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Systematic Literature Review of Interior Design in Virtual Reality Environment

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ABSTRACT

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The purpose of the current paper is to review the potential interior design in virtual reality environment. Therefore, in this systematic literature review, we analyse findings on virtual reality interior design and disseminate this information as a written overview of current studies. Six papers were selected after 146 papers from Scopus databases were shortlisted and subjected to various inclusion and exclusion criteria. Virtual reality has the potential to be a tool for interior designers when it comes to design. Future research can gather more thorough data by incorporating conference articles and merging information from various databases.

1. Introduction

The use of virtual reality has grown during the previous two years [1]. A person's field of perception is covered by a combination of video and audio called virtual reality (VR), which also interacts with the person's perceptual process to give the impression that it was made by a computer and give the actual world more credibility [2]. To better understand virtual reality, let's contrast it with actual observations. We can understand our environment thanks to our senses and our body's perceptive mechanisms [3]. The creation of an immersive virtual reality environment involves the usage of software. Wearing a head-mounted display (HMD) puts the user inside a VR experience, unlike traditional user interfaces, allowing them to interact with the environment and virtual characters in a way that seems authentic. More than any other technology that has ever existed, VR has a special ability to give people the impression that they are somewhere else. As in real life, this enables people to learn from experience [4]. The power of VR is in its capacity to deliver experiences on demand. Users that wear specific gloves, goggles, or other types of gear interact with virtual worlds that have been built and are maintained by software. The virtual world can be observed and

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interacted with by users as though they were actually there [5]. Both mobile and tethered VR applications use gaze tracking, IR sensors, gyroscopes, and accelerometers to adjust the user's point of view naturally [6].

Virtual Reality Interior Design is an application for virtual reality that enables you to design and explore your virtual home. With the help of this application, users may choose a new home design, explore it, and decorate it. They can also decide which design best suits their preferences and what they need to decorate their home with. Also, enable users to create immersive designs for their home ideas. In terms of their objectives and the results of the research in their specific areas, the most recent evaluations of virtual reality papers are summarized in this document. Although it hasn't yet been examined, there is a more recent tendency in this field.

2. Literature Review

The goal of the research was to find studies that examined the use of virtual reality in interior design. Our primary resource for locating the pertinent publications was Scopus. Table 1 lists the search terms that were used:

- i. "virtual reality"
- ii. "interior design"
- iii. "virtual reality"
- iv. "interior design"

Table 1

Number of research articles for the searched keyword

Keywords/Combination of Keyword	Database	Number of Results
"virtual reality"	Scopus	142,491
"interior design"	Scopus	6,295
"virtual reality" AND "interior design"	Scopus	146

A total of 146 articles pertinent to the research issue were chosen from the results in Table 1. Six articles in total were chosen for review in Figure 1 after the inclusion and exclusion criteria were applied, duplicate papers were eliminated.

2.1 Inclusion and Exclusion Criteria

The review comprised five years' worth of full-text, peer-reviewed academic papers. Any non-peer-reviewed or duplicate papers were omitted from the final selection of articles, and all chosen articles were written in English and were published as articles.

