Design of VR Interactive Experience and Immersive Storytelling from the Perspective of Art Therapy

Yifei Wang

University of Pennsylvania

Pennsylvania, USA

Abstract—**The development of VR applications is moving in the direction of diversification, which also constructed a new innovative scene for interactive experience design and immersive storytelling. The capacity and innovation of VR systems to simulate different experiences are particularly suitable for creating healing environments for people with mental health issues. In order to explore the development and future trends of interactive experience and immersive storytelling design of the art therapy environment in VR form, this paper takes the digital VR experience design for art therapy as an example, investigating the application of art healing interaction design. By discussing the dimensions of immersive technologies, immersive narrative, and immersive interaction design strategies of VR experience, as well as the intervention mode of art therapy and the emotion-triggered expression in the VR aesthetic process, the paper explains how to build a human-computer interaction design model and outlines basic principles for its implementation. The acceptance of VR art therapy against other therapies and the positive feeling level compared to related theme projects in classical mediums among target users was examined and analyzed based on that, thus, serving as a reference for improving VR interactive experience design philosophy and art therapeutic purposes towards a more inclusive human-computer interaction landscape.**

Keywords—Virtual reality, art therapy, immersive storytelling, human-computer interaction design

I. INTRODUCTION

Due to the advancement of digital media innovation and VR technologies receiving updates every year, innovative applications of interactive experience and immersive storytelling are gradually emerging and wide spreading, and are utilized in entertainment, social networks, scientific investigation, artistic creation, military training, as well as numerous approaches to employ VR for psychotherapy to help treat mental illnesses such as phobias, anxiety, depression, eating disorders, pain management, and Post-Traumatic Stress Disorder (PTSD)[1-2].

People's mental issues such as anxiety, and depression are highly prevalent disorders in the contemporary world [3]. Art therapy provides a lower threshold solution than classical and professional psychotherapy. However, many traditional artistic expressions have gradually become difficult to meet the growing needs, and innovative trends have emerged.

The unique characteristics of VR, compounded by novel possibilities of artistic expression further expand therapeutic possibilities with drama, painting, dancing, sculpture, clay, sand tables, and other artistic channels through creative interventions as a non-verbal medium [4-5]. In recent years, a few VR psychotherapy projects have emerged as therapeutic tools or treatment plans, which play a good role in positively assisting but little attention has been given to the potential of art therapy, and related research on the novel qualities offered by this creative medium is still insufficient.

This paper takes digital VR experience design for art therapy as an example to explore the changes and development of art healing environment in VR form, exploring the future trends in the strategies, technologies, narrative speaking, and model building based on the abstract ways of mental health with creative exploration.

This experimental project seeks to provide a unique VR art therapy experience to explore while combining art theory and techniques to create sparks in a Metropolis scenario under both a historical narrative and a futuristic lens. It is necessary to consider the dimensions of interactive experience and immersive narration under VR technologies, as well as the perception mode and subjective identity cognition of the audience in the VR aesthetic process, and further explore the emotion-triggered self-awareness expression. This paper proposes a human-computer interaction design model and outlines basic principles for its implementation based on which it examines and analyzes the acceptance of VR art therapy against other standard therapies and the positive feeling level compared to other therapeutic projects, thus serving as a reference for future development and innovation of VR art therapy.

II. DIGITAL ART THERAPY INTERACTION DESIGN REVOLUTION EMPOWERED BY VR

A. The Development Context of Art Therapy Empowered by Technology

Art therapy is a form of psychotherapy that employs artistic creation for integrative personality processes [6]. American Art Therapy Association defines it as a service-oriented profession that uses art media, images, creative artistic activities, and patient responses to works to present individual development, abilities, personality, interests, concerns, and conflicts [7]. Its process includes two types of activities: patients engage in expressive artistic creation or find spiritual resonance in art appreciation, mainly through visual, music, dance, and other art forms to concretize ideas and emotions, relying on the mechanism of super linguistic expression and image interpretation to alleviate psychological disorders. Unlike the purely functional medical environment, art therapy can potentially impact people's health both mentally and physically in the prevention, promotion,

management, and treatment themes, raising psychological well-being and cultivating creative intelligence [8].

However, with the continuous iterative development of related technologies such as image technology, artificial intelligence, Internet of Things, its interaction ways are gradually being optimized from classical to intelligent, flexible, and multi-sensory. Since 21 century, art therapy has been commonly described as an interdisciplinary field [9]. The environment of art therapy has gradually developed from early hospitals and clinics to widespread well-tailored consumer applications to carry out the treatment and enhance the possibilities for therapeutic use [10], integrating personal development and socialization [11].

Human society will enter a virtual-real integration, ubiquitous interconnection, intelligent openness, and decentralized intelligent networking era, and emerging visual immersion technologies represented by VR, AR, and digital twins are constantly empowering and reshaping the art therapy ecology from the aspects of technical systems, narrative structures, content production, and interactive interfaces (Table 1).

