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Augmented vs Virtual Reality

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Abstract

This review paper explores the evolving landscapes of augmented reality (AR) and virtual reality (VR), technologies that are transforming a wide range of industries. While VR immerses users in a completely digital environment, replacing the natural world, AR overlays digital elements onto the real world, enhancing the user's perception of their surroundings. The literature review covers numerous applications of both technologies, highlighting their unique advantages and limitations. Differences in hardware, user experience, and practical implementations are examined to provide a comprehensive understanding of how each technology is being utilized across sectors such as retail, transportation, energy, consulting, and insurance. Concluding remarks emphasize the distinct potential and challenges of VR and AR, suggesting future research directions to fully leverage their capabilities. VR and AR offer unique benefits and face distinct challenges, necessitating tailored approaches to maximize their potential. Future research should focus on integrating these technologies seamlessly into everyday applications to enhance user experience and operational efficiency.

Introduction

Augmented Reality

The term "augmented reality" (AR) was first introduced in 1992 by Boeing researcher Thomas Preston Caudell, who created an AR application for industrial purposes to display assembly diagrams. Today, various definitions of AR exist, with the most widely accepted one provided by Paul Milgram from the Department of Industrial Engineering at the University of Toronto and Fumio Kishino from the Department of Electronics, Information Systems, and Energy Engineering at Osaka University. They propose a continuum of realities that range from the real world to a fully virtual world [4].

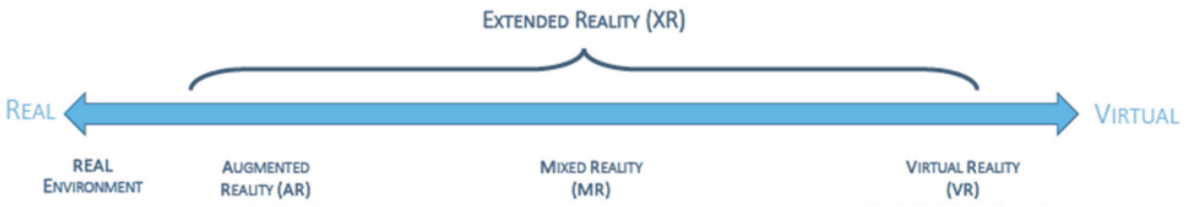

Figure 1. Virtual Reality continuum schematic

AR comprises interfaces that enable interaction between users and digital content, like 3D objects, overlaying them in real time onto the physical environment surrounding the user. For many years, AR usage was restricted to academic laboratory settings and specific experimental tasks such as maintenance and repair. However, today, AR can be utilized in a broad spectrum of applications.

The primary goal of this technology is to offer users additional and valuable information. This significant potential propels these new technologies into various applications, including medical, military, driving assistance, entertainment, and many others [4].

Figure 2. Google AR Glasses

Figure 3. Mario Kart AR edition

Figure 4. A Doctor training interns using AR

Medical Applications

In the medical field, IoT applications are designed to offer unique functions and services by utilizing and managing medical databases. These include remote patient monitoring, identifying and preventing critical illnesses, and supporting elderly patients in intelligent environments. Augmented Reality (AR) in the medical sector enables quick pathology diagnosis through applications like "EyeDecide" and facilitates blood sampling with portable scanners that project the exact location of veins.

Education and commercial sector

In the school environment, AR technologies can enhance students' understanding of technical concepts. For example, by using smartphones with AR applications, students can view the entire structure of the human body, the molecular structure of a chemical agent, or even the structure of the solar system in 3D. In the commercial sector, AR technologies can facilitate product sales and assist users during purchases by enabling 3D viewing of products. This allows customers to see their chosen products in real time, with different colors or accessories, before making a purchase. In the tourism sector, IoT applications combined with AR can provide various services related to flight and baggage status or assist with travel in an unfamiliar city. Applications can display interactive maps, bus and metro lines, or allow travelers to automatically book a taxi based on their preferred location and preferences.

Figure 5. Use of AR in Education

Virtual Reality

Several researchers have defined virtual reality (VR) based on three key properties: (tele-)presence, interactivity, and immersion. Presence generally refers to the sensation of being physically located in a

place other than one's actual location. Interactivity, which impacts presence, is the degree to which users can manipulate their virtual environment in real time. Although researchers' interpretations of presence and interactivity are largely consistent, the concept of immersion has been described in various ways in the literature, warranting further exploration [7].

