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Ph.D. Dissertation

스크린 기반 가상공간의 속성 분석과
예술적 활용

Attribute of Screen-based Virtual Space and its Artistic Uses

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Attribute of Screen-based Virtual Space and its Artistic Uses

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¹ Declaration of Ethical Conduct in Research: I, as a graduate student of Korea Advanced Institute of Science and Technology, hereby declare that I have not committed any act that may damage the credibility of my research. This includes, but is not limited to, falsification, thesis written by someone else, distortion of research findings, and plagiarism. I confirm that my dissertation contains honest conclusions based on my own careful research under the guidance of my advisor

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초 록

사진, 영화의 등장과 함께 20세기는 기술 복제 시대의 예술이 가지는 현실세계의 기록과 재현의 문제를 고찰하는 시대였다면, 컴퓨터의 등장과 함께 21세기 디지털 시대의 예술은 물질을 기반으로 하는 예술형태에서 디지털적으로 생성된 가상공간을 기반으로 하는 예술형태로 넘어가는 혁신적인 변화와 함께한다. 넓은 의미에서의 가상공간의 개념은 환영적 공간을 만들곤 하던 선사시대의 동굴벽화에서부터 르네상스 회화로 이어지는 회화적 가상공간에서 찾아 볼 수 있으며, 현실세계의 공간성과 시간성을 동시에 구현하는 가상공간의 시작은 스크린을 기반으로 하는 영화의 발명 이후로 본격화 되었다. 이후, 컴퓨터로 만들어진 디지털 가상공간은 그 형식과 의미를 확장시켜 몰입적이고 중첩적인 형태로 발전함과 동시에 현실세계의 공간성과 시간성을 새롭게 확장, 변형, 재창조 하고 있다. 이러한 가상공간의 급속한 대두와 함께 디지털 시대의 예술 또한 기존의 물리적 재료와 공간을 기반으로 하던 시각예술과 공연예술의 형태에서 가상공간을 매개로 하는 예술 형태 또는 가상공간 내에서 생성되고 만들어지는 예술형태로 변화하고 있다.

이러한 상황 속에서, 본 연구는 가상공간의 의미와 속성을 정의하고, 그것을 바탕으로 가상공간을 매개로 하는 예술작품들을 재해석하고 분류할 수 있는 이론적 틀을 제시하는 것을 목표로 한다. 이를 위해, 기존에 논의 되고 있는 디지털 미학의 이론과 개념들을 종합적으로 정리하여 도출해낸 세가지 가상공간의 속성을 그 이론적 틀을 구성하는 기본 원리로 삼았으며, 그 세가지로 연결적(Networked), 반응적(Responsive), 다층적(Multi-layered) 속성을 제시한다. 특히, 가상공간의 ‘다층적’ 개념은 글자 그대로 다수의 레이어로 이루어진 합성의 의미에서부터, 연속적인 이미지들이 지속적이고 흔적 없이 연결되는 생성과 변형의 의미로까지 확장하여 다루고자 한다. 이 세 가지의 속성을 바탕으로 그에 상응하는 예술적 활용의 작품사례로 네트워크 퍼포먼스 작품, 인터랙티브 아트 작품 그리고 마지막으로, 뮤직비디오에서 보여지는 다양한 시각효과 사례를 살펴보고 그 각각의 속성을 검증하고 논의하고자 한다.

핵심낱말 스크린, 가상공간, 연결적, 반응적, 다층적, 네트워크 공연, 인터랙티브 아트, 뮤직 비디오, 분류 프레임워크

Abstract

In the 20th century—an age of mechanical reproduction—art faced a new era reconsidering the ways to record and represent the observable world with the emergence of photography and film. Whereas, in the 21st century with the advent of computers, the art of the digital age is accompanied by innovative changes from material-based artworks to art forms based on digitally generated virtual spaces. The concept of a virtual space in a

broad sense can be found in pictorial virtual spaces starting with prehistoric cave paintings to the Renaissance paintings which were intended to create illusionary spaces. Chronically, the beginning of a virtual space that simultaneously realizes spatiality and temporality of the real world has taken off since the invention of film. After, the technologies of computer and internet have expanded the forms and meanings of virtual space to be immersive, responsive and connected. Along with a rapid progression of this digital technology, visual and performing arts have also transformed from being based on physical materials and spaces to being created through virtual spaces or within.

Accordingly, this dissertation aims to define the meaning and the attribute of virtual space and to propose a theoretical framework to reinterpret and classify virtual space mediated artworks. The principal elements forming the taxonomy framework are based on three attributes of virtual space: networked, responsive, and multi-layered. They were derived through investigating and comprehensively summarizing the existing digital aesthetic theories and concepts. In particular, the concept of 'multi-layered' extends from the literal meaning of synthesis of multiple layers to the figurative meaning of generation and transformation of images continuously and seamlessly composited. Based on these three attributes, I discuss and verify the framework and its artistic applications by empirically examining the cases of network performances, interactive arts, and visual effects in recent pop music videos.

Keywords screen, virtual space, networked, responsive, multi-layered, networked performance, interactive art, music video, taxonomy framework

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Chapter 1. Introduction

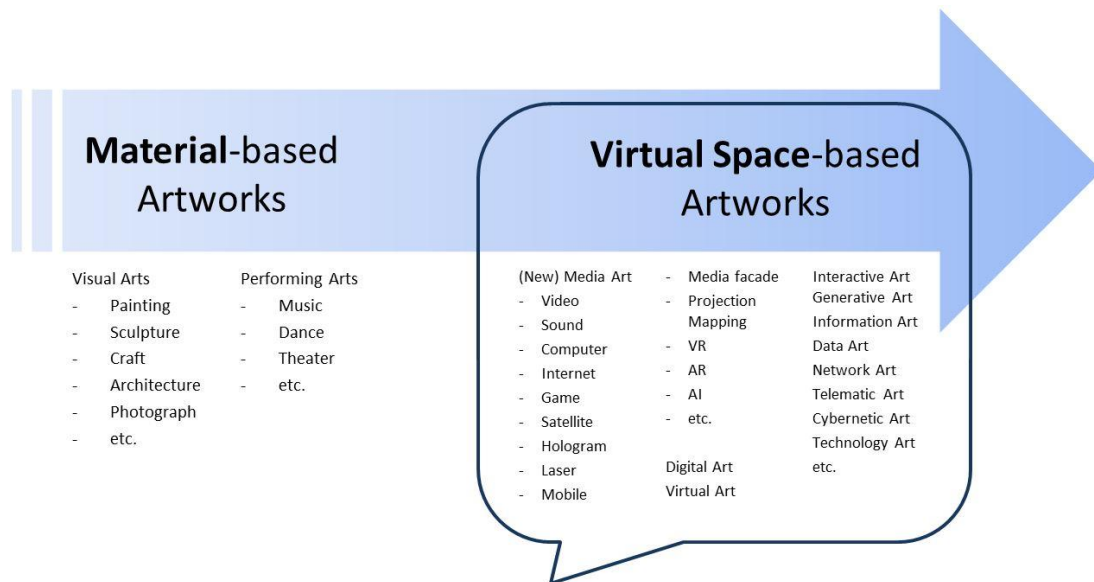
1.1 Motivation

With the emergence of photography and film, 20th century was a new era for arts reconsidering the ways to record and represent the observed world with mechanical reproductions; whereas, with the advent of computers, the art in the 21st century is accompanied by innovative changes from material-based artworks to an art form based on digitally generated virtual space. Walter Benjamin, in his thesis, *The work of art in the age of industry (Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit)* published in 1935, argues that the development of reproduction techniques such as printing, photography, and leading to cinematography diminishes the values of the original artwork, particularly the spatiotemporal presence and the aura and the unique aesthetic authenticity. Also, he discusses the change the techniques bring to the structure of human perception and the experience and its influence on political and social aspects. Benjamin's medium-aesthetic view—that media is not a mere tool used by an artist but a priori condition for the production of new art concepts—has remained as a valid media theory since the development of popular culture represented by the movie and TV industry, and through the late 20th century when computers and the Internet appeared, and until now. With the development of communication technologies such as satellites and the emergence of a dominant mass media such as the TV in the 1960s, artists began to contemplate global connectivity and communication. In 1964, Marshall McLuhan (1994) coined a phrase, "the medium is the message" emphasizing that the form of a medium itself conveys a message. Technologies that reproduce real-world represented by photographs and movies meet the new transition with the appearance of computers. In 1936, Alan Turing (1937) presented his first computer model in a paper called Computable Numbers. Since Ivan Sutherland (1964)—the father of computer graphics—introduced a computer program called Sketchpad, which interprets information drawn directly on a computer display in 1963, illusionary images produced by computers in the 21st century have become realistic virtual worlds than actual world and have allowed people to experience new levels of perception and sensation. In the digital age, photographs and films are no longer synonymous with the images that replicate reality but are extremely realistic and surreal created by generation and synthesis. Various forms of artworks have also changed from forms occupying a physical space based on materials to forms based on a digitally generated virtual space, or have been made entirely of a virtual space and exist only within it.

The concept of a virtual space in a broad sense can be found in pictorial virtual space leading from the prehistoric cave paintings to the Renaissance paintings which were intended to create an illusionary space. And the beginning of the virtual space that simultaneously realizes spatiality and temporality of the real world has taken off since the invention of a media, specifically, a film. Then, the digital technologies such as computers and the Internet have expanded the forms and meanings of virtual space to be immersive, responsive and connected. Along with a rapid progression of this computer technology since the 1980s, visual and performing arts have also changed from being based on physical materials and spaces to being created through virtual

spaces or within.

To interpret and categorize virtual space-mediated artworks, a new theoretical framework is needed beyond the existing visual and performing art genres. Many artists and researchers have classified artworks that have emerged using digital technology as new media art, digital art, information art, data art, interactive art, generative art, network, and so on. Moreover, they have tried to interpret such artworks through aesthetic or technical concepts such as virtuality, immersion, presence, telematics, interaction, and so like. Nonetheless, there are many limitations because terminologies are mainly based on a technical media, and thus researches on artworks using digital technology need more integrated insights. Indeed, as many interactive arts and network arts are pouring out with the popularization of computer and internet, other characteristics of many cultural contents as well as artworks that utilize new technologies such as more advanced computer graphics, virtual reality, augmented reality and artificial intelligence are creating new issues. Therefore, it is necessary to propose appropriate aesthetic concepts and taxonomy framework to interpret and analyze the new artistic cultural contents.



a coherent **Taxonomy Framework** is required

1.2 Research Objective

This dissertation aims to define the meaning of virtual space by combining the historical viewpoints of art and technical viewpoints and proposes a framework to classify and analyze artworks based on such virtual space. In addition, by using the taxonomy framework, I analyze various cases of artworks based on virtual space and re-contextualize the aesthetic meaning of the works. The principal elements forming the taxonomy framework are based on the attribute of the virtual space seen in the digital age. The attributes are derived by comprehensively investigating then summarizing the existing digital aesthetic theories and concepts. Each

criterion for classification aims to quantify the attributes as the most efficient concept. This will provide a theoretical framework and perspective for categorizing and interpreting artistic creations mediated through visual virtual spaces into an integrated view. I propose three attributes of the virtual space: networked, responsive, and multi-layered. In particular, the concept of 'multi-layered' extends from the meaning of synthesis consisting of literally multiple layers to the meaning of generation and transformation by multi-layered layers continuously and seamlessly composited. Based on these three attributes, I discuss and verify the framework and its artistic uses and applications by empirically examining the cases of network performances, interactive arts, and visual effects in recent pop music videos.

1.3 Research Scope

This research addresses artworks and visual contents based on a virtual space, usually in a category called a new media art and new media contents. Due to the popularization of digital media and the change in the way the public enjoys arts, boundaries between artworks and media contents have become increasingly unclear. In this dissertation, I refer to all of them as 'artworks' and also refine the meaning of virtual space which has various concepts from diverse research fields of physics, philosophy, culture and technology. Among the various types of virtual space-based artworks, I have studied the virtual space that is implemented on screens through visual images (Fig. 1).

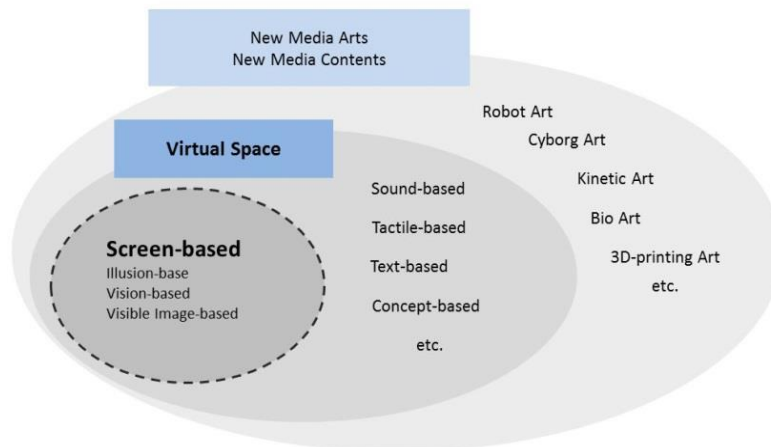


Figure 1 Research Scope: Screen-based Virtual Space Artworks

1.4 Research Framework

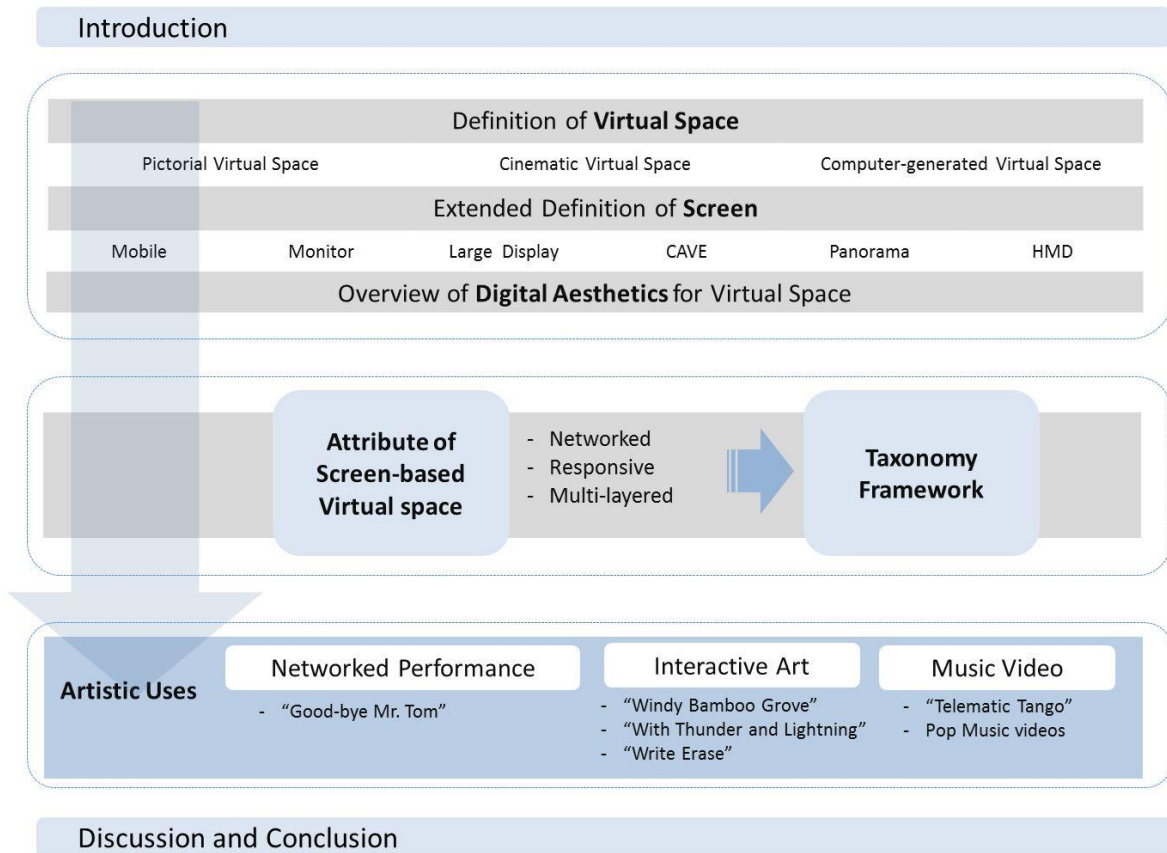


Figure 2 Research Framework

As shown in Figure 2, this thesis consists of five parts. The first part, the introduction (Chapter 1), clarifies the motivation, research objective, research scope, and research framework, and the second part, the background, and literature study (Chapter 2), addresses the definition of virtual space and extended screen and overviews digital aesthetic theories. The third part, Chapter 3, proposes three attributes of virtual space as networked, responsive, and multi-layered, and a taxonomy framework based on them. The fourth part, Chapters 4, 5 and 6, analyze specific artistic practices that utilize the attributes, and finally, the fifth part, Chapter 7, summarizes the conclusion.

In Chapter 1, I describe the research motivation, objective and framework.

In Chapter 2, I review the definition of the virtual space historically from three points of views: pictorial virtual space, cinematic virtual space and computer-generated virtual space, and I define the expanded meaning of screen as various types of display. I also overview the selective digital aesthetics for virtual space and categorize the aesthetic terms to three attributes of screen-based virtual space: networked, responsive and multi-layered.

In Chapter 3, I introduce the framework for systematically analyzing and classifying artistic creations that mediate virtual space. To do so, I propose three attributes of screen-based virtual space: networked, responsive,

and multi-layered. Then, I summarize the issues and the characteristics for each. Particularly, for the multi-layered property, layering type is divided into spatial and temporal layers for an in-depth analysis. In addition, the representative examples of existing artworks based on virtual space are newly reinterpreted and classified by applying the framework of the three attributes.

In Chapter 4—as an empirical study of the application of networked virtual space—a networked performance *Good-bye Mr. Tom* (2012-2013) is introduced, and the networked attribute is verified by analyzing the design and implementation process of the performance

In Chapter 5—as empirical studies of the uses of responsive virtual space—three interactive artworks *Windy Bamboo Grove* (2012), *Thunder and Lighting* (2013) and *Write Erase* (2017) are introduced and the responsive attribute is validated by analyzing them according to three interaction levels: intervention, participation, and creation.

In Chapter 6, I analyze and investigate the properties of various computer-generated visual effects in recent music videos to demonstrate various multi-layered virtual space.

In Chapter 7, the framework of three attributes is applied to 700 cases of media arts, and the findings from the applications are discussed. To conclude, the potential of the proposed framework for re-contextualizing virtual space-based artworks is expanded to future works.

Chapter 2. Background and Literature Survey

2.1 Background

For mankind, virtual space is accompanied by history of images. From the images left in cave murals and ancient relics to the many visual imageries embodied by modern films and computers, there is a desire for mankind to represent a virtual space in it.

The concept of space in the West has played an important role in all fields of cultural history such as physics, philosophy, philosophy, mathematics, religion and art from ancient times to modern times, and there are various concepts and definitions corresponding to them. Looking at the concept of space described in 1953 by Albert Einstein in a short preface to a physicist Max Jammer's book, *The Concept of Space: The History of Theories in Space in Physics*, Einstein contrasts two concepts where “space is a positional property of the world of material objects” and “space is a container of all material objects”. He describes that, in the former case, it is impossible to think of a space without material objects. And in the latter case, material objects can only be conceived as existing in space; space then appears as a reality which in a certain sense is superior to the material world. He also explains that space as container of all material objects was accepted as Newtonian inertial systems. Then, through a concept of field in which components depend on four space-time parameters and four-dimensionality, the concept of relative space and time has been established to overcome the absolute spatial concept (Jammer, 2013). Einstein's theory of relativity rejects Newton's concept of absolute time and absolute space. His theory has shown that time and space are closely connected interacting with each other as a combined continuum, and that matter and energy are also inseparable from the four-dimensional space-time. He also coined a phrase that physical objects are not in space, but these objects are “spatially extended” (Einstein, 1952). It can be said that this is a condensed expression of the connectivity and integration of matter, energy, time and space.

There are many concepts of space not only in the history of physics that overcame the concept of absolute space, but also in religious, artistic, and cultural terms. Margaret Wertheim (2000) has extended the concept of space through the relation of material space and mental space to the description of the religious space in the Middle Ages, the virtual space of the Renaissance painting perspective, the multidimensional superspace, and the cyberspace created by computer network. Thus, diverse concepts of space and their history naturally lead to a concept of virtual space.

In the dictionary, ‘virtual’ means “being such in force or effect, though not actually or expressly such”² or “not physically existing as such but made by software to appear to do so” in the computing era.³ In general,

² *Collins English Dictionary* Retrieved April 28 2018 from <https://www.thefreedictionary.com/virtual>

³ *Oxford Dictionaries* Retrieved April 28 2018 from <https://en.oxforddictionaries.com/definition/virtual>

the term 'virtual' refers to the state of being depicted, imitated, or reproduced to be seen real although it does not physically exist. As digital technology develops, it is used more often to refer to the state created by computer programs. Especially over the last decades, as computers developed, the terms 'virtual' and 'virtual space' have come to the fore in our culture as media, art, and technology. A virtual environment, also called a virtual world, virtual space and virtual reality, can be defined as a computer-generated representation or simulation in which the user of the system perceives themselves to be and within which real-time interaction takes place (Kalawsky, 1993; Biocca et al., 1995; Blascovich et al., 2002; Ho, 2012; Oliveira et al., 2018). From this technical point of view, virtual space indicates an immersive world and reality that is made to provide similar presences and experiences to the real via digital technology. In fact, a computer artist Myron Krueger, the first generation of virtual reality, used the term 'artificial reality' (1983). The spectrum of meaning of virtual space is very wide. According to Or Ettliger (2008), the terms, 'virtual' and 'virtual space' acquire different meanings in the various contexts in which they are used—from imaginary, fictitious or metaphysical to computerized or high-tech. Etymologically, 'virtual' comes from the Latin word, 'virtus' meaning virtue. In medieval English, 'virtual' is also used as a word to mean possessing certain virtues⁴. Taking all these above mentioned etymological meanings into consideration, 'virtual' may be interpreted to indicate a state that is made to appear so as not to exist physically but concurrently, a state that implies a virtue potentially real.

The most fundamental beginning of virtual space in human beings can be the image of mind by the human conscious operation such as memory, imagination, dream, and hallucination. These mental images do not physically exist, but paradoxically exist in the consciousness of someone and are perceived by people as extremely biologic and cognitive phenomena, and they have been recreated and expressed as virtual space in various forms of artworks in human history. All artistic genres from ancient times—such as paintings, music, art, dance, and literature—try to reveal and embody the virtual space experienced by humans in the real world through various media. In other words, 'virtual space' is a conceptual space that does not exist physically, but it can be regarded as an implemented image perceived using various senses, especially the vision. For example, in 1984, the term 'cyberspace' first appeared in William Gibson's novel, *Neuromancer*. He simultaneously depicts cyberspace as a conceptual space formed by information shared and transmitted over a computer network and as an illusionary image embodied graphically by data. He likens cyberspace to a hallucination, a complex visual-perceptual experience.

Cyberspace. A consensual hallucination experienced daily by billions of legitimate operators, in every nation, by children being taught mathematical concepts... A graphic representation of data abstracted from the banks of every computer in the human system. Unthinkable complexity. Lines of light ranged in the nonspace of the mind, clusters and constellations of data. Like city lights, receding.

- from Gibson's Neuromancer in 1984-

⁴ Oxford Dictionaries Retrieved April 28 2018 from <https://en.oxforddictionaries.com/definition/virtual>

Ways to implement virtual space, such as painting, photography, film, and video, changes and progresses along with the development of technology. Especially, with the invention of a film, it became possible to create a virtual space as a video that simultaneously realizes temporality and spatiality, and with the development of computer technology, real-time remote interaction and virtual space transformed freely by generation and synthesis techniques have become available. Many artworks using digital technology, such as the internet interacting with the audience, and algorithms that automatically generate artworks have been newly categorized beyond classical art genres as new media art, digital art, digital performance, and others.

In this context, focusing on the fact that the artworks that emerge after the digital age are mediated through computer-generated virtual space or created in the virtual space itself, this dissertation proposes a taxonomy framework based on the attributes of virtual space to classify and interpret digital artworks. Thus, in this chapter, I redefine the concept of historical virtual space and overview theoretical works of literature to build the taxonomy framework. To do so, first, in the following section, I investigate the types of virtual space in three aspects: pictorial, cinematic, computer-generated. Second, I examine the expanded concept of screen as a physical foundation in which virtual space is practically implemented. Lastly, in order to derive the attributes of a virtual space, I discuss and classify theories and terms from digital aesthetic viewpoints.


2.2 Definition of Virtual Space

I define virtual space as a complex concept from the mental, physical, artistic, linguistic and technical points of views as described in the previous section. A virtual space is a multi-layered aggregation of space, time, and objects that is implemented physically or immaterially so that it does not physically exist but appears to exist, including from mental images as perceptual experience to visuospatial images implemented using various technologies and media.

Virtual space, in a broad sense, is also experienced by mental images made in human consciousness such as a dream, a memory, an imagination, and a hallucination. Mental imagery which is sometimes referred to as 'visualizing,' 'seeing in the mind's eye,' 'hearing in the head,' 'imagining the feel of,' is a quasi-perceptual experience and generally is understood to function as a form of mental representation (Thomas, 2018). Artworks of various forms ranging from ancient to modern times can be said to have embodied such mental images in a physical world by using perceptible methods. The representation of mental images depicts not only the reproduction and the imitation of the real but also the modification or recreation of it. It sometimes represents another reality in the way of surreality, unreality, hyperreality, and such. In the field of art such as painting, sculpture, architecture, music, dance, photograph, film, literature, there are various embodied virtual spaces that can be seen, heard and felt. Above all, visual space has been the most discussed in many areas of virtual space. The virtual space that is visually represented providing perceptible illusionary images plays a pivotal role in all visual media such as painting, movie, and digital image. It can be even said that the history of virtual space is the history of illusionism. Table 1 summarizes the meaning of virtual space from broad to narrow. In the

following, I approach the topic about visual images based virtual space from three aspects—pictorial virtual space, cinematic virtual space and computer-generated virtual space—to demonstrate how virtual spaces are represented historically through visual media.

Table 1 From broad to narrow meaning of Virtual Space

Scope	Virtual Space		Example
broad  narrow	Mental image		Dream, Memory, Imagination, Hallucination
	Representation of mental image		Various art types, Painting, Sculpture, Architecture, Music, Dance, Photograph, Film, Literature
	Vision-based Representation	Pictorial Virtual Space	Painting, Photograph
		Cinematic Virtual Space	Moving picture, Animation, Film, Video
Computer-generated Virtual Space		Computer-generated imagery, Virtual Reality, Virtual World	

2.2.1 Pictorial Virtual Space



Figure 3 left. Lascaux Cave Painting (17000 BP), middle. Painted Garden in the Villa of Livia (30-20 BC), right. Last Supper by Leonardo da Vinci (late 1490s)

Painting contains a divine force which not only makes absent men present, as friendship is said to do, but moreover makes the dead seem almost alive. Even after many centuries they are recognized with great pleasure and with great admiration for the painter.

- from Alberti's On Painting in 1435 -

Pictorial virtual space is an image that is illusively implemented to be realistic as a three-dimensional space or a multidimensional space on a two-dimensional plane. The effort to represent realistic imagery on a flat surface using an illusion dates back to prehistoric times when images first emerged in human history (Fig. 3 left). Cave paintings indicate a typical illusionary space created by combining the sacredness of the space itself with the cave, the physical terrain of the inner wall of the cave, and the image drawn on the surface. According to South African archaeologists David Lewis-Williams and Jean Clottes (1998), even cave art, the oldest artistic creation of humans, may be related to hallucinatory experiences. In 1988, they launched a theory that some of the Upper Paleolithic cave arts were intimately associated with various shamanic practices and the universal features of altered state of consciousness induced by various factors, including psychotropic drugs, had been projected onto cave surfaces as an act to capture the hallucinatory visions. This is similar to a contemporary augmented reality technique in which a digital image is superimposed in real space, or a projection mapping technique that projects a two-dimensional image on real three-dimensional objects. The rugged organic forms of cave walls, which even itself evokes a three-dimensional illusion, combined with the realistically portrayed animal images, results in a realistic replication of the illusion. Thus, the cave paintings of the prehistoric era, tens of thousands of years ago show that the power of illusionary images and embodied virtuality, were no less than the real. This allows us to guess the human desire to implement virtual space.