TABLE I. DEVELOPMENT STAGES OF ART THERAPY

Name	Classical Art Therapy	Art Therapy in Web 2.0	Art Therapy in Web 3.0
Characteristic	Traditional clinical setting emphasizing the healing power of art itself	Multi-disciplinary integrated solution; more social, cultural and leisure functions	High immersivity and sense of privacy; more diversity, customization, and inclusion
Medium	Physical artistic material and product	Digital medium includes phone, PC, robot	Hybrid of virtual and physical medium
Disciplinary	Psychoanalysis and psychotherapy group work	Visual art, counseling, art education, rehabilitation, anthropology, neuroscience, and the study of creativity	Artists, scene designer, software and hardware engineer, art therapist, etc.
Technological requirements	Low-according to the content and medium of art appreciation; the method and material of artistic creation	Medium-internet technology, image production, video projection, data collection, etc.	High-AI, VR, AR, IoT, cloud computing, sound sensing, motion capture, face recognition, etc.
Senses	Mainly visual and auditory	Visual, auditory, haptic	Five senses, multi-modality, and multi-channel interaction
Advantages	High frequency and direct art therapist-client interaction	Compensate for instructing ability of therapist; integrate personal development and socialization	Unbounded realism, size, time, and tele-therapy for value co-creation
Disadvantages	Limited interaction, scenes, and participation with art therapy content	Still deliberately imitates classical forms instead of new technologies and target user characteristics	Easy to fall into technology-centered mode and ignore contents; weak therapeutic relationship

At present, most people's cognition of VR is biased towards its entertainment attributes and ignores its other potentials for its nature like medium specificity, empathy, and presence, technological and emotional embodiment, etc. Exploring the form of immersive VR and the opportunities to bring change to art therapy, it is of great theoretical and practical significance to closely combine a digital and gamified therapy method. A key aspect of VR for psychotherapy is the ability to induce a feeling of "presence" [12], which can be a powerful therapeutic tool promoting personal change and self-reflectiveness [13]. For example, because PTSD mostly occurs after a war or a large-scale disaster, it is difficult to reproduce the scene that can make patients immersive, so the advantages of low risk, safety, and accuracy of VR technology are obvious. Moreover, multiple techniques implementation of VR in psychotherapy depends upon the psychological approach and the specific disorder, such as simulative controlled exposure (e.g., anxiety, phobias, fear of flying), embodied technologies (e.g., eating disorder), cue exposure (e.g., addictions), or distraction (e.g., pain management) have been explored [14].

The interaction paradigm of VR must be very different from the classical way, which poses new challenges to interactive experience design in this context. This paper takes the digital VR experience design for art therapy as an example, to study the interactive technology of digital art therapy experience, immersive storytelling, and interaction design strategies to explore an interactive design model guide for art healing experiences in the era of artificial intelligence.

B. The Emerging Trends of Art Therapy Interaction Design for People with Mental Issues

1) Greater emphasis on natural and inclusive interaction behavior logic

Natural User Interface means that users can interact with the system in a natural, intuitive-based way. For target users with some mental awareness disorder or physical impairment, there is a certain learning threshold for using behaviors with a small operating range, too delicate in control, and more complex in operation process steps with physical interaction intermediaries such as mice, styluses, electronic toys, etc. Nowadays, digital art therapy designed for inclusion can provide target users with more natural, convenient, comfortable, and implicit interaction, such as without excessive learning costs, without any physical input device to experience, without relying on the limitations of a graphical interface and instruction execution in the WEB 2.0 era.

2) Full-sensory multimodal interaction channel

Ana morphine's VR immersive adventure game by Artifact5 is a representation of the treatment of PTSD through

VR technology, exploring themes such as mental health, depression, and loss. The demonstration of VR "Virtual Pain Scene" is a safe and controlled environment of the traumatic process to make the client face up to and control fear. Non-verbal cues in the virtual environment occupy an important part and can cause different understandings. Most existing projects such as Ninja Theory's Hellblade, are designed to stimulate the patient's vision and auditory, while other senses such as smell, taste, and haptic are not yet widely covered.

Multimodal interaction refers to the fusion of multiple senses, and the computer uses multi-channel response input to fully simulate the interaction between people. Research shows that humanity has the limbic system, seen as the human's emotional brain, is composed of a group of brain structures that play a vital role in sensory perception, memory forming, processing & regulating emotions, and motor functions. The more senses an experience activates, the more connections are created in the brain related to our memories, attention, performance, assessment, and so on [15].

With the advent of the digital age, the visual stimulation received by people in intelligent and closed environments for a long time will become stronger, and the comprehensive stimulation of multiple senses will become less than ever before. Inspired by the above, enhancing the experience of the full senses through emerging technologies such as VR will be the future development direction of art therapy interaction.

3) Innovative research and related applications in cognitive science

An interesting topic is to explore the potential impact of VR on behavior, self-image perception, and psychological ownership. The way a player's sense of "self" is shaped by the game elements like body, senses, interaction, and awareness. It allows people to fully immerse into and surround themselves with a 3D virtual world. It is also possible to intelligently analyze art content, therapeutic behavior, and treatment scenes based on deep learning on the behavioral habits and cognitive level of target users and realize feed-forward adaptive active interaction.

Mel Slater in eventLAB, the University of Barcelona has done cognitive experiments focused on using VR to transform the self. This work, inspired by and contributing to the field of body ownership illusions as studied in cognitive neuroscience points to an additional power of VR to change the self not just the place; The Machine to Be Another project creates an embodied VR system that allows anyone to experience the world from the perspective of another; In Time-Body Study by Daniel Landau she has research on the feeling of being inside another person's body and what it could teach us about other, how it will affect the notion of one's own identity, etc. Thanks to such research providing both a practical and conceptual foundation and insights for researchers to investigate the opportunity for experimentation and artistic innovation goals. Depending on the scope, particularly given the potential for an investigation of the relationship between the nature of immersion and a sense of "self", this could prove to be a promising area of exploration.