Some practical uses of VR

- Retailers are utilizing VR in various ways: IKEA uses it to onboard new employees, Macy's enhances customers' shopping experiences with it, and Verizon trains their store clerks to handle hostage and robbery situations through VR simulations.
- In the transportation sector, Deutsche Bahn plans to use VR for training in scenarios that cannot be taught on real trains, such as handling fires. Volkswagen utilizes VR for prototyping, and Tata Motors offers customers the ability to configure cars in VR.
- In the energy sector, E.ON uses VR to train substation workers, Shell employs VR for safety training in deep-water oil projects, and MHI Vestas utilizes VR technology as a sales tool to showcase offshore wind turbines.
- In the consulting industry, Accenture uses VR to assess personnel, PwC conducts diversity and inclusion training using VR, and BDO has begun testing VR's applicability for personnel recruitment.
- In the insurance industry, Farmers Insurance plans to conduct interpersonal skills training using VR, Cigna uses VR for health screenings and to deliver health information to customers, and PNB MetLife consults with their customers through VR.

VR in Research

As industry examples of VR usage have grown, researchers' interest in VR technology has also increased. For instance, a keyword search of the Business Source Premier and eBook. As industry examples of VR usage have increased, so has researchers' interest in VR technology. For instance, a keyword search of the Business Source Premier and eBook EBSCOhost databases for "virtual reality" revealed more than 13,000 publications, with almost half published since 2015. However, the search also indicated that many of these

publications use the term more broadly to refer to any VR-related concepts. The two domains with the most VR research are medicine and education. For example, studies have evaluated VR technology's effectiveness in improving surgeons' operating room performance, and VR-based exposure therapies have been developed for phobias like arachnophobia (fear of spiders).

As IS research focuses on the intersection of technology and business, studying the professional application of VR technology holds significant potential. Despite IS researchers highlighting VR as "a technology in need of IS research", most IS studies have concentrated on virtual worlds or environments rather than VR technology itself. However, the publication trend is positive; most articles addressing VR have been published in the last five years. Conferences such as the Hawaii International Conference on System Sciences (HICSS) and journals like the Journal of Management Information Systems (JMIS) have encouraged IS researchers to explore VR through dedicated tracks and special issues.

IS researchers have studied VR's effectiveness in various domains, such as corporate education and training, technical customer service training, marketing, team-building activities, and increasing users' intentions to collaborate. Additionally, VR-enhanced shopping environments, VR fitting rooms, and VR's impact on business models have also been explored. Despite VR technology's demonstrated usefulness in industry, IS researchers' interest in VR remains relatively low. Most existing research is based on isolated case studies, presenting a challenge for IS researchers to study VR's adoption and effectiveness more comprehensively, identifying its benefits and drawbacks for various purposes. For instance, highlighted VR's affordances, such as reducing risks in simulating potentially hazardous situations and depicting the nonexistent through VR. However, VR's effectiveness in various application contexts remains unclear, as the technology advances more rapidly than the research.

Difference in VR and AR

VR replaces the natural environment with a digital one, immersing the user in a simulated environment through a computer. In contrast, AR overlays digital objects onto the natural environment using head-up devices, AR glasses, or commonly used devices like smartphones or tablets, thereby adding virtual information to the real world.

Literature Review

Luis Munoz et al. (2019). Augmented reality (AR) and virtual reality (VR) technologies are gaining popularity. AR has primarily thrived through mobile applications, with games like Pokémon Go and the new Google Maps utility serving as prominent examples. Conversely, VR has gained traction mainly due to the video game industry and more affordable devices. Despite initial setbacks in the industrial sector, VR is making a comeback in recent years thanks to advancements in devices and processing hardware. This work presents an in-depth study of various fields where AR and VR have been utilized. It involves a comprehensive scoping review of these technologies, examining their evolution over the past years in key categories and the most involved countries. Lastly, we will explore the future trends of AR and VR and identify areas needing further research to enhance their integration into society [1].

Julie et al. (2011). This paper surveys the current state-of-the-art technology, systems, and applications in Augmented Reality (AR). It outlines the work conducted by various research groups, the objectives of each new AR system, and the challenges and problems encountered in building some AR applications. The paper examines the challenges and requirements for successful mobile AR systems. It summarizes the current applications of AR and speculates on future applications and the direction of ongoing research

in AR development. The paper also discusses the challenges AR faces in transitioning from laboratories to industry and forecasts future challenges.

Section 1 introduces AR and the motivations for developing this technology. Section 2 covers AR technologies, including computer vision methods, AR devices, interfaces and systems, and visualization tools. Mobile and wireless systems for AR are discussed in Section 3. Section 4 describes four classes of current AR applications, chosen for their prominence in AR research. Finally, Section 5 discusses the future of AR and the challenges it will face [2].

