"Heart Flows with Zen": Exploring Multi-modal Mixed Reality to Promote the Inheritance and Experience of Cultural Heritage

Wenchen Guo, Zhirui Chen, Guoyu Sun†, and Hailiang Wang*

Abstract— The preservation of cultural heritage (CH) is a complex and promising field. Driven by technological advancements, digitization has emerged as a crucial approach for revitalizing tangible/intangible cultural heritage (TCH/ICH). However, current research and practice remain limited in their exploration of abstract forms of ICH, such as traditional philosophies and ideologies. In this study, utilizing Zen as a context, we designed an immersive mixed reality (MR) experience system, Flowing with Zen, based on formative study and cultural symbol analysis. The MR system integrates multi-modal interfaces, motion capture, environmental sensing, and generative computing, enabling users to engage with four scenarios through meditation, life appreciation, and experiential Zen practice, providing the embodied experience of Zen. Comparative user evaluation (N = 51) revealed that the MR system has significant advantages in eliciting engagement and interest from users, enhancing their aesthetic appreciation and cultural understanding, and increasing the accessibility of Zen. Our research proposes a novel approach and design inspiration for the digital inheritance of abstract ICH.

Index Terms— Zen, Intangible cultural heritage (ICH), Multi-modal, Mixed reality (MR), Embodied experience

1 Introduction

As socio-cultural shifts accelerate, the preservation of cultural heritage (CH) is increasingly recognized as a matter of global significance. Inheriting and disseminating CH and traditional culture is essential for preserving cultural identity and historical memory, promoting sustainable development, and enriching human civilization [1]. Among them, Zen culture, as a special kind of ICH, holds an important role in the world, profoundly influencing individuals' lives and society. Zen, as a spiritual tradition, focuses on cultivating mindfulness and contemplation. It guides people to turn inward, heightening awareness of their present-moment experiences. Through meditation and Zen disciplines, individuals learn to release attachment to daily distractions and superficial concerns. This process fosters a profound sense of inner peace and harmony between body and mind. Such balance is vital and beneficial in our current era, dominated by relentless speed and significant pressure, offering a crucial counterbalance to modern stresses [2, 3].

However, the dissemination and inheritance of Zen encounter hurdles. Public comprehension and accessibility are often hindered by its abstract and complex concepts. As the public tends to receive culture passively, traditional cultural presentations—characterized as professional and serious—are hard to meet public needs, making traditional cultural knowledge seem dull, disconnected from daily life, and lacking interactivity [4]. Additionally, a shift has occurred in how people experience culture, moving from traditional media (books, TV, tours) to the new media era. This disconnection between Zen and new media has resulted in declining awareness and motivation within the younger generation to engage in practice.

The dilemma faced by Zen in inheritance is not an exceptional case. Instead, it represents a common challenge faced by ICH (such as traditional philosophies) in the current context. Therefore, a novel and attractive approach needs to be developed to address these dilemmas to promote public active participation in cultural experiences and to empower the dissemination of traditional cultures such as Zen.

Advances in digital reconstruction, 3D scanning, GenAI, VR/AR/MR, and natural interaction technology now allow digital preservation and access to TCH, such as landscapes, architecture, paintings, and heritage sites. Yet ICH remains less explored [6], especially highly abstract ICH like Zen. This gap motivates our focus on the following research questions.

RQ1: What essential design factors should be incorporated to foster audience engagement and intrinsic motivation with ICH (Zen)?

RQ2: How can design strategies and digital technologies be used to develop an immersive interactive system for experiencing Zen culture?

RQ3: How does the proposed interactive system affect audience immersion, interest, and overall experience compared to alternative approaches to experiencing Zen?

Our work explores an effective approach to address these questions. Specifically, this study originated from a poster exhibition [5] and new media artworks [7] we created between 2023 and 2024. Subsequently, it underwent multiple rounds of design concept updates, technological iterations, theorization, thorough user evaluations, and framework development, ultimately resulting in almost new research work. As an interdisciplinary applied research paper, it presents the following potential **Contributions**:

C1. We have integrated technologies such as motion capture, environment perception, and computational generative art, and proposed a Multi-modal MR System Flowing with Zen, which enhances the immersive experience and accessibility of Zen culture to the audience.

C2. The results of the comparative evaluation show that participants in the multi-modal mixed reality system have gained an ideal user experience, motivation, and learning effects. This empirical evidence suggests that our approach is effective and has competitive advantages.

C3. We have discussed the design strategy and shared a detailed implementation framework, which provides insights and design implications for HCI and ICH communities to develop applications.

2 Background and Related Work

In this section, we first introduce the contemporary value of Zen, then discuss the research and design strategies for CHs. Finally, we elaborate on the inspiration from the Literature and practical needs to revitalize ICH design.

† *Contribution equivalent to co-first author.*
* *Corresponding author: Hailiang Wang.*

- *Wenchen Guo is with The Hong Kong Polytechnic University, Peking University, and Communication University of China.*
  E-mail: winston.wenchen.guo@gmail.com
- *Zhirui Chen is with Renmin University of China.*
  E-mail: chenzhirui@ruc.edu.cn.
- *Guoyu Sun is with Communication University of China.*
  E-mail: gysun@cuc.edu.cn.
- *Hailiang Wang is with The Hong Kong Polytechnic University.*
  E-mail: hailiang.wang@polyu.edu.hk.

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2.1 Core Concepts and Contemporary Values of Zen

Zen is an important sect that emerged during the Sinicization of Buddhism. Its history can be traced back to the introduction of Buddhism from India and the fusion of Chinese indigenous culture, and it has gone through many stages of development. Zen concepts have profoundly impacted the values, philosophical, and aesthetic concepts of the world. Its core concepts include the following [8–11, 40, 42]:

- *Authenticity and Direct Experience*—Zen emphasizes the recognition of authenticity through direct experience, transcending conceptual and linguistic limitations, and directly observing and experiencing the present moment.
- *Emptiness and Non-Self*—Zen emphasizes that all phenomena are inherently empty, without eternal or independent entities. The goal of Zen practice is to transcend the self, abandon afflictions, and realize the state of non-self.
- *Meditation and Mindfulness*—Zen advocates meditation as the primary practice for awakening. Through meditation, practitioners cultivate the power of mindfulness, becoming aware of the changes in thoughts, sensations, and the body, and transcending personal biases and attachments.

In the fast-paced and information-overloaded society, the value and significance of Zen are particularly prominent. On one hand, the emphasis on direct experience and mindfulness in Zen can help people reduce stress, improve focus, enhance mental well-being, and cultivate inner calmness, satisfaction, and emotional quotient. On the other hand, Zen's advocacy of emptiness, non-self, and meditation can help individuals transcend the pursuit of materialism and utilitarianism, go beyond narrow self-views, and promote personal growth and self-realization [2,12,13, 40, 43].

2.2 Review & Discussion of the Digital Applications for ICHs

Benefiting from the development of CG and HCI (e.g. 3D scanning, reconstruction, image processing, rendering, etc.), many TCHs (e.g., paintings [14, 15], architectures [6, 16], cultural relics [4, 37, 48], etc.), have been digitally incorporated into applications such as VR scenarios, mobile AR, online exhibitions and interactive installations. These digitization efforts have added to the vibrancy of many CHs.

In addition, some studies have explored the digitization of ICH. Tan et al. developed a mobile Web-based AR application to motivate people to experience and learn more comprehensively about the craftsmanship, history, and culture of porcelain production [17]. Liu et al. proposed an interactive VR system that integrates three approaches (avatars, participatory performance, and game-based knowledge acquisition) that allows audiences to experience the connotations of the traditional oral performance *Hua'er*, which significantly improves the UX and knowledge level [18].

