

# REAL-TIME INTERACTIVE PERFORMANCE WITH COMPUTER GRAPHICS AND COMPUTER MUSIC

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**Abstract:** This is a report of some applications of human-machine systems and human-computer interaction about experimental multimedia performing arts. The human performer and the computer systems perform computer graphics and computer music interactively in real-time. As the technical point of view, this paper is intended as an investigation of some special approaches: (1) real-time processing and communication system for performing arts, (2) original sensors and pattern detecting techniques, (3) distributed system using many computers for convenience to compose, arrange and perform. Copyright (C) 1998 IFAC

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## 1. INTRODUCTION

The 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 experimental works at concerts and festivals. The new step of this project is aimed "multimedia interactive art" by the collaboration with CG artists, dancers and poets.

## 2. THE CONCEPT OF MULTIMEDIA

The best account for the concept of multimedia art can be found in Fig.1 that is the conceptual system block diagram of this project. In this system there are some types of agents in a computational environment like UNIX X-Windows system. Each agent is produced as a client process. Input images and input sounds are sampled in real-time via

cameras and microphones. The graphic outputs are connected via projectors or display monitors. The output sound consists of that from direct DSP computed by computer and from MIDI-controlled synthesizers. The 'control' agent exists in the center of the system. This agent manages 'control messages' and sends them to the sound agency and the graphics agency in time layer, spatial layer and structural layer. The messages input to these agencies may be divided into four types: (1) traditional 'scenario' of artists: time scheduling, spatial mapping, characteristics of motion, etc, (2) sensor information of the performance: sensor fusion of event triggering and continuous parameters, (3) real-time sampled sound: as a material for granular synthesis and granular sampling, (4) real-time recorded images: as a material to generate CG -- pixel, texture, motion, etc. The 'sound agency' section organizes the 'world model' of sound. It contains many agents, for example, a database about musical theory and music psychology, sound synthesis level generator, note level generator,

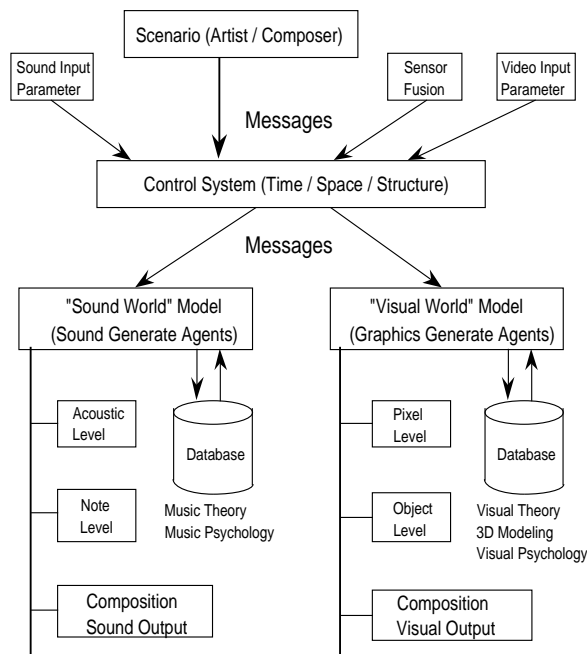


Fig.1. Conceptual system block diagram of the PEGASUS project, multimedia interactive art.

phrase level generator, and sound distributing generators. These agents receive the control messages and send or receive information to and from each other as interaction. There are also many types of agents in the 'graphics agency' section: including pixel level, object level, modeling level, and so on (Nagashima, 1995a).

### 3. EXPERIMENTAL WORKS AND SYSTEMS

In this part there are some reports and discussions about performances as the application of multimedia interactive arts which were realized at concerts and events in Osaka, Kobe, Kyoto, Tokyo and Seoul(Korea) during 1996 to 1997. These performances were the "live visual arts" for the graphic artist and were the "live musical arts" for the music composer, but these could not be produced by each artist only. At the presentation, some

demonstrations of videos will be included.

