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Abstract

As the convergence of Artificial Intelligence (AI) and other recent technologies like Virtual Reality (VR) and Augmented Reality (AR) increasingly continue to redefine human-computer interaction, it becomes of fundamental importance to learn how these advancements can improve one another. This thesis explores the various applications of AI within VR and AR environments, analyzing not only the theoretical aspect but the recent practical implementations as well. Through a comprehensive review of the literature and empirical analysis, this paper focuses on the transformative impact of AI when it comes to improving the experience for the user and expanding the capabilities of immersive technologies when considering the medical, retail, and entertainment fields. Furthermore, it investigates how AI and human cognition can work together within virtual and augmented environments when taking into account potential future uses and societal integration while also taking into consideration the ethical aspect of it all. By analyzing the interplay between AI, VR, and AR, this thesis provides insights crucial for navigating the evolving landscape of immersive computing and shaping its trajectory towards enhanced human interaction and societal empowerment.

1. Introduction

In today's rapidly evolving digital landscape, the most prominent and discussed technology is artificial intelligence. This, in theory, is a computer system capable of performing tasks that would require human intelligence, such as speech and visual recognition. Albeit a relatively old technology, first theorized in 1956 at the Dartmouth Conference, AI has only made massive strides in just the past few years. Researchers questioned one another on the possibility of creating a machine with intelligence indistinguishable from that of a human. Early on they focused on algorithms that could solve mathematical problems and were successful in 1958 with The Logic Theorist. A few years later, the first AI chatbot, ELIZA, was created in 1966 by an MIT professor with the intention of simulating a therapist. It was only capable of simple conversation, which at the time signified an incredible breakthrough in natural language processing[1]. Moving on to the modern era, in only the past couple of years AI systems have evolved tremendously, in fact the two most prominent and advanced examples are: Google's Gemini and OpenAI's GPT-4, which can answer questions, code, create images based on a description and much more. This progress brings to light the almost limitless potential these systems have, where it is possible to break down the barrier between science fiction and reality, from digital assistants to self-driving cars. Within this wide

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[1] PhD, Dr Mandar Karhade, MD. "History of AI: Golden Years (1956–74)." *Medium*, 17 Apr. 2023, https://pub.towardsai.net/history-of-ai-golden-years-1956-74-ca27a0a94c3d

range of possibilities, we find the ability of artificial intelligence to interact with immersive technologies.

The term immersive technologies is quite broad, as it contains everything from simple "4D" cinema experiences to the more recent breakthroughs of virtual reality and augmented reality. The first ever time such a practice was used was for a 4D cinema in 1957 that utilized speakers, fans, and smell generators to create a more immersive viewing experience. VR and AR, on the other hand, are a way of effectively breaking down the barriers between the digital world and reality. VR is defined by the Oxford Dictionary as the computer-generated simulation of an environment that can be interacted with through a specific piece of equipment (helmet with a screen inside or gloves fitted with sensors). AR, on the other hand, is defined by the Oxford Dictionary as a technology that superimposes a computer-generated image on a user's view of the real world, also using specific equipment such as glasses or helmets, thus providing a composite view. The big difference to note here is that while VR has the user interact with digital objects in a completely virtual environment, AR has the user interact with digital objects positioned in the real world. With Apple's new Apple Vision Pro (AR) being released on February 2nd, 2024, immersive technologies have become increasingly discussed not only from an academic perspective but also from an ethical one.

This thesis aims to explore the applications of AI within virtual and augmented reality environments, examining how these technologies are revolutionizing industries

such as entertainment, retail, medical, and construction, and touch on the ethical problems that they present.

