Fortune Air: An Interactive Fortune Telling System Using Vortex Air Cannon

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Abstract. In Japan, people visit shrines in order to pray for good fortune. By determining our fortune, we draw fortune telling paper slips called Omikuji. Omikuji contains predictions ranging from daikichi ("great good luck") to daikyo ("great bad luck") As a novel interactive fortune telling system, we propose "Fortune Air". By generating the adequate pattern of vortex rings with the smoke of the incense aroma according to a prayer's interaction, visual, olfactory and tactile feedback is realized. As a first step of this interactive system, we implemented a prototype of fortune air. For generating the pattern of vortex air rings, we use two air cannons placed side by side. Vortex rings shot by each air cannon make various patterns of air such as merging or repelling. We define four patterns of vortex rings and adapt them as special meaning of couple matching fortune telling system. In this paper we performed two basic experiments to determine the parameters of controlling the pattern of double vortex rings. From the results, we confirmed that distance of air cannons and combination of value of air pressure will increase the probability to generate a designated pattern though it is difficult to control all of the patterns of vortex air rings under everyday environment. Finally we made a fortune air system to evaluate the performance.

Keywords: Interactive air media · Vortex ring · Air cannon

1 Introduction

In Japan, people visit shrines in order to pray for good fortune. By determining our fortune, we draw fortune telling paper slips called Omikuji. Omikuji contains predictions ranging from daikichi ("great good luck") to daikyo ("great bad luck") As a novel interactive fortune telling system, we propose "Fortune Air". By generating the adequate pattern of vortex rings with the smoke of the incense aroma according to a prayer's interaction, visual, olfactory and tactile feedback is realized. In this paper as a first step of this interactive system, we implemented a prototype of air fortune. A user is able to see a fortune generated by two vortex rings according to his choice of a fortune stick. For generating the pattern of vortex air rings, we use two air cannons placed side by side. And vortex rings shot by each air cannon make various patterns of air such as merging or repelling. We define four patterns of vortex rings and adapt them as special meaning of

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couple matching fortune telling system. In this paper we performed two basic experiments to determine the parameters of controlling the pattern of double vortex rings. From the results, we confirmed that distance of air cannons and combination of value of air pressure will increase the probability to generate a designated pattern though it is difficult to control all of the patterns of vortex air rings under everyday environment. Finally we made a fortune air system to evaluate the performance.

2 Related Studies

2.1 Air Media

Generally, vortex ring is generated by a moderate size hole being punched out on one of the faces of a cardboard box, and the side of the box is struck, creating a mass of air that travels linearly while holding its shape. In other words, a vortex air cannon requires a container that has a circular hole, and can be easily built if there is a device to rapidly push the air out [1]. Vortex rings are also highly studied physically, and stability conditions and speed control can be designed according to the well known principles. In our previous research [2], we developed a small air pressured facial tactile display to generate another sensation for theater environment. By applying our previous knowledge, we developed two small air cannons placed side by side to control patterns of vortex ring for this research. As for interactive media system while being unobtrusive, air pressure is used for haptic interface. Suzuki et al. used air jet to give force feedback to improve realistic sensation when interacting with virtual object as an unobtrusive haptic display [3]. Sodhi et al. also developed a compact air pressured tactile display called aireal to give a haptic sensation on CG object to a game playing user in real world [4]. And as an unobtrusive aroma transmitter, vortex ring is used for an olfactory display transmitting aroma far to a targeting user while not diffusing it around the space [5]. In this research, we try to develop to control and create the pattern of vortex rings for physical message. This message is mainly existing visually but in the future the pattern will be used for multi sensory display integrating olfactory and haptic functions.

2.2 Ritual-Related Interactive Interface Design in HCI

In HCI field, we have often seen an interface to enhance the traditional rituals technically. ThanatoFenestra [6] is an interactive altar to change and control the photos of the deceased by a candlelight's movement and burning aroma (a metaphor of incense sticks), which are used for ritual in front of altar to pray for the deceased. This proposed system enhances interaction with the deceased. Our proposed system is not an replacement of an altar for family deceased but for public use. A prayer companion [7] was proposed as a design study for supporting prayers' life by providing RSS news feeds as a resource to the prayer activity to the cloistered nuns. This proposed system is an interface to provide updated news as a resource of the prayer activity for rather technically handicapped people such as cloistered nuns or elderly people. Our proposed device is not providing any social affairs but substitute a fortune telling written by text to a fortune telling predicted by air.

