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Virtual Reality and Its Main Characteristics: A Beginner's Guide

Realidad Virtual y sus principales características: una guía para principiantes

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Abstract: Virtual Reality (VR) is a transformative technology that simulates environments through computer-generated imagery, aiming to replicate real-world experiences. Defined by three main characteristics: immersion, perception, and interactivity, VR has great potential in various fields, particularly in education and therapy. Despite its promise, it has not achieved the level of adoption anticipated, often due to technological and economic barriers. This article provides an introductory guide for beginners, explaining the sensory roles in VR and how these elements contribute to creating immersive experiences. It also explores VR's applications, including its role in training and education, its motivational benefits, and therapeutic uses. Additionally, the article discusses the challenges that hinder VR's widespread implementation, such as high costs, cognitive load, and lack of essential applications. The aim is to shed light on the importance of VR as a powerful educational tool while highlighting the factors impeding its broader adoption.

Keywords: Immersion; Interactivity; Massification; Perception; Senses; Virtual Reality

Resumen: La Realidad Virtual (RV) es una tecnología transformadora que simula entornos a través de imágenes generadas por computadora, con el objetivo de replicar experiencias del mundo real. Definida por tres características principales: inmersión, percepción e interactividad, la RV tiene un gran potencial en diversos campos, particularmente en educación y terapia. A pesar de su promesa, no ha alcanzado el nivel de adopción esperado, debido a menudo a barreras tecnológicas y económicas. Este artículo ofrece una guía introductoria para principiantes, explicando los roles sensoriales en la RV y cómo estos elementos contribuyen a crear experiencias inmersivas. También explora las aplicaciones de la RV, incluida su función en la capacitación y educación, sus beneficios motivacionales y sus usos terapéuticos. Además, se abordan los desafíos que dificultan la implementación generalizada de la RV, como los altos costos, la carga cognitiva y la falta de aplicaciones esenciales. El objetivo es destacar la importancia de la RV como una poderosa herramienta educativa, al mismo tiempo que se resaltan los factores que impiden su adopción más amplia.

Palabras clave: Inmersión; Interactividad; Masificación; Percepción; Realidad Virtual; Sentidos

1. Introduction

In today's era, technology has become an outstanding tool for creating new types of experiences. It can be confidently stated that scenario simulation holds some of the greatest potential among these innovations. Among the various technologies available, Virtual Reality (VR) is undoubtedly the most recognized, as it offers levels of immersion that other technologies are unable to match.

First mentioned in the 1960s by Ivan E. Sutherland, VR has evolved over time, giving rise to new experiences across different fields. Although the term "Virtual Reality" was coined in 1989 by Jaron Lanier, a former Atari employee and executive at VPL Research Inc., the concept has existed under various names that share the same core idea: offering an experience that differs from the user's physical surroundings. Terms such as Telepresence, Virtual Environments, Artificial Reality, and Synthetic Environment have all been used to describe this technology and are still used today [12;39].

VR presents endless opportunities across a wide range of fields; however, it has not yet achieved the level of widespread adoption once anticipated. Several factors may have influenced this limited reach, and understanding them is essential to contextualizing the development and current state of the technology. Likewise, clarifying fundamental concepts such as immersion, perception, interactivity, and the role of sensory input contributes to a clearer understanding of VR and its potential uses across different domains.

This article is organized as follows: Section 2 presents the main contributions of the study, outlining the key insights and objectives. Section 3 details the methodology used to gather and analyze information about Virtual Reality (VR). Section 4.1 introduces the fundamental concepts of VR, including its history and defining characteristics. Sections 4.2 and 4.3 explore VR's applications in education and therapy, as well as its role as a motivational tool. Section 4.4 distinguishes VR from related technologies such as Augmented Reality and Mixed Reality. Sections 4.5 and 4.6 discuss the importance of the senses in VR and the relationship between immersion, perception, and interactivity. Section 4.7 reviews the positive and negative aspects of VR, while Section 4.8 examines the factors hindering its widespread adoption. Finally, Section **??** present the conclusions and suggestions for future research.

2. Contributions

This work provides a comprehensive introductory overview of Virtual Reality (VR), aimed at clarifying fundamental concepts for readers new to the technology. The main contributions include:

i. A clear explanation of VR's defining characteristics; immersion, perception, and interactivity, highlighting their interrelations and importance for creating engaging virtual experiences.
ii. An analysis of the role of human senses in VR, emphasizing how sensory stimulation enhances immersion and influences user experience.
iii. A detailed review of VR's educational and therapeutic applications, illustrating its unique ability to simulate unlikely scenarios and support task repetition in controlled environments.
iv. An evaluation of both positive and negative aspects of VR, including motivational benefits and challenges such as cognitive load and cybersickness.
v. Identification and discussion of the key factors hindering VR's widespread adoption, such as device costs, technological unfamiliarity, and the lack of indispensable applications.
vi. The presentation of this knowledge in a structured, beginner-friendly manner to support wider understanding and potential future adoption of VR technologies in education and other sectors.

