THE MEANING OF VIRTUAL SPACE IN THE ARCHITECTURE OF MUMBAI: A PHENOMENOLOGICAL STUDY OF VIRTUAL REALITY USERS IN INTERIOR DESIGN

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Abstract: The development of virtual reality (VR) technology has transformed the way designers and users perceive and interact with space within the context of architecture and interior design. However, a deep understanding of the meaning of virtual space from the user's perspective remains limited, particularly in urban contexts such as Mumbai, where physical space is increasingly constrained. This study aims to explore and analyze the meaning of virtual spatial experiences in VR-based interior design in the city of Mumbai using a phenomenological approach. A qualitative research method was employed, utilizing phenomenological inquiry through in-depth interviews, participatory observation, and visual documentation involving twenty participants from diverse professional, academic, and end-user backgrounds engaged with VR technology in interior design. Data were analyzed using the Miles and Huberman technique, with validity ensured through credibility, transferability, dependability, and confirmability tests. The findings reveal that virtual space is not merely perceived as a technical visualization tool, but has evolved into an affective and conceptual realm, emotionally, imaginatively, and personally inhabited by its users. The experience of virtual space demonstrates deep user engagement, significantly shaping perception, understanding, and decision-making throughout the interior design process. These insights broaden conceptual understanding in digital architecture and offer practical implications for more participatory and user-centered design approaches, especially within densely populated urban environments such as Mumbai…

Keywords: Virtual Space, Virtual Reality (VR), Architecture of Mumbai, Digital Interior Design, Phenomenological Study

1. Introduction

Over the past decade, digital technological transformation has fundamentally altered how space is perceived, designed, and experienced by urban communities—including in Mumbai, a city known for its density and spatial complexity. Faced with land scarcity and mounting population pressure, Mumbai increasingly demands new approaches to spatial exploration and representation, particularly within the realms of architecture and interior design. Virtual reality (VR) technology has emerged as one such response, enabling interactive and immersive simulations of non-physical space as an alternative to the limitations of tangible built environments [1]. In Mumbai, the use of VR has become widespread, spanning architectural studios, real estate firms, and academic institutions, all of which have integrated *virtual space* into their design processes. However, despite its broad adoption as a technical aid for design presentation and exploration, a deeper understanding of how virtual space is perceived and interpreted by users remains severely limited. Misalignments in spatial perception between designers and users often lead to miscommunication in conveying design intent, potentially diminishing the meaningfulness of the spatial experience being constructed [2]. It is therefore essential to further investigate how Mumbai's urban population encounters and interprets *virtual space*, which is increasingly becoming part of everyday architectural life.

Several studies have shown that the integration of VR in interior design enhances the effectiveness of visual communication between designers and clients, while also intensifying the immersive quality of spatial simulations [3]. Research by Zhang and Thienmongkol

highlights how VR technology, when combined with digital media, creates transformative spatial experiences for users [4]. However, the majority of these studies focus on technical, performative, and aesthetic aspects of *virtual space*, overlooking subjective meaning and user perception. The lack of phenomenological approaches in exploring the meanings embedded in *virtual space* has constrained our understanding of the human–digital spatial relationship. This gap is emphasized by Lei (2024), who observed that although VR allows users to dynamically explore space, the subjective dimension of this spatial experience remains largely unexamined [5]. As such, research that investigates the meaning of *virtual space* from the lens of direct user experience is crucial for filling a literature gap still dominated by technological perspectives.

Based on the aforementioned background, this study aims to uncover and analyze the meaning of virtual spatial experience from the perspective of VR users in the context of interior design in Mumbai. A phenomenological approach is employed, allowing for an in-depth exploration of participants' subjective experiences when interacting with *virtual space*. This research seeks to articulate how non-physical space is perceived, interpreted, and utilized by users—and how this process affects the overall effectiveness of digital interior design. Furthermore, the study intends to contribute to the conceptual understanding of digital architecture, particularly concerning the relationship between technology, spatial perception, and the humanistic dimensions of design. By focusing on the city of Mumbai, the study also seeks to provide a contextual contribution to the application of VR in large urban environments burdened by spatial stress and rapid urbanization, thereby expanding the architectural horizon beyond physical representation toward existential spatial experience.

