# International Journal of Asia Digital Art and Design

# Contents

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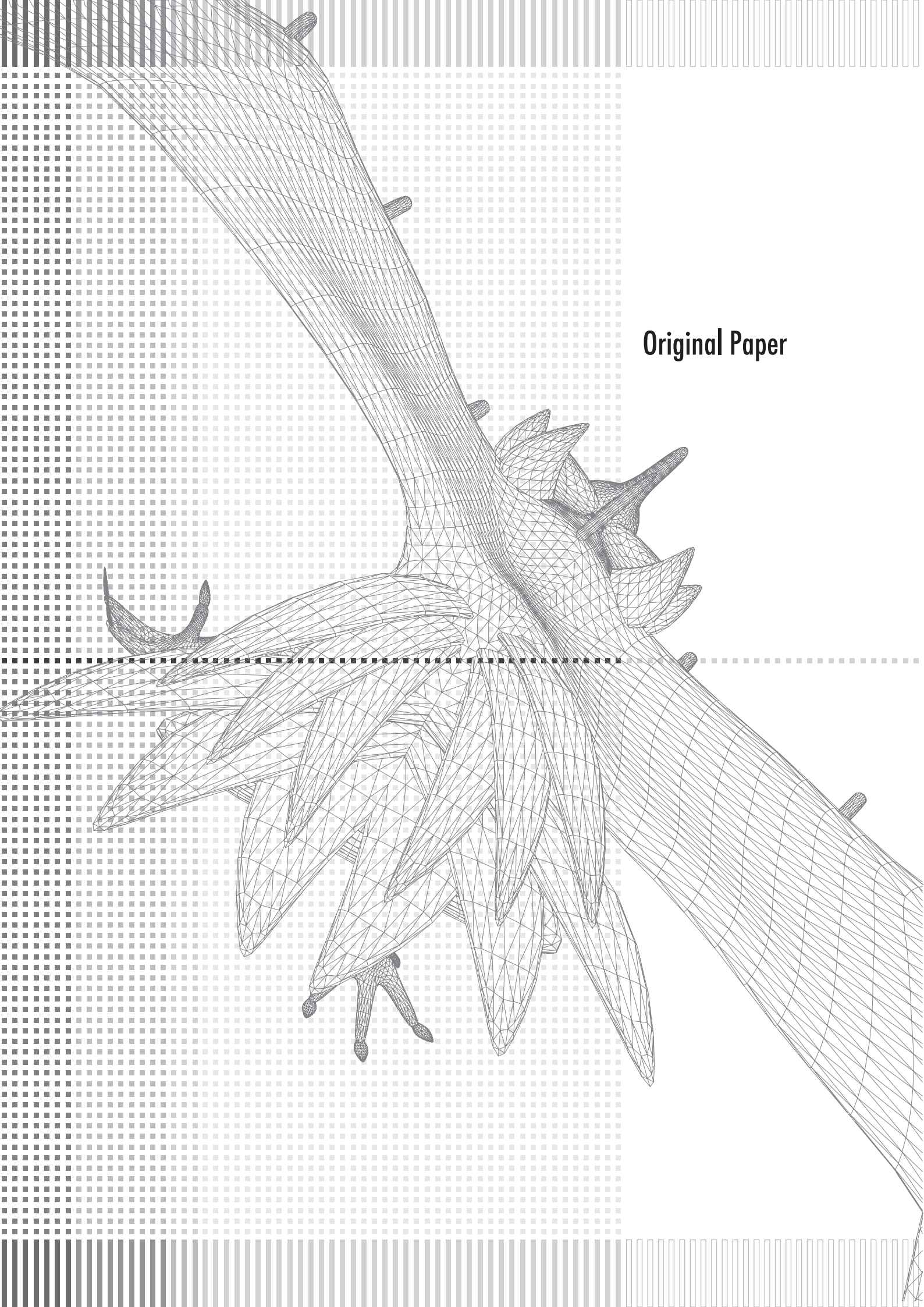
Original Paper

# Research on Animation Lip synchronization technology

A study on application and development of domestic animation Lip synchronization

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**Abstract**

Recently, linguistic communication and learning effect and even delivery of knowledge information and mutual communion was capacitated with English lip sync automation device and voice recognition technology based real time animation character in areas like movie, game, broadcasting, AR with application of animation lip sync. It connotes the possibility of these characters` lip sync using characteristic of animation to efficiently enhance the qualitative level of work in domestic animation creation`s linguistic expression with progress and application of automation technology. In a word, a study on development and practical use of Korean lip sync technique is needed to be made actively in industrial, technical progress of domestic animation. However, it is hard to find a research on commercialization method of Korean lip sync automation technique and excellent performance or example that these techniques were applied in domestic animation up to now.

The reason that development using Korean lip sync technique on domestic animation passed unobserved could be found in problem of sociocultural awareness, production environment and functional value feature. First, in Korea, animation is recognized as subordinate part of movie genre, and sociocultural stereotype that persisted with dictionary definition and feature that unreal and non-objective illusion image with playful exaggeration and symbol that brings optical illusion through apparition of movement is also a problem. Second, labor-intensive method that mobilized many labor was used in production of traditional 2D animation, and since the production was done by specific worker with long acumen and experience, thus it requires long period of production and big consumption expense.

Despite the fact that domestic animation is completed by overcoming poor surrounding with various risks, audiences yet feels that characters move their lip unlike the lines, and experience sound and image does not match, and it causes perception process of negative mental process and defensive mind like anger and distrust. These audiences of animation get interrupted to be empathized into true world that is essentially pursuing, and at the same time any kind of symbolic meaning and metonymic value also cannot be earned from animation.

This researcher look at technical standard which will influence qualitative level of domestic creative animation in the future, and try to think visualization and synchronization problem in linguistic expression of character lip sync scene which is required in 3D animation in production side and audience side.

This thesis try to study on need to develop related technology in the future and development plan by checking importance of Korean lip sync and current use state of technology in maker and audience of domestic animation. Also, looked at method and attitude for future creative animation to use technology with progress of animation Korean lip sync technology in technical side by emerging from non-linguistic act and behavior oriented research of animation. Also, in excellent cases of animation Korean lip sync, it could surpass the limit of children oriented domestic animation which massively produced with small scale and low budget, and contribute on newly illuminate and develop value and meaning of animation to more various and wider socio-cultural class.

**Keywords:** Animation Lip sync, Character facial expression, language visual expression

# 1. Introduction

As a development of computer animation production technology, (Cinematic) movie and game maximized sense of reality of character by combining with various attribution and fundamental work of animation. By using these technology, it feels like living in cinematic special effect that character that only exist in imagination of human actually exist with new terms such as digital actor or avatar. In those mainstreams, in the sense that animation character lip sync technology is visualization of lip movement of character`s speaking scene, possibility of success by applying progress of technology on creative work can be receive attention...

Development of digital technology to authentically express character in domestic animation made huge progress in technological areas such as producing 3 dimensional modeling data, automatically realizing animation movement, however, for lip sync technology for animation character, effort to develop technology to solve problem of awkwardness of foreign movie dubbing, and technology to perfectly match lip sync of Korean speaking character is poor. Actually, Hollywood animation productions develop new software that is needed in work, and use it as independent plug in every time they release new animation, and show off their amazing technology. Of course, under the poor production environment of domestic animation and difficult reality of social, financial limit, necessary expenses on development of high rank technology that requires R&D was inevitably low. Also, domestic animation is small scale industry compare to others, investment support system or research support for vitalization of production is poor.

While forecasting development with excellent use of various technology to surpass problem and critical situation of domestic animation, this chapter will start to discuss that if successful case of animation could be made when technology and art is well harmonized. Thus, this study is progress with purpose on looking at technological progress and present condition of animation lip sync which is method and technology of language expression of character, the core element of animation and finding future development plan.

# 2. Background

## 2.1 Basic concept of Lip synchronization

Animation establishes plan for work in pre-production stage and all prior planning. At this point, voice actors record their voice according to animation script. Main-production which produced whole character animation through production of the first animation lip sync is made. On animation production pipe line, lip sync that starts from preparatory stage is short for lip synchronization, and it means the technical term that match voice on movement of lip of actor or singer on TV or movie.

Lip sync is used as essential part to express character in animation (character sketch), use of this technique can be the base to success exquisite and detailed visualization of character in animation, and it could perfectly reenact dynamic performance and expression in facial part.

In here, lip sync technique of animation is generally the work that perfectly match character`s lip movement with voice actor`s voice in 2D or 3D animation produced with computer graphic, it is particular technology that visualize lip`s shape and change according to vocalization of language to produce the scene that character is speaking. Especially, 3D animation is used as realistic animation production technique by performing emotional performance by managing facial coordinate of character with model data production and transformation. This narrows physical distance between animation and audience by close-up shot, and it becomes very important technology when performing character`s emotion. Therefore, recently, importance of it is more standing out in theater animation, and it is also recognized as one of the main working process in production pipe line.

In computer animation, in-between technique which computer automatically animate image between the first frame and the last frame that set on compute for movement of character in animation. Especially, when making facial animation with character`s face, it is easy to change data and modify lip movement of character model and facial expression, so lip sync which is involved in visualization of shape of lip is developed to work using computer

## 2.2 Lip synchronization technology of Animation

With amazing development of domestic and foreign animation image technology, American animation character production technique is especially changing huge. The convenience of function that can produce lip sync using morph feature or bland shape which computer 3D graphic program has, or development of motion capture technology that enabled immediate and stable data creation for facial animation by attaching sensor on actor`s face without distinction of language are the examples. Use of AR/VR technology which enabled real time interactive animation which is used in virtual reality area and real time game engine is accumulated for a quite long time. For example, "MGS4" series which received attention with the world best level real facial animation accomplished lip sync work in localize stage like animation production process.

It is excellent case of development and use of lip sync automation device which digitize phoneme component of each language and dividing expression (that can express emotion such as anger or laugh) in voice recognition stage by using own lip sync automation technology. Also, by enabling each lip sync in English and Japanese, this game could sold at the same time with each game title in two countries.