2. The Various Fields

2.1 The Medical Field

One of the fields that has been benefiting the most from these immersive technologies is the medical one. In both of the cases of virtual reality and augmented reality, they have been prominent in two parts of the field: education and surgery. Firstly, when it comes to education, one of the biggest obstacles to face for resident trainees is the lack of necessary psychomotor skills and the experience needed to be able to confidently take on procedures, especially when it comes to surgery. The most efficient way of properly developing any skill is through trial and error, which in the medical field is more problematic as doctors have the responsibility to give their patients the best treatment possible. This means that students in training have limited chances of assisting senior surgeons leading to a less experienced individual and longer periods of training time needed for them to feel secure enough to carry out such an important and delicate job. Through immersive technologies, dealing with these complications becomes a more viable task. Both VR and AR have found important roles to play in assisting the education of resident trainees.

Whether in a virtual environment or a real one with digital objects, these tools give students access to more opportunities to test their skills and knowledge, without harming or worrying patients, through more realistic and accurate simulations. An example of this occurring in the current day would be how MIS training centers have been offering VR simulations to surgical students in order to assist them in acquiring the skills needed for a laparoscopic surgery. There are many benefits to using these simulations, as they not only provide a safe environment where mistakes won't endanger patients but also a way for hospitals to have a cost-effective means of training their residents.

As for most fields, the medical one is constantly evolving with new approaches to procedures and surgeries. This can lead to a more complex and harsher selection process. Luckily, this is where artificial intelligence can be of assistance. Recent research has been primarily on how to identify more potentially suited candidates through predictive ability parameters. AI has the potential to perform a fundamental role in helping predict and analyze the Visual Spatial Ability (VSA), which is the current two-dimensional to three-dimensional conversion rate that is being used for these predictions. Research has shown a promising level of correlation between VSA and predicted level of surgical compatibility and skill level, however limited.

A study was conducted by doctors in Baltimore that tested the ability of VR simulation training to improve a student's education and how it affected their VSA. They began by confirming that VSA was a valid parameter for

determining potential in the surgical field. They divided the participants into two groups, one underwent a special curriculum with VR training, while the other had a normal curriculum. The students underwent a nine-day training program which ended in another VSA test. They observed that, through the VR curriculum, students greatly improved their visual spatial imagination, surgical performance, and completion time, even the ones that had lower VSA scores at the initial testing. By day nine, the participants with lower levels on day one, who took part in the VR training, showed a similar amount of surgical competence with respect to those who had a high VSA[2].

In another study, twelve cardiologists participated in a similar experience as the previously mentioned one. In this case, however, the doctors were more experienced. They divided into two groups, one trained with VR simulations and the other used the usual patient-based approach. The results showed that the first group improved significantly better than the second group[3]. We find this important because all of these studies are effectively proving that VR simulations are the most beneficial choice when it comes to training students and assisting medical professionals.

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[2] Sommer, Guillermo Marcos, et al. "The Role of Virtual Reality Simulation in Surgical Training in the Light of COVID-19 Pandemic." Medicine, vol. 100, no. 50, 17 Dec. 2021, p. e27844, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8677906/

[3] Sutherland, Justin, et al. "Applying Modern Virtual and Augmented Reality Technologies to Medical Images and Models." *Journal of Digital Imaging*, vol. 32, no. 1, 13 Sept. 2018, pp. 38–53, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6382635/

Since these simulations are seeing an increase in usage when training students and residents, the most important question one must tackle when discussing immersive technologies in a medical field is: "Will skills learned through VR simulations carry over to the real-world operating room?" Since this has been an ongoing debate for a while now, there have already been studies done on the subject in the early 2000s. However, these studies were quite limited and lacked quality so, with newer information, a recent study has analyzed various articles and data synthesis to find a more reliable answer. 34 sources that investigated whether simulation skills transfer into real-world skills were considered. It is important to further point out that these studies were all testing purely technical skills, and none focused on non-technical skills like communication. The review found that only five showed little to no difference between students who used VR simulations and those who didn't. Also, another important finding of this review is that no studies showed that non-simulation participants improved more than the ones who used the VR training[4].

