판 [pán]

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Thesis

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ABSTRACT

판 [pán] is an interactive visual installation that facilitates a collaborative performance. It provides a space for delightful activities that invites the audience to participate in its synthetic movement. By interacting with a tangible 판 [pán] interface, the installation renders tabletops with a new aesthetic that is generative and organic. Interactive activities are interpreted as softened dynamics visually by a generic particle system algorithm. The three 판 [pán] interfaces are capable of network communication to form an interconnection among participants.

Keywords: Interactive Installation, Tangible Interface, Table, Particle System

I. INTRODUCTION

판 [pán] is an interactive visual installation that facilitates collaborative performance among multiple participants. The title of this work, 판 [pán], is a Korean word invoking several different meanings, such as: *plate, disk, place, stage*. On one hand, this word instinctively stands for a plate that corresponds to the interface of this work, but there is more meaning underlying this spatial definition. The Korean people set up public performance space for everyone to share and participate in delightful performances. 판 [pán] conveys all these meanings and accommodates these activities by providing a tangible interactive medium. Traditional interactive activities are visually interpreted with softened dynamics. Viewers approach 판 [pán] and feel its “life force” and are encouraged to participate in its synthetic movement.

A. Motivation

This section presents the original motivation of 판 [pán] and its initial design concept. At the very beginning of this work, there was only one simple idea that this will be a kind of interactive installation. Because the author was touched by many other similar works during his study and wanted to host audiences as part of the piece, an interactive installation is the most suitable form to this purpose. It was before this work was entitled.

Interactive Art can be distinguished from others forms of art in that it is a dialog between the piece and the participant; specifically, the participant is moved to not only view the piece but to also feel compelled to do something in the context of the piece [4]. From this

point of view, design concepts have been focused on the aspect of user's interaction. Since many interactive installations accommodate only a few people to interact with it at one time, other people become passive viewers or spectators. This idea led the author to think of how to provide more opportunities for the audience to enjoy the piece.

Essentially, the interaction of multiple users requires a certain environment that includes space, communication, and more lively activities so that people choose to interact with the piece. Therefore, the first motivation was to design a spatial performance and activity environment. This concept motivated the title of this work at a later time. The other motivation was a strong personal interest in bizarreness and abnormality. People usually expect what they know and experience. There is no wonder or curiosity in ordinary objects and phenomena. Innovation and novelty typically result from breaking expectations and clichés.

Figure 1: Friedensreich Hundertwasser, KunstHousWien restaurant, Vienna, 1989-1991

For example, the rectangular shape is the most dominant geometric element in the world. But Hundertwasser's irregularly tiled floors in a restaurant tried to break the universal preference of rectangular world (Figure 1) [2]. Most people usually expect grid alignments for

tiles and the arrangement of objects within for the cubic space. By deviating from this general notion, he could create very fascinating space. This idea provided another motivation for interface design. Additional details of how these primitive ideas drive the entire design of the 판 [pán] installation will be discussed in next chapter.

II. DESIGN

A. The meaning of 판 [pán]

While developing spatial concept of the project, the author thought of a cultural aspect of public activity. From old Korean tradition, people usually delight in performing or playing a public space. This tradition was a part of most people's lives for a long time. The title of this work, 판 [pán], has the most appropriate meaning for these activities. At the same time, this word invokes several different meanings, such as: *plate*, *disk*, *place*, *stage*.

Figure 2: Korean Folk Painting by Hong-do Kim

There are many meanings underlying the word's spatial definition. The Korean people set up public performance space in an area where many people would gather. In this space, people are encouraged to participate and enjoy the participation of others. People are invited to join and enjoy all together. Audience does not remain a viewer any more but becomes a player. This is much more active interaction. For instance, Figure 2 shows two examples of such activities. The left image is a performance of a dancing boy and some musicians. The

right image is a light wrestling match in a public space. In the past, these were the most common sights in a marketplace.

