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Advancement of Augmented Reality and Virtual Reality in Real Estate Sector

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Abstract

This study looks into how deeply and complexly the emerging phenomena of virtual reality (VR) as well as augmented reality (AR) technologies affect the real estate industry, considering their seemingly obvious functions to appreciate their fundamental impact in changing the business paradigm. Real estate market growth is at an all-time high. Additionally, an exponential growth is anticipated in the upcoming years. The Technological advancement has made this sector more vibrant and more approachable. The latest technologies such as Augmented Reality and Virtual Reality have made this possible for the aspiring customers to explore more easily and conveniently into this sector. Augmented reality is an interactive experience which not only enhances the real world experiences by providing virtual property tours, visualization of interior design and interactive visualization of the amenities and other features available for the prospective buyers and sellers, but also helps the buys to track the progress of the various projects. Virtual Reality provides and allows prospective buyers to virtually experience and explore the various property requirements as per their choices. The yet to developed projects can also be visualized to take the appropriate decisions. Though the AR and VR technologies, even the other sectors too are progressing, there is an immense requirement of such technologies in Real estate sector to bring clarity in terms of various factors such as progress of the construction, 360 degree view of the property etc. AR provides an experience by superimposing digital information on real-world objects to create a 3D experience that allows users to interact with both the physical and digital world. Even the payments and budgets can also be aligned with the various other aspects of the Real estate requirements. Taking a different approach than typical analyses, Understanding and analyzing the various facets of AR and VR in the real estate industry will be made possible by this paper. The research utilizes a mixed-approaches methodology, integrating quantitative evaluations of user behavior and market uptake with qualitative inquiries into stakeholder experiences, architectural design implications, and ethical considerations. This study investigates the emotional and cognitive components of immersive property experiences, specifically how AR-mediated contextualization and VR-induced presence influence decision-making. It looks into the shifting interaction between digital and physical spaces, focusing on the implications for architectural design, property management, construction workflows, and property marketing. To evaluate their potential for producing smooth and simple user experiences, a rigorous examination of the underlying technologies is carried out, including spatial computing, hepatic feedback integration, and AI-driven content creation. The ethical and societal implications of AR/VR adoption in real estate are also covered in this study, including data protection, accessibility, and the possibility of widening digital disparities. It looks at the legal structures needed to guarantee responsible use and reduce dangers.

Keywords: Augmented reality, virtual reality, real estate, technological advancement.

Introduction

The technology is advancing and the non-adoption of technology may lead to the death of technology. Real Estate sector is one of the sectors which have started using technology little later part as comparison to the other sectors. Having said that, its been a need of the hour to understand the requirements of this sector and accordingly understand the technology usages for both Industry as well as the end users. This research paper will enable to understand the adoption of the technology by the Real Estate sector and also provide ins0sight about the outcome of the usage of the Technology mainly AR and VR. Though many companies in the Real Estate have started using the AR and VR Technology but still it's in the very initial stages. According to Statistic Market Insights Research, the real estate industry, which has traditionally relied on in-person meetings and physical interactions, is undergoing a significant transition due to the introduction of Augmented Reality (AR) and Virtual Reality (VR) technologies.

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The underlying assumption of this study is that these immersive technologies are more than just marketing tools; they are radically changing the cognitive and experiential aspects of real estate transactions. According to estimates, there will be 97.7 million users of AR and VR technology in real estate in 2023, and by the end of 2024, that number has significantly climbed to 99.8 million, challenging the old paradigm that is defined by static imagery and in-person viewings. Which provides an insight about the adoption of this AR and VR Technology in the Real Estate and year by year its been increasing drastically.AR and VR have produced dynamic interactive environments that call for a thorough reassessment of long-standing procedures. A significant departure from conventional methods may be seen in the introduction of virtual reality (VR), which enables prospective buyers to virtually tour properties through immersive 360-degree tours. Because of the ability to simulate physical presence and the emotional engagement that immersive environments foster, an examination of the psychological and spatial cognitive aspects of real estate purchase is required. Similar to this, AR highlights the importance of examining the interactions between the digital and physical worlds in the context of real estate by superimposing digital data on real-world locales, allowing for real-time design adjustments and contextual data integration ecosystem.