3. Methodology

This study employs a descriptive and analytical approach to present the foundational concepts and current status of Virtual Reality (VR) technology. It is based on an extensive review of relevant literature, including seminal works and recent advances related to VR's core characteristics, sensory involvement, educational applications, and challenges to widespread adoption.

The methodology encompasses a thorough literature review, conceptual analysis of sensory engagement in VR, a survey of its practical applications in education and therapy, and identification of barriers to mass adoption through market and user experience evaluations. The synthesized findings are organized to offer a clear and accessible introduction for beginners, emphasizing both the opportunities and limitations of VR technology.

4. Results

4.1. What is Virtual Reality?

From its inception, concepts such as simulation and telepresence have been associated with this technology. Initially, Ivan E. Sutherland discussed the possibility of emulating the real world, with all its characteristics, through the use of electronic devices such as displays and computers, which would later become known as Virtual Reality (VR) [12]. Not long after, Myron Krueger also contributed to the field with the development of responsive environments. However, the term "Virtual Reality", which became the most widely used name for the technology, was coined in 1989 by Jaron Lanier, a former employee of Atari and VPL Research [27].

In 1992, Fuchs emphasized the importance of concepts like immersion in simulated environments and also used terms such as Virtual Environment. He noted that while the technology might go by various names, the core objective remained the same: to create a simulated world [12].

By analyzing the evolving definitions over time, Virtual Reality can be broadly defined as a computer-based system designed to simulate the characteristics of the real world. Although definitions may differ in certain aspects, most of them consistently emphasize three fundamental elements: immersion, perception, and interactivity [2;6;9].

4.2. VR in education and treatment of patients

In the present day, technology has significantly enhanced the process of knowledge transfer between teachers and students. Recognizing the educational potential of Virtual Reality (VR), numerous researchers have begun experimenting with this tool. This interest is largely driven by VR's ability to simulate uncommon scenarios and support the easy repetition of tasks [1;26;33].

A common example is the creation of virtual environments to support medical education. By simulating operating rooms and other clinical facilities, VR enables students to practice surgical procedures without the risk of harming real patients [11;30]. This reduces the cognitive load on students, while increasing their confidence and competence. These benefits tend to improve over time as learners engage in repeated practice within VR settings [7;18;45].

Researchers such as Frank Biocca, Jack Loomis, and Jim Blascovich also recognized VR's potential, particularly within the social sciences, and conducted numerous studies utilizing the technology [4;25]. Blascovich even founded the first research center dedicated to exploring the use of VR in this field during the 1990s. This milestone led to the development of a new form of therapy that employs virtual environments to simulate real-life situations that patients might otherwise avoid. Today, these therapeutic approaches remain widely used, as VR, like in education, offers a controlled, monitorable setting where users can engage in activities repeatedly and safely [16;41].

4.3. VR as a motivational tool

Virtual Reality (VR) offers numerous benefits, but its ability to motivate students and maintain their engagement in learning activities is particularly remarkable [10;35;44]. For this reason, VR is commonly used in educational and training contexts, as it allows learners to repeat tasks without the pressure of severe consequences in case of mistakes or failures.

However, several factors must be considered when applying VR in educational settings. One notable concern is the high cognitive load often associated with its use. Therefore, it is crucial to assess whether VR is suitable for a given learning situation [24]. When implemented appropriately, VR can serve as an outstanding motivational tool, further enhancing its advantages when used to complement traditional educational methods [17].

4.4. Differences between Virtual Reality, Augmented Reality and Mixed Reality

In 1964, Ivan E. Sutherland proposed the creation of an artificial world that would emulate the characteristics of the real world. This vision would be realized through the use of electronic devices, such as computers and related technologies [40]. Over time, advancements in electronic devices have brought this idea closer to reality, enabling the development of unique and immersive virtual experiences. The core principle of Virtual Reality (VR) is to deceive the user's senses and create the illusion of being in a different environment.

In contrast, in 1990, Thomas Caudell introduced the concept of Augmented Reality (AR) to describe a new type of technology that, unlike VR, does not aim to create an entirely new reality, but rather to enhance the user's perception of the real world [15]. This enhancement is achieved by overlaying digital elements, such as text, images, and 3D polygons, onto the physical environment. AR is widely used today, including in educational contexts.

Another technological variation is Mixed Reality (MR), a term introduced in 1994 by Paul Milgram and Fumio Kishino. MR represents a hybrid of AR and VR, where real and virtual elements coexist and interact in real time [31;32]. Figure 1 illustrates the origin dates of VR, AR, and MR technologies.

