THE RESEARCH AND DEVELOPMENT OF MULTI-INTERACTION LEVEL IN "ENLIGHTENMENT" VIRTUAL REALITY NEW MEDIA ART

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ABSTRACT

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The main objectives of this research were (i) to study interaction level theory in Virtual Reality, (ii) to design and apply specific user interaction levels in Enlightenment Virtual Reality new media art and (iii) to observe and evaluate the effects of user interaction levels on the audience while viewing the Virtual Reality new media art. From the audience perspective, the level of user interaction in Virtual Reality can be classified into 3 categories: "Spectator", "Actor", and "Creator-Actor". Based on these three criteria of the user role in viewing new media art, the researcher then designed a series of Enlightenment Virtual Reality arts depicting events of Buddha's enlightenment. A comparative study by observing audience while experiencing 3 different levels of interaction reveals that 1. level of user interaction has direct variation to the amount of time audience spend viewing the artwork and 2. level of user interaction has direct variation to user's physical engagement during the course of viewing the Virtual Reality artworks. The study reveals that by incorporating various user interaction levels in the artworks, the engagement level of the audience's also increased accordingly. This study affirmed the importance of user interaction level for designing effective Virtual Reality new media art-viewing experience.

Keywords: Virtual reality; new media art; multi-interaction level; enlightenment

1. INTRODUCTION

Buddhist art has been an artistic practice since ancient times. Traditionally, the artworks in this genre are influenced by Buddhism: often depicting the story of notable Buddhist figures from Tripitaka text in forms of mural paintings, paintings, and sculpture. One of the most common subjects used as the base ingredient to produce Buddhist art is the story of Buddha's enlightenment. Buddhist art followed believers as the dharma spread, adapted, and evolved in each part of the world. Buddhist art is a medium for preserving and passing on Buddhist beliefs from generation to generation. As time goes on, technologies and media have evolved resulting in newer forms of Buddhist art such as animation, film, and Virtual Reality.

According to the Oxford Dictionary of English, Virtual Reality is the computer-generated simulation of a three-dimensional image or environment that can be interacted within a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a viewing screen or gloves fitted with sensors

(Stevenson, 2010). As a technology, Virtual Reality has been around for decades. The technology has long been considered unfeasible for wide adoption by the consumer market. Aside from the cost factor, another major contributing factor hindering adoption of Virtual Reality was low resolution and narrow field of view (Hutchison, 2007).

Technology accelerated and in August 2012, a first truly affordable Virtual Reality headset Oculus Rift by Palmer Luckey hit the market. Initially, the headset was launched as a Kickstarter crowdfunding campaign aiming to sell approximately 100 units. The campaign was extremely successful and raised 2.4 million dollars from nearly 10,000 backers. Within two years of its initial release, Facebook acquired Oculus for 2 billion dollars (Harris and Cline, 2019). Upon the success of Oculus, many large tech companies such as HTC, Sony, Google, and Samsung also started to offer their versions of Virtual Reality headsets. The competition among the tech titans to secure their places in the Virtual Reality market helped to propel consumer adoption of the technology to an unprecedented level. Nowadays Virtual Reality is more affordable and can be used across many fields including art creation.

The main interests of Virtual Reality since its inception have been toward research, military, and entertainment. In the past, a few avant-garde artists also utilized Virtual Reality to create immersive new media artworks (Quaranta, 2013). Notable Virtual Reality new media artwork are Osmose and Ephemere by Char Davies which were unveiled in 1995 and 1998 respectively. According to the artist, Virtual Reality artworks can transport the audience to a virtual artificial environment by utilizing stereoscopic 3D computer graphics and spatialized sound through real-time interaction (Penz et al., 2004). The emphasis here is audience immersive interaction which sets Virtual Reality apart from other art mediums.

As user interaction is an integral part that encourages the audience to be more engaged while viewing Virtual Reality art, it's imperative to study how the level of user interaction may factor in the viewing experience. This research explores the theory of user interaction level in Virtual Reality, the suitability of the Virtual Reality as an artistic medium, and how such knowledge can be used to effectively design engaging Virtual Reality artworks.

2. RESEARCH OBJECTIVES

1. To study interaction level theory in Virtual Reality.
2. To design and apply specific user interaction levels in Enlightenment Virtual Reality new media art.
3. To evaluate the effects of user interaction levels on the audience while viewing the Virtual Reality new media art.

3. RESEARCH FRAMEWORK

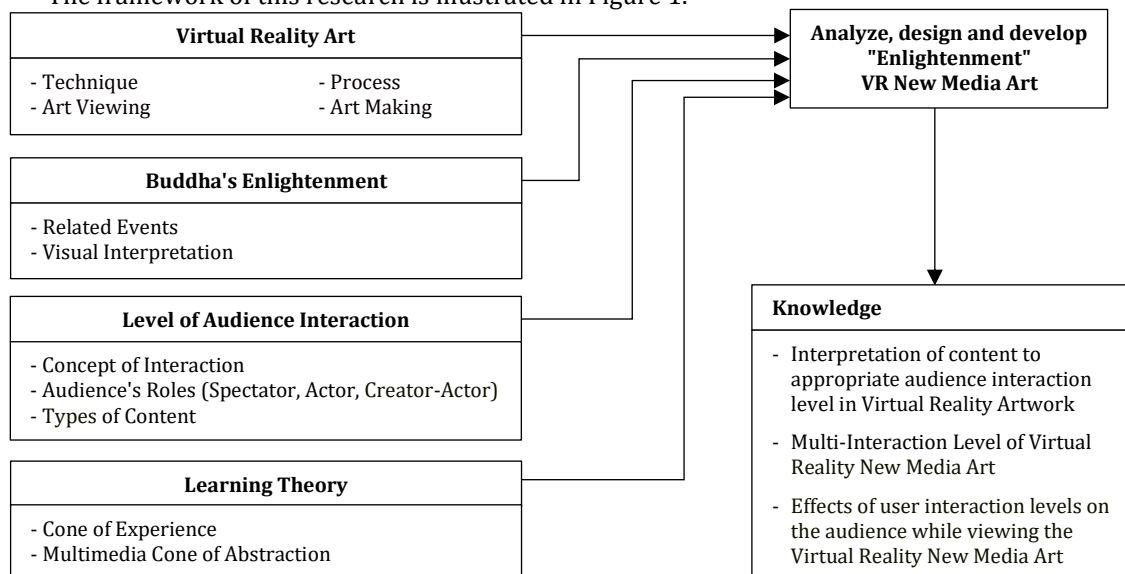The framework of this research is illustrated in Figure 1.

Figure 1: Research Framework

4. RESEARCH METHODOLOGY

4.1 Scope of research

4.1.1 Content scope

As the content of this research is focused on the Buddha's enlightenment events and such subjects are of delicate ones, the literature review process was initially conducted to obtain the appropriate scope of content to design the level of user interaction with Virtual Reality. The selected contents were further reviewed by an expert in Buddhism, Phrakhru Udom Bodhivides, the abbot of Ayodhaya Rajchadhani Temple-India, and the head of special affairs division of Royal Thai Monastery Bodhgaya-India (Bodhivides, 2019). The four topics are:

4.1.1.1 Buddha's dream of birds and its premonition

This event occurred before Buddha's enlightenment. Prince Siddhartha Gautama dreamt that he was approached by four birds of different colors approaching him from the four directions, falling at his feet and turning white. This dream was interpreted by Prince Siddhartha Gautama himself as a premonition that upon his enlightenment the four castes of people including noblemen, priests, businessmen, and poor would come to him seeking the truth of Dharma (Paramanuchitchinorot, 2011).

