sound. I think this information shows another meaning of the musical performance in media art.

Figure 2. *Vocal Breath Sensor*

2.2. SHO Breath Sensor

Next, I report the development of a compact/light bi-directional breath pressure sensor for SHO (Fig.3). SHO is the Japanese traditional musical instrument, a mouth organ. The SHO player blows into a hole in the mouthpiece, which sends the air through bamboo tubes which are similar in design and produce a timbre similar to the pipes in a western organ. The bi-directional breath pressure is measured by an air-pressure sensor module, converted to digital information by 32bits CPU, and converted to MIDI information.

The authoring/performing system displays the breathing information in real-time, and helps the performer for delicate control and effective setting of the parameters (Fig.4). The output of this sensor shows not only (1) the air-pressure inside the SHO, and (2) the volume of SHO sound of course, but also (3) preliminary preparation operation and mental attitude of the performer, so it is very important for the system to detect this information before sound starts.

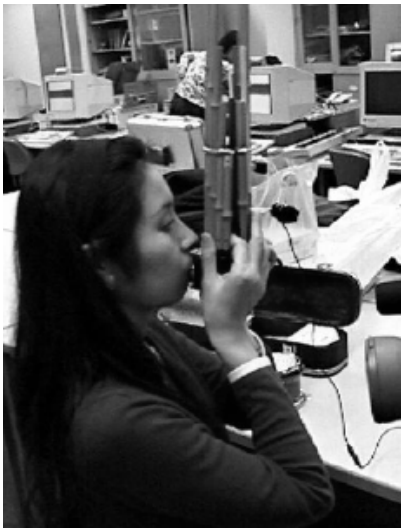

Figure 3. *SHO Breath Sensor*

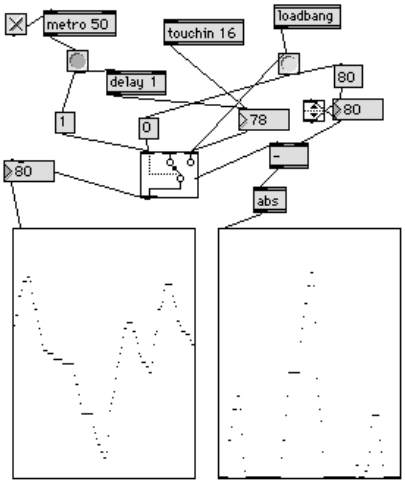

Figure 4. *example of SHO Breath Data*

3. "MUSCLE/GESTURE MUSIC"

Then, I report the development of a compact/light 16-channel electromyogram sensor (Fig.5). This sensor is developed as the third generation of my research in electromyogram sensing, because there are many problems in high-gain sensing and noise reduction on stage (bad condition for bio-sensing). The front-end sensing circuit is designed with heat-combined dual-FETs, and cancels the common-mode noises. Each 8-channel electromyogram signals for one arm/hand is demultiplexed and converted to digital information by 32bits CPU, and converted to MIDI information for the system. This CPU also works as software DSP to suppress the Ham noise of environmental AC power supply. The multimedia authoring/performing system displays all channels electromyogram information in real-time, this graphic information helps not only the performer but also the audience to recognize the relationship among sound / visual / behavior / gesture.

Figure 6 shows a performance with this sensor. Many sensing contacts detect many information of muscles just before the performance, so the sound synthesis software can generate complex sounds without delay with the performance. The live graphics of sensors data also can be generated with the time postponement, which helps the understanding of the relations.

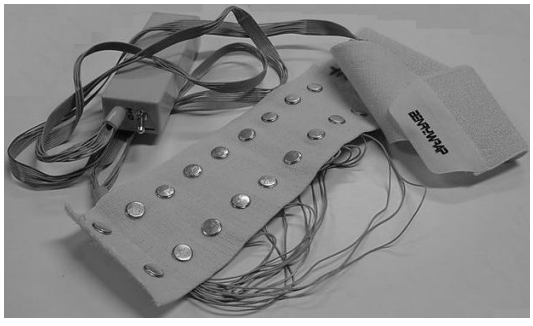

Figure 5. *Electromyogram Sensor (only for one arm)*

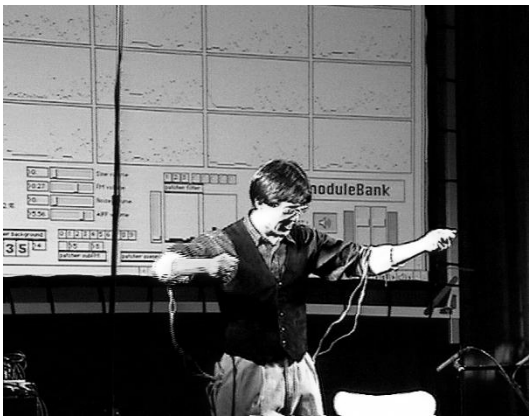

Figure 6. *Performance with electromyogram Sensor*

4. BIO-FEEDBACK SYSTEM

Finally, I report the newest development of a compact and light 8-channel biological feedback system (Fig.7). The feedback signal is high voltage (10V-100V) electric pulses like "low frequency massage" device (Fig.8-9)). The waveshape, voltage and density of pulses are real-time controlled with MIDI from the system. The purposes of this feedback are: (1) detecting performer's cues from the system without being understood by audience, (2) delicate control of sounds and graphics with the feedback feeling in virtual environment, (3) live performance of outside of anticipation with the electric trigger.