However, little research has been done on the digital presentation, interpretation, and experience design of ICH, especially traditional cultural ideology and philosophical concepts [7]. Yu et al. developed an information service APP to preserve and protect the folklore and culture of the *Kitchen God* [19]. Tian et al. developed a *PoeticAR* application based on mobile AR to revitalize traditional poetry and enhance the aesthetic experience for visitors [20]. Using the tradition of the African cautionary tale *Tokoloshe* as an example, Skovfoged et al. developed a VR-based gaming system to preserve the region's ICH [21]. Park et al. developed an MR experiential system based on a headset device, which has been shown through research to enable an increasing number of Māori immigrants to access and experience their language, genealogy, family, and history [22].

These applications are valuable explorations in the digitization of ICH. However, these applications also have the following limitations. First, additional hardware devices intervene in the body and interaction process, which can potentially harm the UX; it can also cause safety issues (motion sickness) [6, 23–25]. Second, the full application of virtualization can lead to an imbalance between cultural authenticity and physical experience and distract the audience [57]. Third, these applications set high expectations for users' digital literacy [24–26] – skilled experience with VR or AR. This is undoubtedly a challenging threshold for the public. It is not difficult to imagine that the range and accessibility of such applications will be limited in ordinary settings.

Based on the above discussion, we chose *Immersive Mixed Reality Based on Physical Space* as the realization solution. On the one hand, it supports the experience of interacting with virtual elements and the real world simultaneously, thereby obtaining a richer, integrated experience and a more realistic perception [26, 27, 57]. On the other hand, in the immersive space, various sensors (e.g., laser radar, infrared/body cameras) exist in a non-intrusive manner, so that the user does not need to rely on additional hardware devices for assistance. The advantage of this approach is that, by ensuring accurate environmental perception, it minimizes the interference and damage to the UX caused by learning costs and physical burden [23, 28], which aligns more closely with the concept of natural interaction.

2.3 Digital Cultural Heritage User Experience

Cultural User Experience (CUX) has gained momentum in GLAM (Galleries, Libraries, Archives, Museums) and CH research [29]. In particular, the continued emergence of digital technologies has added an important dimension. Within this context, discussing UX design strategies for digital cultural heritage is essential.

To answer *RQ*1 and *RQ*2, we reviewed related research from the last 3 years in *IEEE VR/ISMAR*, *JOCCH*, *SIGCHI*, and other top venues at the intersection of digital technology and cultural heritage regarding the review guidelines [30] and methods of Xv et al [16]. The following is our summary of the design inspirations from these studies.

Co-design or Participatory Design can provide a more holistic view of culture by emphasizing the diverse perspectives of stakeholders. For example, Sartini et al. promote inclusiveness and cultural awareness through platforms that actively engage people in curating and interpreting cultural artefacts [31], and Park et al. develop interactive systems for cultural experiences through co-design, working closely with indigenous partners in an effort to recreate local customs [22].

Gamification Design is often used to enhance intrinsic motivation by setting goals, rules, and reward systems. Souropetsis et al. designed the application *CompAR*, which is based on inquiry-based scenarios and uses role-playing to date important artefacts by having groups of students take on the role of art historians to complete a series of tasks [32]. For the heritage site, Xv et al. used gamification mechanisms such as clues, searching, and collecting in their developed *HeritageSite AR* to entice visitors to explore their surroundings (temples vs. ancient pagodas) and complete tasks [16].

Interactive Storytelling based on player agency and virtual avatar. Interactive storytelling facilitates the integration of technology and cultural context to inspire users' resonance. For example. Wang et al. engage the audience in the production process and performance of the *Yunluo* (a musical instrument) and learn about its cultural significance through the historical storytelling [33]. Other CH applications use avatars to assist in storytelling [34, 35]. In this case, visitors engage in dialogue with the avatars as they learn about the CH, which not only promotes motivation to learn but also enhances their engagement. In addition, strategies such as physical space-based, map-based environment-driven [36], and user-created content [37] are often used.

Multi-sensory Design creates a unique experience for digitizing cultural heritage [48]. PerMagnus et al. have initiated the *Multi-Modal Hong Kong* project, which aims to create a soundscape and olfactory database of culturally significant sites to promote the design of future urban spaces and the identity of residents [38]. Taking the virtual restoration of *Dunhuang murals* as an example, Sun et al. developed a VR system that incorporates olfactory and haptic interfaces to provide users with a more immersive experience [39].

3 SURVEYS AND FORMATIVE STUDY

Based on the discussion (Sec. 2), we initially identified technical and design factors to support CH access, but not all of them were sensible and specific. In this section, to further respond to *RQ*1 & *RQ*2, we conducted two surveys, an online survey (Sec. 3.1) and workshops (Sec. 3.2), to gather the attitudes and needs of the public and stakeholders towards Zen culture and CH digitization. Based on the survey results and previous discussions, we refined the design principles to provide strategies for system design (Sec. 3.3).

3.1 Online Survey

We conducted a preliminary survey on Zen and Digitisation by distributing a questionnaire on social media and randomly collected responses from 231 people, with 223 (96.5%) valid responses.

Questionnaire Structure. After participants signed informed consent online, the questionnaire first investigated their demographic information (gender, age, and place of residence), followed by their knowledge of Zen (*Q*1), ways of accessing it (*Q*2), and individual needs (*Q*3-*Q*4), and their experiences (*Q*5) and perceptions (*Q*6) of the digital technology. Here are the detailed questions.

Q1. What is your level of knowledge/understanding of Zen culture?

Q2. In what ways do you learn about or practice Zen culture?

Q3. What is your level of interest in experiencing Zen culture? /

Q4. What do you hope to gain from experiencing Zen culture?

Q5. Have you ever experienced a project using VR/AR/MR technology?

Q6. What is your attitude towards reviving and disseminating cultural heritage (e.g., Zen culture) through technological means?

Participants. Of the 223 valid responses, 128 were female, 94 were male, and 1 did not wish to disclose. The age range was 15-77 years old, with a mean of 40.5 and a standard deviation of 15.6, and they came from 24 provinces in China.

Findings. 1) About 79.8% (n = 178) of the participants had some knowledge of Zen culture, and among those who had less knowledge, the younger group (<35 years old) accounted for a higher percentage of 46.7% (n = 21). 2) Participants learned about Zen mainly through artefacts exhibitions in offline museums, travel (visiting temples), and TV programs. 3) Almost all participants (n = 204) were interested in Zen and wanted to experience its philosophy and aesthetics, relax through practice, soothe the pain caused by illness or stress, and gain a more open-minded outlook on life. 4) Although immersive technologies are more mature, only 34% (n = 76) had experience using VR/AR/MR. 5) About 81% (n =181) of them had expectations for cultural heritage driven by digital technology.

Discussion. First, younger groups, although less informed, may be more open to new technologies, which could be an opportunity to develop interactive systems. Secondly, existing avenues of accessing Zen are almost traditional media, which may not engage the public enough. Digital experience systems can compensate for this, especially by utilizing these avenues (e.g., museums, malls) as "entry" and digital experiences as extensions. Third, the public's main needs are to experience Zen aesthetics, philosophy, and practice relaxation, which will involve how to translate abstract concepts into interactive experiences. Finally, most users have not used VR/AR/MR before, so the design needs to consider newbie-friendliness.

3.2 Workshop

Two workshops were organized to gain a deeper understanding of the expectations and needs of the potential audience. Participants included two Zen researchers, six potential audiences, two media art designers, and one technology development engineer.