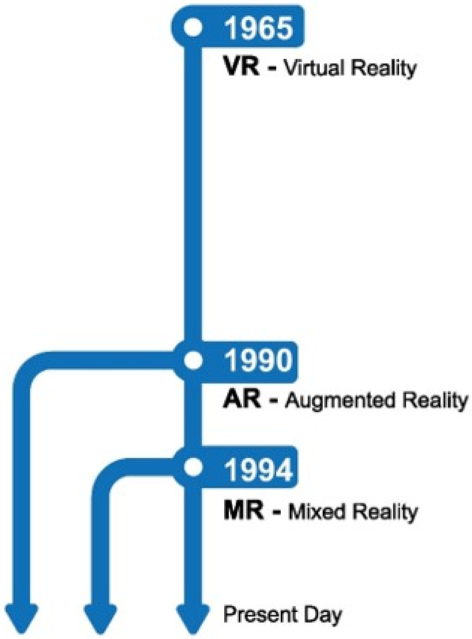

Figure 1. Birthdates of VR, AR and MR.
Source: The authors.

4.5. Senses in VR

Without a doubt, the role of vision in Virtual Reality (VR) cannot be overstated. As the primary gateway to the virtual experience, it is widely regarded as the most crucial sense in the stimulation of VR environments. For this reason, visual input must be carefully considered to deliver a truly immersive experience. Vision is also classified as one of the key "external factors" that contribute to immersion in VR. Although other senses may not play as central a role as sight, they still significantly enhance the immersive quality of VR experiences [19;43].

In reality, the process of creating immersive environments is more complex than it may initially appear. In the real world, we rely on all our senses to interpret and interact with our surroundings. As Sekuler and

Blake noted, the brain serves as our main interface with external reality [5]. Whether in a real or virtual environment, we receive sensory feedback that helps us make decisions based on context. In virtual settings, vision is often prioritized, followed by touch. While this focus is not inherently flawed, it differs significantly from real-life perception, where all senses, though used in varying degrees, contribute to the experience. This underscores the strong connection between sensory stimulation and immersion.

Currently, immersion in VR can be classified into three levels. The first is Desktop VR, considered the most basic form of simulation. It typically involves standard monitors and lacks specialized devices for sensory stimulation, such as headsets or haptic controllers. The second level is Fish Tank VR, which employs more advanced technologies but relies on limited or basic sensory stimulation tools. These setups often provide moderate immersion and minimal interactivity. Finally, Immersive Systems represent the highest level of VR experience, utilizing advanced devices that offer rich multisensory engagement and the deepest levels of immersion [29].

4.6. Immersion, Perception and Interactivity

There are three core elements that are widely recognized as the main characteristics of Virtual Reality (VR): immersion, perception, and interactivity.

The first is immersion, which refers to the ability of a simulation to recreate an environment, scenario, or situation, including the user, through the stimulation of the senses. Immersion enhances the realism of the experience and is essential for establishing a strong sense of engagement.

Immersion, in turn, can lead to perception, often described as the feeling of "being there." It refers to the user's subjective experience of being physically present in a virtual environment, despite being located elsewhere in the real world. This concept is also commonly known as presence.

The third element is interactivity, which is closely linked to immersion. Interactivity refers to the user's ability to interact with the virtual environment and receive appropriate feedback based on their actions [5;9;37;43].

As illustrated in Figure 2, immersion, perception, and interactivity work in synergy to create an engaging and convincing virtual experience, one that enables the user to feel truly transported to a different scenario.

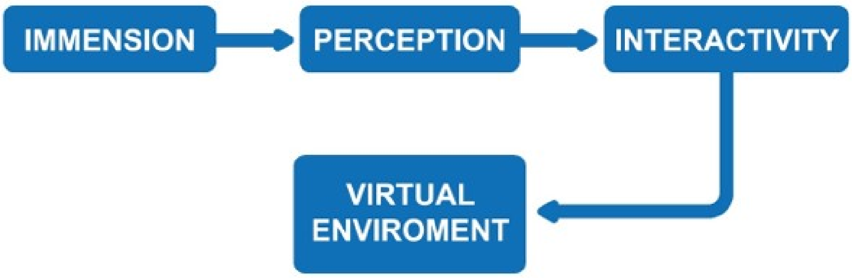

Figure 2. Immersion, perception and interactivity relationship.
Source: The authors.

4.7. Positives and negatives aspects of VR

As previously mentioned, Virtual Reality (VR) is an excellent teaching tool that motivates students and enhances their engagement. Its educational effectiveness increases even further when used in combination with traditional instructional methods. Moreover, VR facilitates the transfer of knowledge between teachers and students, and supports skill acquisition through repeated practice in supervised environments [20].