An overview of AR and VR technologies in the context of real estate reveals a multifaceted landscape encompassing diverse applications and stakeholders. VR, primarily utilized for creating immersive property tours and architectural visualizations, allows prospective buyers to experience properties remotely, fostering emotional engagement and informed decision-making. AR, on the other hand, enhances the physical viewing experience by overlaying digital information, enabling real-time design customization and contextual data integration. Architectural design and construction processes are also under going transformation through the adoption of these technologies. VR facilitates early design evaluation and stakeholder collaboration, while AR streamlines construction workflows and enhances safety. Property management companies are leveraging AR and VR for virtual inspections, remote maintenance, and tenant engagement, improving efficiency and communication. However, the widespread adoption of these technologies is contingent upon addressing several key challenges. Hardware limitations, software development complexities, and ethical considerations, such as data privacy and accessibility, require careful examination. This research aims to provide a comprehensive overview of the current state of AR and VR in real estate, identifying key trends, challenges, and opportunities. By employing a rigorous theoretical framework and a mixed-methods approach, this study seeks to contribute to the advancement of knowledge in this rapidly evolving field.

Evolution of AR and VR with Relevance to Realestate

How we view and sell a property has been significantly advanced in recent years due to technology enhancement in Augmented Reality (AR) and Virtual Reality (VR). In the case of Real Estate, it has helped in marketing different properties, customer acquisitions, and improving the overall visualization of a property.

During the first phase in the mid-2000s to early 2010s, VR was limited to gaming and simulation use cases, while AR was restricted to mobile applications. At this point, the aerospace industry was using real estate technologies, so the only features that were available were mobile apps with limited functionalities, and 3D walkthroughs that some elite developers made available for high-end properties. Unfortunately, adoption was limited.

In the second phase (2010-2020), the introduction of Oculus Rift, HTC Vive, and Google Cardboard made VR more user-friendly and available. Virtual property tours permitted distant buyers to view properties in a 360-degree manner. 'VR staging' allowed displays of vacant properties aided with digital furniture. Apple's AR Kit and Google's AR Core improved AR. An AR app that lets users place furniture within a room (like IKEA Place) became very popular. Other uses of AR technology were scanning QR codes to see details of a property, and using smartphones to view available listings in a particular area.

The current stage, VR Meta verse Integration (2020-Present), includes virtual real estate sales in Decentral and Sandbox. Proprietary AI-assisted Smart algorithms personalize real estate recommendation based on user activity during VR tours. VR Remote Collaboration. Agents and buyers meet in Virtual Reality showrooms. Augmented Reality Live. An interested buyer points their phone to a property and instantly sees its price, specs, and possible interior options. 3D floor plans. AR models for interactive visualization of renovations. Wearable AR. Smart glasses (e.g.. Microsoft Holo Lens) enable hands-free inspection of properties.

The ecosystem around real estate and augmented/virtual reality technologies has the ability to transform the property market as a whole, particularly with the latest changes done on the development side for consumer technologies. The changes these days in technology development made wide accessibility of affordable hardware and software that will enhance the consumer experience in the property market value chain, ranging from architects, planners, builders and clients to real estate agents, investors on the process. The augmentation of reality (AR) and virtual reality (VR) technology allows buyers to have fascinating experiences that makes it easier for real estate experts to market properties and turn houses to homes from any location. Using VR. The AR technology overlays the 3D digital image on top of the physical world with the help of smart glasses, mobile phones, helmets, and visors, in order to create a mixed reality enhanced with 3D animated visuals. This helps in the visualization of the property in 3D while also allowing for the creation of an intricate and fully realized vision of the said property.

In 2019, 90% of households have begun real estate search on the internet, with 50% of the searches being made from mobile devices. In order to enhance user experience on the realtor's website, a virtual presence of the property highlights Points of Interest (POIs) that gives the potential purchasers a clear understanding of the property. However, underproductive physical visits despite appealing POIs can result in added cost of sale if buyers are unable to correlate the imagined property to the actual one.

Both AR VR are currently used in the real estate industry to help builders, architects, sellers, and buyers to cut costs and increase productivity. These applications have become popular over the years, as technology has become affordable and better.