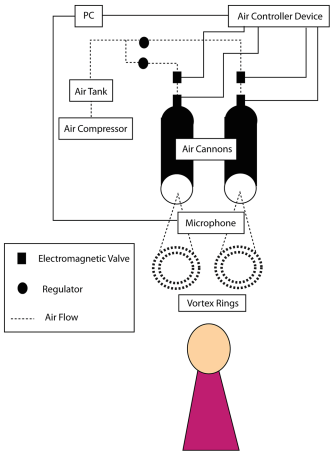

Fig. 1. Fortune air system outline

3 Fortune Air System Scheme

3.1 System Outline

Figure 1 shows system outline of the fortune air prototype. Two parallel air cannons generate two vortex rings by controlling four electromagnetic valves. Two electromagnetic valves are implemented in one air cannon. The one electromagnetic valve flows the compressed air to air container unit of the air cannon. And another valve flows the compressed air from the air container when to generate vortex ring. On and off of these valves are controlled by PC and arduino. Our hypothesis is that by controlling pressure value contained in the air container of each air cannon will change a behavior of two vortex rings.

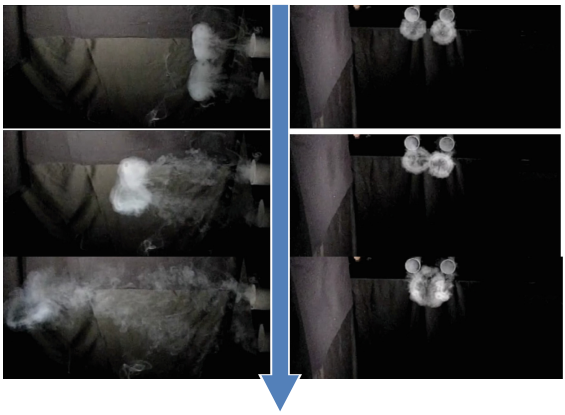

Fig. 2. Merging of vortex rings: side view (left) and front view (right)

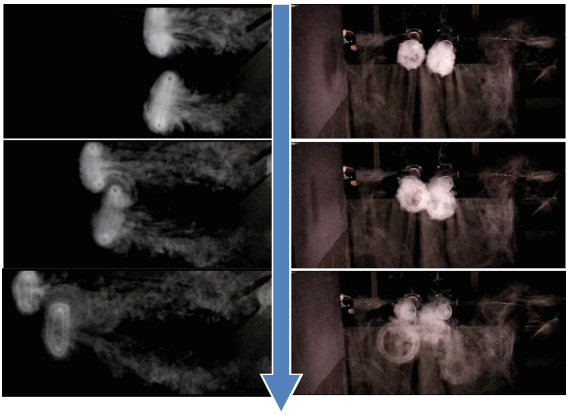

Fig. 3. Rebound of vortex rings: side view (left) and front view (right)

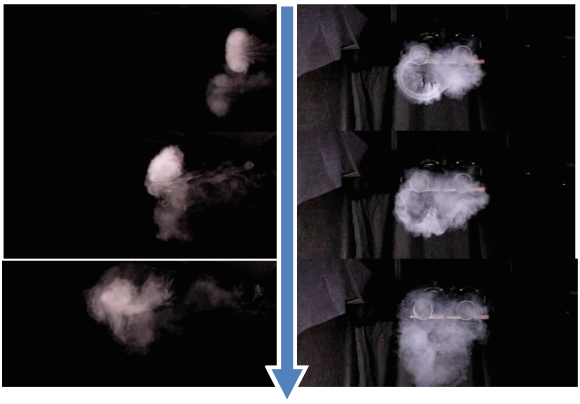

Fig. 4. Disappearance of vortex rings: side view (left) and front view (right)

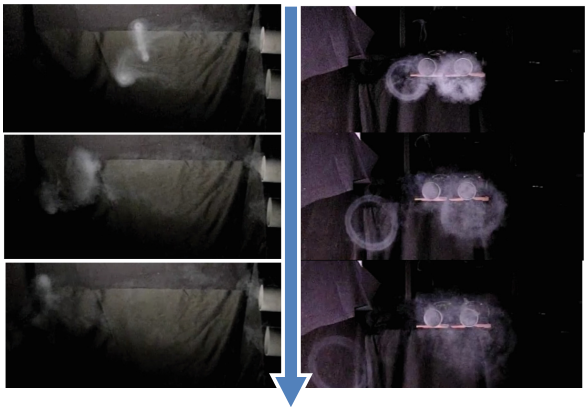

Fig. 5. One-sided disappearance of vortex rings: side view (left) and front view (right)