However, effective implementation of VR is essential, along with a thorough understanding of the context in which it will be applied. The use of VR can impose a high cognitive load on users [24], so it is important to assess whether its use is appropriate for a given situation. Research shows that in certain contexts, traditional educational methods can be equally or even more effective than VR-based approaches [13;22;34].

Additionally, this technology may not be suitable for all users. Studies suggest that 25% to 40% of users may experience cybersickness, a condition triggered by movement in virtual environments, which can lead to symptoms such as dizziness and nausea [14] (see Table 1).

Table 1. Positives and negatives aspects of VR

Positives	**Negatives**
Motivational tool	High cognitive load
Students' engagement	Sometimes VR is not as efficient as traditional educational methods
High effectiveness when used along traditional educative methods	Cybersickness
Facilitate skill acquisition	

Source: The authors.

4.8. What is hindering the expansion of VR?

Over time, Virtual Reality (VR) technology has advanced significantly, enabling the development of more sophisticated devices with enhanced features. Additionally, new, more accessible options, such as Google Cardboard, have emerged. While researchers have long recognized the educational benefits of VR, these technological trends have encouraged further experimentation with its applications [20;38].

Despite these developments, it is accurate to state that VR has not yet achieved widespread adoption. Several factors contribute to this limited diffusion. The first major barrier is cost. Although VR devices are now more affordable than in the 1990s and early 2000s, they are still considered expensive for a large segment of the population [20]. Beyond the head-mounted display (HMD), users often need to purchase a compatible high-performance computer to achieve a quality experience. Both the computer and HMD must meet advanced technical requirements [3;38].

Another factor is the lack of familiarity with VR technology and its benefits, which prevents users from fully leveraging its potential [23]. In addition, resistance to technological change remains a common obstacle. Within organizations, some personnel, particularly among older generations, are hesitant to adopt new technologies. This reluctance is often observed even among teaching staff, who may struggle to adapt to the requirements of VR [42].

A further concern is the potential for cybersickness, a condition characterized by symptoms such as dizziness and nausea when interacting in virtual environments [36]. This can result in a negative user experience and is relatively common, affecting an estimated 25

Moreover, VR has yet to establish itself through an application, program, or use case deemed essential, as seen with mobile phones and communication technologies. Despite offering considerable educational advantages and being viewed as an innovative tool, no VR-based solution has reached a level of necessity that compels widespread adoption.

In fact, studies have shown that in some cases, the use of VR is not recommended due to the high cognitive load it can generate. In such scenarios, traditional teaching methods may prove equally effective, or even superior, to VR-based approaches [8;21;24;28;46]. These limiting factors are summarized in Table 2.

5. Conclusions

Virtual Reality (VR) is a technology designed to provide users with immersive experiences by "tricking" their senses. Through the use of electronic devices, the level of immersion is becoming increasingly close to reality. Although the conceptual understanding of VR has evolved over time, its core characteristics have remained consistent: immersion, perception, and interactivity. This document has explored both the positive and negative aspects of VR, as well as its influence on the senses and how sensory stimulation contributes to its intended effect.

Table 2. Hindering Causes for VR Adoption.

Hindering Causes
Higher prices for optimal devices.
Lack of VR knowledge (benefits, devices, prices, etc.).
Rejection of technological changes.
Cybersickness.
Lack of must-have app.
Cognitive load.

Source: The authors.

The main conclusion drawn from this work is that VR has not yet achieved the expected level of widespread adoption. In fact, its primary use continues to be concentrated in the entertainment industry, despite its enormous potential as a powerful educational tool. Further studies are needed to validate this observation and explore its broader implications. It is clear, however, that several factors continue to hinder the expansion of VR, chief among them being the lack of a widely adopted, essential application or program.

Replicating many VR-based educational experiences requires substantial financial investment, which few institutions can afford, especially in developing countries. To promote broader adoption, efforts should focus on highlighting the benefits of VR in contrast with the costs of implementation. Its capacity to prepare students and professionals through repetitive, hands-on learning is unparalleled, and educational institutions are encouraged to explore its integration, particularly in fields that demand frequent practice and procedural repetition.

Future research should focus on developing essential VR applications that can drive wider adoption across education, industry, and entertainment. Efforts to reduce cognitive load and cybersickness through improved hardware and software design are critical to enhance user comfort and accessibility. Additionally, making VR technology more affordable and accessible, especially in developing regions and educational settings with limited resources, remains a key priority.

Expanding the use of VR in tailored educational curricula and training modules will help validate its effectiveness and promote integration into mainstream learning. Furthermore, increasing user awareness and training can address resistance to technological change, while longitudinal studies are needed to better understand the long-term cognitive, social, and educational impacts of VR. Addressing these areas will be vital for unlocking VR's full potential and supporting its mass adoption.

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All authors have read and agreed to the published version of the manuscript. Please refer to the CRediT taxonomy for the definitions of the terms. Authorship is limited to those who have made substantial contributions to the reported work.

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