4.1.1.2 The moment of enlightenment

At Bodh Gaya, Prince Siddhartha Gautama sat beneath a sacred fig and began to meditate. When his mind was concentrated and purified, he was able to acquire the Three Knowledges. The first knowledge was that of his past lives and the past lives of all beings. The second knowledge was of the laws of karma. The third knowledge was four noble truths which enables him to be freed of all obstacles and released from earthly attachments. The four noble truths are the suffering (Dukkha), the cause of suffering (Samudaya), the end of suffering (Nirodha), and the path to end suffering (Magga) (Buddhadasa Bhikkhu, 1972).

4.1.1.3 The moment of facing temptations

This event transpired after Lord Buddha attained enlightenment. The 3 daughters of Mara, Desire (Tanha), Aversion (Aarath), and Passion (Raga) tried to seduce Lord Buddha hoping to lure Lord Buddha out of an enlightened state by presenting themselves as sensual beautiful ladies of different forms. However, their ill intent has no effect on the enlightened one for Lord Buddha was able to see through their guises (Paramanuchitchinorot, 2011).

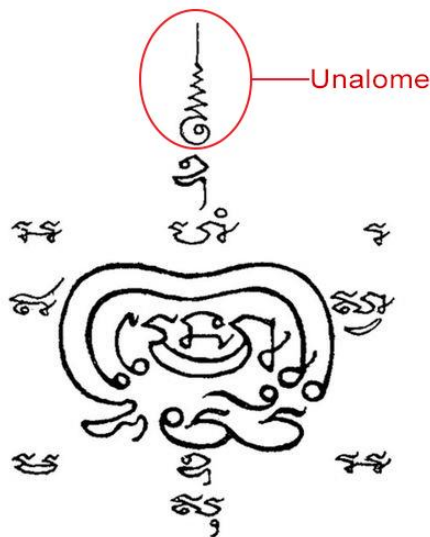#### 4.1.1.4 Unalome, the symbol of enlightenment

Figure 2: Unalome Symbol on Buddhist Talisman (Viriyaburana, n.d.)

According to Sutta Piṭaka, the Unalome Symbol (Figure 2) is a brow hair located in the middle of the forehead of Lord Buddha. It's said to be one of 32 traits of a great man. Hence, the Unalome Symbol is believed to be a representation of the path to enlightenment.

4.1.2 Population scope

The proposed research has been reviewed and approved by the Human Research Ethics Committee of Silpakorn University, which is in full compliance with the Declaration of Helsinki, in accordance with universal

ethics, laws, regulations, and domestic regulations. This research gathered information and suggestions from 9 experts across related fields and collected field data from 107 samples of volunteers who visited the "Enlightenment" New Media Art Exhibition at Sathorn 11 Art Space.

4.2 Research tools

This research focuses on collecting from people who volunteer to participate in viewing the New Media Art exhibition. The researchers used data collecting tools as follows: audience observation forms, audio recorders, cameras, interview questionnaires, electronic equipment such as telephones, computers, and devices to record pictures and data.

4.3 Data collection

The researcher collected data and information in 3 ways:

4.3.1 Data from the theoretical section: Data and information collected from Virtual Reality art and user interaction level-related documents, textbooks, and research from the library's e-database, online database, information about interactions, and new media art concepts.

4.3.2 Data from experts: Data and information collected by interviewing experts in the relating fields are qualitative data used to design the Enlightenment Virtual Reality artworks. The research tools used are audio recorders and cameras.

4.3.3 Data from the fieldwork section: The fieldwork is conducted by observing the audience and asking survey questions. By doing so, the researchers were able to acquire both the qualitative and quantitative data necessary for this study. The research tools used were audience observation forms, interview questionnaires, and cameras. These tools are prepared to collect data and information related to the audience behaviors while viewing the artworks.

5. RESEARCH AND DEVELOPMENT

5.1 Related theories

5.1.1 Levels of user interaction in virtual reality

As an aesthetic medium, Virtual Reality has the innate property which allows the audience to be fully immersed in a virtual environment. The user interaction within the virtual environment adds extra layers of the audience's engagement while viewing the artwork. This sets Virtual Reality as a unique new media art form apart from other artistic mediums. The level of user interaction theory hence plays a major role in adding viewing experience to the audience. The article "Interaction and Interactivity: in the context of the digital interactive art installation" covers a wide range of digital art mediums and interaction. Based on the study, interaction referred to the actions of an audience in relation to media content (Ahmed, 2018).
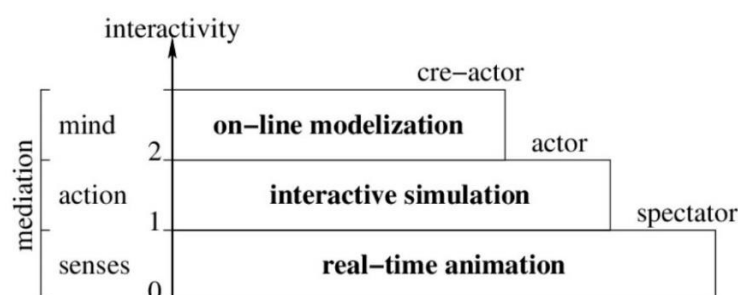

Figure 3: The Different Levels of Interaction in Virtual Reality (Tisseau, 2001)

According to "Virtual Reality | in Virtuo autonomy", there are three types of content within Virtual Reality; 1. Real-time animation, 2. Interactive Simulation, and 3. Online Modelization arranged from lowest to highest interaction level accordingly (Tisseau, 2001), as shown in Figure 3.

With this model of interaction, an audience would be wearing a Virtual Reality head-mounted display. Through his/her perception of the artwork, a decision would be made followed by a set of actions toward the perceived content. Depending on the type of content fed through the head-mounted display, the audience will play a different role while viewing Virtual Reality artwork through 3 forms of mediation; senses, action, and mind (Figure 4).
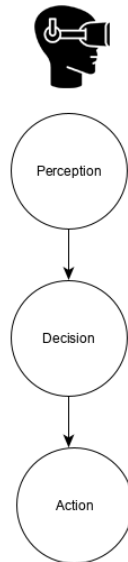
Figure 4: Stages of Interaction in Virtual Reality (Tisseau, 2001)