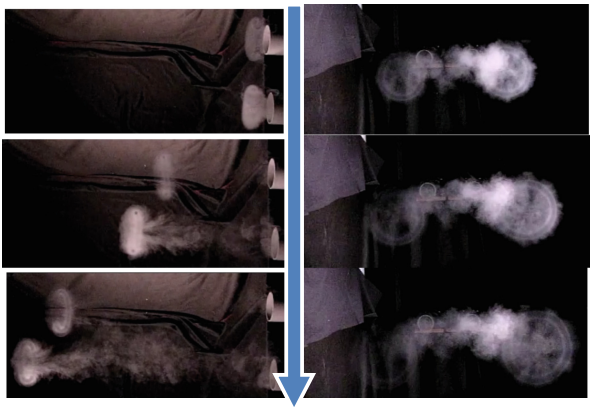

Fig. 6. No interference of vortex rings: side view (left) and front view (right)

3.2 Patterns of Translational Vortex Rings and Their Messages

It is known that translational movement of two vortex rings causes pressure decrease in between and then vortex rings approach each other. We did preliminary experiment to observe the patterns of translational vortex rings by changing air pressure value. We found that there are five patterns of translational vortex rings.

Figure 2 shows "merging." This is a merging of two vortex rings, which makes a large vortex ring. This proceeds slowly while straining in every direction. As this pattern combines two rings into one, we define it as "Good match." Figure 3 shows "rebound." This is a rebound of two vortex rings and each ring goes forward opposite direction. As this pattern acts repulsively, we define it as "Bad match." Figure 4 shows "disappearance." Two vortex rings disappear as they closely approach and rebound strongly. We define it as "Fade." Figure 5 shows "one-sided disappearance." One vortex ring out of two disappears as they closely approach and rebound.

We define it as "One-sided fade." Figure 6 shows "no interference." There is no interference between two vortex rings and each of them goes straight forward.

4 Preliminary Experiment to Evaluate Probability of Controlling Vortex Rings

4.1 Experiment 1

The five patterns of vortex rings we observed need to be controlled in order to make fortune air system. A pattern which is generated by two vortex rings is determined by three factors according to the previous researches [8]. Three factors are impulse volume, distance between air cannons and speed of vortex rings. Adequate interference of two vortex rings will occur by controlling the three factors. In order to observe how two controlled parallel vortex rings behave, we conducted the experiment. Figure 7 shows an air cannon we made for the experiment. A tank contains

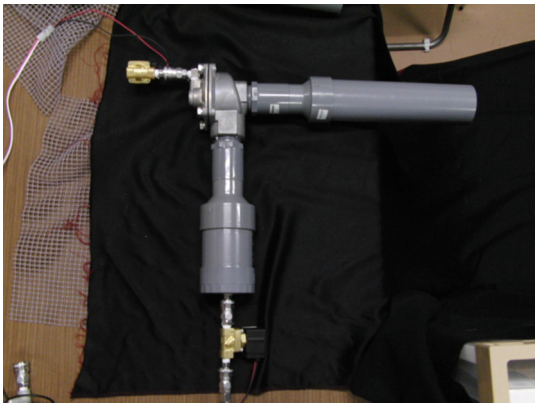

Fig. 7. Air cannon prototype

compressed air flowed from air compressor tank. Released diaphragm valve evolves compressed air and pushed air passes through a cannon with round surface, which swirls air and generate a vortex ring. From our previous research, we determined the parameter of the adequate length of a tube as 40.0 cm, which generates a vortex ring stably. And a diameter of the tube is 7.0 cm and volume of the air tank is 1077 cm3 [8]. For controlling the air flow, we used the diaphragm valve(VXFA23) manufactured by SMC. We found quite an amount of leaks of air with one of the valves. So we repaired it with rubber ring to prevent leaks. This may be impossible to transmit same value of air pressure from two air cannons, but we proceeded the preliminary experiment to observe the pattern.

Instead of controlling impulse volume and speed of air, we control value of air pressure. We tested with five kinds of pressure value; 0.04,0.055,0.07,0.085,0.1[MPa]. As for the distance parameter, we tested three kinds of distance of air cannons;

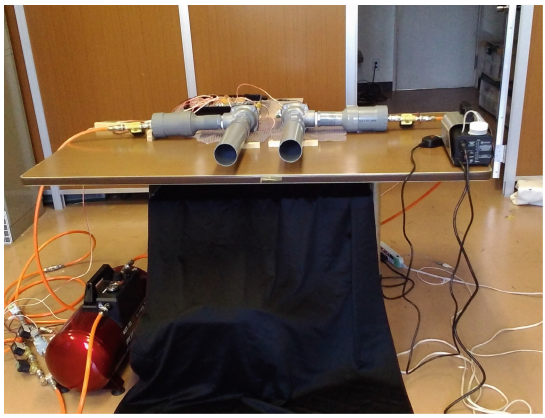

Fig. 8. Experiment settings

14.0,17.5,21.0 [cm]. We did 20 trials of each 15 kinds of settings and observed the pattern of generated vortex rings. Figure 8 shows the experiment settings.

