

Dinner of Luciérnaga- An Interactive Play with iPhone App in Theater

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ABSTRACT

Interactive digital art in the field of performance is emerging as an increasingly important form of artistic expression in Taiwan. *Dinner of Luciérnaga* is an interdisciplinary project produced by more than ten talented members which include the director, dancer, choreographer, artist, interactive designer, sound designer, iPhone app engineer, image processing designer, stage designer and light designer. The goal of this project is to create new modes of interactive participation between the performers and audience through the use of an innovative iPhone application that links dancer to audience and audience to dancer. The application not only plays a key role in connecting the audience and dancer, but also uses an interesting sound generation application that enhances the spectators' experience. It creates and shares special interactive experiences. *Dinner of Luciérnaga* is a story about the relationship of light and human in the digital era. It is a stunning performance in visuals and interactive process with focus on new interface that are put into use in authentic environments for validation by audience.

In this paper, we will discuss our artistic motivation, the development of the digitally interactive performances, and our process for creating the digitally interactive performance entitled *Dinner of Luciérnaga*.

Categories and Subject Descriptors

C.2.1 [COMPUTER-COMMUNICATION NETWORKS]:
Network Architecture and Design-*Wireless communication*; D.1.7
[Programming Techniques]: Visual Programming; H.5.2
[INFORMATION INTERFACES AND PRESENTATION]: User
Interfaces-*Graphical user interfaces*; J.5 [Computer
Applications]: ARTS AND HUMANITIES-*Arts, fine and
performing, Performing arts*.

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General Terms

Experimentation

Keywords

Mobile art, Digital performance, interaction, iPhone App, Image Processing

1. INTRODUCTION

Dinner of Luciérnaga provides artists with an opportunity for pursuing bold new experiences that is enhanced by innovative iPhone application technology. Experimenting with a new form of mapping projection in combination with the use of the iPhone app allows for a more interactive experience for this performance. The audience will encounter and participate in the creation of spontaneous, visual and auditory art as individual spectators connect with the performance via the iPhone application. The performance piece entitled *Dinner of Luciérnaga* is well suited for this endeavor. In this performance, we create a story about "light," which is the source of all life in both nature and even artificially created environments. We need "light" to live.

The Dancers in this story elucidate a concept of solitude, which resembles the virtual world, and connect images of illusion with meditation.

2. ARTISTIC MOTIVATION

2.1 "Light" in life

"Light" is just there. Humans rely on the sun everyday. Without sunlight, life cannot exist. Those who live in the digital era rely on "light" just like our ancestors.

Human eyes are organs that detect light and convert it into electro-chemical impulses within the neurons. The simplest photoreceptors in conscious vision connect light to movement, just like a camera also captures images in terms of light. On a monitor, the electrical signals determine the images. These signals comprise of photons that exist amongst us on the Internet. Validating their own existence, they feed on "light" and are displayed on screens as a single pixel. Hence, "Light" is the medium for the reproduction of beautiful images via projectors, flat panel televisions, and LED displays. The stunning visuals and beauty of "light" are presented in many and various guises.

The detection and the capture of light by the human eye or camera lens, depends on physics and human physiological processes to differentiate colors. Physically, color is light at a particular frequency. When light refracts off the surface of a red apple, the “red” frequency is reflected while the other frequencies are absorbed. This causes the apple to appear red. The decoding of different colors by humans is then explained through physiology. When light is reflected off an object and enters the retina, nerves relay this information to our brain for processing. Our minds then interpret the information into images that are based on our experience and training.

2.2 Living by the “Light”

During the 80s, Fritz-Albert Popp, a professor of biophysics at the University of Marburg at the time, proposed that photons are the energy of life. He believed that when we eat plant foods, the light waves, or photons, in the plants are taken in and stored by your body. When we consume broccoli, for example, and digest it, it is metabolized into carbon dioxide (CO₂) and water, plus the light stored from the sun and photosynthesis. We extract the CO₂ and eliminate the water, but the light, an EM wave, must be stored. When taken in by the body, the energy of these photons dissipates and becomes distributed over the entire spectrum of EM frequencies, from the lowest to the highest. This energy is the driving force for all the molecules in our body. [1]

According to Popp, DNA stores “light waves” and uses them for energy. The waves are the driving force for every molecule in our body and a type of life energy. In this context, a “light wave” is more than just a carrier of an electromagnetic wave. Through data transmission, the wave fuels a system filled with its harnessed energy. It also becomes parts of our body.