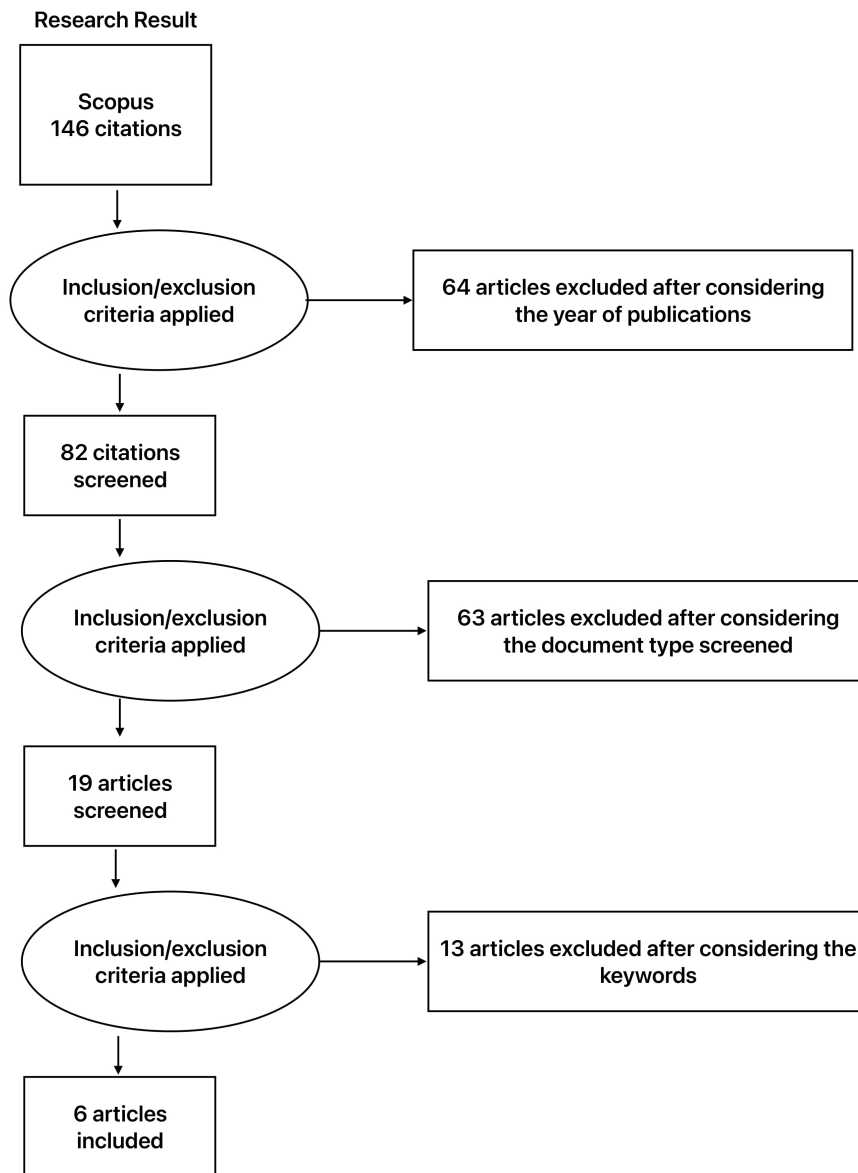


Fig. 1. PRISMA diagram detailing the study identification and selection process

Table 2
 Summary of earlier research

Author	Title of Study	Keywords	Findings	Ref
1. Tian, L.	Application of Chinese Classical Garden Landscaping Techniques in Modern Indoor Natural Landscape Design from the Perspective of Virtual Reality Technology	<ul style="list-style-type: none"> • Influence of old to new type of interior • Transformation from traditional to modern design through multimedia (virtual reality) 	<ul style="list-style-type: none"> • This study examines how ancient gardens have influenced modern space design in terms of the types of spaces created, the forms of their structures, and the language used to describe them. • The foundation of the mechanism for transforming a conventional garden into a modern design through multimedia information is the major focus of this essay. 	[7]
2. Kim, T., Shunayeva, A., Lee, G., Suk, H.-J.	Sketching in-vehicle ambient lighting in virtual reality with the Wizard-of-Oz method	<ul style="list-style-type: none"> • Encourage designers into lighting design workplace 	<ul style="list-style-type: none"> • This study created a lighting sketch tool for vehicle interior designers that is backed by virtual reality (VR). • This study looks ahead to situations and a well-illustrated virtual environment that will draw designers into a stimulating lighting design environment. 	[8]
3. Sai, L., Yufei, H.	Study on the architecture design and interior decoration based on VR technology and computer simulation platform	<ul style="list-style-type: none"> • Reflect structural characteristics of every part from indoor layout • Computer-aided design tools for interior designers 	<ul style="list-style-type: none"> • In this article, the author evaluates interior design and architectural planning using virtual reality and computer simulation platforms. • The advancement of computers will significantly increase the effectiveness and calibre of interior design, according to the expression of interior design. • An adequate understanding of computer 3D animation technology is essential for interior designers as it allows them to reflect the structural qualities of each component from the internal layout while also demonstrating the design's authenticity from the design standpoint. 	[9]
4. Xue, W.	Virtual reality interior design based on paper material and fuzzy evaluation method	<ul style="list-style-type: none"> • Substantive content of fuzzy evaluation method material • Visualize paper product/material such as wallpapers and crafts 	<ul style="list-style-type: none"> • For the reader, this article has to clarify the main virtual reality subcategories before describing how conventional interior design functions. • This article on fuzzy evaluation will go into detail about the method's core ideas and how 	[10]