Tisseau argues that real-time animation amounts to a zero level of interactivity between the audience and the Virtual Reality artwork. While the audience may be under the influence of the artwork, he cannot further his action aside from viewing and hearing what's presented to him through visual and auditory sensory. Thus, the audience is simply a spectator of the Virtual Reality artwork. For the second type of content, Interactive simulation, the audience can physically correspond to the virtual environment and act upon it. Instead of a fixed vista, the audience may change the art-viewing parameter by physically roaming around. This adds an additional layer of interaction. From a third person's point of view, the audience is not only able to physically interact with the virtual artwork, but he/she also fulfilling a role as an actor in the simulation. The last type of content, online modelization, elevates the audience to another level by allowing the audience to alter the artwork within the Virtual Reality environment. In this scenario, the interaction reaches the highest level. The audience can participate in the creation of the artwork and thus becomes a cre-actor or creator-actor (Tisseau, 2001). See Figure 5.
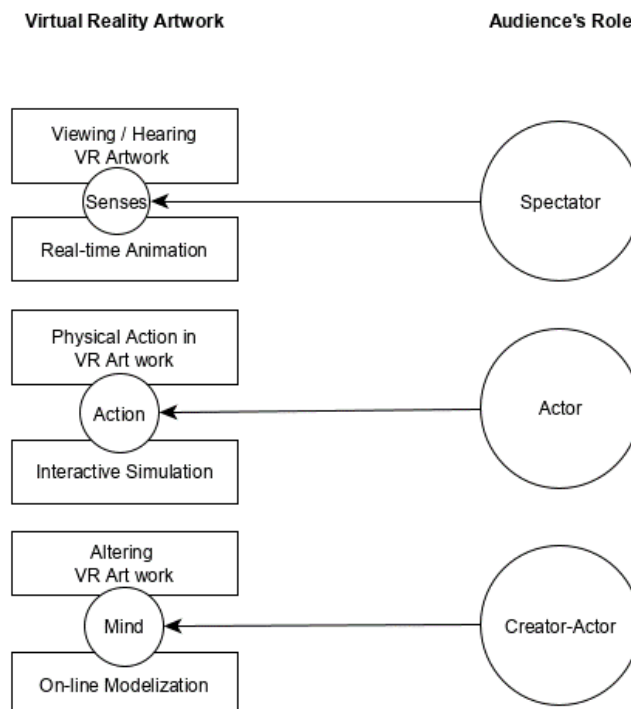

Figure 5: Audience's Role in Virtual Reality (Tisseau, 2001)

The researcher believes that the Level of User Interaction theory can be used to develop a schema. This knowledge can be applied to the design of appropriate interaction within Virtual Reality art that best suits particular content.

5.1.2 Cone of experience and the proposed multimedia cone of abstraction

In Cone of Experience theory (Figure 6), Edgar Dale proposed an idea by incorporating several theories related to instructional design and learning processes that the more concrete the learning activities (toward the bottom of the cone) the more effective they are. In other words, learners are able to retain more information by what they "do" as opposed to what is "heard", "read" or "observed" (Dale, 1969).
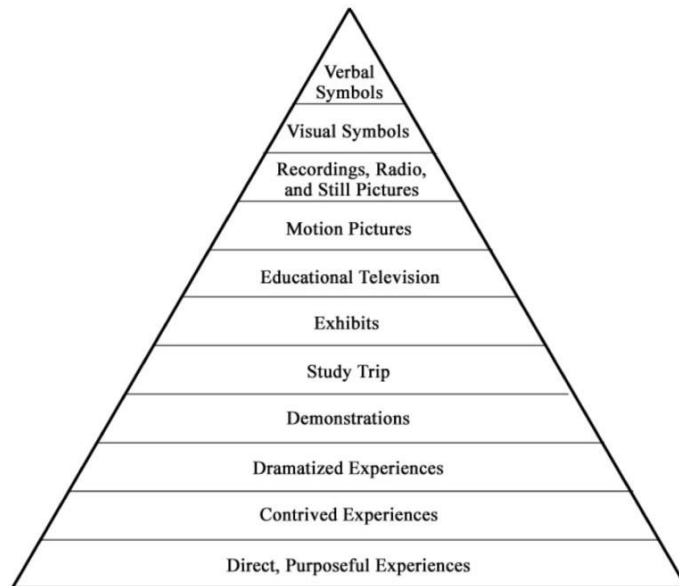

Figure 6: Cone of Experience (Dale, 1969)

Charles Baukal, Floyd Ausburn, and Lynna Ausburn built upon the Cone of Experience theory and arrived at the proposed Multimedia Cone of Abstraction (Figure 7). For this newer study, the researchers place the Virtual Reality technology at the base of the Cone of Experience dubbed Virtual Reality not only can be used as "Direct Purposeful Experiences" but also the least abstract level of all mediums. The researchers argue that Virtual Reality provides very realistic simulations that the audience can interact with and learn best (Baukal et al., 2013).
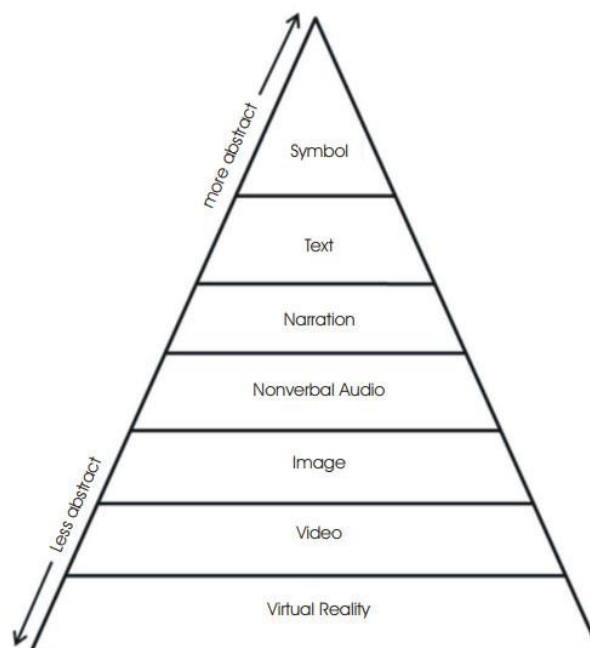

Figure 7: Multimedia Cone of Abstraction (Baukal et al., 2013)

In "Virtual Simulacrum: Reenacting Immersive First-Person Experience Through Virtual Reality Animation" by Gomesh Karnchanapayap and Dr. Atithep Chaetnalao, an academic study to prove the proposed Multimedia Cone of Abstraction theory was conducted. The paper was presented at the International Conference on Innovative Digital (ICID2019).

The paper compared how Virtual Reality animation outperforms digital animation of the same content. The study revealed that the audience was more engaged while viewing and spent considerably longer time viewing animation presented in Virtual Reality than viewing through a digital monitor. The results reassure the use of Virtual Reality as the medium for this research (Karnchanapayp and Chaetnalao, 2019b).

5.2 Design and development of enlightenment new media art through virtual reality

5.2.1 Analysis of the content to design and assign suitable interaction level

Through reviewing Buddhist texts and consulting with Phrakhru Udom Bodhivides, the expert in Buddhism, the researchers are able to analyze each portion of the content and design an appropriate level of user interaction for that particular content. See Figure 8.
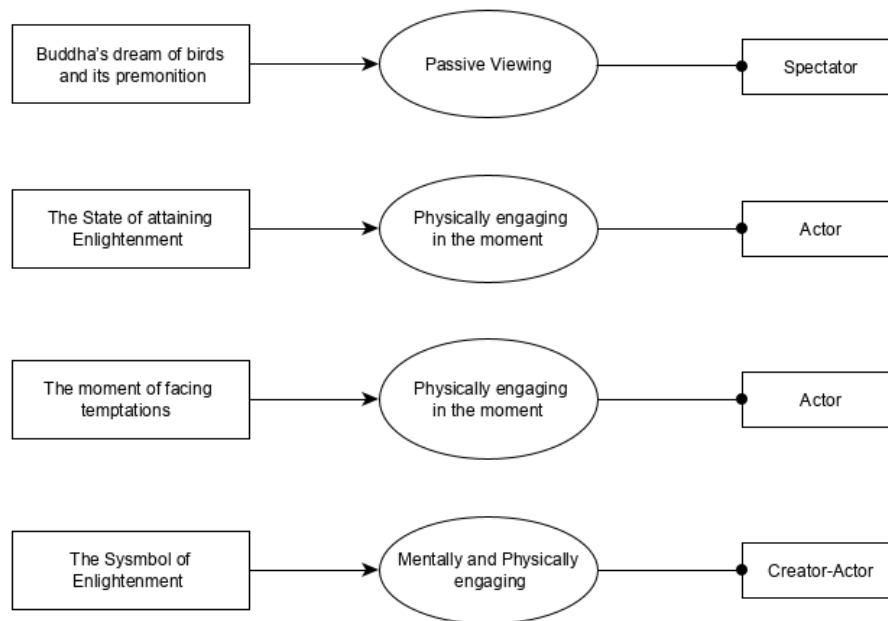