After analyzing these studies, we have discussed how beneficial artificial intelligence and immersive technologies can be to medical education and surgeries. However, the potential they hold is immense, from phobia management to treatment strategies and even personalized rehabilitation

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[4] Dawe, S. R., et al. "Systematic Review of Skills Transfer after Surgical Simulation-Based Training." *British Journal of Surgery*, vol. 101, no. 9, 15 May 2014, pp. 1063–1076, https://academic.oup.com/bjs/article/101/9/1063/6137950#231654295.

programs, all becoming possible and more efficient through these technologies[5]. It is fundamentally important to recognize that we are still in the early stages of this innovation and that a lot of further research and development is necessary. A plethora of improvements can be made. For example, we can improve the AI algorithms to personalize the experience based on diverse patient populations and the recognition algorithms to improve the quality of the VR and AR experience. Also, another big hurdle that hospitals and universities face is the affordability of immersive technologies. Since they are so recent, the cost of each headset, or various equipment needed is still incredibly high and as it is now, would be very difficult to implement it in most places.

2.2 The Retail Field

Technology has significantly influenced the way retailers provide services to consumers and customers' behavior.

"Applied technologies such as artificial intelligence (AI), augmented reality, virtual reality, and mixed reality (MR) are among the biggest disrupters in the rapidly changing retail industry[6]".

[5] Le, Dac-Nhuong, et al. *Emerging Technologies for Health and Medicine: Virtual Reality, Augmented Reality, Artificial Intelligence, Internet of Things, Robotics, Industry 4.0*. *Google Books*, John Wiley & Sons, 16 Oct. 2018

[6] Sung, Eunyoung (Christine), et al. "Consumer Engagement via Interactive Artificial Intelligence and Mixed Reality." International Journal of Information Management, vol. 60, Oct. 2021, p. 102382, https://doi.org/10.1016/j.ijinfomgt.2021.102382

Many industries are incorporating applied AI technology into their marketing strategies in order to optimize their outcomes. AI is able to replicate human characteristics and improve them, therefore many companies are using this new approach to replace various human tasks to reach more efficient results in a shorter amount of time. Using these tools makes the consumer experience more realistic and way more engaging and the implementation of storytelling marketing more effective, which stimulates emotional connection and has a positive impact on products and services' sales[6].

The study *Enhancing brick-and-mortar store shopping experience with an augmented reality shopping assistant application using personalized recommendations and explainable artificial intelligence* "contributes to the literature in the areas of AI and MR by examining the effects of applied technology interactions on consumer engagement, which in turn leads to purchases and unpaid brand endorsement" [7]. Such study, based on the SOR Framework[8], which has been conducted to "investigate consumer responses toward an AI-embedded mixed reality (MR) exhibit in a retail/entertainment complex, where esthetically appealing and real augmented objects are used to provide consumers with unique experiences, show an increase in the MR immersion and a greater consumer engagement". This is reflected in positive

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[7] Zimmermann, Robert, et al. "Enhancing Brick-And-Mortar Store Shopping Experience with an Augmented Reality Shopping Assistant Application Using Personalized Recommendations and Explainable Artificial Intelligence." *Journal of Research in Interactive Marketing*, vol. 17, no. 2, 12 Apr. 2022, https://www.emerald.com/insight/content/doi/10.1108/jrim-09-2021-0237/full/html
[8] Stimulus (S)– Organism (O)– Response (R) framework (Mehrabian & Russell, 1974)

outcomes like an increase in purchases as well as sharing with others the experience. Overall, findings from this study show that interactive AI and MR technology open new paths to promote and optimize consumer engagement[9].

However, as much as there are many positive aspects related to technology, there are also some drawbacks and critical issues that need to be taken into consideration. For example, retailers must be open to change and rapidly adapt to a constantly changing vigorous consumer market if they want to succeed. There have been many cases where some of the most important and large retailers[10] have been forced to shut down, downsize, or reorganize their companies because of the increasing popularity of online retailers. It is fundamental that retailers integrate applied technologies into their marketing strategies to maintain or better yet improve their customers' engagement, loyalty, and behaviors. Some retailers face a few challenges in applying these technologies as they are not always able to do so, or at least not always they do so in an optimal manner.