An example of Roman domestic decor, Painted Garden in the Villa of Livia (Fig. 3 middle), is an immersive wall painting that depicts a garden landscape consisting of trees, bushes, fruits, plants and birds on the walls of a The architecture of virtual space. The fresco creates illusion of an artificial garden. The illusionistic painting techniques such as atmospheric perspective, subtle linear perspective and a kind of trompe-l'œil create a virtual space into which the visitor is integrated and immersed. As if the room and the walls have literally dissolved, and, as if there were real sunshine, breeze and rustle in the wind, the illusion of the landscape transports the viewer into totally another space (Grau, 2003; Harris & Zucker, 2012).

An Italian humanist, Leon Battista Alberti (1404-1472) mentioned “a divine force of painting” showing illusionary images as a reproduction of reality in his famous treatise, *On Painting*, describing all of the painting techniques and theories known at the time including linear geometric perspective (Alberti, 1970). Linear perspective, which is known to have been invented by Italian Renaissance artists, was one of the most effective systems to reproduce three-dimensional space on a two-dimensional plane in a geometric and mathematical way (Fig. 3 right). This perspective system was an important tool and pictorial principle that led to the centuries-old illusionism in Western art history along with the contrast technique and many other artistic techniques, such as the Trompe-l'œil, which are also based on perspectival illusionism. The perspective virtual space that creates a spatial illusion using one fixed viewpoint is still a valid visualization principle in computer graphics to increase the feeling of presence in an immersive virtual reality. The linear perspective has influenced over the course of Western art history as a system of creating an optical illusion.

Not only the linear perspective but also the idea of nonlinear and multiple perspectives have been explored in genres such as Cubism, Surrealism and Asian landscape paintings to reveal an illusionary space. The discrete and deconstructive composition that is seen in cubist paintings can be a typical example for the

nonlinear and multiple perspectives. Perspectives are a way for an artist to recreate the external or inner world through graphic techniques such as synthesis, transformation, distortion, and abstraction from a subjective view departing from depicting the visually perceived image as it is. These nonlinear multiperspective techniques often appear as representative images of consciousness such as memory, dream and imagination, and are utilized for an illusionism that reveals a kind of another reality or potential reality. In traditional oriental paintings, we can easily find the multiperspective expressions. Korean *Chaekgeori* Screens of the Joseon Dynasty are decorative still-life paintings to show as if objects such as books, potteries, precious goods were in there. (Fig. 4 left). For implementing the visionary effect, *Chaekgeori* paintings borrow the western linear perspective method but reinterpret and apply it as a transformed multiperspective. This can be interpreted as reflecting the conceptual attitude such as multiple subjects, movements of viewpoint from a subject to individual objects, fluid change of subject and object relations. The pictorial virtual space created by this multiperspective brings effectiveness of moving viewpoint and embedded temporality rather than one fixed point. Especially, such moving perspective is more clearly shown in landscape paintings. The landscape is unfolded in a panorama, as different points of view coexist seamlessly in one scene, the contemplative viewpoint flows vertically or horizontally. As one example, *Dream Journey to the Peach Blossom Land*, a painting of the Joseon Dynasty, is depicted with panoramic views, departing from the rural landscape of everyday real world on the left, passing through the rugged Middle-earth of the strangely shaped rocks and moving to the utopian peach blossom land on the right (Fig. 4 right). The description of nonlinear and multiperspective space in paintings creates a multifaceted and transformable open space as an interpreted space, not for a stationary viewer. This can be an artistic implementation and visualization that represents the concept of relativistic and multi-dimensional spacetime in modern physics. As we have moved into the computer age, the properties of these multi-perspective virtual spaces have become more generalized. Computer compositing, in which various spaces are combined into a single space, is an essential aesthetic attribute of digital images.



Figure 4 left. Korean *Chaekgeori* Screens (19C), right. *Dream Journey to the Peach Blossom Land* by An Gyeon (1447)

2.2.2 Cinematic Virtual Space

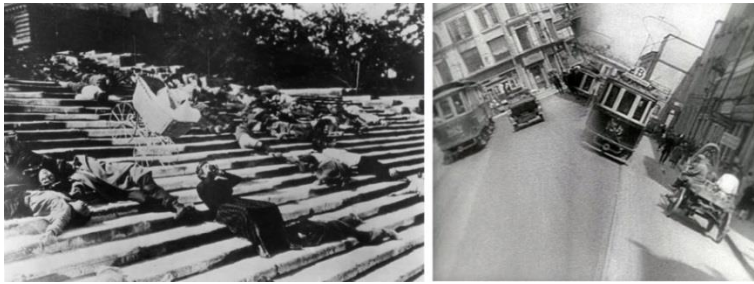


Figure 5 left. *Bronenosets Potyomkin* (1925), right. *Man with a camera* (1929)

A cinematic virtual space is an illusionary image that simultaneously realizes spatiality and temporality. Through the invention of films, implementation of moving image became possible. The illusionary attributes of film images are divided into two aspects: space and time. On the aspect of space, the characteristic that embeds a three-dimensional space on a two-dimensional plane like a photograph or a painting indicates an illusionary attribute. On the aspect of time, ‘movement,’ in other words, implemented temporality in cinemas is also an optical illusion that is made to appear as if it were moving by showing each of the still images continuously. In regard to the illusionary movements of films, a philosopher, Bergson (1911) called it the "false movements" produced by a series of immobile photographic images to imitate real movements of a real object. Whereas Gilles Deleuze (1986) argues that the movement of cinema is already implemented by cinematic devices and that images in films are the images that the movement is already embedded, so-called the ‘movement-image.’ He deals with full-fledged movie images that contain leaps of space and time due to camera movement, editing, and montage. Namely, Deleuze deals with the movement-image from a cinematic point of view rather than from the film devices that perform mechanical duplication and mechanical continuity. On the other hand, Bergson's critical comment is derived from the point of view about the earliest mechanical films which are images of a fixed frame and a single shot without the notion of a montage. From the perspective of Deleuze, beyond copying the three-dimensional reality or being made to look like it is moving, the notion of illusionary space and time in cinema are expanded to the reconstructed and recreated space and time by moving the viewpoints of a camera and by montaging, respectively.

A film is an effective technology in replicating the reality in the same way as humans perceive the external world using vision. However, considering cinematic virtual space, it is even more important that film creates different realities by various cinematography and camera techniques such as tracking, panning, zooming in and out while transforming and distorting the space and time. In 1895, even the Lumière brothers, who first started filming and started to screen the public, were also said to worry about what to take and how to create cinematic images (Toulet, 1995). More than 120 years later since the invention of the film, cinematic virtual space has taken apart everywhere in our culture and life. Today, through the development of graphic synthesis and generation techniques by computers, the current cinematic virtual space is providing a new level of experience representing the possible reality beyond the actual one through hyper-real and hyper-sensate images.

2.2.3 Computer-generated Virtual Space

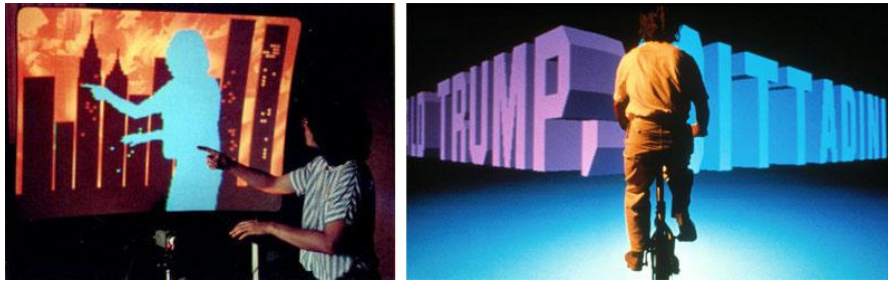


Figure 6 left. *Videoplace* by Myron Krueger (1970s), right. *Legible City* by Jeffrey Shaw (1988)

Computer-generated virtual space is an illusionary space consisted of complex layers of synthetic or generative images and can embody responsive and networked properties. The term, ‘virtual space,’ began to be used extensively after the 1980s, which is in line with the development of computer technology. The meaning of virtual space, in a broad sense, indicates illusionary images seen in various art media, whereas, in a narrow sense implies an immersive environment created by computer technology mimicking the experience of a real world expressed in terms such as ‘virtual world’ and ‘virtual reality.’ Most of the recent photographic and cinematic images we encounter are also computer-generated images that are synthesized and processed by computer programs. This digitally generated illusionary space is composed of multiple layers with adjustable parameters such as objects, backgrounds, textures, filters, lighting, and viewpoints in the process of embodying imagery by a computer program. Each element is modular for facilitating composition, modification, transformation, and replacement at any time. These virtual spaces can be rendered as a single image or a video file—like digital pictures or movies—through the process of rendering or merging. Moreover, the real-time inputs and outputs of the virtual spaces can be made available to users, viewers, or external elements like video games with many manipulatable visual contents. It is also possible in digital space to connect to other remote users, objects or places via a network. For instance, Myron Krueger's *Videoplace*, a pioneering early media art that was produced in various versions from the 70s to the 90s, shows a virtual space where the silhouette image of visitors and the planar images are superimposed through various image processing techniques (Fig. 6 left). In the case of Jeffrey Shaw's *Legible City* (1988), we can see a three-dimensional computer-generated virtual space that can navigate between letters implemented in 3D modeling (Fig. 6 right).

2.2.4 Extended Definition of Screen

The surface where the visual illusion of virtual space is implemented on is called a screen. Virtual space can be realized on screens and by screens. The screen can be the wall of ancient caves or buildings and rectangular frames for paintings, movies, TVs, and computers. It can act as a display which presents cinematic virtual spaces, or an interface between humans and computer-generated virtual spaces. In recent years, there are larger and immersive screens and even frameless screens such as head-mounted displays or transparent glasses. In 1965, Ivan Sutherland, the pioneer of computer graphics described a computer display as a window through

which one looks into a virtual world in his speech of “The Ultimate Display” (Brooks, 1999). His reference to “a window into a virtual world” is the most symbolic representation of the role of the screen that mediates between virtual space and the real world.

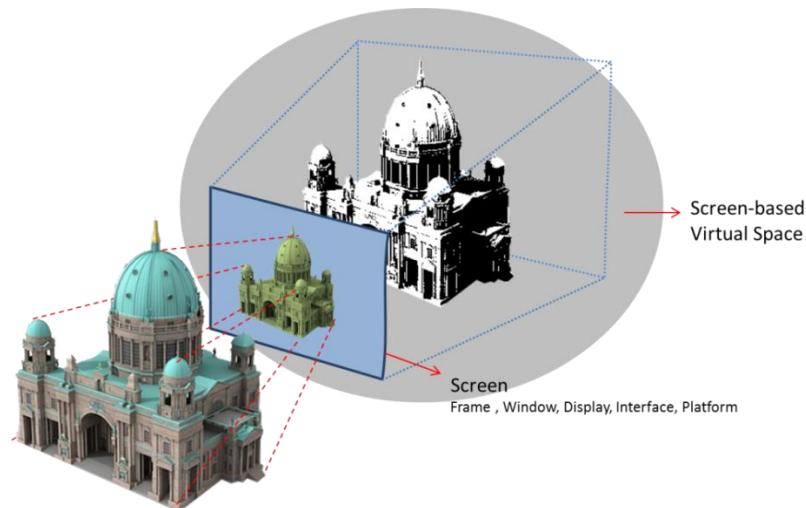


Figure 7 Screen-based Virtual space

With the advent of various digital media, forms of screens has also been diversified—from the cathode-ray tube televisions and big screen of movie theater, portable mobile display, 360 degree enclosed immersive screens such as CAVE system and panorama display, fully immersive head-mounted display without square frame in VR, transparent screen in AR where virtual space is superimposed on real space, and to the most recent retinal display using human retina as a screen (Sugawara, 2017). The screen and the virtual space implemented on the screen are no longer an object or a thing, but an environment or space by itself. Lev Manovich, a new media theorist, says in his representative book, *The language of new media* (2001), "with VR, the screen disappears altogether." He also added that, in VR, the viewer is fully situated within another space, and the physical space and the virtual space coincide. However, strictly speaking, in the situation of wearing a head-mounted display or transparent glasses, it is more appropriate to assume that the screen has not disappeared, but that just the frame has disappeared. The reason that viewers perceive and feel that they have entered a virtual space is that the screen completely surrounds their sight and visually blocks the physical world. I want to define the screen more broadly as a material base or a container that allows the virtual space to exist visually such as pictorial, cinematic and computer-generated virtual space.

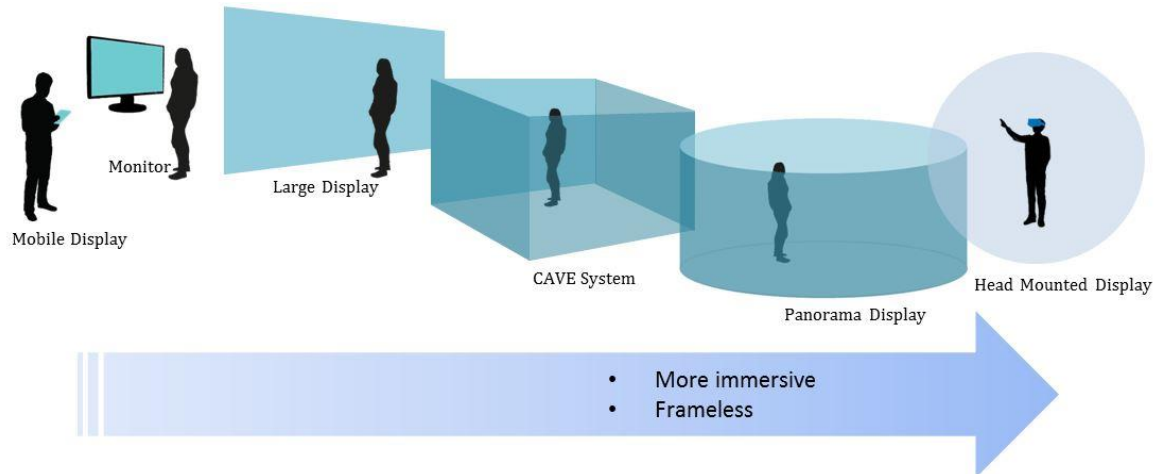


Figure 8 Various Types of Screen for Virtual Space

In this context, the ‘screen-based virtual space’ discussed in this thesis refers to a cinematic and computer-generated virtual space shown with various types of screens encompassing a wide range of displays from rectangular planar shapes to immersive and frameless displays. The illusionary space shown in paintings and photographs corresponds to a screen-based virtual space in a broad range. However, this study does not deal with paintings and photographs but focuses on cinematic virtual spaces as moving images and virtual spaces created by computers. The screen-based virtual space is composed of all types of visual attributes such as abstracts and figurative and is two-dimensional or three-dimensional shown as a visual content in various media.

2.3 Overview of Digital Aesthetics for Virtual Space

The emergences of new media and new technologies always provoke new forms of art and artistic experiments. In particular, the invention of photography and film in the early 20th century neutralized the function of realistic reproduction of existing paintings and has led to the aesthetics of mechanical reproduction, mass production, and also anti-art. Industrialization and the development of electronic media have enabled the use of mechanical devices and robots in arts, and have brought machine aesthetics to surface. In addition, the emergence of TV as a mass media and the spread of video cameras have created video arts that use TVs and moving images as a material for artworks. These new media integrated with existing art genres such as experimental films have assisted the progress of new aesthetic concepts such as interaction and audience participation. Above all, the appearance of computers and the Internet had a wide influence not only on the arts but also on the way of human life and cognition. The pictorial virtual space, which is implemented only on the surface of a plane, has expanded to a three-dimensional virtual space that can be manipulated and navigated over a two-dimensional screen. Beyond the limits of physical place and distance, it is now possible to communicate with other people real-time in a same virtual space. In this way, the variety of digital arts has

emerged, such as works that use the Internet, interact with audiences, and are automatically generated by algorithms. These are new types of artworks that are not captured by the category of the existing visual arts or performing arts genres: painting, sculpture, installation, photography, film, architecture, music, dance, and theater. Thus, in this section, I present the theoretical basis for categorizing and interpreting new artworks focused on the virtual space generated by computers. For that, I summarize the technical and aesthetic theories and concepts over the past few decades to derive common characteristics and attributes of digital virtual space through clustering and classifying the theories.

'Cyberspace' has been used as a representative term for a conceptual space and environment created by networking, information sharing, and digital communication enabled by computers and the Internet, or all cultures encompassing them, ever since William Gibson's 1987 novel *Neuromancer* described cyberspace as the "consensual hallucination" of high-definition immersive graphical representation of data. Exquisitely, Gibson describes cyberspace as a "conceptual space" formed by information sharing on a computer network and as a "hallucinatory image" embodied graphically by data. This reflects the expansion of human consciousness and sensation brought about by the digital technology and the virtual space that it creates. With cyberspace, 'telematics', a typical conceptual term related to computer-mediated communication, is a neologism combining telecommunication and informatics. The term 'telematique' was first used in 1978 in a report by Simon Nora and Alain Minc to the then French president mentioning that telematics is springing to life born of the marriage between computers and communications networks (Nora & Minc, 1980). Roy Ascott, who frequently uses the concept of telematics, says that telematics means the convergence of computers and telecommunication systems, and indicates the technology and the medium at large. From the medium's point of view, telematics exists at the core of the interplay between remote beings and the diffusion of consciousness through such interactions (Ascott, 1984). In the sense associated with the telematics, he also coined a word, 'telenoia', which refers to a networked consciousness, interactive awareness, and mind at large (Ascott, 1993, 2002). The concepts of cyberspace, telematics and telenoia that have risen from the development of computers and telecommunication systems are important concepts related to the expansion of consciousness beyond the distance of a physical space.

Since the 1980s, as new virtual spaces and virtual realities created by communication technologies and computers emerged as important concepts technologically, socially and culturally, there have been numerous researches on the notion of 'presence' in the fields of science, technology, psychology, philosophy, and the arts. The concept of presence is inclusive and has various meanings and definitions. In the field of technology, the most widely defined definition of presence is the sensation of "being there" (Heeter, 1992). In addition, presence has been defined as a "perceptual illusion of nonmediation" which means to feel the illusion of virtual reality created by technology as real without the recognition of technology or media (Lombard & Ditton, 1997). Furthermore, presence has been defined as a subjective experience where the user feels located at a specific place even though the user is physically located somewhere else (Witmer & Singer, 1998). Presence in the technical sense initiated in 1980 when Marvin Minsky referred 'telepresence' as a means of manipulating remote objects through network access technologies such as teleconferencing and telerobotics (Minsky, 1980). Since then, there has been much research on telepresence as a feeling of being in a space although not actually

existing created by the technological mediums such as computers. In addition, many researchers have studied the effect of telepresence that people experience when they interact with computer-mediated or computer-generated environments (Steuer, 1992; Sheridan, 1994; Witmer & Singer, 1998). Furthermore, there are more theories and concepts concerning networking. One is 'connectivity.' The connectivity between people enabled by "interactive telecommunication" (Ascott, 1991), "network morphology and network subjectivity" (Cubitt, 1998), "network aesthetics" (Sack, 2007), "network ambivalence" (Jagoda, 2015), "virtual bodies" (Hayles, 1999), "body in the digital image" (Hansen, 2004), "being here, thereness, and being in the body" (Broadhurst & Machon (Eds.) 2006), and "the digital double" (Diction, 2007). Another concept is 'embodiment' as bodily-mediated perception and many aesthetic concepts of 'disembodiment' and 'dematerialization' on its extension. As seen in many aesthetic studies, due to the development of the Internet and network technology and the development of the Internet and network technology, the awareness of being 'there' in addition to being 'here' where one subject exists physically and the awareness of being together with the other, has become a natural everyday experience in the present age. Seeing, hearing and feeling the world far away, connecting and communicating with each other in an electronic and immaterial virtual space, and existing in multiple places simultaneously is also an important aesthetic concept in new arts emerging in the digital age.

The concept of audience participation and interaction is the most commonly emphasized attribute in digital arts. Visitors are guided to transform, manipulate, and engage in a creative work rather than being passive and be in a one-sided position where they only appreciate the work. The 'interactivity,' which is also a characteristic of digital media, has been studied aesthetically. Studies such as "pragmatist's aesthetics of interactive systems" (Petersen et al., 2004), "aesthetics of use" (Locher et al., 2010), and "aesthetics of interaction" (Kwastek, 2013) have analyzed artworks as an interactive system, and the study on "aesthetic response to facilitate intersubjective discussion" (Iser, 1978) has focused on reactivity. A pioneer in computer art, Myron Krueger (1977) has referred to the audio-visual computer-generated space as a responsive environment which perceives human behavior and responds with intelligent auditory and visual feedback. One of the representative aspects of interactivity and responsiveness in many digital artworks is reflecting the appearance of the viewer in the work. Such reflectivity invites the viewer to feel the connection between the work and the subject feeling the immersion through the resonance phenomenon, and feeling the disembodiment by another self existing in the virtual space created by the work beyond a mere manipulation or control between works and viewers. There are studies related to the notion, such as "reflection of the body" (Merleau-Ponty 1968), "transparency and reflectivity" (Bolter & Gromala, 2006), and "mirroring and attunement" (Wright, 2009).

Many theories and concepts such as "realer than real" (Massumi, 1987), "simulacra and simulation" (Baudrillard, 1994), and "second-order realism" (Darley, 2002) present that modern society is a society in which the virtual is more realistic than the real, and virtuality overwhelms reality. Especially, by the development of computer graphics and multimedia, modern society is an age of 'hyperreality' beyond the level of realistic representation of the real world as an illusion. Theories such as "digital compositing as new types of montage" (Manovich, 2001), "collage and morph" (Spielmann, 1999), "digital hybridisation" (Couchot, 2002),

“continuous variation” (Deleuze & Bene, 1979), and “superposing images” (Gaffney, 2010) which interprets virtual images with a concept of "superposition" of Bergson and Deleuze are concerned about the meaning of digital synthesis and the aesthetic and philosophical meaning of virtual images in modern society. The principle of 'generation' to produce a digital image with the principle of synthesis can be related to the concept of Autonomy created by the algorithm. In 1970's, aesthetic theories such as “generative aesthetics” (Bense, 1971) and “algorithmic aesthetics” (Stiny & Gips, 1979) appeared, and later, complexity principles such as “the beauty of fractals” (Peitgen & Richter, 2013), “evolutionary aesthetics” (Volland & Grammer (Eds.) 2013), and “chaos” (Doll et al. (Eds.) 2005) have presented concepts of digital aesthetic. Furthermore, there are also theories that say that the concept of error such as noise "failure” (Cascone, 2000) and "glitch” (Nunes (Eds.) 2011) are important in music and images produced by computers. Wonbang Kim, a Korean aesthetician, say that these computer-generated images such as anamorphism, diamorphosis variability, transitivity, deformations, modification, multiplication, multimodality, morphing, melting, and drifting are constantly changing in a liquid form and he calls it “the end of a solid sign” (Kim, 2014). In addition, “uncanny valley” (Mori, 1970), “digital uncanny” (Coyne, 2005), “psychedelic experience” (Leary et al., 1966), “the brain as a digital transmitter” (Leary, 1999) and “digital sensations” (Hillis, 1999) are the descriptions of psychological and sensory characteristics that digital images are involved, in technical, aesthetic, and cultural terms. The terms uncanny and psychedelic can be regarded as a representative aesthetic sensibility that characterizes a digital world composed of hyperreal created images, consistently transformed images, and seamlessly synthesized collage images. Furthermore, an American psychologist and counterculture activist Timothy Leary who is known to have called the personal computer the LSD of the 90s claimed that the drug culture itself was a forecast of, or preparation for, the personal computer age (1994). His theories from psychedelics to cybernetics are consistently based on the presumption that humans can create their own reality and that humans can experience another world beyond their limited physical reality. One of the worlds might be the altered perceptual world created by cranial nerve cells, and the other, the digitized virtual world made of bits and bytes.

As we have seen so far, the most influential factors in digital aesthetics since the 1970s and 1980s are the computers, the Internet, and the new space, time, and images created by them. Real-time connectivity and interaction between remote entities enabled by telecommunication, changes in spatiality and temporality, and virtuality and non-materiality brought about by constantly transforming, reacting and resonating images are the most important concepts of the aesthetics of the digital era. In recent years, there have been more complex and diverse artistic attempts due to rapidly developing and changing computer graphics and digital technologies. Accordingly, new aesthetic concepts are needed for interpreting and analyzing the artistic attempts and many various theories are still emerging. In the modern society of the 21st century, the concepts of cyberspace, telepresence, and interactivity by networking and computers have become technically and artificially no longer an epoch-making concept in a specialized field, but an experience that everyone experience and acquire in everyday life and culture. Digital spaces and images produced in all fields of art, science, technology, design, and industry are becoming increasingly sophisticated, multi-layered and expanding.

In this section, I have summarized various theories and concepts of digital aesthetics in order to present theoretical attributes that can categorize and interpret artworks created using computer-generated images and virtual space. When analyzing various digital aesthetics discussed above based on the common characteristics and associations of the concepts and terms, they are clustered into three concepts: '*networked*', '*responsive*', and '*multi-layered*', as shown in Table 2 and Figure 9 below. First, cyberspace, telematics, telepresence, telenoia and the other network-related theories are commonly associated with telecommunication by the Internet and are dealt with the *networked* attribute. Second, the theories about response, interaction, reflectivity and navigation are concerned with responsive and participation-inducing characteristics of digital systems and are clustered into the *responsive* attribute. The reason for proposing the term responsive rather than interactive, which is more commonly used, is that this study does not deal with digital media itself or digital system as a whole, but analyzes the attributes of virtual space. Therefore, I have decided that the concept of responsive is more appropriate, like the responsive environments discussed by Myron Krueger (1977). In addition, while the terms of interaction and interactivity have been extensively addressed in many areas of digital media, and their meanings and concepts are widely applied, responsive, is able to express the attributes of virtual space clearly and specifically than interactive. Third, features such as compositing, generation, complexity, transformation, and uncanny and psychedelic of digital images are classified as *multi-layered* attribute. Computer-generated imageries visualizing or simulating the real world can be infinitely graphically modulated, composited, and recreated. This feature of digital images is not caused by single or fixed property of images but by the fact that objects and spaces can exist in different layers in which each can be infinitely copied, modified, transformed and generated. Aesthetic concepts such as uncanny and psychedelic can also be said to be caused by such attributes. Comprehensively, these features are defined as multi-layered as a common third attribute that digital theories deal with. Networked, responsive and multi-layered, these three attributes are not mutually exclusive concepts, but they are intersectional. For example, concepts such as interactivity, connectivity, and embodiment and disembodiment are common issues to networked and responsive attributes. The concept of immersion or presence can be regarded as the most basic virtual space being categorized into any of the three categories. These three attributes are intended to derive the most optimized concepts within the limits of existing digital aesthetic categories.

Since the 1990s, there have been several theoretical attempts to classify and characterize the VR system, multimedia, and media art that are relevant to my study. David Zeltzer (1992) presented a taxonomy of graphic simulation systems based on three components: autonomy, interaction, and presence. Moreover, Grigore Burdea (1993) proposed three I's of virtual reality: immersion, interaction, and imagination. Also, in the book of *Multimedia: From Wagner to Virtual Reality*, edited by Randall Packer and Ken Jordan, the authors summarized the characteristics of multimedia as integration, interactivity, immersion, hypermedia, and narrativity (Packer & Jordon (Eds.) 2002). Also, there was a discussion of aesthetics of new media art dealing from the perspectives of networked, interactive and algorithmic (Drucker, 2005). Along with this research trend, I present three attributes of virtual space in this thesis as shown in Table 3: *networked*, *responsive*, *multi-layered*. In Chapter 3, I discuss each attribute in-depth.