2.3 “Light” in Digital Art

New media artists choose to work directly with light--which is also utilized as a reveal- along with the physical manifestations of light such as images or video projections. In a 1998 art piece entitled *Rapt*, we see how Justine Cooper scanned her body into a Magnetic Resonance Imaging (MRI) machine and later used the scans together with medical software to animate them into a haunting black and white video that takes us into the interior vistas of soft tissue. (Figure 1) Another example has to do with *Light in Forest - Heart's Core* by He-Lin Luo and I-Chun Chen. The art piece is an artificial entity of light that emits brighter light when awakened by a participant’s touch. When participants are not within the space of the piece and not touching it, the tentacles of the Light in Forest breathe lightly and rhythmically, revealing a semi-dormant state. When the participants enter and start the “Light in Forest” dance, their bodies respond to each of its dancing tentacles. In this circulatory system of a “semi-dormant method of breathing” and “exercise model for an awakened state,” the message of human existence is converted into visual symbols and control parameters of light. (Figure 2)[2] In Marie-Jeanne Musiol’s *the Radiant Forest: Energy Herbarium*, electro photographic imaging and Kirlian photography expose the magnetic fields surrounding different life forms and present an alternative view of our world. When observing the continuously changing light signals surrounding the living organisms, one no longer sees life in a static form. Rather, life is perceived as an open system or dynamic entity that interacts with energy fields. [3] (Figure 3)



Figure 1. Justine Cooper, 1998, *Rapt. RAPT II (1998)*, incorporates 76 slices/MRI scans to create Cooper's 10 meter long databody. See <http://justinecooper.com/>



Figure 2. He-Lin Luo and I-Chun Chen, 2011, *Light in Forest - Heart's Core*



Figure 3. Marie-Jeanne Musiol, 2011, *the Radiant Forest: Energy Herbarium*,” Electromagnetic Photography, Lightboxes and Video.

3. PERFORMANCES WITH MOBILE PHONE

3.1 Mobile Art

As mobile phones become cheaper, smaller, and more powerful, mobiles have become an increasingly important form of media and tool to facilitate art. From the earliest days of mobile art, James Buckhouse’s *Tap* in collaboration with Holly Brubach, was

commissioned by Dia Center for the Arts in 2002. He created virtual dancers that could be trained and exchanged in users' palms. [4] The utilization of mobile phones in public spaces is an emerging form of artistic expression nowadays. Mark Shepard's *Tactical Sound Garden* draws on the urban, community gardening culture to posit a participatory environment for new spatial practices and social interactions within technologically mediated environments. [5] [6]

3.2 Mobile phones as an interface in Theater

The use of digital technology has become more frequent within theater. The application of new media to performance is extremely diverse. Important digital performance subjects include virtual reality, liquid architecture, telematics, and surveillance. [7] Despite the ubiquitous use of digital technology in theatre, mobile phones are rarely used in performance. An inspiring example of the use of mobile technology in theatre is *Dialtones* (A Telesymphony, 2001), a project by artist Golan Levin. The production used ring tones to create a concert performance whose sounds were wholly produced through the carefully choreographed ringing of the audience's own mobile phones. The concert was presented at the Ars Electronica Festival in September 2001, and at the Swiss National Exposition in May and June of 2002. [8]