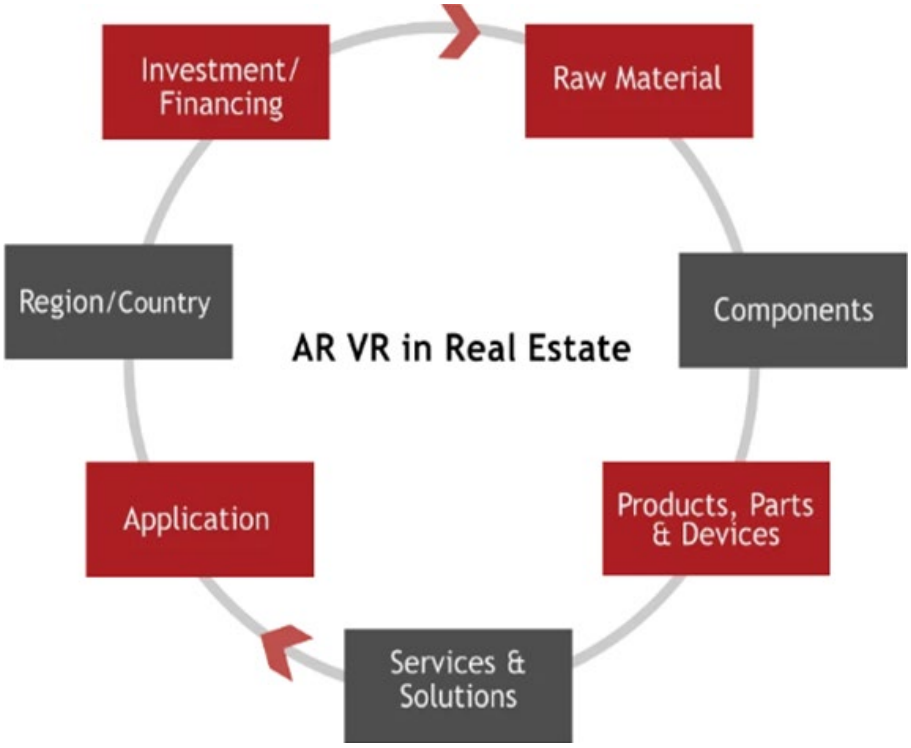

Fig 1: AR, VR in Real Estate

This technology follows a path from nascent experimental systems to refined and marketable platforms, distinguished by an improvement in hardware, software, and computational capabilities. Initial VR systems, developed largely for niche use such as flight simulation and military training, were dominated by large hardware, minimal interactivity, and low-resolution monitors.at the beginning stage the ideas of AR are not frequently used and it is based on primitive head-mounted displays and limited computer vision, were restricted to specialized uses. The Usual usage of AR and VR was speed up was speed up by the development of authoritative processors, quick screens, and superior motion tracking technologies, which made it possible to produce engaging and interactive virtual reality experiences for large consumer markets.

The Usual usage of AR and VR was speed up was speed up by the development of authoritative processors, quick screens, and superior motion tracking technologies, which made it possible to produce engaging and interactive virtual reality experiences for large consumer markets. Simultaneously, advancements in cloud computing, computer vision, and mobile computing have made it possible for mobile AR apps to grow, democratizing access to AR experiences via smart phones and tablets. Alongside evolution, hardware and software capabilities have been increasingly blurred, leading to the creation of increasingly smooth and user-friendly user interfaces. we've seen some amazing progress in cloud computing, computer vision, and mobile computing, which has really opened the door for mobile AR apps to flourish. This has made AR experiences much more accessible through smart phones and tablets. Alongside this evolution, the lines between hardware and software have become more intertwined, resulting in smoother and more user-friendly interfaces that everyone can enjoy.