Table 2 Overview of Digital Aesthetics for Virtual Space

Digital aesthetics	Authors	Keywords	Attribute of Virtual Space
Cyberspace	Gibson (1984/2000)	the consensual hallucination of high-definition immersive graphical representation of data.	Networked
Telematics	Nora & Minc (1978)	Broad field of computer-mediated communication	
	Hiltz & Turoff (1978)	Network nation, Computer-mediated communication	
Telepresence	Ascott (1984)	Network consciousness, distributed authorship	
	Minsky (1980)	Teleconferencing	
Telenoia	Ascott (1993)	Networked consciousness, interactive awareness, mind at large	
Network	Cubitt (1998)	Network Subjectivity, Interminable Identities, Network Morphology	
	Sack (2007)	Network Aesthetics	
Connectivity	Ascott (1991)	interactive telecommunications	
Embodiment / Disembodiment	Merleau-Ponty (1945/1996)	Bodily-mediated aspect of perception	
	Hansen (2004)	digital facial image, affective bodily perception, warped space	
	Broadhurst & Machon (Eds.) (2006)	Being here', 'Thereness', 'Being in the body' of embodiment	
	Brown (2006)	Being here', 'Thereness', 'Being in the body' of embodiment	
Response	Dixon (2007)	virtual body, the digital double	
	Krueger et al. (1985)	Responsive environment	Responsive
Interaction	Iser (1979)	Aesthetic response	
	Zeltzer (1992)	Autonomy, interaction, and presence: a taxonomy of graphic simulation systems	
	Petersen et al. (2004)	pragmatist's aesthetics of interactive systems	
	Locher et al. (2010)	Aesthetics of use	
Reflectivity	Kwastek (2013)	Aesthetics of interaction in digital art	
	Merleau-Ponty (1964/1968)	Reflection of th body	
	Bolter & Gromala (2006)	Transparency and Reflectivity	
	Stern et al. (1985)	Affect attunement	
Navigation	Wright (2009)	Mirroring and attunement	
Algorithm	Manovich (1998)	Navigable space	Multi-layered
Algorithm	Stiny & Gips (1978)	Algorithmic aesthetics	
	Drucker (2006)	Interactive, algorithmic, networked: aesthetics of new media art	
Generation	Bense (1971)	Generative aesthetics	
Evolution	Voland & Grammer (Eds.) (2013)	Evolutionary aesthetics	
Compositing	Porter & Duff (1984)	Compositing digital images	
	Manovich (2001)	Compositing, Modular media, New typs of montage	
Superposition	Deleuze & Bene (1979)	Superpositions, 'Une ligne de variation coninue', Variability, Transformation, Modification, Fold, Body without organs	
	Gaffney (2010)	superposing images	
Hybridization	Couchot (2002)	digital hybridisation, editing, cutting, pasting, transformations, deformations, multiplication, displacement, animation, storage, erasure, morphing	
Complexity	Doll et al. (Eds.) (2005)	Chaos, Complexity, Curriculum and Culture	
	Peitgen & Richter (2013)	The Beauty of Fractals, Images of Complex Dynamical Systems	
Error	Cascone (2000)	aesthetics of failure	
	Nunes (Eds.) (2011)	errant communication, poetics of noise, failure, glitch	
Hyperreality	Massumi (1987)	Realer than real	
	Darley (2002)	Simulation, second-order realism, hyperrealism	
Transformation	Deleuze & Gattari (1987)	Creative Transformation, 'Becoming', Rhizome	
Fluidity	Kim W.B. (2014)	Fluiduty and the end of the solid symbol	
Uncanny	Freud (1919)	'Das Unheimliche'	
	Mori (1970)	Uncanny valley	
	Coyne (2005)	Digital uncanny	
Psychedelic	Leary et al. (1966)	Psychedelic experience	
	Hillis (1999)	Digital sensations	
	Kent (2010)	Psychedelic information theory	

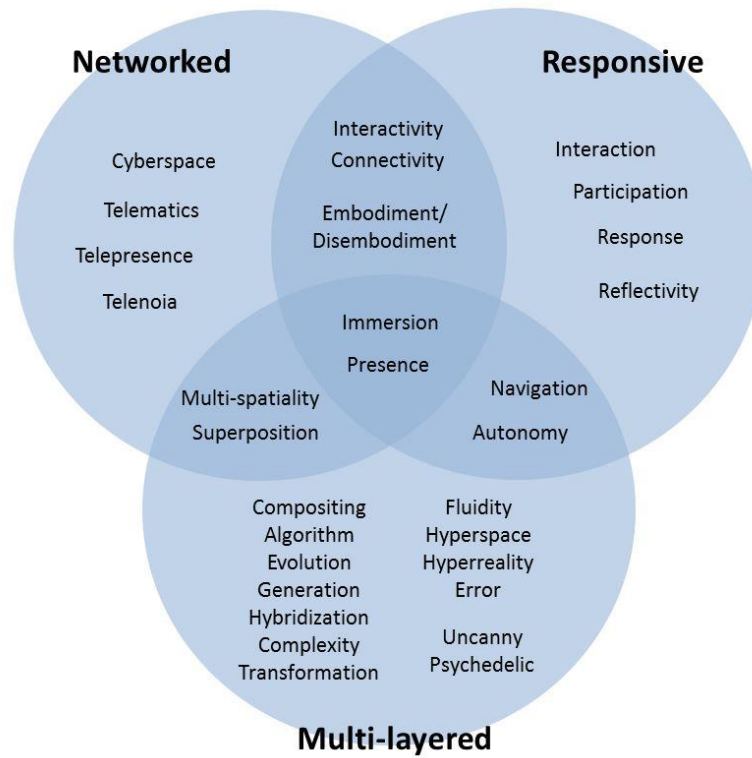


Figure 9 Clustering of Digital Aesthetic Notions

Table 3 Comparison with similar taxonomy theories of virtual reality, multimedia, and new media art

Zeltzer (1992)	Burdea (1993)	Coomans & Timmermans (1997)	Packer & Jordan (2002)	Drucker (2005)	Jungsun Park (2018)
Graphic simulation systems	Virtual reality triangle	Virtual reality definitions	Characteristics of multimedia	Aesthetics of new media art	Attribute of virtual space
Presence	Immersion	Immersion Real space	Immersion	Networked	Networked
Interaction,	Interaction	Interaction	Interactivity	Interactive	Responsive
Autonomy	Imagination	Autonomous agent Simulation Visualization	Hypermedia Narrativity Intergration	Algorithmic	Multi-layered

Chapter 3. Three Attributes of Virtual space

3.1 Networked Virtual Space

A networked virtual space is a virtual space implemented by screen-based images online and images that are connected to remote places, users, or objects through networking technology. In this dissertation, I do not deal with mental images and non-visible conceptual space. And also, computer interface or system interface space such as internet access, web surfing, and system manipulation is out of the research scope. The networked virtual space covered in this thesis is a conjunctive space created by composing or integrating two or more remote spaces or mediated images of people or objects connected by a network. In addition, even if the real-time interaction between remote users or participants is not performed in a virtual space, the resulting image created through a network connection is regarded as having an inherent network property. Representative virtual spaces with the networked attribute can be found in examples such as teleconferencing videos or multi-access online game spaces, as well as in video screens seen in artworks such as web art or networked performance. The networked virtual space covered in this thesis is based on the concept of networking, telepresence, and connectivity. In a networked virtual space, the remote subject or object 'there' may exist 'here' as a mediated image (e.g. video), and may also exist in the form of a computer-generated avatar. Remote subjects are immersed in such a networked space and feel that they are connected to each other and feel the presence that they exist together in one space.

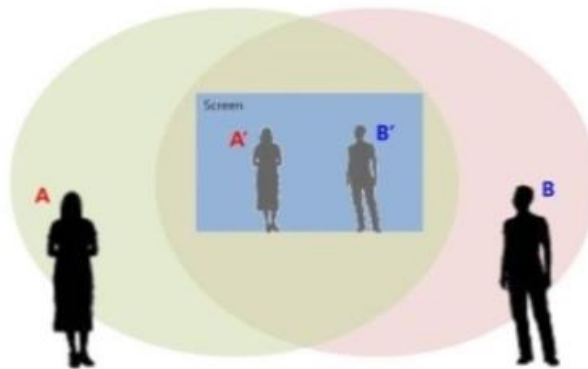


Figure 10 Networked Virtual Space

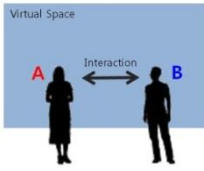
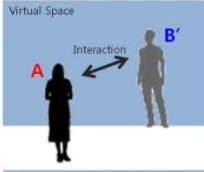
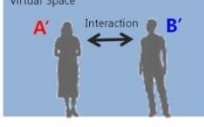
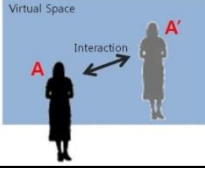
Networked Virtual Space and Interaction

The fact that the network connects the subjects or objects implies that they are interacting with each other in real time at the same time. The broad meaning of the word 'interaction' is that it is an act performed with an object, a person, or an existence in a given environment. The word includes a comprehensive array of

meanings, such as communication, message delivery, transactions, interconnectivity, interactivity, bi-directionality, selectivity, and controllability. Moreover, it includes a wide range of interactions conducted between humans, between humans and machines, and between media (Rafaeli, 1988; Rafaeli & Sudweeks, 1997; Downes & McMillan, 2000; Smuts, 2009). In this section, I discuss the types of interactions that occur in or with the networked virtual space. The interactions of remote subjects in/with networked virtual spaces are generally classified into three types as shown in Table 4.

The [A-B] type indicates face-to-face interactions between actual people in a physical space, and it is used as a reference category to classify the types of interactions performed by remote people in networked environments. The [A-A'] type indicates the recursion effect that occurs because of the round-trip process of transferring the data in a networked system. In this case, a person's interactions occur with a delayed image of the same person. This interaction type can be produced even in undistributed environments. The other two types of interactions, [A-B'] and [A'-B'] are the most typical types of interactions in or with networked virtual spaces. The [A-B'] is a type where a real person in a physical space interacts with an opposing person through video transmissions or avatars; particularly, it is an interaction between a real person in a physical space and the dematerialized image of a virtual person. While, [A'-B'] is an interaction type that occurs when remote people are simultaneously combined into one virtual space, and in virtual forms, interact with each other in that created networked space.

Table 4 Interaction type based on networked virtual space

A-B	Real Person-Real Person		face-to-face interactions between actual persons in a physical space
A-B'	Real Person-Virtual Person		a real person in a physical space interacting with an opposing person through video transmissions
A'-B'	Virtual Person-Virtual Person		individual remote persons combined into one video, and in virtual forms, interact with each other in that virtual space
A-A'	Real Person-Virtual Oneself		recursion effect that occurs because of the round-trip process of transferring the data

3.2 Responsive Virtual Space

Responsive virtual space refers to a space that reflects or responds to various elements of the real world such as users, viewers, or the environment in real time. “Response is the medium,” once claimed Myron Krueger in 1970s as he explored the concept of responsive environments. Here, he described that responsive environment is a real-time interactive computer-mediated space which perceives human behavior and responds with auditory and visual feedback (Krueger, 1977). According to Edmonds, Turner, and Candy (2004), interactive artworks transform viewers into participants, and they are magnified by digital technology and the development of generative systems in arts that have a basis on sound, image, and multimedia. When discussing the characteristics of computer-based media arts, no term is more often mentioned than audience participation and interaction. Lev Manovich (2001) even says that “used in relation to computer-based media, the concept of interactivity is a tautology.” What this phrase means is that manipulating and controlling information in real-time are computer-intrinsic functions. Interactivity that induces some feedback by user's intervention and manipulation is an essential and fundamental feature that distinguishes the computer from the former media. This study also deals with interactivity as an important issue when discussing the properties of digitally generated virtual space, although I use the term ‘responsive’ rather than ‘interactive’ because the term interactive is extensively applied to the broad meaning of the relationship between a system and a person in the digital media. Therefore, interactive is not a suitable term for referring to the attribute of the virtual space itself. Rather, as the initial concept of ‘responsive environment’ proposed by Krueger (1977), the meaning of responsive expresses the attribute of virtual space more clearly, and it is a term that reflects the cognitive and psychological reaction beyond systematic meaning. Thus, the responsive virtual space has the aesthetic basis of participation, connectivity, reflectivity, and the matter of body such as embodiment and disembodiment including the aesthetics of interaction.



Figure 11 Responsive Virtual space

Responsive Virtual Space and Interaction

In networked virtual space, the interaction between distant subjects such as users, viewers, and performers is an important issue. Whereas in responsive virtual space, the interaction between real subject and virtual space is an important point of discussion. While many studies on interactive arts have dealt with interactivity from the aspects of technical systems, user experience designs, and more, this study systematically summarizes the types and levels of interaction between the audience and the virtual space in artworks based on the overview of the existing researches about interaction framework. In particular, the interaction level is used as a basis for designing virtual spaces that respond to the movement and manipulation of viewers and is also applied as a criterion for quantifying the level of the responsive virtual space as an axis of the three attributes of the virtual space.

Since the 1990s, there have been numerous studies to classify and systematize the interactions between the audience and the systems in interactive arts based on human-computer interaction. The researches about interaction type can be grouped into three perspectives as Table 5 shown. The first group is the studies that typify interactions according to the participation of visitors, in other words, these studies classify the type of 'participant' (Clark, 1996; Sherrell, 2015; Sheridan et al., 2006; Heitlinger & Bryan-Kinns, 2013). The second is the studies that classify interactions according to the 'distance,' whether the interaction is direct or indirect (Brignull et al., 2003; Prante et al., 2003; Vogel et al., 2004; Grønbaek et al., 2006; Fischer et al., 2012). The third is the studies that analyze interactions focusing on whether the 'contents' provided by the system are passive or direct (Brown et al., 2011; Sommerer & Mignonneau, 1999; Hannington & Reed, 2002; Edmonds et al., 2004). Based on the summary of their respective interaction types, this study proposes different levels of interaction between virtual space and audience in interactive artworks: *implicit*, *interventional*, *manipulative*, and *creative* (Table 5). First, 'implicit interaction' is a cognitive interaction and reaction without direct physical participation, such as observation, appreciation, and sympathy. Second, 'interventional intervention' is the involvement with the artwork through involuntary interactions requiring little mental and physical burden without active participation or a manipulative act. The third, 'manipulative interaction' is the case when active participation and physical manipulative actions are demanded after comprehending ways to manipulate the interface. The final 'creative interaction' is an engagement that requires a creative process through some degree of creative thinking and action, often leading the viewer playing an active role to produce the result (Table 6). Interactive artworks as responsive virtual spaces implemented by computers thus require and induce participations from various aspects when interacting with the audience.

Table 5 Overview of Interaction Levels from the Point of Views Participants, Distance and Content

Point of View	No Interactivity	Interactivity						
		Receptive			Participatory			
Participant	Clark (1996)			eavesdropper	bystander	side participant	addressee	
	Sherell (2015)			streakers		Samplers, Browsers		studiers
	Sheridan et al. (2006)				bystander	audience	participants	performers
	Heitlinger&Bryan-Kinns (2013)					surface engagement	associative engagement	deep engagement
Distance	Brignull et al. (2003)	peripheral awareness				focal awareness		direct interaction
	Prante et al. (2003)	ambient zone	notification zone					cell interaction zone
	Vogel et al. (2004)	ambient display				implicit Interaction	subtle Interaction	personal interaction
	Gronback et al. (2006)	remote attention	first attention			implicit interaction		explicit interaction
	Fischer (2012)			comfort space	pote space	social space	interaction space	
Content	Brown et al. (2011)			spectating	enhanced engagement	crowd sourcing	co-creation	audience-artist
					curatorial	interpretive		inventive
	Sommerer&Mignonneau (1999)				pre-designed		evolutionary	
	Hannington&Reed (2002)					passive	interactive	adaptive
	Edmonds er al. (2004)	static				dynamic-passive	dynamic-interactive	dynamic-interactive (varying)
	Levels of Interaction with Virtual Space					Implicit	Interventional	Manipulatory

Table 6 Levels of Interaction with Responsive Virtual Space

Levels of Interaction	Characteristic	Difficulty of Interaction		Interface	Openness of System	Awareness
		Mentally	Physically			
Implicit Interaction	- Without direct interaction - Observation	Low	Low	Implicit	Closed ↓ Open	Observation
Interventional Interaction	- Inducing feedback by intervention - Interventional participation	Average	Average	↓ Explicit		Response
Manipulatory Interaction	- Required explicit and specific manipulation - Manipulatory participation	(Variable)	High			Interaction
Creative Interaction	- Required creative thinking or behavior - Imaginative, inventive, creative participation	High	(Variable)	(Variable)		Creation

3.3 Multi-layered Virtual space

The third attribute of virtual space proposed by this thesis is multi-layered. A multi-layered virtual space is a virtual space created by composing, overlapping, or generating different spaces or objects simultaneously or sequentially. The most important difference between the attributes of the physical space of the real world and the virtual spaces generated cinematically or digitally is that while the real physical space consists of a single continuous attribute, the virtual space is composed of multi-layered properties of synthesis, superposition, and transformation. Compared to the networked or responsive attributes discussed above which are related to the inherent systematic nature of virtual space such as connectedness by networking, or responsiveness and functioning, multi-layered is an attribute of a visual composition principle that creates an illusionary external of a virtual space. In this paper, the concept of 'multi-layered' extends from the meaning of synthetically compositing multiple layers to the meaning of generating and transforming multiple layers to be continuously connected without a trace. Multi-layered virtual space is classified into the two layering types: first, spatial multi-layered virtual space in which different spaces or objects are composited simultaneously into one space, and second, temporal multi-layered virtual space that is continuously generated and transformed into other spaces or objects over time.

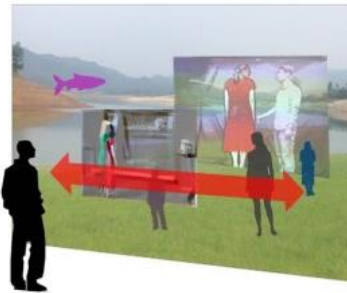


Figure 12 Spatial Multi-layered Virtual Space

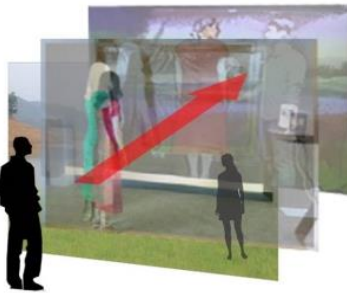


Figure 13 Temporal Multi-layered Virtual Space

Spatial multi-layering and temporal multi-layering are respectively the principles of 'compositing' and 'generation' in visualizing virtual space. These principles are comparable to Lev Manovich's (2001) comment on

'spatial montage' and 'temporal montage' claiming that editing or montaging in films are salient techniques that create a fictional reality. Manovich states that a spatial montage is a montage within a shot composed of separate realities that form contingent parts of a single image, and that a temporal montage is composed of separate realities that form consecutive moments in time. Comparatively, in this paper, I propose a multi-layering concept that can be applied not only within a shot but also within a scene and a frame, and not only to the movie but also to computer-generated, responsive and networked virtual space. To summarize again, spatial multi-layering refers to the concurrently compositing layers that contain different spaces or objects, and temporal multi-layering is sequentially generating and transforming successive layers of different spaces or objects.

Multi-layering is not only a principle that implements virtual space using visual effects but also applies to the principle of creating a narrative in arts. For instance, in the examples of “micro-narratives” presented by Manovich (2001) which are the paintings of Hieronymus Bosch (15c) and Pieter Breugel, different events are depicted as taking place within a single pictorial space. This depiction can be considered as a spatial layering narrative. Whereas in Lewis Carroll's novel *Alice in Wonderland* (1898), a series of narratives from one space to another or from one world to another using a rabbit hole metaphor is a representative example of temporal layering narrative. In general, temporal narratives correspond to most of the narrative or the way of editing that show different scenes and places over time in many films and videos (Table 7). More specifically, spatial and temporal layering can be divided according to the connectedness of the layers, that is, whether the boundaries of the layers are revealed, or seamless without a trace during the synthesis and continuation of the layers. In spatial layering, seamed cases correspond to the composite techniques such as double exposure, split screen, and seamless cases correspond to chroma-key compositing, 3D model compositing. Meanwhile, in temporal layering, seamed cases are the film techniques such as editing and film-montaging, and seamless cases are the visual effects such as morphing, dynamic simulation, generative and recursive imaging (Fig. 14).

Table 7 Spatial and Temporal Layering in Multi-layered Virtual Space

Spatial Layering	Temporal Layering
- Different layers of spaces or objects are concurrently synthesized.	- Different layers of spaces or objects are sequentially generated or transformed.
- Spatial montage (Manovich 2001)	- Temporal montage (Manovich 2001)
- Spatial narrative: Hieronymus Bosch(15c), Pieter Breugel(16c): Different events are represented as taking place within a single pictorial space. Micro-narratives (Manovich, 2001)	- Temporal narrative: <i>Alice in Wonderland</i> (1865): falling through a rabbit hole into a fantasy world, entering into the image without staying on the image surface



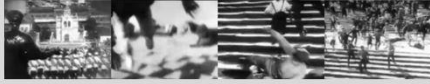




	Spatial	Temporal
Seamed	<ul style="list-style-type: none"> - Double Exposure - Split Screen  <p>man with a camera (1929)</p>  <p>The Boston Strangler (1968)</p>	<ul style="list-style-type: none"> - Film Editing - Film-montage  <p>Battleship Potemkin (1925)</p>
Seamless	<ul style="list-style-type: none"> - Chroma-key Compositing - 3D Model Compositing  <p>Rise of the Planet of the Apes (2011)</p>  <p>The Life of Pi (2012)</p>	<ul style="list-style-type: none"> - Morphing - Dynamic Simulation - Generative Space - Recursive Space  <p>Face Morphing</p>  <p>Other Earth (2014)</p>

Figure 14 Spatial/Temporal and Seamed/Seamless Multi-layering Type

In multi-layered virtual space, spatial layering and temporal layering are the salient visual principles for creating illusionary space such as 20th century movies with numerous visual contents and computer-based images from the 21st century. With the advancement of computer graphics technology, the boundaries and traces of synthesis have completely disappeared, and the autogenerated figures and animations have begun to simulate reality perfectly. The cinematic and computer-generated virtual spaces that are created in the way of spatial/temporal and seamed/seamless multi-layering are getting more hyperreal and surreal. These characteristics extend human sensation and recreate another world beyond the real world. In the following sections, I propose a taxonomy framework for virtual space-based artworks based on the attributes of networked, responsive, and multi-layered virtual space, and analyze various media artworks of virtual space.

3.4 Taxonomy Framework based on Attribute of Virtual Space

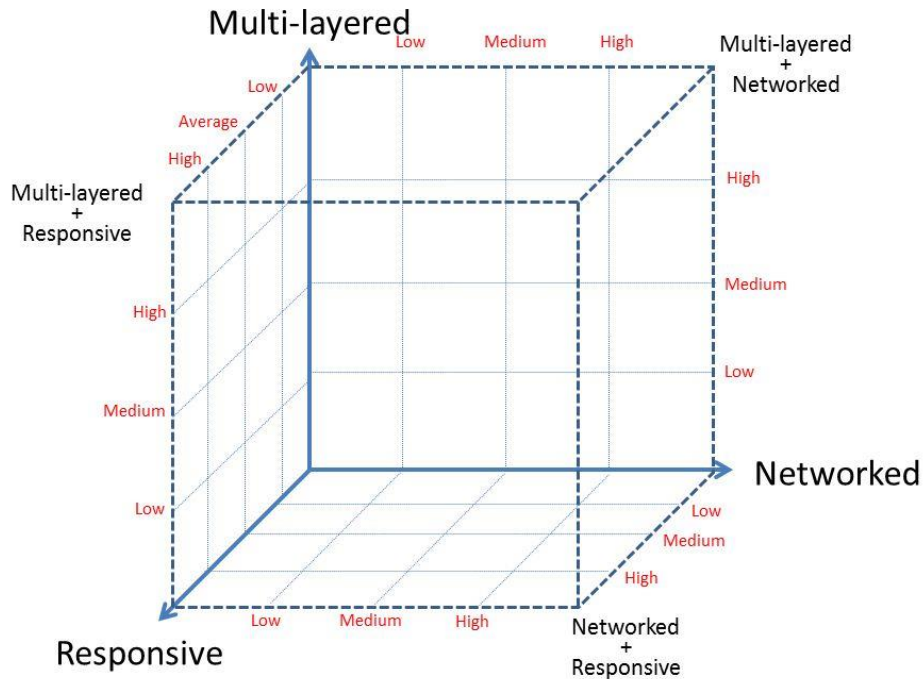


Figure 15 Taxonomy Framework for Virtual Space-based Artworks

Based on the three attributes of virtual space derived from the overview of digital aesthetics, I propose a 3D cube model framework for qualitative comparison and classification of artworks and media contents mediated by virtual space. The three attributes—networked, responsive, and multi-layered—are placed on the x, y, and z coordinates of the framework and respectively low, medium, and high are assigned between 0 and 1 to quantify each attribute. The criteria for assessing a quantitative level between 0 and 1 for the three attributes are as follows:

1) Networked

Level	Criteria for Networked Attribute
0	No networking
Low	Networking is used, but one-directional virtual space
Medium	Two users or spaces are connected and composited into a virtual space
High	More than three users or spaces are connected and composited into a virtual space
1	An unlimited number of users or spaces connected and composited into a virtual space

2) Responsive

Level	Criteria for Responsive Attribute
0	No response (Implicit interaction)
Low	Non-user elements induce response of virtual space
Medium	User interventionally induces response of virtual space (Interventional interaction)
High	User manipulatively induces response of virtual space (Manipulatory interaction)
1	User can create response of virtual space (Creative interaction)

3) Multi-layered

Level	Criteria for Multi-layered Attribute
0	Made up of a single live action layer
Low	Live action footage consisting of countable layers
Medium	Live action + computer-generated footage consisting of countable layers
High	Computer-generated footage consisting of countable layers
1	Computer-generated footage consisting of uncountable layers(e.g. fully auto-generated footage)

First of all, the criteria for networked attributes are whether if there is a bidirectional networking in real time or not and how many remote spaces, users, or objects are networked. When no networking was used, the level was 0, and when networking was used but one-directional, the level was assessed as ‘low’. An example of the case included in the ‘low’ level would be the live TV shows that broadcast networked remote performers. In this case, the viewer cannot connect to the virtual space (TV footage) but has an internal networked property. The live TV shows that use networks can be conceptually considered as if multiple viewers are connected but the way it is shown to the viewers via a TV monitor is unidirectional. In contrast, there are cases when remote spaces or users are networked to be in one virtual space. The most common form is telecommunication in which two or more users or places are connected into one virtual space. In the case of two users or places being networked, the level was considered ‘medium’ with a score of 0.5, and in the case of three users or places being networked, the level was considered ‘high’ with a score of 0.75, and finally, in the case when unlimited number of users and places can be networked, the level was assessed as 1. A representative example of level 1 would be the Massively Multiplayer Online Role-Playing Game (MMORPG) where numerous users can be networked into a game system in real time to play as avatars.

Secondly, for the criteria of the responsive attribute, which is an element that induces response toward the virtual space, was quantified using the level of interaction difficulties or complexities with the users or

surrounding environment. For this factor, the interaction levels with responsive virtual space (implicit, interventional, manipulatory, creative) were applied. In the case when there is an implicit interaction with no physical feedback or change, the level was considered 0, and in the case when there is a limited response caused not by the user such as a virtual space where real-time data is causing the response the responsive level was considered 'low' with a score of 0.25. Furthermore, when the virtual space is interventionally altered without manipulatory actions, the level was considered 'medium' with a score of 0.5, and when the virtual space was altered and showed response due to a manipulatory action, the level was considered 'high' with a score of 0.75. Lastly, for cases when the user was able to create a virtual space inventively, the level was 1. Here, the term 'creative' includes examples when the user becomes an artist to create as well as when the user plays a partial role creating predefined forms or patterns through hardware and programs. As examined above, the criteria for quantifying the responsiveness not only take the degree of responsiveness of virtual space into account but also considers until what standard the virtual reality was designed to interact within the overall system. Additionally, in network performances, the responsive attribute may change depending on whether it is viewed from the performer's perspective or the audience's perspective. For instance, in general, while the virtual space is created as the remote performers interact with each other displayed as images on the stage, the audience enjoying the performance does not have a responsive influence to the virtual space. In this case, the scoring was based on how and by what the final product of virtual space responded to.

