Multi Rubbing Tactile Instrument

Yoichi Nagashima
Shizuoka University of Art and Culture
2-1-1, Chuo, Naka-ku, Hamamatsu,
Shizuoka, JAPAN 430-8533
nagasm@suac.ac.jp

ABSTRACT

This is a report of a novel tactile musical instrument. This instrument is called "Multi Rubbing Tactile Instrument (MRTI2015)", using ten pieces of "PAW sensor produced by the RT corporation". Previous research was focused on "untouchable" instruments, but this approach is fully tactile - "rub" and "touch". The ten PAW sensors are assigned on the surface of the egg-like plastic case to fit the ten fingers grasping the instrument. The controller is mbed (NucleoF401RE), and it communicates with the host PC via high speed serial (115200bps) by an MIDI-like protocol. Inside the egg-like plastic case, this instrument has eight blue-LEDs which are controlled by the host in order to display the grasping nuances. The prototype of this instrument contains realtime visualizing system with chaotic graphics by Open-GL. I will report on the principle of the sensor, and details about realizing the new system.

Author Keywords

Tactile, touch, rubbing, mbed

ACM Classification

H.5.2 [Information Interfaces and Presentation] User Interfaces–Haptic I/O, H.5.5 [Information Interfaces and Presentation] Sound and Music Computing.

1.INTRODUCTION

The author has long been working in Computer Music and Media Arts - composition, performance, and developing new instruments [1]. In 2010-2011, the author developed a new musical instruments focusing on the concept of "untouchable" like multi-channel Theremin [2]. In contrast, this is a new approach with an emphasis on the opposite point of view; touching, treating and rubbing heavily with fingers. As previous research shows, it is well known that human interaction is sensitive and critical with hands, especially fingers [3].

2.PAW SENSOR

The "RT corporation" in Japan released the "PAW sensor" in 2014. The "PAW sensor" (fig.1-left) is a small PCB (size 21.5mm * 25.0mm, weight 1.5g) with a big cylinder of urethane foam on it.

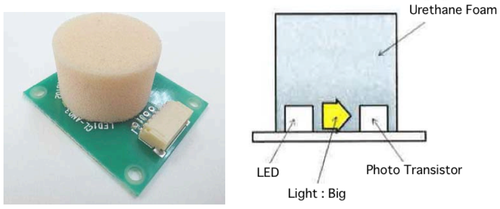

Fig. 1 PAW sensor (left) and low pressure case (right).

On the PCB connector (6 pins) there is a very simple signal assignment; GND, +3.3V power, two inputs for control of LED1/LED2, and two voltage outputs of Phototransistors Photo1/Photo2. Fig.1-right shows the PAW sensor with low pressure. The density of the Urethane Foam is low, so the light of LED strongly reaches the Phototransistor. Thus the output voltage of the Photo transistor is higher.

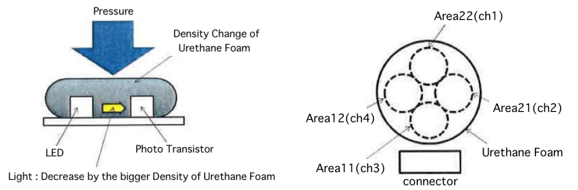

Fig. 2 High pressure case (left) and the virtual coordinates (right).

Fig.2-left shows the PAW sensor in the case of higher pressure. The density of the Urethane Foam is higher, so the LED light weakly reaches the Phototransistor. Thus the output voltage of the Photo transistor is lower. Fig.2-right shows the virtual coordinates system of the PAW sensor. Area22(ch1) is the output voltage of the Photo2 when LED2 is ON, Area21(ch2) is the output voltage of the Photo1 when LED2 is ON, Area21(ch3) is the output voltage of the Photo1 when LED1 is ON, and Area12(ch4) is the output voltage of the Photo1 when LED1 is ON. LED1 and LED2 are controlled time sharing - each ON time is 250us with 250us intervals for the setup/recovery time. So, the CPU will repeat these loops; "LED1 On, LED2 Off" - "both LED off" - "LED2 On, LED1 Off" - "both LED off" each with 250us.

3.THE 1ST PROTOTYPE

At first, I produced a prototype system of the PAW sensor with mbed - NucleoF401RE board. Figure 3 shows the system which is connected to a PAW sensor, and mbed-USB is connected to the host.

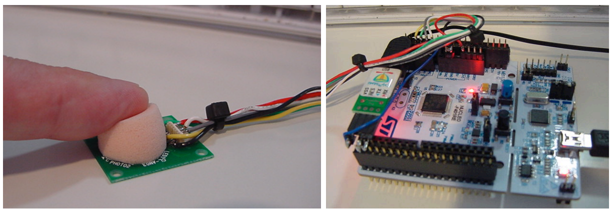

Fig. 3 The 1st prototype system of the PAW sensor.

After I completed the first experiment with the PAW sensor, I started to consider developing a new musical instrument. I gave this first prototype system [4] to a student in my seminar to produce her new installation work using this new technology. After checking both the demonstration YouTube movie and my sample Max patch, my student Mao Miyamoto started to consider the theme of her new installation work. The concept was "sexual touch/rub generates sexual voices". Because she had mastered my lecture "sound design", she started recording/sampling her voices with many styles of sexy situations at first. She was in the drama club in high school, so she could act out many situations.

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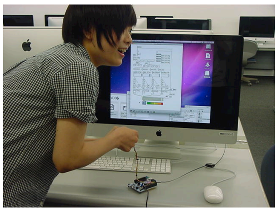

Fig. 4 Mao Miyamoto demonstrates her system.