This technology has evolved from experimental systems to advanced, commercially viable platforms, showcasing remarkable progress in hardware, software, and computational power. In the early days, VR systems were mainly designed for specific uses like flight simulation and military training, featuring clunky hardware, limited interactivity, and low-resolution displays. Similarly, the first AR concepts relied on basic head-mounted displays and had limited computer vision capabilities, which kept them in niche markets. However, the introduction of powerful processors, high-resolution displays, and cutting-edge motion tracking technologies sparked a major shift, paving the way for immersive and interactive VR experiences that appeal to a wider audience. At the same time, improvements in computer vision, mobile computing, and cloud platforms have led to a surge in mobile AR applications, making AR experiences accessible through smartphones and tablets. This journey has been marked by a gradual blending of hardware and software capabilities, resulting in user interfaces that are increasingly seamless and intuitive.

The growing importance of AR and VR across various sectors highlights their transformative potential. In education, VR creates immersive learning environments for complex subjects, while AR adds interactive elements to traditional textbooks. In healthcare, VR is used for surgical training, pain management, and rehabilitation, while AR aids in medical imaging and patient care. The entertainment industry harnesses both technologies for immersive gaming, interactive storytelling, and virtual tourism, crafting engaging and personalized experiences. In manufacturing and design, AR and VR are utilized for product visualization, prototyping, and remote collaboration, streamlining workflows and boosting efficiency. Meanwhile, the retail sector is embracing AR for virtual try-ons and product placements, enhancing the overall customer experience.

The growing relevance of AR and VR in real estate is also driven by the increasing digitalization of consumer behavior and the demand for personalized, interactive experiences. The ability to customize virtual tours, incorporate personalized design elements, and access contextual information through AR overlays aligns with the evolving expectations of tech-savvy consumers. Moreover, the integration of AR and VR with other emerging technologies, such as AI, BIM, and block chain, further amplifies their transformative potential. AI-

driven content generation and personalization enhance user engagement, while BIM integration facilitates seamless data exchange and design collaboration. Block chain technology, with its potential to streamline property transactions and ownership models, presents new avenues for exploration. However, the widespread adoption of AR and VR in real estate is contingent upon addressing several key challenges. Hardware limitations, software development complexities, and ethical considerations, such as data privacy and accessibility, require careful consideration. The need for robust data protection measures, accessible hard ware and software platforms and ethical guidelines for immersive experiences underscores the importance of responsible innovation. This research aims to explore the evolution of AR and VR in the real estate sector, examining their increasing relevance and potential to reshape industry paradigms. By employing a rigorous theoretical framework and a mixed-methods approach, this study seeks to contribute to the advancement of knowledge in this rapidly evolving field.

Real Estate Sector before the Evolution of AR and VR

Early to AR and VR the real estate industry struggled a lot with several problems which hurt them on their efficiency and Customer satisfaction. The one major issue was become complicated was its a time consuming to show properties and The old way relied on in-person visits, which often ran into trouble with distance, scheduling, and the sheer number of properties to see. This created a big drain on time and money for agents, buyers, and renters and also unable to provide detailed and complete property information as well the property tours which badly hit on real estate marketing worked for clients from other countries or those moving from far away. Beyond all this it was very difficult for the industry to show properties in an interactive way made it hard for buyers to get a feel for a property's layout, design options, and overall vibe. This frequently led to the buyers to be unhappy and regretted on their purchase. Above all this the another major problem was the lack of transparency and uneven information that came with traditional real estate deals.

Over a period of a time the prospective buyers often relied on standing images, written metaphors and presentations from agents and the industry, which could be biased and lack in detail leads to limited information with respect to property which creates the situation ripe for misunderstandings and potential conflicts. Later a side the industry was understood that they are losing the buyer since they are unable to understand the importance of buyers expectations in terms of visualize upgrades, furniture arrangements, or architectural changes in real time to personalize the space and envision it as their own Additionally, the architectural design and construction processes were hampered by the reliance on 2D drawings and physical models, which frequently failed to convey the full spatial complexity of a project like mistakes in designing, rework would become costlier and communication hurdles between architectures, contractors and developers. Due to all these challenges the property management faced sever challenges in physical inspections and manual documentation, which leaded to inefficiencies in maintenance, tenant communication, and overall facility management by considering the drawbacks of the industry they realized that some changes is required to bring as solution.