There are many of compound words including the word, 판 [pán]. One example related to activity and performance is '*Kut-Pan*' (a compound word with a show on a stage or in a public place). '*Kut-Pan*' means eating and playing together while temporarily forgetting about ordinary, tiring work. This idea came from old traditions during the agricultural age when these traditions stated that doing something together is the essence of the '*Kut-Pan*' [1].

Figure 3: '*Sa-mul Nolie*' - Korean Folk Performance of four musical instruments

'*Samulnolie*' in Figure 3 is a example of '*Kut-Pan*'. With several types of percussion instruments, players perform rhythmical music to cheer people up and encourage them to share the joy of life together. These diverse meanings of 판 [pán] converge onto its unique spatial and behavioral definition. This is the spirit of the 판 [pán] installation.

B. Interface & Interaction

The idea for the interface originated from another meaning of 판 [pán], which is a plate or table coupled with one type of traditional furniture. The spatial meaning of 판 [pán]

is more abstract in implication, but the other meaning here is more concrete. A table has a fundamental function— a stable piece of furniture that holds objects on its top surface. The next idea for the interface was to use table's physical shape but apply different functionality to it. This alteration could potentially attract people and could make this installation peculiar. The second motivation of this piece, abnormality and bizarreness, resulted from this alteration. Now, the design of the 판 [pán] interface as means of user interaction is in its first raw form.

Before providing more details about the 판 [pán] interface, it is necessary to explore the broader concepts of interactive art, physical computing, and tangible media. All these areas are fairly similar and have many of common approaches to human and computer interaction. Physical computing is about creating a conversation between the physical world and the virtual world of the computer. The process of the conversion of one form of energy into another is what enables this flow [5]. Professor Hiroshi Ishii treats this conversation or conversion as Tangible Bits. Following citation describes the concept of Tangible Bits.

> *Tangible Bits allows users to "grasp & manipulate" bits in the center of users' attention by coupling the bits with everyday physical objects and architectural surfaces. Tangible Bits also enables users to be aware of background bits at the periphery of human perception using ambient display media such as light, sound, airflow, and water movement in an augmented space [3].*

Tangible Bits is a form of data or information that flows between user and computer through *a certain physical interface*. In general, we call it input or output based on its

direction of flow. A table of 판 [pán] is this kind of physical interface. Many interactive art works include computers and sensors to respond to motion, heat or other types of input [4]. Computers and sensors are the gateway of the conversation, the conversion of energy, and the flow of Tangible Bits.

The design idea of the 판 [pán] interface is primarily to give life to a common table. This has two important meanings. One is to play a role of a gateway to communicate with an audience– basically a type of sensing. The other is to satisfy the meaning of 판 [pán]– a more active space for public activity. The vitality of the table interface has two separate approaches. One approach is that a table itself is alive, while the other is alive because of an audience's physical interaction and activity. The former can be achieved by giving a live visual effect on a tabletop. The latter is more close to the true sense of 판 [pán]. The combination of these two idea forms the interface of 판 [pán]. Therefore, the design concept is that user gives life to the interface by interacting with the table interface, and this performance becomes the live force of the space. Without an active audience, 판 [pán] is just another example of an ordinary table in space.

To accommodate more dynamic participation from the user, the 판 [pán] has a moveable tabletop. A user can actively incline the tabletop or spin it. Because the tabletop is the most dominant component of a table, it plays a role of sensing interaction and displaying feedback. Feedback of the user physical input appears as various dynamic forms of visuals on the tabletop. Typically, a user approaches the interface, grasps the tabletop, and plays with the tabletop. These interactions cause the visuals to appear. 판 [pán] has an interface that is

playful and controllable and can accommodate dynamic activity and interaction instead of one-way observation.

