Reconstructing The Campfire in The Digital Age: An Empirical Study of Collective Interactive Fields in Public Interactive Installations

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Abstract. In contemporary public spaces saturated by digital technologies, individuals' dependence on smart devices has continued to intensify, drawing them ever deeper into fragmented modes of information consumption. As a result, the frequency of face-to-face offline communication has declined markedly, while genuine emotional connections have gradually weakened. This phenomenon of "co-presence without co-experience", in which physical proximity coexists with emotional distance, not only erodes the social interaction functions traditionally embedded in public space, but also accelerates the dilution of collective consciousness in digital contexts. It has thus become an urgent issue within current public space research. In response to this condition, the present study focuses on the need to reconstruct interpersonal interaction in public spaces and proposes an interactive design strategy based on the metaphor of the "digital campfire". The paper details the design and implementation of the interactive installation *Revelation*. Drawing on Émile Durkheim's sociological theory of collective effervescence and the framework of embodied cognition, the study constructs an open interactive field that integrates ethnic symbols, totemic imagery, and future-oriented aesthetics. The findings indicate that by introducing multi-user collaborative activation thresholds and multisensory immersive feedback, interactive installations can effectively disrupt digital isolation and guide participants from passive observation toward active cooperation. Through ritualised interaction, participants are encouraged to rebuild a sense of collective belonging. Beyond a detailed analysis of the installation's hardware architecture, software logic, and symbolic system, this paper further explores the potential for reconfiguring interpersonal relationships through technological intervention from a posthumanist perspective, offering a practice-oriented pathway for addressing the dilemmas of public interaction in the digital age

Keywords: interactive design; public space; collective effervescence; digital campfire; posthumanism.

1. Introduction

In the present era, digital technology is no longer merely a tool but has become a fundamental environment shaping human existence. With the widespread adoption of mobile internet, the Internet of Things, and augmented reality technologies, smart devices have emerged as the primary interfaces through which individuals connect with the world. However, this pervasive connectivity has also produced a profound social paradox: while individuals achieve unprecedented levels of hyperconnection in virtual networks, they increasingly experience an island-like atomisation in physical reality.

In contemporary urban public spaces, whether in subway carriages, cafés, or city parks, the collective presence of people absorbed in their screens has become a familiar sight. Although individuals share the same physical coordinates, their attention is entirely captured by the glowing devices in their hands. Psychologist Kenneth Gergen conceptualises this condition as "absent presence" [1], in which the body is physically present while consciousness drifts elsewhere (Gergen, 2002). Sherry Turkle further argues in *Alone Together* that although people turn to technology in search of intimacy, they often sacrifice the complex, uncertain, yet vital emotional connections afforded by face-to-face interaction (Turkle, 2011) [2].

This condition of "co-presence without co-experience" has gradually stripped public spaces of the qualities that Ray Oldenburg defines as those of the "third place", namely informal public venues

beyond home and work where people regularly gather, relax, and interact (Oldenburg, 1999). As a result, public spaces increasingly retain only their functions as transit nodes or sites of physical congregation, while their roles in fostering collective cohesion and emotional exchange continue to erode. [3] Traditionally, public spaces served as central sites for information exchange, emotional expression, and the formation of collective consciousness. Under digital conditions, however, the coexistence of physical proximity and emotional distance places the continuity of collective memory at risk.

Against this backdrop, the present study seeks to explore how interactive installation design can be used to reconstruct deep social interaction within public spaces. By constructing an open interactive field that integrates ethnic symbols, totemic imagery, and future aesthetics, the study aims to evoke a primal and immersive group experience analogous to that of a campfire gathering. Through this approach, it seeks to awaken deep emotional resonance among participants, re-establish a sense of collective belonging in public space, and provide a practical pathway for addressing the challenges of public interaction in the digital age.

2. Literature Review

Interactive installation art fundamentally transforms the role of the audience. Viewers are no longer passive observers but active participants, and the work itself can only be "completed" or fully manifested through audience input. Without participation, the work remains incomplete (Paul, 2003). [4] Roy Ascott's concept of "cybernetic art" further emphasises that art should not be understood as a static object, but as an interactive system. In this view, the core of interactive art lies in participatory action and the co-construction of meaning (Ascott, 2003).