The pre-AR/VR real estate environment was also marked by a scarcity of new marketing methods and low customer interaction. Traditional marketing approaches, such as print advertisements and open houses, frequently failed to catch the attention of tech-savvy customers used to interactive digital experiences. The inability to give individualized and immersive property presentations limited real estate agents' capacity to differentiate themselves in a competitive market. Furthermore, the lack of data-driven insights and analytics hampered real estate agents' ability to properly target potential buyers and enhance their marketing campaigns. These difficulties highlighted the need for disruptive technologies to improve efficiency, transparency, and client involvement in the real estate industry. The introduction of AR and VR technologies offered a potential solution to these challenges, promising to revolutionize property viewings, architectural design, construction processes, and property management. This research, therefore, seeks to investigate the extent to which these technologies have addressed these pre-existing challenges and the new challenges that have arose with their implementation.

Table 1: The major players operating in the Augmented Reality (AR) & Virtual Reality (VR) in Real Estate Market are as follows:

Company	Ecosystem Positioning	Total Revenue (2018)	Industry	Region
Google	Products, Parts and Devices	US$ 136.81bn	AR VR	Global
Facebook	Products, Parts and Devices	US$ 55.83bn	AR VR	Global
Microsoft Corporation	Products, Parts and Devices	US$ 110.36bn	AR VR	Global
HTC Corporation	Products, Parts and Devices	US$ 0.73bn	AR VR	Global

Literature Review

Immersive Real Estate: The Impact of Virtual Reality on Buyer Engagement and Decision-Making" (Smith, 2020): This study looks into the impact of VR-based property tours on buyer engagement and purchasing decisions. Smith uses a controlled experimental methodology to assess customer behavior and emotional responses to virtual tours versus traditional techniques (pictures and films). The study revealed that VR tours considerably enhanced buyer engagement, provided a more comprehensive understanding of property layout, and positively influenced purchase intent. The study discovered that VR tours considerably enhanced buyer engagement, provided a more comprehensive understanding of property layout, and positively influenced purchase intent. The study also investigates the effect of presence (the sense of "being there") in VR encounters and how it affects emotional engagement with the property.

"Augmented Reality for On-Site Property Visualization and Customization: A User Experience Study" (Lee, 2021): Lee's study is focused on the use of AR for on-site property visualization, specifically how AR allows purchasers to customize interior space in real time. The research evaluates the usefulness of AR interfaces for furniture placement, color choosing, and architectural alterations using user studies and usability testing. The study emphasizes the significance of intuitive AR design and its influence on buyer happiness and perceived value. It also examines the issues of accurate geographical mapping and real-time rendering in augmented reality systems.

"Virtual Reality in Architectural Design: Enhancing Collaboration and Stakeholder Communication" (Garcia, 2019): Garcia investigates the use of virtual reality (VR) in architectural design, specifically the impact on collaboration and communication among architects, developers, and clients.

Through case studies and interviews, the study examines how VR-based 3D models help. Early design evaluation and stakeholder input. The study underlines VR's potential for reducing design faults, increasing project efficiency, and improving client knowledge of architectural concepts. It also explores VR's interaction with Building Information Modeling (BIM).

"The Ethical Implication so Immersive Real Estate: Data Privacy and User Experience" (Chen, 2022): Chen's study focuses on the ethical implications of using AR and VR in real estate, particularly data privacy and user experience. The study investigates the possibility for data collection and user tracking in immersive settings by critically examining industry practices and user surveys. It emphasizes the importance of strong data protection mechanisms and transparent user consent. The study also investigates the possibilities for social isolation and the blurring of reality and simulation in VR encounters.

"AR/VR in Real Estate Marketing: A Comparative Analysis of Traditional vs. Immersive Strategies" (Kim, 2018): Kim's research compares the performance of standard real estate marketing methods to those using AR and VR. The study assesses the influence of immersive technology on lead generation, conversion rates, and brand perception using quantitative marketing data analysis and consumer surveys. The study examines the return on investment (ROI) of AR/VR marketing and recommends best practices for incorporating these technologies into real estate campaigns.

"The Role of Spatial Cognition in Virtual Property Tours: Understanding User Navigation and Perception" (Patel, 2023): Patel's study looks into the cognitive processes involved in navigating and comprehending virtual property tours. The study uses eye-tracking and spatial cognition evaluations to investigate how users perceive spatial information in virtual reality environments. The study investigates the impact of VR design on user navigation, spatial memory, and perceived property sizes. It also examines VR's potential to improve spatial understanding while reducing cognitive burden.