III. IMMERSIVE DIGITAL ART THERAPY INTERACTION DESIGN EXPLORATION EMPOWERED BY VR

A. Model Framework

This paper explores information architecture construction, as well as the interactive experience and immersive

storytelling strategies under VR technology through a project "Bridge of Houses". Based on the practice and evaluation, the human-computer interaction design model of an immersive healing environment in VR mode can be summarized:

A 3D world with multiple scenes that can be explored as a character in a VR head-mounted display (HMD) based on interactive mechanics and immersive narrations, which has healing interval factors of art therapy. Each scene has designed flows under strategies of viscerality, immersion, embodiment, story-making, etc. It could awaken the inner child and positive feelings of the players and it can also be a Sandplay therapy game for each protagonist. The tools allow designers to control user experience including storyboarding, sound, puzzle solving, space promenade, NPC interactivity, conscious music creation experience, etc.

A series of immersive animation and 360° videos could be viewed online for narrative storytelling. A structured design document with included images, illustrations, and templates was provided for future production or environment.

A transdisciplinary perspective strengthens the field of art therapy by assimilating disciplinary contexts and personal preferences into a comprehensive framework (Fig.1). Compared to the classical art therapy model [16], it has a more dynamic change of each factor according to different scenarios and perspectives that are specific: immersive technologies, interaction methods, and user experience design.
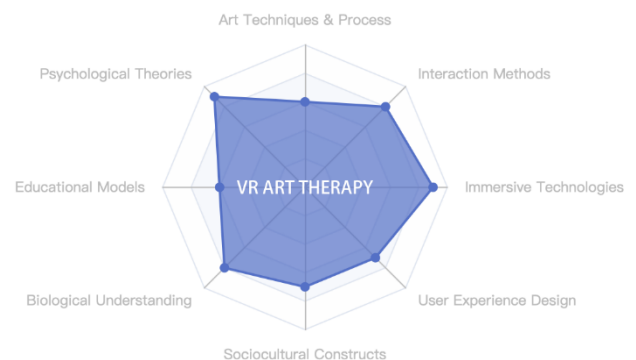

Fig. 1. Transdisciplinary model of VR art therapy

1) Gameplay

Experience the scene with a Subjective POV and get an immersive experience by manipulating the environment in one's cognitive zone according to one's own judgment. The project is following the VR system design in 1985 Fisher's VIEW system: 6 degrees of freedom ("6DOF"), multi-user, haptic feedback, voice control, spatial audio, and gestural interface [17]. Also, human experience is an important factor that the article published by Survios "What is Active VR?" demonstrates six elements: immersion, presence, embodiment, free movement, shared space, and dynamic spectating [18].

The characteristics of the experimental project design in this paper are as follows：

1)   Driving visitors to get a connection of emotional bonds and find inner desires, which is to face the objective reality of an experience - what someone with no prior knowledge will do naturally. A compelling emotional bond formed by virtual space and social clues can bring

immersion and incorporate puzzle-like narratives, such as exploring new spaces or upgrading gameplay mechanics, to drive world-building and engagement of players.

2) Constructing hybrid experiences that combine live action with animation or time-based stories with interactivity. Seven various kinds of experiential worlds are provided corresponding to the different theme settings, giving various feelings, and engaging different personality types, where the player can explore and discover, learn, and collect, burst out inspiration and creative enthusiasm, or just find a little relaxation, heal, etc.

3) Depicting consciousness in a virtual space of "consciousness creation" responding to the project research area where the player can change through more "natural" input, move the body and limbs to keep the entire house in balance, fly around waving their arms to explore or make sounds to launch "bubble dialogs" to disrupt self-conscious behavior, etc.

4) The visitor is ultimately the storyteller in this medium, from the identification of the avatar to the semi-embodiment to the subjective, the process of realizing one's own objectification, and finally forming the critical opinion and finding the authentic self-choice.

2) Story Setting

Story: It is a journey of a talented musician to find memories lost due to an accident about musical dreams, family, and love. For the player, it's a linear tour to get inner peace through self-awareness meditation, a connection of emotional bonds with familiar friends from the historic world and strangers in today's community, and find a childlike heart with sensory and immersive activities, gradually dismantling the psychological defenses and piecing together a complete story by gathering fragmented memory plot clues.
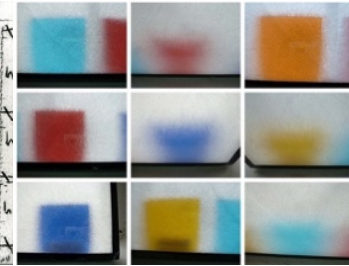
Environment: The project originates from one of the unbuilt conceptual proposals of architect Steven Holl in the early 1980s (Fig.2). It's not an imitation of reality for it serves as an impossible place to visit, but a semi-fiction "ornate collection of urban villas" in Highline in Chelsea, providing a passage at the pedestrian level so that the promenade is a series of public courtyards. All the housing starts from the same scheme although each of them adopts a different personality regarding the individual expects to host.