[5] Guided by this theoretical lineage, contemporary interactive installation practices have evolved alongside digital technologies. Rather than focusing solely on macro-level system construction, recent studies have increasingly refined and deepened specific technical and experiential pathways. Existing research on interactive installations generally concentrates on three core dimensions. The first is perceptual augmentation, which extends human sensory boundaries through augmented or virtual reality technologies. The second is data visualisation, which renders invisible urban or biological data into visible forms. The third is gamified experience, which employs entertainment mechanisms to attract and retain user engagement.

In recent years, interactive installations have undergone a shift from visual display toward digital placemaking. Fredericks et al. (2023) [6] argue that installations should be embedded in physical space as forms of social infrastructure, with the aim of repairing fragmented community connections. Empirical studies by Parker et al. (2020) [7] further demonstrate that only designs that respond to shared emotions and collective memory can move beyond short-lived novelty and foster sustained social connections among strangers.

At the level of interaction mechanisms and experiential depth, Colley and Häkkilä's (2021) [8] systematic review identifies multi-user collaboration as a key factor in breaking down social barriers. However, many existing designs remain at the level of parallel gameplay and lack mechanisms that require high degrees of synchronised cooperation. Mekler and Hornbæk's (2019) [9] framework of meaningful experience in human–computer interaction emphasises that installations should move beyond momentary sensory pleasure and instead cultivate deeper layers of meaning and narrative engagement. To create space for such meaning-making, Odom et al. (2018) [10] advocate for "slow technology", which encourages users to disengage from efficiency-oriented interaction rhythms and enter reflective states. From a posthuman design perspective, Wakkary (2021) [11] further suggests that installations should not be treated as passive tools but as non-human agents entangled with human actors.

Taken together, although existing scholarship has made important contributions to understanding the social value of interactive installations and the reflective potential of slow design, there remains

a notable gap in research addressing the integration of slow-paced reflection with ritualised multi-user collaboration.

Building on this gap, the present study adopts Émile Durkheim's concept of "collective effervescence", introduced in *The Elementary Forms of Religious Life*, as its core theoretical foundation. Durkheim argues that society is not merely the sum of individuals, but a reality in its own right. In totemic worship and religious rituals of early societies, collective action, shared sounds, and shared attention generate intense emotional energy that transcends individual experience, enabling participants to perceive themselves as part of a greater whole and to develop a sense of the sacred and of belonging (Durkheim, 1995).

[12] The campfire rituals of early human societies represent a prototypical form of collective consciousness formation. Beyond providing warmth and safety, the campfire functioned as a symbolic centre for knowledge transmission and group cohesion. Its flickering light, radiating heat, and centripetal spatial structure naturally facilitated face-to-face communication and storytelling. In modern urban civilisation, electric lighting and electronic screens have largely replaced the social functions of open flame, yet the human desire for collective emotional connection around a shared centre remains deeply ingrained.

Accordingly, this study proposes the concept of "reconstructing the campfire in the digital age". By replacing real flames with light sources that simulate breathing rhythms, the installation transforms the campfire into a digital ember suited to contemporary contexts. Through this technological reconfiguration, the study seeks to recreate the warmth of pre-technological communal gatherings and to rebuild a human refuge within the digital wilderness.

2.1. Spatial Characteristics of the Site and Atmosphere Construction

The project was situated in an indoor exhibition hall located in the Beidaihe Art Town in Qinhuangdao. This area is widely recognised for its distinctive cultural and artistic ecology and attracts a large number of urban middle-class visitors and art enthusiasts seeking spiritual retreat. Through on-site observation and field investigation, the study identified two core spatial characteristics that directly shaped both the formal configuration of the installation and its interactive logic.

The first characteristic is the elongated, linear narrative space. The exhibition hall adopts a corridor-like layout, a spatial structure that inherently supports narrative progression. Unlike open plazas, this elongated configuration restricts visual dispersion and compels visitors to move forward along a predetermined path. The process of movement resembles a transition from the everyday world into a sacred cave or tunnel. From a psychological perspective, this gradual enclosure and diminishing light facilitate a detachment from external distractions, guiding visitors into a preparatory, ritual-oriented mental state.