Lastly, for the criteria for the multi-layered attribute, whether if live action footages and computer-generated footages were used or not, and how many layers were created through synthesis and generation were considered. To quantify, the visual elements of virtual space were classified into two: live action elements and computer-generated elements. When the virtual space was created using only one live-action footage, the level was considered 0. When the virtual space was created using multiple live action footages through compilation and synthesis, the level was considered 'low' with a score of 0.25, and when created using live action footage and additionally, computer-generated images, the level was considered 'medium' with a score of 0.5. An example of a level 'medium' would be the recent digital movies that use blue screens to complete the footages of actors with computer animated characters, background, or special effects into multiple layers. On the other hand, the scenes that have been produced only with a computer were considered level 'high' with a score of 0.75. This case would be the 3D animations where the characters, objects, and background become layers to be compiled into one scene. Finally, the virtual space that was automatically computer-generated was considered a level 1. In this case, the layers become uncountable and the scene itself becomes fully auto-generated footage.

In the next section, using the above criteria, the virtual spaces present in representative early media arts since 1970—the era of when virtual spaces began to be created using computers—as well as in recent movies, images, and media contents were analyzed and scored (Table 8) and was plotted onto the coordinates of taxonomy framework cube (Fig. 22).

Table 8 Overview of Coordinate Sets for Virtual Space-based Artworks

	Artwork	Networked	Responsive	Multi-layered	Genre
1	The Last Nine Minutes (1977)	0.25	0	0.25	Network performance
2	Satellite Arts project (1977)	0.5	0	0.5	
3	Good-morning Mr. Orwell (1984)	0.75	0	0.5	
4	Telematic Dreaming (1993)	0.5	0.75	0.25	Network art
5	Videoplace (1974)	0.5	1	0.75	
6	MMORPG (2018)	1	1	1	Online game
7	AR National Geographic (2011)	0	0.5	0.5	Interactive art
8	The Legible City (1988)	0	0.75	0.75	
9	A-Volve (1993)	0	1	1	
10	The Life of Pi (2012)	0	0	0.5	Movie
11	Toy Story (1995)	0	0	0.75	

Douglas Davis was one of the video artists that used telecommunication in the 1960s and the 70s. In 1976, Davis produced the world’s first satellite performance entitled *Seven Thoughts* (1976). As the first one to use satellite as an individual and not a public broadcast, he conveyed his thoughts in Houston’s Astrodome for ten minutes alone. As an artwork where he connected the dome and the satellite for audiences to stumble upon him on TVs or radio stations, the message of the artwork was that no matter wherever you are in this world, anyone can make contact (Baumgartel, 2001; Arns, 2004). Through the cutting edge communication mode at the time, this artwork could be the first attempt to seek a new spatial communication method between humans beyond physical space. Afterwards, in 1977, in Kassel Documenta, the performance of Nam June Paik, Charlotte Moorman, and Joseph Beuys were broadcasted in TVs through satellites. Here, Douglas Davis performed *The Last Nine Minutes* which conveyed a message that he wanted to communicate or connect with the audience beyond the invisible wall of a TV screen. Although these satellite live broadcast performances were not two-directional performances, they were artworks motivated by the fact that the artists’ messages were being communicated to many anonymous audiences. While *The Last Nine Minutes* is a network performance that uses telecommunication using satellite, it was a unidirectional live TV show. According to the criteria, the networked attribute of virtual reality was low with a score of 0.25, the responsive attribute was limited resulting in a score of 0.25, and the multi-layered attribute was also 0.25 with a compilation of two live-action footages (Fig. 16).



Figure 16 Douglas Davis, *The Last Nine Minutes* (1977)

Meanwhile, Kit Galloway and Sherrie Rabinowitz had attempted a series of *Satellite Arts Projects* since 1975. And in 1977, Galloway and Rabinowitz created their first representative artwork named *Satellite Arts Project: A space with no boundaries* (1977) using satellite networks. This artwork is a performance consisted of two groups of dancers remotely located in Maryland and California coordinates their dances. And the images are sent through a satellite to appear as if they are dancing in the same space. The result of this performance, both the form and the appearance, is similar to the result of the networked performed still today. The virtual space properties in this artwork are as follows: the networked attribute level is ‘medium’ (0.5) connecting with two different places, the responsive attribute level is 0 with no manipulation by the audience, and the multi-layered attribute level is ‘medium’ (0.5) with two different live action footages are compiled with a layer of image processing (Fig. 17).

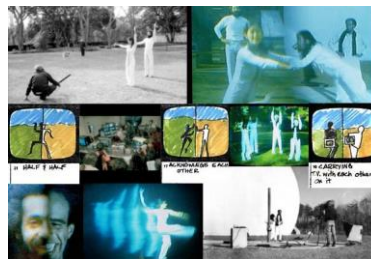


Figure 17 Galloway & Rabinowitz, *Satellite Arts project* (1977)

Good Morning, Mr. Orwell (1984) was the first global multi-directional network performance planned and directed by Nam June Paik using satellite and TV where artists in eight cities were networked in real time to show various performances. This performance was broadcasted in live to major cities including New York, Paris, Cologne, Berlin, Hamburg, Los Angeles, San Francisco, and Seoul. At the time, Nam June Paik, in Pompidou Center Control Tower, composited and edited videos of the live performance taking place in New York and Paris and videotapes from Cologne. Paik’s accomplishment of interactive artwork using satellite and TV continues with *Bye Bye Kipling* (1986) and *Hand in Hand* (1988). The virtual space properties in *Good Morning, Mr. Orwell* (1988) are as follows: as a live TV broadcast networked across eight cities, the networked attribute level is ‘high’ (0.75), the responsive attribute level is 0 with no possibility of audience engagement, and the multi-layered attribute level is ‘medium’ (0.5) composed of more than two spaces shown on a split screen through

image processing (Fig. 18). If the responsive attribute examined from the perspective of Nam June Paik, who was editing all the images being sent from all the networked cities, compiling the data, and directing the performances, there was a creative interaction. However, in this dissertation, the result of the creation and the responsive attribute from the perspectives of the audience were quantified.



Figure 18 Paik Nam June, *Good Morning Mr. Orwell* (1984)

Telematic Dreaming (1992) was a pioneering network installation by Paul Sermon which dealt with concepts of physical presence and telepresence. This installation consisted of two beds and bedrooms that were located in two remote places. Using multiple video cameras, a person on the bed of the exhibition space was projected onto the bed of another room situated in a different exhibition space. The person was able to interact with another existing in the remote room in real-time. Specifically, an interaction took place between the virtual body—or telematic body or mediated body—and the real audience. The surreal and intimate experience with the virtual body was realized through the image projection mixed with computer graphics and real-time responsiveness (V2_Lab for the Unstable Media, 2018). The virtual space properties in this artwork are as follows: the networked attribute is level 'medium' (0.5) with two networked spaces, the responsive attribute is level 'high' (0.75) with the active audience participation which was reflected in real-time as images that the audiences could see, and the multi-layered attribute is level 'low' (0.25) where the opposite images were projected onto the bed in real-time and was simply compiled with live action footages onto the monitor (Fig. 19).



Figure 19 Paul Sermon, *Telematic Dreaming* (1992)

In 1969, Myron Krueger, a pioneer of virtual reality and interactive art, developed the prototypes called "responsive environments," that respond to the movements and gestures viewers through a system of sensing floors, graphic tables, and video cameras (Turner & Krueger, 2002). In the paper *Videoplace_an Artificial*

Reality, Krueger described the installation *Videoplace* (1970-1990s) as a computer graphic environment where a participant sees his or her own live image and sometimes sees an image of other people at different locations projected on a video screen. In addition, occasionally there would be appearances of graphical objects and creatures interacting with the participant's image (Krueger et al., 1985). The *Videoplace* explores the concept of full body interaction in a shared telecommunication space. The graphic images on the screen can be regarded as a networked virtual space in which everything responds to the actions of participants. This artwork can be considered as an early media art that has evenly adapted the three virtual reality properties. With two different remote users connected, the networked attribute level is 'medium' (0.5), with the users playing the game using specific gestures and drawing in the virtual space, the responsive attribute level is 1 as a creative interaction, and finally with spaces that are computer-generated where users' appearances were compiled into many layers and were image processed as silhouettes, the multi-layered level is 'high' (0.75).

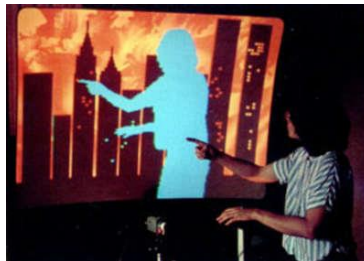


Figure 20 Myron Krueger, *Videoplace* (1975)

Jeffrey Shaw's *Legible City* (1988) is an interactive art installation where the visitor rides a stationary bicycle through a simulated representation of a city constituted by computer-generated, three-dimensional letters that form words and sentences (Jeffrey Shaw Compendium, 2018). The installation provides moving images projected on a large screen corresponding to the rider's manipulation of pedaling and handling, thereby giving the rider a sense of navigating through the virtual city. This embodied participation of the viewer along with the real-time interaction of the bicycle and image is profoundly engaging with enhancing illusionistic presence in virtual space of interactive art. Examining the virtual space properties of *Legible City* which is a computer-generated 3D letter city, the networked attribute level is 0 because there was no networking involved, the responsive attribute level is 'high' (0.75) due to the necessities of active participation and manipulative interactions such as a user getting on the bicycle and pedaling, and finally, the multi-layered attribute level is also 'high' (0.75) as a computer-generated 3D space.



Figure 21 Jeffrey Shaw, *Legible City* (1988)

A-Volve (1993) by Sommerer and Mignonneau is a classic work of genetic art created with artificial life, evolution, and gene manipulation. Visitors can create virtual three-dimensional creatures with their finger drawing on a touchscreen, and then using a projector, these visual beings are displayed onto a water-filled basin (Media Art Net, 2018). According to the artists, Sommerer and Mignonneau (1994), the movements and behaviors of the virtual creatures were decided by their forms; how the audience had designed them. These creatures also interacted with the visitors reacting to their hand movements in the water. When the user tried to catch a creature, it tried to flee and if got caught, it stayed still. The creatures that were automatically generated and animated with algorithms of evolutionary process create a virtual ecosystem where they are born, interact with other creatures by consuming or being consumed, and face death, in the virtual world. When analyzing the virtual space properties of this artwork, there is no networked attribute resulting in level 0. On the other hand, the responsive level is 1 as an artwork that requires creative interactions from the audiences who create the creatures hands-on. In addition, the multi-layered attribute level is also 1 because these created creatures were automatically reproduced into 3D and they continue to exist inside the artwork based on the evolutionary process algorithm.

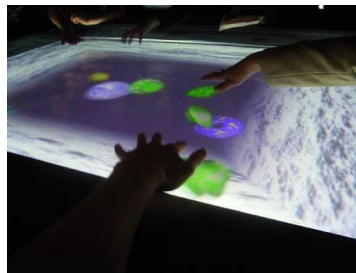


Figure 22 Sommerer/Mignonneau, *A-Volve* (1993)

The pioneering media artworks from the 1970s to 1990s reviewed and analyzed above were influential to the later artworks that incorporate digital technology, and for this reason, similar works were consistently produced. And after the 1990s, new digital technologies and developed computer-imaging technologies were reflected onto the virtual space properties. Since the release of *Toy Story* (1995), the very first movie that was entirely computer animated, now it is hard to find video contents that do not use computer graphics (Fig. 23 left). In addition, computer-generated 3D footages and live-action footages no longer distinguish themselves from each other (Fig 23 middle). An augmented reality installation for the National Geographic Channel, which was launched in a shopping mall in Hungary in 2011, projected a passerby in a predefined location onto a big screen in front showing interaction with various wild animals (Fig. 23 right). Another example would be the Massively Multiplayer Online Role-Playing Games (MMORPG), which are online games where thousands of users connect to play their roles. Among the MMORPG, there are games that not only provide a realistic and detailed 3D computer-generated world from the first person point of view but games that provide opportunities for users to intervene in the game world, transforming the game environment, and creating. These MMORPG games manifest all of the three properties of virtual space—networked, responsive, and multi-layered—at the highest level of 1. Correspondingly, people are casually interacting with the virtual space and objects more and more

which reflect themselves, and are experiencing existence as another self.



Figure 23 left. *Toy Story* (1995), middle. *The Life of Pi* (2012), right. AR National Geographic (2011)

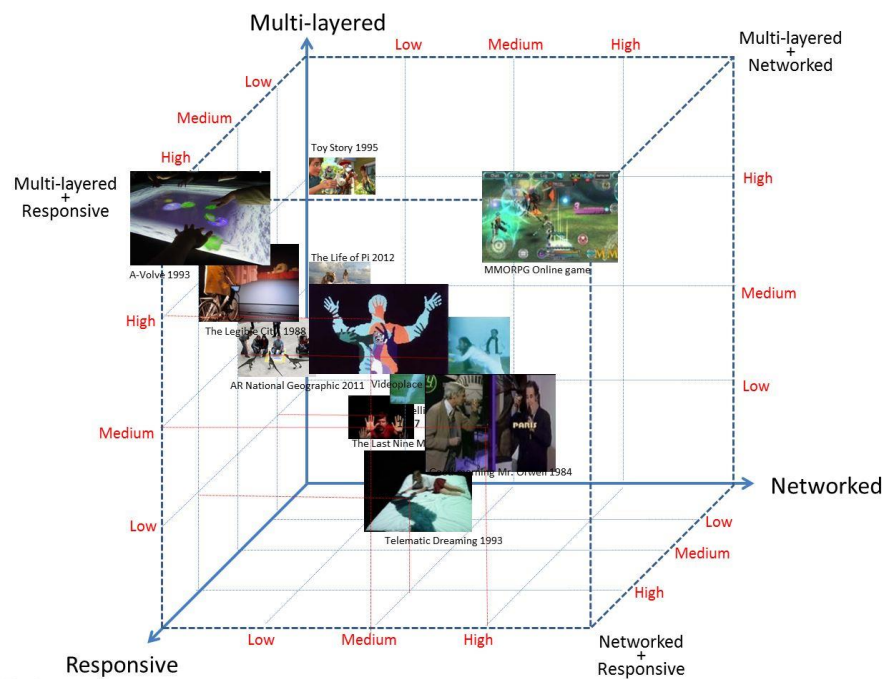


Figure 24 Classification of Virtual Space-based Artworks

Figure 24 shows the virtual space-based artworks and media contents analyzed so far plotted in the taxonomical cube model of three attributes of virtual space. In the subsequent chapters of 4 and 5, network performances and interactive arts designed by the author of this dissertation are discussed. The design and the implementation processes are described and are analyzed based on the three attributes of the virtual space as empirical research. Finally, in Chapter 6, I investigate the multi-layered attribute of the visual effects in recent pop music videos and their aesthetic characteristics.

Chapter 4. Networked Virtual Space in Networked Performance

4.1 Introduction: *Good-bye Mr. Tom* (2012-2013)



Figure 25 Main Stage of *Good-bye Mr. Tom* by KAIST GSCT EXP lab (2012-2013)

Good-bye Mr. Tom—produced by KAIST GSCT EXP lab in 2012-2013—is a networked performance in which the performers in two remote locations were connected via the Internet interacting with each other in a new virtual space in real-time. *Good-bye Mr. Tom* was performed twice on stage, at the 34th Asia Pacific Advanced Network Meeting (APAN) in 2012 and at the 2nd Association of Asia-Pacific Performing Art Centers Conference (AAPPAC) in 2013⁵. The performance at the APAN meeting connected Daejeon (South Korea) to the venue of the meeting in Colombo (Sri Lanka) in real-time using high-speed Internet. During the AAPPAC conference, Korea Advanced Institute of Science and Technology (KAIST) and the Daejeon Art Center were connected the same way. We designed the virtual space shown onstage as networked and multi-layered virtual space by compositing live videos of remote performers in real-time. Furthermore, we included narrative aspect as well as visual effects to strategically exploit the technical limitations of the live telematic performance such as time delay and deterioration of video quality. We have attempted to present the immersive experience of connectedness that is shared in networked virtual spaces providing aesthetic values beyond the technical faultlessness of system.

Roy Ascott (1990) said that virtual space is a category of experience that can be shared through telematic networks allowing movements with the virtual presence of others who are in their corporeal materiality at a distance, physically inaccessible or otherwise remote. A networked virtual space appears in telematic

⁵ *Good-bye Mr. Tom* (2013) video link: <https://youtu.be/wIRyrDQaF3E>

performances that use telecommunication technologies connecting multiple locations and presenting real-time interactions and activities of performers in the separate places (Pérez, 2014; Birringer et al., 2001). In or with the virtual space, the distant performers interact with each other transcending the physical distance, and the audience, as well as the performers, immerse themselves in an experience of “telematics embrace.” How can they feel the presence of others overcoming the distance like being together? How can there be an immersive experience of virtual rendezvous? In this chapter, I examine the design of the networked virtual space, storyline and visual effects for the sense of connectedness in a networked performance.

4.2 Implementation

4.2.1 Scenario and System Design

The motif for the scenario of *Good-bye Mr. Tom* originated from the lyrics of David Bowie’s song *Space Oddity* (1963) which is about an astronaut, Tom, boarding a spaceship to enter the outer space and then loses communication with the ground control to ultimately become lost in the outer space. The performance proceeds as follows. First, a short film is played showing the ground control and the launching of the spaceship. Then, Major Tom lands on the moon and tries to connect to his beloved one on Earth. Their communication is difficult because of the faint and delayed signal. Finally, they join in the virtual space. She on the moon and him at ground control, they mirror each other’s movements to create an ensemble. They virtually touch each other and embrace. But, unexpectedly, the connection is broken. An urgent situation is depicted by showing the two characters’ anxiety, with a fearsome noisy sound, and with a distorted image. After a while, they connect again, but Major Tom disappears into the abyss of outer space.

Figure 26 illustrates the system configuration of *Good-bye Mr. Tom* (2012). It shows the two endpoints, KAIST in Daejeon and the meeting venue in Colombo that were connected by a network. The system was comprised of three computers and three cameras, and one main computer in Daejeon controlled all of the operations. All videos and sounds were mixed and transported using an interaction design software MaxMSP/Jitter in the main computer. Another computer in Daejeon was used to process the images with 3D depth data from a depth camera, Kinect (Fig. 27).

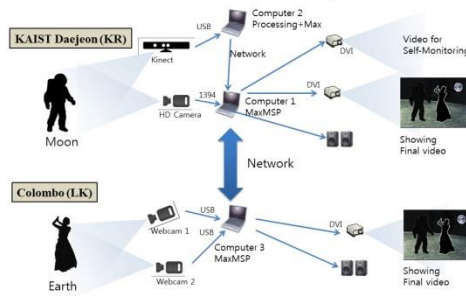


Figure 26 *Good-bye Mr. Tom*, System Configuration



Figure 27 Sub-stage of *Good-bye Mr. Tom* in KAIST(KR)

4.2.2 Creating Networked Virtual Space

At the connected locations of *Good-bye Mr. Tom*, one space was set as a ground control on Earth, and the other space was set as the moon where the spaceship had landed. One male and one female performer at each location danced through real-time interactions. The interactions between the two performers were designed to follow the [A–B’], [A’–B’], and [A–A’] types of interactions (Table 4). In particular, the scenes designed as [A’–B’] were scenes in which the separate performances were merged into one video, and a virtual embrace was achieved when the two performers in the two remote spaces met in one virtual space. The video projected on a large screen on the main stage consisted of four different layers. One was the real-time live action video of the female performer in Colombo, the other was the real-time live action video of the male performer in Daejeon, the third was an image of the outer space landscape, and the last was a video of a moving Earth. In addition, the video on the main stage was a typical networked virtual space created by two shared remote spaces. We created three types of virtual space scenes by synthesizing the two live videos and two images in real-time using chroma keying:

Scene 1: Astronaut Tom walks on the moon. This scene was produced by compositing images of the outer space landscape and the video of the male performer (Fig. 28).

Scene 2: Astronaut Tom and his lover dance together on the moon. This scene was created by compositing footages of the female performer onto the scene 1 with the background removed by chroma keying (Fig. 29).

Scene 3: Astronaut Tom and his lover dance together on the ground control. This scene was implemented by

compositing the male performer onto the footage of female performer with backgrounds removed by chroma keying along with infinitely repeated visual effects (Fig. 30).



Figure 28 Interaction type A-B' in *Good-bye Mr. Tom* (2012)



Figure 29 Interaction type A'-B' in *Good-bye Mr. Tom* (2013)



Figure 30 Interaction type A-B', A'-B', and A-A' in *Good-bye Mr. Tom* (2013)

4.2.3 Aesthetic Exploitation of Deteriorated Video Quality

1. Earth and Moon Metaphor

Interaction types [A-B'] and [A'-B'] (Figs. 28 and 29) demonstrate that synchronization during real-time interactions—such as exchanges of dialogues and gestures with a video of the opposing performer—is very important in networked performances. However, video transmission delays that occur in networked environments have negative effects like causing lower quality interactions and reduced immersion of the audience. Decreasing the video resolution is one way to decrease the video transmission delay time under these restrictive conditions; however, this approach can undermine the engagement of audience familiar with (and expecting) high-quality images. For the first performance of *Good-bye Mr. Tom*, the networked cities, Colombo and Daejeon, were separated by a distance greater than 5,800 km, and low-resolution video footage (320*240) was used to reduce the delay time when transmitting videos. To compensate for the negative effects of the low-

resolution video footages, aesthetic expressions were integrated into the performance to minimize the problem such as storytelling, image processing, and choreography. From the storytelling perspective, the two cities of Colombo in Sri Lanka and Daejeon in South Korea were set as two vastly distant locations, the earth and the moon, and the low video resolution was presented to the audience as valid, to a certain extent, for depicting the circumstances in the story. In the storyline of the performance, the male and the female are situated on the moon and on Earth, respectively. They meet and then part in a symbolic virtual space. The storytelling aimed to engage the audience in the story of the female who was left on Earth to communicate with her lover in outer space, and this partly helps the audience to be generous regarding the time delay and low-quality video problems.

2. Fake Disconnections and Noise

Technical problems, such as network disconnections or flickering signals often occur during networked performances. Moments, such as a broken “telematics embrace,” embarrass and discourage the performers as well as the audiences, and they disrupt the sense of immersion. During these events, appropriate and immediate improvisation by the performers or the technical staff to keep the performance moving eases the tension and re-engages the audience with the performance. When audience immersion is muddled, as described above during a telematic artwork, it can be understood that an aesthetic element, to some extent, presents an opportunity to validate and assure the authenticity of the event (Giges & Warburton, 2010). During the Good-bye Mr. Tom performance, we intentionally incorporated problems of rupture and discontinuity into the storytelling. Noise effects and flickering effects were implemented through image processing and intentional fake disconnections, noise, and blackouts also were produced using programs such as MaxMSP and Processing. By intentionally interjecting problems—such as time lagging, video quality degradation, and the disconnection common to networked performances—into the content of the actual performance and the episodes of interactions and communication between the moon and Earth, we were able to enhance the narrative of the telematic love story creatively. Technically, the noise effects were implemented using 3D cloud points data, and the specialized sounds and noise effects were generated through MaxMSP to express the unstable communication conditions, the disconnection of the transmission between Earth and the moon, and Tom’s disappearance into outer space (Fig. 31).



Figure 31 Noise Effects for Fake Disconnection

4.3 Discussion

This chapter analyzed and classified the interactions between performers in remote locations typical of networked performance based on the ways that individuals and the system interact in a telematic environment and on the ways that people communicate with each other. Various interaction types were used to create a narrative structure for a performance of *Good-bye Mr. Tom*, a story about two lovers that separates only to meet again communicating in a virtual space. In addition, in the performance, we attempted to resolve technical limitations and failures, such as latency in time, degradation of the image quality, and disconnection, that tend to occur in poor network environments. To that end, we employed storytelling, along with corresponding methods of artistic expressions, such as image processing and choreography.

The virtual space created by *Good-bye Mr. Tom*, specifically, the images shown on the large screen located in the center of the stage, can be considered as a networked and multi-layered space created by the overlapping of two performers in remote spaces in real time using chroma keying technique and synthesis. When the attributes are quantitatively analyzed based on the taxonomical framework, with two remote spaces networked, the networked attribute level is 'medium' (0.5) and with a space that reflects the performers' movements intervening for the alteration of virtual space, the responsive attribute level is also 'medium' (0.5). Lastly, with the compilation of the two performers' images, the moving earth image on the moon surface, four live-action footages are compiled, and with the inclusion of computer-generated visual effects through image processing, the multi-layered attribute level is also 'medium' (0.5). Similarly, the coordinates the networked, responsive, and multi-layered attribute levels of *Good-bye Mr. Tom* based on the taxonomy framework is 0.5, 0.5, 0.5. (Fig. 32)

In conclusion, *Good-bye Mr. Tom* is a telematic theatrical artwork in which two different locations are connected via a network, and people in these spaces (i.e. the performers and the audience) meet and interact in a created virtual space. This space can be understood as the 'visual virtual space' presented by overlapping the spaces of the two performers and broadly defined as the 'perceptual virtual space' that the audience perceives and embraces.

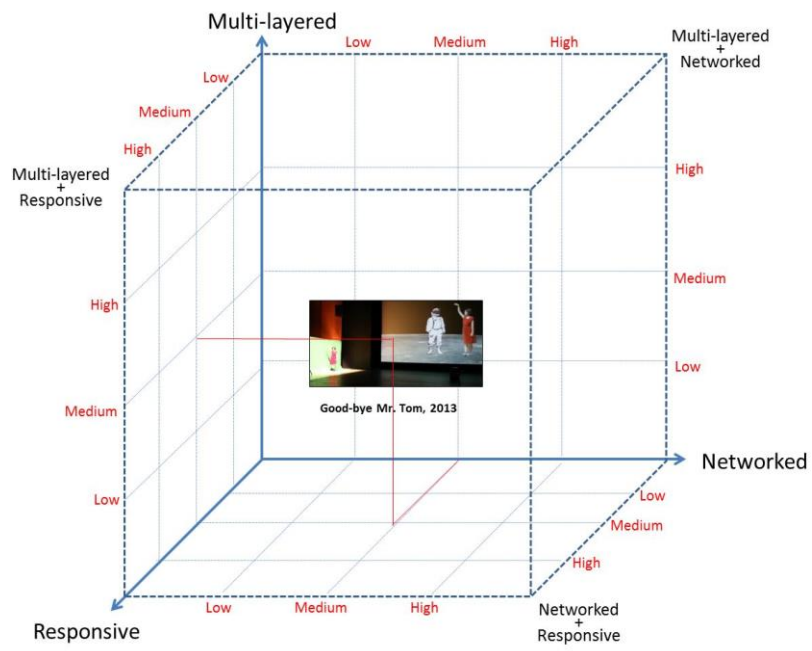


Figure 32 Taxonomy of Networked Performance *Good-bye Mr. Tom* (2012-2013)

Chapter 5. Responsive Virtual Space in Interactive Art

5.1 Introduction



Figure 33 *Windy Bamboo Grove* (2012), *With Thunder and Lightning* (2013), *Write Erase* (2017)

A typical artwork genre that manifests responsive virtual space is interactive art. Interactive arts use different kinds of digital technologies to create a virtual space that reacts to the audience or the surrounding environment. Specifically, interactive arts induce participation of the audience and react to their movements, actions, and sounds beyond a passive unidirectional observation. Through this interactivity, the audience becomes a part of the artwork and experience connection with the environment expressed as a virtual space. In this chapter, three interactive artworks—*Windy Bamboo Grove* (2012), *With Thunder and Lightning* (2013) and *Write Erase* (2017)—produced by the author of this dissertation are introduced and the design of the responsive virtual space and the implementation process are examined based on the interventional, manipulatory and creative interaction level (Table 7).

