Received June 30, 2013; Accepted September 15, 2013

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

This research is supported by Ministry of Culture, Sports and Tourism(MCST) and Korea Creative Content Agency(KOCCA) in the Culture Technology(CT) Research & Development Program.

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

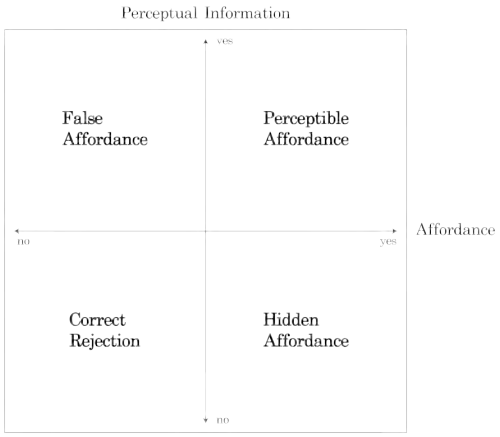
Gibson proposed affordance from an ecological psychological point of view. In his book Gibson emphasized affordance as the most important concept, defining it as "everything that environment surrounding animals offers and stimulates.1) His

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



<**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

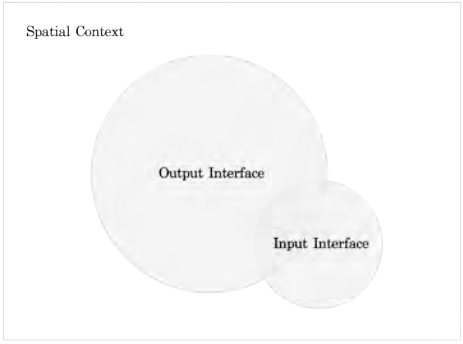
Major studies commonly define environment as everything that surrounds humans including objects, by applying the concept in a broad sense. In interactive media art exhibition, environment refers to exhibition space excluding the artworks, separated from the latter. Also, the studies above mostly see 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.

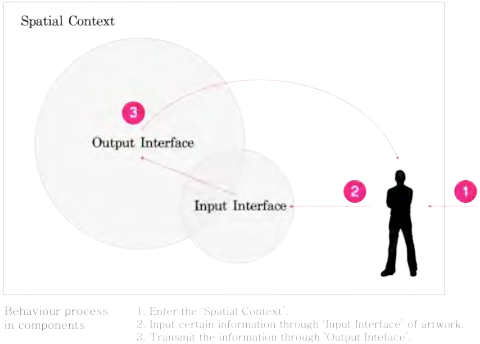


<**Fig. 2**> Components of interactive media art exhibition

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.



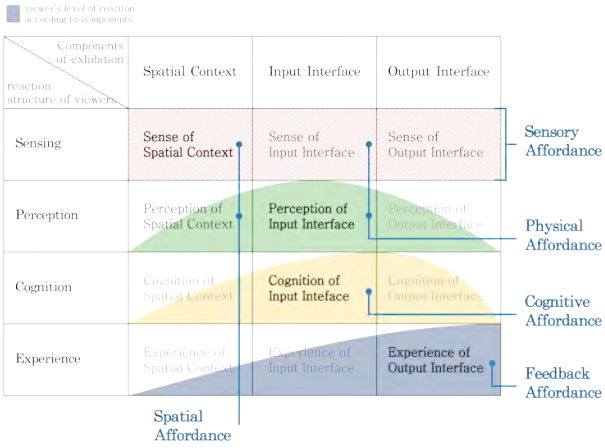
<**Fig. 3**> Viewers’ behavior process

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

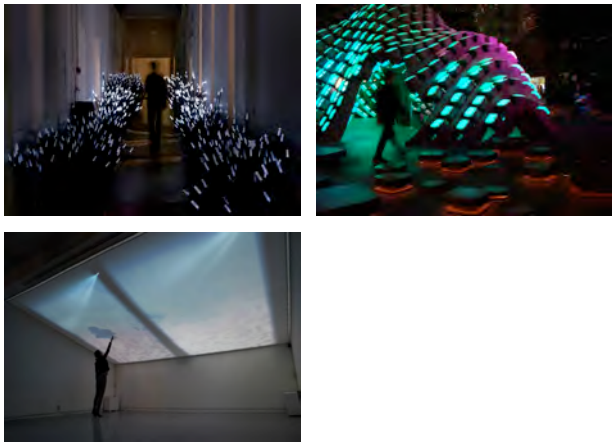
To classify affordances, the author examined the relationship between components of media art exhibition, the space, and reaction structure of viewers in the exhibition. It was found that the reaction structure is realized sequentially according to the components that the viewer encounters. Stimulation 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).

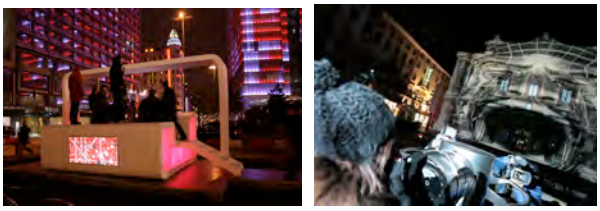
<**Fig. 6**> (Left) Shaw J. The Legible City.1988 (Center) VR/Urban. SMSLINGSHOT. 2010 (Right) Tsubokura T. Shadow touch!. 2011

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.



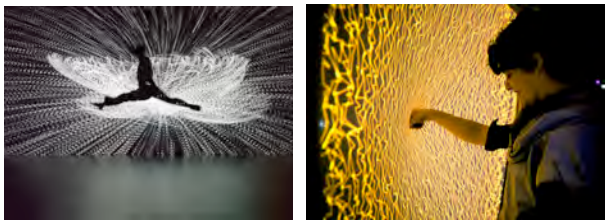
<**Fig. 7**> (Left) Dexia Tower kiosk (Right) 1024 architecture. Perspective Lyrique. 2010

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.



<**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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