The second characteristic is the site's favourable acoustic isolation and resonance performance. The space effectively blocks external noise, creating an acoustically insulated environment. At the same time, the elongated hard-wall structure produces distinctive reverberation and echo effects. Under such conditions, the sound design of the installation does not require high output power to fill the space, while subtle sonic variations can be clearly perceived and amplified. This acoustic quality significantly enhances sensory immersion, enabling visitors' attention to be fully focused on the dynamic interplay of light and sound within the installation.

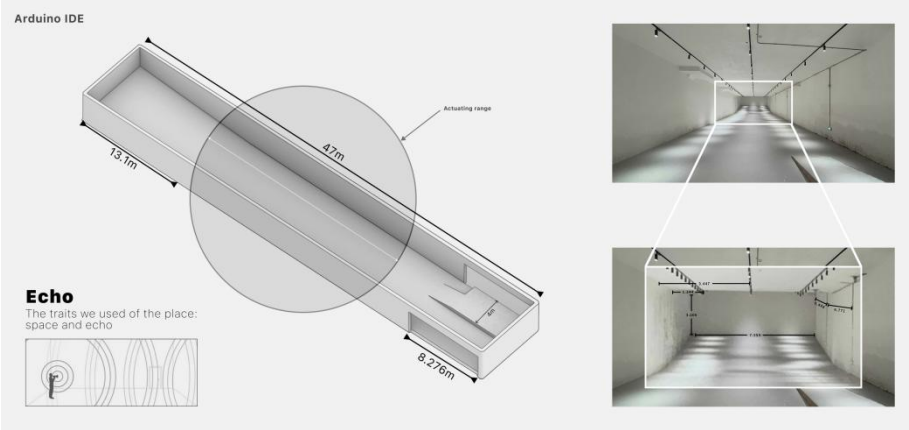

Figure 1. Spatial analysis of the exhibition hall

2.2. User Research and Design Challenges

Based on 35 valid questionnaire responses concerning interpersonal interaction and smart device use in gathering scenarios, this study conducted an in-depth analysis of the core challenges of public interaction in the digital age, as well as users' latent social needs. The findings provide empirical support for subsequent design decisions and strengthen the logical grounding of the installation's design rationale.

The survey results indicate that smart devices have become a major barrier to deep offline interaction. However, this barrier does not arise solely from users' active preference, but rather from a form of compelled behavioural dependence. On the one hand, fear of missing out drives passive attention. A total of 51.43 percent of respondents reported that their primary reason for using mobile phones in social gatherings was anxiety about missing important information. This suggests that users are not unwilling to interact, but are instead constrained by the pressure of external information flows. On the other hand, there is a pronounced disjunction between behaviour and cognition. Although 71.43 percent of users reported only occasional device checking, as many as 85.71 percent clearly recognised that such fragmented usage reduces real interaction with people physically present.

This vicious cycle, in which anxiety leads to device reliance and device reliance undermines present-moment interaction, constitutes the central design challenge addressed in this study. Users find themselves physically co-present yet socially isolated, and external intervention is required to break this impasse.

Beneath these challenges lies a strong yet unmet demand for social interaction. First, users express a clear desire for device-free interaction. In the survey, 82.86 percent of respondents indicated that they either desired or strongly desired opportunities to engage in communication without device interference during gatherings. Second, a sense of frustration emerges due to the absence of initiating cues. When others remain focused on their screens, 62.86 percent of users reported feelings of hope that someone would initiate interaction, or feelings of loneliness and loss. Third, interaction thresholds constitute a critical obstacle. Sixty percent of respondents cited a lack of shared topics of interest as the primary reason for not putting down their devices, while 57.14 percent attributed this reluctance to the absence of someone willing to initiate interaction or a suitable trigger.

Taken together, these findings suggest that users are not resistant to social engagement, but lack a low-threshold, natural ice-breaking mechanism. Consequently, the installation cannot function merely as a visual display. It must operate as a social catalyst that provides shared topics and collaborative tasks, transforming passive waiting into active participation.