Story world: Each urban villa is given a title, describing metaphorically the person (and social class): House of the Decider; House of the Doubter; House for a Man Without Opinions; The Riddle; Dream House; Four Tower House and Matter and Memory. Of course, each house was accompanied by a text describing how each of these houses is occupied and their psychological metaphor, program, and narration.

B. Model Design of Immersive Experience

The model is designed to create a healing atmosphere with senses of immersion, narrative, and interaction. As an important healing factor, the interactive immersion experience in the VR environment is designed under strategies of viscerality (includes sound and vision, but also other senses), immersion, embodiment, and story-making compared with the form of an ordinary art healing environment, which is very suitable for modern art therapeutic purpose.

1) Visual Aspect: Look and Feel

The overall style and tone of this project environment is a VR-based immersive experience, marked by Impressionist art theory and emerging aesthetic fields. The environment is warm color feeling blends with the soft light environment to calm and relax people's emotions. The stylistic inspiration was drawn from Steven Holl's previous sketches representing some interconnections of the proposed story world.

Diverse forms, colors with daylight, stereoscopic content, and explorative paths have shaped the style and tone of space, which activated positive feelings. The artistic setting of the architecture and environment references some of the brightly colored, emotionally triggered design styles. In the process of evidence-based design, the color psychology intervention from the project research phase was referenced. Space and narrative coherence are unified, beginning from blankness to elaboration, then back to simplicity and austere at the end.

(a) Bird view of environment   (b) Watercolors from Steven Holl   (c) Glass façade tests from Steven Holl

Fig. 2. 3D model of story setting in Unity environment

2) Theme Music

Research shows that music and involved adjunctive activities may enhance caregiving behavior by promoting a sense of well-being and distracting patients from pain and other unpleasant symptoms, thoughts, and feelings [3].

In the setting of the audio environment, spatial audio is selected to direct (or misdirect) the player's attention for its unique aspect of immersion design, which requires one viewer with headphones and head-tracking but can be at any position.

BGM and sound effects are designed for all events and narrative scenarios to increase immersion, i.e., a sad tone for the broken room, while warm and pleasant for the memory and outdoor scene. Some audio clips that conform to the project's storyline settings are used in the selection of content, like piano pieces that sound fluid and softly contoured. Take Debussy's impressionist work Clair de Lune in this project as examples, the rigorous structure and logic of classical music cannot be seen, instead, strange fantasy factors, hazy feelings, mysterious colors, and harmonic effects are depicted with a rich imagination. The scenery such as the bright moonlight,

the surging sea, or the illusions of the summer afternoon can heal people's moods and calm them. Indeed, the name indicates the connection of this music with the Symbolist who tried to illuminate more inaccessible regions of the human soul, by creating suggestive images and evoking moods.

3) Immersive Mechanics based on VR experience

The project uses sensations of presence, embodiment, perception, agency, and witnessing as creative variables to enhance the immersive experiences. All forms of engagement overlap, including emotional immersion(empathy) and sensory immersion(presence), but there is no fixed ratio between them.

According to the story world, the project creates immersive emotional responses through subtle clues left by NPCs or real players involved, and can be triggered in real-time or asynchronously, these in-game connections with personality and social systems can build a sense of community and can stimulate empathy or social immersion.

Five senses are incorporated as tools to make sense of the outside of "embodiment" and the essential elements for survival in the virtual world. For example, wearable transducers deliver variable frequency vibrations or impact to specific parts of the body; scents are infused into the air to create an olfactory sense of presence, etc.

Additionally, a 3D space with higher resolution, frame rate, and more detail was expected to create to meet people's growing expectations for visual expression and make it easier for players to immerse themselves in the virtual world.

4) Emotional Response

Emotional Design is an important element not only in the art form but also in the art therapy approach. The project tries to fulfill the needs of players/viewers corresponding to their inner triggers and anticipate and design for their emotional state that can let their level of focus maximize their performance in pleasurable feelings from the activity.

During the immersive experience, the players/viewers could experience the recreated traumatic scene to release emotions based on story animation created by real-person motion capture technical environment (Fig.3), and positive feelings from the activities, like peace, relaxation, happiness, creativity, curiosity, fun, etc. Also, they can raise awareness of themselves and create moments of quiet introspection through meditation. The Flow theory was adapted into the project design for its relationship with game design and emotions [19].
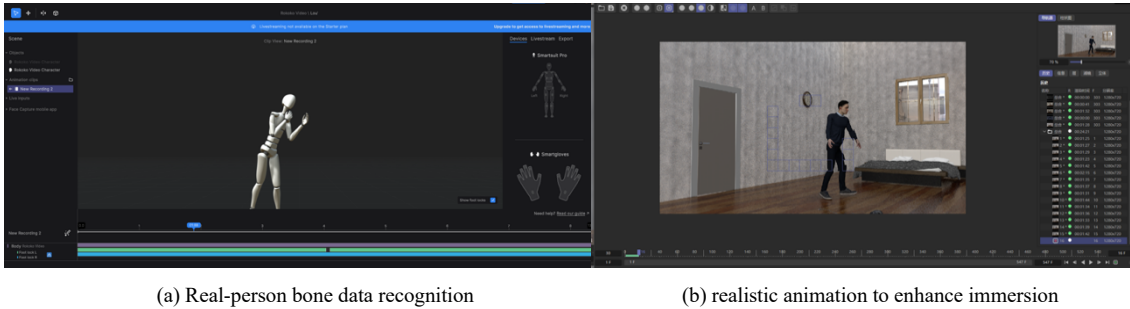