5.	Xue, W.	VR Technology Based on the Interior Design and Artistic Value Analysis and Optimization Methods	<ul style="list-style-type: none">• User's interaction in real-time feedback to human face, eye rotation, hand movement with the virtual environment.	<ul style="list-style-type: none">• Users can engage with the virtual environment by making use of some very natural technology, like as their own eye rotation, hand motions, and other behavioural movements. The computer will recognise these movements and provide real-time feedback to the user's face as a result.• Computer graphics technology is mostly used to produce in-the-moment, three-dimensional visual effects.	[11]
6.	Gao, Z., Huang, J.	Design and application of virtual reality technology in 3D interior design and simulation system	<ul style="list-style-type: none">• 3D interior design with virtual reality technology applied to the design and simulation system	<ul style="list-style-type: none">• Virtual reality interior design enables the user and the designer to experience the impact of what they see. Additionally, it enables users to have an immersive experience by making them feel as though they are inside the created virtual setting.• The virtual reality technology is used to create and implement the simulation system in this article, which uses a 3D interior design and simulation system as the research object.	[12]

Virtual reality is one of the study areas with the highest interest since the technology has evolved substantially over the years and is continually evolving. Scopus was used for the systematic literature search. The publication trends considered in this review from 2008 are shown in Figure 2. Every year until 2022, the quantity of articles will rise significantly. After that, a decline to less than 50 publications were seen between 2019 and 2020, but an increase to more than 100 publications was seen from 2021 to 2022.

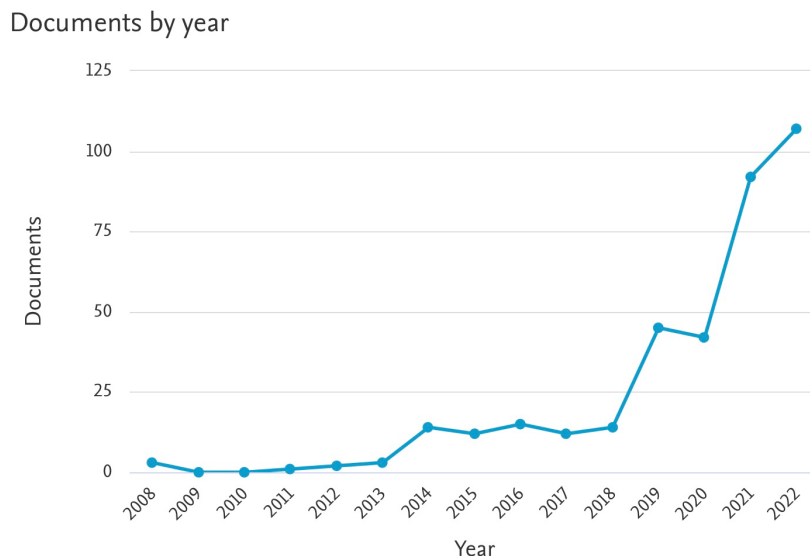


Fig. 2. Document publications trends (Source: Scopus)

Documents connected to the virtual reality domain came from a single source and were of diverse forms. Reviews accounted for 71.5% of all published documents in the Scopus database, followed by articles with 23.2% and conference papers with 1.1%, as shown by the contrast in Figure 3.

