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VIRTUAL ATMOSPHERES: A COMPARATIVE STUDY BETWEEN THE PHILOSOPHICAL LEXICON AND A-FRAME

Introduction

This paper examines the relationship between atmospheres, immersive experiences, and digital design through a case study developed as part of a doctoral research project at IULM University.

The aim is to investigate the philosophical and aesthetic potential of virtual reality, with particular attention to designing digital settings that evoke a sense of situated presence. From this perspective, technical tools become critical-expressive media capable of translating the categories of atmospheric aesthetics through the syntax of code. This conceptual framework enables the paper to articulate not only a theoretical alignment between the philosophy of atmosphere and VR design, but also its concrete application within the case study. The main research question is how aesthetic-affective concepts such as presence, resonance, mood, and affordance can be translated into concrete design elements.

Connections between the lexicon of the philosophy of atmospheres and the technical language of virtual reality are explored through the components and properties of the A-Frame framework. This dialogue aims to design a metalinguistic apparatus that mediates between the technical structure of the digital environment and the phenomenological quality of the immersive experience.

To operationalize this comparative framework, the research develops a systematic mapping between philosophical concepts (atmosphere, resonance, affordance, presence) and A-Frame technical parameters (light, color, material, animation properties, visibility controls). This mapping serves not only as documentation, but as a conceptual tool – a grammar of immersive interaction – that can inform future approaches to virtual heritage design. The following sections present the case study, the design

methodology, and the analytical framework through which this bridge is constructed and evaluated.

The essay is divided into four parts. First, it presents the theoretical framework and methodological premises of the case study. The second section describes the design phases that led to the construction of an immersive environment, focusing on operational decisions and the tools used. The third section approaches code as a conceptual space and offers philosophical considerations of interactive dynamics in VR. The final section presents concluding reflections on the aesthetic value of virtual reality as an affective practice and a field of atmospheric design.

1. Presentation of the case study and theoretical framework

This case study is an applied outcome of an ongoing doctoral project at IULM University, which focuses on enhancing cultural heritage through extended reality. The six-month research project at Fondazione Valenzi in Naples aimed to enhance part of its artistic heritage – the exhibition *From Guttuso to Matta* at Castel Nuovo, Naples – using digital media and technologies. This included developing prototypes for virtual galleries and tours, as well as integrating augmented reality into the physical exhibition space. The selection of the *From Guttuso to Matta* exhibition was significant both for the historical and artistic value of the works on display and for their integration into the physical space of Castel Nuovo. The perceptual qualities of the site, such as the natural light filtered through high windows, the arrangement of the artworks, and the geometry of the space, made it clear from the outset that the digital design should go beyond visual documentation to convey a form of ‘situated presence’.

Virtual reality creates conditions for rethinking the modalities of access, use, and representation of cultural heritage. By recreating and restoring spaces in their experiential and sensory complexity – a revolution with technical, aesthetic, and philosophical implications – the user is invited to participate perceptually and cognitively, rather than simply retrieve information.

Böhme’s philosophy redefines the role of aesthetics as the orchestration of appearance: no longer an analysis of the beautiful, but a cultivation of atmosphere and the conditions of sensible presence. In the digital realm, this translates into the possibility of ‘composing’ affective environments in which technical parameters

serve perception. In this context, the essay proposes considering A-Frame – an open-source, HTML-based framework for building 3D and VR environments on the web, originally developed by Mozilla (2015) – not only as a technical tool for constructing virtual environments, but also as a critical-expressive medium whose use is hypothesized within a conceptual framework oriented toward the investigation of atmospheres. If the immersive quality of experience depends on an integrated set of sensory stimuli – realized through technical parameters describable in formal and specific languages (code, rendering specifications, 3D models) – then translating these parameters into sensory experiences in virtual reality requires an additional layer of interpretation: a metalinguistic apparatus capable of mediating between technical syntax and perceptual qualities. The atmospheric lexicon – grounded in aesthetic-affective categories such as mood and resonance – provides an interpretive key that integrates the technical dimension and embodied experience: ‘to design atmospheres is to design the felt presence of space’ (Böhme 2013).