4. THE DESIGN THINKING OF INTERACTIVE TOOL AND PROCESS

4.1 An Interactive digital performance

How does one present the characteristics of real time interactive digital performance? How can the audience play a role in the performance? How can the audience become an essential element in a performance? The reason why we raise these three questions is because these questions illustrate an important point. Though there are many real time interactive performances that connect both audience and performers via images and a medley of apparatuses in other countries, interaction between the audience and performers is rare in Taiwan. However, the answers to these three questions aren't difficult to answer thereby implying that there is great room to create interactive performances here in Taiwan. Audience participation in theatre has a long history that begins with the 'Happenings in the 1960.' [9] In 1965, Robert Rauschenberg presented *Open Score* in the event named "9 Evenings: Theatre and Engineering." At this spectacle, two tennis players were given racquets with fitted, contact microphones. When the racquets hit the ball, the racquets picked up the reverberations produced by the sound of the balls. The sound triggered an automatic mechanism that shut off the 36 lights on the Armory ceiling one by one. Nearly 500 people then assembled on the stage where they were filmed by infrared cameras that had been set up on the balcony. Each participant was required to move around in accordance with ten memorized instructions provided by Rauschenberg. (Figure 4) [10]

Cultivating the spirit of our aforementioned predecessors, we embarked on a mission to create a new type of "interactive performance." In the beginning, we considered making a control instrument for each member of the audience. However, budgetary demands and insufficient capability of the control instrument rendered this solution impractical. According to the script, the apparatus necessary for the performance would need to be capable



Figure 4. Robert Rauschenberg presented "Open Score"

of taking photos, playing sound and animations, and connecting a wireless network that would then link to a server that would control images on stage. Also, it would be beneficial if the audience could bring a device into the theatre that they were familiar with and didn't require preparation on our part. To fulfill these necessities, we had to find a device that included said features. On the basis of the above criteria, we chose the iPhone as the interactive apparatus.

To use the iPhone as our interactive tool, we designed an application that could capture a picture, generate sound and receive commands. We define the function of captured pictures as the meaning of light capturing implement and optical storage. The sound generation function turns the iPhone into an instrument. The function of receiving commands helps execute broadcasting and animation broadcasting functions. With those functions, audiences can follow the instructions to execute artistic preferences and to receive data.

5. DINNER OF LUCIÉRNAGA

5.1 Light as metaphor

We use the term "Luciérnaga" as a metaphor to indicate how humans interact with light. Luciérnaga is symbolic in many ways. In Spanish, Luciérnaga means firefly. It also refers to the notions of you and I, information and instruction, as well as demand and hope. The "Luciérnaga" is a firefly, is light, is we. Therefore, the *Dinner of Luciérnaga* is a story of how light is a resource of energy resembling the role of food. The light is the key elements to construct a kitchen. It could be the cooking material and could be the dinner ingredient. At the end of the performance, the light in itself is a dinner.

In this performance, there are a series of light dots that represent the audience's response to the performers actions. The dancers respond to these dots by spontaneously, but smoothly incorporating this new set of stimuli in the performance. Inherent in this production is the interaction and inevitable tension between performers and audience. However, such a relationship spurs creativity and mutual understanding.

In order to facilitate this sort of interaction we had to create an interface named-"Luciérnaga" so the invited audience could enjoy this production. This simple iPhone application enables music generation, unique sounds due to an accelerometer, and the ability to capture light and images via camera. So that the audience can

fully participate with the performers, spectators must download the app from the iTunes App store prior to entering the theatre.

5.2 The scenario of play

The play includes five parts and is 50 minutes in length. The first part challenges the mobile phone connected and controlled platform. It is the initial basis of whole play. The second part shows the relationship between human and light. The third and fourth parts present one's solitude. The final part shows the collapse of the virtual world with paper scraps.