Another focus of the interface design is that 판 [pán] is not for individuals but for groups of multiple participants as they collaborate and perform within the space of 판 [pán] installation. The three 판 [pán] interfaces provide the ability for collaboration by utilizing network communication between them. The communication creates another level of dialogue— inter-presence and collaborative performance. The intercommunication of interfaces is important because the participant can recognize the presence of the activity of others within his or her sight through the visual feedback on tabletop even though participant does not watch others nearby. One can see his or her presence on the other interface too. This gives rise to another issue— the visual identity of each user. The next section will present more details on this issue.

C. Visual Design

The tabletop of a 판 [pán] interface is a space for the display of visual elements as we discussed in the previous section. It is also a moving part of interface. There are several dynamic characteristics of this tangible interface that include *touching, tilting, rotating, and restoring*. One good example of dynamic forms is '*Sang-mo Nolie*' (Figure 4), one act of a performance named '*Sa-mul Nolie*'. Performers wear hats with ribbons on top and move their heads actively. Ribbons fly in space and make beautiful forms like the ribbons used in rhythmic gymnastics. These ribbons are smooth and act as a free form of lines.

Figure 4: '*Sang-mo Nolie*' - Hat Ribbon Performance

The 판 [pán] installation receives its driving force from a user's interaction. As soon as participant inclines a tabletop, one can imagine changes of gravity on surface of table. The rotation of a table can also create angular acceleration on the surface. Suppose there was a ball on tabletop. What would happen when a user rotated or tilted the tabletop? The response of the ball would be prompt and continuous, and the trace of its movement would form smooth lines. Giving control of a ball to the user can provide the means to draw his or her attention to participate in the piece with delight.

The visual effect of a particle system is used to create 판 [pán]'s abstract dynamic display. Each particle system consists of many individual particles. Each particle has its own characteristics and moves independently of the other particles. Each particle in the system shares common attributes with the other particles so that all of the particles create a common effect even though each of particles moves independently [10]. This behavior and the outcome of particle system is perfectly coupled with the main concept of 판 [pán], which is the harmonious union of individuals in microscopic level.

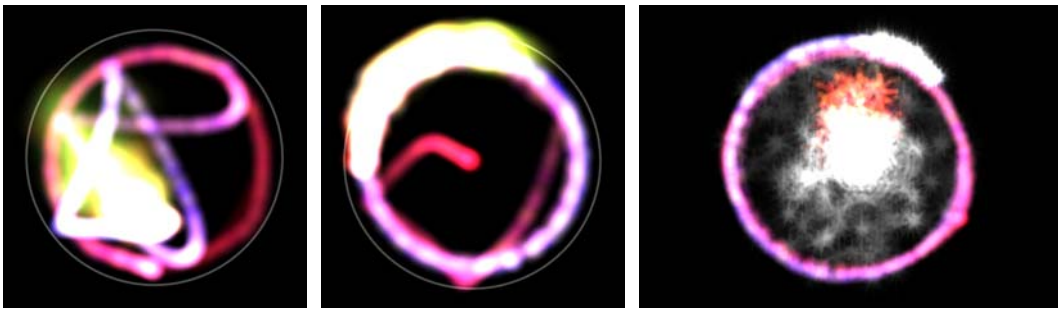

Figure 5: Early Prototype of visual component

Figure 5 illustrates the result of an early prototype of particle system. The first and second images in the figure show similar forms of the aforementioned ribbon performance. In this experiment, the concept of a rolling ball was used to move the position of particle generator or emitter.

Since we are using three 판 [pán] interfaces for multi-user interaction, we need to consider its visual identity. First of all, the visual element of each participant's tabletop should also appear on the others' tabletops. In other words, there will be three particle systems on one tabletop. Then, the question becomes how to differentiate each user's particle system. Within the above design scheme, one user who interacts with one of the interfaces can control only one of visual entity– the particle system. Therefore, the other participants control the other two visual entities. Here the user control means the status of tabletop that is changed by user. This is an ownership between interface, visual entity, and user.