The research took shape as an experimental, design-exploratory investigation in which technical decisions were guided and simultaneously tested by a theoretical framework based on atmospheric aesthetics. It should therefore be understood as a preliminary testing ground for the concrete application of the concepts of atmosphere, affordance, and presence. This led to observing and investigating whether, and how, a virtual setting can convey perceptible qualities in line with the conditions of the place. A virtual environment can likewise address the body through diffuse spatial qualities rather than isolated objects, attuning perception on an affective rather than merely informational level.

1.1. Methodological premises and evaluation of the immersive experience

The research used experimental design methodology, iteratively testing theoretical principles and technical decisions based on user feedback. During development, the prototype was evaluated in informal sessions with the Foundation’s team. Evaluation focused on three dimensions: sense of presence – whether users felt situated within the space rather than merely observing it; navigational fluidity – ease of orientation and movement through hotspots and visual cues; and perceptual coherence – whether the

modulation of light, color, and sound created a unified affective atmosphere consistent with the physical site.

Preliminary feedback provided several insights that guided iterative refinement. For example, users reported that certain viewing angles felt disorienting, prompting the team to adjust hotspot placement and add visual transitional cues to enhance spatial continuity. Similarly, observations that ambient sound levels sometimes overwhelmed the visual focus led to recalibration of audio triggers. These adjustments demonstrate how atmospheric and phenomenological principles – presence, resonance, embodied engagement – can inform and guide technical decision-making in real time, supporting the premise that philosophical concepts have operational value in digital design practice.

Although exploratory in scale, this evaluative procedure aligns with established approaches in presence research, which emphasize iterative testing and perceptual feedback (Slater 2009; Witmer, Singer 1998). The goal was not to measure presence quantitatively but to assess phenomenological coherence – whether the environment attuned users to a meaningful experience of situated perception. As Griffero (2014, 16) notes, perceiving an atmosphere ‘mostly means being touched by it in the felt-body’, implying that such coherence must be assessed not only at a visual–cognitive level but also in terms of embodied attunement.

2. Modeling the environment: From documentation to the immersive space

Building on these methodological premises, the following section outlines the specific steps taken to design and implement the virtual tour.

Digitizing the Valenzi Collection into an immersive format has proven to be a potentially effective tool for mediating and enhancing cultural heritage, especially in terms of remote access.

From this perspective, the challenge lies not only in accurate reproduction but also in transforming virtual space into a meaningful experience – avoiding the impression of a mere ‘informational container’. Passive consumption is insufficient: for an experience to be truly immersive, it must allow touching, exploring, and wandering. The sense of presence is further reinforced through interaction – user-friendly commands, immediate feedback, and tactile or visual stimulation.

In developing the prototype of the virtual 360° rendering of the Cittanova Valenzi room, two alternative design strategies were considered. The first involved creating a single panoramic environment that would provide an overall view of the room, though at the expense of precision and interactivity. The second consisted of constructing a sequence of interconnected 360° shots, each enriched with interactive and informational overlays. This latter approach was adopted, as it was judged to be the most effective in ensuring both greater spatial accuracy and a richer immersive and informational experience.

The decision to adopt the interconnected 360° approach was not merely technical; it reflected a commitment to the philosophical premises outlined in Section 1. From the outset, the design team conceived the virtual tour not as a neutral replica of the exhibition, but as a guided yet open experience of situated perception. The sequence of nodes was discussed and refined with the explicit aim of balancing contemplative pauses and smooth transitions, so that each hotspot would correspond to a meaningful vantage point rather than a purely technical stitch in the photographic sphere. Decisions about camera height and direction of viewing were therefore based on *in situ* observations of how visitors moved and oriented themselves in the physical room.

By creating multiple vantage points within the virtual setting, each enriched with sound and interactive elements, the experience seeks to recreate not a neutral documentation of the space, but a phenomenologically coherent experience – one in which the user's navigation itself becomes a form of embodied perception. The spatial accuracy ensures that orientation cues (wall placement, architectural rhythm, natural light direction) remain intelligible, while the interactive overlays allow for a modulation of attention: the visitor can choose to linger, explore, or move forward based on visual and acoustic affordances embedded within the environment. In this way, technical parameters become carriers of atmospheric intention.