Figure 8: Analysis of the Events and Suggested Levels of User Interaction in VR Artworks

For "Buddha's Dream of Birds and its premonition", the event occurred in a dream state which cannot be controlled by Lord Buddha. Hence, the dream unfolded in a limited viewing scope. In this context, Lord Buddha would be considered a spectator to his very own dream. When compared this content to the Level of User interaction in Virtual Reality theory, the appropriate choice to develop this content into Virtual Reality format is real-time animation.

In the moment of attaining enlightenment, Lord Buddha was physically sitting down under a sacred fig. In this context, he became the actor playing out the role. The same can be said about the moment when Lord Buddha was facing temptations. Thus, these two scenarios are best represented as interactive simulations.

For Unalome, the symbol of enlightenment, Lord Buddha was mentally and physically engaging in various activities his entire life to attain the state. He's both the actor and creator of his very own path. Hence, Unalome is best represented as online-modelization in a Virtual Reality Artwork.

5.2.2 Materials and equipment used in the making of enlightenment new media art

Based on the above conclusions, the researchers were able to find suitable programs and equipment necessary to develop and exhibit Enlightenment New Media Art.

5.2.2.1 Virtual reality software

In the case of real-time animation, the researchers utilized Particulate, a real-time Virtual Reality particle creative tool. The program runs on the Oculus Rift Virtual Reality platform under the Windows 10 operating system. The simulated animation can be used to create millions of particles instantaneously providing artistic visual representation to the audience wearing the head-mounted display immediately.

For interactive installation and online modelization, the researcher would like to encourage the

audience to engage in physical activities during the course of viewing the artworks. The researchers employed Google Tilt Brush, a software that permits the creation of Virtual Reality art with the ability to physically moving around in the system.

5.2.2.2 Virtual reality head mounted displays

Particulate, the selected software for creating real-time animation, requires the use of Oculus Rift CV1 Head Mounted Display tethered to a Windows 10 computer. The device features two PenTile organic light-emitting diode (OLED) displays at 1080 by 1200 resolution per eye with 90 Hertz refresh rate and a 90° field of view (Oculus For Developers, 2021).

Utilizing Google Tilt Brush to create spatial-based interactive installation and online modelization that allow the audience to physically roam around, it's imperative to use Oculus Quest Head-mounted display units for they are standalone Head-mounted displays which do not require additional wires for operation. An Oculus Quest headset runs on a Qualcomm Snapdragon 835 processor equipped with 4GB RAM. The headset has two PenTile organic light-emitting diode (OLED) Matrix displays of 1600 by 1440 resolution per eye with 72 Hertz refresh rate and a 90° field of view (Oculus For Developers, 2021).

5.2.3 The Design of enlightenment new media art exhibition

In Buddha's Dream of Birds and its premonition, the researcher utilized abstract style of visual representation as per suggestion by Professor Preecha Thaothong. The researchers employed Particulate software to create real-time immersive flying particles of various colors. The colors emblematize the birds in the story. As the audience puts on the headset, the real-time animation will begin playing. There are 4 particle generators set to 4 different colors; red, green, yellow, and purple representing noblemen, priests, businessmen, and poor castes respectively. The generators were programmed to slowly emit colored particles toward the audience in real-time. As the particles fly closer to and surround the audience, they would gradually turn white. See figure 9.
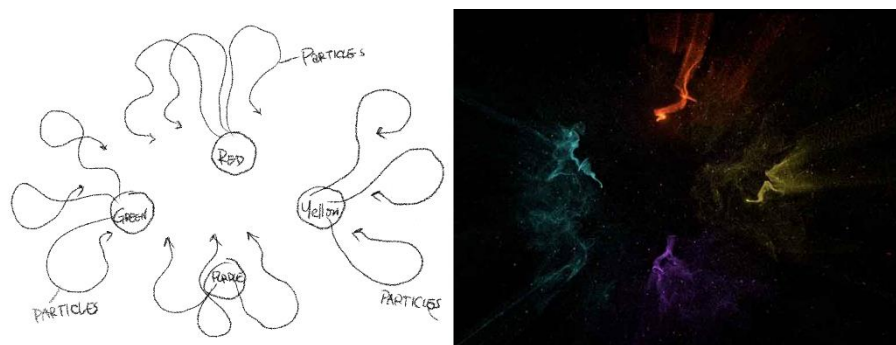

Figure 9: Sketch and Final Artwork of Buddha's Dream of Birds and Its Premonition

The installation and viewing area of this artwork is 1.5 by 2 meters housing a VR enabled notebook with Oculus Rift CV1 equipped with sensors (Figure 10).
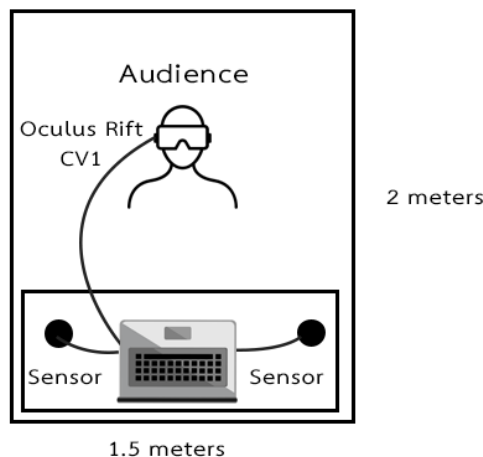

Figure 10: Buddha's Dream of Birds and Its Premonition Installation Plan

The visual data projected through the oculi of the headset, in this case, Oculus Rift, was complemented by a 3-minute narrated voice telling the story of Buddha's Dream of Birds and its premonition. In this artwork,

the audience is given a role as a spectator with the ability to look around 360° within the virtual environment by turning his/her head.
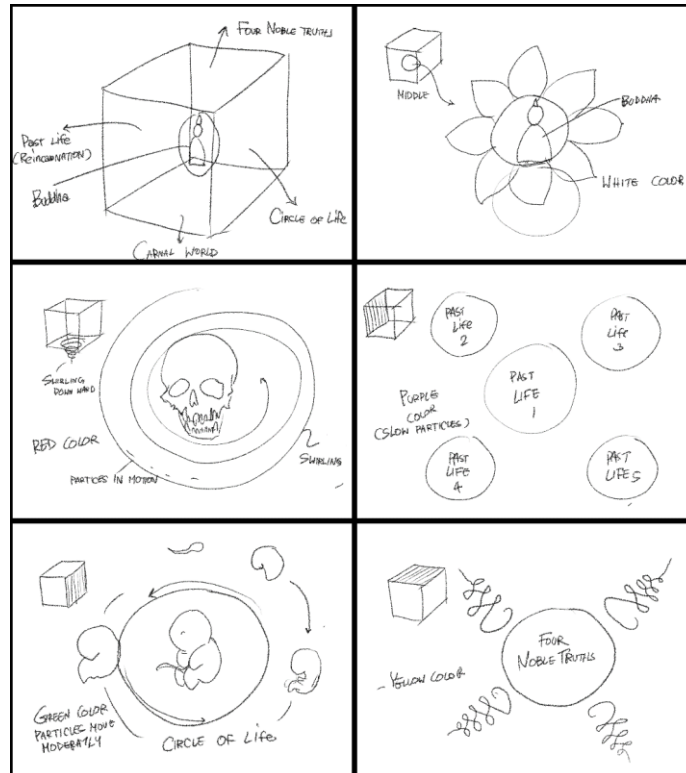