Case above showed successful case that is similar technology that recent theater domestic 3D animation to produce systematic animation lip sync by using voice recognition and data processing technology in pre-production stage. Additional research development is needed in each area to replace consumption of labor for Korean lip sync for domestic animation by using automation device and method technology above, and improve quality of production. The result of application for progress of animation lip sync technology and creation will actually reinforce expectation and trust on CG movie or theater animation character that audience be enthusiastic about, and it will do the role to find essential meaning and value of animation by emotionally approaching to audience without any detail act or movement.

Thus in the sense of marketability of domestic animation, children and even teenagers will remember positive influence of animation until they become elderly according to quality of animation character`s lip sync. Also, as being proved that watch of video with character lip sync technology has educational effect in Edu-entertainment area, it will do important role on becoming contents that reinforce emotional purification function of animation and perform positive social influence.

# 3. Discussion

## 3.1. Development of Lip sync technology

### 3.1.1 Lip sync of Animation production side
When televising American or Japanese animation, since it uses recording method that dubbing Korean on already made animation, audience lose their concentration because the line of character and mouth shape does not match, and sometimes it interrupted empathy or absorption to character. American style animation production has its advantage to perfectly match mouth shape with every frame with pre-recording method which is Pre-Recording & Voice Actor then sync with that sound or pre-recording method. Pre-recording method like American theater animation released after 90s, in other words, pre-recording voice before start to animating received a good evaluation that it made good work.

In traditional animation production, most of Korean style or Japanese style took a method that produce animation first, and voice actor record script while watching the video (after-recording), or experienced worker choose mouth shape of animation character which respond to actual pronunciation from mouth shape data base and make it to animation with individual sense. Since these methods do not reflect actual voice pronunciation of human, it decreases reality.

Because of the production process and reason above, realization of animation character lip sync is mostly made by experienced person without benefit of technical progress. In order to match recorded voice and mouth shape of character,

this requires abundant labor from specific worker with know-how in relevant experience and long production time. This has been a reason to entire production cost in social, economic sense. Especially domestic animation industry which mainly targets children uses relatively small production cost, thus it has huge burden on developing character lip sync technology and it is hard to invest money on this part.

### 3.1.2 Lip sync of Animation appreciator side
Like in <Hen that left garden> which was successful of audience appeal as domestic theater animation, it used production system that record voice of actors first then work according to that, and it is different from previous method of existing Korean animation that drew first then record voice of voice actor. This is excellent successful case of animation character lip sync which ruled out awkwardness of character`s line and expression and maximized audiences` immersion.



<**Fig. 1**   Pre-recording for Lip sync by Famous actors, "Hen that left garden", Myung FIlm, Animation production 2011>

Like the case above, domestic animation was successful on character lip sync by successfully using voice performance of famous actors, it also suggest possibility that development of voice recognition technology that analyze pre-recorded voice file will contribute on realizing character`s mouth shape and expression vividly according to animation production feature. In marketability of domestic animation, the factor that can successfully make a box office hit most efficiently and fast might be voice recording of actors` voice performance.

In progressive aspect of industrial technology according to sales increase tendency with market size, like the case of <Hen that left garden> which was successful case that applied Korean character lip sync technique using pre-recording, entire case including <Guardians, dream works> that opened in Korea received great respond from Korean audience with voice performance of the best actors, expansion and use of Korean animation character lip sync automation device technology will continue in the future, and applying field of technology will be expanded and artistic application of important technical factor to producer and audience.

It could be seen that absolute majority of current animation market is animation that targets children, but since this animation targeting pre-school children is made with relatively small production cost, it has great burden on producing character lip sync. However, case study of children audio-visual education which is main target of animation

shows matching between animation character voice and mouth shape influence verbal development and language learning. Also, currently U.S has legal regulation on broadcasting that all imported animation must have match of character`s lip sync to be televised. In order for animation to be developed and successful in domestic and foreign market, lip sync of animation character must be perfectly realized phonetically and visually. It will bring positive synergy effect that fusion of art with utilization of effective technology to children animation producer who has to produce high quality animation with low cost and individual creator as well.

## 3.2 Application of Animation Lip sync technology

### 3.2.1 Necessity of Animation Lip sync technology

In the aspect of audience, lip sync technology directly connects with various elements of animation that consist animation such as image and word, story and sound, and music. It is tend to develop into human-based technology that formats individual sense, experience and cultural context with technique that match visual image and voice, and help it to experience animation world with playful and creative method directly and indirectly, and help to understand world, oneself, and others and to communicate with.

In industrial technology aspect, there is technology like <lip sync animation offering method with real time voice recognition> which is registered patent of domestic company, it has somewhat complicated process and method with 5 step process starting with changing to digital type voice data, however, it is the method that offers lip sync animation with real time voice recognition, it is utilized as simple voice information service using web based cyber helper, thus it has distance from technology required to produce animation.

However, excellent case that is utilized in actual animation in animation production, producer and 3D character animation contents development firms` project with domestic IT technology development firm in 2005 could be found. Utilization of this technology was developed based on the fact that Korean learning tool that is provided to hearing impairment children are based on foreign software and it is inappropriate source to learn Korean language.

Practical use technique log detail process regarding need of animation lip sync will be looked into. It is technology that input real time voice of human through recorded sound, file and script information of voice, then analyze start and end time of each Korean pronunciation syllable and phoneme, and size information of each syllable pronunciation, and output that information with each image frame of available animation.

It is 'lip sync animation key-frame automatic generation method' that automatically produce key frame information by synchronizing 3D face model`s mouth movement and mouth shape to voice file based on this voice recognition technology.

From these cases, it could be known need and usefulness that enables to produce natural and realistic lip sync animation of 3D character in animation for verbal expression issue of animation lip sync.
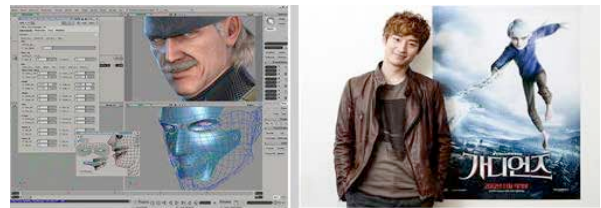


< **Fig.2** Facial expression in Game MSG vs. Animation>

It is as an animation character lip sync automation device and method that could maximize efficiency of animation production, it pre-records script voice before starting animation in main production, choose matching mouth shape by separating consonant and vowel in script track, perfectly match mouth shape of animation character and voice of voice actor and output computer graphic animation synchronize video. It has effect that makes audience to understand the world of various characters meet from media in daily, cultural space and enable immersion of emotion and communication by enhancing perfection of animation video and enhance quality. This thesis had pre-industrial technology study on inevitable reason and purpose of lip sync technique for verbal expression of animation character. Industrial flow and vision of technique that automate animation character`s lip sync industrial technology development of animation character was looked into, and in the aspect that un-matching of animation voice and verbal expression will hinder development of animation in the future, issue of current condition and utilization of lip sync technique was looked into from current animation industry.

### 3.2.2 Practical use of Animation Lip sync system

First, in production technique side, pre-recording method to make lip sync work is developing related technology on auto-mating device and process to utilize in animation in the future. It is as a pre-production process of one animation, it is the pre-recording process of voice actor`s voice of character accordance with script. Lip sync is pre-recording and work method, and that is work stage that produce mouth shape of character`s speaking in animation. In this stage, pre-record planned scenario script with casted actor`s voice performance, and lip sync technology device or software recognize and analyze voice file.

It is considered as part of animation about character`s facial part until now, and it has certain device feature that made method of computer that lip of model follow the moving representative dot and make lip sync automatically for computer character made into data process technology method. Computer software such as <Bland shape> and <Morph>, the data changing technique method is used for animating the face of digital character.

Core contents of production process with device that compose

lip sync technology is divided into synchronization process that enable to choose voice information to mouth shape and visualization process that play after combining data to video.

Invention of lip sync automation device and method that could be found in recent patent technology in Korea suggest realistic method that automatically realize lip sync of animation character by accurately reflecting production feature of animation and Korean pronunciation structure by using voice recognition technology.

If development of these technologies can be commercialized to technology that could be used in actual animation work production, it would have meaning on developing both animation industry and creation that use mother language and contribute on quality increase of domestic animation. Also, this possibility of using animation lip sync automation technology on work in poor production environment of domestic animation would have to provide computer recording medium that recorded program that could be operated in computer.



< **Fig. 3** Comparative table of Mouth Chart English vs. Korean for lip sync in animation by Tak hoon Kim, 2009>

In development of domestic technology, Takhoon Kim suggested in his thesis that Korean lip sync has difference of mouth shape compare to English due to vocalization that opens mouth small for all pronunciation. This issue based on expansion of animation character`s feature. Therefore, it is deeply agreed that lip sync Korean mouth chart is studied as a part of art work that visualize mouth shape by dividing dialogue into syllables rather than linguistic or phonetic side. Thus, it is considered as a point of view that suggest various applicability of animation in visual image medium as a pop culture art rather than one dimensional industrial technology with use of lip sync technology.

In animation of American major movie production, it improves audience` immersion by producing high quality animation by perfectly show character`s performance with realization of perfect lip sync, so it could perfectly realize Korean lip sync when developing domestic animation, and furthermore, if development of Korean based character`s facial animation continues, industry that could use lip sync automation will be useful in domestic purely creative 3D animation as well as movie that requires high quality CGI in the future.

As looked into production technology side earlier, it would be important to take a look at what influence would utilization of audiences` lip sync who are target to watch that object. In the aspect of audience, implication of regulation on recent American public TV animation mentioned earlier has great social and cultural impact. Bill that permits only matched lip sync with character for broadcasting of all imported animation in America would be the case. From animation <Duli> that made big flow in vitalization and development of animation in domestic market to <Pororo> and currently hitting <Lava>, the case of all these TV series animation mainly targeting children, critical mind occurs on educational influence that if mouth shape of character`s lip sync would influence language learning side.