No matter the positive results revealed from this Study, AI and MR solutions are still considered new so there's still further research to carry out in order to better comprehend the most efficient application method of these technologies and analyze consumers' reactions. In fact, current findings have

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[9] Sung, Eunyoung (Christine), et al. "Consumer Engagement via Interactive Artificial Intelligence and Mixed Reality." *International Journal of Information Management*, vol. 60, Oct. 2021, p. 102382, https://www.sciencedirect.com/science/article/abs/pii/S026840122100075X
[10] In U.S., some of the retailers that have gone through these phases are: Toys "R" Us, Sears, Forever 21, Barneys New York, RadioShack, (Cain & Biron, 2019)

not been certified, so evaluating the efficiency of AI and MR technologies in the retail sector is challenging and still ongoing.

It is becoming obvious how the retail sector is going towards omnichannel retail and how this new way of doing business is becoming the future. Digital technologies, such as augmented retail shopping assistants, are enhancing and improving the customer shopping experience[11]. However, such technologies cannot be applied clearly to all retailers as some of them are a smaller reality and have only physical stores or simply undergo a few challenges in applying these new technologies, in particular due to lack of skills or funds. While department store revenues have declined since 2001 and e-commerce revenues are continually growing, today's retailers have to overcome significant struggles to remain competitive[11].

In an era of constant change and evolution and in a phase of digital transition, it is even more fundamental for retailers to maintain and improve consumers' experiences to attract new customers and make relevant profits. Therefore, many retailers are working on and renovating their strategy to adapt to this changing environment. In particular, they are implementing digital retail in their business approach. A few examples of this are the creation of applications and websites related to their stores, and social media, as well as in

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[11] Zimmermann, Robert, et al. "Enhancing Brick-And-Mortar Store Shopping Experience with an Augmented Reality Shopping Assistant Application Using Personalized Recommendations and Explainable Artificial Intelligence." *Journal of Research in Interactive Marketing*, vol. 17, no. 2, 12 Apr. 2022, https://www.emerald.com/insight/content/doi/10.1108/jrim-09-2021-0237/full/html

some cases the possibility to suggest and try out the combination of some products if not the product standalone. This strategy has been applied, not only to keep up the pace with this new way of doing business, but also to remain competitive and increase the growth in customers' retention and revenues. In this regard, "personalization and interactivity are key elements for creating a constructive experience, leading to beneficial changes in customers' behaviors and intentions toward retail, positively affecting purchase intention and actual sales[12]".

One of the most discussed topics is the effect the use of smartphones has on customers shopping experience and on the total amount of sales. A concrete example of such smartphone-based technology is an "augmented reality shopping assistant application (hereafter ARSAA), which uses augmented reality (AR) to display content (i.e. tailor-made offers, product comparison, and recommendations) by leveraging machine learning techniques (i.e. recommender systems) and explainable artificial intelligence (XAI) [12]".

A study carried out on the impact of an ARSAA artifact on consumers' in-store shopping experience demonstrated that using such artifact can actually improve the consumers' experience. Such technology allows customers in

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[12] Zimmermann, Robert, et al. "Enhancing Brick-And-Mortar Store Shopping Experience with an Augmented Reality Shopping Assistant Application Using Personalized Recommendations and Explainable Artificial Intelligence." *Journal of Research in Interactive Marketing*, vol. 17, no. 2, 12 Apr. 2022, https://www.emerald.com/insight/content/doi/10.1108/jrim-09-2021-0237/full/html

actual physical stores to have a more interactive, customized and a simulation of an online shopping experience[13].

However, the use of these technologies has a significant cost, so before moving forward with such implementation, retailers need to be sure that they are efficient and that they have significant positive impacts. Therefore, it is important that further research is conducted.