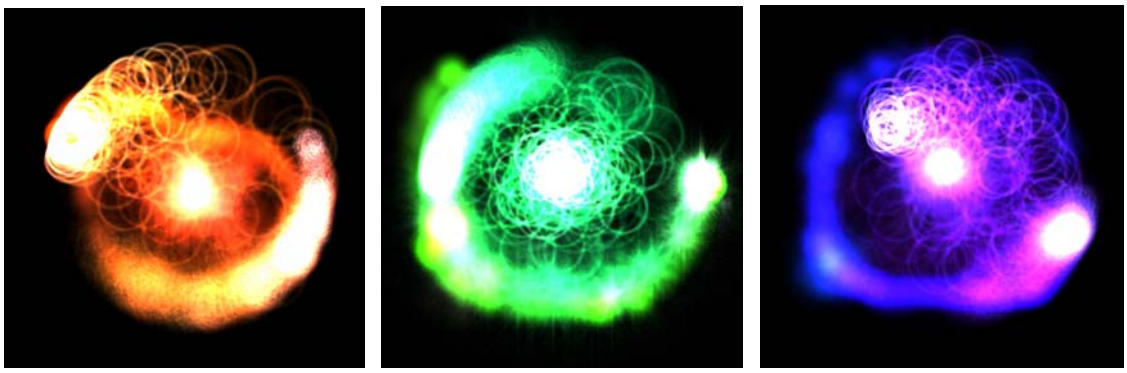

Figure 6: Final Particle System Screenshot (Red, Green, Blue color scheme)

The design of the visual identity has two phases. The first is the distinction between the three interfaces. The second is the distinction between the visual entities. Figure 6 shows the final design of the particle system including a visual identity factor. First of all, the three interfaces have different color schemes– red, green, and blue. This is an obvious differentiation that can be easily figured out even as users glance at each table. This satisfies the first notion of visual identity among interfaces. The second identity is established by different styles of the particle systems. We have three different types of particles in the final design– ring, flare, and glow texture.

One more interesting thing that remains is that the user is still uncertain which one is his or hers with the above two visual identities. The only possibility is to play with the 판 [pán] interface and figure out which one responds to his or her interaction. This is the core design concept of interaction and visual identity because this strongly encourages a user's participation and collaboration.

D. Sound Design

The 판 [pán] installation has two different types of sound effects. One is background music, and the other is a collision sound. Both sounds are also interactive based on the speed and the position of the particle emitter. As the emitter moves around faster, the volume of background music plays the louder. When the emitter collides and bounces against the edge of tabletop, system generates a collision sound.

Three different background music sources were sampled from the traditional Korean musical instrument performance named "*Sa-mul Nolie*" and then processed by sound software to distort or expand its playing time. Each sample corresponds to one of the interfaces and is distinguished by overall tones and the mood such as the sound frequency and the tempo. Speakers are embedded into base platform of the 판 [pán] interface in order to localize each sound rendering.

Many of the design aspects of 판 [pán] installation were covered in this chapter. The next chapter will present more details of installation and technical aspects.

III. INSTALLATION

A. Overview

The 판 [pán] installation has three table interfaces and uses ceiling mounted LCD projectors for visual rendering onto tabletops. Figure 7 shows a sketch of the installation. Each 판 [pán] interface uses one PC and one LCD projector to provide the best combination of performance and reliability.

