Technical Report

Interactive digital installation using various traditional musical instruments in kabuki for multiple participants

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Abstract
We developed and exhibited an interactive digital installation titled "Kabuku" for multiple participants at the outdoor square of the Kanazawa 21st Century Museum of Contemporary Art to provide cultural night tourism in Kanazawa city. Kabuku can intuitively express loop music with various traditional musical instruments used in kabuki. A laser range finder is used to recognize multiple participants. Images are projected on the floor surface. Approximately 85 % of respondents had a good impression of the projected image expression of our installation, and approximately 90 % of respondents had a good impression of the sound expression. This paper demonstrated that our installation could be well represented both visually and auditorily.

Keywords
interactive, installation, traditional performing arts, musical instruments, kabuki

1. Introduction

The number of tourists from the metropolitan area that visits Kanazawa has been increasing due to the opening of the Hokuriku bullet train since 2015. In Kanazawa City, "Promotion of stay type tourism" is listed as a pillar policy in the promotion event implementation plan[Kanazawa City, 2013]. As concrete policies, Kanazawa city has been promoting cultural tourism in the evenings in the form of a project titled "Kanazawa Night Museum." We have exhibited some interactive installations as part of the project at the outdoor square of the Kanazawa 21st Century Museum of Contemporary Art since 2014. Our works are based on Kanazawa's traditional performing arts such as Kaga temari [Obushi, 2018], Kaga yuzen, and gold leaf. However, despite the importance of sound effects, our works were biased toward projected image expression and interactive techniques. Efforts on auditory expression by sound were inadequate. This study devises a system titled Kabuku (Figure 1), which is compatible with visual expression and auditory expression. Our concept of work is that it can be enjoyed by numerous participants simultaneously based on the theme of instruments used in Kabuki, which is a representative Japanese traditional performing art. The instrument sound is outputted from the standing position of the gathered participants.

Figure 1: Kabuku exhibition

Kabuki instruments include various kinds of musical instruments, such as a small hand drum (Kotsuzumi in Japanese), large hand drum (Otsuzumi in Japanese), side base drum (Taiko in Japanese), wooden clapper (Hyoushigi in Japanese), and flute (Fue in Japanese). The auditory expression can be enriched using these various sound types. Through experiences of this work, participants can learn about kabuki's musical instrument, and have an opportunity to experience Japanese traditional arts.

2. Related work

PocoPoco [Kanai, 2011] is a new music interface. Anyone can easily compose a loop music by simple playing methods such as "push", "grasp", and "turn". It is a sequencer-type electronic musical instrument that can be intuitively operated even by participants who are not familiar with the complex interfaces of electronic musical instruments by expressing sounds with light and movement. Kabuku also expresses loop music as well as PocoPoco; however, we used instruments in kabuki rather than electronic sounds like PocoPoco. PocoPoco operates one interface with a single person, whereas Kabuku can be played with a group of participants gathering at a wide range of places and cooperating to compose music.

Sonodial [Kobayashi, 2013] is an interactive sound installation that recognizes participants using a Kinect sensor and expresses acoustic sound with intuitive interactivity. The shadow of the generated participants shows a visual expression that can be understood intuitively by projecting while changing its shape.

Vibracion Cajon 2.5 [Kanebako, 2014a], which is a percussion instrument, combines an expressive visual system using LEDs, allowing mutual communication through vibrations. This work can not only hear sound but also is visual and tactile in nature. Vibracion Cajon 3.0 [Kanebako, 2014b], which is a

new version, is an interactive installation with percussion instruments (Cajon) and floor projection with visual and auditory sensation. When the sensor attached inside the Cajon detects the timing and strength when hitting the Cajon, synchronizing with the rhythm, the vibration becomes stronger, and the corresponding image is projected.

3. Proposed system

Our system is developed from open source C++ toolkits "openFrameworks" for sensor processing, video rendering, sound output, among others.

3.1 System configuration

The system configuration is shown in Figure 2. The flow of the system is shown as follows.

- Measure the position of the participants using the laser range finder.
- Determine the area where the participants are located from the measured position.
- Compare the coordinates of the area where the participants are located and the white line flowing on the screen.
- While the participants are in the area, an animation is projected by the projector and sound is outputted by the speaker when the white line overlaps the area.