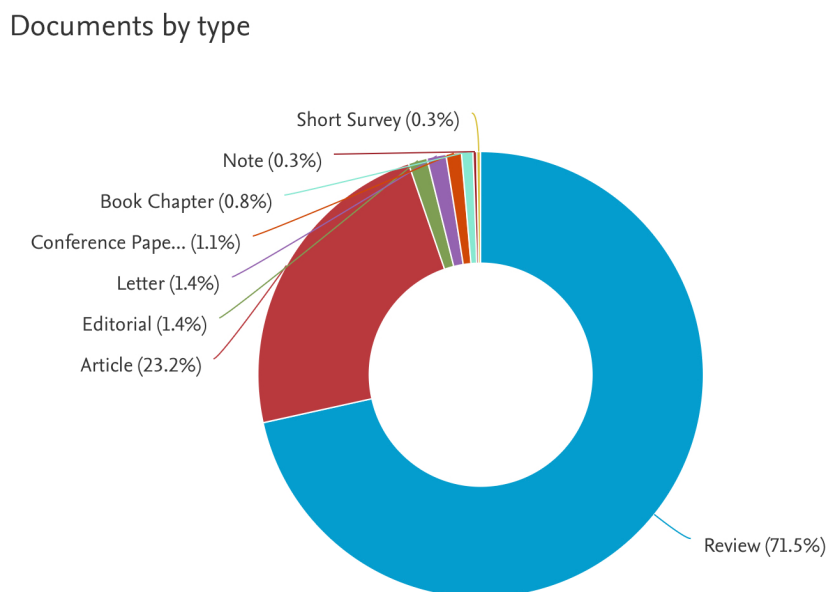


Fig. 3. Document publications trends (Source: Scopus)

Additionally, Scopus displays document publications by subject. According to reports, 51.5% of the subjects are related to medicine. In their database, the health profession came in third with 6.4%, followed by the neuroscience with 8.8%. In Figure 4, the comparison of documents released by subject area is displayed.

Documents by subject area

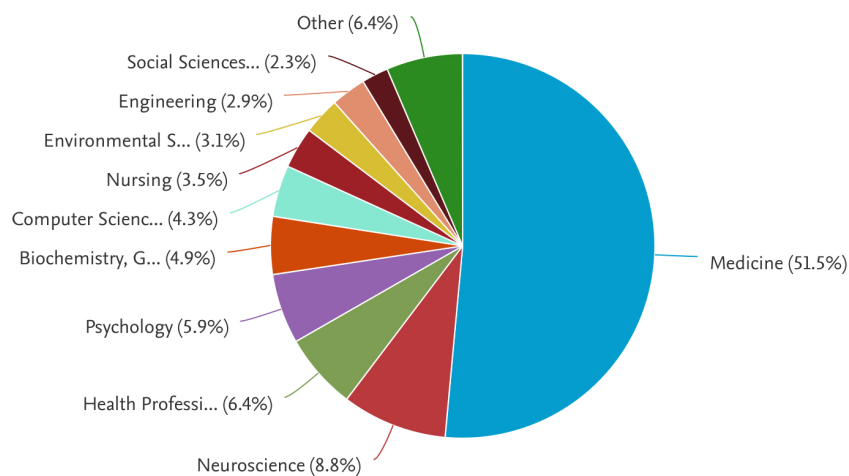


Fig. 4. Subject-based comparison of document publications (Source: Scopus)

3. Virtual Reality Interior Design

Virtual reality design is where users can engage with the virtual environment with their hands, eyes, and hearing just like they would in the physical world [13]. Then, users also able to enjoy virtual reality thanks to the system. Additionally, it promotes the self-determination hypothesis, which encourages effective behaviour by supporting users' innate propensity towards it [3]. If there is a system that uses VR technology to display all furniture in a virtual setting, users may have a more intuitive grasp of interior design [14]. With the ongoing advancement of computer hardware and software, three-dimensional computer technology is being employed to create the illusion of an interior environment. On the one hand, the operation of design software has advanced and is now quick, easy, and practical. On the other hand, the three-dimensional technology simulation of the space's light, material, and texture can practically duplicate the real impression. It has the ability to intuitively and accurately depict real space, observe the three-dimensional space model from different perspectives, and quickly launch a number of different schemes at once [15].

Three categories—non-immersive, immersive, and semi-immersive—are used to classify the VR system [1]. Compared to the other two, the non-immersive offers a less immersive experience. Only a mouse and joystick are required for human interaction with the environment [16]. The best illustration of a non-immersive setting is a video game. Although it serves as a stand-in for reality, semi-immersive utilises the hybrid system [6]. This kind of setting is widely employed for educational purposes [17]. Take the flight sim, for instance. The maximum level of immersive virtual reality is offered by the immersive category, though [1]. Consider the head-mounted display (HMD) system or a virtual reality room that is completely furnished. The virtual reality system category is listed in the Table 3 below, along with information and resources.