Technology does not always have positive effects and it is not always seen as a benefit. There are still a variety of people that are averse to it, especially the "old generations". Various customers still prefer to shop in physical stores in an old tradition manner, interacting with just the employees, that way they can see the product, feel it, try it and ask for advice.

2.3 The Entertainment Field

The field that sees the most demand for the progress and evolution of immersive technologies is the entertainment one. From video games and theme parks to concerts and other live events, VR and AR hold immense potential to increase the quality of customer experience.

Traditional digital media has been replaced by more advanced technology, such as VR, which has radically impacted the videogames and

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[13] Zimmermann, Robert, et al. "Enhancing Brick-And-Mortar Store Shopping Experience with an Augmented Reality Shopping Assistant Application Using Personalized Recommendations and Explainable Artificial Intelligence." *Journal of Research in Interactive Marketing*, vol. 17, no. 2, 12 Apr. 2022, https://www.emerald.com/insight/content/doi/10.1108/jrim-09-2021-0237/full/html

movies sectors. VR makes everything look more realistic, making the consumers' experience more enjoyable and tangible.

One of the earlier stages of these innovations was mostly for video games and basic necessities. Beginning mostly with mobile devices, many app creators came up with different ways of using the phone as a simpler AR device through the screen and camera[14]. Games like PokemonGo allowed to see the monsters one would catch in the game flying around the room. Other necessity apps also implemented original ideas, for example, Google Maps added a feature, where if you were on foot, there was the option of scanning your surroundings and it would show you a blue path on the ground that leads to your destination.

A few years ago, Microsoft HoloLens 1 and Google Glasses were released. However, since the technology was so new, the quality of the products was too low for their price and the average customer could not afford it or didn't see the need in having one. After that failure, companies started increasing their research on VR rather than AR. The next step was led by gaming companies like Valve and Sony which created their own VR headsets, the first for computer (PC) gaming and the second exclusively for their console: the PlayStation. With these new devices came a plethora of playable games, some new and some

[14] Frajberg, Darian. "Artificial Intelligence and Augmented Reality for Entertainment Applications." *Www.politesi.polimi.it*, 3 Feb. 2020, https://hdl.handle.net/10589/152139

remade from non-VR games like Skyrim, Dota 2, and even the traditional Chinese game Go. Some games even develop artificial intelligence in order to create non-player adversaries to face like in the aforementioned VR Go. However, since the current versions of these AI are currently under development, they are still considered to have a low level of adaptability and are somewhat easily predictable[15].

On the other hand, while complex AR like the HoloLens 1 and the Google Glasses failed, the mobile scene was still going strong. While major mobile companies like Apple and Samsung provided the devices, it was the job of developers to create apps and programs that could bring AR within reach of consumers. At this point, commercial AR Software Development Kits (SDK) became essential for app developers. They provided the necessary tools for visual recognition and tracking that enabled AR programs to function. There are studies that were carried out on the comparison between a multitude of SDKs like Wikitude and Vuforia. However, these were limited by the fact that they mostly relied on GPS tracking and simple visual recognition, lacking important features like sensor readings, understanding how an outdoor environment is non-stationary, and most importantly a more complex usage of the camera to capture the environment. This point is when two of the most prominent mobile companies, Apple and Google, stepped in and created their

[15] Reiners, Dirk, et al. "The Combination of Artificial Intelligence and Extended Reality: A Systematic Review." *Frontiers in Virtual Reality*, vol. 2, 7 Sept. 2021, https://www.frontiersin.org/articles/10.3389/frvir.2021.721933/full

own SDKs, ARkit for iOS and ARCore for Android. These were much more advanced compared to their predecessors. Their most notable improvement was the evolution of visual features since they considered more factors like depth, object size, and light estimation[16]. This was one of the reasons, the previously mentioned PokemonGo was able to succeed in creating a consumer-friendly and high-level mobile AR experience.