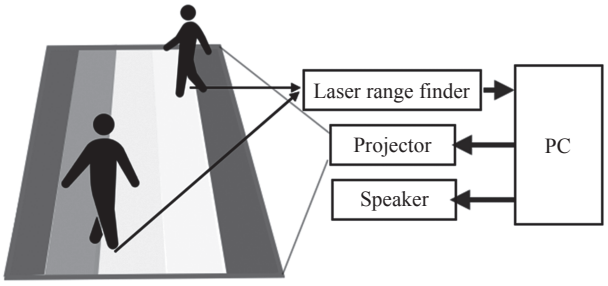

Figure 2: System configuration

Figure 3 shows the image when the projection screen is viewed from above. The screen is divided into a total of 20 areas of 5 × 4 and participants stand in each area in which various images and sounds are output. Musical instruments to be output are allocated the five divided vertical areas, and the timing of outputting each sound is changed by the horizontal area divided into four areas and the white line flowing on the screen.

The white line is set to continuously flow in the screen, such as 1 → 2 → 3 → 4 → 1 → 2 and so on. When a participant is not recognized normally, each area is projected in a light color. When a participant is recognized in an arbitrary area, the area is projected with a dark color. Then, when the white line flows over the dark area, the sound assigned to that area is appropriately output.

For the sounds used in this study, we adopted five instruments, namely a small hand drum, large hand drum, side base drum, wooden clapper, and a flute used in kabuki. A small hand drum pops sound. A large hand drum sounds sharp higher than a small hand drum. A side base drum beats at finer shorter intervals than small and large hand drums. A wooden clapper hits two trees. A flute is different from the four instruments, it maintains sounds of various pitches for a period of time.

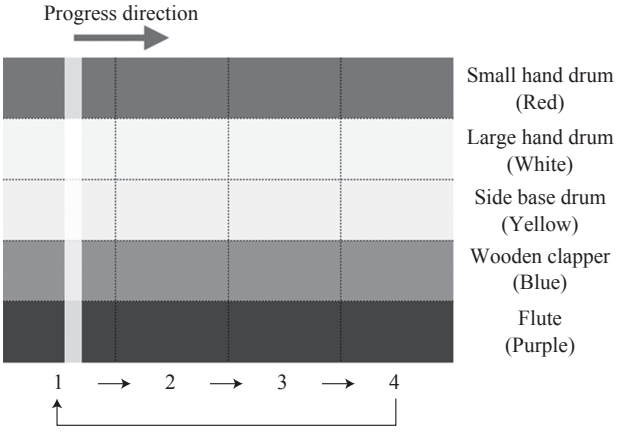

Figure 3: Projection image and sound effect

We purchased these sound effects in AudioStock. Basically, one sound source is used for each instrument. Since a whistle has more sound notes and a wider range of expressions, five kinds of sounds are randomly selected.

The floor is projected in five colors (red, white, yellow, blue, purple) of the kabuki's lid curtain and each instrument is assigned to a different color. In deciding the combination of colors and musical instruments, we associated the color from the tone of each instrument to achieve a good balance overall. A flue places edge since it only expresses melodies in five instruments. The three drums are placed in close proximity.

We implemented animations that spread ripples of the color from the area where the participants are recognized, and an animation that draws a circle using the magnitude of the frequency component by FFT analysis in real time.

A laser range finder, developed by Hokuyo, URG-04LX which has been conventionally used in computer vision of robotics, is used as the hardware for recognizing participants. Table 1 shows the main specifications of URG-04LX. As the

Table 1: Main specifications of URG-04LX

Power source	5V DC (USB Bus power)
Measuring area	20 to 4000 mm, 240°
Accuracy	20 to 1000 mm ± 10 mm
Angular resolution	0.352°
Light source	Semiconductor laser diode
Scanning time	100 ms/scan
Interface	RS232C, USB
Size (W × D × H)	50 × 50 × 70 mm
Weight	Approx. 160 g

software for recognition of participants, we use a background subtraction method which is compared with an acquired image and a background image in advance.

3.2 Projector setup

The usual floor projections were projected onto the floor surface by setting the projector at a high position or reflecting from a high place with a mirror. However, this work uses the ultra-short focus projector "RICOH PJ WX 4152" which is a mirror reflection type; this made it possible to project images directly from near the ground. This makes it easy to adjust the screen size and correct its position. With the old model "RICOH PJ WX 4151," it was not possible to project with a tilt or the floor by reflecting it with a mirror.