A new approach is required to understand digital space in a more humanistic and context-sensitive manner—especially within urban landscapes such as Mumbai, where physical limitations intersect with immersive technological advances. This research is vital, as the dimension of spatial meaning in VR contexts has often been overlooked in architectural discourse, despite users' subjective spatial experiences playing a critical role in shaping design quality. As Wan (2019) points out, the success of *virtual space* lies not only in visual and technical accuracy but also in the depth of user engagement in experiencing that space [6]. Additionally, studies such as Yahya et al. (2024) indicate that users who feel a high level of emotional engagement with digital space tend to offer more meaningful and relevant design feedback [7]. Grounded in both empirical observations and existing literature, this research is positioned to bridge the gap between technology and human perception in digital architecture and to pave the way for a more reflective and participatory design practice in the age of non-physical space.

2. Research Method

This study focuses on the phenomenon of user experience with *virtual space* within the context of architectural interior design in the city of Mumbai. The advancement of virtual reality (VR) technology has created new opportunities to simulate non-physical spaces that users can access, feel, and interpret directly. However, in practice, there exists a perceptual gap between designers and users regarding the digitally simulated space, resulting in a compelling phenomenon: how *virtual space* is subjectively understood by users from various backgrounds, including clients, designers, developers, and academics. In a city like Mumbai—marked by spatial limitations and complex social dynamics—the emergence of *virtual space* offers both a contemplative domain and a challenge in bridging digital reality with urban conditions. Therefore, the main object of this research is not only *virtual space* itself but also the meanings and experiences users associate with it as an alternative reality within the interior design process.

This study employs a qualitative methodology using a phenomenological approach, aiming to reveal the deep meanings embedded in users' subjective experiences of *virtual space* in interior design. This approach was selected for its ability to investigate reality based on how individuals or groups perceive and interpret specific events—in this case, their interaction with *virtual space*. The primary data source consists of firsthand accounts collected through in-depth interviews with informants who have direct experience using VR in architectural interior contexts in Mumbai. Secondary data were drawn from academic and non-academic literature relevant to the research theme, including references on *virtual space*, VR technology, the architecture of Mumbai, digital interior design, and previous phenomenological studies related to spatial perception. These secondary sources support the theoretical framework and help contextualize the interpretation of field data.

The study involved 20 participants from various professional backgrounds relevant to the topic, including architects, interior designers, VR users,

academics, technology developers, and researchers or critics in digital architecture. Participants were selected purposively, based on their direct involvement in the use of VR for interior design, and to ensure diversity of roles within Mumbai's digital architecture industry. Key informants included Ravi Deshmukh, a senior architect from Studio Mumbai; Ananya Mehta, an architecture lecturer; and Priya Kulkarni, an interior designer from Urban Nest Interiors. Other participants included VR users such as Sneha Patil and Kavita Menon, who were clients in home design projects. Technology developers and consultants like Vikram Shah and Aarti Nair also contributed perspectives on technical aspects and user experiences in virtual environments. This diversity was intended to present a comprehensive understanding of how *virtual space* is interpreted from various viewpoints—both as end-users and as actors in the design process.

Data collection was carried out through three primary techniques: in-depth interviews, direct observation, and documentation. Semi-structured interviews were conducted to allow informants the freedom to narrate their personal experiences with *virtual space*. All interviews were recorded and transcribed for qualitative analysis. Observations focused on participants' interactions with virtual environments in design studios, exhibition spaces, and educational institutions using VR as a medium for design exploration. The researcher noted body movements, facial expressions, and verbal responses to capture participants' reactions to the visual and spatial experiences. Documentation included photographs, videos, and screenshots of *virtual space* simulations, used as supporting data in interpreting user narratives. These three techniques complemented each other in capturing experiential dimensions from both verbal and non-verbal responses to the presented digital space.