Figure 11: Sketch of the Cube of Enlightenment
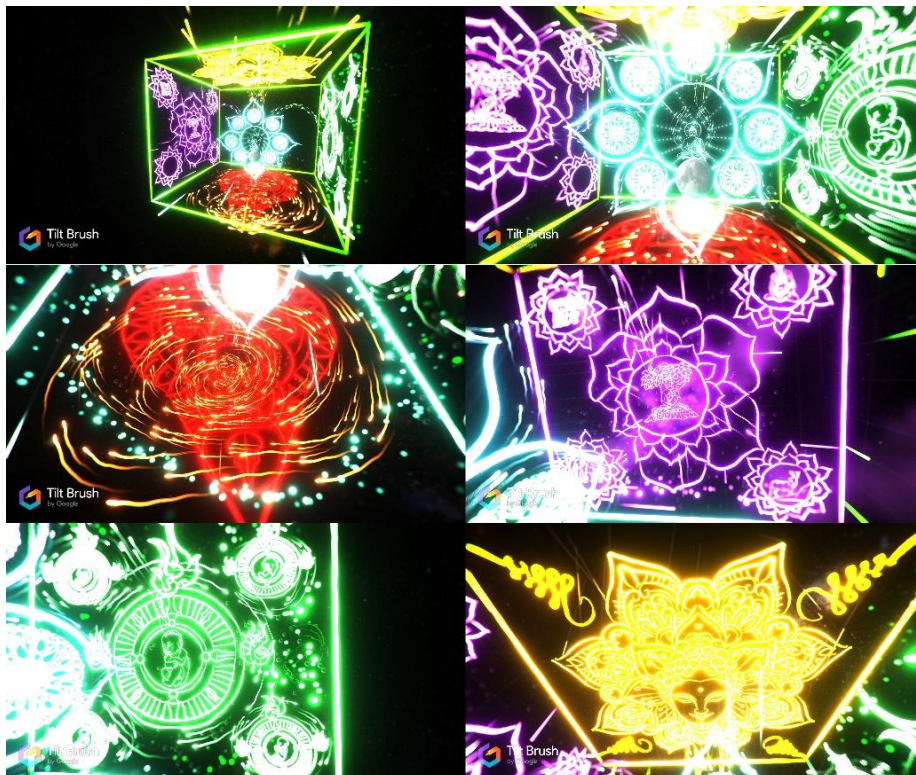

Figure 12: Final Artwork of the Cube of Enlightenment

For the moment of Enlightenment, the researcher wanted to capture the state of Buddha attaining the three knowledges. According to the Buddhist scriptures, Tripitaka, during the first watch of the night, he's able to gain insight into the recollection of past lives. The second watch, he's earned the insight into the births and

deaths of all beings. Finally, during the third watch, Four Noble Truths were attained. By consulting with a Buddhist expert and revered abbot, Phrakhru Udom Bodhivides, the researchers were able to translate the content into a visual representation, The Cube of Enlightenment (Figure 11-13). The virtual art is painted and animated in Google Tilt Brush depicting a virtual room where Buddha attained enlightenment. The floor represents the carnal world which Lord Buddha no longer associates with, the left wall represents the artist's view of reincarnation, the right wall represents the circle of all living things, and the ceiling represents four noble truths which Lord Buddha discovered.
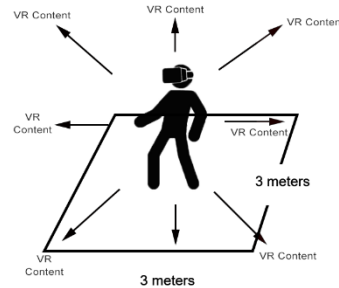

Figure 13: The Cube of Enlightenment Installation Plan

The Interactive simulation can be viewed by wearing Oculus Quest, a standalone Virtual Reality head-mounted display that allows the user to roam around and examine the space wirelessly while experiencing the simulation. The physical setup of this interactive installation takes up an empty area of 3 by 3 meters for the audience to interact with. The user can perform spatial interaction with the artwork by moving around as if the virtual room truly exists. The visual data projected through Oculus Quest was complemented by a 3-minute narrated voice telling the story of Buddha attaining enlightenment. In this scenario, the audience's given a role as an actor playing out a scene within the interactive simulation.

Figure 14: Sketch and Final Artwork of the Crown of Lust VR artwork

The researcher utilized surrealism to portray the moment when Buddha was facing temptations. The virtual art was painted and animated in Google Tilt Brush. All elements in this sculpture are analogies to convey a Buddhist philosophy that Lord Buddha could see through the guises of Mara. The flaming skull is used to represent a person facing the consequence for treasuring Desire (Tanha), Aversion (Aarath), and Passion (Raga) by wearing the crown. Such three temptations were depicted as the small humanoids in the act of coitus decorating the crown (Figure 14-15).
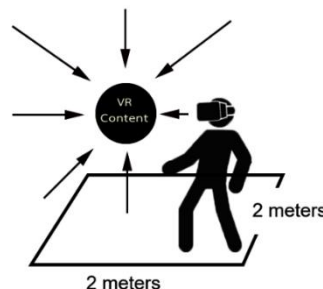

Figure 15: The Crown of Lust Installation Plan

In this case, the virtual object was placed in the center of the installation. This interactive simulation makes use of Oculus Quest: it is a standalone Virtual Reality head-mounted display that allows the user to walk around the virtual object wirelessly. The physical setup of this interactive installation takes up an empty area of 2 by 2 meters for the audience to interact with. The visual data projected through Oculus Quest was complemented by a 3-minute narrated voice explaining the artist's intention of using the crown and skull for this context. In this experiment, the audience was given a role as an actor playing out a scene within the interactive simulation.

Figure 16: Unalome VR artwork

For the last installation, the researcher built and expanded upon the results from the study by Gomesh Karnchanapayap and Dr. Atithep Chaetnalao in "Virtual Reality Sculpting-the Quintessential Sculpting Medium of the Digital Era", which was presented at the 7th Burapha University International Conference on Interdisciplinary Research in 2019. It indicates that Virtual Reality is an effective and easy to learn as a creative medium (Karnchanapayap and Chaetnalao, 2019a). The researcher created a Virtual Reality New Media Art that the audience not only can view the Unalome symbol but also can create his/her version in Google Tilt Brush.
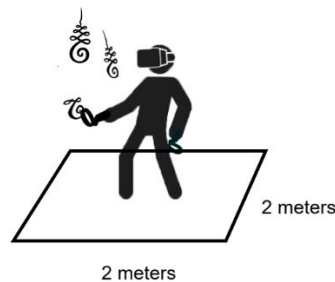

Figure 17: Unalome Installation Plan

The researcher provided the audience with a sample Unalome symbol and a series of on-screen instructions to get started in creating the symbol in Virtual Reality (See Figure 16-17). The manipulation and creation process can be done through the use of Oculus Quest Touch Controllers. The physical setup of this online modelization installation takes up an empty area of 2 by 2 meters for the audience to learn and create. Aside from the visual cues given to the audience, the researchers also provided a 3-minute audio narration about the meaning of the Unalome symbol in both Thai and English languages. In this experiment, the audience's given a role as a creator-actor who is able to create an artwork while playing out a scene in the online modelization system.