In the projection test, we projected from a height of approximately 60 cm above the ground; however, the area of the image projected on the floor surface is small, and it is unsuitable for many participants experiencing the work simultaneously. When we adjusted the height to make the projected area as wide as possible within the range where the sensor can recognize participants correctly, we observed that projection from a height of approximately 115 cm above the ground is the best. The projected area at this height was 360 cm in length and 620 cm in width (Figure 4). In this manner, we aimed at a project environment that allows more participants to enjoy it simultaneously by aiming at projecting images as wide as possible.

We summarized the outline of the work and the exhibition in a video and uploaded it to YouTube (https://youtu.be/EfbX6B-NFI4c).

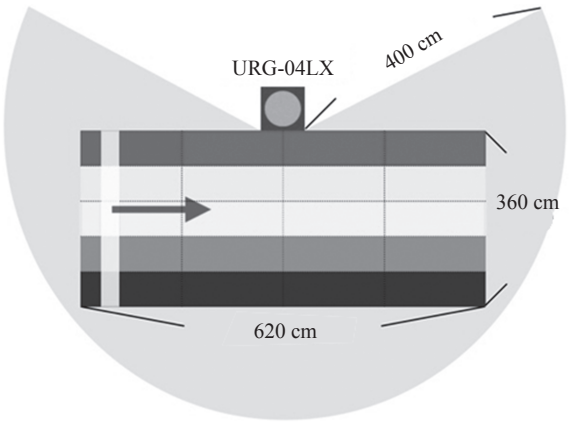

Figure 4: Projection size

4. Evaluations

We exhibited at the outdoor square of the Kanazawa 21st Century Museum of Contemporary Art on October 20th (Friday) and 21st (Saturday) 2017. According to Kanazawa city, the number of participants on the first and second days was 800 and 1000, respectively. There was a total of 1,800 participants, and 55 participants (26 men, 29 women) cooperated in the questionnaire over two days.

The first question was "How was the image expression of this work? (5-grade evaluation.)" The results are shown in Figure 5; 31 respondents selected excellent and 16 respondents selected good. Approximately 85 % of respondents had a good impression of the image expression of this work.

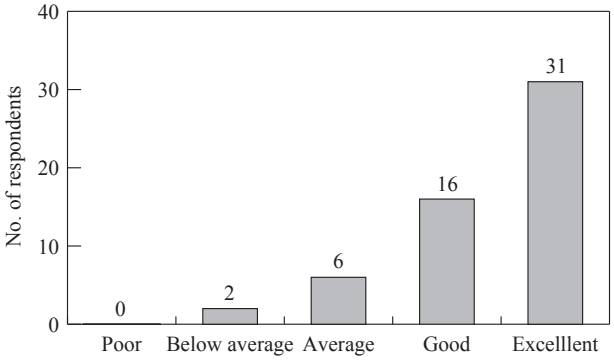

Figure 5: Questionnaire results of image expression

The second question was "How was the sound expression of this work? (5-grade evaluation.)" The results are shown in Figure 6; 35 respondents selected excellent and 15 respondents selected good. Approximately 90 % of respondents had a good impression of sound expression.

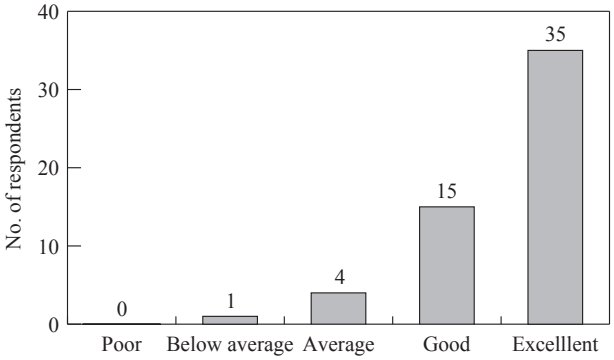

Figure 6: Questionnaire results of sound expression

The third question was "Do you think that you enjoyed this work more visually or audibly? (6 grades from 1 to 6, where hearing enjoyment is closer to 6, and visual enjoyment is closer to 1.)" The results are shown in Figure 7. Since the average evaluation value is 3.62, this work was enjoyed with a slight emphasis on hearing.