1. When members of the audience enter the theater, they will get a unique identifier printed on a piece of paper. Also, they are asked to access our wireless local network and save their unique identifier in the "Luciernaga" app. When the signal is connected, the audience becomes one of the light dots presented on stage. The audience members can control their own lights by waving the iPhone. Also, when the iPhone is waved, a unique sound is generated according to the direction and force of the shaking. In the app, there is one light ball that will change its size by analyzing the brightness of the photo that people took. The audience can send the message-- including the size of light ball-- to the stage by touching down on the iPhone screen. (Figure 5, 6)

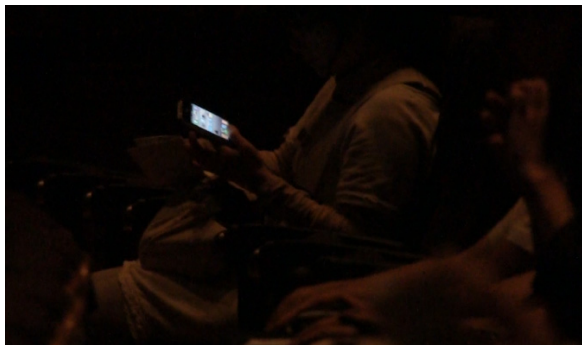


Figure 5. The audiences are interacting with their iPhone.



Figure 6. The light dots represent the audience.

2. After the interactive opening, the light dots are random and out of control as the dancer walks into the center of stage. The dancer starts to play with the light in the mode of push, adhesion and integration by using different body movements. The relation between dancer and light are conflicted. He plays with the light, but at the same time tries to escape from the light. (Figure 7, 8)



Figure 7. Dancer played with light, but also tried to escape from light.



Figure 8. The dancer was Inundated by light.

3. However, the light is proves to be inescapable. It becomes the elements to build up a kitchen. The dancer constructs the kitchen with the light and creates a blueprint kitchen. (Figure 9)



Figure 9. The dancer constructs a kitchen with the light and creates a blueprint kitchen

4. In the kitchen, the dancer cooks his own dinner while waiting for another to join him for dinner. Alas, no one came. (Figure 10) During the dancer's process of cooking, the audience would send commands to trigger the music clips stored in the audience's iPhone and dynamically control the parameters to create a special surround sound effect. The animation of creatures-- such as a cat or butterfly-- would

spontaneously appear and disappear on the stage and then appear in the audience's iPhone through wireless network. In this final scene, the dancers seem to walk into the audience's iPhone in terms of a virtual animation, and turned to be fragmentation.



Figure 10. Dancer cooks it owns dinner waiting for someone to have dinner with him. Alas, no one came.

5. Finally, the dancer is still having dinner alone, while the virtual world has collapsed. The virtual world continues to fall apart, while in reality objects of paper scraps are pouring down symbolizing the effects of the virtual world. (Figure 11) It symbolized that in deeper of our hearts, we always influenced and swing back and forth between the real and virtual worlds.



Figure 11. The world is falling apart.

5.3 Interactive performance experience with the iPhone

Generally, the audience watches a performance and receives messages passively from the digital image of performance. In this project, the audience sends messages to the digital image control apparatus in the performance and can therefore interact with the dancer using their mobile phones. To do this, we developed an iPhone app named *Luciernaga* that is available in the iTunes App Store. As we know, iPhone is with camera function. In some sense, it can use to capture light and storage light. In our performance, we adopt this concept and people can use this function to play the light ball showed on iPhone. In the theater, the audience can use their iPhone to take part in the performance. They can control the objects on the stage and generate special sounds to create a soundscape for the live performance. Therefore,

the *Luciernaga* app is a medium between audience and performance.

6. SYSTEM FRAMEWORK

6.1 Stage Design and Equipment Supply

Generally speaking, the projection is only used on the screen of the stage or the bottom of the stage. In order to increase the projection area on the stage, we use picture-frame stage design. (Figure 12) Each layer of the frame is marked to three different depths on the stage space. First, we used a paper model to explore the relationship among image, stage, and dancer.

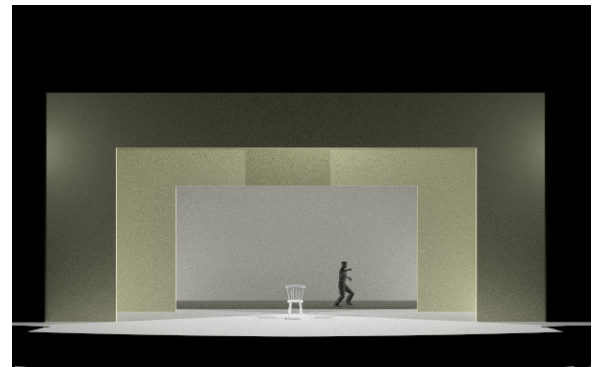


Figure 12. This paper model simulates the stage design.