The initial phase of the project was dedicated to gathering the preliminary data required for constructing the virtual space: information on the physical positioning of the artworks, acquisition of available digital images, transcription of captions and infographics displayed in the gallery, and a floor plan survey of the space, which was not available.

In this context, the first photographic session was conducted using Android and Apple devices (smartphones and iPads), supported by auxiliary lenses such as fisheye. The initial images – taken freehand and then with a tripod – revealed several critical issues, including the complexity of natural and artificial lighting and the need to adapt shooting angles to the future placement of hotspots to effectively simulate traversal and interaction within the physical space.

At this stage, critical reflections arose regarding the need to digitally render the corporeality of physical experience and movement in space (Böhme 2017; Griffero 2014). The design process increasingly aimed to make the immersive experience not only informative but also affectively meaningful, grounding the virtual tour in a philosophical understanding of atmosphere as a relational and lived quality.

The second session therefore focused on the connecting points between the shots and on optimizing the initial shooting angles.

The third phase of the project was dedicated to setting up the 360° virtual environment, developed using software for creating panoramic experiences accessible via browsers, mobile devices, and VR headsets. At this point, the work proceeded in several stages: first, the best shots were selected, excluding those compromised by blurring, particularly in the critical overlap areas of the visual circle. Next, the navigation path was defined by configuring the order of photographs and identifying linking points through hotspots. Finally, the virtual tour was configured and published on the Orbix360 platform, completing the first version of the immersive experience.

Within this framework, the combination of spherical environments and localized sounds creates the illusion of being inside rather than observing from outside. The user can freely explore the space by moving the screen, allowing for a visualization consistent with the original point of capture. Even in these environments, the immersive quality does not depend solely on the accumulation of data, but on the presence of structural invariants within the optical flow, which enables the user to orient, act, and experience space as meaningful. In Gibson's ecological account (1979, 16), these invariants are part of the ambient optic array, providing stable information about surfaces and spatial relations as the observer moves.

Visual elements (forms, colors, lights, shadows, details) and ambient sounds (echo, noises, directionality), in their perceptual coherence, are calibrated to ensure the sensation of presence. Following Lombard and Ditton's foundational definition, presence in digital media is 'the feeling of being in a mediated environment': a psychological state in which the user experiences spatial immersion despite awareness of technological mediation (Lombard, Ditton, 1997). However, the design strategy pursued here aims to minimize the perception of mediation by ensuring that atmospheric coherence – the unified modulation of light, sound, and spatial rhythm – creates a sense of authentic spatial situatedness. In other words, while the environment is necessarily mediated by technology, the goal is to make that mediation perceptually transparent, so the user's attention remains focused on the affective and embodied quality of presence rather than on the apparatus itself.

Spatial elements are thus considered both in their technical materiality and in their evocative function: lighting is not only an optical value but also an emotional condition; color is not merely a property of the surface but a quality that 'pervades' space.

As Böhme (2014, 5-16) emphasizes, the aesthetic impact of materials depends primarily on their luminous qualities: surfaces contribute to atmosphere formation through the ways they reflect, diffuse, or absorb light.

The 360° photographic tour establishes an initial layer of atmospheric design, grounded in spatial continuity and audiovisual coherence. In the next section, attention shifts from panoramic composition to code, examining how A-Frame's syntax functions as a conceptual space where affordance, resonance, and presence are operationalized.

3. Code and philosophy: Toward a grammar of immersive interaction

After an in-depth analysis of movement modes within the environment and the identification of strategic focal points – capable of maximizing the inclusion of elements through 360° gaze rotation – the need arose to enrich the shots both visually and functionally by integrating two types of interactive content.

First, the information contained in the captions of the artworks, which was barely legible in the original images, was made accessible through the software's native information hotspots, thus

avoiding more complex solutions based on custom boxes or direct programming. Second, the ability to enlarge the digital images of the artworks was implemented, addressing the interest of students and specific audiences in the technical and stylistic details of the exhibited works. After testing customizable boxes, the final solution combined the software's native image-loading system with portions of A-Frame code, designed to more precisely regulate the modalities of interaction with the artworks.