On the basis of the identified challenges and user needs, this study established key interactive strategies for the installation, each directly supported by survey data. First, a task-driven interaction mechanism was adopted. Since 60 percent of respondents expressed a preference for initiating interaction through small, low-pressure tasks, the installation incorporates a collaborative foot-pedal triggering system. Through simple bodily cooperation, social pressure is reduced and collective

gathering is naturally encouraged. Second, minimal operation and flexible duration were prioritised. A total of 42.86 percent of users preferred interactions requiring only simple guidance, while 51.43 percent hoped for flexible interaction durations. These findings support the use of intuitive pressure sensing and light-based feedback, allowing users to participate through bodily intuition. The experience can be brief or extended, without imposing psychological burden. Third, a totemic narrative was employed to foster emotional resonance. In terms of conveying core values, 54.29 percent of respondents favoured concise text-and-image explanations. Accordingly, the installation projects totemic symbols representing the evolution of civilisation, using direct visual language to establish shared topics and respond to users' desire for deeper emotional connection.

3. Research Findings

Through on-site observation and field investigation, the study found that the exhibition space possessed excellent acoustic insulation and reverberation properties, creating strong potential for enhancing visitors' sensory experience. As the internal sound and lighting systems were not affected by external disturbances, visitors' attention could be fully concentrated on the dynamic changes of light and sound generated by the installation. Building on these spatial conditions, the study explored the feasibility of adopting a centripetal installation configuration.

The primary structure of the installation adopts a composite form composed of multiple layers of hollowed spherical shells. Its design inspiration is drawn from natural processes such as cell division and seed germination, symbolising the originary state of life and echoing the concept of a "spark" or "fire seed". At the same time, the structure incorporates a precise geometric segmentation logic. The spherical surface is composed of 32 hollow circular module units, whose positions were determined through meticulous calculations of projection light paths to ensure uninterrupted and continuous projection patterns on the surrounding walls. A metal skeletal frame serves as the main load-bearing structure, while individual components were fabricated and assembled using 3D-printed modules. The overall form integrates organic biological morphology with the rigour of technological fabrication, symbolising the tension and dialogue between civilisation and nature, as well as between the primordial and the future.

To convey deeper layers of meaning through interaction, the projected totems construct a narrative of civilisational evolution based on a multi-layered concentric-circle structure. Each concentric layer contains an independent symbolic system representing a distinct stage in human history. The innermost layer depicts the origins of life and primitive production, including bodily silhouettes and hunting gestures, symbolising early life forms and exchanges with natural energy. The second layer represents biological symbolism and industrial civilisation, incorporating imagery such as gears and the DNA double helix to signify the Industrial Revolution and developments in modern biotechnology. The third layer addresses spiritual civilisation and philosophical reflection, featuring motifs such as the Buddhist lotus and the golden spiral, symbolising the advancement of religious belief and rational science. The outermost layer consists of abstract elements such as a geometrised "all-seeing eye" and radiating beams of light, signifying "revelation" and humanity's gaze toward an unknown future.

All patterns were hollowed using laser-cutting techniques on basswood plywood and closely laminated with PDLC smart film. When the halogen point light source is activated, these patterns are magnified and projected onto the surrounding walls with sharp clarity. The expansive totemic imagery unfolding across the exhibition walls not only forms a powerful visual focal point but also functions as a collectively meaningful "object of projection", echoing Durkheim's notion of sacred objects undergoing collective transformation within ritual contexts. Surrounded by these luminous murals, visitors confront symbolic representations of civilisation and collectively participate in a virtual ritual within an immersive spatial environment.