4.2 Result

Tables 1, 2, and 3 show numbers of generated vortex ring of each pattern with controlled pressure value of each distance of air cannons. The result indicates that there is a tendency of generated pattern according to the distance of two air cannons as well as pressure value. But "no interference" appears comparatively high pressure with any distance. This is because vertical force of each vortex ring is stronger than the horizontal force which attracts each vortex ring. One-sided disappearance occurs under the condition of 0.055 MPa and wider distance (21.0 cm). The distance is adequate so that the vortex ring located in front pushes the one in back. As for merging and rebound, they often occur under the condition of 0.04 MPa without the relations to distance condition. This is because the horizontal force is balanced each other. The relative speed of each vortex must affect the generation of either pattern. As for the migration, two vortex rings approach with the same speed, which causes to generate a big vortex ring. As for the rebound, two vortex rings approach with a slightly different speed. As two vortex rings hit unevenly, no migration but rebound occurs instead.

The experiment confirms that slight difference of speed of two vortex rings determine the pattern of vortex rings.

Table 1. Numbers of generated patterns of vortex ring with 14.0 diameter cannons

14.0cm	0.04MPa	0.055MPa	0.07MPa	0.085MPa	0.1MPa
merging	10	3			
rebound	7	1			
disappearance	3	15			
one-sided disappearance		1			
no interference					
others			20	20	20

Table 2. Numbers of generated patterns of vortex ring with 17.5 cm diameter cannons

17.5cm	0.04MPa	0.055MPa	0.07MPa	0.085MPa	0.1MPa
merging	14	5			
rebound	6	2	2		
disappearance		8			
one-sided disappearance		1			
no interference				20	20
others		4	18		

Table 3. Numbers of generated patterns of vortex ring with 21 cm diameter cannons

21cm	0.04MPa	0.055MPa	0.07MPa	0.085MPa	0.1MPa
merging	5				
rebound	3	9			
disappearance	1				
one-sided disappearance		5			
no interference		1	18	20	20
others	11	5	2	0	0

5 Experiment to Define the Configuration of Air Pressure to Increase the Probability of Generation of the Designated Pattern of Vortex Rings

5.1 Experiment 2

From the previous experiment, we confirmed that the difference of speed affects the generated pattern of double vortex rings, especially merging and rebound. So as the next step, we executed an experiment to evaluate if it is possible to generate an intended pattern of vortex rings. In this experiment, we observe the pattern of vortex rings by changing the air pressure of each air cannon. In order to execute the experiment, we made new air cannons as Fig. 9 shows. Main change of the device was that we changed diaphragm valve of air cannon (VXZ260), which has less leak of air than the previous one. From the previous experiment, we determined the distance of two air cannons as 17.5 cm. This is because it was observed four patterns except for one-sided fade evenly rather than other two conditions. We also fixed the air pressure of one air cannon as 0.045 MPa. And we evaluated how the generated pattern changed among five kinds of air pressure; 0.04, 0.043, 0.045, 0.047, 0.05 MPa. We did 50 trials of each condition.

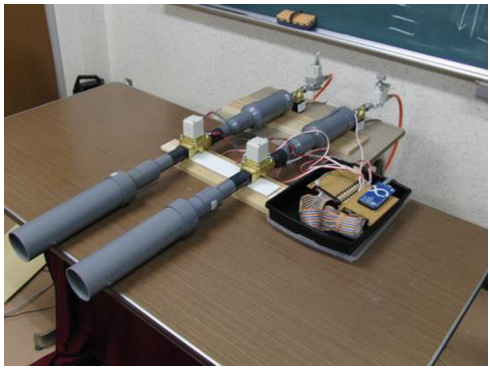

Fig. 9. Revised air cannons

5.2 Result

Table 4 shows the result of the experiment. Though we could not control the generated pattern exactly from controlling the level of air pressure but we found a tendency of generated pattern by combination of air pressure. Five kinds of patterns were able to be generated among the combination of either air pressure. Especially among three kinds of air pressure; 0.043, 0.045, 0.047 MPa, each merging, disappearance and rebound condition was observed one-third probability. From the result, we found the range of air pressures which are likely to generate merging, disappearance or rebound and no interference is highly generated by 0.04 MPa. And among the range of air pressure we tried, there were little generation of the pattern of "one-sided fade." It concludes that four patterns of two vortex rings are likely to be controlled by changing the combination of air pressure.