(a) Real-person bone data recognition   (b) realistic animation to enhance immersion

Fig. 3. Animation created in motion capture working environment

5) Game interactive mechanics

Many VR games allow multiple people to participate in the interaction, which is essential for fostering social relationships and partnerships among patients. Game behaviors based on VR interaction environment can effectively eliminate people's strangeness and loneliness in the environment, and transfer and alleviate negative emotions such as fear and depression. Play therapy itself is an important means of art therapy, in this project, followed by the methods of game design including play-centric design, multi-perspectival design, iterative design, intuitive interactions such as collecting/trading, discovery/exploration, collaboration/competition, puzzle solving, resource management, etc. are considered in the experience, which is inspired by and combined with art healing methods like meditation and other positive thinking practices [20-21].

C. Model Details of Interaction Experience and Immersive Storytelling

The project takes advantage of different views and imaginative mechanics to create a playing experience from multiple scenes (Fig.4).

It is explored in a first-person perspective with many different characters revealing the story step by step. The interactive mechanic is mainly based on the player's movement and some interactions with NPCs and objects that help solve the puzzles and promote the storyline (Table 2).

Fig. 4. Multiple scenes of the playing experience

TABLE II. DESIGN SCRIPTS

	Narration	Setting	NPC	Main senses	Interaction	Puzzle elements	Emotions
Prologue	The visitor stands under the bridge, slowly walking up.	Start point of bridge	None	Sight, auditory	Space promenade using Teleport; lullaby and notes flying above the field of vision	Text clues hidden in the lyrics flying in the sky	Curiosity
House 1: House of the Decider	"When I was a child, I wanted to become a musician."	Childhood home	An old man prompts him to find memories following the puzzle map.	Sight, auditory	Watch videos; find clues	Memory videos, photo walls, guitar, childhood toys, text clues	Fun
House 2: House of the Doubter	"The effort to chase my dreams."	School dormitory	The roommate tells him to check the plan sheet.	Touch	The swing of the pendulum to switch the memories	Plan sheet, guitars sent by mother at the bed, clocks	Concentration
House 3: House for a Man Without Opinions	"I did it! I was praised by the audience as a talented musician."	Home in New York	The landlord prompts him to check achievements in the display case.	Touch	Watch the display case of the award-winning experience	Display case, newspaper on the wall, mother's guitar	Pleasure
House 4: The Riddle	"Lost memory of music due to an accident."	Hospital	Doctor prompts that he was injured due to a fire accident and had amnesia due to stress trauma.	Smell	Aisles shaking and fire effects. Scents are infused into the air.	Guitar with burnt strings, olfactory cues associated with fire	Anxiety
House 5: Dream House	"Melancholy and confused, I want to end my life."	The orchestra's room	A musician friend prompts him that he can't play the guitar that well due to amnesia.	Auditory	Choose music of different emotions to see shape changes of water crystals.	Messages from audience, composition for the first winner time for his mother	Extremely disappointed, fall into despair
House 6: Four Tower House Taste	"Redeemed."	Hometown home	Mother encourages him to continue, and most importantly, live happily and freely.	Taste	Eat the food made by mother, the childhood and music memories are gradually revived.	Food made by the mother, childhood picnic	Relaxation

| House 7: Matter and Memory | "Set off again for the land of dreams. " | Train station hallway | The old man, the future himself, prompts him to repair guitar. | Sight, auditory | Repair the guitar, create a composition by plucking strings and handwriting. | Damaged guitar, musical manuscript | Creativity |
| Ending | "Innovation emerges from seeing beauty and interest in small things in unexpected places and giving them a new life." | Under the bridge | None | Sight, meditation | In a car driving to the beginning automatically under the bridge, with quiet introspection. | Text clues hidden in the outline of buildings on the street | Peace and well-being, self-awareness |

For the puzzle-solving scenes in House 1 based on the puzzle map given by NPC, there are four rooms, and an exhibition area corresponds to a series of tasks (Fig.5). Got inspiration from some puzzle adventure games with a storyline such as Monument Valley from Ustwo games, What

Remains of Edith Finch from Giant Sparrow, and Little Nightmares II from Tarsier Studios, the project has developed some innovative ideas including immersive storytelling, emotional tone, puzzle games, adventure scripts, etc.

Fig. 5.   Interaction mechanics of puzzle-solving elements

For the performance scene, gestures, body interaction, and intentions associated with music notes are involved, such as color, shapes, etc. to make players get rid of representational, and closer to sensory and conscious experience (Fig.6).