Before the workshop, all participants were provided with a Zen culture starter pack (including a textual introduction to Zen and a video), which to help participants acquire basic background knowledge for in-depth discussions. In addition, we prepared Zen artworks (e.g., paintings, music) and examples of digitization cases (academic papers and museums/business cases) for their reference.

Each session lasted 2 hours and consisted of the following parts:

a) Icebreaker & Opening. The facilitator (the first author) first introduced the background, objectives, and participants of the workshop. The theme of the workshop was introduced by raising questions such as "*What is your initial impression of Zen?*" "*What do you think are the shortcomings of the current way of disseminating traditional culture?*". Then, we shared the challenges faced by Zen culture and data from the online survey in section 3.1 to raise awareness of the problem.

b) Focus on Core Issues. After the opening session, the facilitator directed the participants' attention to the following core questions:

- *How to meet the challenges of abstraction and obscurity in Zen culture?*
- *What Zen elements appeal to you most when designing interactive experiences (What do users expect to get out of it)?*
- *How to create a Zen atmosphere through digital technology?*
- *What kind of emotional connection or reflection would you (the public) like to get out of interactive experiences?*

c) Brainstorming. Participants came up with key phrases and brief solutions for each question from the perspectives of cultural connotations, their own cultural experiences, and technological feasibility.

d) Discussion. All members presented and integrated the proposed key phrases or brief solutions, and voted and ranked them according to the criteria of importance, feasibility, and innovation.

e) Consensus Refinement. The facilitator used the Double Diamond Model framework to guide the process, converged the discussion in stages, and summarized the key ideas. Finally, Zen researchers assessed in terms of religious ethics to avoid misuse or disrespect.

3.3 Design Considerations

Based on the in-depth discussions in the workshop, as well as previous formative research and literature review, we summarize a set of advanced design strategies for multimodal immersive systems to create effective connections between the Zen, the audience, the immersive experience, and the interactive environment.

DC1. *Focus on the analysis of symbols and imagery elements.* First, a multidimensional analysis of the symbol system and imagery elements of Zen culture is necessary to establish a correspondence between them and the core concepts of Zen. This correspondence will guide the direction of the subsequent design, thus reducing the degree of abstraction in Zen culture.

DC2. *Create an immersive experience through multisensory design.* In addition to highlighting the ethereal and tranquil atmosphere regarding vision and hearing, olfactory and tactile design should also be considered. For example, scent interactive devices could be designed, and natural fragrances can be used to create a serene and relaxing olfactory experience; in terms of haptics, materials with a unique sense of touch could be used to enhance the audience's perception of the real environment.

DC3. *Promote the integration of body and mind with Zen through embodied cognition and behavioral design.* The audience can be guided to wander in space through unique visual effects to feel Zen; they can also be encouraged to meditate and introspect by setting up comfortable meditation areas. Rituals that require the audience's physical participation can be designed to trigger specific interactive effects to enhance their sense of participation.

DC4. *Metaphorical Design* [49–51] is essential for conveying Zen philosophy and aesthetics. We can convey the concept of Zen through rich imagery and variations in themes of interaction scenarios. In addition, the metaphorical design can be personalized and interpreted by audiences according to their own experience and understanding.

4 SYSTEMS DESIGN AND DEVELOPMENT

This section describes the design and development process of the system *Flowing with Zen* (see Fig. 1). First, we perform a semiotic analysis of Zen culture and translate it into design strategies (Sec. 4.1), followed by the development of the interactive system (Sec. 4.2) and a description of the technical framework (Sec. 4.3).

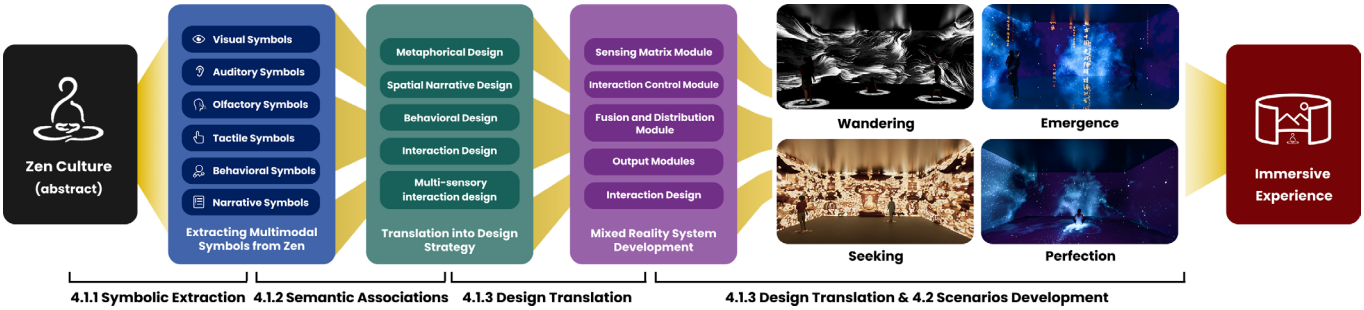

Fig. 1. Design and development process of the MR system.

Table 1. The mapping between symbol elements, semantic (Zen principles) associations, and design transformation (some examples).

Type →	Symbol Elements →	Semantics / Essentials/ Guidances in Zen →	Design Transformation to MR System
Sensory Symbols	Visual-Water Flow	It symbolizes life's ever-changing flux, teaching the heart to remain unattached and fluid, embracing the present moment like a gentle stream.	As the Scenario 1 Main Visual Effect - Algorithm-generated and adapting to audience number and walking speed, symbolizing the world's ever-changing nature and the free - flowing mind.
	Visual-Sutras	It visually symbolize the profound wisdom and teachings of Zen, serving as a guide on the path to awakening.	As the Scenario 2 Main Visual Effect - Sutra texts rain down; when touched on the wall, they dissolve into particles, illustrating how Zen wisdom resonates deeply within people.
	Visual-Lotus	Signifies the potential for pure awakening (bodhi) and compassion to blossom unstained from the mud of worldly suffering and delusion.	As the Scenario 3 Ground Interactive Projection - When the audience walks, the "step by step, a lotus flower grows" visual appears, reflecting Zen aesthetics and a pure mind.
	Visual-Seal of Wishes (Varada Mudra)	It signifies boundless compassion, awakening our innate power to give selflessly and embrace all beings.	As the Scenario 4 Main Visual Effect - When the audience has folded their hands and is in a calm mood, the Seal of Wishes will move to the ground in front of them.
	Visual - Cosmic Emptiness / Void	It represents the boundless, formless reality beyond concepts—the ultimate ground of being where all distinctions dissolves.	As the Scenario 4 Main Visual Effect - It embodies the Zen concepts of "nothingness" and "emptiness."
	Auditory-Water Flow	As the sound effect in Scenarios 1, 2 and 4, Water Flow is a metaphor for life's impermanence, inviting the audience to listen deeply and find stillness in its fleeting song, Chanting focuses the wandering mind, its rhythm leading to wordless presence where devotion meets inner peace, and Zen Bell's resonant tone punctuates meditation, calling practitioners to profound presence, marking transitions, and symbolizing the awakening mind's clarity.	
	Auditory-Chanting		
	Auditory-Zen Bell		
	Tactile-Zen Stone	As the physical decorations of the Scenarios, Zen Stone stands in flux, embodying a steadfast mind that rests unwavering in its natural stillness and Zen cushion anchors practice, a humble seat where patience blossoms in the simple act of being present.	
	Tactile-Zen Cushion		
	Olfactory-Sandalwood	It symbolizes how Zen teachings purify our mind and world, and represent the internal virtues of self-discipline, meditation, and wisdom	As the scent in Scenario 4, the fragrance of sandalwood reminds the audience to look within.
Practice / Ritual Symbols	Walking Meditation (Kinhin)	Cultivates mindful awareness in motion, teaching that meditation is not confined to stillness but is the continuous practice of presence with each step.	As the behavior/ritual dsign in Scenario 3 - When the audience walks, the "step by step, a lotus flower grows" visual appears, reflecting Zen aesthetics and a pure mind.
	Place palms together reverentially (Gassho)	This gesture of profound respect, gratitude, and unity – palms together signifies the harmony of self and other, practitioner and Zen.	As the behavior/ritual design in Scenario 4 - When the audience has folded their hands, the Seal of Wishes will move to the ground in front of them.
Narrative Symbols	Birth-death is nirvana	It reveals that enlightenment arises not by escaping life's cycles, but by fully embracing the raw, impermanent flow of existence—where every ending births a beginning, and breath holds timeless presence.	We've mapped this Zen principle to four-scenario transitions, metaphorically expressing the philosophical depth of life's cycle.