Data analysis followed the Miles and Huberman model, consisting of three key stages: data reduction, data display, and conclusion drawing and verification. Data reduction was conducted by filtering relevant information from interviews, observations, and documentation aligned with the research focus. The data were then displayed in the form of thematic matrices and interpretive narratives to facilitate pattern and meaning identification. The final stage involved drawing conclusions based on recurring themes found in participants' experiences and conducting cross-validation across data sources to ensure consistency. To guarantee data validity, four criteria were applied: **credibility** through source triangulation, **transferability** via thick contextual descriptions, **dependability** using an audit trail throughout the research process, and **confirmability** through transparent documentation of all analytical steps. A phenomenological lens guided the interpretation process, allowing the researcher to uncover the essential structure of users' experiences with *virtual space* through reflective and descriptive analysis centered on their subjectivity.

3. Discussion

Virtual Space

Virtual space within the context of interior architecture in Mumbai reveals a new dynamic in how space is interpreted and experienced by users. Field observations indicate that *virtual space* is not merely a digital replica of physical environments, but rather serves as an interactive and immersive medium in the design process. Users engage directly with digital environments via VR headsets, enabling them to explore space both spatially and emotionally. This experience transcends static visualization, encouraging active participation in spatial design. In many cases, *virtual space* is more idealized and structured than Mumbai's complex physical environment, acting as an imaginative mirror of how individuals envision their living or working spaces. Visual documentation also revealed reflexive user gestures—such as avoiding virtual walls or reaching for virtual objects—signifying a high level of spatial realism. This phenomenon supports the notion that *virtual space* can be considered a new spatial entity in digital architecture: one that does not necessarily reflect physical reality, but instead represents the aspirations, expectations, and personal perceptions of its users.

Explaining Virtual Space

Interview findings suggest that *virtual space* enables more intuitive creative collaboration between designers and users. Most informants noted that VR facilitates faster comprehension of design, as users are able to feel the atmosphere and function of a space in real-time. The software allows instant modifications based on client feedback, making the design iteration process more dynamic. Documentation from design sessions also captured strong emotional responses—such as visible satisfaction when design elements aligned with personal preferences. This supports the idea that *virtual space* not only constructs spatial perception, but also fosters emotional connections between users and space. Within *virtual space*, aesthetic and

functional aspects can be tested simultaneously, offering designers new insights into user perception. This helps create spaces more attuned to user needs while delivering a more personal and memorable experience.

Virtual Space and the Research Problem

Virtual space in digital architecture has proven instrumental in bridging the gap between spatial perception and the real conditions of Mumbai's urban environment. Observations show that most virtual design spaces avoid the complexity of actual urban settings, favoring orderliness, minimalism, and openness—qualities that visually contrast with Mumbai's dense and layered physical reality. This suggests a disjunction between idealized spatial desires and actual urban constraints. Users tend to accept and feel more comfortable in simplified, organized virtual spaces. These findings emphasize the need to understand *virtual space* not merely as a design tool, but as a new social space that shapes how urban dwellers imagine ideal environments. Thus, *virtual space* functions not only as a medium for design, but as a manifestation of the desire for new spatial order in urban life.

Virtual Reality (VR)

Virtual reality (VR) plays a pivotal role in shaping *virtual space* and users' spatial experiences. Observational data show that VR is used not only to visualize design but also to interactively test the functionality of interior elements. VR is applied across multiple contexts—from professional design processes and architectural education to conceptual explorations in digital exhibitions. For instance, a laboratory at IIT Bombay utilizes VR to simulate responsive spaces that morph based on user movement. Documentation reveals that users' interactions with *virtual space* via VR often trigger physical and emotional reactions that closely resemble real-world experiences. Some clients expressed excitement when they felt immersed in a simulation, while others experienced disorientation due to mismatches between bodily movement and visual feedback. These findings underscore that the quality of VR experiences is significantly shaped by technical factors such as resolution, latency, and spatial alignment.