There is assumed situation that opportunity to crate high value would be increased in movie and game that realized high quality animation character. In those situations, animation producer or creator`s position accordance with progress and development of lip sync technology would have to be using this as a tool to make accurate language expression by surpassing existing concept that lip sync would just visualize talking shape of mouth. This would make opportunity to change social recognition that could re-illuminate important meaning and value of animation and it would be developed more.

## 4. Conclusion

After 2000, as production technology of whole world animation industry becoming 3D from 2D digital method, it used mixed type between 2D and 3D, and from 2004, it changed fast to 3D animation. With this international trend, 3D creation has been increasing in Korea recent few years and it is urgent to develop animation production technology that could reduce risk by reducing production cost and production period of animation. Especially, as the game that use real time animation character and virtual reality based digital character video production assumes live air as well as 3D production type TV animation, company tend to increase their related projects, and demand to develop animation production technology that could enhance efficiency of contents production is rapidly increasing as well.

In industrial aspect, since cartoon/animation/character industry has low cultural barrier such as linguistic, geological and racial, thus it is easy to expand to overseas and it is soft industry with great effect to create work, thus it is considered as representative advanced country type industry. It is because one hit product could expand into overall cultural contents industry such as movie, drama, game, play, musical and character, and create high value added product.

However, since domestic animation industry is produced based on character`s gesture performance by leaning too much

towards children market, thus it seems need to develop Korean character lip sync technology that could visually accurately express pronunciation expression with linguistic characteristic of Korean character in animation or detailed emotional and cultural difference is passed unnoticed.



<**Fig. 4** From Duli to Lava animation character, Economic growth prospective table by Korea economy, 2013>

As it shown in the table above, domestic animation market will record 568 billion KRW this year. Start with baby dinosaur "Duli" in 1983, there are virtual characters in the center of domestic animation like "Pucca". As commercialized animation <Pororo> that had greatest success until a recent date has been produced since 2003, 2013, currently domestic animation is growing fast such as "Robocarpoly" and "Lava".

In recent domestic patent technology of Korean cultural contents and industries, effort to develop real time lip sync animation production technology using voice recognition in idea stage or theory stage could be found. This will make Korean speaking character to have authentic speaking scene more efficiently and easily in domestic animation. Also, as effect of Korean character that can correspond in real time, Korean lip sync automation device that applied in real time animation character, and the technology that compose that was revealed in areas like movie, broadcasting, smart contents, game video, AR/VR which claims to be high technology, it is being commercialized.

However, it could be told that animation made base of creation with pure domestic animation technology is growing centered on children. This means mass media animation expand its range of influence on growing children and audience. Also, it has been developing hectic by considering movement of character as a main technology with strategy to show plausible scene in real world with exaggeration and personification, thus technology development of lip sync in domestic animation and discussion on its utilization could not be done. The point of view that just match mouth shape of character for animation lip sync like dubbing foreign movie and having pattern of modification would affect as cause of hindrance in development of animation in the future.

Thus, for linguistic problem and that influence of domestic animation that aiming world market, industrial technology development that realize character`s script and facial expression is prior project, and it could be used as core value technology with superiority of technology competitiveness that make animation Korean lip sync character based on creativity and originality of country`s culture through progress of industrial technology to success in domestic and foreign market.

In the future, like the development of device technology that automates character Korean lip sync technology of animation, change of recognition on proper use and technology of animation lip sync technology for visualization of language expression would be needed in production of domestic animation rather than just focusing on non-linguistic expression

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# Affordance in Interactive Media Art Exhibition

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**Abstract**

Interactive media art that actively integrates digital technology is a field of art focused on interaction. It completes the work of art with the viewers by handing a part of it over to them. However, in bringing in digital technology, increasingly, more artworks focus on the technology and neglect active participation of the viewers. In order to put the viewers at the center, it is important to understand the cognitive process by which viewers go through when viewing an artwork. To do so, it necessitates research on 'affordance,' which is a concept to induce a human behavior based on cognitive psychology. In design field, research related to affordance is actively being undertaken in order to increase the usability of objects regarding user-oriented design. However, in the field of art, there is lack of relevant research in terms of naturally inducing the process of viewers appreciating an artwork.

This study aimed to integrate the concept of affordance to the field of art for the purpose of inducing active participation of viewers in interactive media art exhibition. Therefore, previous research related to affordance, which has been actively conducted in the design field, will be reviewed and, based on the literature, the affordance that is suitable for the field of art will be newly classified as spatial, physical, cognitive, feedback, and sensory affordance..

**Keywords:** affordance, Interactive media art, media art exhibition

# 1 Introduction

## 1-1. Background and Purpose

With the rapid development of digital technology, there has been a change in communication between people and artworks. Especially, interactive media art, which utilizes new media based on digital technology, changed viewers into participators who complete part of an artwork. By actively using digital technology in order to bring out interaction between viewers and artists, interactive media art has adopted the latest digital technology. However, it also created a tendency to blindly focus on technology. Artworks must be created for viewers, rather than technology, in order to create active interaction. To do so, it is necessary to understand how viewers behave and respond. Affordance enabled viewers to naturally participate and experience true intent of an artwork. However, previous research related to affordance is mainly focused on design. This study aims to integrate the concept of affordance to interactive media art.

## 1-2. Scope and Method

The concept and scope of affordance in previous research will be reviewed, as well as how the concept is to be applied to interactive media art exhibition. By examining the relationship between viewers and exhibition space through reaction structure of viewers at exhibition and exhibition elements in interactive media art exhibition..

# 2 Discussion of Affordance Theory

## 2-1. Formation of Affordance Theory

Affordance was first mentioned by an ecological psychologist James J. Gibson. Donald A. Norman focused the conventional concept of affordance on design, which, then, began to be used from the viewpoint of interaction between human and computer. Later, in many fields, research has been conducted on objects that can help users behave in a certain way. In this study, the concept will be reviewed based on the studies by the most influential researchers on affordance, Gibson, Norman, Gaver, Hartson, and Zhang.
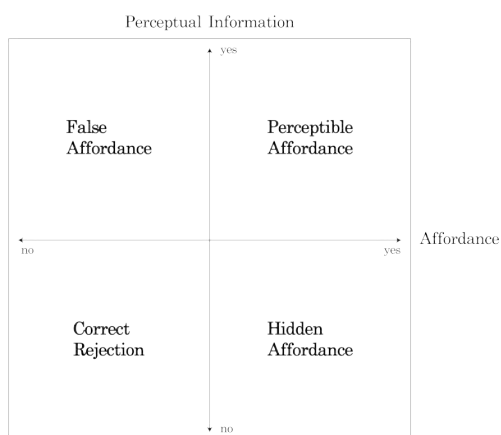
### 2-1-1. Gibson

Gibson proposed affordance from an ecological psychological point of view. In his book Gibson emphasized affordance as the most important concept, defining it as "everything that environment surrounding animals offers and stimulates.1) His affordance, in a broad sense, is relationship between environment and animals.2). Here, environment means the

surface that separates substances in the space where animals live. Simultaneously, the environment affords animals. Gibson argues that information related to affordance can be obtained through the information such as composition and layout of a surface. He focuses on visual information, a surface, to develop the concept. Gibson says "an object can be said to have affordance that induces the act of 'sitting,' if it is solid, horizontal, has a broad surface, and is high as human knees.3)". His affordance is a characteristic of an environment itself. Therefore, it is independent from animals that process cognitive information, and animals just need to pick up affordance without remembering or deducting an environment. At the same time, each environment has different affordances to different animals and induces different behaviors. And it exists without changing, regardless of the purpose and intent of animals.

### 2-1-2. Norman

Norman(1999) focuses on the mechanism of cognitive process. Rather than picking up information, he refers to affordance that changes according to deduction through prior knowledge and experience of a user. The range is also reduced to the relationship between tangible objects and users that use them. Norman applies affordance mainly as a clue to manipulating objects in everyday life. The clue enables users to use an object in an easy and intuitive way. Norman defines affordance as "a perceived or practical characteristic of an object, especially the fundamental attribute that determines how it can be used. "4) Norman classified Gibson's affordance, which has the characteristic of information pickup, as real affordance and affordance dependent on the experience, knowledge, culture, and cognitive ability of a user as perceived affordance. Real affordance refers to inducing an action to manipulate an object based on its physical characteristics, while perceived affordance refers to affording a particular behavioral cognition of a user based on the appearance of an object. By offering a clue to operation method, it shows a possibility of an action.

### 2-1-3. Gaver



Perceptual Information

False Affordance  |  Perceptible Affordance

Correct Rejection  |  Hidden Affordance

Affordance

<**Fig. 1**>    Four types of affordances (Gaver, 1991)

Gaver attempted to approach the concept of affordance by

focusing on the strengths and weaknesses of technology related to possibility offered to users. He developed the concept by examining "how, as a characteristic of an environment related to behavioral system, an object is perceived and how the perception affects the culture"5). And he believes it is defined in the process of social interaction with users. In other words, he defined it as a tool focused on the link between an actor and action and design and objects.

He distinguishes affordance that an object has and affordance at an informational level that is perceived by an actor. As shown in Fig 1, he classifies affordances based on existence of affordance and perceptual information. The most common case is perceptible affordance. Hidden affordance is when, for proper operation, other external clues must be used for deduction. False affordance refers to a mistake that is not relevant to the object. Lastly, if both affordance and perceptual information is not given, an actor cannot perform any action. An action of real actors is not simple but complicated. For that reason, he combined the affordances and introduced a sequential concept. Sequential affordances exist overlapped with one another in one space. And when an affordance is revealed, the next one appears. In the process, the actor perceives affordance by using other senses than vision, such as auditory and tactile senses.