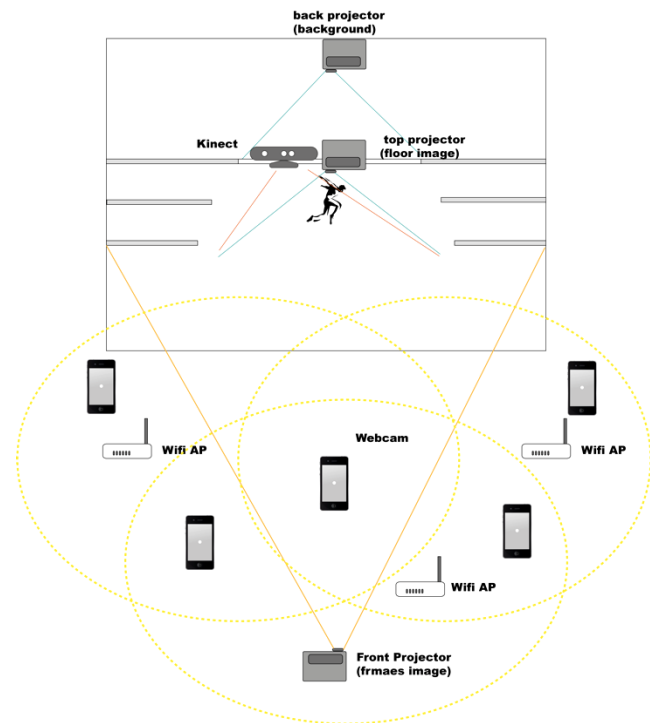


Figure 13. The hardware installations for image display set on the stage and auditorium in theater.

Overall, there are three projection areas on the stage. They are the floor, background screen, and frames. In order to avoid the shadow of the dancer on the background screen, we set the back projector on the stage. Three projectors are connected to three computers separately, but in a synchronized operation through internal LAN. (Figure 13) Each computer sends and receives simultaneously. Therefore, even if the background screen and frames use different projectors, the animation of the image is linked.

6.2 Luciérnaga App for iPhone

The Luciérnaga App is an iPhone application developed by openFrameworks and utilizes PureData for audio synthesis. It is a sound production application that allows spectators to use the camera and motion sensor in iPhone to generate a special sound. We analyze the captured pictures to change the size of the light ball based on the brightness and adjust the sound frequency based on the size of light ball. (Figure 14) The app can generate a unique sound depending on the different gestures and accelerometer values. The sound generation algorithm is shown in Table 1.

There are two hidden functions activated by using a trigger from Luciérnaga Server. One is sound creation and the other is animation. For sound creation, we have one professional sound artist who is responsible for controlling the soundtrack in the live performance. Through our system, the artist can use a DJ controller to send some commands that activate all iPhones in the audience. The designed sound clips were already part of the app and the artist can easily decide which sound clip and at what volume he wants a clip to play at any given moment. For animation, the audience can interact with the performance unexpectedly. There is one scene that shows animations such as a running cat or a flying butterfly appearing in the projection screen on stage. When the animation disappears on the big screen, the system will send messages to the users' iPhones to trigger the corresponding animation via our server in a wireless local network.

In the theater, we arrange eight zones for the iPhone users. Based on their unique identifier, we can know accurately determine their positions since the connection is built up. With our wireless local network, we can send different commands to activate different sound effects or trigger different animations on the users' iPhone that correspond to the scene (Figure 15) In the performance, the artist can control all connected iPhones to create different sounds at different volumes or orders in different zones. The sounds from the different zones are then synthesized into a melody. This process brings a unique sound experience for the audience and the overall performance.