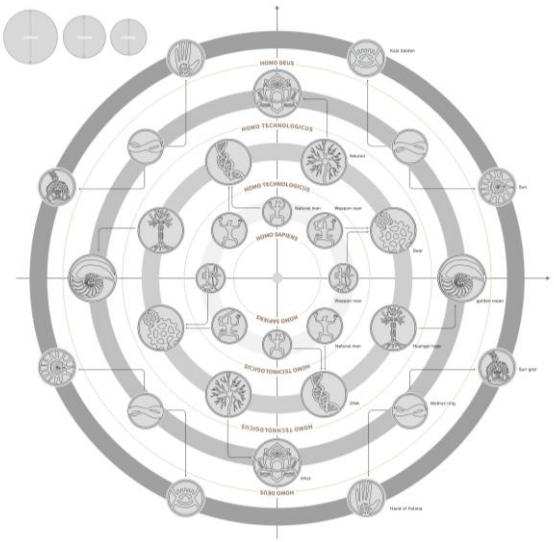

Figure 2. Expanded view of projected totemic patterns

In terms of materials, the installation primarily employs PDLC (Polymer Dispersed Liquid Crystal) smart film, which serves as the core component enabling dynamic visual transformation. PDLC film contains dispersed liquid crystal particles. In its unpowered state, the liquid crystal molecules are randomly oriented, resulting in a translucent, frosted appearance. When alternating current is applied, the molecules rapidly align, restoring optical transparency.

A halogen bulb was selected as the primary internal point light source. Compared with diffuse light sources such as LEDs, halogen bulbs produce light beams that more closely approximate an ideal point source, yielding sharper shadow edges and higher contrast. This property ensures that projected patterns maintain crisp outlines even over long projection distances, preventing excessive feathering or blur. In addition, the warm colour spectrum of halogen light evokes the warmth of a traditional campfire, further reinforcing the primitive and intense ritual atmosphere. Light from the sphere precisely projects its patterns throughout the exhibition space, forming an enveloping dynamic mural that enhances spatial immersion and emotional intensity.

During the dormant phase, the spherical surface emits a faint, breathing-like glow that draws attention to the installation's form and generates an atmosphere of mystery and restraint. Once the collective activation threshold is reached, the PDLC film instantly switches to a transparent state according to the programmed sequence, and the halogen light becomes the dominant light source. The beam penetrates the smart film to complete the projection, producing a dramatic cave-like shadow effect. This design realises an instantaneous transition from "enclosed contemplation" to "open eruption", visually enacting the emotional shift from silent incubation to collective effervescence. In doing so, visitors are transformed from passive observers into active participants embedded within a shared totemic space. The alternation between opaque and transparent states also metaphorically reflects the dynamics of concealment and revelation between emotion and reality under technological mediation.