5.2 Interventional Interaction: *Windy Bamboo Grove* (2012)

Windy bamboo grove (by Jungsun Park 2012)⁶ is an interactive artwork where the images of bamboos—painted by a Korean-born French painter Ungno Lee (1904 –1989)—react audiovisually to the audience’s location and movement. For instance, when the audience passes by in the front of the forest-like ink-and-wash painting image of a bamboo, the bamboo sways as if there has been a wind and produces a sound of wind. The painter Ungno Lee painted who enjoyed painting bamboos began to paint ‘embodied’ bamboos ever since realizing that his artworks have been idealistic after seeing the bamboo forest swaying from a gust of wind. Using the digital technology, the visual swaying which is already innately embodied in the painting was implemented as an embodied sensation where the body of the audience became a part of the artwork. The body

⁶ *Windy bamboo grove* Video link: <https://youtu.be/Ps3vhWtsK2I>

captured by the computer causes an alteration in the image and sound as one of the input and space reacts as if it is connected to the body. If the audience moves their arms side to side to create wind, the gestures become the wind and sway the bamboos in the painting, and the swaying becomes a sound creating an illusory wind. Sensations in the digital era are expanded and are amplified to stimulate other dormant sensations. In *Windy Bamboo Grove*, synesthesia in arts is transformed into new sensations using technology, and thereby surpasses the sensational limitation the traditional artworks bring.

As an artwork that naturally reacts to the audience's approaching without an active intervention, the responsive level is "medium" (0.5). Also for the multi-layered attribute, the level is 'medium' (0.5) with nine two dimensional ink-and-wash painting of bamboos compiled using dissolve effect. It can be considered as a spatial multi-layered space with each bamboo reacting differently to the audience's position.

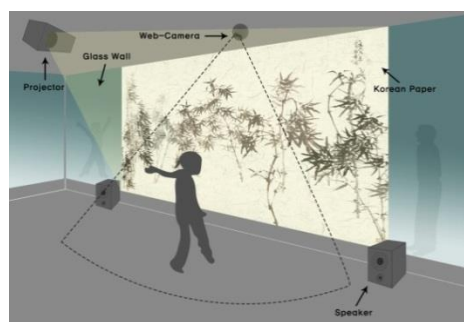


Figure 34 *Windy Bamboo Grove's System Illustration*



Figure 35 *Windy Bamboo Grove (2012)*

5.3 Manipulatory Interaction: *With Thunder and Lightning* (2013)

When space and people interact and people interact with each other, space and people are transformed and transfigured continuously. In *With Thunder and Lightning* (by Jungsun Park 2013)⁷, the moment of this reaction between space and people was captured. When an audience enters a dark space where there are sounds of thunder somewhere far away, storm clouds gather; and when audiences have physical contact with their hands

⁷ *With Thunder and Lightning* Video link: <https://youtu.be/GdJmcSmd38Q>

on different touchpads, the space thunders with lightning strikes. This virtual space—with the view of storm clouds on the screen and the sound of thunder—and audience are connected and reacting to each other through the circuits of the computers. Moreover, when people have physical contact, the subtle current, emotions, tension, and intimacy also flows. This moment was expressed through thunder and lightning.

As an artwork designed to interact with the audience and the audiences to interact with each other through physical contacts, the manipulatory interaction level was required. Ten video clips each one to two seconds long that created the virtual space with lighting were used at random when there were physical contacts between audiences. The ten video clips played at random can be considered a multi-layered space, but as live-action footages, the multi-layered attribute level is ‘low’ (0.25).

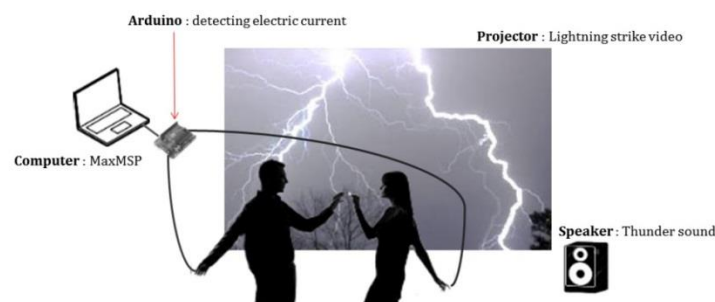


Figure 36 *With Thunder and Lightning*'s System Illustration



Figure 37 *With Thunder and Lightning* (2013)

5.4 Creative Interaction: *Write Erase* (2017)

An interactive audiovisual installation *Write Erase* (by Jungsun Park, 2017)⁸ allowed the audience to participate and experience the process of materialization, disintegration, and transformation of characters into abstract painting. In *Write Erase*, when the audiences input a desired word through a keyboard, the words were rewritten on a screen in forms of vine tentacles, pinwheels, flowers and butterflies. And when the audiences make gestures as if erasing the words, they were led to create interactive artworks in the form of abstract paintings. In detail, when the audiences moved their hands in front of the word, the vine tentacles extended outward from the words, pinwheels scattered in all directions, butterflies on the flowers flew away, and the

⁸ *Write Erase* Video link: <https://youtu.be/Rvq7UlrosCU>

words disappeared. This artwork was designed to let people participate and experience the process of abstraction from the materialized words like writing then erasing or creating and destroying. Through the process of inputting the words, the audiences were enforced to take part in the creation of the virtual space. Although the difficulty of creation was not high, the artwork needed creative interactions where the audiences had to think up a phrase they wanted. Therefore, the virtual space responsive level is categorized to be 1. Furthermore, while the pinwheel and butterfly themes were composed to countable layers, the vine tentacles theme was implemented using an algorithm which puts the virtual space in the generative space category resulting in level 1 for the multi-layered attribute.

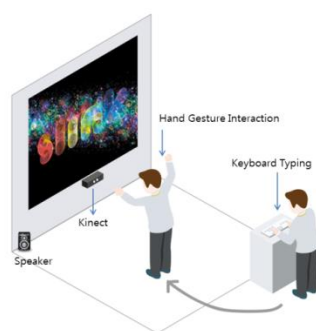


Figure 38 *Write Erase's System Illustration*



Figure 39 *Write Erase (2017)*

5.5 Discussion

The three artworks discussed so far were categorized based on the taxonomical framework.

1) In the case of *Windy Bamboo Grove* (2012) designed to be at an interaction level of intervention, the networked attribute level is 0, the responsive attribute level is 'medium' (0.5) which required not necessarily active and intended gestures, and the multi-layered attribute level is also 'medium' (0.5) with the composition of pictorial images of nine different bamboo images and computer-generated images that animate bamboos swaying using dissolve effect.

2) As for *With Thunder and Lightning* (2013) designed to be at an interaction level of manipulation, the networked attribute level is 0, while the responsive attribute level is 'high' (0.75) where audiences were

motivated to actively interact to create virtual space by placing their hands on the touch pads and making physical contact with another audience. The multi-layered attribute level is ‘low’ (0.25) because in this artwork ten video clips of lighting were randomly played.

3) In the case of *Write Erase* (2017), the networked attribute level is 0; meanwhile, the responsive attribute level is 1 since the audience had to input the phrase that they wanted and had to erase and destroy using the hand gestures thereby creatively constructing virtual space. Lastly, the multi-layered attribute level is also 1 because the abstraction created through hand gestures were generative shapes (See Table 9 and Fig. 40).

Table 9 Coordinate Sets for *Windy Bamboo Grove*, *With Thunder and Lightning* and *Write Erase*

		Networked	Responsive	Multi-layered
1	Windy Bamboo Grove (2012)	0	0.5	0.5
2	With Thunder and Lightning (2013)	0	0.75	0.25
3	Write Erase (2017)	0	1	1

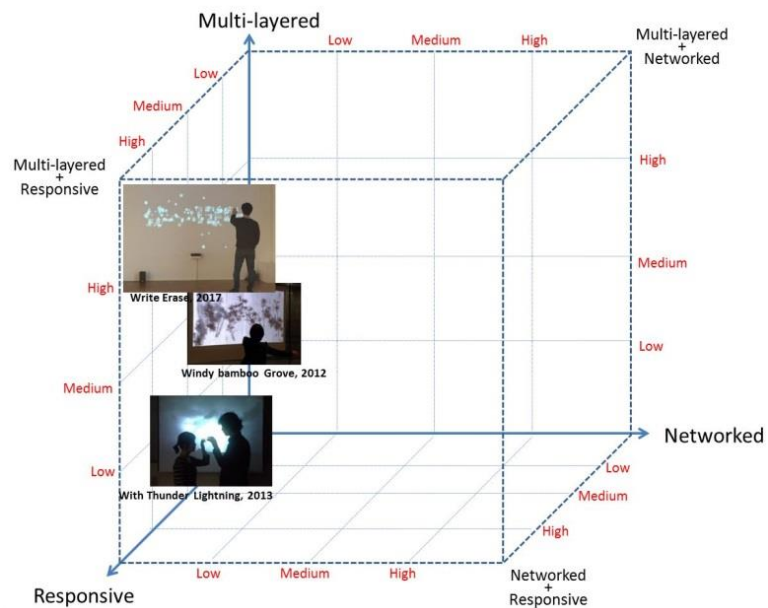


Figure 40 Taxonomy of *Windy Bamboo Grove*, *With Thunder and Lightning*, *Write Erase*

Chapter 6. Multi-layered Virtual Space in Music Videos

6.1 Spatial Multi-layering: *Telematic tango Telematic Love* (2013)

6.1.1 Introduction



Figure 41 *Telematic Tango Telematic Love* (2013)

Telematic Tango Telematic Love (by Jungsun Park 2013)⁹ is a network performance in the form of a music video that captures the moments of commune and loss as two lovers tango across real space and virtual space (Fig. 41). In this music video, a typical spatial multi-layered virtual space is shown where different layers of virtual space are composited into one using chroma key method and dissolve effect. As a network performance in the form of a music video, where two remote spaces are compiled in real time into one image, the attributes of networked virtual space is inherent.

First of all, when examining and analyzing *Telematic Tango Telematic Love* using the taxonomical framework, the virtual space has an attribute of remote spaces being networked and performers interacting. However, the purpose of this artwork was not the performance but the telematic performance being produced into a music video. Therefore, the virtual space of this artwork does not hold a responsive attribute from the perspective of the audience who are simply viewing the video even though the audience can realize that the performers are reacting to each other using the real-time network. On the other hand, with a recording of two remote performers being compiled into one real-time, the artwork has a spatial multi-layered space in the form of ‘virtual space within a virtual space’ and ‘frame within a frame’. In addition, with videos compiled using chroma key method and computer-generated effects using dissolve effect, the multi-layered attribute level is ‘medium’ (0.5) resulting in a coordinate value of (0, 0, 0.5) (Fig. 42).

⁹ *Telematic Tango Telematic Love* (2013) video link: <https://youtu.be/wIRyrDQaF3E>

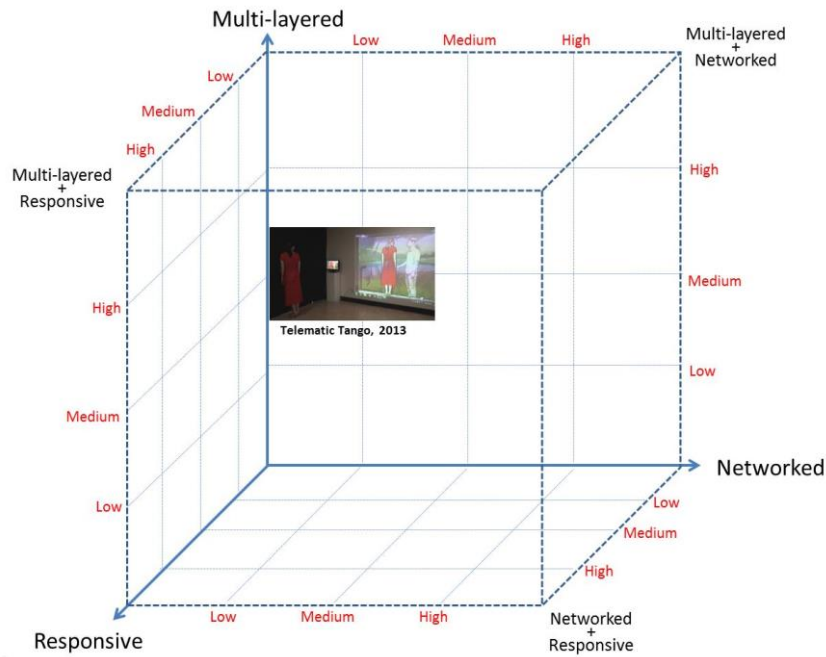


Figure 42 Taxonomy of *Telematic Tango Telematic Love* (2013)

6.1.2 Structure of Multi-layered Virtual Space

1. Scenario

Telematic Tango Telematic Love begins with two lovers dancing the tango in front of a video clip of a blue lake. The man who was dancing suddenly disappears into the video of the blue lake playing in the background and the woman continues to dance with the man in the video but feels a sense of loss. In the next scene, the woman also enters the virtual scenery of the blue lake. Then, two lovers who were dancing in a virtual space reunite with each other in an actual place with blue lake and green field. However, the dancing lovers suddenly disappear only leaving the landscape of blue lake and green field. This artwork leaves the audience viewing the artwork at unease destroying the boundary between reality and virtual but also delivers a message that the video they are watching is an illusory reality.

2. Frame within a Frame

The scene which the man disappears into the real landscape in the middle of dancing with the woman in a virtual landscape was implemented using a network connecting the man and the woman in real-time (Fig. 43). Again, when the woman enters the real landscape to be with the man shows that the woman actually exists outside the screen. Here, the compilation of two remote people was implemented using the chroma key method. The scenes that connect two remote people into one virtual space were shot using frames. The woman performer in the real space danced while looking at the man performer and herself in the landscape video. The music video illustrates different stages of virtual space through shooting the scenes in frames (Fig. 44).

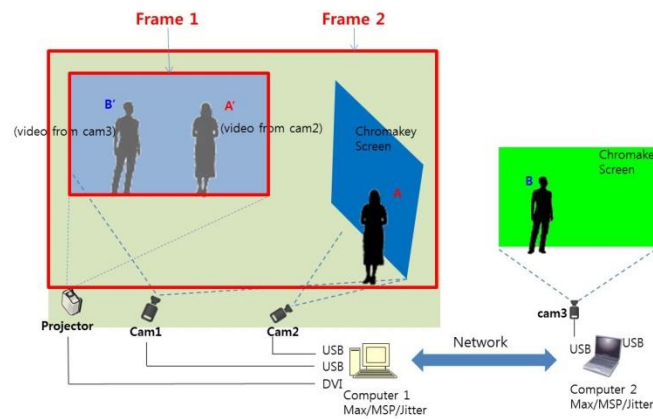


Figure 43 Telematic Tango Telematic Love's System Configuration

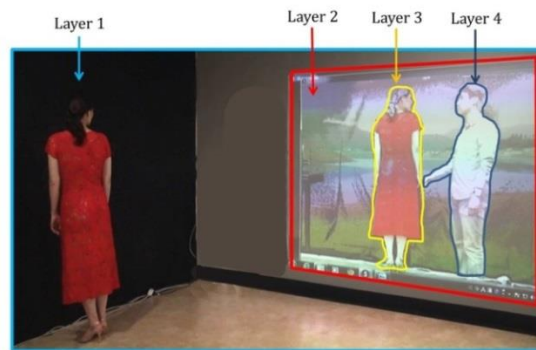


Figure 44 Multi-layered Virtual Space Constructed by Real-time Chromakey Compositing and 'Frame within a Frame' Cinematography

3. Dissolve effect

The last scene of the music video is where two real people dance inside the virtual landscape. After when two lovers apart from each other, they meet in virtual space but again reunite in a real space same place as the virtual. However, they disappear in the end as if they are going back to somewhere in the virtual space leaving the real landscape. This last scene where the lovers disappear was implemented using a dissolve effect and was synthesized using temporal continuity; these effects separate the landscape and the lovers into different layers. At the same time, they bring the effect that the scene being watched is also a virtual space that is confined inside a frame of a music video. It can be said that this last scene implements spatial and temporal multi-layered virtual space simultaneously (Figs. 45 and 46).



Figure 45 Multi-layered virtual Space by Dissolve Effect



Figure 46 Structure of multi-layered virtual space in *Telematic Tango Telemaic Love*

6.1.3 Discussion

Through the frame of a music video, audiences are able to uncover two frames simultaneously, one of the real woman in front of the chroma key screen and the other of the two lovers inside a virtual space. The identity of virtual and real transfigures endlessly as the lovers and the landscape exist in both the real and virtual spaces. Here the real becomes virtual, and the virtual becomes real then again becomes virtual. Through the concept of virtual within virtual and the continued scenes of mise-en-abyme, the boundary between the virtual and real, and the original and copy, disappears. Here, the audiences experience both the immersion and the awakening at the same time. When two lovers in remote spaces are synthesized into one scene, the audiences are led to experience the immersion into their telematic embrace while they are led to awakening perceiving the woman's worthless gestures outside the frame. But the experience of 'summoning into reality' plays a role paradoxically increases the sense of immersion into the world of another frame. Various types of connectivity arise in this networked performance video. The first is the juncture of two physically distant places in the interspace of the mediatized forms via the network (See Frame1 in the Fig. 42). The other is the immaterial connectedness between the audience and the performance through immersion and liveness. The interaction between the real and the mediatized live, the interaction between the two mediatized live figures from different remote spaces in a virtual space, and the audience's immersion and awakening between the virtual and the real can be affected by the multi-layered structure of the video. A frame within frame and elimination of borders between scenes by dissolve effect create multi-layered virtual space.

Audiences today no longer sense a contradiction between being immersed in media and being aware of

its mediacy. Such ambivalence of the audience, encompassing the target and meta levels towards the media, and the multiple selves wavering between immersion and awakening, allow them to immerse deeper.

6.2 Temporal Multi-layering: Recent Pop Music Videos

A music video is a trendy genre that blends various artistic genres experimenting. Of the popular art genres, music videos often act as test-fields for experimenting with up-to-date cinematography or graphics technology and reflect the latest trends in arts. Music videos have evolved from being merely a filmed version of the song's live performance to experimental audio-visual artworks, including cinematic experiments and performing arts.

6.2.1 Visual effects

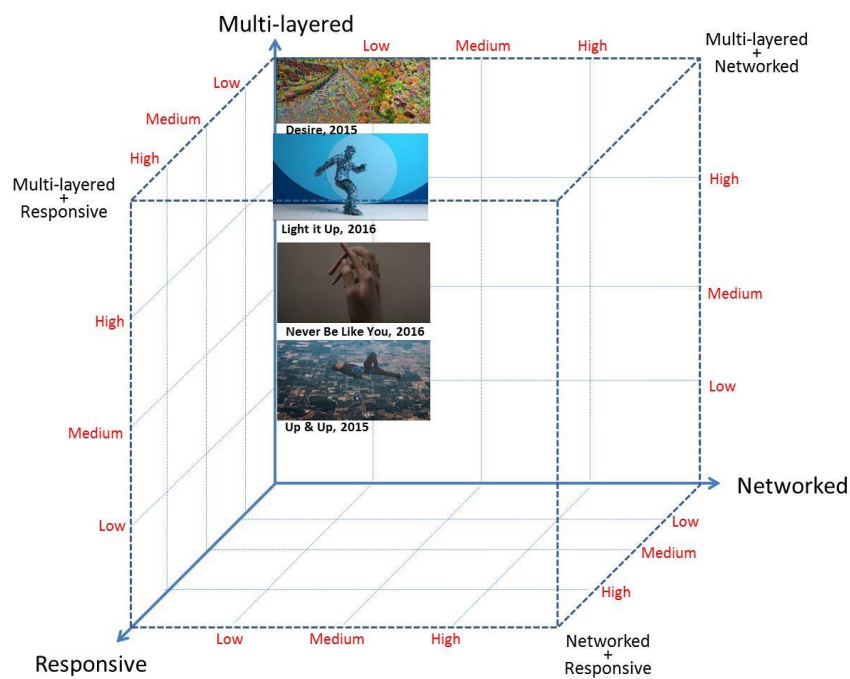


Figure 47 Taxonomy of Recent Music Videos

In this section, I focus on the examination of the visual effects in recent pop music videos as cases for temporal multi-layered virtual space. Temporal multi-layered virtual spaces illustrate the process of production, transformation, and transfiguration as spaces or objects of different attributes are continuously layered according to the seamless temporal flow. In general, music video contents do not have the networked and responsive attributes besides the music videos that are created online by online users or videos that the user can alter in

accordance with the music. Music videos, like movies, are produced using cutting edge shooting and graphics technologies as a genre that creates visual virtual space. In many music videos, there are unreal and hyperreal scenes implemented using seamless compilation of shots of real scenes with computer-generated characters or backgrounds. In addition, music videos often include recursive images automatically generated using image morphing algorithm. Recently, there have been appearance of computer characters in replacement of the actual singers or actors implemented using motion capture technique, and appearance of realistic by unreal virtual space using various visual effects. The images created and the virtual space created by them are quite multi-layered and demonstrate well the concept of temporal multi-layered attribute. In this section, four music videos each representing the four levels of multi-layered attributes were analyzed. For the 'low' level, a music video entitled *Up&Up* (2016) was selected which is a compilation of shots of clips, for the 'medium' level, *Never Be Like You* (2016) was selected since there is a layer of computer-generated visual effects on top of shots of scenes, for the 'high' level, *Light It Up* (2016) was selected because it is an animation completely made using images produced by a computer, and lastly, for level 1, *Desire* (2015) was chosen because it includes computer-generated images that were recreated using automated algorithm.

British rock band Coldplay's music video for *Up&Up* (2016) could be a representative example of a surreal composition of disparate live-action images, depicting a turtle floating in a subway, eagles flying underwater, synchronized swimmers in a teacup and a herd of fish covering the sky. This type of composite visual display is a typical 'dépaysement' technique of surrealism involving altered sensation via juxtaposing incongruous elements. This surrealistic method is very effective for taking viewers on a strange, but sometimes, as seen in the *Up&Up* video, contemplative journey into a world composed of two different realities in an unrealistic way. (Fig. 48 left.)¹⁰

Another music video, *Never Be Like You* (2016), by Australian musician Flume, depicts the altered sensations of bodies such as melting, warping and drifting. A woman wakes up in her bed and looks at her fingers. As she moves her fingers, they stretch, bend and begin to distort. During scenes of drinking and dancing, bodies, objects and spaces become warped, melted and wavering. The speed and rhythm of the distortion are very flowing and fluid, thus depicting a delirious dreamy atmosphere. These sensations reflect one of the frequently encountered symptoms of psychedelic experience, which is the feeling that the body is heavier or lighter, has greater or lesser density (Masters & Houston, 1966). The video aptly expresses the delirious dreamy atmosphere through flowing and fluid footages implemented using time displacement technique that distorts the images by shifting pixels across time. In other words, the areas determined in a particular time are replaced by the other time in the same footage and an actual "time distortion" occurs in the video similar to the altered sensation of a body induced by a brain. (Fig. 48 right)¹¹

¹⁰ Source: <https://youtu.be/BPNTC7uZYrI>

¹¹ Source: <https://youtu.be/-KPnyf8vwXI>



Figure 48 left. *Up&Up* (2015), right. *Never Be Like You* (2016)

The music video of *Light It Up* (2016) by American electronic music group Major Lazer consists of a dancing performance of avatars, created with state-of-the-art animation techniques such as motion capture and dynamic simulation. The avatars are portrayed as faceless figures disassembled and reconstructed with various materials like fur, string, particles and more. While watching the figures' rampageous movements, the explosion of technicolour, and crumbling of materialized bodies, the figures appears like ritualistic existences dancing in a trance—not human, nor animal, nor material, but could also be all of them. Intriguingly, another version of a video for the same song features a Ghanaian traditional funeral ceremony in the way of a documentary, including religious and mystical mourning, crying, laughing, singing and dancing. Apparently, the vivid material-human figures' performance is based on the Ghanaian people's ceremony as a symbolic performance representing death, extinction and rebirth. (Fig. 49 left)¹²

Music video by London-based electronica group Years & Years' *Desire* (2015) is produced entirely by using a computer vision program of machine learning and neural networks technologies. The program enhances the patterns and colours of the video source, and as a result, creates an intensely hallucinogenic appearance. The artificial intelligence program effectively mimics the process of image perception in the human brain. The images generated by the program are inevitably similar to hallucinatory images in altered human consciousness induced by psychedelics. It might be said to be a hallucination or dream of computers. Since fractal images popularized in the 1980s, the obsessive dream-like visuals of neural networks could be regarded as the newest computer generated form of psychedelia. (Fig. 49 right)¹³



Figure 49 left. *Light It Up* (2016), right. *Desire* (2015)

¹² Source: <https://youtu.be/r2LpOUwca94>

¹³ Source: <https://youtu.be/NYVg-V8-7q0>

As investigated so far, many visual effects in music videos—*dépaysement* by compositing, drifting and melting by time displacement, motion capture, dynamic simulation and image generation by neural networks technology—create digital images that are consisted of simultaneous composition of different places or incongruous objects, or that are seamlessly connected and transformed into other figures over time. Therefore, undeniably, the spatial properties of many music videos are multi-layered.

6.2.2 Narrative

In comparison to the artworks mentioned in Chapter 5 which were interactive installations and networked performances, the music videos in Chapter 6 take music and narratives also into account as essential factors on top of visual elements. Of the two factors, the narrative factor coincides well with the multi-layered attribute of virtual space dealt with in this dissertation. Especially, the cases of temporal layering that change according to the temporal change can be found. One of the representative stories is a ‘frame story’ in which protagonists deviate from everyday life, traverse another reality, and then return. In two music videos, *Mind Mischief* (2013) and *The Less I Know the Better* (2015) by Australian band Tame Impala, such frame narratives unfold. For instance, in the videos, psychedelic effects are maximized using the narratives that contrast technicolor scenes of teenagers’ sexual fantasies with ordinary school vignettes. In the former music video, a school-boy inhales a cloud of smoke, then live-filmed scenes are altered into an animated world and, in the later music video, when a girl and a boy cast furtive gazes at each other the scenes change from ordinary school space into technicolored semi-animated world to express their vivid sexual fantasies. The fantasy scenes are quite surreal and psychedelic, especially, in the former, an animated sequence featuring a sense of body's dissolution and abandoned feeling. In both videos, the teenagers escape from everyday school life and fall into their sexual fantasy and pass through a psychic experience as if it were a rite of passage, and then come back to reality. An important aspect of this narrative is that the protagonists come back to reality in the end. Through awakening, they—also the viewers—notice the de-realization of the other world more vividly, and furthermore, share the feelings that the furtive experience does not remain just as a fantasy but as a materialized sensation. In such a way, through the alternating narrative of immersion and awakening, and multi-layered narrative of the surreal space and the real one, dizzying immersion are maximized, and the viewers are guided to traverse the hallucinatory world (Fig. 50)¹⁴



Figure 50 left. *Mind Mischief* (2013), right. *The Less I Know the Better* (2015)

¹⁴ Source: left. https://youtu.be/BgK_Er7WZVg , right. https://youtu.be/sBzrzS1Ag_g

In American hip hop artist Childish Gambino's *Sweatpants* (2014) and English rock band Radiohead's *Daydreaming* (2016), a multi-layered narrative of loops and transcendence were recreated through an obsessive, recursive but poetic narrative. The music video *Sweatpants* features the experience of becoming trapped within a chain of thoughts in the way of repetition and multiplicity (PsychonautWiki, 2017). Visually, a man walks into a dinner room, sits on a table, inserts a coin into a jukebox, steps outside, checks his phone and comes back into the dinner. This sequence of scenes repeats itself causing the man to go through the loop again, noticing the people replaced by himself. Repeatedly, the hysteria gets more intensive until the last loop where the jukebox is turned on and he is surrealistically taken into a dark forest with slow music and dancing figures. (Fig. 51 left)¹⁵ Another video *Daydreaming* begins with a scene where a man comes into a dark tunnel. He opens a door, keeps walking, opens another door, keeps walking, and repeats. After the last opening, he steps out, climbs a snowy mountain, enters a cave, and lies down next to the fire. (Fig. 51 right)¹⁶ Throughout the repetition, he moves from one space to another that are illogically connected, and seemingly enters a different world. The repetition may seem obsessive and hysterical, but it brings release in the end. Similarly, in an actual psychedelic state, loops can often trigger a state of anxiety, but at the same time can also offer transcendental moments that provide a feeling of overcoming the limits of everyday life. The two videos depict such transcendence through a dark forest (Williams & Harvey, 2001) and a mystical fire scene in a cave. In fact, the forest is one of the common symbolic settings for representing a drug-state drama (Masters & Houston, 1966). Moreover, caves are often used to metaphorically express archetypal space as Lewis-Williams and Clottes (1988) had described it, "the mind in the cave and the cave in the mind."