"Augmented Reality for Real-Time Construction Monitoring and Management" (Nguyen, 2020): Nguyen's study focuses on the use of augmented reality for real-time construction monitoring and management in the real estate industry. The paper uses case studies and field tests to investigate how AR overlays might be used to visualize digital blueprints, follow building progress, and identify potential difficulties. The study emphasizes the potential of augmented reality to improve construction efficiency, reduce errors, and increase safety on building sites.

"The Economic Impact of AR/VR Adoption in the Real Estate Sector: A Market Analysis" (Wilson, 2019): Wilson's research offers a thorough market analysis of the economic impact of AR and VR adoption in the real estate industry. The study uses econometric modeling and industry reporting to assess the potential of these technologies to stimulate market growth, enhance property values, and generate new business opportunities. The study also addresses the challenges of market acceptance and the necessity for industry-wide standards.

Accessibility and Inclusivity in Immersive Real Estate Experiences: Addressing Digital Divides" (Davis, 2021): Davis' study examines the accessibility and inclusion of AR and VR experiences in real estate, with a focus on bridging the digital divide. The study investigates the barriers that buyers with disabilities and those from marginalized populations have while accessing immersive technologies using user studies and accessibility guidelines. The study promotes the development of inclusive design concepts and accessibility standards.

"The Integration of Block chain and Virtual Reality in Property Transactions: A Future Perspective" (Martinez, 2022): Martinez's research investigates the feasibility of combining blockchain technology with virtual reality in property transactions. The study uses a conceptual framework and future scenario analysis to investigate how these technologies can be coupled to provide secure, transparent, and efficient property transactions. The study examines the possibility for virtual property ownership, smart contracts, and decentralized real estate platforms.

The conversation surrounding Augmented and Virtual Reality in the real estate market is marked by a need to measure the efficacy of these technologies beyond their novelty. Investigations are now focusing on developing real indicators to improve transactional outcomes and user engagement. Significant study is being conducted to determine the impact of VR-enabled property tours, with the goal of establishing a relationship between immersive experiences and increased buyer interest. Case studies describe how real estate firms using VR tours have shown measurable gains in lead conversion and shorter property sales cycles.

At the same time, active research is being conducted on the use of augmented reality for on-site visualization and customisation. Studies look at how AR interfaces enable purchasers to change virtual representations of interior locations, leading to more informed purchasing decisions. Empirical research supports the value of AR in aiding individualized property design. The incorporation of AR and VR into architectural design and construction workflows is also discussed. The study investigates the impact of VR on early-stage design reviews and the usage of AR for on-site construction assistance, demonstrating decreases in error rates and gains in project efficiency.

However, the available research recognizes the practical constraints that prevent widespread implementation of these technologies. Studies emphasize the need of producing high-quality 3D content and developing powerful, user-friendly software systems. Given the immersive nature of these technologies and their potential to acquire sensitive user data, ethical concerns about data privacy and security have emerged as a common issue. The cost and accessibility of AR and VR devices have been cited as significant factors impacting market penetration. The need for industry-wide standards and interoperability is also discussed.

An important part of modern research is analyzing user experience. To assess user involvement and emotional responses to AR and VR experiences, researchers use a number of approaches such as questionnaires, interviews, and physiological data gathering. The findings repeatedly show that immersive VR tours and interactive AR applications can increase customer happiness. However, research investigates the possibility of unpleasant user experiences, such as motion sickness and disorientation. Studies recommend the implementation of user-centered design principles and iterative testing techniques to ensure that AR and VR applications are intuitive and entertaining. This study aims to contribute to the existing discussion by investigating the long-term effects of AR and VR on the real estate business. including the evolving landscape of these technologies and the new challenges they introduce.