While gaming is the sector in which immersive technology is seeing the greatest usage, other ones have also had some interesting and useful innovations. Live events like sports, concerts, and plays have been offering VR live viewing so that, even if you can't go there in person, you can still enjoy and don't miss out the show. A recent example is when an internationally acclaimed Korean group called BLACKPINK had a full digital show on the Meta VR in 2023, simulating a first-row concert experience. Theme parks have also incorporated VR in their rides, which associated with other ways of increasing the immersion, whether it be moving parts or a spatial sound system, greatly increases the quality of customer experience[17]. For example, in Japan, there is a chain of indoor theme parks called Joypolis that are filled with these types of immersive activities. They range from driving cars and flying anime-inspired

[16] Frajberg, Darian. "Artificial Intelligence and Augmented Reality for Entertainment Applications." *Www.politesi.polimi.it*, 3 Feb. 2020, https://hdl.handle.net/10589/152139
[17] Abdelmaged, Mohamed Adel Mahmoud. "Implementation of Virtual Reality in Healthcare, Entertainment, Tourism, Education, and Retail Sectors." *Mpra.ub.uni-Muenchen.de*, 2021, https://mpra.ub.uni-muenchen.de/110491/

spheres to a full VR battlefield where you can participate in up to 3v3 fights against other players at the park with a massive area to move around in.

Finally, another sector that is believed to have great potential in this regard is the film industry. The rapid development of these technologies allows filmmakers to turn their products from a two-dimensional space into a three-dimensional one. It also has been assisting them in the production phases of the movies or shows. With AR they can, more easily and efficiently, collect the needed material for the project from a camera. It also gives the ability to film digital content in the real world, simplifying the CGI and special effects works in the post-production phase[18]. In this ideal three-dimensional viewing experience, artificial intelligence can play an important role in perfecting the recent breakthrough in interactable movies and shows. A very primitive example of this is a visual novel that went viral on YouTube a few years ago called Façade. It turned the player into a character of the novel where they could input text and the other characters would react and respond accordingly and it would change the events occurring. The non-player characters used basic AI similar to chatbot technology in order to converse with the player and create an immersive reality where one can feel as if they were a member of the cast. Façade was the first to implement the aspects of believable agents, the ability to interact with the story, and simple language processing all in one interactive

[18] Papathanasiou, Argyro, et al. *Artificial Intelligence, Augmented Reality, Location-Based Narratives, and User Participation as Means for Creating Engaging Extended Reality Experiences*. May 2022

visual novel[19]. These aspects linked to current day technology and the use of AR and VR have the potential to create a truly incredible and immersive cinematic experience where one isn't simply watching a movie but changing it and actively participating in how it turns out. This is similar to how Netflix approached producing interactive shows on its platform, where the person watching made choices that changed the outcome of the story.

3. The Ethical Aspect

There is a constant and quick development and evolution when it comes to immersive technologies. However, no matter the significant amount of positive effects these new innovations have, we cannot ignore the obvious relevant drawbacks. It can have a negative impact on consumers in terms of mental health, safety, physical, social, or ethical issues. This is why it is very important to conduct accurate tests and analyses before putting such technologies on the market, as well as defining limits on their use. Some gamers for example, when abusing the use of VR technologies, can lose track of reality, and start living in their own bubble, and even avoiding social outings because

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[19] Mateas, Michael. "Interactive Drama, Art and Artificial Intelligence - ProQuest." *Www.proquest.com*, Dec. 2002, https://www.proquest.com/openview/e595243a4cf188c21b72f0e31c85348d/1?pq-origsite=gscholar&cbl=18750&diss=y

they are too involved in their digital world. This is only one of the many negative effects such technologies can cause.