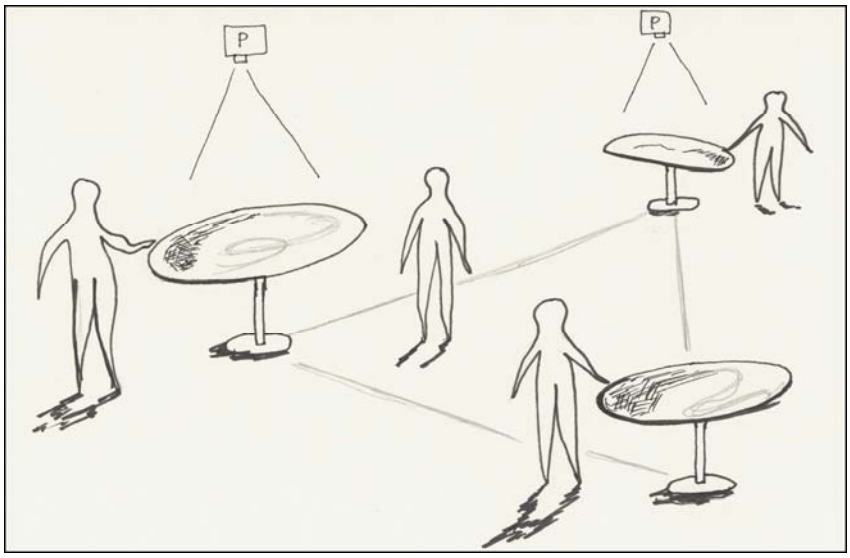

Figure 7: Sketch of Installation Overview

In order to best focus the attention of the audience in the exhibition space, all of the unnecessary elements are removed from floor. Computers, projectors, and all miscellaneous equipment are mounted on the ceiling. Therefore, there are only 판 [pán] interfaces on the floor and nothing else. The remainder of the space is for the audience members to enjoy the piece.

B. Interface

The 판 [pán] interface is the most important part of this project. It is carefully designed and crafted. Three 판 [pán] interfaces are equipped with a mechanical joint to make a top plate rotate and tilt at the same time while using a sensing unit to detect the status of table (e.g. the angle of the tilting and the speed of the rotation) being manipulated by a user.

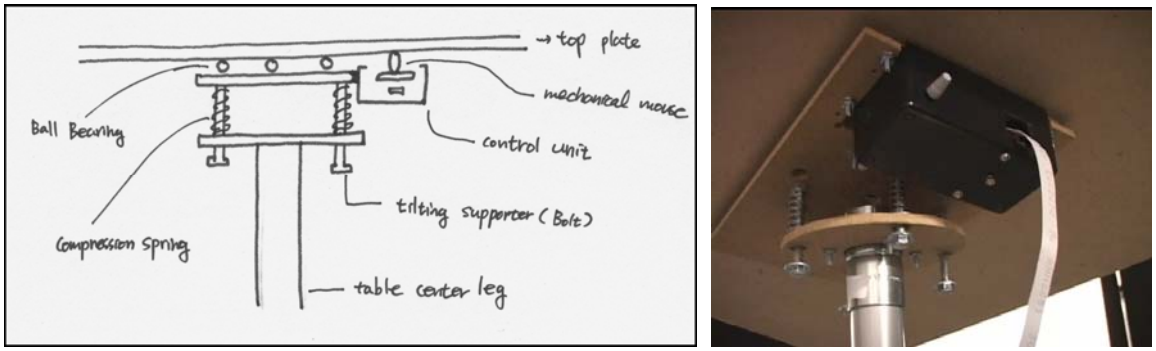

Figure 8: Sketch of 판 [pán] Interface Joint and Picture

Figure 8 illustrates the idea of the mechanical joint for the 판 [pán] interface. The base support plate of the mechanical joint uses four separate compression springs and poles in order to support a middle plate that has a sensor unit. A ball-bearing apparatus, similar to a Lazy Susan Bearing, connects the rotation that occurs in between the middle and top plate.