Table 3
 System Category for Virtual Reality

Category	Feature	Gears
1. Non-Immersive	- Less immersive - Less sophisticated component	- Stereo display monitor for a 3D environment or glass
2. Immersive	- Most high-priced - Absolute depth of immersion - Experiencing the virtual environment (VE)	- Head-mounted display (HMD) - Tracking hardware devices - Data glove input devices
3. Semi-Immersive	- A hybrid or augmented reality system - The high-level of immersion	- Desktop type of virtual reality - A few physical models

Virtual reality interior design is one of the most anticipated domains in research since the technology has evolved substantially over the years and is continually evolving. Scopus was used for the systematic literature search. The publication trends considered in this review from 2008 are shown in Figure 5. Every year until 2022, the quantity of articles will rise significantly. After that, a decline to less than 5 publications were seen between 2011 and 2016, but an increase to more than 10 publications was seen from 2017 to 2022.

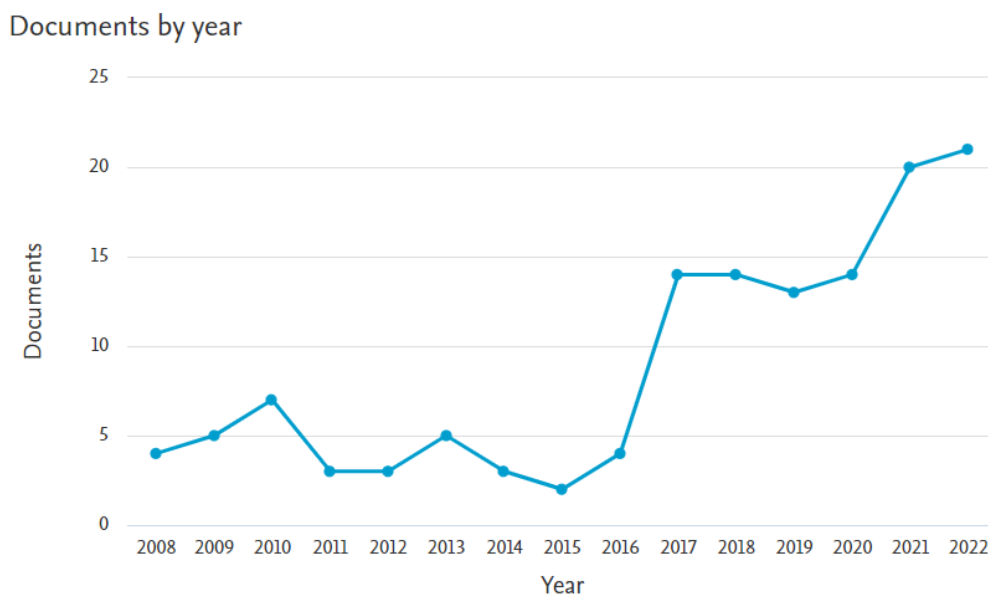


Fig. 5. Document publications trends (Source: Scopus)

Documents connected to the virtual reality interior design domain came from a single source and were of diverse forms. Conference papers accounted for 65.2% of all published documents in the Scopus database, followed by articles with 31.8%, book chapter 2.3% and note with 0.8%, as shown by the contrast in Figure 6.

Documents by type

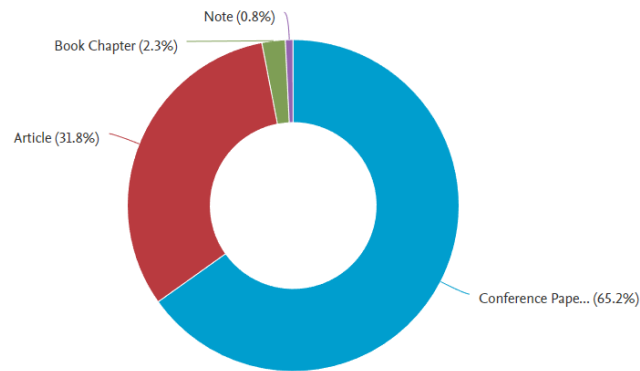


Fig. 6. Documents by type

Additionally, Scopus displays document publications by subject. According to reports, 29.2% of the subjects are related to computer science. In their database, the engineering came in third with 22.7%, followed by the other subject's area with 8.8%. The comparison of documents published by subject area is shown in Figure 7.