5.3 Expert interviews

To gain insights for improving effective levels of interaction in Virtual Reality art suitable for portraying Buddhist stories, it's necessary to seek the experts in the related aspects of this study. In addition to contributing their knowledge as data for the research, upon viewing the artwork prototype, these experts

were also responsible for providing feedback and suggestions to improve upon.

5.3.1 Experts in Buddhism and history

The researcher consulted with Phrakhru Udom Bodhivides, the abbot of Ayodhaya Rajchadhani Temple-India (Figure 18) and the head of the special affairs division of Royal Thai Monastery Bodhgaya-India to derive the scope of the content for this research. Phrakhru Udombodhivides advised the researcher to adhere to the content in Tripitaka text (Bodhivides, 2019).

Figure 18: Phrakhru Udom Bodhivides Tests Enlightenment Virtual Reality Art Prototype

Figure 19: Professor Chedha Tingsanchali Tests Enlightenment Virtual Reality Art Prototype

Professor Chedha Tingsanchali, the expert in India's archeology and a full-time professor at the department of art history at Silpakorn University (Figure 19), provided information and historical accuracy regarding the forest where Lord Buddha attained enlightenment. According to Professor Chedha Tingsanchali, the forest situated by the bank of the river Neranjana was then known as Uruwela. There is no man-made building in the secluded forest. The expert also reassured that the prototype is suitable as a new art medium (Tingsanchali, 2019).

5.3.2 Experts in fine art and design

Professor Preecha Thaothong, Thailand's National Artist in 2009 (Figure 20), stated: "Art is like a wheel that is in constant motion—as with time that changes all things. The process of creating art and the art movements, involve style, concept, technique and subject matter, whether it be in the past, present, or future. Visual art expresses one's imagination, intellect, and individuality as well as reflect the cultures of mankind.". Upon examining the research, he further reassured the appropriateness of utilizing Virtual Reality technology as an artistic medium to express Buddhist beliefs. He suggested the art style can even be abstract to reach a wider audience (Thaothong, 2019).

Associate Professor Pisprapai Sarasalin, Dean of Faculty of Arts and Design Rangsit University (Figure 21), concurred with Professor Preecha Thaothong and further suggested how to space can be used to implement spatial interaction of the audience within Virtual Reality atop physical space (Sarasalin, 2019).

Figure 20: Professor Preecha Thaothong Tests Enlightenment Virtual Reality Art Prototype

Figure 21: Associate Professor Pisprapai Sarasalin Tests Enlightenment Virtual Reality Art Prototype

5.3.3 Experts in story interpretation

Mr. Om Ratchawej, a well-known comic artist who's specialized in illustrating Buddhist stories (Figure 22), affirms the use of Virtual Reality as a compelling Buddhist storytelling medium. He believes Virtual Reality technology would be particularly effective especially to the younger generations for this technology has just started to bloom in their times. "As technology progresses, art mediums that are used to depict and pass on Buddhist stories may evolve. In the past, we might use traditional mediums like pen, pencil, or clay to create Buddhist art. For my time, the comic was a novel medium to depict Buddhist stories, I believe modern technology like Virtual Reality can be the next wave of the medium used to spread Buddhism.", stated Mr. Om in the interview (Ratchawej, 2019).

Figure 22: Mr. Om Ratchawej Tests Enlightenment Virtual Reality Art Prototype

Figure 23: Mr. Nat Yoswatananont Tests Enlightenment Virtual Reality Art Prototype

Mr. Nat Yoswatananont, an animation director of the critically acclaimed Thai animation (Figure 23), "The Legend of Muay Thai: 9 Satra", agreed that Virtual Reality is a new storytelling platform that allows fuller audience immersion and interaction that any other medium. By wearing the Virtual Reality head-mounted display, the audience can magically escape to another dimension. Upon experiencing the Enlightenment Virtual Reality Art prototype, he's certain this medium can enhance interaction level for the audience (Yoswatananont, 2019).

5.3.4 Expert in technology and new media art

Dr. Kongkiat Hirankerd, a Virtual Reality scholar and a technology advocate (Figure 24), approved the application of Virtual Reality for telling Buddhist stories in this research. Once the technology has been widely adopted by the mass, Virtual Reality will be an extremely versatile technology for it can be accessed and enjoyed from anywhere while providing an immersive interactive experience. He further stated in the future Virtual Reality might be an effective method of passing on Buddhist culture far and wide (Hirankerd, 2019).

Mr. Jitsing Somboon, a prominent New Media Artist (Figure 25), suggested that interaction in Virtual Reality would add an additional layer of immersion to Virtual Reality art. For him, Virtual Reality art is like a doorway to a dream world where anything's possible (Somboon, 2019).

By consulting experts in the fields related to the study, the researchers obtained the information necessary to improve the Virtual Reality artworks to their final versions ready for the exhibition.

Figure 24: Dr. Kongkiat Hirankerd Tests Enlightenment Virtual Reality Art Prototype

Figure 25: Mr. Jitsing Somboon Tests Enlightenment Virtual Reality Art Prototype

5.4 Enlightenment virtual reality new media art exhibition

5.4.1 Choosing the venue for new media art exhibition

Much thought went into choosing the venue for the exhibition. As the content of the research is Buddhism expressed through a contemporary art style and Virtual Reality technology. There are three possible venue types: a traditional Buddhist oriented venue, a neutral venue, and an avant-garde venue.

Buddhist oriented venues are places of Buddhist worship such as Buddhist temples, and Buddhist sites. Neutral venues are locations without Buddhist affiliation such as public art museums and galleries. Avant-garde venues are unlikely locations for exhibiting religious-related artworks such as pubs and restaurants that also have space allotted for art exhibitions.

While Buddhist oriented venues attract people interested in Buddhism, the majority of such places meant to be used for daily religious activities. Hence, housing an exhibition in Buddhist oriented venues would not be convenient. Neutral locations contain no religious context and attract mainly and only attract a limited audience who are interested in traditional art. However, in the case of avant-garde venues, these places draw attention to all kinds of audiences who are willing to explore new art territories.

Figure 26: Sathorn 22 Art Space: Front and Side Alley Entrances

Based on the aforementioned reasons, the researcher decided to hold the exhibition in an avant-garde venue. With the generosity of Mr Mike Boon, the manager of Sathorn 11 Artspace and Restaurant, the Matrix: Enlightenment exhibition took place at Sathorn 11 Art Space (Figure 26). The place is an interesting mixture of art space and restaurant. The art space area is situated on the front of the venue. Behind the art space is a dining area. This establishment attracts foreigners and Thais who wish to experience the intertwining of art and dining. This makes Sathorn 11 Art Space suitable as the venue for this study.