4.1 Multidimensional Analysis, Semantic Association, and Design Transformation of Zen Symbols

4.1.1 Symbolic Extraction

Transforming Zen culture into a digital interactive system faces the challenges of abstraction and obscurity. Based on the framework of semiotic analysis [40–43], phenomenological analysis [52–54], and the sensory experience design-oriented perspective [51,52,55], we extracted sensory symbols, behavioral symbols, and narrative symbols from Zen's complex cultural symbol system and analyzed them [42,44] to provide a source for design.

Sensory Symbols. They mainly include visual symbols (colors, Zen motifs (lotus, withered landscapes, calligraphy, emptiness, hand gestures, etc.), auditory symbols (sound of bells, running water, chanting, etc.), olfactory symbols (sandalwood fragrance, tea aroma), and tactile symbols (stone-coldness, Zen cushion-roughness).

Practice Symbols. Mainly include walking meditation, sitting meditation, holding hands with the characteristic behavioral rituals of Zen.

Narrative Symbols. This mainly includes Gatha (Zen poetry), discourses, etc. For example, the cosmology of the cycle of birth and death is both a starting point for philosophical reflection and a goal to be transcended in Zen cultural symbols.

4.1.2 Semantic Associations

As shown in Table 1 (second and third columns), after extracting the multidimensional symbols, we further looked for associations between these symbols and the core concepts, emotions, and interaction scenarios of Zen [8, 10, 41,42]. For example, the Zen seat in visual symbols represents firmness of heart and stability of meditation, and the lotus flower symbolizes purity; symbols such as bells and sandalwood incense are often associated with the philosophy of calmness in Zen; and behavioral symbols such as wandering and meditation are associated with reflection, perception, and wisdom.

4.1.3 Design Translation

As shown in Table 1 (third and final column), we translate the symbols and associated semantics into specific design strategies according to categories. For example, for visual symbols, we will incorporate typical imagery such as water flow, lotus flower, and Zen seat into the visual design of the scenarios, and present them with interactive effects, light and shadow variations, and physical decorations; for behavioral symbols such as walking and guesture, we will incorporate them into the embodiment design. For narrative symbols, e.g., the cosmology of the cycle of life and death, we will use metaphors through variations in scenario themes.

4.2 Scenarios Development

Based on our early artworks and feedback from the VRW/SIGGRAPH exhibition, we conducted multiple rounds of iterations [5, 7]. Finally, the system presents four themed scenarios: "*Ephemeral Stream*," "*Sutra Rain*," "*Seeking Blossoms*," and "*Nirvana's Embrace*" (see Fig. 2), following the sequence of time. Audiences will experience the immersive transition between these scenarios in the space, which also serves as a narrative for the journey of life and the trajectory of existence. The aim is to make the audience perceive the flow of time and contemplate philosophical questions related to the cycles of life (A metaphor for the concept of "*birth-death is nirvana*" in Zen through scenario change). Details of scenarios are described below.

4.2.1 Scenario 1: Ephemeral Stream

In the initial scenario (see Fig. 2a), we embodied the Zen philosophy of life's perpetual flow within a generative visual design framework.

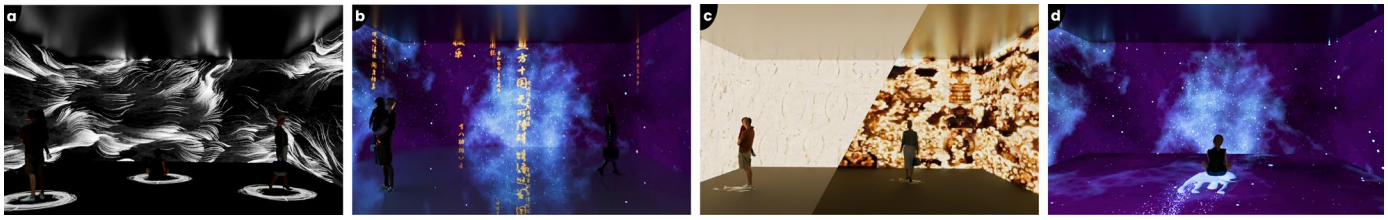

Fig. 2. Visual effects of four scenarios.

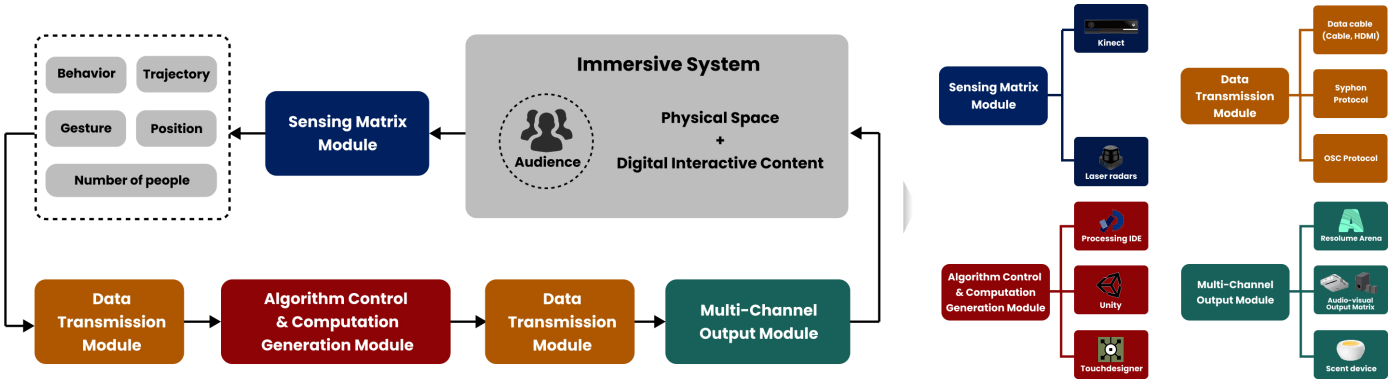

Fig. 3. Left: system architecture and operational processes; Right: technical modules.

The linear symbols serve as abstract representations of water flow. Within Zen philosophy, this flowing water imagery embodies the perpetual flux of existence, symbolizing both life's continuous transformation and the virtues of steadfast progression and unclouded mental clarity. Thus, "Ephemeral Stream" transcends mere linear patterns to evoke the trajectories of all living beings. These dynamic visual symbols surpass verbal expression, enabling audiences to contemplate the essence and states of worldly existence.

Interaction Mechanism. The water flow's visual effects are generated through algorithmic means, where randomized algorithms (Perlin noise principles) govern trajectory generation. As audience movement or occupancy shifts, the system dynamically modulates: 1) Quantity of trajectory lines; 2) Generation velocity; 3) Amplitude of random variation. In addition, the ground projection interactive effects will be triggered and change based on how long the audience stands there. The longer the audience stands there contemplating, the more complex the visual effects will be.