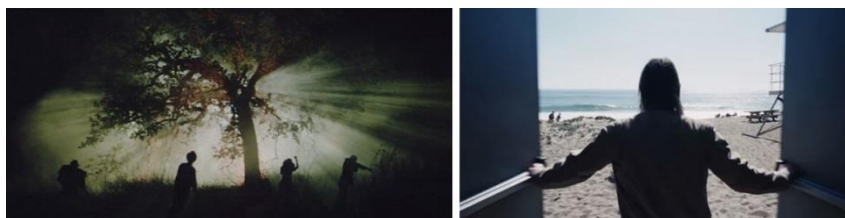


Figure 51 left. *Sweatpants* (2014), right. *Daydreaming* (2016)

The multi-layered narratives discussed so far refers to a narrative concerning the connection of spaces and movements within rather than a storyline. According to Janet Murray (1997), a narrative can be experienced as a virtual reality since immersion is the experience of being transported to an elaborately simulated place. Immersion is not a matter of mental contemplation, but a phenomenon that occurs at a sensory level of a body, and is a moment when the boundary between the object and the subject diminishes being surrounded by another reality. In this way, similar to visual effects, narratives of traversing immersion have frequently been used in music videos to establish or convey multi-layers.

¹⁵ Source: <https://youtu.be/ExVtrghW5Y4>

¹⁶ Source: <https://youtu.be/TTAU7ILDZYU>

6.2.3 Uncanny and Psychedelic

Up to now, this section has explored the representative examples of temporal multi-layered virtual space in music videos from the aspects of visual effects and narratives. I examined various types of multi-layered visual effects using compositing, morphing, time displacement, dynamic simulation, and neural networks. After the discussion, I analyzed the music videos that unfold narratives passing through immersion, loops, and transcendence. Such multi-layered narratives in virtual reality involve immersion to the extent that the awareness of physical self disappears and one is surrounded by another reality. From the mesmerizing visual effects to narratives, the experience of moments which are totally absorbing in virtual space present the allure of imaginary worlds. And the influence of the immersive experience on multi-layered virtual space of music videos has shown how recent digital images can expand sensory perception and how the sense of immersion can be experienced more physically. In recent years, advancing digital technologies and graphics software have opened a way toward a new expression of multi-layered and synthesized visions. As is always the case in art, in music videos and many other media contents, through ‘traversing immersion’ in virtual space, we are transported to another world beyond the real world.

While analyzing the virtual illusionary space and the computer-generated image of the digital age from the multi-layered perspective, uncanny and psychedelic concepts are encountered as an important aesthetic concept. The uncanny is the psychological experience of something that is simultaneously familiar and unfamiliar. The concept of the uncanny was fixed by Sigmund Freud (2003) in his essay *Das Unheimliche* in 1919. He described it as “the opposite of what is familiar” and as anything that reminds us of the frightening realm of our own unconscious mind, of repressed memories and impulses. Robotist Masahiro Mori (1970)'s theory of the uncanny shows that when such beings appear very real while deviating almost imperceptibly from a perfect human likeness, our comfort level suddenly drops into the uncanny valley (Coyne, 2005; Suler, 2016). Especially in recent years, due to advanced computer graphics technologies, numerous uncanny images were generated by computers. The seamless synthetic and algorithmic images are gradually becoming more surreal and hypervisual, namely, expanding visual perception beyond ordinary human vision. These hypersensate digital images can be described as simultaneously an atypical collapse of the figurative and a revelation of the other figurative. The uncanny feelings toward these digital images are a representative sensitivity in this time.

In addition to the uncanny discussed herein, the psychedelic can convey current tendency. From prehistoric cave paintings to virtual reality today, psychedelics have played essential roles in many different cultural areas, such as in religion, philosophy, art, and technology. For instance, in prehistoric times, shamans used drugs, music, and dance to give themselves, as well as others, hallucinations and states of altered consciousness. According to South African archaeologists Lewis-Williams and Clottes (1998), cave paintings may be the oldest psychedelic artwork. They claim that prehistoric people saw the hallucinatory visions projected on cave surfaces and captured these visions as cave paintings. In such a way, hallucination became a part of everyday life in the prehistoric period as a representation of mythical beliefs. In modern society, digital technologies allow humans to experience psychedelic realities made of bits and bytes. These digital images and

virtual realities are not experienced magically or psychologically—like in primitive religions—but as a physical reality. Advocate of psychedelic drugs and counterculture activist Timothy Leary (1994) claimed that the drug culture itself was a forecast of, or preparation for, the personal computer age. One engaged in virtual reality mindfully distinguishes the unreal from the real, and becomes more than a spectator; instead, as a proactive immersant, the person moves to and fro freely between virtual and real worlds. Today, a psychedelic phenomenon does not occur at the scale of the individual anymore under the influence of drugs but is shared publicly in forms of art such as films, games, and other media. Among them, music videos are a popular art genre reflecting the latest experimental trends. In the previous section, I reviewed some of the most recent representative music videos from the aspects of visual effects and narratives to show how synthetic and generative digital images can convey uncanny and psychedelic experiences, and how viewers get immersed in the expanded reality using the music video as a medium.

Due to recent developments in neuroscience, the psychedelic phenomenon has expanded beyond just influencing the creation of art to being the subject of scientific research into human consciousness and the brain. For instance, scientists revealed that psychedelic compounds could make brains hyper-connected (Petri et al., 2014) and could “reset” brain activities (Carhart-Harris et al., 2017). Gilles Deleuze (1998) also mentioned that “the brain is the screen,” thus relating cinema to the biology of the brain. This neuroplasticity of the brain, the psychedelic visions induced by it, and the images representing these visions are intimately related and operate together. These images can be recreated digitally – often appearing excessively realistic and sensuous, and furthermore, uncanny – through visual effects such as saturated colors, intricate and repetitive images, curved or warped patterns, seamless transformations, weird distortions, hyperreal textures, and more. The images have already over-reached the goal to represent the world realistically, or rather, another reality of the senses, as Manovich (2001) has stated: the “synthetic computer-generated image is a realistic representation of a different reality.”

As the last uncanny and psychedelic work, I review a recent video work entitled *Makin' Moves* (2017), directed by a graphic artist Kouhei Nakama, that expresses the sensations of body distortion very radically. Using highly detailed 3D scanning and generative motion graphic technologies, the video portrays realistic human figures becoming sliced, fragmented, and proliferated. The sliced and malleable body figures show paradoxical humor, however, at the same time, these awkward movements connote inevitable death image like something repressed in the unconsciousness. The schizoid and collapsed body images hypnotically divide and disperse the mind of a viewer placing the one in-between a sense that there is a physical body and a sense that there is none. The uncanny visual effects and animations have successfully assimilated the feeling of hallucination. This music video demonstrates that uncanny and psychedelic experience can be implemented through physical images, not just through illusion or delusion (Fig. 52)¹⁷

¹⁷ Source: <https://vimeo.com/218597363>

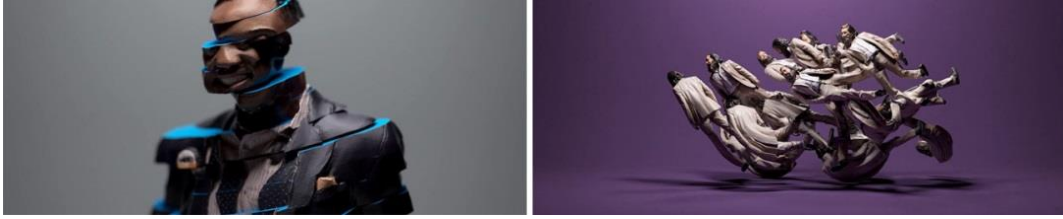


Figure 52 *Makin' Moves* (2017)

As Roy Ascott (2000) coined the term “vegetal reality” to express the third axis of reality, humans live in transformed realities, expanded and different. In the era when the creation of artificial life and intelligence, the hybridization of body and machine, the blurring of the border between virtual and real, and the emergence of the senses of another dimension manifest, researchers must investigate the emerging technologies and the matter of mind involved by them, and fully comprehend how the unveiled consciousness have pervaded everyday lives. Uncanny and psychedelic perspectives will be the starting point for understanding the expanded reality and consciousness; and as a part of this accomplishment, artworks, music videos and various media contents based on multi-layered virtual spaces have already represented the hyper-sensate realities. The concept of the uncanny and the psychedelic being issued in various aspects of psychology, aesthetics and technology can be an important contemporary sensitivity in the digital and post-digital age.

Chapter 7. Conclusion

7.1 Discussion

In this section, I investigate over 700 media artworks mediating the screen-based virtual space from the 1970s to the present including all works analyzed so far in this thesis. The artworks are quantified, classified, then coordinated into the three-dimensional space of taxonomy framework based on three attributes of virtual space: networked, responsive, and multi-layered. Using the result, meanings behind clusters and distributions are summarized along with the general trend over time. The works being analyzed are mainly selected from winning projects of the Ars Electronica Archive-Prix from 1987 to 2017, from Medien Kunst Netz (Media Art Net), a media art online archive site, and from a book New Media Art (Tribe et al., 2006). First, I summarize changes and trends over times derived from the analysis of 700 media artworks and then conduct a detailed analysis through the taxonomy framework model. In particular, the categories of the Ars Electronica Archive-Prix, in which new categories are emerging and whose names are changing, are used as a reference for understanding trends of the period.

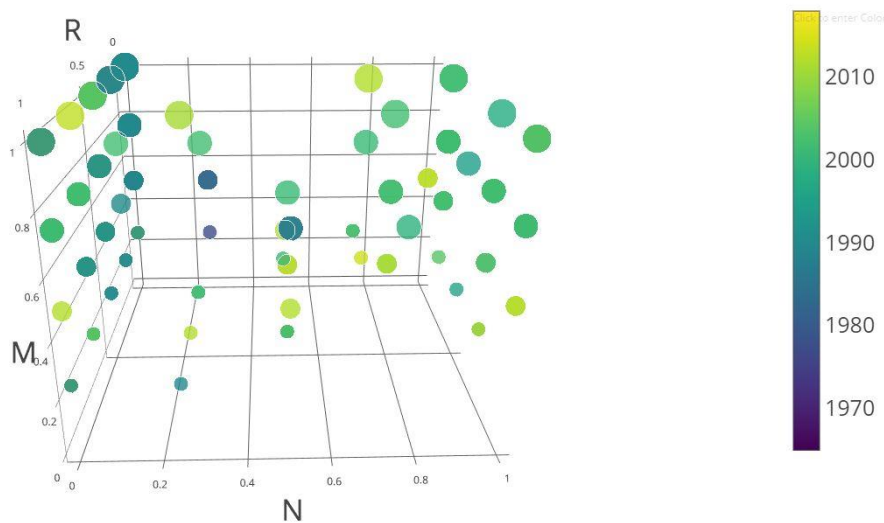


Figure 53 Changes in the Time and Distribution of Artworks from 1968 to 2017

Figure 53 shows the media artworks and media contents from 1974 to recent years classified and distributed through the cube model using 3D scatter plots method. In addition, the year of the work is indicated using different colors so that the graph restrictively shows the flow of times. First, I analyze the characteristic trends of artworks that appear in same periods from a technical perspective.

1. 1960 ~ 1970s : Video art

The earliest works analyzed in this study are video artworks of the 1960s and 1970s. With the advent of

affordable handheld cameras in the 1960s, video art became a trend of art through artists such as Nam June Paik, Joan Jonas, Vito Acconci, Bruce Nauman, and Bill Viola (Tribe et al., 2006). These early video artworks show the beginning of media arts with one scene one cut videos in a form of conceptual performance without any editing or synthesis (regarded as a single-layer virtual space) and in a form of video installations transforming the signal of screen image using computer synthesis and morphing techniques.

2. 1970 ~ 1980s : Satellite art

In the 1970s and 1980s, network performances using satellite and TV emerge, and these are the earliest examples of networked properties in arts since satellites were not easily accessible to ordinary people at the time. *Satellite Arts Project* (1977) by Galloway and Rabinowitz and *Good-morning, Mr. Orwell* (1984) by Nam June Paik remain representative and symbolic works of network performances using satellites.

3. 1980s ~ present : Computer graphics and animation

In the 1980s, with personal computer becoming popular, computer graphics and computer animation began to appear in the field of art, along with the terms of 'computer art' and 'computer aesthetic'. The digital images created by computer algorithms and programs presented another possibility of being infinitely modified, transformed, and automatically generated, comparative to previous visual modes of photos, movies, and videos. In 1987 when the Ars Electronica Archive launched, the categories were divided into computer graphics (CG) and computer animation (CA) along with computer music. However, the CG category disappeared in 1995 while the CA remained as a main prize category until 2017.

4. 1990s ~ present: Interactive art

With the development of computer graphics arts, interactive arts that respond to and interact with audiences using computer systems also began to emerge in the 1990s. Starting with pioneering works such as Myron Krueger's *Videoplace* (from the 1970s to 1980s) and Jeffrey Shaw's *The Legible City* (1988), responsive spaces and responsive artworks using various multimedia have been newly created by many artists until now. The Interactive Art (IA) category first appeared in the Ars Electronica Archive in 1990 and continues to this day.

5. 1995 ~ present: Net art

Along with computers, as the Internet become popular in the 1990s, the trend of media arts began to change dramatically. Beginning with early telematic artworks of 1980s such as Roy Ascott's *Elecrica* (1983) and *Aspects of Gaia* (1989) that use computer networking, Internet-based arts become popular with the dot-com boom in the 1990s. The term 'net art' came into being in 1995, and the category called 'Net Vision' was introduced in the Ars Electronica Festival. In the 1990s, net-based arts, artworks accessible to a large number of unspecified users anywhere on the planet, played pivotal roles with these interactive arts. In the Ars Electronica Archive, the field of 'Net Vision' had been abolished since 2007 and had been replaced by 'Digital Community', which has been established since 2004. Since the 2000s, net art has evolved into a form of digital community

where activists create platforms using the Internet, gather and share information focusing on various social, political, and environmental issues. This trend reflects a change in the use of the Internet as an intermediary for the political and social activities of communities, rather than merely building a visual virtual space on the Web.

In order to analyze the plotted artworks, I divided the taxonomy cube into nine areas and examined the meanings of each area and the tendency of the works that fell into the area (Fig. 54). First, network performances, network installations and web arts appear in the area of ①. This indicates that many works with network attribute have also responsive attribute. In general, the virtual spaces in network arts are connected and responsive. They can be synthesized and be edited in real-time providing interactions between remote performers. Satellite arts in the 1970s and 1980s cluster in the area of ② where networked attribute is present but not responsive. Reason for this is because viewers cannot intervene in the virtual space although they are connected in real-time globally by communication technology. These network performances or network installations are made up of several remote places connected to each other, whereas web arts or net arts connect a myriad of anonymous users around the world through the web. Therefore, the network attribute of web arts and net arts corresponds to level 1 categorized into the area of ③ in most cases. The area of ④ corresponds to numerous typical interactive artworks that operate only with a local system without the networking of remote places or users. Furthermore, in this area, there are many interactive contents implemented using AR and VR devices, 360-degree photographs and videos, and virtual spaces created by 3D modeling tools. The area of ⑤ is a virtual space that has no networked attribute with all interactive attributes like modularity, such as movies and videos. In the modern day society, still many videos are shot as live-action or are created by computers. The live-action footages are also modified, edited, and added with various visual effects and image processing through computer software. Especially, with the development of computer graphics, there are many highly realistic and surreal images that stimulate and expand the limits of human senses. Some examples of the artworks that correspond to the area ⑥ are generative arts, data visualizations, and computer animations. Among the contemporary media contents, the most representative work that categorize into area ⑦ is the virtual space of Massively Multiplayer Online Role-Playing Games (MMORPG). Many online games realize the highest level of illusionary 3D space implemented through 3D modeling and of real-time interactions between players and game worlds. For the area of ⑧ where all the attributes correspond to 0, video works consisted of a single shot without any processing such as editing or synthesis in the early experimental video arts are the examples. Finally, in the case of the area ⑨, a virtual space consisted of a single layer, that is, a work which has not undergone any synthesis or processing, correspond to this area. However, it is rare to find virtual space images that are generated without the process of compositing, editing, and computational work in modern digital culture. In other words, the multi-layered attribute is the most representative and inevitable attribute of digital images.

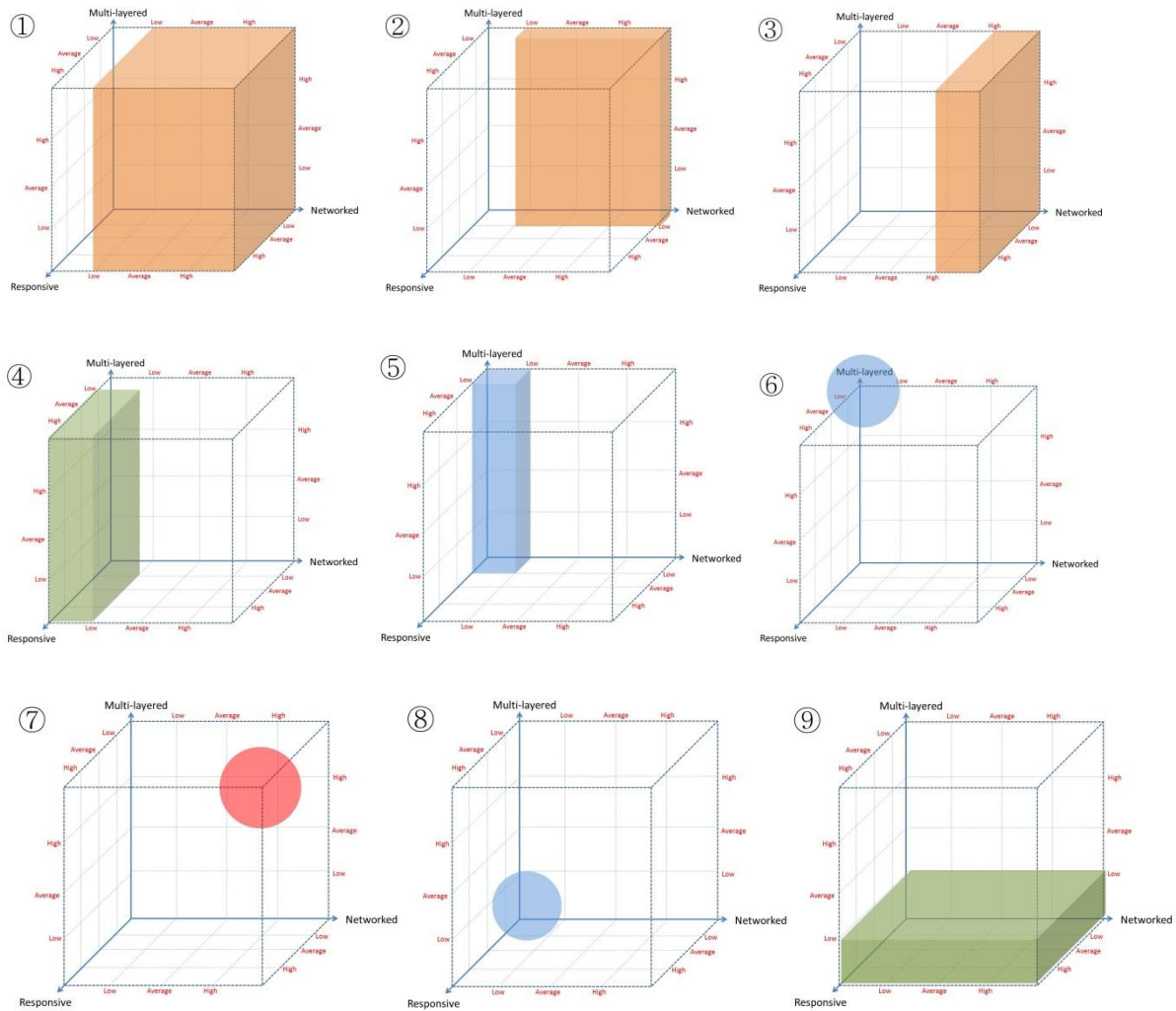


Figure 54 Breakdown by Area of the Taxonomy Framework

In conclusion, it is verified that various forms of media art including screen-based virtual spaces—from video arts of the 1970s to films, computer animations, interactive arts, net arts, online games, data visualizations, networked performances, and audiovisual performances—can be applied to the taxonomy framework of networked, responsive and multi-layered attributes. Moreover, according to the classification and distribution tendencies, trends in times and their meanings can be analyzed. Similarly, the existing works can be re-contextualized systematically using the taxonomy framework proposed in this dissertation. With the popularization of TVs and the development of information and communication technologies in the 1970s and 1980s as well as the emergence of computer and Internet in the 1990s, many artists have created a variety of works that utilize and experiment with these technologies. Especially since the 1990s, the number of network artworks and interactive artworks have increased significantly. With new emerging digital graphics technologies since the 2000s, more and more synthetic and multi-layered images are being produced.

7.2 Summary

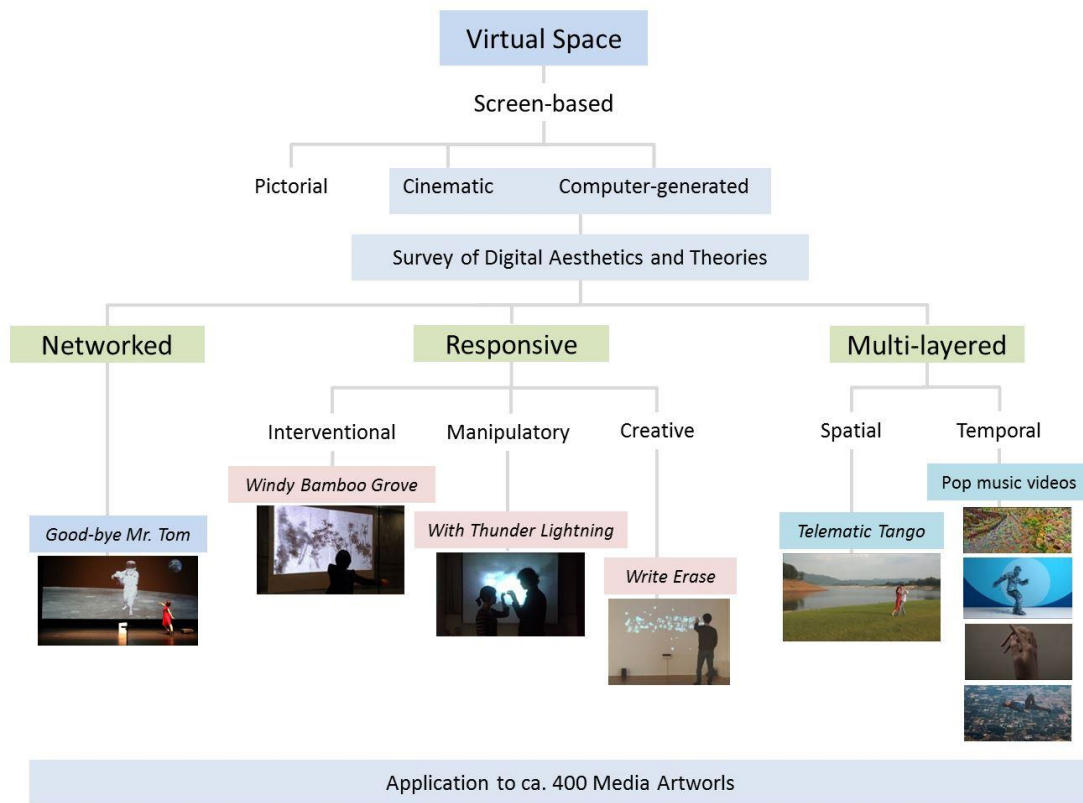


Figure 55 Summary of this Dissertation

In this dissertation, concepts of the virtual space were refined as pictorial virtual space, cinematic virtual space, and computer-generated virtual space, and three attributes of virtual spaces were derived from the survey of existing digital aesthetics and theories to propose and verify the taxonomy framework for virtual space-based artworks. Based on the three attributes—networked, responsive, and multi-layered—the taxonomy framework was proposed and applied to the networked performance, interactive artworks, and music videos as empirical studies. Then for verification, 700 existing media artworks were plotted onto the 3D coordinate of the framework.

1. Networked attribute

The networked artworks have explored new and innovative concepts such as the connectivity of spaces through information and communication technology, cyberspace as virtual space on the network, and accompanying expansion of human consciousness. Networked virtual spaces use networking technology to implement communication and interaction between remote places, environments, users or objects. Network arts that connect or superpose the spaces and web arts where many anonymous people access and leave feedbacks

can be considered as typical networked virtual space artworks. A 3D virtual space of online games in which a large number of users access to communicate within the virtual space also corresponds to a networked space. Other interfaces that access networks or platforms that are based on networks such as messenger services, social network services, digital communities, search sites, photo and video sharing sites and alike have similar networked attributes, although not covered in this study.

2. Responsive attribute

Interactive artworks have changed the relationship between artifacts and viewers from one-sided and passive appreciation to active interaction and participation. Interactivity is settled as an important notion not only in arts but throughout all fields that encompass cultural technologies. Responsive virtual spaces that enable interactions are being offered to us in a variety of forms such as interactive artworks, games, VR/AR content, applications, and authoring tools being used and experienced in everyday life. Most of the digital media and most of the interfaces and screens of computers, smartphones, and digital devices are responsive. Responsive virtual spaces are produced and consumed in every single field of our society such as entertainments, games, industries and more. The artistic experiences that Interactive arts experimented and implemented are now routinely provided and shared by interactive systems, interactive devices, and multimedia contents.

3. Multi-layered attribute

Today, with the development of computer graphics, virtual spaces have become increasingly realistic, sophisticated, and multi-layered. We still enjoy a lot of media contents such as movie, TV, videos on the web, and digital photos that provide just pictorial or cinematic virtual spaces without responsiveness or interconnectivity. All these virtual spaces—responsive or connected, pictorial or cinematic—are multi-tiered. The multi-layered attribute means that space is elaborately composed and created with multiple and multidimensional layers of spaces, objects, and images, regardless of whether or not each layer or module is activated. The concept of layering in this study is polysemous and metaphorical, from the meaning of graphically combining several different images or objects in a space to the meaning of cinematically creating images of movement and narratives. Therefore, multi-layered virtual spaces manifest both the composited or superposed spatial images and the edited or generated temporal images.

7.3 Limitation and Future Work

The taxonomy framework proposed in this thesis is to systematically analyze and construct principles of virtual spaces. Thus, the framework has not been verified whether it is applicable or not to artworks that are not based on virtual space. In addition, even if an artwork incorporates a virtual space in a part of the work, the framework has limitations to review the overall work from the artistic point of views such as design styles, meanings of narratives, metaphors and so on. Meta-conceptual problems about artworks such as aesthetic experiences and artistic values have not been dealt with in this study. However, the discussions of the uncanny

and the psychedelic in Chapter 6 partially cover the theme through the expanded multi-layered concept. Another limitation is that although objective criteria are provided to quantify the three attributes of virtual space, subjective judgment can be intervened. Lastly, providing only five levels in the framework—0, low, medium, high, and 1—could bring limitation in terms of intricacy of quantification.

The taxonomy framework classifies and interprets contemporary artworks that are based on virtual spaces, and the attributes of virtual spaces are used as the criteria for classification. Many contemporary works of art are either mediated through the digitally created illusionary space or are created entirely within the virtual space. However, recent artworks are constantly expanding their contents. For instance, the shapes that are constructed in the digital space either through artificial intelligence programs, vital phenomena, or hybridizations between heterologous types, are being materialized into the real world with 3D printing techniques.