Table 4. Numbers of generated patterns of vortex ring

	0.04MPa	0.043MPa	0.045MPa	0.047MPa	0.05MPa
merging	2	4	17	25	2
rebound	6	17	21	2	16
disappearance	14	20	8	22	23
one-sided disappearance	1	3	4	1	1
no interference	26	6	0	0	8
others	1	0	0	0	0

6 Fortune Air Prototype System

We made a prototype system of air fortune especially for love matching. This interactive system tells four types of fortune by the pattern of vortex rings, good matching, bad matching, disappearance and no interference. Prototype system is shown in Fig. 10. A user pulls out one of stick fortunes, which was implemented different type of resistor in each stick. By putting the picked stick on the plate which has two conductive poles, the regulator changes its value of output voltage, which determines 7 air pressure value from the range of 0.04 to 0.05 [MPa] shot by an air cannon. The selected value of air pressure probably determines the pattern of vortex rings. Figure 11 shows stick fortunes and a plate.

The flow of the user interface is as follows;

a. A user pulls one of the stick fortunes and put it on the plate.
b. He does two bows and two claps and one bow performance, which is a traditional pray style at shrine in Japan and the system detects the sound of two claps and vortex rings are shot by air cannons.

This prototype system was demonstrated on February 28th 2014 at the conference site. About a hundred participants tried a fortune air and enjoyed the generated pattern of

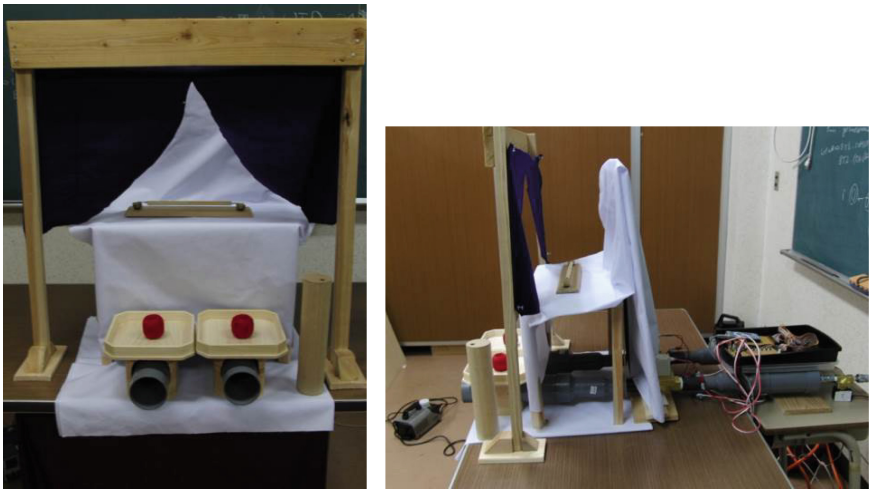

Fig. 10. Fortune air prototype: front view (left) and side view (right)

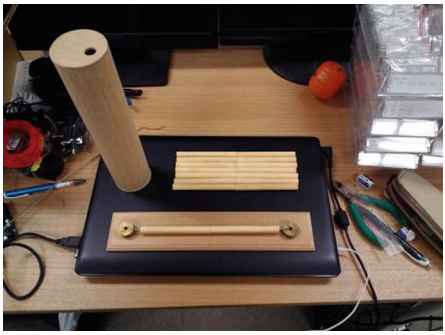

Fig. 11. Stick fortunes and a plate

vortex rings. Though it is difficult precisely control the pattern, we confirmed that this system is effective to enjoy the probability of the generated pattern as an entertainment system.

7 Conclusions and Future Works

In order to propose a novel interactive system called fortune air, we implemented a prototype of fortune air as a first step. For generating the pattern of vortex air rings, we use two air cannons placed side by side and vortex rings shot by each air cannon make various patterns of air such as merging air ring or repelling air ring. We define four patterns of vortex rings and adapt them as special meaning of couple matching fortune telling in order to make the interaction. In this paper we performed a basic experiment

to determine the parameters of controlling the pattern of double vortex rings and implemented the system for evaluating system performance of generating these patterns. And we tested its performance by demonstrating at the conference. We confirmed that it would be possible to make interactive fortune telling system by vortex rings. We will implement a camera tracking system to track the pattern of vortex rings so that the system will detect the pattern automatically.

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