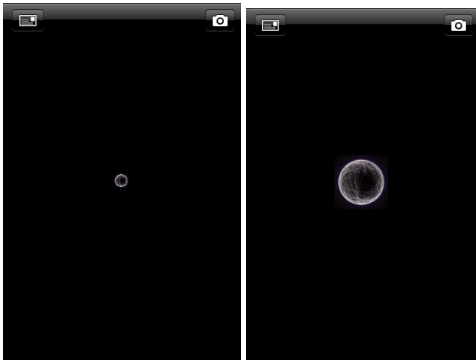


Figure 14. Capturing pictures to change the size of light ball.

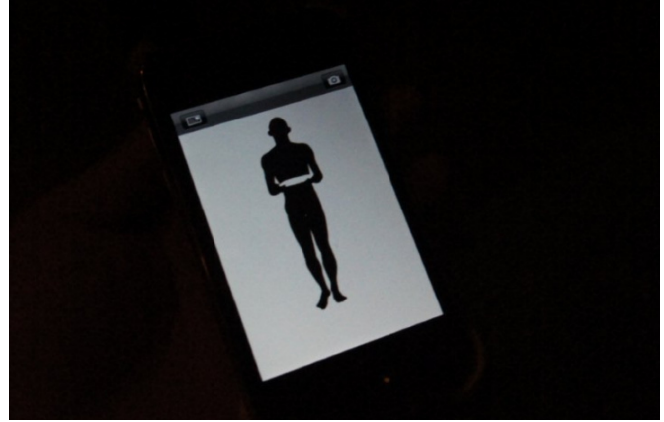


Figure 15. Animation will be triggered during the performance.

INPUT: accelerometer data x, y, z and $ball_size$ from user
volume and Q from server

OUTPUT: special sound

Q is a parameter sent from server

x, y, z and $ball_size$ are sent from user by iPhone
 α and β parameters.

$f(x), g(y)$ and $h(z)$ are linear functions.

τ_1 is a constant value for delay time.

θ_1 and θ_2 are parameters used in filter.

Function *SoundGenerator* ($x, y, z, ball_size, volume, Q$)

Begin

sound = *BandpassFilter*(sound, Q)

modulator_delay = $\alpha \times (1 + \sin(y))$

sound_delay = *Delay*(sound, modulator_delay)

gain = $\beta \times (|f(x)| + |g(y)|)$

modulated_faded = *LogarithmicGain*(sound_delay, gain)

effect = $h(z) \times \text{Delay}(\text{modulated_faded}, \tau_1)$

mix = modulated_faded + effect

mix₁ = *LowpassFilter*(mix, θ_1)

mix₂ = *HighpassFilter*(mix₁, θ_2)

mix_compressed = *Compressor*(mix₂, δ)

new_sound = *LogarithmicGain*(mix_compressed, volume)

return new_sound

End

Table 1. SoundGenerator Algorithm in iPhone

6.3 iPhone Wireless network control

We set up a local wireless network with three wireless access points and arrange them in accordance to the 8 different zones in the theater. In order to make sure the stability of the signals are strong enough and the bandwidth sufficient enough to connect with 96 iPhones, we set three AP with Wi-Fi signals in the auditorium arranged in a triangle. Open sound control protocols are used to communicate with each other. This type of system framework can synchronize the visual generation, sounds, and

iPhone control. Therefore, there are two key components in our framework. One is the Luciérnaga Server and the other is the Luciérnaga app.

The Luciérnaga Server is a control server written by Processing. It can monitor the statuses of the iPhone and send commands to online iPhones to activate different events during the different scenes in the performance. Luciérnaga Server has a control panel that displays the online status of users launching the Luciérnaga app. Figure 16 is the screenshot of the control panel of Luciérnaga Server. The top left of the panel shows the current status of performance. The bottom left of the panel shows the iPhone online/offline status corresponding to the user's seat position in the theater. The Black color means that the user is online and the white color means the user is offline. Each position has a unique identifier and the user can connect to the server via the app. The seat position indicators will change from white to black when the seat owner successfully connects to server. The seat number correlates to different zones. There are five buttons on the top right panel to send some commands to the Luciérnaga app via OSC protocol in a local wireless network. Through the server, we can utilize the physical sound controller to change the volume of each iPhone. We can also adjust the volume for iPhones in different zones.