### 2-1-4. Hartson

Despite the emergence of design focused on HCI and usability, Hartson believed the importance of Norman's perceived affordance has not received attention. Hartson argues that "in design, affordance is offering something to help a user with a desired action.". This is not so different from the conventional concept of affordance; however, he saw objects as function-oriented tools. And he classified and defined affordances as shown in Table 1.

| Type | Description | Example |
|---|---|---|
| Cognitive Affordance | Design that helps users when wanting to know something | Button label that helps predict what will happen when a user clicks the button |
| Physical Affordance | Design that helps users with physical actions | A button that is sufficiently large so that users can accurately click it |
| Sensory Affordance | Design that helps users with feeling something | The size of letters on a label for users to easily read them |
| Functional Affordance | Design that helps users complete a task | An upper menu that shows a function to classify a series of numbers (which appears when the users click a classification button)` |

<**Table 1**> Types of affordances (Hartson, 2003)

Although Norman did not classify symbols, constraints, and customs as affordance, in cognitive affordance, Hartson did. Physical affordance is a design attribute that helps with physical actions relating to a tool, while functional affordance provides a purpose to it. Sensory affordance is related to visual, auditory, and tactile senses of a user. By using these senses,

they can pay attention to a tool and it supports cognitive and physical affordances. Thus, Hartson classified affordances according to the reaction process of users. Design attributes are proposed relating to the process of how a user feels, recognizes, and acts regarding a tool. Through this process, users interact with tools. Hartson says, "the process where users feel, perceive, and take action shows how they learn about and use an object by each affordance"7).

### 2-1-5. Zhang

As the latest researcher who reclassified affordances into five types, Jiajie Zhang classified affordances as biological, physical, perceptual, cognitive, and mixed affordances. Zhang argued that affordance is an allowable action designated by environment combined with characteristics of an organism. Reexamining affordance in the broad cognitive system, he classified environment and organisms as distributed cognition, and external space and internal space of affordance, while clearly defining the relationship between the two spaces by setting four factors. In Zhang's classification, biological affordance is based on the biological process of an organism. Physical, perceptual, and cognitive affordances are explained in a conventional sense. And Zhang argues many affordances exists as a combination of more than one affordance.

### 2-2. Significance and Limitations

Major studies commonly define environment as everything that surrounds humans including objects, by applying the concept in a broad sense. In interactive media art exhibition, environment refers to exhibition space excluding the artworks, separated from the latter. Also, the studies above mostly see environment as a fixed space. Applying affordance in such spaces is partly appropriate, but it will have to be interpreted in an integrated viewpoint in organic spaces such as an intelligent space with advanced technology. In addition, previous studies conducted for the purpose of design usability involve highly typified elements such as how an object performs a functional role. However, in interactive media art, which is a field of art where an artist expresses and asserts his or her subjective view, usability is not discussed importantly. Therefore, previous research will be selectively adopted.

Previous research illustrated lack of research on spatial characteristics of and feedback for actual interactive media art. Therefore, in this study, the concept of affordance will be focused on interactive media art exhibition and the attributes of affordances will be examined in a more integrated viewpoint.

### 2-3. Affordance in Interactive Media Art Exhibition
### 2-3-1. Definition of Interactive Media Art and Scope of Exhibition

Interactive media art refers to the type of art where viewers actively participate in and, therefore, connect with an artwork 8). The interface of an artwork connects the physical body of a viewer to the artwork, so that the viewer can experience it with different senses 9). The interface is used for inducing viewers' action and participation as a mediator. Exhibition

space for interactive media art exhibition means a venue where viewers can interact with those artworks and a new type of exhibition space that enables emotional communication between artworks and viewers 10). In a broad sense, affordance is related to the relationship between environment and people. Therefore, affordance is classified based on relationship between exhibition space for interactive media art and viewers in such space.
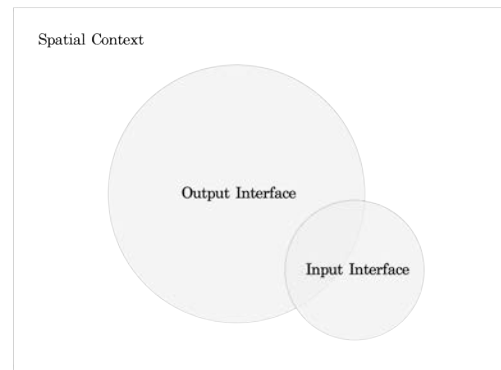


<Fig. 2>  Components of interactive media art exhibition

### 2-3-2. Components of Exhibition

Interactive art interface is composed of preprocessing that causes interaction, that is, input and output, which is the result of interaction 11). And, in exhibition composed of interactive media art, input interface and output interface form the main elements and spatial context a supporting element.

Spatial elements of exhibition control the actual movement of viewers. As a supporting element for an artwork, it helps the audience become more immersed in the artwork and feel the mood, concept, direction and flow of the overall exhibition. It is expanded in a more organic and diverse way based on various technologies. As the most direct interface that connects artworks with audience, the input interface receives data inputted by participation of the viewers. Therefore, a sensor inside the interface is also an input interface. Output interface is the element that visualizes and enables the feedback given by the input interface to the viewers. These components can be combined as one or separated as completely difference spaces according to the intent. The audience view the artwork based on the components of interactive media art exhibition and experience a series of reactions by facing them.
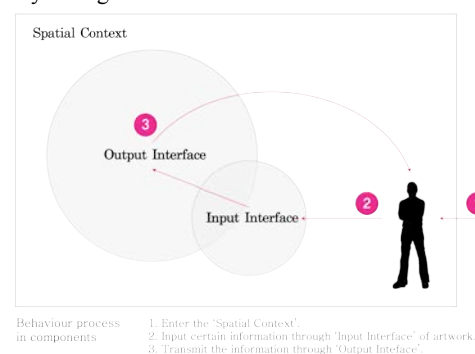


<Fig. 3> Viewers' behavior process

### 2-3-3. Reaction structure of Viewers in Exhibition

Interactive media art transforms viewers as participators in the artwork so that they can gain a more profound experience. In the process, they can experience the intent of the artist. Therefore, it is important to understand how the viewers react in different spaces while viewing the exhibition. According to Hartson(2003), users experience sensing, perception, and cognition while feeling, understanding, and using a tool. In Fig. 3, the viewer repeats the behavior process in interactive media art exhibition. This behavior process is progressed according to the components of the overall exhibition.

## 3. Affordance Found in Interactive Media Art Exhibition

To classify affordances, the author examined the relationship between components of media art exhibition, the space, and reaction structure of viewers in the exhibition. It was found that the reaction structure is realized sequentially according to the components that the viewer encounters. Stimulation is continued by all elements, i.e., the exhibition space itself as well as input and output interface. Based on visualization of this sequential reactions to components of exhibition, it was possible to extract meaningful elements among exhibition components that showed the highest reaction structure.
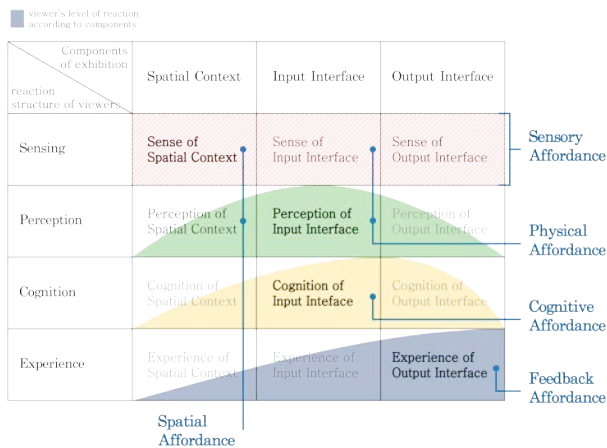


<**Fig. 4**> Components of interactive media art and viewers' reaction

### 3-1. Spatial Affordance

Viewers first react to spatial elements in exhibition. They are led to behave according to the artist's intent by the space that composes the overall atmosphere of the exhibition. In exhibition space, affordance does not force the program and function of the space to the users but suggest, indirectly, the possibility of various functions, developing the dynamic interrelationship, an active behavior of users, through communication between space and users 12).
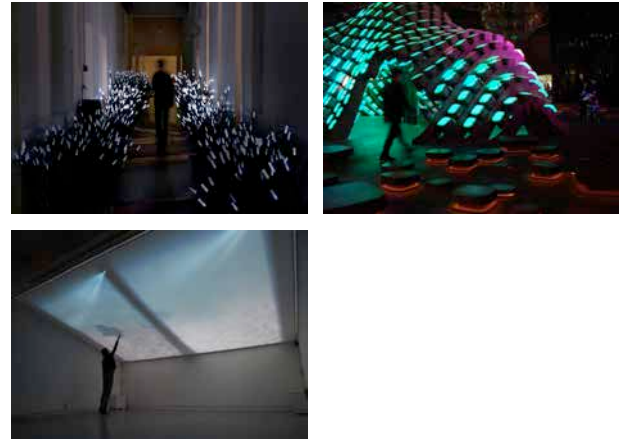


<**Fig. 5**> (Left) Roosegaarde D. Dune 4.0. 2006    (Center) d'strict. Live Capsule 2011 (Right) everyware. Cloud Pink. 2012

Spatial affordance instructs viewers how to behave and what position to take when entering the exhibition space. The spatial structure that surrounds the artworks determines the viewers' action. 'Dune 4.0' installed an artwork on the wall in a long corridor so as to lead viewers to walk in between. It is a case of spatially limiting the action of viewers. Also, the shape, light, and sound let viewers know the overall mood of the exhibition and lead them to focus on certain parts of the artworks. Recently, the forms and methods are becoming more diverse. The exhibition space and artworks are sometimes united, and the space is distorted, transformed, or changed dynamically. 'Live Capsule' controls different cubic capsules independently, and light and move them as a response to viewers' sound and movement. The space itself is used as an interface interacting with viewers.