Explaining Virtual Reality

Findings from interviews and documentation show that VR in interior design offers far more than a visualization tool—it has become an experimental medium for architects and designers to explore spatial possibilities unconstrained by the physical world. Many informants shared that VR enables the creation of dynamic, adaptive, and even metaphorical spaces—beyond the limits of gravity, materials, or real-world structures. Designers reported a shift in mindset, from placing objects to crafting immersive experiences. This signifies a new design paradigm in *digital interior design*, where the affective experience of users becomes central to the process. In this context, *virtual reality* becomes a bridge between spatial perception and emotion, allowing users to "feel" the design before it is built.

VR and the Research Problem

The presence of VR in Mumbai's architectural design landscape brings both opportunity and challenge. On one hand, VR democratizes access to spatial experiences, allowing non-technical users to explore, comprehend, and contribute to the design process. On the other hand, there are issues arising from mismatches between virtual expectations and physical constraints in Mumbai. Some users experience disorientation when virtual elements—such as staircases or room dimensions—do not align with real-world conditions. This highlights the importance of designing *virtual space* not only to be visually immersive but also to consider ergonomics and bodily perception. Within the scope of this research, *virtual reality* proves essential for revealing phenomenological and contextual spatial experiences in Mumbai's complex urban setting.

Digital Interior Design

Digital interior design developed through VR platforms demonstrates enormous potential in expanding the conceptual boundaries of interior space. Observations and documentation from studios and academic institutions show that digital design not only replicates real environments but also enables the creation of conceptual spaces—such as bedrooms that transform over time or workspaces that respond to user movement. Student projects at IIT Bombay feature real-time technologies allowing interior spaces to evolve based on user preferences. Visually, these digital designs are striking—emphasizing minimalism, spatial symmetry, and the manipulation of light and materials untethered from physical constraints. These phenomena indicate that *digital interior design* is not merely a visual representation of space, but a performative, emotional, and interactive spatial medium.

Explaining Digital Interior Design

Interviews with design practitioners and VR technicians reveal that *digital interior design* opens up limitless opportunities for both functionality and aesthetics. Real-time simulations allow users to directly experiment with spatial elements such as color, texture, lighting, and furniture layout. This responsiveness enhances the design process by adapting closely to user needs. Furthermore, documentation from client sessions illustrates how designers and users can collaborate within the same *virtual space*, making decisions instantly. This reality reframes our understanding of space as a dynamic process rather than a static end product.

Digital Interior Design and the Research Problem

In Mumbai's urban context, *digital interior design* represents an effort to create alternative spaces that better align with the expectations and needs of its inhabitants. While the city's physical environment is often constrained by density, inequality, and visual chaos, digital design offers versions of space that are orderly, clean, and adaptable. These findings affirm that digital design is not just a visual tool, but a form of resistance against the non-ideal conditions of physical space. Through a phenomenological lens, user experiences of *digital interior space* become a gateway to understanding how space is felt, interpreted, and personally meaningful. Thus, *digital interior design* through VR contributes significantly to the formation of spatial meaning in today's urban digital era.

4. Conclusion

This study reveals that *virtual space* in the context of interior architecture in Mumbai is not merely a digital simulation of physical environments, but a new spatial reality that embodies personal perception, emotional engagement, and design participation. The findings show that *virtual reality (VR)* enables users—whether designers, clients, or laypersons—to experience and interpret space in a deeply immersive and intuitive manner. Rather than functioning only as a visualization tool, *virtual space* fosters collaborative dialogue and emotional resonance, highlighting its role as both a technical and affective design medium. In densely populated cities like Mumbai, where spatial constraints are significant, VR-based *digital interior design* offers users an imaginative and organized alternative to chaotic real-world environments. The study also reveals a perceptual gap between idealized virtual environments and the physical urban context, underscoring the need for ergonomic and phenomenologically grounded design practices. Ultimately, *virtual space* becomes a manifestation of human aspiration for spatial clarity, emotional comfort, and interactive participation. As such, this research contributes conceptually to digital architecture by bridging technology, spatial perception, and human experience, while emphasizing the importance of designing with and for the user in urban digital realities.

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