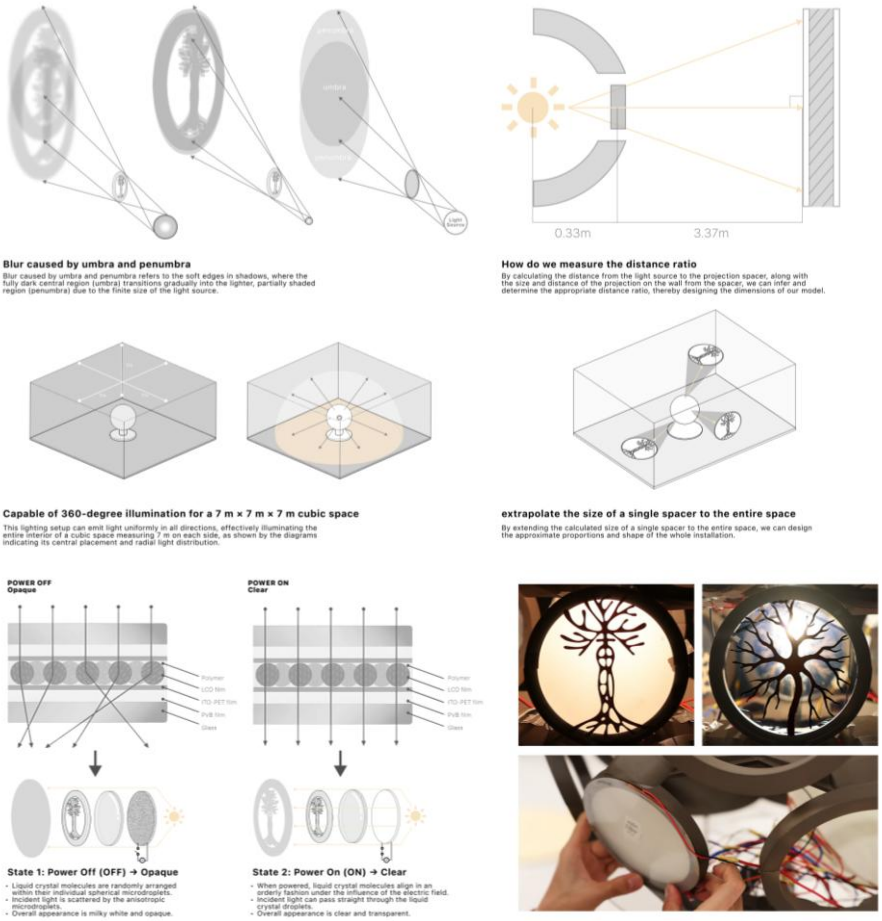

Figure 3. Technical diagram of PDLC smart film integration

From a technical perspective, the installation's control system is centred on the Arduino Mega 2560 microcontroller. Based on the ATmega 2560 chip, this board provides 54 digital I/O pins and 16 analogue input channels, offering sufficient resources for constructing multi-channel sensor matrices and output control systems.

Multiple pressure sensors and contact switches were installed beneath floor mats around the installation, forming a circular interaction node matrix for real-time detection of participants' positions and numbers. When sensors are triggered, the microcontroller calculates participation levels and spatial distribution through composite logic algorithms. Relay modules are integrated into the circuit to control the high-voltage power supply of the PDLC film, ensuring synchronous state switching. High-power MOSFET driver modules regulate the on–off state and brightness of the halogen bulbs through PWM dimming, enabling precise control of lighting intensity.

Overall, the hardware system adopts a modular architecture. The central control board manages sensor input and data processing, while driver and expansion modules are connected via standard buses. This configuration ensures engineering reliability while facilitating later debugging and maintenance.

The interaction logic is structured around three core principles: non-linearity, threshold-based triggering, and collective action. Four pressure foot pedals are distributed around the installation, each equipped with pressure sensors. The system continuously monitors all sensor nodes. When no pressure is detected, the PDLC film remains opaque, while LEDs and halogen lights flicker dimly and the sound system plays subtle ambient audio, signalling that collective cooperation is required to unlock the next experiential stage. When one or more sensors detect pressure exceeding the predefined threshold, group participation is recognised and the dormant mode ends. At this moment, the PDLC film switches sequentially from bottom to top into a transparent state, lighting systems surge to maximum brightness, and a grand soundscape is synchronously activated via TouchDesigner. TouchDesigner, a node-based real-time visual programming environment widely used in interactive

media, maps sensor inputs to complex lighting and sound outputs in *Revelation*, generating a synaesthetic experience. The interaction algorithm follows an accumulative activation logic that encourages increasing participation, guiding visitors to collectively accomplish the central ritual act of "ignition".