The physical elements of space, such as the wall, floor, column, and ceiling, lead the movement of viewers. The lights that are used outside the artwork attract the viewers' attention and focus them on the emphasis. Sound also create the overall mood and offers indirect suggestion about the artwork. Moreover, the relative composition and arrangement of the artwork and space can significantly change spatial affordance. 'Cloud Pink' placed a fabric slightly above the average human height. Viewers naturally looked up and reached out to touch the artwork. The composition and arrangement of the exhibition space and artwork can lead different actions of viewers.

### 3-2. Physical Affordance

Different artworks have different input interfaces. The physical elements of the interface, that is, shape, size, material, position, and color, informs viewers of what input information to provide. Physical affordance is the most important consideration in composing an input interface, and helps viewers know what physical action to take to the input interface. This is similar to physical affordance explained by Hartson(2003). Constraints proposed by Norman (1988) as affordance that can be applied to design plays an important role in improving physical affordance. Constraints means limiting the range of possibilities, in other words, the number

of alternatives. "Difficulty in a new situation is closely related to how many options are available in that situation."13).
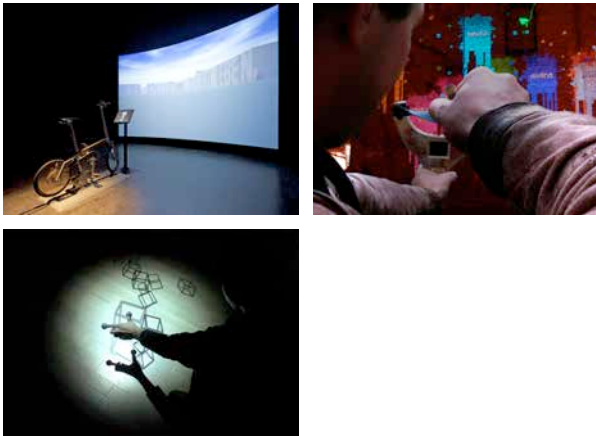


<**Fig. 6**> (Left) Shaw J. The Legible City.1988 (Center) VR/Urban. SMSLINGSHOT. 2010 (Right) Tsubokura T. Shadow touch!. 2011

The triangle saddle at the waist height leads people to sit on it and the pedal placed around the feet leads people to place their foot on it. By physically making the pedal movable in a circular motion, people are led to ride the bicycle as a result. 'SMSLINGSHOT' used a slingshot as an input interface. Because of the physical shape, the lower part of the Y becomes a handle and the sling is pulled to aim at the target. This form is used for viewers to input any word and shoot it on the wall so that the word is displayed. The physical affordance of the interface naturally leads the action of viewers. Although there is no social name for it, it is more important for an object made by an artist to have good physical affordance. Shadow touch!' allows people to the hemispheric cap to put on the thumb and index finger to touch, hold, or throw a projected object. The caps are of the size that can be fitted on the finger and the hemispheric shape suggests its role as a pointer in the artwork. Even if they have never seen the type of interface, viewers can understand what action to take based on physical affordance.

### 3-3. Cognitive Affordance
Cognitive affordance helps viewers predict what will happen next after they perform an action induced by physical elements of an input interface. Hartson (2003) used cognitive affordance as a design to help users when they want to know something. In other words, symbols and labels marked on a tool is cognitive affordance.
The kiosk installed on Dexia Tower for people to directly control the LED façade helps participation by putting a label on the button and allowing people to restart it by pressing the respective button. Recently, as more complex and diverse interfaces are used, there are many cases where the label is made for each function of the interface for instruction. However, in artwork exhibition, cognitive affordance helps viewers cognitively predict the next action without any direct instruction. Correspondence can be used to induce an action

without using direct signs. Correspondence defined by Norman is "a technical term referring to relationship between two things. Here, it means the relationship of control devices, their operations, and the results"14). Viewers can instantly understand the relationship if the correspondence relationship is properly set between the input interface and output interface. 'Perspective Lyrique' is an artwork that changes the projection image mapped on the building according to the sound inputted to the microphone. The microphone installed in front of the building and image projected on the building is naturally connected. The human face image enables prediction that if the audience makes sound on the microphone, the image will respond to the sound. Thus, when the audience makes a sound on the microphone, the sound is transformed and the mouth of the image changes and plays the sound.
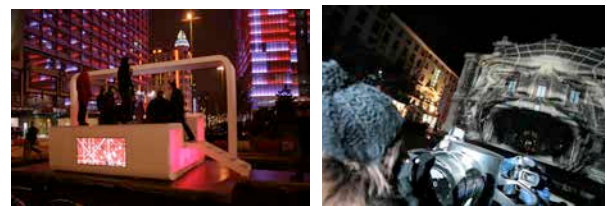


<**Fig. 7**> (Left) Dexia Tower kiosk (Right) 1024 architecture. Perspective Lyrique. 2010

Interactive media art minimizes use of direct cognitive methods using signs or labels. For that reason, it is focused on natural correspondence between the input interface and output interface. The correspondence formed by the artist must be socially and culturally comprehensible to the viewers.

### 3-4. Feedback Affordance
Feedback affordance helps viewers communicate with the artwork by letting them know, in the process of viewers outputting the inputted information through the input interface, whether the result is the output from the viewers. The reaction of viewers inputted through perception and cognition of the input interface is visualized by the output interface. Here, it should be considered how well the output from the input is visualized, how quick the response is, if the same input gives the same output, and whether there is any error. In other words, feedback affordance is determined by how well the internal system is designed in a systematic manner. Also, most interactive media art exhibition has a flow in terms of the action that the viewers first take and actions that are induced according to the flow of the artwork. Therefore, it is important that the viewers receive feedback and are led to the next action.
A representative case of interactive performance, 'apparition' changes the background image by detecting the dancer's movement in real time. According to the speed of the movement, the speed or density of the image changes. The image follows the movement of the dancer. If the change in image does not take place immediately, the relationship between the image and action of the dancer on the stage will be broken.

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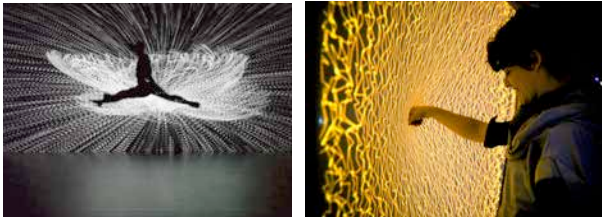
<Fig. 8> (Left) Klaus Obehiemer. apparition, 2004 (Right) .Aaron Sherwood and Mike Allison. Fire Wall, 2012

In addition to visual elements, auditory elements are used to offer instant reaction to the audience. Sound can offer information than cannot be delivered otherwise 15). Recently, interactive media art uses various senses such as tactile and auditory senses as well as vision of viewers. Particularly, using auditory elements is very important when providing feedback. Fire Wall' changes the image and sound according to the depth created by pressing a cloth. Pressing it deeper changes the image more dramatically, sound faster and volume louder. In such artwork, it is difficult to detect the change properly if there is no immediate response to the viewers' action, as there will be no relationship between the action and output interface. In order to use the sound effectively, it is necessary to first understand the natural relationship between the sound and information to be delivered and then create meaningful sound based on it.

### 3-5. Sensory Affordance

Sensory affordance encompasses all the affordances above, and refers to how the components are correlated and enable viewers to have sensory experience. The correlation of space, input interface, and output interface determines how naturally viewers are involved in the intent of the artwork. Similar to the sensory affordance explained by Hartson (2003), it helps, supports,, and promotes users to see, hear, and feel the subject. Sensory affordance includes discoverability, differentiability, legibility, and audibility.



<Fig. 9> The Crown Fountain.

It is similar to the overall purpose of interactive media art, because the viewers must be able to experience the message and emotion intended by the artist through the unified and sensible composition among each interface and components of the exhibition. 'The Crown Foundation' is a case that used the surrounding space and interface in a harmonious way, because all the elements of the artwork attract the viewers' attention and use various senses including visual, tactile, and auditory senses.

The five affordances proposed above mostly do not exist in isolation but are combined with one another. Zhang(2006) argued that many affordances are created by combination of more than one module. Especially, in exhibition space, mixed affordances are formed because there are different interfaces.

## 4. Conclusion

Interactive media art is completed when the viewers interact with and become participators in the artwork. In delivering the message of the artist, the viewers become the subject and gain active experience. Development of digital technology is contributing to helping viewers' participation. However, until recently, interactive media art has been focused on technology instead of inducing active participation of viewers. It is important to consider the cognitive process through which the viewers appreciate the artwork.

This study aimed to enable viewers to actively participate in interactive media art exhibition, instead of focusing on the technology, by adopting affordance as the main concept although it has not been actively dealt with in the field of art. Delivering the artist's message is an important characteristic of interactive media art. Therefore, a new standard is required for existing affordance research that is based on usability with a focus on effectiveness and efficiency. Therefore, it is meaningful in that the research examined affordance that can be applied to the field of art.

The affordance research conducted in the design field established criteria for classification and selectively apply characteristics of the classified affordances. By establishing the relationship between components of exhibition and reaction structure of viewers as the standard, it classified affordance into spatial, physical, cognitive, feedback, and sensory affordances. Later, the author wishes to apply the classification standards to an actual interactive media art exhibition to bring out analysis and improvements.