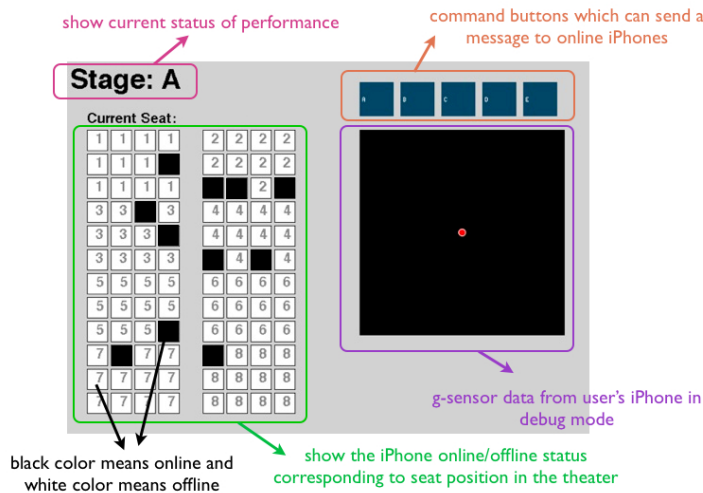


Figure 16. The control panel of Luciérnaga Server

6.4 Real-time image processing

Based on the stage design, we use a number of design principles. Firstly, each layer of the frame will be treated as an independent display. (Figure 17) Secondly, the image on the stage is specially designed according to the depth of the space and the scenario of the play. (Figure 18) Thirdly the three-frames are regarded as one.



Figure 17. The visual elements are generated and stacked within the first frame.



Figure 18. The projection of the kitchen is mapping the depth of the space to each picture-frame.

We generate real-time animation by using an open source programming language called Processing. In the scene with the light ball game played with the iPhone, we use Processing to create over 96 balls in advance. Before the iPhone is connected on the Wireless Network Server, the movement of the balls is randomly control by Processing. Control will be transferred when the Wireless Network Server broadcasts the on-line ID of iPhones to Processing through OSC protocol. The audience can control where their ball passes through in the different projection areas. Each Processing program between computers that connect with the projector is also connected through the OSC protocol. (Figure 19)

We used 3D Project Mapping for visual animation design in order to enhance the immersion of the picture-frame stage. The physical engine of the Processing libraries creates boxes, eclipses, triangles stacked in a particular projection space. The 3D kitchen, in line with the frame structure, is constructed on the stage and rotates to follow dancer's movements. The dancer can open the fridge in the left side of the second layer of the frames and turn on the tap in the left side of the background screen.

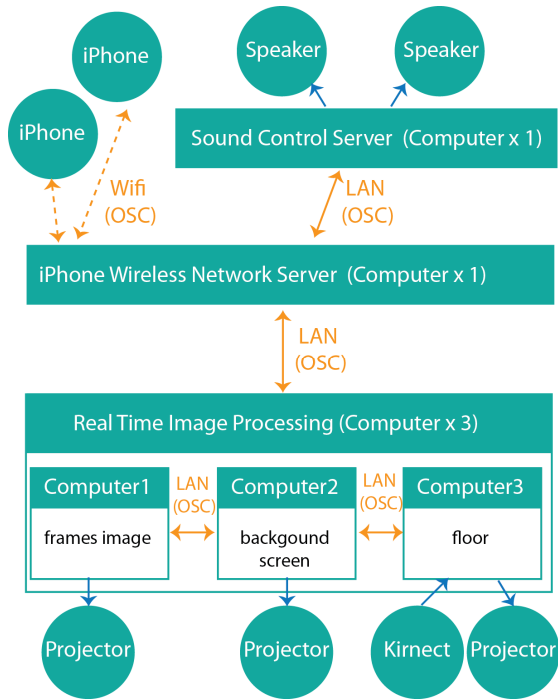


Figure 19. The software connection delivers the signals among each kind of hardware.