Among the tools for immersive design, A-Frame is a general-purpose framework for building 3D and VR environments on the web. Through custom elements like HTML (Santos, Cardoso 2019), it is possible to structure complex scenes in a design approach oriented more toward phenomenological coherence than graphic realism.

By emphasizing this aspect, the virtual environment can be conceived not only as a 'geometric space' composed of isolated stimuli, but as a structured optical setting – an ambient arrangement perceived directly.

In this sense, A-Frame prioritizes the construction of phenomenologically coherent environments over photorealistic rendering. It also makes the relationship between code and perception particularly transparent, revealing how even apparently simple technical choices influence the emotional tone of space – an aspect especially relevant in museum contexts, where spatial curation is simultaneously aesthetic, narrative, and experiential.

In A-Frame, even simple fundamental components – native elements such as basic geometries – can transform an abstract scene into an interactive visual environment, modeled as an open structure that can suggest actions, trigger experiences, and serve as a testing ground for pre-atmospheres through equirectangular images, fog, and particles. It is not the vision of 3D 'cubes', but rather the sensation of the dampness of a cave (low lights, echoes, dripping sounds); the calm of a forest (diffused light, rustling, natural colors); or the energy of an environment (artificial lights, noises, movement). Just as atmospheric design does not work with objects but with effects, in VR environments textures, shadows, and lights become carriers of resonance, capable of defining the mood of digital space.

3.1. Affordance *and* Resonance in Interaction Design

The tested interaction model can be described as follows:

```
animation__mouseenter="property: visible; to: true; startEvents: mouseenter"
animation__click="property: scale; to: 2 2 2; dur: 300; startEvents: click"
animation__mouseleave="property: visible; to: false; startEvents: mouseleave"
```

Fig. 1: A-Frame animation code controlling visibility and scale changes in response to three interaction events: mouseenter, click, and mouseleave

When the virtual area corresponding to an artwork is approached, the image can be clicked or tapped to activate a three-phase sequence. The first click **reveals** a digital version of the artwork; the second enlarges it; and a third click – or alternatively, moving away from the active area or shifting one’s gaze – causes the image to disappear, allowing navigation to resume. This interaction mode ensures a fluid and natural experiential flow, attuned to the user’s rhythm and emotional engagement. Such coherence reflects Gibson’s notion of ambient and ambulatory vision, countering the idea of perception as a mere sequence of ‘snapshots’¹. The visibility of an object that appears upon the gaze or enlarges with a click also represents a micro-event of resonance (Rosa 2016; 2018): the environment responds². As Rosa (2016, 298) stresses, resonance is not a mere echo but a relation in which subject and world mutually affect and transform one another – an idea that helps conceptualize these micro-events of environmental response.

Although minimal in code, this sequence prompts a broader reflection on the philosophical implications of immersive design. Properties such as *mouseenter*, *click*, and *mouseleave* define the possibilities for interaction, influencing both the visibility of elements and the temporality of the experience.

The *visible* parameter regulates the appearance of the object not only in response to the mouse, but also in relation to the position of the headset or the user’s gaze, producing an effect of

¹ «The assumption that we perceive in a sequence of pictures [...] is quite false» (Gibson 2014, 209).

² Responsive Environments and Animation, *A-Frame Documentation*: <https://aframe.io/docs/1.2.0/-components/animation.html> (last accessed: 19 August 2025).

perceptual reactivity that brings the digital experience closer to the physical one.

The *dur* parameter, which defines the duration of an action (such as the enlargement of an image), introduces the theme of experiential time. In VR, temporality is not linear but malleable, shaped by the user's behavior. In this sense, immersive time is plastic. Interactions do not occur according to a predetermined continuous flow, but emerge from the situated relationship between gestures, attention, and environmental response. Within an active interplay between user and space, behavior is oriented through visual or tactile cues that guide attention and action.

These properties articulate what, how, and when the space presents itself to the user. In other words, they make explicit the affordances – a relation already identified in game design (Zimmermann 2022). In Gibson's ecological theory (1979, 119-131), affordances are the actionable properties of the environment – what it 'offers, provides or furnishes' to an organism. Böhme (2017) extends this notion aesthetically, suggesting that atmospheres themselves function as affordances: diffuse, pre- and inter-subjective qualities that address the body and orient lived experience.