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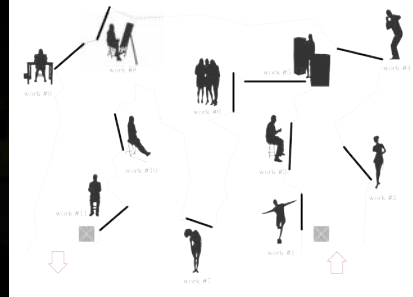15) Donald A. Norman, op, cit., 1988
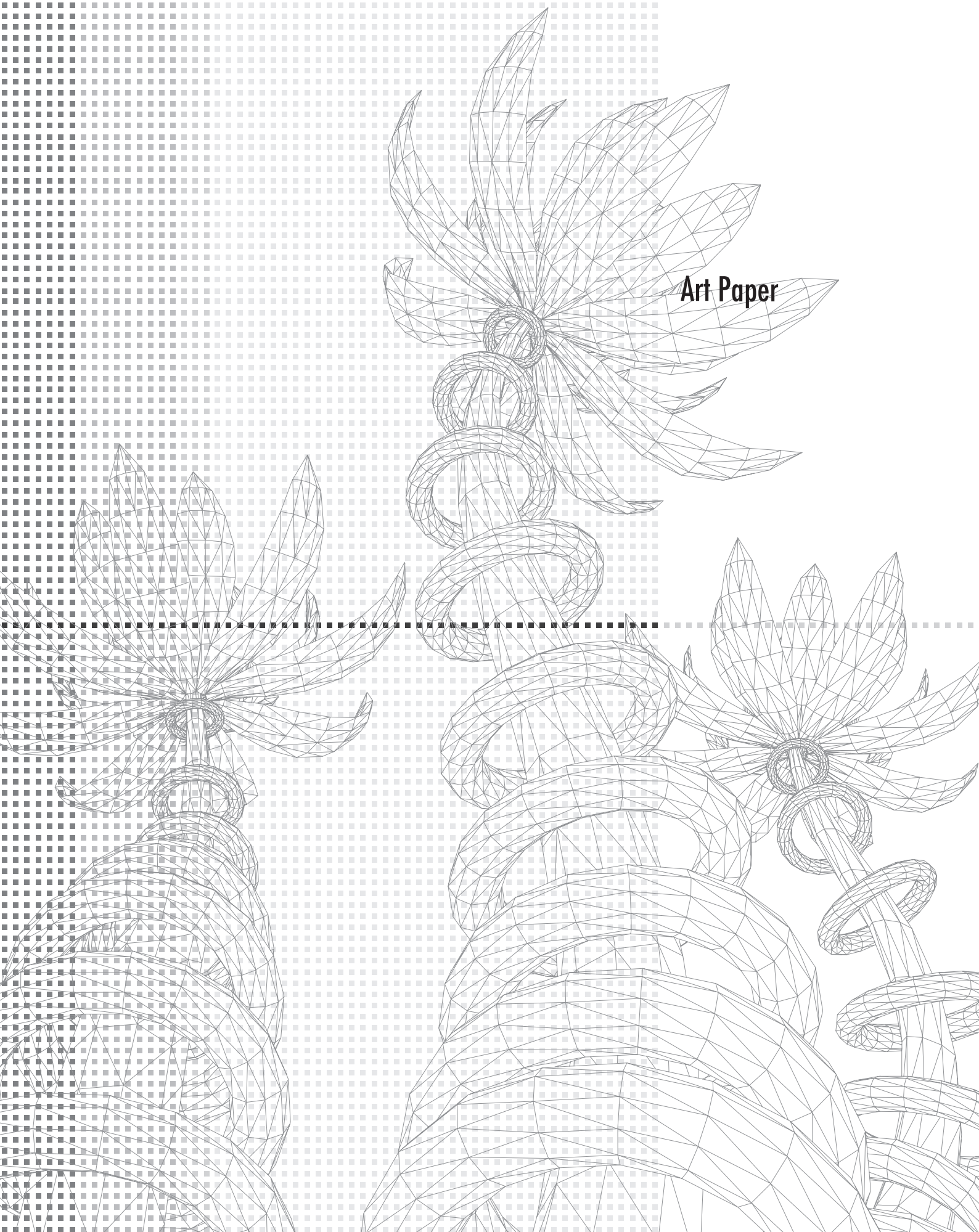
Art Paper

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# Analyzing Exhibition 'Le Système des Objets' by Affordance

**Abstract**

This paper brought the concept of affordance and applied into interactive media art exhibition and classified in 5 affordances. Spatial affordance, physical affordance, cognitive affordance, feedback affordance, sensory affordance. By classification, 11 artworks from actual interactive media art exhibition 'Le système des objets' deducted the comprehensive list of improvements. As a result, suggestion of the series of artwork 'lay bare' which displayed in the exhibition were made. After analyzing 'lay bare' by affordances in detail, supplemental points were applied in 'lay bare Ⅱ'. In this progress, affordance applied selectively. By applying the classification in actual exhibition and suggesting the series of artwork, affordance this paper explored the possibilities of utilizing in art.

**Keywords:** Interactive media art, exhibition 'Le système des objets', affordance

# Lay Bare Ⅱ :

## 1 Introduction

### 1-1. Background and Purpose of the study

In interactive media art, to increase the interaction with the spectators, works and artists, the affordance which could be induced naturally from the spectator's behavior was important. However, the study on the affordance in the area of art was insufficient. The paper 'research on the affordances in interactive media art exhibition' was a research newly defined and classified of affordances on the basis of previous studies related to the affordance, according to the art area. In this study, on the basis of classified affordances, it was needed to review how to apply in the actual display situations, and the complement and improvement derived from the application process. Through this, it was to review how to apply affordances in the art area, and by suggestion of related works, to present the theoretical background to derive a new Improvement.

### 1-2. Scope and method of study

The research on the affordances conducted in the field of media art, 'the study on the affordances in interactive media art exhibition' was reviewed, and the exhibition 'the System of objects' based on the spatial affordance, physical affordance, cognitive affordance, feedback affordance, sensory affordance classified by this study were analyzed. Furthermore, based on the derived direction of complement and improvement, the related work of 'lay bare' that was the work in the exhibition was proposed.

## 2 Interactive media art exhibition 'the System of objects'

### 2-1. Installation and exhibition of work

Exhibition 'the System of objects (Le système des objets)' was held from March 2, 2013, to March 8 at Ewha Womans

University. It promoted the understanding of the producing authoring tools through a real exhibition as part of the business, 'The integrated authoring tool development in the media art' conducted and supported by Korea Creative Content Agency under the Ministry of Culture, Sports and Tourism. To do this, in fact, by production and exhibition of the media art works, it was to experience and to apply what was needed for authoring tools.

The different types of work were made depending on using what kind of media and how it was represented in media art. In this project, it was to develop authoring tools for the three-dimensional facade LED, 3D projection mapping, tangible interfaces, kinetic installation, interactive facades, interactive performance. Among these, projection mapping was the most sought-kind work until recently the most produced interactive media art. Therefore works were consisted of sensors such as webcam, pressure sensors, distance sensors, and the interactive projection mapping utilizing a variety of interfaces in the exhibition.

## 2-2. Derivation of complement and Improvement

As actually producing the Interactive media art exhibition and looking at the reaction and the action of the spectators, it was possible to derive the complement according to the proposed affordances classification as follows.

**Table 1.** Analysis of artwork based on affordance

| Work | Affordance | | | | | Complement |
|------|----|---|---|---|-----|-----------|
| | Sp | P | C | F | Sep | |
| Invisible compromise | Δ | Δ | Δ | Δ | O | secure enough space / modify the scaffold form to stair form of low level / set indirect lighting in scaffold / modify response rate / rectify video not to stand out / rectify scenario with reality |
| Now what is the your dream? | O | Δ | O | Δ | O | fix the sensor installed inside stand and minimize error range / make pop-up book more stably / additional function of sound work |
| Lay bare | Δ | Δ | O | Δ | Δ | configurate space formed narrow hall / control sensor range of camera in detail / rectify video scenario in situations / additional function of olfactory work |
| A Snooper | O | O | O | Δ | O | chnage the coordinate of mouse controller inside flashlight / control video change range in detail |
| Hide and expose | Δ | O | Δ | Δ | Δ | change exhibition space / add sound work |
| Beyond the border | O | O | O | Δ | Δ | rectify eyes of people in video / give perspective / shadow effect |
| My Venus | O | Δ | O | Δ | O | rectify system to recognize in detail / modify system / apply sensor on the road |
| Artist | O | O | Δ | Δ | Δ | supply feedback to return to initial condition / widen the interval between interfaces / rectify interface not to show sensor |
| Strange dialogue | O | O | O | Δ | O | rectify system to enable natural dialogue / suggest limitation on the keyboard |
| Receiver of communication | O | Δ | Δ | Δ | O | rectify system / rectify interface material / rectify video to respond between interfaces |
| Letters from... | O | O | O | Δ | O | not to loose adjustable resistance and button |

## 2-2-1. Spatial Affordance

Exhibition 'the System of objects' was consisted of the different and unique exhibition space from the existing interactive media art exhibition space that could be commonly accessible. The exhibition space that made up of a tent structure made a large passages naturally raised the engagement of the spectators due to the limited circulation of the spectators and at the same time led to the flow of the entire exhibition. However, works were not fused with its own interface well in some part. Since it was difficult to know the information on each work in advance, it was lack of association between configuration and interface. Specifically, each works failed to secure enough space to make room so that it had difficulty for the independent space. However, as the projection images was major, by assimilating space itself to the screen, spectators were able to experience that the works were in harmony with a space.



**Figure 1.** Spacial elements of 'the System of objects'

### 2-2-2. Physical Affordance

Physical affordances was determined by physical form and the size of the input interface. and it was applied to the input interface. In the case of 'Invisible compromise', the scaffold installed a pressure sensor at the foot was used for the input interface. It was appropriately produced to meet the size and width of foot size, but the form of a simple rectangular shape alone was insufficient to induce spectators standing to the stadium. In order to compensate for this, the indirect lighting should be installed to be aware of the scaffold and the stairs should be installed to induce the climbing actions. Only one low step staircase could be derived enough to induce the climbing behavior.



**Figure 2.**   A foot step of "Invisible compromise'

### 2-2-3. Cognitive Affordance

It was cognitive affordance that helps to predict the outcome or results conduct get by the input of the spectator. Since the input interfaces used in display were flashlight, keyboards, radios, etc. which the spectators had been already learning about the function of these interfaces, it was possible to predict the results and result actions when using these interfaces. In addition, when the correspondence between each input interface and output interface was natural, the cognitive affordance could be improved. In case of the 'receiver of communication' using the receiver as input interface, the end of receiver was connected with the thread, but because a thread in images was not connected with the thread of the actual receiver, the appropriate response was not fulfilled.