4.2.2 Scenario 2: Sutra Rain

In this scenario (see Fig. 2b), based on the suggestions from the discussions of previous workshop participants, we extract, transform, and process profound and inspiring Zen poems into perceptible visual scenes, presented in the form of a continuous rain of words.

Interaction Mechanism. When participants engage tactilely with wall-projected scriptures during reading, the texts undergo gradual chromatic dissolution. This spatial design immerses users within a dynamic lexicon of rainfall, establishing visceral connections with ancient wisdom traditions while demystifying linguistically obscure passages through embodied interaction.

4.2.3 Scenario 3: Seeking Blossoms

As the core scenario among the four (see Fig. 2c), it features digitally reconstructed elements from *Dunhuang Mogao Caves*' precious relics: the stone wall replicates the *Wall of Buddhas*, while the mural reinterprets the *Pure Land Picture*. Interactive lotus projections on the ground embody Zen's worldview - symbolizing purity and tranquility maintained amidst life's tribulations through natural imagery.

Interaction Mechanism. 1) Wall Revelation: When audiences touch the *Wall of Buddhas* (realized by radar monitoring), a crushing simulation algorithm (RayFireRigid component) triggers virtual erosion, causing the surface to peel away and gradually reveal the *Mural Pure Land*. 2) Embodied Lotus: Through embodied behavior design, footsteps generate lotus blossoms in real-time, creating the aesthetic phenomenon of "*step-by-step lotus growth*" that responds dynamically to user movement.

4.2.4 Scenario 4: Nirvana's Embrace

The "Nirvana's Embrace" scenario (see Fig. 2d) guides the audiences' vision back to the universal expanse. Within this immersive environment, Zen bell acoustics accompany sandalwood scent and slow-moving particles to enhance tranquillity. Audiences may freely wander or meditate, culminating in an experience of "emptiness." When the scenario ends, three bells ring, echoing the theme of the scene and symbolizing the end of the interactive process.

Interaction Mechanism. When motion capture technology and joint tracking algorithms detect folded hands (dynamic time warping), indicating a calm state, the *Seal of Wishes* translates to the ground before the audience, symbolizing the fulfillment and realization of aspirations.

4.3 Technical Framework & Workflow

Figure 3 shows the technical framework and workflow of the system. It mainly consists of the following modules and high-performance graphics workstations.

- *Sensing Matrix Module (SMM).* It consists of a motion camera (Azure Kinect) and radars (Hokuyo) to realize environment sensing. Kinect is used to recognize the audience's unique gesture of folding their hands in Scenario 4. The radar matrix establishes multiple detection areas (ground and wall) to detect the position, number, movement trajectory, speed, and other variables of the audience in the space, and then realizes the projection interaction on the wall/ground (Supports concurrent identification of up to 8 users, and positioning accuracy at 2cm).
- *Control & Computation Generation Module (CCGM).* It consists of computational art platforms (Processing IDE / TD) and a rendering engine (Unity) to realize the interaction judgment, filtering, and transmission of Sensers' data, and complete the corresponding effect feedback function.
- *Multi-channel Output Modules (MOM).* Firstly, based on the multi-channel audio-visual fusion technology, stereoscopic display technology, and physical correction (geometry and color correction, edge blending) system, a projection system is

established to match the physical environment. Then, multiple high-lumen, high-resolution projectors are utilized to project images onto the walls of the space, forming a visually immersive environment; and then, through the sound and olfactory devices (concentration control of about 1%), the audience is provided with a richer sensory experience.

- *Data Transmission Module (DTM)*. We use the OSC and Syphon protocol to exchange and synthesis real-time image data between different applications; moreover, we use the TUIO (Tangible User Interface Object) protocol for radars' data to control modules, especially for multi-touch and pose tracking.

Workflow. After the audience enters the interactive area, *SSM* identifies, and acquires the number, position, and action data of the audience(s) and transmits it to *CCGM*. *CCGM* generates interactive effects according to pre-defined algorithms (effects such as "*lotus flower in every step*", etc.), then transmits the multi-modal content through the Syphon / Spout protocol to *MOM*. *MOM* fuses, divides, corrects, and distributes the scenes according to the size and shape of the actual exhibition space, and transmits them to the audio, visual, and scent output matrices. These matrices output digital content and scent in the exhibition space (U-shaped folding space).

5 EVALUATION

In this section, we conduct a between-group controlled experiment in response to *RQ*3, which is to evaluate how the system affects audience immersion, interest, and experience. Subsequently, we reported experimental design details such as participants (Sec. 5.2), process (Sec. 5.3). Finally, we analyzed and discussed the data (Sec. 5.4).

5.1 Evaluation Methods and Indicators

5.1.1 Evaluation of Digital Cultural Heritage Applications

As various cultural heritage digital applications continue to be developed, researchers have become increasingly concerned about the public's experience and learning outcomes during the interaction.

A review of the literature related to the computer and cultural heritage community [4, 6, 16, 22, 31-39, 45-48, 60] reveals the following: the sample size of participants is generally 10 to 70. In terms of evaluation indicators for user experiences, they mainly include usability, personalization, interest, learning performance (short to medium-term), motivation, and learning effectiveness. In terms of evaluation tools and forms, questionnaires, and interviews based on participants' subjective reports are the most common methods, and the number of questionnaires is about 7~30 questions. In terms of validity and reliability, the results in the literature show a high level.

5.1.2 Evaluation Dimensions & Indicators

Based on the literature review (Sec. 5.1.1) and *RQ*3, we used the mixed-method approach (combining UX questionnaires, knowledge tests, and semi-structured interviews) as methodology.

First, we identified four evaluation dimensions – *UX (Satisfaction, Quality of Interaction, Personalization)*, and *Learning Performance*.

- *User Experience Scale.* We developed 14 more detailed questions/statements for the three indicators of UX, each of which is accompanied by a 5-point Likert scale (Please see Fig. 5 for details). The higher the score given by the participants, the more desirable the situation is on the corresponding indicator. UX Scale aims to collect their feelings about the multidimensionality of the interaction space, narratives, and sensory experiences.
- *Zen Culture Knowledge Post-test.* The questionnaire consists of a total of 10 questions and is designed strictly based on the information provided during the interaction process and the content that appears in the audio and video to ensure the relevance and fairness of the test content. The questionnaire consists of multiple-choice, judgmental, and short-answer/fill-in-the-blank questions. The test paper was scored out of 10 points. The higher the score, the better the learning performance.

After participants had completed the questionnaire, we also conducted semi-structured interviews with participants, with questions centred on the evaluation dimensions and specific indicators to explore the reasons behind participants' subjective ratings. For example, "*What was most and least satisfying about this experience?*" "*Did the experience give you a sense of immersion? Why?*"

5.2 Participants

The procedures and protocols of this study adhered to ethical requirements and were approved by the School of Animation and Digital Arts at Communication University of China (approval date: 20240105). 45 participants were recruited in our study by invitation and by posting information using social media platforms. In addition, 6 audiences showed interest in our experiment when visiting the offline exhibition and volunteered to participate. All participants voluntarily signed a consent form. Ultimately, we collected data from 51 participants (*Female* = 27, *Male* = 24, *Aged* = 15 to 73 years old, $M = 31.05$, $SD = 14.84$). The sample size and distribution met the standards for relevant studies in the HCI and VR communities.