Documents by subject area

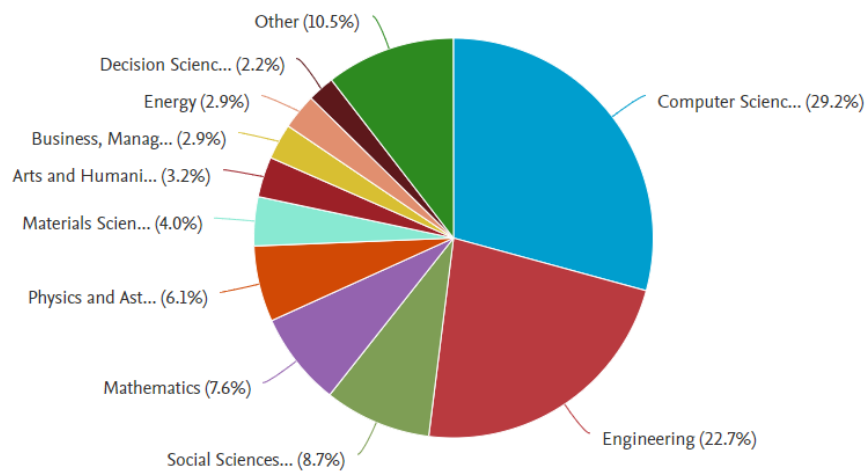


Fig. 7. Comparison of documents published by subject (Source: Scopus)

Artificial intelligence, human-computer interaction, sensing, computer graphics, and other disciplines are all combined in Virtual Reality (VR), a flexible technology [18]. Study finds clear analogies between studies in virtual environments and VR. Virtual worlds incorporate interactive features that allow users to explore and control their surroundings, as well as visual and sensory design elements, to create elements of exploration and using skills to interact with the environment [19]. The experiences of one individual are filled by VR and gives the impression that it was created by a computer using a combination of video and audio with the help of their perceptual system [20]. These applications also included multimedia elements, which include a mix of text, audio, photos, drawings, and interactivity [21,22]. Graphic instructions and information are also conveyed through pictures and illustrations [3].

An immersive VR environment was used to evaluate the psychological and physiological responses to stressful events in a recent study on mindfulness practise and meditation [23]. It has been demonstrated that using real-world events generated by virtual reality can reduce anxiety and increase mindfulness [24]. The most major distinction between non-immersive and immersive virtual reality is the degree of presence (or immersion), which the immersive version attempts to augment through the use of stereoscopic visualisation and other resources [25].

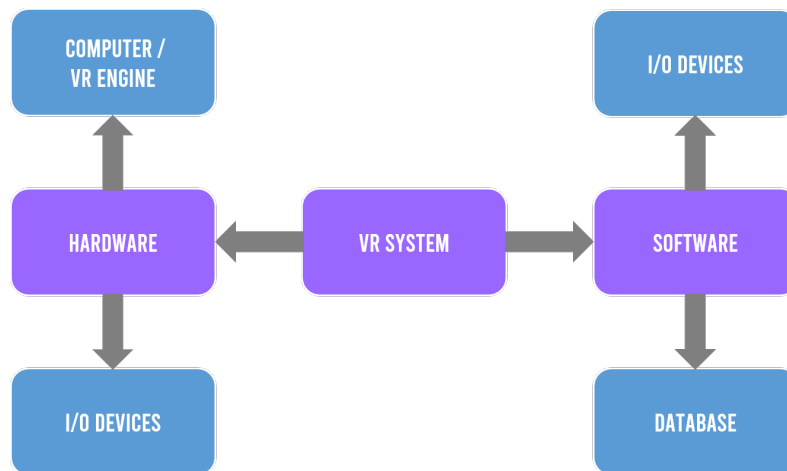


Fig. 8. Virtual Reality System

Virtual reality can be categorised into three categories based on system characteristics: immersive (head mounted displays, or HMDs), non-immersive (monitors or wall projections to display 3D images on a 2D surface), and augmented (improving perception of reality combined with computer-generated sensory input) [26,27]. While VR has the potential to be totally immersive. Users commonly become disoriented and even experience VR sickness, which is described as the sensation of self-motion that is exclusively produced visually (as opposed to physically moving) and that induces symptoms including nausea, headaches, and disorientation [29].