For future works, the screen-based virtual space will still be the basis for interpreting many artworks, but the conceptual expansion of the virtuality is necessary to interpret contemporary arts that are evolving in many different ways. The concept of virtual space can be broadened to illusionary spaces based on sounds, music, narratives, movements as stereophony is a very common sound-based virtual space, and dance and mime are performing arts that create a body-based virtual space. Furthermore, the scope of the research can be extended multidisciplinary spaces such as molecular nano-space, outer space and neurological hallucination space which are deserved to be called post-digital spaces. The conceptual expansion will lead to the reinterpretation of the networked, responsive, and multi-layered concepts of the taxonomy. The reinterpretation can be accomplished at cognitive, sensory, psychological, neuroscientific, philosophical, and aesthetic levels beyond technical and systematic levels. Networked attributes might be broadened beyond the Internet and telecommunication technologies to connected feelings, connected consciousness, and connected neurons. Meanwhile, responsive attributes might be elaborated beyond the concept of simple user interactions to more complex interactions such as reactivity to objects, machines, animals, environment, or human consciousness. Lastly, multi-layered attributes could go beyond mere graphical techniques of synthesis and generation to the concepts of multi-space, multi-reality, multi-selves, expanded consciousness, expanded reality and heterogeneous hybrid. Figure 56 illustrates these all possible concepts that can be extended in the framework. Materiality, liveness, and intelligence are considered as new conceptual axes in the framework.

The motivation of this study was the transition from material-based arts to virtual space-based arts. However, another transition is expected where the virtual space-based arts become materialized. This makes sense since our lives are based on virtuality and materiality simultaneously compatible with each other. The proposed framework discusses the attributes of visual virtual space, but in the end, a new vision is necessary to include both the virtuality and materiality. There are also artificial intelligent beings that are becoming more and more automated and creative than reactive, and the matter of liveness is still important. Therefore, the expansion of the concept and the utility of the framework should be considered in future works. Insight into new forms of artistic expression will also be investigated in the extended framework.

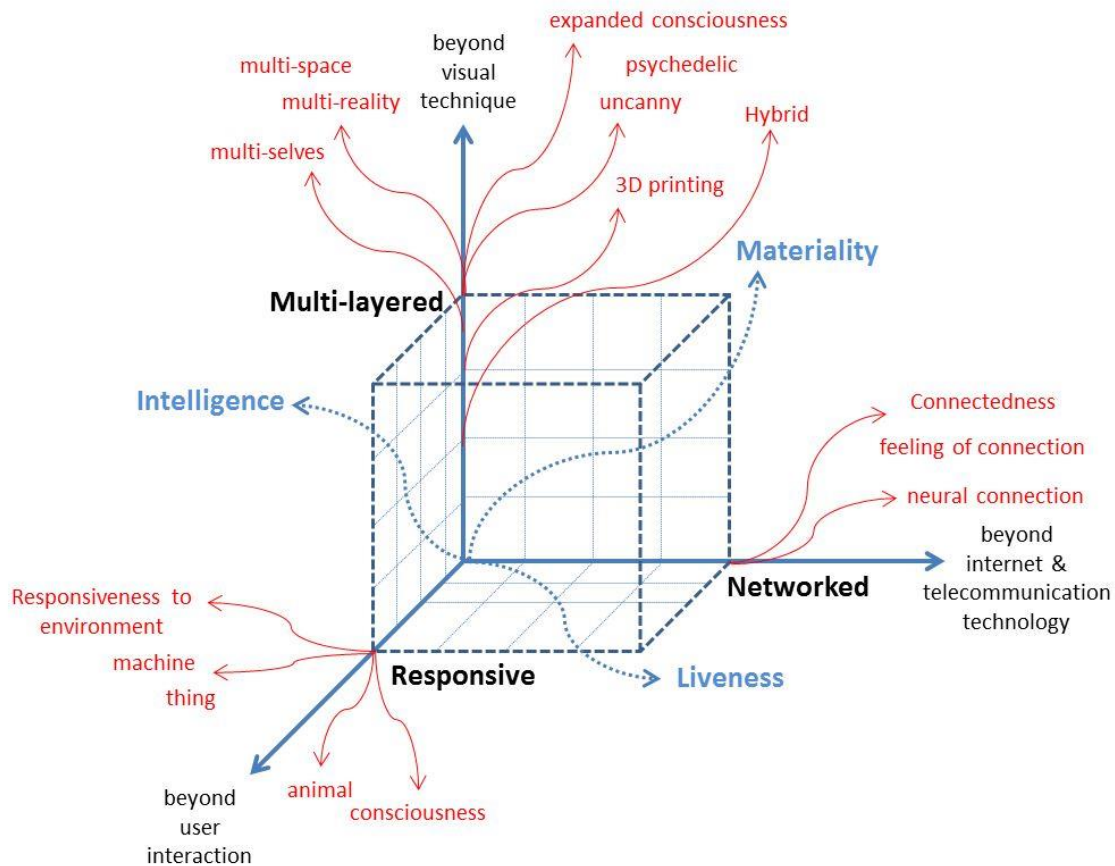


Figure 56 Expanded Concepts from the Taxonomy Framework

7.4 Closing Remarks

Among the three attributes of virtual space presented in this thesis, the multi-layered attribute has many implications for interpreting not only the screen-based spaces, but also other types of spaces such as multisensory virtual space created by narratives, sounds, and gestures. Furthermore, many digital concepts and theories could be reinterpreted from the aspect of multi-layered property as I have analyzed the uncanny and psychedelic experiences in recent music videos in terms of temporal layering in the second section of Chapter 6 of this thesis. It could be an attempt to extend the multi-layered concept to the aesthetics of recent digital images and narrative. Interestingly, the notion of multi-layering is basically connected to the concept of space-time and the universe in modern physics. And the multi-layered attribute could also be expanded beyond the graphical and technical aspect to the metaphysical and philosophical concepts such as multiple consciousness of human, multiple self, and multiple reality as a basic principle of digital aesthetics.

New types of arts, technologies and socio-cultural patterns are continuously emerging, and the changes they bring to human mind and consciousness are ongoing. Accordingly, to explore and interpret these phenomena, the framework model of virtual space should be expanded and further developed including various aspects of aesthetics and technologies. The process of the framework should begin from the multi-layered perspective as a starting point for understanding the matter of space and time, the real and the virtual, and the material and the immaterial in the digital and also the post-digital age.

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Appendix

Taxonomy Coordinate Sets of Media Artworks from 1965 to 2017

	Artwork	Networked	Responsive	Multi-layered	Genre
1	Magnet TV (1965)	0	0.75	0.25	Interactive art
2	Wall floor positions (1968)	0	0	0	Video Art
3	I am Making Art (1971)	0	0	0	Video Art
4	Centers (1971)	0	0	0	Video Art
5	Vertical Roll (1972)	0	0	0.25	Video Art
6	Golden Voyage - Hommage to Magritte (1973)	0	0	0.25	Video Art
7	Videoplace (1974)	0.5	1	0.75	Networked installation
8	Suite 212 (1975)	0	0	0.25	Video Art
9	The Last Nine Minutes (1977)	0.25	0	0.25	Network performance
10	Satellite Arts project (1977)	0.25	0	0.5	Network performance
11	Escher (1979)	0	0	1	Digital Print
12	Beauty Composites (1982)	0	0	0.5	Video Art
13	The Lift Project (1983)	0	0.5	0.25	Interactive art
14	Good-morning Mr. Orwell (1984)	0.25	0	0.5	Network performance
15	I do not know what it is I am like (1986)	0	0	0.25	Video Art
16	Luxo Jr. (1987)	0	0	0.75	3D animation
17	Mental Images (1987)	0	0	0.75	3D animation
18	Urbana (1987)	0	0	0.75	3D animation
19	Balloon Guy (1987)	0	0	0.75	3D animation
20	Beyond Picasso (1987)	0	0	1	Animation
21	Calculated Movements (1987)	0	0	0.75	Animation
22	CG Town (1987)	0	0	0.75	Animation
23	Concrete People (1987)	0	0	0.5	Animation
24	ECOLOGY II: FLOAT II (1987)	0	0	1	Animation
25	Knot Reel (1987)	0	0	0.5	Animation
26	Paradis Perdu (1987)	0	0	0.75	Animation
27	Science of Industry (1987)	0	0	0.75	Animation
28	Tuber's Two Step (1987)	0	0	0.75	Animation
29	Zoom into Seahorse Valley (1987)	0	0	1	Animation
30	INTERVALLE (1987)	0	0	0.5	Computer graphic
31	temple-2.land (1987)	0	0	0.75	Computer graphic
32	Hocher (1987)	0	0	0.5	Computer graphic
33	Close Encounter (1987)	0	0	0.75	Computer graphic
34	Mona/Leo (1987)	0	0	0.25	Digital Print
35	PETER GABRIEL (1987)	0	0	0.5	Music video
36	Red's Dream (1988)	0	0	0.75	Animation
37	Gate (1988)	0	0	0.75	Animation
38	Time as Code: Chronokratie (1988)	0	0	1	Animation
39	Bau (1988)	0	0	0.75	Animation
40	Breaking the Ice (1988)	0	0	0.75	Animation
41	Journeys to nothingness (1988)	0	0	0.75	Animation
42	Jumpin jacques splash (1988)	0	0	0.75	Animation
43	Occursus cum novo (1988)	0	0	0.5	Animation
44	Picture (1988)	0	0	0.5	Animation
45	Stationary Imagination (1988)	0	0	0.75	Animation
46	Stylo (1988)	0	0	0.75	Animation
47	The last days of good ans evil (1988)	0	0	0.75	Animation
48	Don't Touch Me (1988)	0	0	0.75	Animation
49	Beam (1988)	0	0.25	1	Audio visualization
50	Brokenheart (1989)	0	0	0.75	Animation

51	Eurhythmy (1989)	0	0	0.75	Animation
52	Flying Logos (1989)	0	0	0.75	Animation
53	Paris 1789 (1989)	0	0	0.75	Animation
54	Pibos (1989)	0	0	0.75	Animation
55	Locomotion (1989)	0	0	0.75	Animation
56	Steady State (1989)	0	0	0.75	Animation
57	CaLightscope (1989)	0	0.25	1	Audio visualization
58	The Abyss "Pseudopod Sequence" (1989)	0	0	0.5	Film
59	Illusion 1 (1989)	0	0	0.5	Video
60	Journey through Italy (1989)	0	0	0.5	Video
61	Puzzle Museum (1989)	0	0	0.5	Video
62	Scenes at a Street Comer (1989)	0	0	0.75	Video
63	The contest of form (1989)	0	0	1	Video
64	The dream (1989)	0	0	0.5	Video
65	Tin Toy (1989)	0	0	0.75	Video
66	Dirty Powe (1990)	0	0	0.75	Animation
67	Star Life (1990)	0	0	0.25	Animation
68	Knickknack (1990)	0	0	0.75	Animation
69	Photosynthesi (1990)	0	0	0.75	Animation
70	Tipsy Turvy (1990)	0	0	0.75	Animation
71	Gossip (1990)	0	0	1	Generative art
72	The Trees are Walking (1990)	0	0.25	0.25	Installation
73	Videoplace (1990)	0.5	1	0.75	Interactive art
74	The Helpless Robot (1990)	0	1	0.25	Interactive art
75	The Legible City (1990)				Interactive art
76	Alambic Rhythms (1990)	0	0.25	0.5	Interactive art
77	A Remembrance of the Victims of National Socialism (1990)	0	0.5	0.25	Interactive art
78	Je suis (1990)	0	0.75	0.5	Interactive art
79	Light Strokes (1990)	0	1	1	Interactive art
80	Machine Dreams (1990)	0	0.5	0.25	Interactive art
81	Transmissions: In the Well (1990)	0	0.5	0.5	Interactive art
82	TÜ R FÜ R HUXLEY (1990)	0	0.5	0.75	Interactive art
83	Conversation (1990)	0.25	1	0.25	Networked performance
84	Fuji (1990)	0.5	0.25	0	Networked performance
85	Footprint (1990)	0	0	0.5	Video
86	A Passing Shower (1990)	0	0	0.75	Video
87	A Sequence from the Evolution of Form (1990)	0	0	1	Video
88	Geo-Genetic (1990)	0	0	0.5	Video
89	Particle Dreams (1990)	0	0	1	Video
90	Seven prophecies (1990)	0	0.25	0.25	Video installation
91	Panspermia (1991)	0	0	0.75	3D Animation
92	EGGY (1991)	0	0	1	AI
93	Maxwell's Demon (1991)	0	0	0.75	Computer animation
94	Grinning Evil Death (1991)	0	0	0.75	Computer animation
95	Indo-Dondaine (1991)	0	0	0.75	Computer animation
96	The Invisible Man in Blind Love (1991)	0	0	0.75	Computer animation
97	Visions from the Amazon (1991)	0	0	0.75	Computer animation
98	Electronic Purgatory (1991)	0.7	0.5	0.5	Digital performance
99	Think about the people now (1991)	0	1	0.5	Interactive art
100	Very Nervous System (1991)	0	0.5	0.75	Interactive art
101	In den Mund gelegt – The Media is not the message (1991)	0	0.25	0.25	Interactive art
102	Käferlein (1991)	0	0.5	0.75	Interactive art
103	Orpheus: Current Diversions (1991)	0	0.5	0.5	Interactive art
104	Suspicious Minds (1991)	0	0.75	0.25	Interaktive Kino
105	METEORE (1991)	0	0	0.5	Video

106	MOVE-X (1991)	0	0	0.5	Video
107	Superanimism (1991)	0	0	0.5	Video
108	The Castle (1991)	0	0	0.5	Video
109	Wet Science (1991)	0	0	0.5	Video
110	Le Pépin Géant De Arp (1992)	0	0	0.75	Computer animation
111	Not Knot (1992)	0	0	0.75	Computer animation
112	Free for All (1992)	0	0	0.75	Computer animation
113	How to make a decision (1992)	0	0	0.75	Computer animation
114	On The Run (1992)	0	0.25	0.75	Computer animation
115	Power Surge (1992)	0	0	0.75	Computer animation
116	Sub Oceanic Shuttle (1992)	0	0	0.75	Computer animation
117	Terminator II (1992)	0	0	0.5	Film
118	Home of the Brain (1992)	0	0.5	0.75	Interactive art
119	The Exquisite Mechanism of Shivers (1992)	0	1	0.25	Interactive art
120	Zerseher (1992)	0	0.5	0.5	Interactive art
121	About Five Idylls (The Narcissist) (1992)	0	0.5	0.5	Interactive art
122	A Memory Project (1992)	0	0.75	0.25	Interactive art
123	Event Horizon (1992)	0	1	0.25	Interactive art
124	House II (1992)	0	0.75	0.25	Interactive art
125	Iconworld (1992)	0	0.75	0.75	Interactive art
126	Life On A Slice (1992)	0	0.75	0.5	Interactive art
127	Portrait One (1992)	0	0.75	0.25	Interactive art
128	Liquid Selves (1992)	0	0	0.5	Video
129	Digitaline (1992)	0	0	0.5	Video
130	Lakmé (1993)	0	0	0.75	Computer animation
131	Endogenesis (1993)	0	0	0.75	Computer animation
132	Death Becomes Her (1993)	0	0	0.5	Film
133	Smdk (1993)	0	0.75	0.75	Interactive art
134	Is Anyone There? (1993)	0	0.75	0.5	Interactive art
135	7 objects meet (1993)	0	0.75	0.75	Interactive art
136	Braindrops (1993)	0	0.25	0.5	Interactive art
137	Digital Rear Window (1993)	0	0.75	0.25	Interactive art
138	Edge of Intention (1993)	0	0.25	0.75	Interactive art
139	Handsight (1993)	0.25	0.75	0.75	Interactive art
140	L'Autre (1993)	0	0.5	0.75	Interactive art
141	Virtual piazza (1993)	0.75	0.75	0.5	Interactive art
142	Room of one's own (1993)	0	0.75	0.25	Interactive art
143	The desert dreams a mirage (1993)	0	0.5	0.5	Interactive art
144	Virtuelle welten (1993)	0	0.75	0.75	Interactive art
145	A-Volve (1993)	0	1	1	Interactive art
146	Telematic Dreaming (1993)	0.5	0.75	0.25	Networked installation
147	Chip Radio (1993)	0.75	0.25	0.25	Networked performance
148	Ex Memoriam (1993)	0	0	0.5	Video
149	Infrared Roses Revisited (1993)	0	0	0.5	Video
150	Legacy (1993)	0	0	0.5	Video
151	Curtain Trip (1993)	0	0	0.5	Video
152	Devil's Mine (1993)	0	0	0.5	Video
153	Quarxs (1994)	0	0	0.75	Computer animation
154	Artificial Life Metropolis CELL (1994)	0	0	1	Computer animation
155	Displaced Dice (1994)	0	0	1	Computer animation
156	Rhapsody in Light and Blue (1994)	0	0	0.75	Computer animation
157	Tableau d'amour (1994)	0	0	0.75	Computer animation
158	These are the days (1994)	0	0	1	Computer animation
159	Telematische Skulptur III (1994)	0.25	0.25	0.25	Data visualisation
160	Jurassic Park (1994)	0	0	0.5	Film
161	Kinoetic Evolution 91994)	0.75	0.75	0.25	Interactive art
162	ALIVE (1994)	0	0.75	0.5	Interactive art
163	An Anecdoted Archive from the	0	0.75	0.5	Interactive art

	Cold War (1994)				
164	Reponsive workbench (1994)	0	0.75	0.5	Interactive art
165	The Virtual Body (1994)	0	0.75	0.5	Interactive art
166	The Virtual Cage (1994)	0.25	0.5	1	Interactive art
167	Utopia (1994)	0	0.75	0.25	Interactive art
168	Video Streamer (1994)	0	0.75	0.5	Interactive art
169	Das plastische Licht (1994)	0	1	0.25	Interactive performance
170	Teleporting an Unknwon State (1994)	1	0.75	0.25	Net art
171	Realtime (1994)	0.75	1	0	Network performance
172	No Sex (1994)	0	0	0.5	Video
173	Menagerie (1994)	0	0.75	0.75	Virtual reality
174	Placeholder (1994)	0	1	0.25	Virtual reality
175	Toy Story (1995)	0	0	0.75	3D Animation
176	God's Little Monkey (1995)	0	0	0.5	Computer animation
177	Artificial Fishes: The Undersea World of jack Cousto 919950	0	0	1	Computer animation
178	Astro Canyon Coaster (1995)	0	0	0.75	Computer animation
179	Dead Air (1995)	0	0	0.75	Computer animation
180	Edifice (1995)	0	0	0.75	Computer animation
181	The Mask (1995)	0	0	0.5	Film
182	Forrest Gump (1995)	0	0	0.5	Film
183	SERIOA2A (1995)	0	0	1	Generative art
184	Superstars (1995)	0	0.5	0.5	Interactive art
185	Las Meninas (19950	0	0.75	1	Interactive art
186	Passage Sets / One Pulls Pivots at the Tip of the Tongue (1995)	0	0.75	0.5	Interactive art
187	America's Finest (1995)	0	0.75	0.25	Interactive art
188	BAR-MIN-SKI: CONSUMER PRODUCT (1995)	0	0.75	0.75	Interactive art
189	Entropy Machine (1995)	0	0.25	1	Interactive art
190	Gardens in the Machine (1995)	0	0.75	0.75	Interactive art
191	Is God flat? (1995)	0	0.5	0.5	Interactive art
192	Lautriv Chromagnon/Medusa & Lautriv III NEM (RC) (1995)	0	0.75	0.75	Interactive art
193	The Trace (1995)	0.5	0.5	0.75	Interactive art
194	TURBULENCE (1995)	0	0.75	1	Interactive art
195	Binary Ballistic Ballet (1995)	0	1	0.25	Interactive performance
196	Electro Clips (1995)	0	0.5	0.25	Interactive performance
197	Agolo (1995)	0	0	0.5	Music video
198	wwwwwwwww.jodi.org (1995)	1	0.5	0.75	Net art
199	Ringo++ (1995)	1	1	0.25	Net art
200	aMAZEing web (1995)	1	0.75	0.75	Net art
201	Face to Face (1995)	1	0.75	0.25	Net art
202	The File Room (1995)	1	0.75	0.25	Net art
203	Hypertext (1995)	1	1	1	Net interactive art
204	Osmose (1995)	0	0.75	0.75	Virtual reality
205	VR/RV (1995)	0	0.75	0.5	Virtual reality
206	Period (1996)	0	0	0.75	Computer animation
207	Tian-An-Men (1996)	0	0	0.5	Computer animation
208	Cities of the Past - Brugge (1996)	0	0	0.75	Computer animation
209	Jumanji (1996)	0	0	0.5	Film
210	Global Interior Project (1996)	0.75	0.75	0.5	Interactive art
211	Motion Phone (1996)	0.5	1	0.75	Interactive art
212	Cross-active System (1996)	0.5	0.75	0.75	Interactive art
213	Dialogue with knowbotic south (1996)	0.25	0.75	1	Interactive art
214	Eye to Eye (1996)	0.75	0.75	0.5	Interactive art
215	Inter Dis-communication Machine (1996)	0.5	0.75	0.25	Interactive art
216	RESIDENT (1996)	0	0.75	0.75	Interactive art

217	Sense:less (1996)	0	0.75	0.75	Interactive art
218	Virtual Wheelchair (1996)	0	0.75	0.75	Interactive art
219	Three Men Three Legs (1996)	0.75	0.75	0.75	Internet game
220	Like a Rolling Stone (1996)	0	0	0.75	Music video
221	Etoy (1996)	1	0.75	0.25	Net art
222	HyGrid (1996)	1	0.75	0.25	Net art
223	Journey as an Exile (1996)	1	0.75	0.5	Net art
224	Electro Magnetic Poetry (1996)	1	1	0.25	Net art
225	My Boyfriend Came Back from the War (1996)	1	0.5	0.25	Net movie
226	The Visible Human Project (1996)	0	0	1	Video
227	Busby (1997)	0	0	0.5	Commercial
228	COCA COLA (1997)	0	0	0.5	Commercial
229	Adrenaline (1997)	0	0	0.5	Computer animation
230	An Artist (1997)	0	0	0.5	Computer animation
231	The Big Deal (1997)	0	0	0.75	Computer animation
232	Dragonheart (1997)	0	0	0.5	Film
233	Border Patrol (1997)	0	0.5	0.5	Interactive art
234	Anonymous Muttering (1997)	0	0.75	0.5	Interactive art
235	Life Journey (1997)	0	0.75	0.75	Interactive art
236	Moppet (1997)	0.75	0.75	0.75	Interactive art
237	Ottos Mops (1997)	0	0.75	0.5	Interactive art
238	Encyclopedia of Clamps (1997)	0	0.75	0.5	Interactive art
239	The Information Age, (1997)	0	1	0.5	Interactive art
240	Venetian Deer (1997)	0.75	0.75	0.5	Interactive art
241	Funky Towel (1997)	0	0	0.75	Music video
242	Sensorium (1997)	1	0.25	0.5	Net art
243	Make Money Fast (1997)	1	0.75	0.25	Net art
244	TechnoSphere (1997)	1	1	0.75	Net art
245	Ambitious Bitch (1997)	1	0.75	0.5	Net art
246	Container City (1997)	1	0.75	0.5	Net art
247	Energized Gaming Culture (1997)	1	0.75	0.25	Net art
248	Jodi (1997)	1	0.75	0.25	Net art
249	he Multi-Cultural Recycler (1997)	1	1	0.5	Net art
250	Music Plays Images x Images Play Music (1997)	0	1	1	Sound visualization
251	The Invisible Shape of Things Past (1997)	0	0.75	0.75	Virtual reality
252	The Sitter (1998)	0	0	0.75	Computer animation
253	Landscape (1998)	0	0	0.5	Computer animation
254	Runners (1998)	0	0	0.75	Computer animation
255	Ellipsoid (1998)	0	0	0.75	Computer animation
256	A-Light (1998)	0	0	0.75	Computer animation
257	Gallop Racer2 (1998)	0	0	0.75	Computer animation
258	Trade Secrets from the Violin Masters (1998)	0	0	0.75	Computer animation
259	Deep Askey (1998)	0	0	0.75	Data visualization
260	Digital Scores (1998)	0	0	0.75	Data visualization
261	Titanic (1998)	0	0	0.5	Film
262	Men in Black (1998)	0	0	0.5	Film
263	Spawn (1998)	0	0	0.5	Film
264	Flubber (1998)	0	0	0.5	Film
265	The Legible City (1998)	0	0.75	0.75	Interactive art
266	World Skin (1998)	0	0.75	0.5	Interactive art
267	Plasm: not a crime (1998)	0	0.75	0.5	Interactive art
268	Interactive Poetic Garden (1998)	0	0.75	0.75	Interactive art
269	Bernadette (1998)	0	0.75	0.5	Interactive art
270	Focus 91998)	0	0.75	0.5	Interactive art
271	Holodeck (1998)	0	0.75	0.5	Interactive art
272	Portable Effects (1998)	0	1	0.5	Interactive art
273	Simultaneous Perspective (1998)	0	0.5	0.5	Interactive art

274	Shredder 1.0 (1998)	1	0.75	1	Net art
275	IO_dencies (1998)	1	0.75	0.5	Net art
276	PostPet (1998)	1	0.75	0.75	Net art
277	Xchange (1998)	1	0.75	0.5	Net art
278	Lekso's Codebox (1998)	1	0.75	0.5	Net art
279	Nerve Garden (1998)	1	1	1	Net art
280	Roomancer (1998)	0	0.75	0.75	Net art
281	Guinness Surfer (1999)	0	0	0.5	Commercial
282	What Dreams May Come (1999)	0	0	0.5	Computer animation
283	Snack and Drink (1999)	0	0	0.75	Computer animation
284	Bad Night (1999)	0	0	0.5	Computer animation
285	Bike-a Roadmovie 91999)	0	0	0.75	Computer animation
286	Bingo (1999)	0	0	0.75	Computer animation
287	Ghostcatching (1999)	0	0	0.75	Computer animation
288	Un Temps Por Elle (1999)	0	0	0.75	Computer animation
289	A-trees (1999)	0	0.25	1	Data visualization
290	A Bug's Life (1999)	0	0	0.75	Film
291	A Viagem (1999)	0	0	0.5	Film
292	The Intruder (1999)	0.5	0.75	0.25	Game art
293	Difference Engine #3 (1999)	0	0.75	0.5	Interactive art
294	Landscape One (1999)	0	0.75	0.25	Interactive art
295	Systems Maintenance (1999)	0	0.75	0.75	Interactive art
296	Dsperisson (1999)	0	0.75	0.5	Interactive art
297	Easel (1999)	0	1	0.5	Interactive art
298	HAZE Express (1999)	0	0.75	0.75	Interactive art
299	MetaField Maze (1999)	0	1	0.75	Interactive art
300	Robots Avatar (1999)	0.5	0.75	0.75	Interactive art
301	SCANNER++ 91999)	0	0.5	0.5	Interactive art
302	Traces (1999)	0.5	0.75	0.75	Interactive art
303	Space Invaders Act 7732 (1998)	1	1	0.5	Net art
304	Glasbead (1999~2000)	0.75	1	0.75	Net art
305	Keo (1999)	1	1	0.25	Net art
306	Ginga (1999)	1	0.75	0.25	Net art
307	Map of the Market (1999)	0	0.25	0.25	Net art
308	Phase(x)3 (1999)	1	1	0.5	Net art
309	The Shredder (1999)	1	0.75	0.75	Net art
310	Verbarium (1999)	1	1	0.75	Net art
311	Maaz (2000)	0	0	0.75	Computer animation
312	Maly Milos (2000)	0	0	0.75	Computer animation
313	Disembodies (2000)	0	0	1	Computer animation
314	Zen (2000)	0	0	1	Computer animation
315	Audi Telematic (2000)	0.25	0	0.5	Computer animation
316	Fight Club (2000)	0	0	0.5	Film
317	Toy Story 2 (2000)	0	0	0.75	Film
318	Vectorial Elevation, Relational Architecture #4 (2000)	1	1	0.25	Interactive art
319	Audiovisual Environment Suite (2000)	0	0.5	0.75	Interactive art
320	Asymptote (2000)	0	0.75	0.25	Interactive art
321	Borderland (2000)	0	0.75	0.25	Interactive art
322	Experiments in Touching Color (2000)	0	0.75	0.25	Interactive art
323	Unconscious Flow (2000)	0	0.75	0.75	Interactive art
324	Room with a View (2000)	0	0.75	0.5	Interactive art
325	Chemical Brothers (2000)	0	0	0.5	Music video
326	Zeitgenossen (2000)	1	0.75	0.75	Net art
327	Toywar (2000)	1	0.75	0.75	Net art
328	TeleZone (2000)	1	0.75	0.75	Net art
329	A Body of Water (2000)	0.75	0.5	0.5	Network installation
330	Captive (2000)	0	0	0.5	Video
331	Musca Domestica (2000)	0	0	0.5	Video