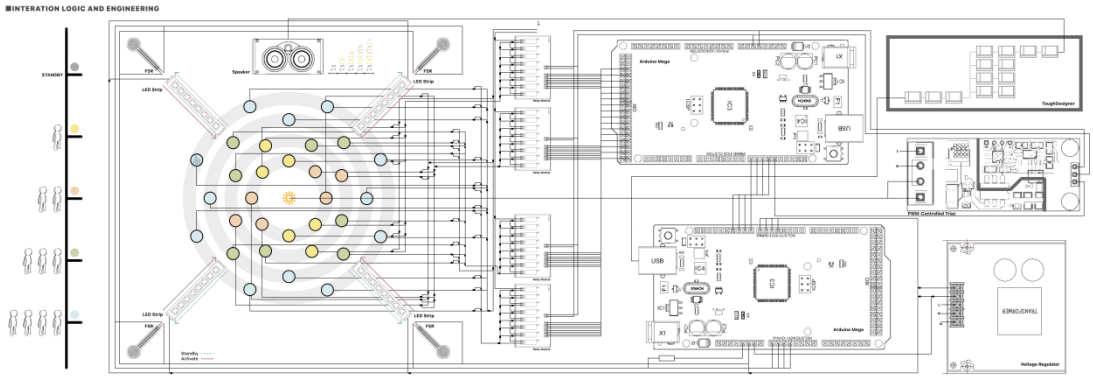

Figure 4. Schematic diagram of the device interaction logic

As an experimental integration of technology and aesthetics, *Revelation* presents a critical reflection on interpersonal relationships in the digital age through interactive art. Formally, the installation constructs a monumental totemic field of light and shadow through precise engineering. More fundamentally, its core value lies in placing bodily participation at the centre of the experience, thereby re-enacting humanity's most primordial collective rituals. As prior research has suggested, the essence of interactive art lies in audience experience, with interactivity itself constituting the primary source of meaning.

When visitors activate the installation through their own actions, they shift from detached spectators to participants in collective behaviour. Body and thought intertwine within the situated experience, affirming the core premise of embodied cognition, namely that cognition emerges from dynamic interaction among participants, tools, and environments. In an increasingly algorithm-driven society, the significance of *Revelation* lies in its provision of a temporary release from digital surveillance through tangible light and sound. By enabling shared movement and resonance, the installation facilitates a return to authentic collective experience and the reconstruction of an internal sense of belonging. The findings affirm that regardless of technological advancement, shared experiences rooted in collective action and embodied cognition remain among the most enduring spiritual bonds of human society.

4. Conclusion and Discussion

Addressing the widespread phenomena of "absent presence" and interpersonal detachment in public spaces in the digital age, this study adopts the digital campfire as its central metaphor and integrates the sociological concept of collective effervescence with an embodied cognition perspective. Through this framework, it completes the full-cycle design and empirical investigation of the interactive installation *Revelation*. Based on 35 valid questionnaire responses, the study systematically examined users' underlying psychological states in gathering scenarios and confirmed that users are not resistant to social interaction. Rather, they lack low-threshold opportunities for initiating engagement. This finding provided the empirical foundation for adopting small task-driven interaction as a core strategy for breaking social stalemates.

In the design and implementation process, the installation was shaped in close response to the elongated spatial configuration and acoustic characteristics of the exhibition site in the Beidaihe Art Town of Qinhuangdao. The main structure takes the form of a multi-layered hollow sphere symbolising life gestation and civilisational evolution. Through concentric totemic patterns, the installation constructs a visual narrative that progresses from primal instinct to future-oriented revelation. On the technical level, the system is centred on the Arduino Mega 2560 as the core control

unit and innovatively combines PDLC smart film with high-contrast halogen point light sources. A multi-user collaborative threshold mechanism based on a pressure sensor matrix is integrated into the interaction logic. Only when multiple participants cooperate does the installation transition instantaneously from a fogged, silent state to a transparent, eruptive mode, with a grand soundscape synchronously activated through TouchDesigner. In doing so, the installation recreates the centripetal spatial experience and sense of belonging associated with primordial campfire gatherings within a contemporary physical environment.

Beyond a design practice, this study constitutes a response to the relationship between technology and emotion within a posthumanist context. As a medium of speculative future archaeology, *Revelation* metaphorically reflects a liminal moment in human evolution, positioned between the figure of Homo sapiens and the imagined emergence of a technologically augmented human condition. Through immersive sensory resonance, participants are encouraged to reflect on the boundaries between technology and humanity. The findings demonstrate that although digitalised modes of existence have become normative, collective rituals grounded in bodily experience remain an effective pathway for reactivating social affect. By enforcing collaborative participation, the installation successfully disrupts closed human–machine interaction loops and establishes a new relational configuration of human–installation–human. This outcome confirms the potential of interactive installations to move beyond visual spectacle and to reconstitute the spiritual core of public space.

While the current installation remains partially dependent on specific acoustic and lighting conditions, future research will further explore modular design strategies and multimodal interaction technologies to enhance environmental adaptability. Such developments aim to enable the installation to intervene in a wider range of everyday public spaces and to continue examining the long-term value of interactive art in reconstructing social connection.

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