We first collected their demographic information (including age, gender, occupation, prior experience using VR/AR/MR, etc.), and then we conducted a pre-test to evaluate their prior knowledge about Zen. The results of the pre-test showed that most participants lacked sufficient knowledge about the exhibition content and related information, which provided a relatively fair starting point for this study. Finally, participants were randomly assigned to three groups:

- *Experimental Group* (MR system experience, $n = 15 + 6$, $M = 31.90$, $SD = 13.66$).
- *Control group A* (VR system experience, $n = 15$, $M = 29.87$, $SD = 15.24$).
- *Control group B* (Mobile phone-based Web pages, $n = 15$, $M = 32.20$, $SD = 15.45$).

During the grouping process, we employed a stratified randomized method to balance the groups by gender, age, prior experience with VR/AR/MR, and prior knowledge of Zen, thereby controlling for the potential impact of these factors on the results.

5.3 Experimental Procedure and Tasks

The experiment was divided into three phases: preparation, formal experiment, and data collation. Figure 4 illustrates the flow.

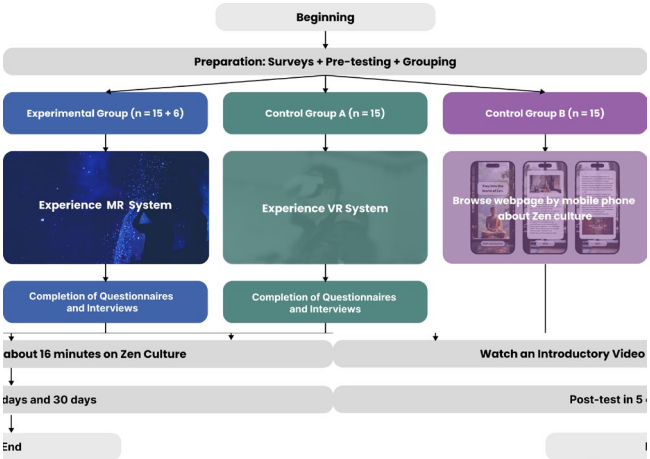

Fig. 4. Flow of the experiments.

Preparation. We grouped participants according to their demographic information and prior knowledge to balance the differences between the experimental and control groups.

Formal Experiment. We set up three experimental conditions to compare: 1) The MR experience system was set up in an offline art exhibition space (Approx. 8 $m \times 4.2\ m \times 3.5\ m$); 2) The VR experience was built in Pico Neo 3 and was set up in an empty room (Approx. 8 $m \times 4\ m \times 3m$); 3) Mobile phone based web pages (developed by

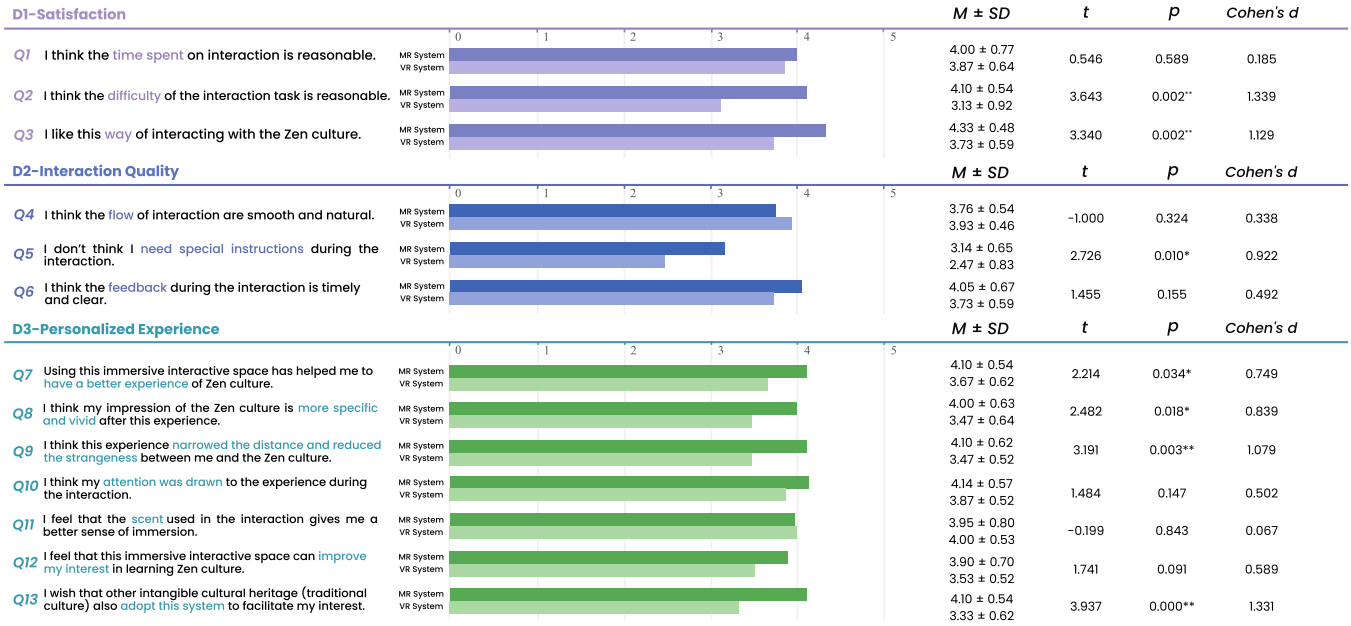

Fig. 5. Statistical Results of the UX Scale (* p<0.05 ** p<0.01).

HTML5/Javascript) showcasing Zen culture knowledge (text, images, and a video). This baseline assesses traditional screen, non-immersive ICH content access, reflecting the current museum digital communication mode (e.g., online exhibitions, mobile guides).

- *Participants (P_E) in the Experimental Group* received short instructions (a card with a short description) about the interaction method before the experiment. Afterward, they (single or multiple, but no more than three) entered the MR environment for the experience (the experience process lasted about 12 min). After the experience, they were asked to fill out a questionnaire and were interviewed briefly (about 10 min).
- *Participants (P_C) in Control Group A* received instructions on the VR interaction method before the experiment. Afterward, they entered the VR environment wearing a headset device and using handheld controllers for the experience (about 14 minutes). After the experience, they were asked to fill out a questionnaire and undergo a short interview (about 14 min).
- *Participants in Control Group B* used their mobile phones to browse the webpage about Zen culture online (about 6-8 minutes). Since the interactivity of the webpage was very weak compared to the MR and VR systems, considering fairness, the questionnaire and interviews were not conducted. Control group B was set up to investigate only the learning performance and knowledge retention of participants learning Zen culture based on traditional, low-interactive media.

In addition, all participants were asked to watch a video introducing Zen culture (16 min). After 5 days, and after 30 days, all participants were asked to answer a 10-question test (from the Zen culture video) within 10 min. The scores were used to evaluate the participants' learning performance in different groups.

End of Experiment. We expressed our gratitude to all participants and gave them a gift (a USB flash drive or a book) worth $ 10.

5.4 Results and Analysis

All participants completed every phase of the experiment, yielding a 100% response rate with complete data validity. Initial reliability analysis of questionnaire and test results demonstrated high internal consistency, with Cronbach's α coefficients exceeding 0.75 - surpassing the conventional threshold of 0.70. Subsequent statistical analysis employed descriptive statistics, independent samples t-tests, analysis of variance (ANOVA), and Cohen's d effect size calculations, with full results visualized in Figure 5. Finally, integrated findings from quantitative questionnaires and qualitative interviews are reported thematically according to predefined analytical dimensions.