5.4.2 The exhibition

The exhibition floorplan (Figure 27) was laid out to best direct the audience to experience the artworks in the order of level of user interaction from the lowest to the highest interaction level. "Buddha's Dream of Birds and its premonition" was placed adjacent to the entrance, followed by "The Cube of Enlightenment", "The Crown of Lust", and "Unalome" respectively. The purpose of this arrangement is to allow the audience who are new to Virtual Reality can slowly gain confidence in wearing a head-mounted display and operating within Virtual Reality. Roles that are given to the audience progress from "spectator" to "actor" and ultimately "creator-actor".
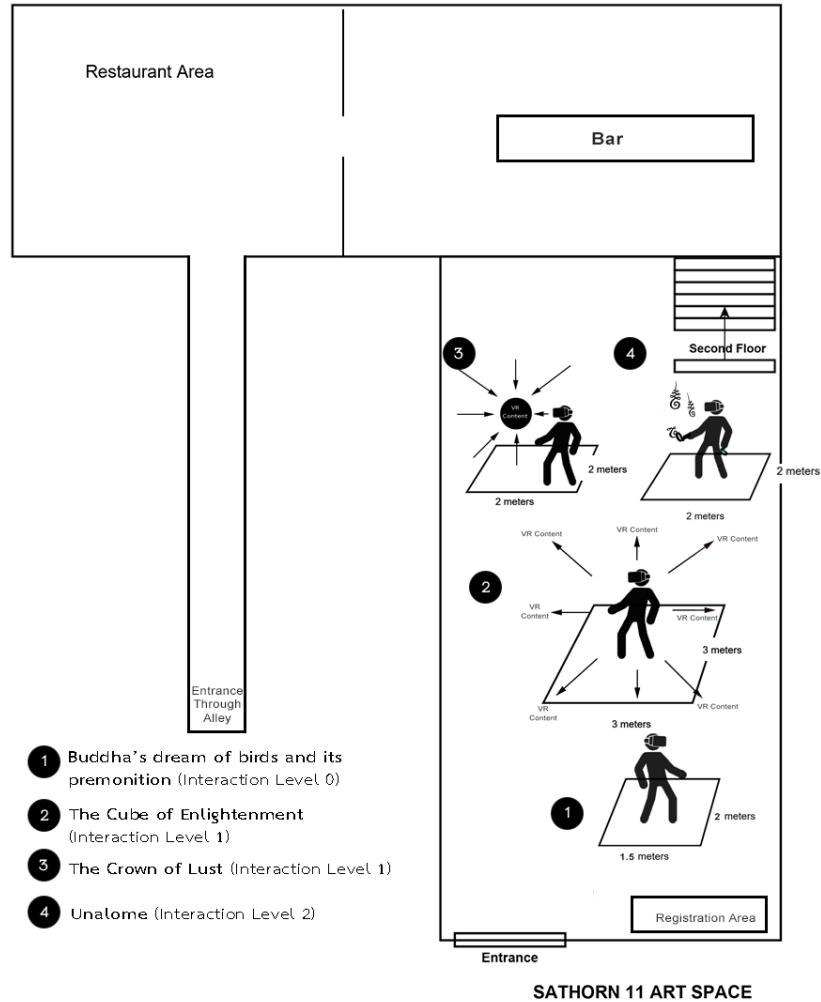

Figure 27: The Exhibition Floorplan at Sathorn11 Art Space

Figure 28: The Opening of the Enlightenment Virtual Reality Art Exhibition

Figure 29: Professor Wattana Jutavipard Experiences "Buddha's Dream of Birds" VR Artwork

Figure 30: An Audience While Experiencing "The Cube of Enlightenment" VR Artwork

The researchers employed four assistants to observe the audience and collect data. Stationed next to the artworks, assistants explained the research objectives to the audience along with how the data collection will be conducted. Assistants were equipped with observation tools used to collect information ranging from the time each person spent viewing the Virtual Reality artwork, to the behaviors the audience might exhibit during the course of experiencing the artwork. The audience members who completed viewing all four artworks were presented with a set of questionnaires to evaluate the art-viewing experience. Figure 28-30 show the atmosphere at the opening of the Enlightenment Virtual Reality Art Exhibition.

6. RESULTS AND DISCUSSION

6.1 Results

For the duration of 20 days during which the exhibition was publicly accessible at Sathorn 11 Art Space, 107 samples were collected through volunteer sampling. The average audience viewing time is shown in Table 1.

Table 1: Average Audience Viewing Time

Artwork	Average viewing time (seconds)
1. Buddha's dream of birds	310
2. The Cube of Enlightenment	560
3. The Crown of Lust	520
4. Unalome	740

All four Enlightenment Virtual Reality artworks were presented with 180 seconds of audio narration related to the event depicted in the artwork. In "Buddha's Dream of Birds", the Virtual Reality artwork was designed as a real-time animation limiting the role of the audience as a spectator. The average viewing time for this artwork is 310 seconds. "The Cube of Enlightenment" and "The Crown of Lust" were depicted as interactive simulations that further expand the audience's physical capability as actors while experiencing and playing out the artworks. The average viewing times for the two artworks are 560 and 520 seconds respectively. In the

case of "Unalome", the Virtual Reality artwork was devised as an online modelization that extends the role of the audience to a creator-actor which in turn has the highest average viewing time of 740 seconds. From the data collected, the amounts of time spent viewing the artworks vary according to the level of user interaction—the more the user can interact with the artwork, the more time he or she is willing to engage in viewing the artwork. The level of the audience interactivity is shown in Figure 31.
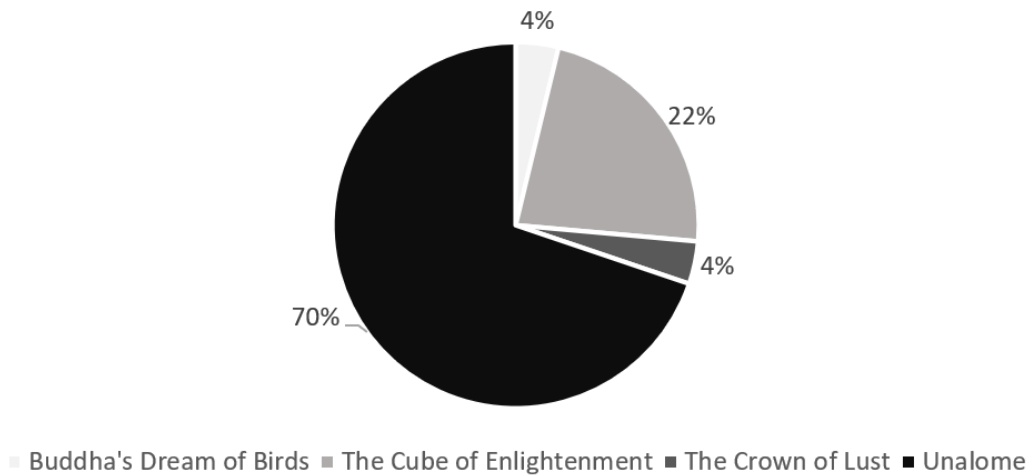

■ Buddha's Dream of Birds ■ The Cube of Enlightenment ■ The Crown of Lust ■ Unalome

Figure 31: Level of Interactivity According to the Audience

According to the audience, "Unalome" is the Virtual Reality artwork which has the highest level of audience interactivity, followed by "The Cube of Enlightenment", "The Crown of Lust", and "Buddha's Dream of Birds". The results are in concord to the levels of interaction the researcher designed the artworks to be.