#### 3.1 "Asian Edge"

The multimedia interactive art called "Asian Edge" was composed in 1996 and performed at the JACOM (Japan Computer Music Association) concert in Kobe in July, 1996. This work was inspired with Asian feelings, Asian culture and the integration of dance, graphics and performance. At this performance, there requested these equipments: SGI Indy<1> (for computer sound with MIDI) running original software produced by the composer to generate many sounds in UNIX environment, SGI Indy<2> (for computer graphics with MIDI) running original software to generate real-time 3D graphics controlled by sensors, Macintosh<1> running MAX patch to manage sensor fusion information, Macintosh<2> running MAX patch to control synthesizers, sampler S2800i, synthesizer K4r<1> and K4r<2>, effector SE50, microphone for performer, special Lute (original sensor) produced by the composer, MIBURI and SNAKEMAN (original special sensors produced by composer), original MIDI merger, original MIDI filters, original MIDI video switcher, four video players for BGV controlled via MIDI, four video cameras controlled via MIDI, three video projectors to display graphics and 4 channels stereo PA system (see Fig.2).

All materials of computer sound part are arranged from recorded Asian instruments, and signal processed with original softwares written by C in SGI IRIX(Unix), and multiple player software is also produced. Each sound file is not played by fixed sequence, but triggered by MIDI real-time control by sensors. Indy workstation for sound part and graphics part are controlled with MIDI. In addition, back ground videos and live videos of performance with four video cameras are real-time switched by MIDI-video switcher and three video projectors with the performance. Performer also speaks and sings

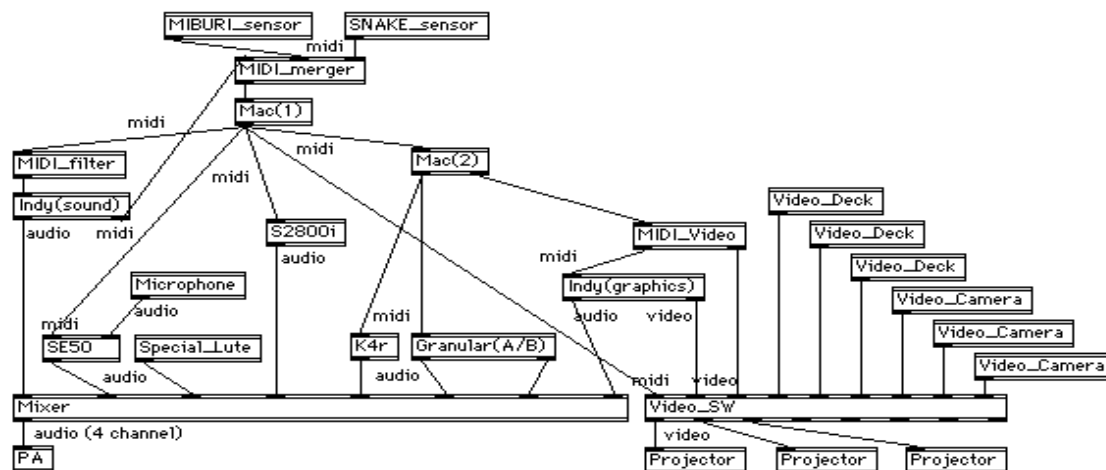


Fig.2 System block diagram of "Asian Edge".



Control Box  
for MIDI conversion



Angular Sensors

Fig.3 "MIBURI" sensor.



Fig.4 "SNAKEMAN" sensor.

some phrases, this live voice and pre-sampled and processed sounds are modified by effector or generated by sampler. MIBURI sensor detects the motion and the body-language of performer, SNAKEMAN sensor generates trigger actions, and special Lute is performed as traditional musical instrument.

The MIBURI sensor has 6 angular sensors for human joints. Normally these sensors detect both wrists, both elbows and both shoulders. The angular sensor module outputs voltages corresponding with its current angle. The control box supplies power for sensors and converts these inputs to MIDI messages



Fig.5 Performance of "Asian Edge".

with A/D converter and microprocessing unit. The MIDI message which means "motion language of the performer" is received by MAX software of Macintosh computer, and pattern detection and recognition algorithm work to generate live computer music and live computer graphics (Fig.3).

The SNAKEMAN sensor detects the cutting speed of infrared beam. This sensor may detect from 500msec to 30sec range with logarithmic compression for 7bits MIDI data representation. The MIDI message which means "scene change" is received by MAX software of Macintosh computer, and the control algorithm works to change the scene to generate live computer music and live computer graphics (Fig.4, Fig.5).