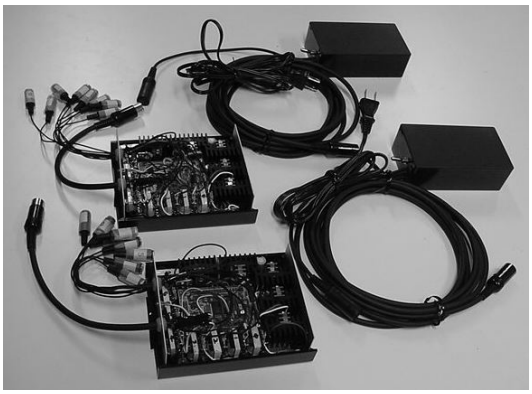

Figure 7. *Bio-Feedback System*

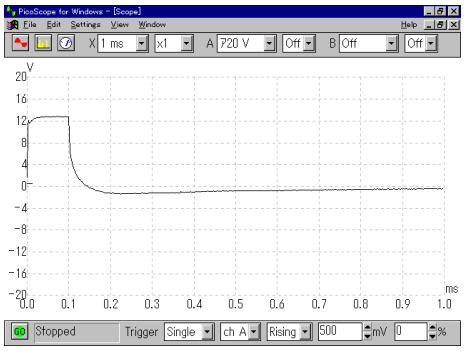

Figure 8. *example of Bio-Feedback signal*

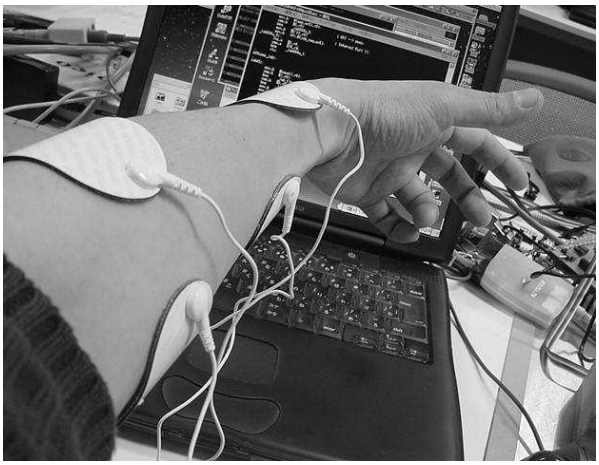

Figure 9. *Bio-Feedback contacts*

4.1. Application Example (1)

Figure 10 shows the performance of the work "It was going better If I would be sadist truly." composed and performed by Ken Furudachi in February in Japan. There were 2 DJ (scratching discs) performers on stage, and the DJ sounds generates many types of bio-feedback signals with Max/MSP and this system. The performer shows the relation between input sounds and output performance just by his body itself. This work is the first application of the system.

Figure 10. *Performance of "It was going better If I would be sadist truly."*

4.2. Application Example (2)

Figure 11 shows the performance of the work called "Flesh Protocol" composed by Masayuki Akamatsu and performed by Masayuki Sumi in February in Japan. The performer is a professional dancer, so he can receive two times bigger electronic pulses with his strong and well-trained body.
The composer produces many noises and sounds with Max/MSP, and the converted signals control the body of the performer on stage. The relations of them are well shown in real-time with the screen and motions on stage.

Figure 11. *Performance of "Flesh Protocol."*

Figure 12. *Performance of "Ryusei Raihai"*

4.3. Application Example (3)

Figure 12 shows the performance of the work called "Ryusei Raihai" composed by Masahiro Miwa in March in Japan. The four performers connected to the system are "instruments" of the special message in Internet with the composer's filtering program. When one special data occurs in the network, one of the performers is triggered by the system, then he/she plays bell on the hand in real-time.

4.4. Possibility of "Hearing pulse"

I want to discuss about a possibility of "hearing pulse" without using ears. In experiments during development of this system, I found many interesting experiences to detect "sounds" without acoustic method (speaker, etc). The numbed ache from this Bio-feedback system is different with the waveshape, frequency etc. This shows the possibility for hearing-impaired person that a sound can be perceived without using an ear. Another experiment, the sourse is changed from simple pulses to musical signals also shows the possibility of listening to the music with this feedback.

5. CONCLUSIONS

Some researches and experimental applications of human-computer interaction in multi-media performing arts were reported. Interactive multi-media art is the interesting laboratory of human interfaces and perception/cognition researches. I will continue these researches with many experiments.

6. REFERENCES

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