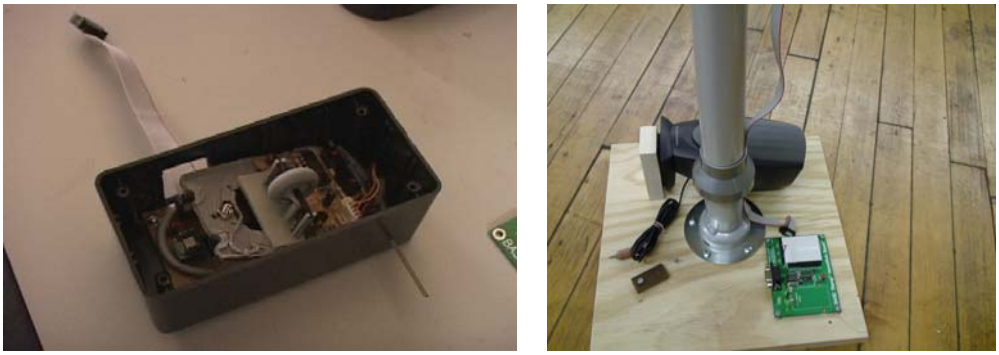

Figure 9: Sensing Unit and Microcontroller on Base Platform

The sensing unit has a two-axis accelerometer sensor (Memsic 2125, [10]) and a modified mechanical mouse inside (left image of Figure 9). Taking apart a common obsolete mechanical mouse can provide low-cost but quite reliable encoders to measure rotation [10]. The unit connects to the BasicStamp2 microcontroller on the base platform of the table interface (right image of Figure 9). The 판 [pán] interface also has small speaker on the base plate. All of the necessary communication and power cables connect to ten conductor ribbon cable that runs to a PC and a power supply.

C. System

판 [pán] has a PC that operates each interface, which includes three in total. They are communicating each other using a Fast Ethernet network. Each system is responsible for sampling interface status, computing dynamics, and generating visual and sound rendering. There are three PCs on the ceiling-mounted platform (Figure 10). By hanging the PCs, all of the cables, plugs, and power strips remain hidden. One disadvantage of this configuration is the difficulty of easily accessing controls such the PC power button in addition to the keyboard and the mouse. To prevent the problem of an inaccessible keyboard and mouse, an RF or Bluetooth cordless keyboard and mouse are used to control system remotely.

Figure 10: 판 [pán] installation system (three PCs)

D. Software

The entire application software of 판 [pán] installation is written in C++ and uses the OpenGL and OpenAL libraries. OpenGL is the premier environment for developing portable, interactive 2D and 3D graphics applications [6]. OpenAL is a cross-platform 3D audio API appropriate for use with gaming applications and many other types of audio applications [7]. Both libraries are free to download and provide an easy way to implement graphics and sound in an application written in the C/C++ language.

판 [pán] has two separate applications running on each machine. One is a sampling application, and the other is the main 판 [pán] application. The sampling application continuously reads sensor data and writes the data to a shared file. The main application reads this shared file to get the status of the interface as well as handles all the other computation. The reason why it is necessary to run a separate sampling application is to keep the rendering frame rate between 30 and 50 frames per second. This is because it is slower to sample the sensor data than to render audio and graphics.

The main application software performs the following jobs: reading data, computing dynamics, communicating over the network, and rendering the audio and the video. The most significant part of this application is the particle rendering system. The particle system is designed to provide a more generic method of forming individual particles. Each particle system can be defined in a text file format to specify its behavior and shape. At the execution time, the system loads this particle specification file and generates the visuals. Using this

generic algorithm, the application can generate an unlimited number of styles of particle systems, which creates a more organic form of visuals.

Figure 11: Primitive Texture of Particle (from left to right, Ring, Flare, and Glow)

Each particle element uses rectangular polygon and has a texture mapped onto it. Figure 11 illustrates this unit texture used in the final installation. In addition to texturing, the rendering algorithm applies alpha blending and vertex color to multiply hundreds of particles on the screen. These techniques are key to generate various organic visual styles. In the final application, about five hundred to seven hundred particles are rendered in a single frame, and the particle system populates about fifty to one hundred particles per second. This is only for one visual entity. Therefore, on one interface, there are about two thousand particles per frame.