**Figure 3.** A receiver of 'receiver of communication'

### 2-2-4. Feedback Affordance

The feedback affordance was the affordance to the feedback given by the input of the spectator. In exhibition, since there was not enough fast reaction time between spectator behavior and output, it was difficult to experience some of the work. In case of reaction rates as well as the input interfaces which were day-to-day things, the spectator's participation was decreased due to failure to meet spectator's expectations in the functions. The flashlight was used in the work 'A Snooper' as the input interface. However, in this work, in fact, the expected results were not shown as a feedback. Because the remote mouse controller installed inside lanterns was very tricky to operate, as well as the initial coordinate values were not properly set. As the function of flashlight that was recognized by spectators did not correctly reflect to the output interface, the participation of spectators was falling and it became difficult to experience the work.



**Figure 4.** Broken flash light of 'A snooper' and 'Artist'

### 2-2-5. Sensory Affordance

The interactivity between spectator and the work would vary greatly depending on how much exhibition had connectivity between the interfaces and was expressed sensately. The desk and chair with keyboard in 'Strange dialogue' were used as input interfaces. And the same desk and chair were also used as the output interface. People in the screen were waiting in holding a pencil and sketchbook instead of a keyboard. The space was also made an independent space with the recessed structure. Since the overall coordination and linkage of the work were very good, the spectator would be able to sit in the chair naturally. Like this, the sensory affordance helped to induce action by giving linkages on the overall composition of the work.



**Figure 5.** 'Strange dialogue'

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# 3 Proposal of related works

In this section, the related work with the work of this researcher 'lay bare' in the works displayed in the exhibition 'the System of objects' was proposed. While keeping with the overall concept and scenario of the 'lay bare', on the basis of an analysis of the exhibition 'the System of objects', the improvement direction was set to increase the interaction with the spectators.

## 3-1. Intention and scenario of planning

The 'lay bare' with the temporary title, 'grub' was sarcastic that food itself was not consumed in modern society, rather than social symbol of the food was consumed, and it was a video work that since the figure enjoying the food itself was discovered in personal space, it made be ashamed. In this work 'lay bare', people＇s actions were changed by spectator＇s eyes. It was important where the spectator's eyes to stay, and because of this, what kind of interaction with the work. In order to bring spectator＇s eyes as input, both sides of screen where the work was projected were set as the inlet and the outlet of the exhibition space.

**Table 2.** A scenario of 'Lay bare＇

| Spectator's Circulation | Input | Scenario | Remark |
|---|---|---|---|
| Spectator's Circulation | Input | Scenario | Remark |
| before enter | | gobble food | after fade in and replay |
| when entering | data 'in' recognition | surprised | configuration in 3 stages |
| when staying | | hide the food and | compose a variety of scenario and replay randomly |
| when going out | data 'out' recognition | send the spectator | |
| after go out | | discard food | after fade out reset |

Spectator＇s eyes were divided into 5 through the circulation that spectator entered into the entrance and went out to the exit. Spectator's eyes configuring the path through the constraints of behavior were to provide a linear scenario such as 'eat-surprised-hide-send-discard'. Spectators had the same path with a constant flow path by constraint of the exhibition space and experienced the work of the same scenario. Thus, to provide a more rich and diverse experience for each spectator, a variety of images for each case was to configure. In addition, considering more than one spectator, the surprised images were constructed dividing into three stages.

## 3-2. Application of affordances properties

The work 'lay bare Ⅱ' was proposed as a format to improve the more participation of the spectators in the work 'lay bare'. Thus, the affordances was looked into how to apply it to the 'lay bare' in the exhibition 'the System of objects' and it was suggested ways to improve.

### 3-2-1. Spatial Affordance

The work by using the rear projection technique was provided the image from one side of the screen, and in the form of hall space, the entrance and exit were separated clearly and the space was configured to ensure the independence of the work.

Especially when eating or being surprised images were played, because it was used by a particular sound, other works should be enough to secure the distance. In addition, in order to provide the scenario according to the spectator's eyes, before entering the spectator at the entrance to check the screen, it was to consist of the space of the hall structure. In the exhibition 'the System of objects', it could be configured freely as desired to keep the tent structure in the exhibition space. Because holding the frame with rod and specifying the desired side as the projected screen, the spectators＇ diverse behaviors could be led and the work could be projected from different angles. Thus, in the first situation, as intended, plenty of space organization was possible, but in the process of deployment along with other works, the independent space was difficult to secure. In addition, due to large width, in the position of the spectator, it was difficult to recognize the entrance and the exit section clearly.
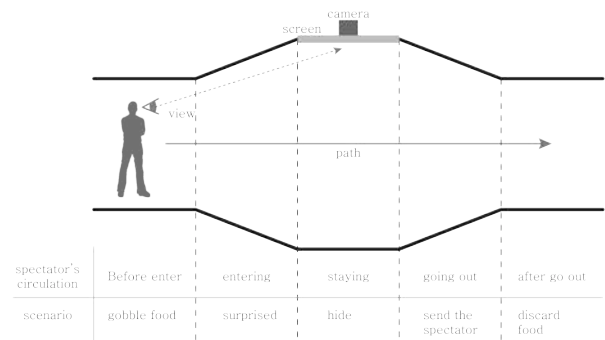


**Figure 6.** Spatial structure at the first time

The spatial affordance indirectly presented potentiality for the work. Thus, in the work 'lay bare', it was important to configure the circulation matching the concept of the work. In the related work, the width was to be created more narrowly to secure the independence of the work and to clarify the entrance and exit section. If reducing the width of the space, the spectator could be awakened from previous work, as well as it could be secured independence. In order to clearly distinguish between the inlet and outlet sections, additional lighting could be used. If the lighting was set on the space where the spectators eyes were staying in front of the work for a long time, the spectators were naturally derived under the lighting to enjoy the works. While narrowing the width, the contact angle with the screen where the work was projected on should be adjusted accordingly. Because from the range that begin to narrow upto the entrance of the work, the vision for the screen surface was to secure sufficiently. As a result,

spectators could experience a little deeper.
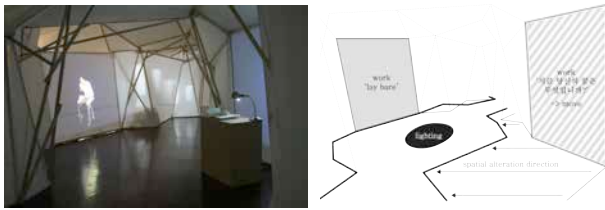


**Figure 7.** Positioned 'Lay bare' and the re-organized space structure

**3-2-2. Feedback Affordance**
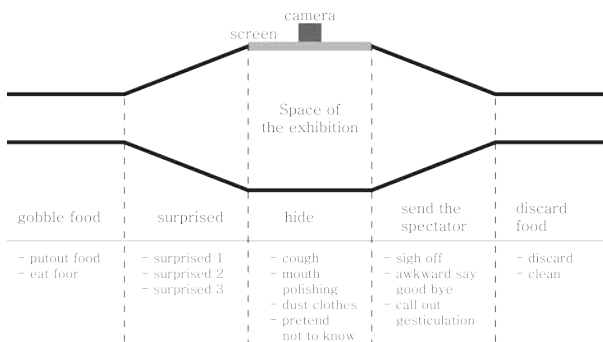


**Figure 8.** Scenario followed by space structure of the first time

The 'lay bare' providing the linear scenario was getting to a feedback that was the scenario itself provided by the circulation of spectators. In order to be able to know whether the feedback was deployed by the spectators, it was important if the scenario was well organized. The scenario of 'lay bare' set at the beginning was set to both sides of the screen as the entrance and exit section, and it was to provide images per section formed by the two intervals as a standard.

The five scenario depending on the spectator's circulation were big scenario such as 'eat', 'surprised', 'hide', 'send', 'discard' and by providing more than one picture for each scenario, a variety of situations were to provide randomly to the spectators.

<Picture9> scenario configuration according to initial exhibit space

In the exhibition 'the System of objects', it was possible to look into the reaction of the spectators for a variety of scenarios that were designed in the first. There were spectators who reacted and experienced to meet the intention of the work, but there were also the spectators who did not understand the whole context of the work. When the spectator entered into the entrance section, the surprised video is played. The video who was directed to the most dramatic direction due to the emergence of video spectators make sure that what was surprised. As the reaction was big enough, some of the spectators to get feedback continued to stay the inlet section to determine if there was feedback. While the spectators were staying in front of works, the video that was playing showed

the actions to hide. However, the context of the configured scenarios were not naturally accepted by the spectators. Each image was not connected naturally and was cut off because of the difficulty in reading the context. So in the four scenarios ' to cough ',' mouth polishing ',' to dust clothes',' to pretend not to know', one scenario that had the most natural flow, "to pretend not to know" and the 'called out gesticulation' which was a scenarios provided in 'send' was to provide. In particular, the video 'called out gesticulation' was a image that instruct the direct action to the spectator so that it was able to induce relatively higher participation. The 'sigh off' and 'discard' of the video images in the exit section did not stimulate the spectators. Since these images were relatively small sound and the videos were static movement, the spectators could not recogniz properly if it was the feedback by themselves. Thus, by using the dynamic movement or sound, the clear and concise feedback needed to be provided.