5.4.1 Satisfaction

The results show that both systems were affirmed by the participants in terms of satisfaction with time spent, but the experimental group had significantly higher satisfaction with the interaction task (M = 4.10 > 3.13, t = 3.643, p < .01) and interaction form (M = 4.33 > 3.73, t = 3.340, p < .01) than the control group A. One of the main reasons is that the experimental group was based on a mixed reality space, which utilized natural behaviors that were familiar to users to reduce the difficulty of the interaction, while control group A used a VR device that was difficult for beginners to learn. In the interviews, some of the participants in control group A had difficulties because they "*couldn't remember how to operate the device*, (P_C3)" "*I felt a little strange when I used the Handheld Controller*, (P_C4, P_C13)" and "*it took time to get used to fully virtualized view*. (P_C3, P_C4)"

5.4.2 Quality of Interaction

The two systems scored similarly and were not significantly different in terms of interaction smoothness (Q4, p > .05), timeliness, and clarity (Q6, p > .05), with the experimental group scoring slightly lower than the control group A (M = 3.76 < 3.93). Some participants noted that "*switching between scenarios was not smooth enough and a bit abrupt*" (n = 6), "*the position of the ground tracking projection was not precise enough*" (P_E5, P_E17), and "*there was a delay in the interaction effect*" (P_E5, P_E17, P_E18).

For Q5, although significantly higher than the control group A (M = 3.14 > 2.47, t = 2.726, p < .05), the experimental group was also less than ideal. Even though we instructed both groups of participants before the experience (instruction cards and tutorials), some participants, especially middle-aged, older adults and those with no VR experience, felt that the interaction lacked cues during the experience. The takeaway is to add visual or auditory cues during the interaction.

5.4.3 Personalization

Next, we will analyze three indicators in the personalization dimension: imagination, immersion, and motivation.

Imagination ($Q7 \sim Q8$). Both groups received favorable ratings (M = 4.10/3.67). More than 70% (n > 26) of the participants believed that *Flowing with Zen* allowed them to experience better Zen culture, especially deepening their impression and understanding of the concepts of "*reincarnation*" and "*no-self*". Some had various interpretations of

the changing and flowing water effects in Scenario 1, "*as if they were crowds of people chasing fame and fortune*" (P_E 2), "*inside themselves*" (P_E 7), "*time passing by*" (P_C 5, P_C 7). Others mentioned that "*the transition of the four scenes seemed like a human lifetime"* (n = 11), "*a gradual process of enlightenment* (P_C 5)." Regarding the wishing seal in Scenario 4, some participants thought that "*it was as if the Buddha came to guide/comfort me* (n = 14)." This suggests that the system was effective in helping them develop a personalized understanding of cultural connotation, bridging the gap between the participants and ancient philosophy.

Immersion (Q9 ~ Q11). Both groups received high scores (>3.5), which is inextricably linked to our use of multisensory and behavioral design strategies. On the one hand, most participants (n = 27) felt that the scent (sandalwood) made them more engaged and said the scent "*soothed me*" (n = 7) and "*made me feel like I was in a temple*" (P_E 7, P_C 13, P_C 15). On the other hand, enhancement through embodied behavior may have facilitated their understanding of abstract concepts as well as aesthetic experiences. For example, the effect of "Step by Step" produced by walking allowed almost all participants (n = 30) to experience the aesthetics of Zen. In addition, in Scenario 3, participants were surprised by the appearance of the *Pure Land* after touching the wall (P_E 4, P_E 7-10, P_E 15). In the final Scenario, the participants triggered the scene effect by a special gesture, "folding their hands", where they sat in silence and meditated in the void, "*gradually forgetting themselves and their surroundings*".

The data also show that MR systems scored significantly higher than VR (M = 4.10 > 3.47, t = 3.191, p < .01), which may be due to the properties of physical space that MR systems rely on. For example, in the MR system, we used real stones as scene decorations that participants could touch. Still, in VR, they were replaced with digital 3D models that could also be manipulated by the handheld controller but lacked direct tactile perception. Some participants also mentioned that the models were realistic but still fake. In addition, we observed that in the MR system, almost all participants naturally sat down on the ground to meditate, but in VR, only 10 did, participants (P_C 4, P_C 13) said, "*I'm not too daring to sit down on this virtual floor*" and "*I don't know if I'll fall if I sit down*". These situations suggest that the participants' trust in the VR environment and objects influenced user behavior and immersion level [56].

Motivation (Q12~ Q13). Ratings indicated that both MR and VR systems were conducive to increasing their motivation (M = 4.10 > 3.33, t = 3.937, p < .001). Participants indicated that traditional culture was abstract and boring, whereas today's mode would motivate them to participate. Increased intrinsic motivation may also be related to the "mind-flow experience" (immersion), i.e., when they are fully engaged in the activity, feeling fun and fulfilled, they may experience a state of high concentration and enjoyment. MR systems were scored higher, probably due to their higher accessibility and lower learning costs. In addition, participants (P_C 1, P_C 5) in the VR group raised the need to "*share and discuss the experiences simultaneously*," which is a natural advantage for MR systems, but requires the development of multi-user environments for VR [56, 57].

5.4.4 Learning Performance

We evaluated participants' learning performance and knowledge retention in the short and medium term. We further used ANOVA to investigate the differences in test scores among the three groups (see Fig. 6 and Table 2).

Table 2. Results of the test scores (* p < .05 ** p < .01).

Test	Experimental Group	Control Group A	Control Group B	F	p
Pre-test (baseline)	3.48 ± 0.93	3.40 ± 0.99	3.47 ± 0.92	0.032	0.969
Post-test (after 5 days)	7.40 ± 0.97	7.07 ± 1.00	6.20 ± 1.03	6.541	0.003**
Post-test (after 30 days)	6.88 ± 1.05	6.43 ± 1.08	5.37 ± 1.06	9.056	0.000**

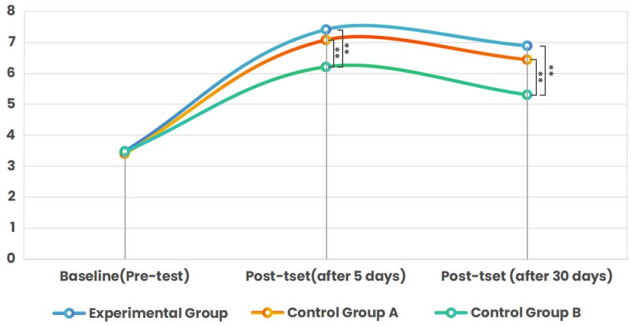

Fig. 6. Line graph of the learning test scores.

The data show that the different groups presented significant differences for the two Post-test scores, except for the Pre-test (Baseline) (not between the experimental group and control group A). This result suggests that both MR and VR systems can facilitate participants' learning and memory retention of cultural heritage knowledge and are suitable as scaffolds for cultural heritage education.

To control for confounding factors, participants were advised not to inquire about the answers to the test during the assessment. After the experiment, to our delight, two people in the experimental group said that they began to learn about Zen culture systematically; one in the control group A enrolled in the hybrid meditation training course.

6 Discussion, Limitations, and Future Work

ICH is a new term representing living cultural expressions, practices, representations, knowledge, and skills that are recognized by groups as distinctive aspects of identity [20, 39]. Currently, most of the digitization work focuses on tangible heritage, and some of the applications developed for ICH tend to the crafts and performances. However, there is still no mature and practical framework to support ICH in the face of traditional ideas and philosophies [6, 7].

In this study, we propose a novel design strategy for ICH through the literature, formative research, and integration of CG, AI, and HCI technologies to develop an immersive MR system. The evaluation revealed that the MR system has competitive advantages in fostering participants' engagement, aesthetic appreciation, and cultural understanding, as well as increasing the accessibility of Zen. Next, we will discuss the thoughts and insights that the research has brought us.