The project creates a music experience based on VR. There are 3D stereo blocks of various shapes given different

sounds. When putting on the device and tapping or clicking a shape, it will make a sound. The volume depends on how hard people tap. If using a headset like the HTC VIVE, the players can add shapes too. This experiment demonstrates cross-device co-presence in VR, allowing anyone to join in.
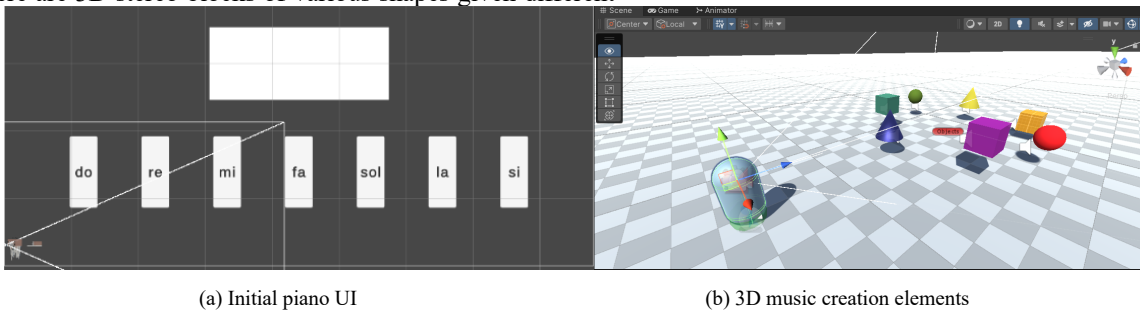

(a) Initial piano UI   (b) 3D music creation elements

Fig. 6.   Iterative music experience setting

IV. IMMERSIVE TECHNOLOGIES FOR INFORMATION ARCHITECTURE AND MODEL CONSTRUCTION

Generated Virtual Environments are generated dynamically by computers using game engines (e.g., Unreal / Unity / Houdini / Hubs Mozilla) platforms which provide powerful development options. In the environments for storytelling, viewers can walk around and explore, but interactivity is limited. VR Stories have elastic timelines and

are aligned with the logic of animation. In the environments for gaming, viewers interact with objects, environments, and characters to solve puzzles, compete, collect, explore, etc. Based on the selected game engine platform, the digital VR art therapy project development process mainly necessary to go through 3D modeling, material editing, and rendering, 3D animation, model import, environment setting, scripting, generating release files, etc. (Fig.7)
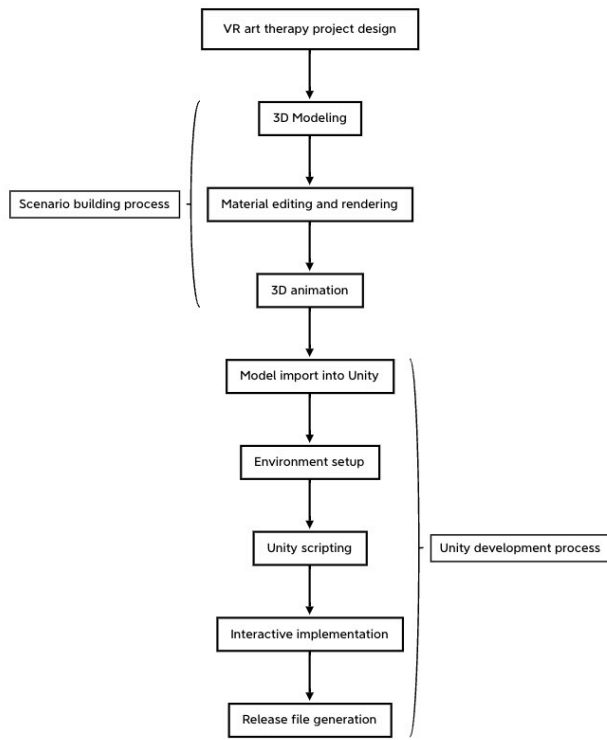
Fig. 7. System development flow chart

During the concept stage, the web VR environment in Spoke was used to test some ideas. This article selects Unity for the final distribution, for maximum flexibility is of primary importance in a medium, which can also be exported to various other platforms so that more potential audiences could be reached. The ways to experience this project contains Mobile VR like Oculus Quest 2 and PC or Console based VR like Oculus Rift, HTC VIVE /Index/Cosmos/PS-VR, etc. Phone-based VR is not considered because of its low experience quality and is unsuitable for displaying the healing environment created in this project. Unity also provides users with some unique opportunities to explore 3D worlds from an immersive 1st-person view thanks to the work currently being done with head-mounted displays and body-based interfaces, which can better demonstrate the thoughtfulness of the therapeutic concept than any other traditional media form.

A. 3D Modeling

For the immersive scenario building, the environment and objects are considered to digitally build the healing world. 3D models were first carried out by using 3DSMAX. 3D assets were finally exported into the Unity platform to write the script program. World Creator was used to generate the terrain and landscape to create the outdoor and indoor environment. The city was modeled into an HDRI environment through the 360 Camera feature provided by Cinema4D. The 3D objects were mapped into the 2D plane through Motion Tracking. Interior Map technology was used in urban's construction to produce a relatively realistic night view of the city without increasing the number of surfaces and internal modeling.

B. Material Editing and Rendering

Some objects were done using the photogrammetry shooting workshop. After taking images of compositions from all angles, they were processed in computer software and uploaded 3D scans to sketchfab and posted and inputted into the project. For some keyframes that required detailed building, Maya-based hard surface modeling and Zbrush-based sculpting modeling were used. Substance Painter was used for 3D texturing to bring the creations to life thanks to its smart materials, flexibility, and visual quality for model baking. All this modeling work was then needed to process with Octane Render, Redshift, and Marmoset Toolbag 4 to meet the realistic performance requirements for real-time or Computer-generated imagery (CGI) parts.