To overcome some of the drawbacks of these technologies, like issues related to people's autonomy and privacy, a study, *Ethical issues of educational virtual reality*, identifies as possible solutions a greater awareness of the correct use of VR technology and of the privacy policies of the products they use, develop standards for educational VR that keep learners' autonomy and privacy intact. The usage of immersive technologies without human supervision may not be appropriate for educational purposes as children and adolescents may encounter inappropriate or potentially traumatic representations.

"The autonomy-conserving utilization of realistic virtual environments requires societal awareness, stringent data protection legislation, methods of user control to avoid manipulation, as well as informed consent[20]". Once the challenges have been adequately addressed, realism and virtual reality could actually present numerous valuable educational opportunities.

However, besides these negative aspects, there are also various positive effects. "The growth of VR technologies leads to an increase in new products and accelerated development of VR in industries such as education, healthcare, household management, tourism, and video games, impacting social and

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[20] Skulmowski, Alexander. "Ethical Issues of Educational Virtual Reality." *Computers & Education: X Reality*, vol. 2, 2023, p. 100023, https://www.sciencedirect.com/science/article/pii/S294967802300017X

economic sectors[21]". The use of such technologies creates the need for resources with special certain skills and the creation of new tailored jobs.

Especially in recent years, technology has played a very significant role in our lives. In particular, during the COVID-19 pandemic, it was key to education as it has allowed students to keep learning through online classes. A similar approach was applied in the work environment, as a lot of people thanks to the digital devices and systems, were able to perform their jobs from the comfort of their own home. It made a difference also at a social level, as thanks to the smartphones, everyone was able to keep in touch with one another through video calls, messages, and social media. Also live events, online shopping and many more virtual experiences made it possible for everyone to continue conducting similar daily routines as they were used to before quarantine.

Ethical aspects regarding immersive technologies can be related to: privacy concerns, psychological influence, social isolation, potential abuses, potential physical hazards, and unrealistic expectations[22].

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[21] B. Kenwright, "Virtual Reality: Ethical Challenges and Dangers [Opinion]," in *IEEE Technology and Society Magazine*, vol. 37, no. 4, pp. 20-25, Dec. 2018, https://ieeexplore.ieee.org/document/8558774

[22] Kabha, Robin. "Ethical Challenges of Digital Immersive and VR." *Ethical Challenges of Digital Immersive and VR*, 2019, https://www.amity.edu/gwalior/jccc/pdf/jccc%20june%202019%20final-41-49.pdf

Privacy: immersive technologies constantly collect and examine significant amounts of data related to users, potentially violating their privacy and compromising data security.

Psychological influence: immersive experiences can lead to extreme emotions and distort the reality, having a difficult time distinguishing the real world from the virtual one. This is a critical aspect especially for children as they are still developing and could be negatively influenced.

Social isolation: some users could find themselves absorbed by their parallel virtual life and the addiction of continuing to play, that it could make them lose the incentive to go out and socialize.

Potential abuses: such immersive technologies could be used for wrong and unethical reasons.

Potential physical hazards: the use of some digital devices can worsen humans' physical senses, not allowing them to be able to focus on what's going on around them, which increases the chances of finding themselves in a dangerous situation.

Unrealistic expectations: such exposure may cause individuals to perceive a distorted sense of reality, developing skills or competences coming from the digital world.

4. Conclusion

Immersive technologies are constantly evolving and are already beginning to blur the lines between science fiction and reality across various fields. We have discussed how these innovations have made progress in multiple important sectors, from improving the quality of education students receive and the care patients undergo to creating a more personal retail environment and revolutionizing the vast world of entertainment.

However, as in all realms regarding technological advancements, it is critical to keep debating and discussing the ethical implications and negative drawbacks such progress could lead to.

As the world is changing, and technology is becoming increasingly more important and utilized in our daily lives, it is important to carry out further studies to address the consequences of these newly developed immersive technologies, not only focusing on their positive outcomes, in order to make a good and optimal use of them.

In the meanwhile, it is important to carefully monitor the development and implementation of these technologies, while increasing users' awareness and education in the correct use of them.

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