### 3.2 "Johnny"

The multimedia interactive performance called "Johnny" was composed in 1996 and performed at the Japan - Germany Media Art Festival in Kyoto in October, 1996. This work was inspired with "Battle and Session" of music, graphics and dance. On the

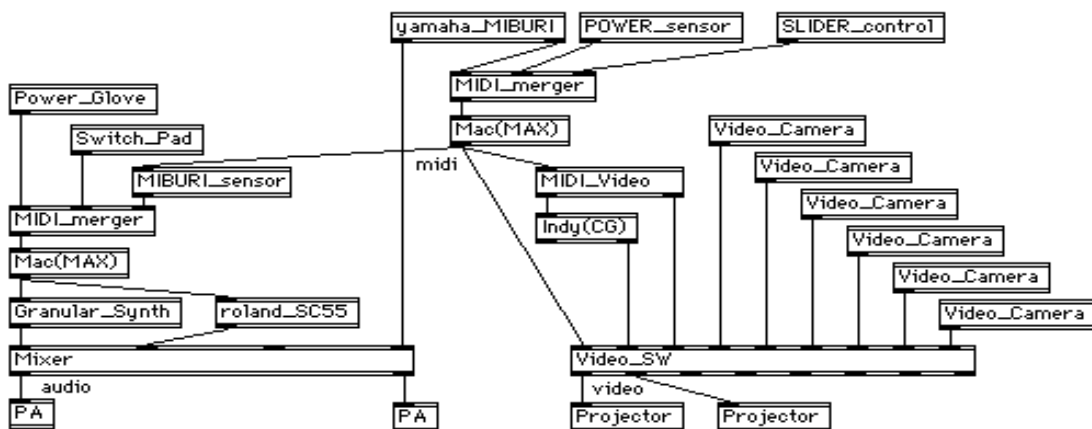


Fig.6 System block diagram of "Johnny".



stage there were 3 performers: (1) dancer who wears MIBURI sensor to detect body language for conducting and solo performance, (2) CG artist who controls the video mixer to generate live video and (3) musical performer who has MIDIGLOVE sensor and plays MIDI control pads to arrange the background music in real-time. Fig.6 is the system block diagram of "Johnny".

The MIDIGLOVE sensor is developed by arrangements with PowerGlove which is a controller of Nintendo Entertainment System by the composer. There is a small microprocessing unit on the glove to detect the status of fingers, and the 4-bits decoded information is transmitted via 250MHz wireless. The MIDI message from the receiver module is received by MAX software of Macintosh computer, and pattern detection and recognition algorithm work to generate live computer music and live computer graphics (see Fig.7).

### 3.3 "Brikish Heart Rock"

The interactive computer music called "Brikish Heart Rock" was composed in 1997 and performed at the concert in Kobe in October, 1997. This is live computer music for two performers: a flute player and a sensors' player. The flute part is independent of the computer system electrically, and the player can play any improvisational phrases with the score. The sensor player performs two original sensors: TOUCH sensors pad and the "MiniBioMuse" sensor. In this piece, the MIDI outputs of "MiniBioMuse" was not used, the audio output was only used.

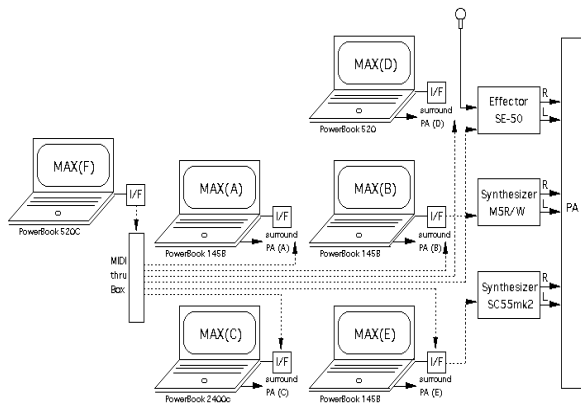
The main concept of this work is the "session" mind of rock and jazz musicians. Performers may play any phrases, sounds and rhythms with the real-time generated BGM part from MAX patches. The BGM band starts as simple 8-beats rock patterns, and grows with 16-beats or euro-beat and randomly insert some faking rhythms. Performers must pass these fake rhythms with playing no gestures, so this rule is one kind of a game. The "MiniBioMuse" player may move both arms and hands as an improvisational performance like a dance. The analog output of the sensor is the noise signal of

muscles, so the sounds are real-time processed with the effector. The duration of this piece is not fixed because the two performers and the operator of the computers may continue any scenes, and may repeat any BREAK patterns with their improvisation.