C. 3D Animation

The animation part of the project uses a 360-video camera with compatible video editing software to create videos with decent image quality. The video part simulates a spherical viewing screen with the viewer at the center, effectively emphasizing presence or witnessing. Viewers can look in any direction but cannot walk around. For the animation part with characters, the project adopts a solution provided by Rokoko Inc., a 3D motion capture toolkit that includes Smartsuit Pro II and Rokoko FaceCap and has functions such as real-time body and face motion capture and image recognition through optical sensors and bone data recognition to create more realistic character movements to enhance the immersion.

D. Unity Development Process

Once the overall model is created, the material is pasted, and the animation design is completed, the model can be packaged and exported to the Unity project folder. The main development work in Unity3D is environment setup, scripting, interactive implementation, and release file generation.

Unity provides sound, graphics, rendering, and physics features that allow the setting of the environment. Take the auditory setting as an example, a procedurally generated 3D environment was used to create spatial audio, and sounds in Unity may be directional, with control over proximity, volume, reflectance, etc. Sounds may be ambient, environmental, object/location-based, or event-based according to the story. Binaural audio is the delivery system used by VR headsets to create the experience of spatial audio using headphones and head-tracking. It performs complex calculations of proximity, reflectance, etc., and total control over audio experience based on position, environment, actions, etc.

Virtual Reality Toolkit (VRKT) and SteamVR Plugins are used for the scripting part. In the SteamVR Plugin, there is an input system that allows HTC VIVE to interact with entities in the virtual scene. Implementing an interaction consists of three steps: defining an action (defined in SteamVR Input in Unity), binding an action (binding a locally hosted page), and using an action (writing C# Scripts, i.e., writing a C# Script component implementation in VS). Among them, the C# component uses bound actions to interact with the virtual scene, which mainly includes two parts: grabbing objects and making laser pointers to achieve teleportation. Then hang the written C# script component on the controller and set the public property value. About this part of the feeling is: define the state properties (grabbable objects, teleportal places), implement (grab, teleport) actions, listen in update whether the input source (left and right controller controllers) trigger bound buttons and there are game objects that meet the conditions (grabbable objects, teleportal locations), and if the two are satisfied, execute the implemented (grab, teleport) actions. To achieve the interaction functions and effects in the story, this project uses several components such as the player and hand of the interaction system, teleporting modules for location transfer, interactable components, throwable

components, UIElement components, skeleton poser, item package, LoadLevel component, etc.

After the development and operation test, the scenes could be generated and exported to Demo in the Build Settings option in the File menu.

E. Other Tools

For other software and 3D Databases used in this project including Sketchfab / Quixel MEGASCANS (3D objects Databases), Mixamo (3D Character animation), Trnio / Scann3D / PolyCam (3D scanning app for photogrammetry), Meshroom (Photogrammetry), etc.
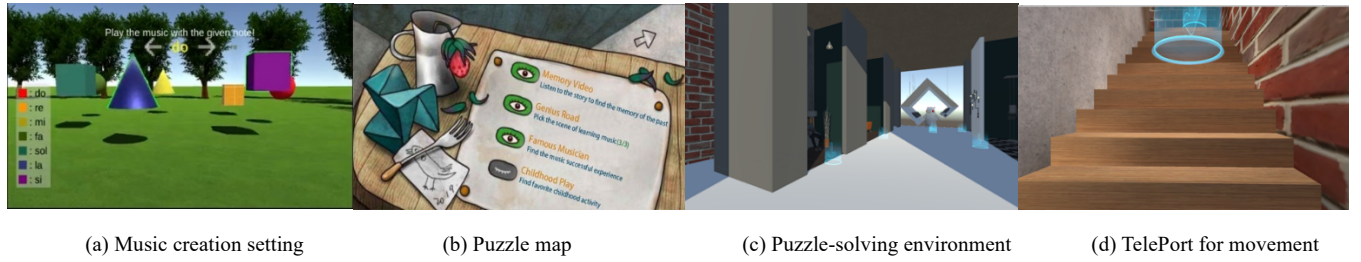
V. RESULTS

A. Model Test Validation

Several rounds of rapid prototyping and play tests in different environments were done for the project concept and work-in-progress, which consists of screenings, play-throughs, interactive demonstrations, and process documents with included art assets, descriptions, storyboards, paper prototypes, unedited footage, etc., accompanied by slides, video, and some playable interactive Unity environments (Fig.8) using HTC VIVE equipment for some of the testers [22]. Then user feedback was collected from team members and participants hired. For this step, some pieces of constructive advice were gathered especially to inform which aspect to create a better state of completion version to show the conceptually iterative process and goals to achieve through the VR format along with the space for future development.

| (a) Music creation setting | (b) Puzzle map | (c) Puzzle-solving environment | (d) TelePort for movement |

Fig. 8. Playing user interface

1) The operation of the test model

Operating platform: HTC VIVE based on Steam VR; monocular resolution: 1600×1600; screen type: Samsung pentile OLED; refresh rate: 90Hz; field of view (FOV): 110°; estimated pixel density (PPD): 9.3; interpupillary distance adjustment (IPD): hard interpupillary distance 61-72mm; tracking system: Valve Lighthouse 1.01 base station positioning; characteristics: support full body tracking, dedicated wireless module.