IV. EPILOGUE

A. Show Description

The exhibition had been held from May 13 to 15 as a part of the Electronic Visualization MFA Thesis Group Show. It was a very successful show and had many visitors. Since this was the first exhibition of the 판 [pán] installation, this experience provided many lessons.

Figure 12: 판 [pán] Exhibition Overview

Figure 12 shows 판 [pán] installation in exhibition place. It was dark space for projection but bright enough to see others since there were three projector images that provided ambient light in exhibition space.

The show turned out to be very successful because many people enjoyed the 판 [pán] installation and were willing to play with it regardless of their understanding of the design philosophy. Throughout whole exhibition, two important observations could be made. One is how people know what they are supposed to do with the 판 [pán] installation. The other is an understanding of user's representation and collaboration with other participants.

B. Questions of Interaction

How do people know what they are supposed to do with this installation? When there is someone already playing with the interface, the audience can easily realize how it works because they can see what the current participant is doing. In this case, it was not necessary to explain how to use it. When someone is the only person at at the piece at a certain time without prior experience, the audience simply observes the piece and hardly touches the interface. Providing a brief guide that would encourage active participation could reduce this passive behavior.

This issue indicated that it was necessary to provide minimum guidelines or a description of the work before a participant approaches the piece. An appropriate desciption might be: "You may touch and play with the table." This description does not have to be provided only with text. Another option is the use of visual icons or descriptive images showing the moment of performance. This can be done easily done by taking a picture of a "model" participant. Otherwise, there should be always a person available who explains the work during the exhibition period.

C. Visual identification and Collaboration

Initially, participants determined the changes of the visual rendering after their interaction. This did not take such a long time. After this recognition, they tried to find out how they affect the visuals. The difficulty of this phase depends on whether there are people interacting with the other interfaces. If there is another person playing with the other interface, it takes some time to find the particle system that user controls because the other one or two particle systems are also moving around on tabletop. However, participants found their visual identity in several minutes. For a very inactive audience, it was necessary to give some hints such as the following: “Keep the tabletop inclined to one direction for a while and find which particle system is falling in that direction and staying there” and “Which particle system makes a trace of movement?” Then, they found their own particle systems. This is very exciting and meaningful moment— watching people’s collaboration and effort to figure out their individual identifications.

After identifying ownership on one interface, it changed to more fascinating stage. The audience started to look at the other interface nearby and ask: “What is going on over there?” Once they realized the capability of the network communication and visual synchronization of the 판 [pán] installation, users were much more willing to collaborate with others, show off their control, and watch for their inter-presence on the other tabletop instead of the one right in front of their eyes. Sometimes a participant asked the others: “Let’s move all to this side. Drive yours in this direction!” (Figure 13). It was very delightful for me to watch these audiences who tried to make more global changes on all three of the 판 [pán] installations.

Figure 13: Users' collaboration in exhibition

Despite various difficulties during the exhibition, the 판 [pán] had an outstanding performance. The original purpose of the design was fulfilled as people enjoyed 판 [pán]. People could feel the strong ownership and relationship among three interfaces and made a richness of performance with other participants.

V. CONCLUSION

In the work, 판 [pán] interactive installation, a variety of meanings of the word 판 [pán] were presented in addition to its design concept and the exhibition results. The richness of its meaning resides in its cultural characteristics.

- A spatial definition—

  It is a *place* where people gather, play, and share a feeling of solidarity.

- A meaning as collaborative activities and performance—

  Many instances of traditional performances are rooted in the abstract meaning of 판 [pán]. Essentially it provides the place for the public to enjoy and enrich their life together. It is a pure delight and joy of a community.

- A form of table interface—

  A table interface comes from the other meaning of 판 [pán], which is *plate*. It is designed to accommodate the audience's participation and collaboration by providing a capability of inter-presence and inter-communication among the three interfaces.

With this simple mechanism of interaction and interface design, one can successfully ascertain the possibility of the concept of 판 [pán]. The audience enjoyed the installation and led to many collaborative interactions.

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