Following the idea of affordance as a suggested action – central to interactive design and here extended to the emotional and perceptual domain – the technical form does not prescribe a path but opens a field of possibilities³. When interaction is conceived not as a sequence of artificial inputs but as a dynamic process unfolding through bodily movement in space, situated comprehension emerges naturally. This shift – from scripted interaction to embodied exploration – enables phenomenologically coherent immersion even within virtual settings.

³ «The fact that a stone is a missile does not imply that it cannot be other things as well. It can be a paper weight, a bookend, a hammer, or a pendulum bob. It can be piled on another rock to make a cairn or a stone wall. These affordances are all consistent with one another» (Gibson, 2014, 126); information makes sense for the organism that directly picks it up from stimulation, insofar as it is presented by the environment as affordances.

3.2. Mapping philosophical concepts to A-Frame technical parameters

The analysis above shows that the relationship between philosophical categories and technical implementation is neither arbitrary nor merely metaphorical. To make this mapping explicit and systematic, the following table illustrates how core concepts from atmospherology and phenomenology have operative equivalents in A-Frame syntax and properties.

Philosophical Concept	Phenomenological Description	A-Frame Parameters / Features	Technical Function in VR	Example in the Case Study
Atmosphere / Mood	Pre-reflective affective tonality that shapes the subject's mode of being-in-the-environment (Böhme; Griffero)	light, color; material, fog; global scene configuration	Modulates brightness, chromatic temperature, reflectivity, and depth cues, shaping emotional tone	Diffused warm lighting and desaturated colors construct a solemn and contemplative atmosphere mirroring the material qualities of Castel Nuovo
Resonance	Reciprocal affective responsiveness between subject and environment (Rosa)	animation with startEvents; visible; sound components	Produces reactive feedback (visual and auditory) that makes the environment appear responsive and alive	Artworks appear when approached and expand on click, creating micro-events of mutual responsiveness between user and environment
Embodied Presence	Feeling of co-located, situated perception in the environment; alignment of body schema and virtual space (Heeter; Griffero)	camera rig; look-controls; movement/navigation settings	Defines the user's virtual embodiment through head rotation, spatial positioning, and navigation consistency	The node-based 360° pathway preserves coherent sightlines, supporting bodily orientation and an illusion of being physically anchored in the room
Affordance	Actionable possibilities suggested directly by spatial cues (Gibson; Böhme)	Hotspots; cursor interactions; click/tap events; interactive areas	Guides user behavior implicitly by suggesting actions without prescribing them	Hotspots on artworks visually propose zooming and caption access, enabling intuitive exploration without forcing a linear route

Philosophical Concept	Phenomenological Description	A-Frame Parameters / Features	Technical Function in VR	Example in the Case Study
Temporality (Duration)	Experiential pacing that shapes continuity, anticipation, and rhythm in immersive interaction	dur; animation timing; delays; sequencing logic	Establishes temporal rhythm of events, preventing abrupt transitions and shaping narrative flow	The ~300 ms enlargement of images provides a smooth experiential tempo, supporting natural, continuous interaction

Tab. 1: Comparative Table: Philosophical Categories and A-Frame Parameters

This table serves several functions simultaneously. First, it shows that the metalinguistic bridge between philosophical and technical language is not speculative but operational: each concept has identifiable technical correlates. Second, it reveals that A-Frame features, though designed for general 3D/VR development, possess latent phenomenological depth – they can be repurposed as instruments for atmospheric composition. Third, it provides a template for future projects: designers with atmospheric goals (e.g., ‘convey solemnity’ or ‘enable embodied exploration’) can consult this mapping to identify which A-Frame properties to prioritize and how to calibrate them for phenomenological purposes.

Conclusion

The feedback collected highlighted several significant issues. In particular, the reduced sense of embodiment in the mobile version – limited to head or framing movements – was not perceived as authentic exploration but rather as an artificial experience. This underscores the urgency of designing experiences that evoke bodily presence even without advanced controllers, by calibrating tactile, auditory, and visual stimuli. Similarly, the lack of transitional moments contributed to the perception of an environment that was not particularly user-friendly, emphasizing the importance of creating fluid and cohesive transitions to sustain immersion and continuity.