The TOUCH sensor is developed by the composer. This sensor has 5 electrostatic sensing pads for human electricity. This sensor is also an installation of human interface, so it has 80 LEDs to demonstrate 16 \* 5 display messages of touch events. The microprocessing unit on the board detects the status of touch performance, and the sensing information is transmitted via MIDI. The MIDI message from the sensor is received by MAX software of Macintosh computer, and pattern detection to generate live computer music (see Fig.8).

The "MiniBioMuse" sensor is also developed by the composer as a part of composition. This sensor has 3 electrode bands: two are sensing pads and one is common ground to reduce noises. This sensor has a microprocessing unit in it, and detects electric pulses of muscles, and generates not only direct analog signals but also converted MIDI information (see Fig.9).





### 3.4 "The Day is Done"

The interactive computer music called "The Day is Done" was composed in 1997 and performed at the concert in Kobe in October, 1997. This is live computer music which focuses the "voice" as a material of music. This piece contains many types of "voices": human voices, signal processed natural voices, and computer generated voices of Macintosh. The lyric "The Day is Done" written by W.Longfellow is only used for its fantastic sounds and images. The other concept of this piece is the keyword "environment". Many natural sounds are used for the environmental atmosphere: stream, waterfall, rain, seashore and waves. These images are inspired by the Joumon-Sugi (7000 years old Japanese cedar) and the Yakushima island in Japan.

This piece contains two musical elements. The back-ground part is pre-processed and fixed to DAT or CD. The signal processing compositions are: SGI Indy workstation standard "soundeditor", original tools for signal processing, and original multi-playback tool and UNIX shell scripts. The real time part requires 6 Macintosh computers (running MAX with "speak" object produced by Mr. Ichi in Japan), and two performers: vocal (mezzo soprano) and "computer percussionist" who plays 6 Macintosh click-buttons in real-time. The two performers use stop-watches to adjust their timings, but they can

perform with free feeling of improvisation.

### 3.5 "Atom Hard Mothers"

The multimedia interactive art called "Atom Hard Mothers" was composed in 1997 and performed at the concert in Kobe in October, 1997. This is live computer music with live computer graphics and live video images which focuses the concept of "multimedia game". The two performers play each special sensor as instruments, and the output information of these sensors controls musical and graphical objects in real-time.

The music part of this piece contains three types. The background sound part is pre-processed with SGI Indy and fixed to DAT or CD, and this part is generated only from voices of a 'bell-ring' cricket. The live-background music part is real-time composed and played with MAX algorithms, and this part may be played differently at each performance. The performers' parts are generated with their sensors: special HARP sensor, SNAKE sensor and MIBURI sensor (see Fig.11).

The graphic part of this piece contains three types, and these sources are real-time switched with performances and projected to the screen: pre-processed background image video (Hi-8), real-time generated computer graphics and live images of performers on the stage. The computer sounds and computer graphics are brought up by the two performers as "mothers", and grows up with improvisations. This piece is an interactive art version of the TAMAGOTTI game in a sense.

The HARP sensor is developed by the composer as a part of composition. This sensor has 3 horizontal beams and 13 vertical beams of LED-photoTR pairs with optical fiber sensor modules. The control system of it detects these 16 light beams crossing events, and generates MIDI messages of the status. The MIDI message from the sensor is received by