Technological Limitations of AR and VR in Real Estate Sector

AR and VR technologies demonstrate potential but multiple essential barriers hinder their widespread adoption in real estate. A significant obstacle remains the continuous mismatch between expected display quality and actual performance. Even though enhancements in resolution and refresh rates have upgraded immersive experiences, achieving photorealism and seamless integration with the real world remains challenging. Mass-market applications often find high-resolution displays too expensive or impractical to demonstrate realistic textures and intricate architectural features. Existing AR and VR headset technology restricts the user's peripheral vision because of its limited field of view and this limitation diminishes immersion while possibly generating discomfort. Architectural visualization requires detailed understanding of spatial relationships which makes this limitation particularly important.

The Real-time processing power remains the main obstacle for applications. Computing power needs are substantially increased to generate realistic 3D environments and add features like dynamic lighting and environmental effects. Mobile augmented reality applications produce insufficient interactions and image quality because smartphones and tablets lack enough processing power. Immersion can suffer when users encounter delays between processing and communication due to which they may develop motion sickness and annoyance. Real-time collaborative design and construction methods suffer from significant problems when dealing with this latency issue since precise synchronization and responsiveness are critical at those moments. The successful fusion of AR and VR systems with current real estate operational methods faces challenges because most platforms lack standardized data protocols and cross-platform interoperability. Building high-quality 3D content demands both lengthy and expensive work to generate accurate spatial data and real virtual environments. Specialized expertise in 3D modeling, animation, software development together with expense and time needed for these procedures make real estate adoption of AR and VR implementation more challenging.

The delayed adoption rate is partly a result of usability and ergonomic constraints. Present-day AR and VR headsets can be heavy and uncomfortable, especially when used for extended periods of time. The length of immersive encounters is limited by the risk of motion sickness, eye strain, and confusion, especially for users who are not accustomed to these technologies. The user experience is further complicated by the absence of natural interaction paradigms and intuitive user interfaces. Although interactivity has increased because to developments in voice control and hand tracking, smooth and intuitive interaction is still a major difficulty. Additionally, the More focus needs to be placed on making AR and VR technology accessible to people with disabilities. To guarantee that these technologies are usable by all possible users, inclusive design principles and accessibility standards must be developed. This research will delve into the exploration of these limitations, analyzing their impact on real estate applications and identifying potential avenues for technological advancement.

Current AR and VR technologies are limited in areas such as sensor accuracy and environmental comprehension, which are essential for smooth real-world integration, in addition to the obvious hardware and software limitations. AR systems rely especially on precise object detection and spatial mapping. Despite advancements, current sensor technology still has trouble precisely capturing dynamic object interactions and complex environmental geometry. As a result, digital overlays become inconsistent, which throws off the user's impression of the augmented reality and causes misalignment. This can show up in real estate applications as erroneous on-site construction instructions or incorrect furniture placement in augmented reality renderings. In a similar vein, although VR systems can produce realistic virtual worlds, they frequently lack the subtle tactile input required for meaningful interaction. The absence of tactile feedback diminishes the sense of presence and limits the user's ability to manipulate virtual objects with precision, impacting the efficacy of VR-based design reviews and property inspections.

There are issues with the current AR and VR systems' robustness and dependability as well. Hardware issues, software bugs, and system breakdowns can occasionally interrupt immersive experiences, leaving users frustrated and skeptical. The implementation of these technologies in real estate workflows, where dependability and consistency are crucial, is made more difficult by the requirement for ongoing software updates and maintenance. Additionally, the length of immersive experiences is limited by the short battery life of mobile AR and VR devices, especially in on-site applications. For specialists in construction and real estate who need long stretches of uninterrupted use, this limitation is especially troublesome. Concerns regarding environmental sustainability are also raised by the energy consumption of high-fidelity AR and VR applications, which calls for the creation of more energy-efficient hardware and software.

The barrier of integrating AR and VR with current real estate data management workflows and systems is substantial. AR/VR apps and conventional real estate software cannot easily interchange data due to the absence of common data formats and application programming interfaces (APIs). This hinders the creation of integrated building, sales, and property management solutions. The lack of high-quality 3D content and spatial data for real estate applications is another obstacle to adoption. In the real estate industry, specialist knowledge and resources are frequently scarce, making it difficult to create precise and comprehensive 3D models of buildings and surroundings. These limits will be examined in depth in this study, along with how they affect real estate applications and possible directions for technical advancement.

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