332	Underwerk (2000)	0	0	0.75	Video
333	For The Birds (2001)	0	0	0.75	3D animation
334	AP200 (2001)	0	0	0.75	3D animation
335	F8 (2001)	0	0	0.75	3D animation
336	Trick or treats (2001)	0	0	0.75	3D animation
337	LE PROCESSUS (2001)	0	0	0.75	Animation
338	L'Enfant de la Haute Me (2001)	0	0	0.5	Animation
339	KAM (2001)	0	0	0.75	Animation
340	Matrix (2001)	0	0	0.5	Audiovisual nstallation
341	Manhattan Timeformations (2001)	1	0.25	1	Data visualization
342	The Perfect Storm (2001)	0	0	0.5	Film
343	Ovalprocess (2001)	0	1	0.75	Ineractive sound installation
344	Brainball (2001)	0.5	0.25	0.25	Interactive art
345	Camera Musica (2001)	0	0.75	0.75	Interactive art
346	Floating Eye (2001)	0.25	0.5	0.25	Interactive art
347	Rakugaki (2001)	0	0.75	0.5	Interactive art
348	Signwawe Auto-Illustrator (2001)	0	1	0.75	Interactive art
349	You think therefore I am (2001)	0	0.5	0.5	Interactive art
350	Polar (2001)	0.5	0.75	0.75	Interactive inatallaiton
351	Dice Raw (2001)	0	0	0.75	Music video
352	Blinkenlights (2001)	1	1	0	Net art
353	360degrees (2001)	1	0.25	0.5	Net art
354	DMG:IO* vs. R3:DEV* (2001)	1	0.75	0.5	Net art
355	KALIBER10000 (2001)	1	1	0.75	Net art
356	Bump (2001)	0.5	0.75	0.25	Networked art
357	ImaHima (2001)	0.75	0.25	0.75	Online app
358	Bytes for all (2001)	1	0.25	0.75	Online campaigns
359	Banja (2001)	1	1	0.75	Online game
360	Phantasy Star Online (2001)	1	1	1	Online game
361	Austropolis (2001)	1	0.75	0.75	Online game
362	Praystation (2001)	1	0.25	0.75	Online learning
363	Warp Records (2001)	1	0.25	0.75	Online system
364	2001 (2001)	0.75	0	0.25	Real-time video installation
365	BoomBox.net (2001)	1	0.25	0.75	Streaming service
366	Intransit (2001)	0	0	0.5	Video
367	Le conte du monde flottant (2001)	0	0	0.5	Video
368	Lightmare (2001)	0	0	0.75	Video
369	Moving Illustrations of Machines (2001)	0	0	0.75	Video
370	Synchronicity (2001)	0	0	0.75	Video
371	Waking Life (2001)	0	0	0.75	Video
372	Pedestrian (2001~2002)	0	0	0.75	Video Installation
373	AnnLee you proposes (2002)	0	0	0.75	3D animation
374	MOUSE (2002)	0	0	0.75	3D animation
375	POLYGON FAMILY: EPISODE 2 (2002)	0	0	0.75	3D animation
376	Monsters Inc (2002)	0	0	0.75	3D animation film
377	AlphaWolf (2002)	0	0.25	0.75	AI animated character
378	BMW Pool (2002)	0	0	0.5	Commercial
379	.logicaland (2002)	1	0.25	0.75	Data visualization
380	Minitasking (2002)	1	0.25	1	Data visualization
381	Panic Room (2002)	0	0	0.5	Film
382	PainStation (2002)	0	0.75	0.75	Game
383	PLX - PARALLAX OF THE GAME (2002)	0	0.75	0.75	Game
384	Rez (2002)	0	0.75	0.75	Game
385	Velvet-Strike (2002)	0.75	0.75	0.75	Game art
386	n-cha(n)t (2002)	0.25	0.5	0.25	Interactive art
387	Body Movies - Relational Architecture No. 6 (2002)	0	0.5	0.5	Interactive art
388	Body Brush (2002)	0	0.5	0.75	Interactive art

389	Dialtones (2002)	0.75	0.75	1	Interactive art
390	FX Factory (2002)	0	0.75	0.75	Interactive art
391	Globe Jungle Project (2002)	0	0.75	0.5	Interactive art
392	R111 (2002)	0	0.5	1	Interactive art
393	The Visitor: Living by Number (2002)	0	0.75	0.25	Interactive art
394	Crossing Project (2002)	0	0.75	0.5	Interactive inatallaiton
395	BotFighters (2002)	1	0.75	0.75	Mobile game
396	They Rule (2002)	1	0.75	0.75	Net art
397	CarnivorePE (2002)	0.25	0.25	0.75	Net art
398	Global String (2002)	0.75	0.75	0.75	Networked art
399	Harvey (2002)	0	0	0.5	Video
400	The Time Machine (2002)	0	0	0.5	Video
401	Donnie Darkoe (2002)	1	0.25	0.5	Website
402	Dolce Vita (2003)	0	0	0.5	Commercial
403	Tim Tom (2003)	0	0	0.5	Computer animation
404	Gestalt (2003)	0	0	1	Computer animation
405	Pipe Dream (2003)	0	0	0.75	Computer animation
406	Untitled (2003)	0	0	0.75	Computer animation
407	[domestic] (2003)	0.5	0.75	0.5	Game art
408	Can you see me now? (2003)	0.75	1	0.5	Interactive art
409	Nybble-engine-toolZ (2003)	0.75	0.75	0.75	Interactive art
410	Cinéma Fabriqué (2003)	0	1	0.5	Interactive art
411	Deep Walls (2003)	0	0.5	0.25	Interactive art
412	Last (2003)	0	0.5	0.5	Interactive art
413	Pockets Full of Memories (2003)	0	1	0.5	Interactive art
414	Habbo Hotel (2003)	1	1	0.75	Net art
415	Noderunner (2003)	0.75	1	0.5	Net art
416	PuppetTool (2003)	1	1	0.75	Net art
417	Flow (2003)	1	1	0.75	Net art
418	Remind Me (2003)	0	0	0.75	Video
419	Toyota (2004)	0	0	0.5	Commercial
420	Ryan (2004)	0	0	0.75	Computer animation
421	Birthday Boy (2004)	0	0	0.75	Computer animation
422	Parenthèse (2004)	0	0	0.75	Computer animation
423	Finding Nimo (2004)	0	0	0.75	Computer animation
424	Microcosm (2004)	0	0	1	Computer animation
425	This Wonderful Life (2004)	0	0	0.75	Computer animation
426	1000 Deathclock in Paris (2004)	1	0.75	0.75	Interactive art
427	3 minutes2 (2004)	0	0.75	0.75	Interactive art
428	Loops (2004)	0	0.5	0.75	Interactive art
429	Messa di Voce (2004)	0	0.75	0.75	Interactive art
430	We interrupt your regularly scheduled program (2004)	0	0.25	0.75	Interactive art
431	Ah_Q (2004)	0	0.75	0.75	Interactive game
432	Somnambules (2004)	1	0.5		Net art
433	1 year performance video (2004~2005)	1	0.25	0.25	Net art
434	The Parthenon (2004)	0	0	0.75	Video
435	City Paradise (2005)	0	0	0.5	Computer animation
436	Man OS 1 / extraordinaireur (2005)	0	0	0.5	Computer animation
437	POD (2005)	0.25	0.25	0.25	Data visualization
438	The Incredible (2005)	0	0	0.75	Film
439	Interface #4 / TFT tennis V180 (2005)	0	0.75	0.75	Game installation
440	Bondage (2005)	0	0.25	0.5	Interactive art
441	Capture (2005)	0	0.5	0.75	Interactive art
442	Gravicells (2005)	0	0.5	0.75	Interactive art
443	Intimate Transactions (2005)	0.5	0.75	0.75	Interactive art
444	Life: A User's Manual (2005)	0	0.5	0	Interactive art
445	Run Motherfucker Run (2005)	0	0.75	0	Interactive art

446	SonicWireSculptor (2005)	0	1	0.75	Interactive art
447	[V]ote-Auction (2005)	1	0	0.25	Net art
448	10X10 (2005)	1	0	0.25	Net art
449	Decoy (2005)	1	0.5	0.25	Net art
450	NEtROBOt (2005)	1	0.75	0.75	Net art
451	Flüux:/terminal (2005)	0	0.25	0.75	Sound visualization
452	TV-IV (2005)	0	0.25	0.75	Sound visualization
453	Electronic Performers (2005)	0	0	0.75	Video
454	MTV: Crow (2006)	0	0	0.75	Commercial
455	Rexona: Stunt City (2006)	0	0	0.5	Commercial
456	458nm (2006)	0	0	0.75	Computer animation
457	Kein Platz für Gerold (2006)	0	0	0.75	Computer animation
458	Discord: metal and meat (2006)	0	0	1	Computer animation
459	Datamatics (2006)	0	0	1	Data visualization
460	COLORS Project (2006)	1	0.25	0.5	Data visualization
461	Cyclone.soc (2006)	0	0.75	0.75	Data visualization
462	Streamfishing (2006)	1	0.25	0.75	Data visualization
463	Sin City (2006)	0	0	0.5	Film
464	Drawn (2006)	0	1	0.25	Interactive art
465	Double helix swing (2006)	0	0.75	1	Interactive art
466	S.U.l. (2006)	0	0.75	0.5	Interactive art
467	TARTARUS (2006)	0	0.75	0.75	Interactive art
468	The Khronos Projector (2006)	0	0.75	0.5	Interactive art
469	Glyphiti (2006)	1	1	0.75	Net art
470	SOBJECT (2006)	1	0	0.25	Net art
471	SwarmSketch (2006)	1	1	0.25	Net art
472	The Virtual Marathon (2006)	1	0.75	0.5	Net art
473	Happiness Factory (2007)	0	0	0.75	Commercial
474	Travelers: Snowball (2007)	0	0	0.5	Commercial
475	Codehunters (2007)	0	0	0.5	Computer animation
476	Apnee (2007)	0	0	0.5	Computer animation
477	Lost OdysseyOpening Cinematics (2007)	0	0	0.75	Computer animation
478	Renkan (2007)	0	0	0.75	Computer animation
479	Seeker (2007)	0	0.75	0.5	Interactive art
480	Animalia Chordata (2007)	0	0.75	0.25	Interactive art
481	Deep Wounds (2007)	0	0.5	0.75	Interactive art
482	Se mi sei vicino (2007)	0	0.75	0.75	Interactive art
483	SGM Iceberg Probe (2007)	0	0.75	0.25	Interactive art
484	SHO(U)T (2007)	0	0.5	0.5	Interactive art
485	Unreflective Mirror (2007)	0	0.75	0.5	Interactive art
486	Herinnerdingen (2007)	1	1	0.25	Net art
487	KhirkeeYaan (2007)	0.75	0.5	0.25	Network installation
488	Nothing Happens (2007)	1	0.75	0.25	Network installation
489	aC + LIA (2007)	0	0.25	0.75	Sound visualization
490	Exploding Camera (2007)	0	0	0.25	Video installation
491	Five Pieces of Evidence (2007)	0	0	0.25	Video installation
492	levelHead (2008)	0	0.75	0.75	Augmented reality
493	Lux Neon Girl (2008)	0	0	0.5	Commercial
494	SMIRNOFF "SEA" (2008)	0	0	0.5	Commercial
495	Madame Tutli-Putli (2008)	0	0	0.75	Computer animation
496	I Am Legend (2008)	0	0	0.5	Film
497	Ratatouille (2008)	0	0	0.75	Film
498	a plaything for the great observers at rest (2008)	0	0.75	0.75	Interactive art
499	Extended Cognitive Tools (2008)	0	1	0.75	Interactive art
500	Globe Fire (2008)	0	0.75	0.75	Interactive art
501	It's fire, you can touch it (2008)	0	0.75	0.75	Interactive art
502	The Replenishing Body (2008)	0	0.75	0.25	Interactive art
503	Salmon Dance (2008)	0	0	0.5	Music video
504	Augmented Sculpture Series (2008)	0	0	0.75	Projection mapping

505	Reactable (2008)	0	1	0.75	Sound visualization
506	Mindplotter (2008)	0	0	0.75	Video
507	ReConstitution (2009)	0.75	1	0.5	Audiovisual performance
508	HA'Aki (2009)	0	0	0.75	Computer animation
509	SKHIZEIN (2009)	0	0	0.75	Computer animation
510	Corpora in Si(gh)te (2009)	0.25	0.25	0.5	Data visualization
511	The Dark Knight (2009)	0	0	0.5	Film
512	Dix (2009)	0	0	0.5	Film
513	WALL-E (2009)	0	0	0.75	Film
514	In the Line of Sight (2009)	0	0.5	0.25	Interactive art
515	Red Psi Donkey (2009)	0	0.25	1	Interactive art
516	Tank Man Tango (2009)	0.75	0	0.25	Network performance
517	Mortal Engine (2009)	0	0.25	1	Performance
518	Relative Realities (2009)	0	0	0.25	Sound video installation
519	Flying in Tune (2009)	0	0.25	0.25	Sound video installation
520	The Nest That Sailed The Sky (2009)	0	0	1	Video
521	Watch Me! (2009)	0	0	0.25	Video installation
522	Rheo: 5 horizons (2010)	0	0	1	Audiovisual installation
523	Heart Chamber Orchestra (2010)	0	0.5	1	Audiovisual performance
524	Hand From Above (2010)	0	0.5	0.5	Augmented reality
525	Logorama (2010)	0	0	0.75	Computer animation
526	Loom (2010)	0	0	0.75	Computer animation
527	Living Light (2010)	0.25	0.25	0.25	Data visualization
528	Nuit Blanche (2010)	0	0	0.5	Film
529	Avatar (2010)	0	0	0.75	Film
530	Pixels (2010)	0	0	0.5	Film
531	Men In Grey (2010)	0.5	0.25	0.25	Network art
532	TaxiLink (2010)	0.5	0.75	0.25	Network installation
533	abcdefghijklmnopqrstuvwxyz (2010)	0	1	1	Sound video application
534	Mobile Crash (2010)	0	0.75	0.25	Sound video installation
535	Adapting for Distortion (2010)	0	0	1	Sound video installation
536	The Sandpit (2010)	0	0	0.5	Video
537	Nokta (2010)	0	0	0.75	Video
538	Flower (2010)	0	1	1	Video game
539	Home (2010)	0	0.75	0.25	Video installation
540	The external world (2011)	0	0	0.75	2D animation
541	Mei Ling (2011)	0	0	0.75	2D animation
542	Third&Seventh (2011)	0	0	0.75	3D animation
543	Chernokids (2011)	0	0	0.75	3D animation
544	Die Kiste (2011)	0	0	0.75	3D animation
545	Raving Rabbids Travel in Time (2011)	0	0	0.75	3D animation
546	Slimtime 920110	0	0	0.75	3D animation
547	The Ishiyama Excursion (2011)	0	0	0.75	3D animation
548	The Origin of Creatures (2011)	0	0	0.75	3D animation
549	A Hidden Place (2011)	0	0	0.25	Audiovisual nstallation
550	Eye contact with th ecity (2011)	0	0	0.25	Audiovisual nstallation
551	King Kong 360 3D (2011)	0	0	0.75	Film
552	AR National Geographic (2011)	0	0.5	0.5	Interactive art
553	Algorithmic search for love (2011)	0	0.75	0.25	Interactive art
554	Empathetic heartbeat (2011)	0	0.75	0.25	Interactive art
555	Wearable Nets (2011)	0.75	0.75	0.5	Interactive art
556	Sentient City Survival Kit (2011)	0.75	0.75	0.5	Interactive art
557	SOUR/MIRROR (2011)	1	0.75	0.5	Interactive art
558	Be Your Own Souvenir (2011)	0	0.75	0.5	Interactive art
559	Particles (2011)	0	0.5	1	Light installation
560	Six-Forty by Four-Eighty (2011)	0.25	0.75	1	Light installation
561	Metachaos (2011)	0	0	0.75	Video
562	Black Rain (2011)	0	0	0.5	Video
563	Chase (2011)	0	0	0.5	Video
564	The Experience of Fliehkraft (2011)	0	0	0.5	Video

565	Flux (2011)	0	0	0.75	Video Installation
566	Aalterate (2012)	0	0	0.5	2D animation
567	Christmas card to friends (2012)	0	0	0.75	3D animation
568	Fat (2012)	0	0	0.75	3D animation
569	The Fantastic Flying Books of Mr. Morris Lessmore (2012)	0	0	0.75	3D animation
570	Rango (2012)	0	0	0.75	3D animation
571	Zing (2012)	0	0	0.75	3D animation
572	ADM8 (2012)	1	0	0.5	AI bot
573	Caldera (2012)	0	0	0.75	Animation
574	L'ère bête (2012)	0	0	0.5	Animation
575	Benoît and the Mandelbrots	0	1	0.5	Audio visual performance
576	#tweetscapes (2012)	1	1	1	Data visualization
577	The Life of Pi (2012)	0	0	0.5	Film
578	Rise of the Planet of the Apes (2012)	0	0	0.75	Film
579	Irrational Computing (2012)	0.75	0.25	1	Installation
580	The Body is a Big Place (2012)	0	0	0.25	Installation
581	The Great Work of the Metal Lover (2012)	0	0	0.25	Installation
582	Windy Bamboo Grove (2012)	0	0.5	0.5	Interactive art
583	Memopol-2 (2012)	0.25	0.75	0.25	Interactive art
584	It's a jungle in here (2012)	0.5	1	0.5	Interactive art
585	Moon Goose Analogue (2012)	0.5	0.75	0.25	Interactive art
586	Ideogenetic Machine (2012)	0	0.75	0.75	Interactive art
587	LightType (2012)	1	1	0.5	Interactive art
588	Loeschen/Delete (2012)	0	1	0.75	Interactive art
589	MNM v091 (2012)	0	1	0.25	Interactive art
590	Osadok / Aftertaste (2012)	0	0.5	0.5	Interactive art
591	Dark Glasses. Portrait (2012)	1	0.75	0.25	Net art
592	Fly tweet (2012)	1	0.25	0.5	Net art
593	Good-bye Mr. Tom (2012-2013)	0.5	0.5	0.5	Network performance
594	I am thinking in a room, different from the one you are hearing in now (2012)	0	1	0.25	Sound performance
595	Rear window loop (2012)	0	0	0.5	Video
596	Assassin's Creed Revelations (2012)	0	0	0.5	Video
597	Countdown (2012)	0	0	0.75	Video
598	Crossover (2012)	0	0	0.5	Video
599	The city five years old (2012)	0	0	1	Video
600	Unnamed soundsculpture (2012)	0	0	1	Video
601	Forms (2013)	0	0	1	3D animation
602	Oh Willy (2013)	0	0	0.75	3D animation
603	Ars Rata (2013)	0	0	0.5	3D animation
604	Rollin' Safari (2013)	0	0	0.75	3D animation
605	Shelter (2013)	0	0	0.75	3D animation
606	The Carousel Family (2013)	0	0	0.75	3D animation
607	Duku Spacemarines (2013)	0	0	0.75	Animation
608	Ballpit (2013)	0	0	0.5	Animation
609	It's Such a Beautiful Day (2013)	0	0	0.75	Animation
610	Palmipedarium (2013)	0	0	0.75	Animation
611	Snail Trail (2013)	0	0	1	Animation
612	0b0000.tms (2013)	0	1	1	Audio visual performance
613	Cube with Magic Ribbons (2013)	0	1	1	Audio visual performance
614	Duali (2013)	0	0.5	1	Audio visual performance
615	La Biblioteca Ciega (2013)	0	1	1	Audio visual performance
616	With Thunder and Lightning (2013)	0	0.75	0.25	Interactive art
617	Voices of Aliveness (2013)	0	0.75	0.5	Interactive art
618	Exploded Views 2.0 (2013)	0	0.75	0.75	Interactive art
619	Hidden Fields (2013)	0	0.5	1	Interactive dance performance
620	Borderlands Granular (2013)	0	1	0.75	Interactive tool
621	SjQ++ (2013)	0	1	0.75	Interactive tool

622	Blaus (2013)	0	0	1	Laser projection
623	N_Polytope (2013)	0	0.25	1	Light installation
624	Telematic Tango (2013)	0	0	0.5	Music video
625	Mutual Core (2013)	0	0	0.5	Music video
626	Do Not Touch (2013)	1	0.75	0.75	Net art
627	Dronestagram (2013)	1	1	0.5	Net art
628	Under An Alias (2013)	0	0	0.75	Projection mapping
629	Voice Array (2013)	0	0.75	1	Sound visualization
630	MeTube (2013)	0	0	0.5	Video
631	Subconscious Password (2013)	0	0	0.5	Video
632	Perfume Global Site Project (2013)	1	1	1	Visual tool
633	Futon (2014)	0	0	0.75	2D animation
634	Land (2014)	0	0	0.75	2D animation
635	Walking City (2014)	0	0	0.75	3D animation
636	Birds (2014)	0	0	0.75	3D animation
637	Columbos (2014)	0	0	0.75	3D animation
638	Light Motif (2104)	0	0	0.75	3D animation
639	The Chimera of M (2014)	0	0	0.75	3D animation
640	The Rise and Fall Globosome (2014)	0	0	0.75	3D animation
641	Thing (2014)	0	0	0.75	3D animation
642	Clouds (2014)	0	1	1	Creative tool
643	Shaowland (2014)	0	0	0.25	Film
644	Other earth (2014)	0	0	1	Generative art
645	Cellular Forms (2014)	0	0	1	Generative art
646	Disarming Corruptor (2014)	0	1	0.75	Graphic tool
647	Peace Can Be Realized Even Without Order (2014)	0	0.5	0.75	Interactive art
648	The Machine To Be Another (2014)	0.5	0.75	0.5	Interactive art VR
649	Sports Time Machine (2014)	0	0.75	0.75	Interactive installation
650	Box (2014)	0	0.25	1	Interactive projection mapping
651	Loophole4All.com (2014)	1	0	0	Net art
652	Swarm (2014)	0.75	0.25	0.25	Networked installation
653	Late for Meeting (2014)	0	0	0.5	Video
654	Recycled (2014)	0	0	0.5	Video
655	Symphony no. 42 (2015)	0	0	0.75	2D animation
656	World of Tomorrow (2015)	0	0	0.75	2D animation
657	The reflection of power (2015)	0	0	0.25	Film
658	Augmented Hand Series (2015)	0	0.75	0.75	Interactive art
659	Emps Mort/Idle Times (2015)	0	1	0.75	Interactive film
660	Mirage (2015)	0	0	1	Laser projection
661	Light Barrier (2015)	0	0	1	Light projection
662	Up & Up (2015)	0	0	0.25	Music video
663	Desire (2015)	0	0	1	Music video
664	Denken Sie Groß (2015)	0	0	0.5	Music video
665	Reid willis (2015)	0	0	0.5	Music video
666	Omote (2015)	0	0.5	1	real-time projection mapping
667	Marilyn Myller (2015)	0	0	0.25	Stop motion animation
668	Bär (2015)	0	0	0.5	Video
669	Descent (2015)	0	0	0.5	Video
670	YouTube Smash Up (2015)	0	0	1	Video
671	Coordinated Movement (2016)	0	0	1	3D animation
672	geist.xyz (2016)	0	0	1	3D animation
673	uncanny valley (2016)	0	0	0.75	3D animation
674	Random Darknet Shopper (2016)	1	0	0.5	AI bot
675	Rhizome (2016)	0	0	0.75	Animation
676	7001 (2016)	0	0	1	Animation
677	Ghost Cell (2016)	0	0	1	Animation
678	Rare earthenware (2016)	0	0	0.5	AR video
679	Flow: A Sea of Real-time Data (2016)	0	0.25	1	Data visualization
680	Architecture of Radio (2016)	0	0.5	1	Data visualization

681	Pathfinder (2016)	0	1	1	Generative tool
682	Fairy Lights in Femtoseconds (2016)	0	0	1	Laser-induced plasma
683	Bio-Inspire (2016)	0	0	1	Mapping Video
684	Never Be Like You (2016)	0	0	0.5	Music video
685	Light it Up (2016)	0	0	0.75	Music video
686	Cold Stares (2016)	0	0	0.5	Music video
687	Exhausting a Crowd (2016)	1	1	0.75	Net art
688	Never Say Never (2016)	0	0	0.5	Video
689	Simulacra (2016)	0	0	0.5	Video
690	Branded Dream	0	0	0.75	3D animation
691	Find my way home (2017)	0	0	0.75	3D image
692	Blade Runner—Autoencoded (2017)	0	0	1	Generative art
693	Oder from chaos (2017)	0	0	1	Generative art
694	Everything (2017)	0	1	0.75	Interactive animation game
695	Fluid Structure (2017)	0	0.5	1	Interactive art
696	Write Erase (2017)	0	1	1	Interactive art
697	Best of luck with the wall (2017)	0	0	0.25	Video
698	M2 hospital (2017)	0	0	0.5	VR documentary
699	Out of Exile (2017)	0	0.5	0.75	VR installation
700	Zero Days VR (2017)	0	0	1	VR movie

Curriculum Vitae

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Education

Ph.D. in Culture Technology: Graduate School of Culture Technology (GSCT)
Korea Advanced Institute of Science and Technology (KAIST), September 2013- August 2018
M.S. in Culture Technology: Graduate School of Culture Technology (GSCT)
Korea Advanced Institute of Science and Technology (KAIST), September 2011-August 2013
M.F.A. in Sculpture: Stuttgart State Academy of Art and Design, Germany
Summer Semester 1999-Winter Semester 2000/2001
B.F.A. in Sculpture: Seoul National University, Korea, March 1993-February 1997

Publication

M.S. Thesis:

A study on method to enhance effectiveness and presence of interactivity in networked performance: based on the analysis of ‘Good Morning Mr. Orwell’/ Park, Jungsun / KAIST (2013) / Advisor Prof. Wohn, Kwangyun

Journal Paper:

Jungsun Park and Kwangyun Wohn, “Traversing Immersion: The Psychedelic Experience in Recent Music Videos”, The Senses and Society, 2018

Eunlip Lee, So Hyeong Lee, Jungsun Park, Yuri Choi, and Kwangyun Wohn, "Inter-shelf: Interactive Multi-layered Bookshelf Visualization for Robotic Art Archive Exhibition", The International Journal of New Media, Technology and the Arts, 2017

Exhibition/Performance

Solo Exhibition

2017 Artience Daejeon 17, <Microorganism, Ice and Light>, Parking Gallery, Daejeon, Korea

2017 <Inner Hearing>, Trout Fishing Gallery, Daejeon, Korea

2015 <Oh Mother and Sister>, Byunbang Gallery, Daejeon, Korea

Group Exhibition/Performance

2018 <Weather>, D Museum, Seoul, Korea

2017 Science Art 2017 <Carbon Free>, Jeju Museum Of Art, Jeju, Korea

2017 <Chemical Garden>, KRICT Space C#, Daejeon Korea

2017 10th Cheongju Craft Biennale Main Exhibition Section 3 Aesthetic Relationship, Cheongju, Korea

2016 Local CT Festival <Alsongdalsongdang>, Jeju, Korea

2016 <Project Artists Rooms>, Jungdong Small Museum, Daejeon, Korea

2016 Paris Leeungno Residence Report, Daejeon Cityhall, Daejeon, Korea

2015 Paris Leeungno Residence Open studio <MONEM3NT>, Vaux-sur-Seine, France

2014 <Project Daejeon 2014 ,The Brain> ArtiST Project, Daejeon Museum of Art, Daejeon, Korea

2014 <Water_Innocence>, Soma Museum, Seoul, Korea

2014 Sapporo International Art Festival (SIAF 2014), Sapporo, Japan

2013 Networked Performance ‘Good-bye Mr. Tom’, Association of Asia Pacific Performing Arts Centres (AAPPAC) Conference, Daejeon Arts Center, Daejeon, Korea

2012 Networked Performance ‘Good-bye Mr. Tom’, Asia Pacific Advanced Network (APAN) Meeting, Colombo, Sri Lanka

2012 Special exhibition, House of Eungno Lee, Hongseong, Korea

2012 <See Art In Technology>, Spacessee, Daejeon, Korea