Despite these limitations, the experiments with A-Frame have demonstrated the potential to develop a true operational lexicon for digital design, in which technical parameters correspond to the aesthetic-philosophical categories of atmospherology. Affordance,

for example, emerges through properties such as *click*, *mouseenter*, and *components*, which do not prescribe behavior but suggest possibilities for action, creating a situated interactivity that activates the relationship between body, environment, and intentionality. Resonance appears in the affective quality of interactive and responsive environments: animations and sound triggers show how simple visual or auditory feedback can foster connection (Griffero 2014, 108; Rosa 2016).

A crucial distinction arises between materiality and immateriality in virtual environments. While parameters such as textures and geometries are materially discrete, properties like light, sound, and fog function as relational qualities – they define space through affect and presence rather than physical substance. The modulation of mood through light, color, and material further confirms the affective nature of space, consistent with themes developed by Heidegger and Böhme. Heidegger's concept of *Stimmung*, or *mood* (Heidegger 1927), as a fundamental attunement of the subject to Being, finds concrete expression in the calibration of atmospheric parameters: lighting does not merely illuminate but establishes an emotional tone; color does not merely decorate but permeates the perceptual field; material does not merely structure but conditions embodied encounter. For example, in the case study, dim lighting and warm colors created a welcoming atmosphere, while more reflective materials and cooler hues evoked a more detached emotional stance.

In this way, atmosphere reveals itself as an emotional tonality that envelops the subject and transforms perception into experience. The practice of atmospheric composition in virtual environments thus becomes an actualization of Heideggerian phenomenology, translated into the operational language of digital code. This explicit integration of Heidegger's notion of *Stimmung* also addresses a recurring gap in atmosphere studies: while Böhme's framework is frequently emphasized, its ontological grounding in Heidegger's analysis of affective attunement is often underdeveloped. Making this connection explicit clarifies that atmospheric experience in VR is not merely an aesthetic effect but a mode of disclosure, aligning the design of digital environments with phenomenological accounts of how moods open a world.

While the experiments with A-Frame have yielded promising results, several limitations warrant acknowledgment. First, the use of 360° photographic panoramas, while computationally efficient

and web-accessible, differs significantly from fully modeled 3D environments in terms of visual fidelity and user agency. Users cannot freely move through space but instead jump between fixed vantage points; this constraint, while intended to guide contemplation, also limits the spontaneity of embodied exploration. Second, the choice of Orbix360 and A-Frame – rather than industry-standard engines such as Unity or Unreal – prioritizes accessibility, lightweight deployment, and code legibility over graphical sophistication. This trade-off reflects a specific design philosophy: atmospheric coherence and phenomenological depth need not depend on photorealistic rendering but can be achieved through strategic calibration of more modest visual parameters. Nonetheless, future iterations might benefit from hybrid approaches that combine 360° imagery with selective 3D modeling to expand user agency while maintaining computational efficiency.

Affordance, resonance, materiality and immateriality, presence, and mood function not only as theoretical concepts but also as design tools that guide the creation of sensitive environments. In this interplay of code and philosophy, a broader debate emerges, envisioning VR not as a medium for reproduction or information transfer, but as an aesthetic and affective practice – where digital design becomes a critical act of atmospheric composition.

The atmospheric lexicon developed here has implications that reach beyond the specific context of heritage visualization. In educational settings, similar atmospheric design principles could enhance virtual tours or immersive historical reconstructions, where emotional and spatial coherence strengthen cognitive retention. In interactive game design, the concept of affordance as both technical and phenomenological can inform more ethically and aesthetically sensitive approaches to environmental storytelling. In contemporary museology, institutions increasingly explore how digital extensions of physical exhibitions can complement, rather than replace, embodied experience; the framework presented here offers practical guidance for such integration. More broadly, this work contributes to an emerging discourse in digital humanities and critical spatial design: the recognition that technology is not neutral but inherently carries philosophical and aesthetic propositions that require careful interrogation and intentional calibration.

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