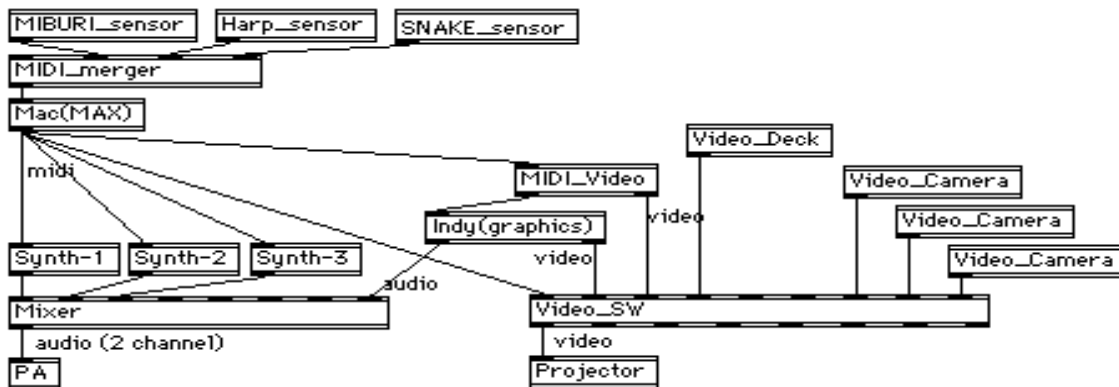


Fig.11 System block diagram of "Atom Hard Mothers".



MAX software of Macintosh computer, and generates live computer music and live computer graphics (see Fig.12).

#### 4. DISCUSSION

For live performance like these multimedia arts, it is most important to manage "events" with "timing" and "actions" in algorithmic environment. In the algorithmic composition, there are many structural components to perform: for example, a group of sequential events, triggered events with sensors, masking condition for other events, waiting sequences for triggers, and so on. It is difficult to handle this complex status with traditional environments for composition and performance like commercial sequencers or "timeline" object of MAX. This drives us to the question how to deal with many kinds of components and how to compose and perform easily. This project is developing the compositional environment with multi-media, and reports a new idea to solve this problem.

There have been developed some types of modules to construct interactive performance of algorithmic composition. These modules contain many inputs and outputs to connect with other modules like the patches of MAX. Composers can use the modules

as universal parts of the composition in this environment, and it is easy to construct a big structure with the concept of hierarchy. Some of the input nodes are: "start trigger", "sensor input", "sub sequence finish", "sensor masking time", "stop trigger", "stop masking time", "scene id", "initialize", and so on. The output nodes are: "trigger to next", "start sub-sequence", "stop sub-sequence", "status ID", "scene ID", and so on. These modules can be used hierarchically and recurrently, and it is easy to see the construction of the relation of compositional information (see Fig.13). One of the advantages of this idea is an ability of debugs for the composition. Each scene described with the proposed module has much independence and this enables the "partial rehearsal" in composition or performance (Nagashima, et al., 1995b).

#### 5. CONCLUSION

It is important for research of human-machine systems and human-computer interaction to experiment as applications. The live performance like multimedia performing art is suitable for its real-time condition. Some new projects for new works are running.

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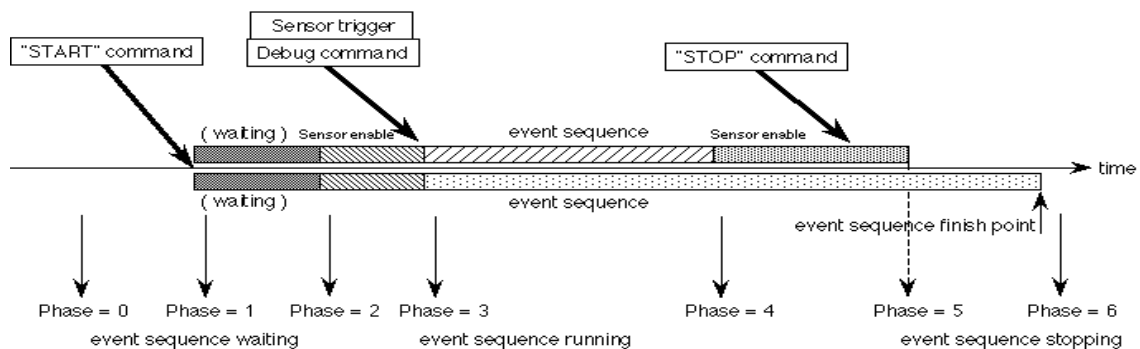


Fig.13. Control module for events of performance.