6.1 Advantages and Challenges of Immersive MR Space in Supporting Digital Experiences of ICH

First, immersive MR space seamlessly integrates virtual elements with tangible physical environments, offering a unique and personalized interactive experience [7, 22,23, 57] compared to the VR condition and mobile phone. This contextual advantage is not fully disentangled from the system design itself. Therefore, MR space fosters high immersion and imagination, and enhances learning motivation, effectively improving cultural knowledge retention. Notably, many younger participants documented their experiences via mobile photography and videography at the offline exhibition, sharing these recordings on social platforms. In a sense, this dissemination extends cultural reach beyond physical space, further stimulating the social aspect of the exhibition. Even individuals unable to physically attend the exhibition can establish a connection with CH through aesthetically compelling audiovisual fragments.

Second, unlike VR and mobile AR, MR aligns more naturally with established cognitive patterns, reinforcing embodied cognition while lowering barriers to engagement. By eliminating the need for specialized VR hardware or dedicated applications, MR space reduces the learning curve and cognitive load and promotes the democratization and inclusiveness of digital cultural experiences [59].

Third, as an emerging form of New Media Art, MR is gaining international traction. Its potential extends beyond experimental settings, reaching broader audiences and integrating with commercial ventures. For instance, China's 2024 Immersive Industry Report

highlights a dramatic rise in immersive projects—from one in 2013 to over 3,000 in 2024—spanning theater, film, exhibitions, and urban spaces, underscoring its reliance on new media art frameworks [61].

Despite these strengths, key challenges persist. First, balancing personalization with mass appeal remains difficult in public immersive spaces. For example, participants reported different preferences for interaction duration and scent. Multi-user environments also risk disruptions from concurrent participants. Second, narratives within immersive spaces are constrained by time, space, and fluctuating user numbers, often resulting in linear or unstructured digital storytelling. Third, immersive MR demands significant spatial resources. While spatial awareness is central to immersion, smaller venues face constraints due to limited space, which can compromise UX quality.

6.2 Design Recommendations to Support the Digitization of Abstract ICH

Since ICH represents the collective practices and civilizational evolution of communities, developing a universally applicable design framework remains a complex yet critical endeavor. While challenges persist, our study yields transferable insights for ICH digitization.

DR1. Effective digitalization of CH requires formative surveys and co-design to identify challenges in inheritance. Large-scale surveys can quantify the public's pain points and preferences, helping research teams decide on the means and technologies for deconstructing and digitising cultural heritage. Co-design workshops with Zen researchers, practitioners, and audiences establish diverse perspectives when devising strategies, preventing designer-centric bias. Stakeholder collaboration can also translate abstract concepts into design inspiration, linking academic depth with public accessibility.

DR2. Constructing symbol systems based on semiotic analysis. Effective abstract ICH digitization requires the multimodal symbol extraction, semiotic/phenomenological analysis, and design transformations that establish meaningful connections between artistic expression, technology, experiential design, and cultural context. Simplistic or didactic approaches to cultural transmission—such as rote-based knowledge transfer or passive dissemination—fail to achieve meaningful engagement. Instead, audiences' personalized interpretations of traditional symbols, their participatory interactions, and real-time feedback should be actively integrated into the artwork's design. This positions New Media Art as a dynamic, co-creative process where audience agency enriches cultural narratives.

DR3. Enhancing abstract cultural contexts via embodied behavioral design. Leveraging embodied cognition enhances immersion and emotional resonance. For instance, integrating culturally rooted physical rituals—such as Zen Buddhist practices like walking meditation, seated contemplation, or prayer gestures—into interactive workflows reduces participants' self-consciousness while heightening focus. This embodied approach bridges physical actions with virtual narratives, deepening users' connection to cultural symbolism.

DR4. Embed multi-sensory experience scaffolding. Beyond visual and auditory stimuli, immersive spaces should actively engage underutilized senses. In our study, the automated dispersion of sandalwood scent during meditation sequences promoted tranquility, demonstrating how olfactory cues can amplify thematic coherence and emotional impact. In addition, some decorations in the space provide a tactile experience, like stones and rough Zen cushions.

DR5. Design experience for deployment in real-world heritage or museum environments. First, the deployment of the system should be coordinated with existing heritage space. The U-shaped folding space aligns with typical museum gallery/atelier dimensions. Projection-based output (using Ultra-short throw high lumen projectors) allows flexible adaptation to irregular surfaces, avoiding architectural modifications. Secondly, consideration should be given to reducing interference with the system. The sensing matrix (Azure Kinect/Radar) operates unobtrusively from ceilings/corners, minimizing interference with physical artifacts or visitor flow. This addresses museum concerns about hardware disruptions. Thirdly, modular design can be used to improve technical flexibility. It allows museums to curate subsets for small spaces. In addition, we recommend using a single screen/wall projection to mitigate space constraints.

Additionally, the technical accessibility of ICH applications remains a challenge. Although audiences generally do not need to wear special hardware devices when experiencing MR systems based on physical spaces, intuitive and clear interaction guidance is still extremely important. For example, visual cues (such as light guidance) and audio cues can be used to enhance the clarity of interaction logic, reduce cognitive load, and enable audiences to focus on the cultural content rather than being constrained by technical issues.

6.3 Limitations and Mitigation Strategies

Our work has limitations in the following aspects. 1) The analysis of Zen cultural symbols emphasizes sensory design alongside semiotic and phenomenological frameworks, which may hinder deeper interpretation. 2) While the number of participants in our study meets HCI sample size guidelines, there may still be sample bias. Additionally, to avoid imposing excessive restrictions on participants, we did not use methods like eye tracking or heart rate detection. To mitigate these issues, we've fully utilized existing datasets and prioritized methodological triangulation. This involves integrating diverse evidence sources, such as UX questionnaires, interview transcripts, demographic data, and experimenters' observational records, for comprehensive reporting and analysis. 3) The lack of user experience data from control group B slightly weakens the relative advantage of the study. 4) The internationalization and cross-cultural applicability of the design strategy need to be further explored.

6.4 Future Work

In the future, we will deepen our research in the following aspects.

1) We will explore ways to improve adaptability in cross-cultural contexts. The current system is designed for a predominantly Asian demographic. To enhance its applicability in international and cross-cultural contexts, we plan to: a) conduct surveys and co-design initiatives to understand the local community's comprehension and preferences regarding Zen culture, and involve local experts and the public in the design process to gain their unique insights and preferences; b) conduct a further semiotic analysis is carried out to find the parts that resonate with the local audience in Zen culture, to establish a cultural symbol system adapted to them and improve the acceptance of the cultural narrative; c) conduct trial runs or exhibitions to gather genuine experiences and feedback from the community, and refine the system; d) optimize the system's modular design for easy replacement of symbolic elements and cultural themes.

2) We will continue to enhance the embodied and personalized experience of the system. We plan to: a) Introduce new forms of interaction and data types, such as using electrodermal activity (EDA), electroencephalography (EEG), or heart rate sensors, to enhance the meditation experience. b) Inspired by participant suggestions, we plan to develop a Digital Buddhist/Zen Dialogue System based on large language models (LLMs) to enhance adaptive narrative and personalized interaction. c) Optimize system guidance design, such as through more user-friendly indicators like lighting and sound prompts, to improve accessibility for children and older adults.

7 Conclusions

In this paper, our core work is to explore an effective approach to digitising ICH. Taking Zen culture as an example and based on a review of its core concepts and related work, we initiated online surveys and workshops, before designing and developing an immersive MR system. Subsequently, we conducted a pilot study, which demonstrated that our proposed approach had a significant positive effect on the UX and learning process compared to other forms. By converging MR immersion, ICH, and UX optimization, this approach facilitates Zen accessibility while pioneering scalable transmission mechanisms for diverse cultural heritage ecosystems.

Acknowledgments

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