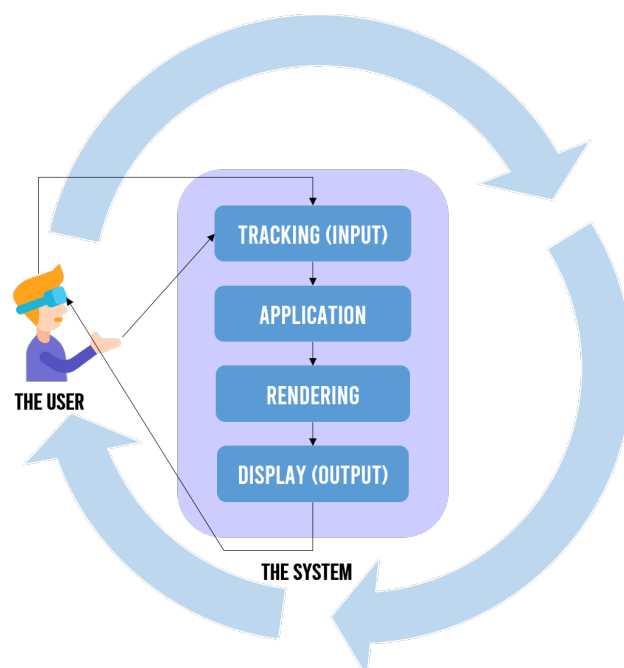


Fig. 9. Virtual Reality Simulation Loop

Technology for virtual reality (VR) is now used in a number of social contexts. It also promotes the usage of traditional interior and architectural design components [29]. Approaching architecture, interior design, and landscape architecture in a cultural and creative business is the best time to introduce VR [30]. Our own home is the 3D environment we interact with on a daily basis. Centralism is becoming more noticeable in how individuals decorate their homes as living standards grow and people begin to worry more about their quality of life. As a result, it is crucial to use VR technology to improve interior design for people [31].

Many designers and target marketers may be able to benefit from accessible and rapid performance solutions by utilising technology for indoor performance using virtual reality. Users will have a better intuitive understanding of interior design if there is a system that displays all furnishings in a virtual space using VR technology.

4. Discussion

This research has examined the use of virtual reality in interior design by reviewing existing literature. The findings suggest that virtual reality can greatly aid interior designers in the design process, particularly when creating home designs. The studies reviewed showed that the most commonly measured outcome was the use of virtual reality as a design tool. Virtual reality allows designers to use the virtual environment as a guide, helping them to develop new ideas and visualize their designs. Additionally, the immersive experience of virtual reality allows designers to see their designs in a more realistic and interactive setting, which can inspire them to create innovative designs. Furthermore, virtual reality technology can also be used to create virtual walkthroughs and 3D visualizations of structural elements, such as indoor layouts. Overall, virtual reality can be a valuable tool for interior designers, allowing for a more natural, efficient and accurate design process.

5. Conclusions

Virtual reality technology advances human-machine interaction to the next level. This study demonstrated how virtual reality might significantly benefit many areas of society in addition to opening the door to potential new discoveries. Additionally, this study discovered various restrictions and limits that prevented them from utilising technology to its maximum potential. The current results, according to this study, need to be thoroughly investigated. The use of virtual reality technology is anticipated to be significant for a very long time. Technology today frequently undergoes rapid change. This review has limitations as findings are circumscribed by literature data retrieved from selected journals in Scopus. Future research should incorporate conference articles and combine data from various databases, such as Web of Science and Scopus, to obtain more thorough data. It should also suggest potential research directions based on the analysis of review results and the author's expertise, which could result in incomplete data. The outcomes and conclusions from this study will be presented to a group of professionals in subsequent work for additional validation.

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