6.5 Motion Capture on the Dance and Choreography

The whole performance of *Dinner of Luciérnaga* is done through only one dancer on the stage. In order to create better translation of actions into an image, a Kinect sits upon the dancer to detect movement and to get positional information. All the image effects are real time determined by the dancer movements. The Kinect Program design has two modes. One is to detect the dancer's displacement then convert it into the acceleration, the x-axis, and the y-axis in Processing. Another is to capture the depth data of Kinect that reflects the dance movements such as floor work or jump. These data values for the variables can be used to generate the image color, shape, quantity and size in Processing.

The interaction between dancer and the projection image occurs mainly in the construction of the virtual kitchen scene. In the beginning, the dancer is in a position to "collect" the light ball generated by the audience's iPhone. The light ball will move around the dancers. A special action is then set up – one leg elevation and then fall – in this part of dance to centralize the light ball. In this process, the light ball gradually becomes sticky then finally transforms into a group of lights. In the next part of dance, the dancer needs to create the kitchen components with the light group. Therefore, this choreography is a combination of the seven methods of measurement that include angle, length, number, depth, frequency, brightness, and weight. The element of motion capturing is important to consider when each measurement of action is designed. For example, the angle variables in the programming are controlled by the three-points that are detected from dancer's hands and body. When the variables change, the image on the stage will change immediately.

7. THE CHALLENGE AND USER EXPERIENCE

7.1 The challenge

The project had three challenges. The first challenge is to get the Luciérnaga App on the app store in time. We distributed the Luciérnaga App only one day ahead of when the show began. The second challenge is that we only had four days to work in the theater which included setting up the stage, positioning the projectors and Wifi control system, system testing and rehearsal. Before work in the theater began, we didn't have a chance to integrate whole parts of the performance, since we didn't have the rehearsal space. In the morning of final day, we were still testing the system, programming the images and adjusting the light design.

The third challenge was in helping the audience to understand the interactive process. Since there were 8 different zones, the audiences needed to find seats according to the login identity number and log on to the Luciérnaga Server. The audience also needed to turn on the phone and turn the volume up during the performance. The audience also had to learn to use the app. We recruited volunteers to help and instructed the spectators as they arrived.

7.2 Response from the audience

Overall, the audience enjoyed the production. After entering the theatre and connecting to the server, the spectators enjoyed seeing the light dot on stage. Members of the audience began sway their iPhone to create sound. When the iPhones were swayed in different angles and speed, different sounds were produced, and the light dot began rolling. Also, they were surprised to see a cat or butterfly show up on the screen of iPhone later in the performance. However, members of the audience were confused and uncomfortable when the iPhones were turned on and the volume turned up at certain scenes even though the spectators were told this info. The second issue is that not all members of the audience had an iPhone. We were told that we should create a Luciérnaga app for a android phone. However, one spectator said that she very much enjoyed the show even though she didn't have iPhone. She was surprised when she saw the images and heard the sounds coming from the other iPhones. All the spectators enjoyed the show. The scenes of the projected images were significant and the stage design was simple, but beautiful. The dancer as choreographer, developed a performance that resonates with the emotional anxiety of humans nowadays.

8. CONCLUSION

In terms of the iPhone application, the audience uses it to capture the light and get interaction in this performance. It symbolizes that this procedure have the audience into part of the light, and invite them to capture, explore, and believe the existence of the light. In doing so, we in turn, validate our own existence and that of our world. The main theme of the performance – Luciérnaga is to investigate the nature of the light, and study how people build the immersive relationship with the light.

In the working process, we are in a search for new communication styles and new forms of theatrical expression. When you enter the theatre hall with an iPhone, you become a part of the performance. You are not just a viewer, but become one of the performers, creators, and actors. The interactive process through the iPhone is an experiment. With personal interface, we wish to create a brave, new theatrical experience.

9. ACKNOWLEDGMENTS

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