The results of the free-form questionnaires regarding the experiences of the work include "the condition of the light when stepping on the ground was beautiful", "the sound of the Japanese style rhythmically venue". Some of the participants did not know about the event, but rather passed near the venue; however, there were many participants who came to watch and became familiar with the music because they heard a Japanese-style sound from afar.

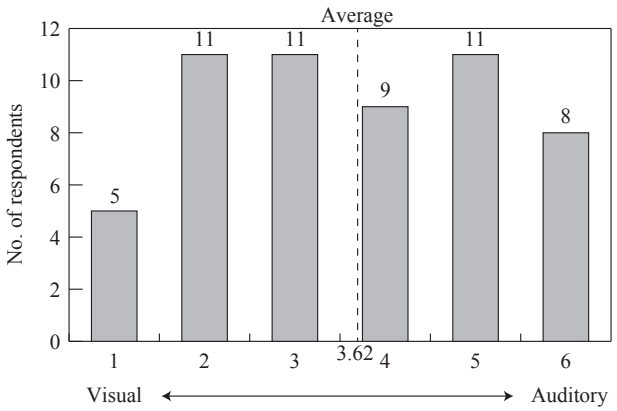

Figure 7: Visual and auditory questionnaire results

Participants who jumped at the moment when the white line came and participants who did not understand the system of the work without knowing the correspondence between the color and the musical instrument were scattered among the states of the participants.

At this exhibition event, participants wearing black shoes were not recognized well. The reason for this is the overlapping of the background subtraction method adopted as the participant recognition method for this time, and the night exhibition event. As a solution to this problem, it is now better to recognize other participants wearing black shoes, and thus it is better to improve the exhibition environment than to change the detection method. One way to achieve this is by placing a light source around the work. As a result, the background image acquired by the laser range finder using the background difference method becomes brighter (white) than usual, and the recognition of black shoes becomes easy.

A review point of the work is that it takes time for the participants to understand the system, such as the white line flowing on the screen, correspondence between color and sound of each area, and timing of sound output. After the event at the 21st Century Museum of Art, the following improvements were made to the system to solve these problems (Figure 8).

- Display the sound of the instrument for each area in the screen as text.
- Turn the white line flowing on the screen off and display the area brightly when the sound is output.

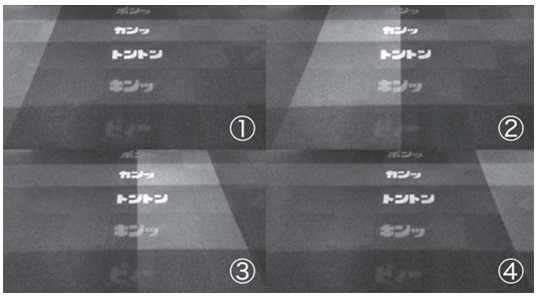

Figure 8: Improved projection image

5. Conclusion

We described the interactive installation “Kabuku” for multiple participants and its exhibition events in order to contribute to the improvement of the night sightseeing in Kanazawa city.

By adopting a laser range finder to recognize participants, this system allows people to enjoy it simultaneously within the range of the sensor. We increased the interactivity by changing the instrument output depending on the position of the participants in terms of sound by enriching the theme of instruments used in Kabuki. The questionnaire results show that this study could be expressed well visually and audibly.

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References

Kanai, T., Kikukawa, Y., Suzuki, T., Baba, T., and Kushiyama, K. (2011). PocoPoco: A tangible device that allows users to play dynamic tactile interaction. *SIGGRAPH 2011, Emerging Technologies Proceedings*.

Kanazawa City (2013). Bullet train opening promotion event implementation plan. https://www4.city.kanazawa.lg.jp/data/open/cnt/3/19525/1/promotion_event.pdf.

Kanebako, J. (2014a). Vibracion Cajon 2.5: Music-based experiment attempting to mutually transform various media and create new possibilities. *Annual design review of Japanese Society for the Science of Design*, Vol. 19, No. 1, 10-15.

Kanebako, J. (2014b). Vibraction Cajon 3.0. http://kanejun.com/works_vc3.html.

Kobayashi, R., Nishihachijo, K., and Muraoka K. (2013). Sonodial: An interactive sound installation using artificial shadow. *Transactions of the Virtual Reality Society of Japan*, Vol. 18, No. 3, 267-276. (in Japanese)

Obushi, N. and Koshino, M. (2018). Temari and shadow: An interactive installation combining virtual handicraft and real shadow. *Proceedings of VRIC’18*.

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