Fabio Arena et al. (2022). Modern society is increasingly intertwined with parallel realities beyond the physical world. Virtual reality (VR) has become an integral part of daily habits and activities, closely related to the concept of augmented reality (AR). AR, a technology that continues to grow robustly, was envisioned several decades ago. This paper provides an overview of AR, tracing its origins, exploring its primary applications, and offering essential information. A portion of the article is dedicated to the hardware and software components used in AR systems. The final part highlights the design limitations, current shortcomings, and potential future applications of this remarkable technological innovation [3].

Dhiraj Amin et al. (2015). Augmented reality (AR) is a technology that integrates digital content with real-world information in real time. AR allows direct access to implicit information associated with context instantaneously. It enhances our perception of the real world by enriching what we see, feel, and hear in the physical environment. This paper provides a comparative study of various augmented reality software development kits (SDKs) available for creating AR apps. It explains how AR differs from virtual reality (VR), the functioning of AR systems, and the different types of tracking used in AR [4].

Kangdon Lee (2012). There are numerous methods for educating and training individuals in the specific information and skills they need. These methods include classroom lectures with textbooks, computers, handheld devices, and other electronic appliances. The choice of learning innovation depends on an individual's access to various technologies and the infrastructure of their environment. In a rapidly changing society with abundant information and knowledge, it is crucial to adopt and apply information at the right time and place to maintain efficiency in both educational and business settings. Augmented Reality (AR) is one technology that significantly transforms the location and timing of education and training. This literature review research explores AR, its application in education and training, and its potential impact on the future of education [5].

Isabell et al. (2020). Virtual Reality (VR) has become a popular IT topic in recent years. When Steven Spielberg adapted Ernest Cline's popular novel, "Ready Player One," into a film, VR reached an audience of millions. However, few people know that core VR technology has been around since the 1960s. For a long time, high equipment costs and insufficient quality prevented its widespread adoption. Many had even declared VR "dead" due to it being "over-hyped" for a long time and stuck in the 'trough of disillusionment' of Gartner's Hype Cycle. However, the advent of affordable, consumer-grade VR headsets for gaming and entertainment has led to a resurgence of interest in VR. Although VR's development is ongoing, since its arrival on Gartner's 'slope of enlightenment' in 2016, VR has matured enough to no longer be part of Gartner's Hype Cycle [6].

Sharmistha Mandal (2013). Virtual reality (VR) is a technology that allows users to interact with computer-simulated environments, whether these environments simulate the real world or are entirely imaginary. VR enables users to experience, feel, and touch the past, present, and future. It serves as a medium for creating personalized worlds and customized realities, ranging from video games to virtual tours of the universe, from walking through dream homes to exploring alien planets. VR allows us to

encounter the most intimidating and challenging situations safely and with a learning perspective. However, few people truly understand what VR is, its basic principles, and its unresolved issues. This paper presents a historical overview of virtual reality, lists basic terminology and classes of VR systems, and provides an insightful study of typical VR systems, highlighting the challenges VR faces [7].

Conclusions

Augmented Reality (AR) and Virtual Reality (VR) are both groundbreaking technologies, but they differ significantly in their applications and societal impact. AR enhances the real world by overlaying digital information onto physical surroundings, making it particularly useful in areas like education, healthcare, and retail. For example, AR can help students visualize complex concepts in real-time or allow consumers to try products virtually before buying. VR, however, creates entirely immersive experiences, transporting users into fully virtual environments. This makes VR ideal for gaming, training simulations, and entertainment, offering experiences that are impossible to replicate in the real world.

AR is likely to have a broader societal impact due to its integration with daily life. It enhances productivity, learning, and decision-making without requiring users to leave the real world. For instance, AR can assist in navigation, provide real-time information during surgery, or help workers in manufacturing with precision tasks. VR, while powerful in specific niches like training and therapy, is more isolating and primarily serves entertainment or specialized training purposes. Thus, AR's ability to augment rather than replace reality makes it more universally beneficial.

When it comes to cost, AR generally has a lower barrier to entry. Many AR applications can be accessed through smartphones or tablets, which are already widely available. This makes AR more accessible and cost-effective for both consumers and businesses. VR, on the other hand, typically requires specialized hardware like headsets and controllers, which can be expensive. High-end VR systems also need powerful computers, adding to the cost. Additionally, the development of VR content is often more resource-intensive, further increasing expenses.

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