Gesture Sensor in Virtual Performer

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ABSTRACT

Virtual Performer is an interactive media-art environment, composed of multi-sensors, control modules which generate action from input information, computer graphic and sound generator. It interprets other musician's acoustic and motion gesture in real-time, and generates music accompanied by CG. Performers and the audience can experience something new in the music, or sound abstract image in the Virtual Performer's environment.

This report describes multi-sensors developed in order to acquire sound and skill in playing musical instruments, especially focusing on motion sensors developed for the shakuhachi, a traditional Japanese bamboo flute. The shape of the shakuhachi is simple and has only five holes. The player's well-controlled physical actions, represented by head shaking and fingers moving near the holes, make its sound fully expressive. Our aim is to use such gestures as the controllers of accompaniment and sound effects of a shakuhachi solo. The sensors of Virtual Performer Environment do not restrict the performer's action. The output signals of the sensors are used complementarily in order to acquire data with high resolution in broad space.

1 SYSTEM

Main Sensors especially for the shakuhachi System and player are the following: sensors base on supersonic measurement, gyroscope, and moisture indicator. Supersonic transmitters are equipped on a performer's hands or body. Receivers are arranged in a cube of several meters around the performer. This sensor can detect the performer’s action. Three small gyroscopes are developed in order to acquire precise movement of the performer’s head. Contact sensors surrounding each hole of the shakuhachi can indicate the finger's position. [1,2]

1.1 Supersonic sensor

The sensor is constructed with 8 pairs of transmitters, receivers and interval timers with I/O interface.

![Diagram of Virtual Performer](image)

Fig.1 Block Diagram of Virtual Performer

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Supersonic transmitters are put on the player. The supersonic frequency is 40KHz, and transmits channels individually. They transmit, in order of channel, supersonic waves every short duration, about fifty waves or 30ms sequentially. Supersonic receivers detect waves at the same time.

A personal computer controls interval times through I/O port and is linked to the supersonic transmitters by wireless. The radio frequency is 300MHz. The computer sends a 'start pulse' to each interval timer. It sends commands of 'channel select' and 'start signal' to a supersonic transmitter. Signals from the supersonic receivers are amplified and converted to stop pulses for interval timers. The computer receives values from interval timers and calculates exact locations by relations of trigonometry. This sensor can detect in a 3 meter cube with 9 millimeter accuracy. (See Fig.1)

1.2 Gyroscope

The second part contains Vibratory Gyroscopes utilizing Piezoelectrically driving Metal Bar which is extremely downsized, highly sensitive, and easy to operate. They themselves do not have any mechanism. They have about twice as much sensitivity as mechanical gyroscopes which has been generally used. Three transducers attached to the head-band of the performer continuously output three-axis angle velocities at 50Hz Cycle. Signals, 0-5 Volts, are converted to 8 bit serial binary data by an AD converter and a 16 bit single chip processor. The data is transmitted to a consolidation module by wireless. The radio frequency is 150MHz. (See Fig.2)

(* Murata Seisakusho produces this sensor.)

1.3 Moisture indicators

This sensor is generally used to detect the moisture in wood, paper etc. however we used it to detect a resistance of the human's body. We have used this sensor to detect the contact of the player's finger at present. We are now engaging in producing these sensors to obtain gradual control of fingers. When these sensors are attached to a hole of the shakuhachi, it can detect a finger's pressure around the hole linearly. However a condition of the Human's skin continually changes by his physical condition or humidity. We have been constructing sensors based on the idea of dynamic control of thresholds.

![Fig.2 Block Diagram of Supersonic Sensor](image)

![Fig.3 Block Diagram of Console](image)

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Every hole of the shakuhachi has four metal contact sensors. They are connected to high-gain amplifiers. When the performer touches the sensors, they can indicate a very small amount of leak between them and the ground. The system can obtain information of the finger's positions by four sensors. The data is transmitted by wireless (150MHz). (See Fig.3)

1.4 Other sensor

In addition to these three sensors, an image processing sensor, which detects the light of the light-emitting diodes attached to the performer's body is used in order to acquire rough movements. The infrared light attached to a camera enables us to use this sensor in the ordinary lighting environment. When the lens is changed, it is possible to alter its range.

2 CONCLUSION

This paper has described sensors of Virtual Performers. In the system we combine the sensors which are supersonic sensor, gyroscope, and moisture indicator. They realize the high resolution measurement in a short distance. The images processing sensor take change of the rough resolution. It is difficult for machines to recognize outside information as humans do. Complementary utilization of multi-sensors make it possible to realize human-like perception in the Virtual Performer. The sensors do not detect the breath of the performer we perceive, however our system has an acoustic sensor. It can detect most of the breath control in playing the shakuhachi.

We are planning to develop a Synthesized Shakuhachi with a breath sensor.

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References