She prepared many sound files of her voice with many nuances while acting with PAW sensor in many styles, the system changes the mixing balance of volumes and playback speeds with Max/MAP "groove~" object. Figure 4 shows the demonstration by Ms. Miyamoto [5]. In spite of the initial concept of "sexual impression", the final voices generated from the system seems "pretty" or "cute", if anything. This is the result of her own characteristics and cannot be helped..

4.THE MAIN APPROACH

In parallel with her project, my project for the PAW sensor was also started. My first impression was that I did want to use 10 "PAW sensors" for the ten fingers. If all sensors are placed on the same plane like a keyboard, the style of musical performance seems unnatural, because all finger tips must not move like a piano or organ. A cube or mechanical shape is also unnatural for fingers/hands to grasp. Finally I found an egg-shaped plastic container (Fig.5-left).

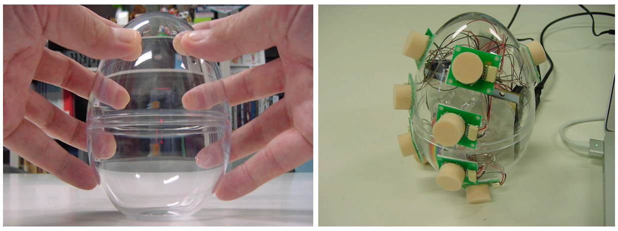

Fig. 5 The egg-shaped container (left) and MRTI2015 (right).

From a human palm shape, I disposed the sensor corresponding to the thumb on the front side, and placed sensors corresponding to the remaining four fingers vertically on the other side. I named the instrument "MRTI2015" which means - Multi Rubbing Tactile Instrument (Fig.5-right). The egg-shaped plastic container was a good size to contain the NucleoF401RE. However the USB-mounting (uploading) part had to be cut in the end. The egg-shaped plastic container was transparent, so I had an idea to contain the LED-based display inside the container. The eight blue LEDs did not face the outside directly. They faced the reflecting plate affixed onto the PCB.

5.SOUND SYNTHESIS

The output protocol from the NucleoF401RE serial port (speed=112500bps) is very simple, with mapping from the outputs of PAW sensors to MIDI control change message. Thus, all method of signal synthesis and graphic synthesis depends on the Max/MSP/jitter programming.

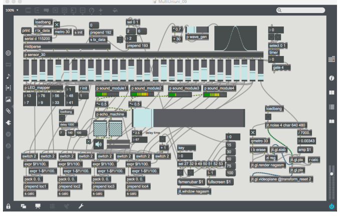

Fig. 6 The main Max7 patch of MRTI2015.

Figure 6 shows the entire screenshot of the host of MRTI2015, the patch of Max7. The NucleoF401RE has a maximum 16 channels of A/D inputs. On the other hand, the total number of the output voltage of 10 pieces of PAW sensors is 40 channels maximum. The thumb, index finger and middle finger have a richer degree of freedom, but the ring finger and little finger's movement in conjunction with each other, and their degree of freedom are less. So I assigned the information of fingers to A/D channels; 4 channels to both "thumb and index finger and middle finger" (total 12 channels), and 1 channel to each ring finger and little finger. Impressed by the 1st experiment using the PAW sensor, I decided to apply the "formant synthesis" based sound generating system for the MRTI2015. The system has four sound synthesis modules (4 voices), and the input information is scaled and assigned to the parameters for the "formant synthesis" function which is programmed within the "gen~" object.

6.VISUALIZATION

For this new instrument featuring the nuances of 10 fingers, I also decided to generate realtime graphics not using existing images or movies. I have been performing many original works of computer music as interactive multimedia arts, and I know well that the "relation and synchronicity" between the visual part and the musical part is very important for the audience. In the main patch of Figure 6, some outputs from the PAW sensors are connected to the realtime CG synthesizing block in jitter. I checked and arranged from the jitter-examples folder of Max, and finally programmed using a fractal/chaotic algorithm to generate 2-D grayscale realtime graphics. Figure 7 shows the example of changing images with slight changes of one parameter "depth" [6-7].

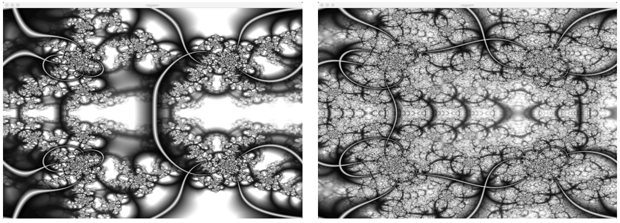

Fig. 7 Example of realtime CG.

7.FUTURE WORKS

Just now, the development of MRTI2015 has finished in hardware and in firmware. However, the system has great possibility to become an effective musical instrument with the development of the host program by "Max". With many experiments in my lab and at experimental demonstrations, I got many ideas and good advice to develop the final stage of this project. I intend to compose a new work for my Europe-Russia Tour in the summer of 2016.

8.CONCLUSIONS

This is a report of a novel tactile musical instrument called "Multi Rubbing Tactile Instrument (MRTI2015)", using ten pieces of "PAW sensor produced by the RT corporation". I reported the principle of the sensor, details about realizing the new system, and sound and graphics in order to create new media-arts performances.

9.REFERENCES

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[5] http://www.youtube.com/watch?v=8rwjmhaiNzs

[6] http://www.youtube.com/watch?v=Pju887HEJ7M

[7] http://www.youtube.com/watch?v=2SD84alrN1A