Table 2: Observed Audience Behaviors

Artwork	Observed Physical Behaviors			
	Head Movement	Attempt for Physical Contact	Spatial Interaction	Partake in Content Creation
1. Buddha's dream of birds	●			
2. The Cube of Enlightenment	●	●	●	
3. The Crown of Lust	●	●	●	
4. Unalome	●	●	●	●

Audience behaviors while viewing the artworks were also varied according to the levels of user interaction (Table 2). While the audience immersed in "Buddha's Dream of Birds", the only exhibited activity was the head movement. In "The Cube of Enlightenment" and "The Crown of Lust", the audience showed both the attempt for physical contact and spatial interaction. The audience would naturally try to extend their arms out trying to touch virtual elements or walk around in the virtual environment presented through the Virtual Reality head-mounted display. Lastly, in "Unalome", the audience would take his/her time learning how to maneuver and successfully creating the symbol of Enlightenment in the virtual world.

6.2 Conclusion

In this study, the researchers explored the concept of interaction level of Virtual Reality and its suitability as an art medium for portraying the Buddha's enlightenment. By studying theories relating to the idea of interaction, it can be concluded that there are three levels of user interaction in Virtual Reality which the audience would assume the roles as "Spectator", "Actor", and "Creator-Actor" respectively (Figure 31). The study based on the Proposed Multimedia cone of Abstraction proves that Virtual Reality is suitable as an interactive art medium. The researchers produced and exhibited a series of Enlightenment Virtual Reality arts depicting events of Buddha's enlightenment based on the concept of interaction level and suggestions from experts.

The study reveals that not only the level of user interaction has a direct impact on the amount of time audience spend viewing the artwork, but the level of user interaction also has a direct effect on the user's physical engagement level during the course of viewing the Virtual Reality artworks. Increased engagement levels can be observed from exhibited physical activities such as physical movement, attempt to reach virtual objects, response to virtual spatial by physically moving within a virtual environment, and engaging in the process of art-making within a Virtual Reality environment.

A new paradigm for creating an engaging and meaningful Virtual Reality Art exhibition can be constructed based on the concept of the multi-interaction level and the content (Figure 32).
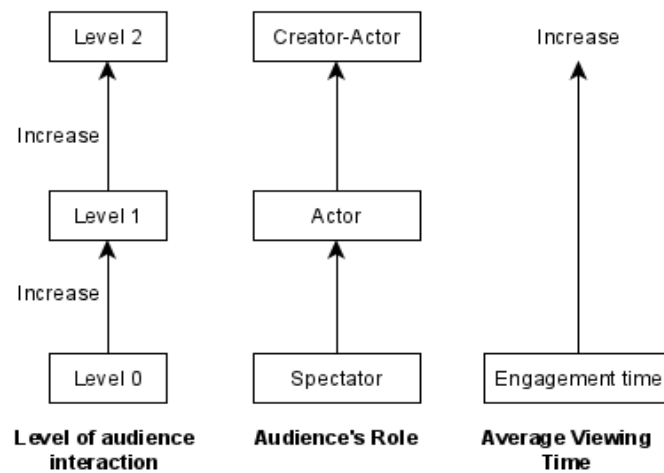

Figure 32: Relations Between Level of Audience Interaction, Audience Role, and Viewing Time in Virtual Reality Art
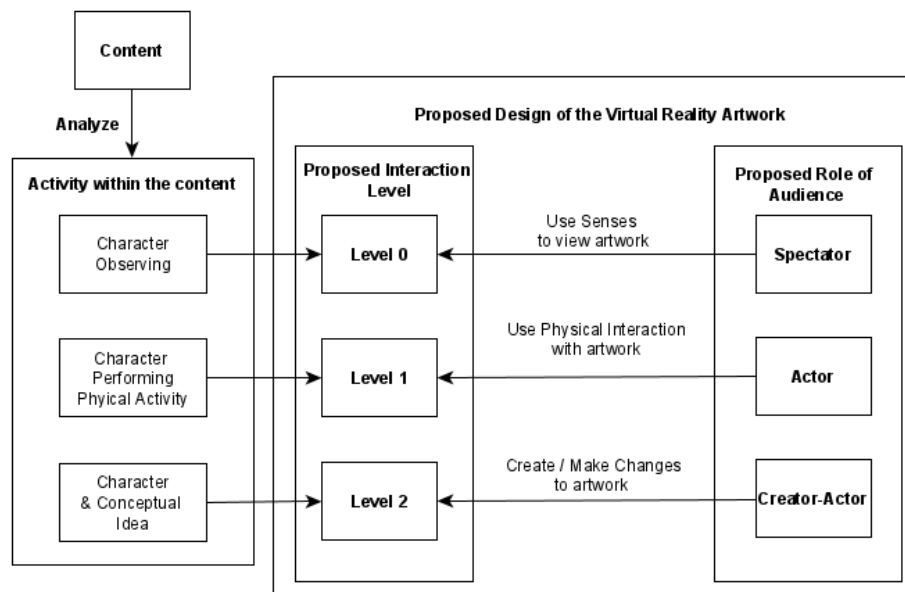

Figure 33: The Paradigm of Creating Virtual Reality New Media Art Based on the Concept of Multi-Level Interaction Level and the Content

The nature of the content of which the artwork will be developed can be used as a factor to determine the level of interactivity. Content with passive nature may not need the audience to be a creator-actor. A narrative content may only require the audience to assume to role of a spectator in the Virtual Reality art, while more complex content can employ higher interaction levels to allow the audience to spend more time interacting. As shown in Table 1, as the level of interaction increases, so does the time spending in the Virtual Reality artwork.

Level 0 of interaction is suitable as introductory art pieces. For this level of interaction, the audience will be eased into the concept of Virtual Reality art. In this setting, the audience has the least responsibility. The audience assumes the role of a spectator becoming familiarized with viewing artwork through a Virtual Reality head-mounted display.

Level 1 of interaction adds extra layers of interactivity introducing the audience to the concept of spatial interaction with virtual objects or environments. In Level 1, the role of the audience is elevated from spectator to actor in the new media art. As this level requires a higher level of engagement from the audience, it is suitable as intermediate artwork that establishes the concept of action within the Virtual Reality environment to the audience.

Level 2 of interaction requires the most engagement level from the audience. In this setting, the audience is required to learn how to operate tools within the construct to co-create artwork. To expect the audience to be able to perform at this level of interaction, it's imperative for the audience to gradually acquire interaction skills from Level 0 and Level 1. Hence, this level of engagement is used on the latter artworks as the audience has been familiarized with the concept of interaction level from previously viewed artworks.

This paradigm can be used to effectively enhance and design how an audience can take part in each Virtual Reality art within an exhibition. Lastly, this multi-interaction level concept also adds variety and life to the art exhibition making it a meaningful and engaging art-viewing experience.

6.3 Suggestions

The researchers would like to suggest other researchers to conduct further studies on this subject. Future research may investigate the same topic but with the evaluation of knowledge about the content. For example, the audience might perform a pre-test evaluating the knowledge about the content then take a post-test to examine whether the audience has gained more knowledge by viewing the Virtual Reality artworks and how different interaction levels may contribute to this.

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