**Table 3.** Scenario comparison of 'Lay bare' and 'Lay bare 2

| Location of spectator | Video scenario | | | | | |
|---|---|---|---|---|---|---|
| | lay bare | | | | lay bare 2 | |
| | Before installation | | After installation | | Related works | |
| before enter | eat | put out food | eat | put out food | **eat** | **put out food** |
| | | eat food | | eat food | | **eat food** |
| inlet section | surprised | surprised stage1 | surprised | surprised stage1 | **surprised** | **surprised type 1** |
| | | surprised stage2 | | surprised stage2 | | **surprised type 2** |
| | | surprised stage3 | | surprised stage3 | | **surprised type 3** |
| in front of work | be settled | cough | hide | pretend not to know | **hide** | **hide food according to the spectator** |
| | | mouth polishing | | | | |
| | | dust clothes | | call out gesticulation | | |
| | | pretend not to know | | | | |
| outlet section | send | sigh off | send | sigh off | **send** | **get angry** |
| | | awkward say good bye | | | | |
| | | call out gesticulation | | | | |
| after exit | discard | discard | discard | discard | **discard** | **discard** |
| | | clean | | | | |

The feedback affordance helped to see clearly that the output value by the spectator was appeared by the spectator. The control was required such as better visualization of the output values and the faster response speed. Thus, in the 'lay bare Ⅱ', the scenarios was modified to have a consistent flow according to the spectator's circulation and interactive works changed by the spectator's eyes were to create. Eating picture remained the same, but the sound was more clearly increased to deliver and to recognize the initial situation. The surprised video was aware of the feedback by the spectators to maintain this structure, but more and more surprised video divided into three stages, instead of more surprised video, different kinds of surprised videos were divided and provided. There was no need to limit the number of spectators, and the more dramatic direction became possible. Hide images should be available to provide the video interacted by the spectator's eyes rather than to provide different pictures at random, In the interval, depending on the location of the spectator's eyes, poses to hide the food were different.

This was able to provide a consistent scenario, as well as according to personal eyes flow of the spectator, the work to be experienced would be different. In this case, depending on the eyes, based on the work by providing a high degree of reflection that respond in real-time, the feedback by the spectators should be clarified. Overall, the video was short and concise configuration and, in particular, the video that was replaying in the inlet section and the outlet section should be directed as dynamic and dramatic images.

### 3-2-3. Physical Affordance

The work 'lay bare' did not show the input interface to accept input values resulting from the interaction with the spectator. In the case of other works, stool, pop-up book, flashlights, a keyboard, a receiver, a radio were used. Like this, to use such a specific input interface might be advantageous to drive the behavior of the spectators. However, because this work was changed by the spectator's eyes and behavior, it did not require a specific input interface. The sensors that was not apparent in the work was installed to accept spectator's eyes and behavior as the input, so the spectator could focus on the work.

In the exhibition 'the System of objects', webcam was used as a sensor to identify the spectator's circulation. The path of the spectator was identified by placing it in the top left of the screen of work, and the spectator's movements were detected by pixelating the screen. Webcam with a unique composition of the exhibition space in the screen capture that artist wanted could be set the inlet and outlet sections that artist wanted. However, because the work itself did not reveal the input interface, the spectators were confused to take what kind of action in the first place. In order to shift as the author intended to move naturally, the other affordances were used to complement. In addition, there were spectators who did not move as intended path by the author. In order to continue to see the surprised video, some spectators kept staying the inlet section and some moved also from the exit section in the opposite direction to the inlet section. Because inlet and outlet sections were fixed by using a webcam, the scenario tailored to the direction of movement of the spectator could not be provided.

Therefore, it needed to build a system to identify any direction of spectators' movement. In addition, the WebCam took a lot of influence of especially light, so that it was sensitive to the changes of exhibition space. This work has been implemented unstably. This work has been implemented unstable. Therefore, in order to implement a stable work, it was needed to a minimum to reduce the influence of light.
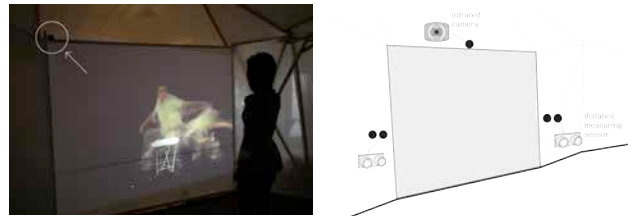


**Figure 9.** Web cam position of 'Lay bare' (L), Sensor position of 'Lay bare 2'(R)

The work 'lay bare Ⅱ' utilized the other affordances as assistance to follow the circulation that author intended when the spectator faced to the work for the first time. The spectator's circulation was constrained by the spatial affordances. As a result, even if there was no physical input interface, the spectator's input would be able to get more clearly. And according to the spectator's circulation that move freely, it was to set up the system. Without setting the entrance or exit, it was to determine the interval by the spectator's circulation. For this, the distance sensor was installed two each space respectively in the space of the inlet section and the outlet section, and spectators' circulation direction would be able to determine. Since the distance sensor was not affected by the light, and would recognize the distance of the object that placed in front of the sensor, the movement of the spectator was able to recognize more stably. In addition, when staying situation that the spectator faced the work, depending on the spectator's eyes, in order to enable the work to interact, an infrared camera has been installed to track the spectators' s eyes in the spectator section that encouraged to stay and installed the lighting. This was an eye-tracking system based on a video to track the relative position of the pupil and it was a way to measure by the eye movement. In the middle of the top of the screen, an infrared camera was installed, and it would be in line with the spectator staying space. Also if possible, this sensor would not be appeared.

### 3-2-4. Cognitive Affordance

In the case of cognitive affordances, an affordance helped to predict the future. The display method for this was naturally to configure the counterpart of input and output interface. However, this work should not provide clues for the prediction.

### 3-2-5. Sensory Affordance

The sensory affordance was an affordance that how the spectators feel sensately by connectivity of the exhibition components. As one work that composed of the exhibition 'the

System of objects', it was in harmony with other works, but the work itself did not provide a harmonious linkage. Thus, in order to improve the linkage between each component, the spectator's senses should be actively used in the 'lay bare Ⅱ'. Increase the size of the sound and it should be configured richer. In addition, because the image centered to eat, so that to make eating behavior look more outstanding, the images were reconstructed as the composition that highlight people's upper body.

### 3-3. Construction of related work

The input values that led to a change in scenario with the video scenarios as the center were controlled through a distance sensor and an infrared camera.
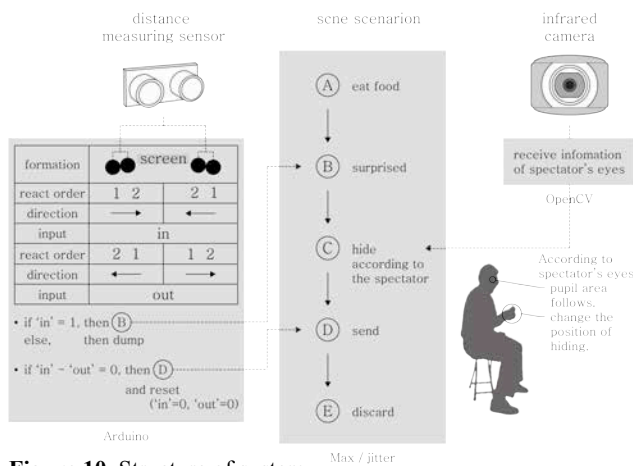


**Figure 10.** Structure of system

Two distance sensors that were installed on each side of the screen recognized if spectator's coming up or going out in order to respond. The input values of distance sensors were transferred to Max / jitter using the Arduino. Measure the direction of the movement of the spectator in real time, and considering the number of spectators, the configured scenarios were provided. Offer the scenario B based on the first person at all times, and only if all have gone, offer the scenario D. Scenario C was govern by an infrared camera as the sensor. The eyes of the spectator were tracked through the sensor. A program to track the eyes used the OpenCV. The input value was transmitted through the Max / jitter in the implementation of accepting information of the infrared camera and tracking system. The components of 'lay bare Ⅱ' were composed of exhibit space consisting of rod and textile, distance sensors and infrared cameras that are obscured in the input interface, and output interface with rear projection image.
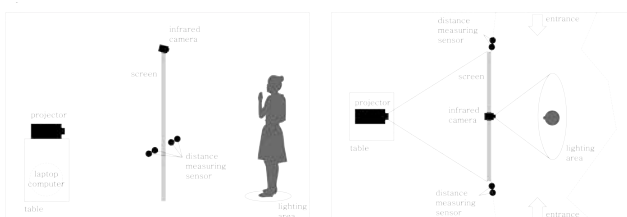


**Figure 11.** Blueprint of 'Lay bare 2'

## 4. Conclusion

In this study, affordances of interactive media art exhibition were classified and applied to the actual display and the related works had tried to be suggested. The participation of the spectator derived through previous studies, 'research on the affordances of interactive media art exhibition' was analyzed based on the five kinds of affordances, but there were the limitations to apply them on the exhibition of the art works uniformly. Because the work was not a design, we could not judge that classified affordances must be applied with the result that would have the value as a work. Only, as the technology-driven work, it was just one of the ways to increase the participation of the spectator rather than to be lack of interactivity. Thus, classified affordances should be used selectively according to the artist's intention and the situation on the display. Nevertheless, in this study, if using classified affordances in construction of a display, theoretical background was presented to composed of display more richly.

On the basis of an analysis of the exhibition 'the System of objects', the work of this researcher 'lay bare' complement was analyzed in detail and by deriving the direction of the improvement, the related work, 'lay bare Ⅱ' was proposed. In practice, however, because it failed to go through the process of implementing of the work, there was the limitation that no observation how the interaction of the spectator and the work could be done. In particular, compared to the previous work, 'lay bare', it was not checked the potentiality on the changes of the participation and experience of the spectator. However, on the basis of five affordances, detailed analysis was possible, and based on this work, the proposal of works to improve the affordances was possible. Based on this, future research was presented.

The exhibition 'the System of objects' was an exhibition with only a projection technique. Therefore, through this exhibition, there were limitations in the derived complements. In addition, by utilizing not only projection but also various media, the research on the interactive media art was needed. Because affordances appeared differently depending on the media, so the participation could be enhanced by offering the affordances in consideration of this. In addition, when the related work 'lay bare Ⅱ' was actually displayed, and looked at what happens the interaction with the spectator. Thus observe if the improved affordances have been applied well to the 'lay bare'. In the process of being guided the behavior of the spectators, it helps to analyze the intuitive and easy to access by what criteria and it would be classified the better affordances by analyzing.

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