2) User study procedure and analysis

The results were analyzed based on different factors of the perspective of immersive technologies, storytelling, interaction, mental state, and positive feeling level to examine the acceptance of VR art therapy among people with mental issues against other psychological or pharmacological standard therapies.

The patient groups that art therapy may be exposed to include learning disabilities, physical disabilities, addictions, and other psychological diseases such as autism, eating disorders, etc., of which depression is the most common and familiar psychological problem. Participants in this study employed people with depression and were not screened for depth or severity, but were selected based on depressive position: sadness, loss of interest and pleasure in life, tiredness, and lack of motivation to do things, uselessness, discomfort, worthlessness, and guilt [23].

Participants evaluated the project in terms of viscerality, embodiment, interactive engagement, narration, and positive feelings. Participant's health literacy was evaluated using Rapid Estimate of Adult Health Literacy (REALM) [24] and Newest Vital Signs (NVS) [25]; REALM measures one's ability to read health materials and instructions, at a comprehension level of high school or lower, while NVS assess the likelihood of limited health literacy based on numeracy, prose, and document literacy measures. During the interview, participants were asked about preferences for each immersive factor, mental states with interacting, feedback on interface features, and perceptions of VR art therapy.

There were 20 participants (12 female, 8 male) with ages ranging from 19 to 42 recruited in the study. 9 were assessed as having high health literacy and 11 as low in terms of health literacy. Some participants were excluded from recruitment due to safety concerns - participants that were suffering from severe pain or mental issues that could impair communication.

Collected quantitative data included form-survey responses and averaged 30-minute interaction logs (balanced time with this project and other paper/video/phone-based therapeutic projects), self-reported evaluations of each factor and positive feeling, as well as participant-specific measures (e.g., health literacy). A 15-minute interview for reporting experience and perceptions was conducted and then analyzed.

Table 3 reports the form-based survey of personal feeling levels and the scores of immersive factors using a 1 to 10 scale.

TABLE III.   ANALYSIS OF EXPERIMENTAL RESULTS

Factors / Scores	Viscerality	Embodiment	Interaction	Narration	Positive Feelings level
9-10	0	1	2	3	1
7-8	4	5	6	10	8
5-6	12	11	6	6	6
3-4	4	1	5	1	5
1-2	0	2	1	0	0

According to the analysis of the quantitative and qualitative results, the project has good evaluation in terms of audiovisual affect, embodiment, interactive experience, and narration. Results show that all these factors are independently

and simultaneously correlated with positive feelings. For the acceptance, high health literacy participants prefer using VR art therapy over standard therapy (10 of 11), while low health literacy participants slightly prefer standard therapy (5 of 9).

Most participants said that VR technology took them to another world of creative freedom, immersive experiences from which they could gain power, enjoyment, and positive feelings. But a few participants were disappointed by the lack of concrete interactions compared to the real world for limited exposure to VR project, and two participants offered to think about the need for inclusive design for patients with cognitive, perceptual, or physical disabilities, and the long-term therapies of replaying the project based on AI recommendation which can provide feedback and push content based on users' previous and real-time behavior data.

The results are from the exploration of the art therapy project consisting of information architecture construction, as well as the interactive experience and immersive storytelling strategies under VR mode. Based on the above data and analysis, the human-computer interaction design model of an immersive healing environment in VR mode can be verified and summarized, and the future digital art therapy interaction design trends and methods can be explored based on this model during the further research phase.

B. Further Research

There are several aspects that could be re-scoped and investigated in future work. First, to establish an overall diagnosis of the sensory perceptions of an art therapy VR experience and explore how the reduced awareness of physical space brought about by immersion can help with relaxation, trauma re-creation, stress relief, etc. Technology, time, and detail ideas could achieve a more complete immersion effect in the healing model, such as improved visual effects, better characters communication handling, AI recommendation based on the algorithm for long-term therapies, and the combination of eye movement, EEG, and other biofeedback data acquisition modules for individualized treatment, etc. Second, the project wants to examine the study of multiple intertwined factors that give players a sense of immersion in the virtual world, and the types of immersion most useful and valuable for discussing the therapeutic purpose could be investigated. Additionally, the inclusive design for patients with cognitive, perceptual, or inner ear problems that may feel disoriented should be considered in some way within the design strategy and the big picture.

VI. CONCLUSION

Emerging technologies represented by virtual reality are driving digital art therapy programs to a new stage. Groups with mental health problems and researchers dedicated to art therapy are respectively the target users and creators of digital art therapy content in the era of artificial intelligence, and they put forward higher demand for immersive narrative and interactive experiences of digital art therapy. This paper discusses the development context and emerging trends of digital art therapy under VR empowerment and summarizes the human-computer interaction design model with basic principles for its implementation through the research project, which can lay a foundation for further exploring the future trends and methods of digital art therapy interaction design. Based on this model, the interaction design of aesthetic healing programs that provide immersion for users with mental health problems is explained from several aspects such

as information architecture construction, interactive experience, immersive narration, intervention mode, and emotional expression under VR technology. It examines and analyzes the acceptance of VR art therapy against other therapies and the positive feeling level compared to art therapeutic projects in other mediums among people with mental issues. It provides people a reference for promoting the art healing experience in the era of artificial intelligence to a more human-computer integration interactive picture.

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