ISSN 2320 - 2602

Volume 13 No. 1, January 2024

International Journal of Advances in Computer Science and Technology

Available Online at http://www.warse.org/IJACST/static/pdf/file/ijacst041312024.pdf

https://doi.org/10.30534/ijacst/2024/041312024

Applications of Augmented Reality in different domains

Adith P Kotian[1], Afran Sayyed Karim[2], Ashwin Kumar[3], Ishwar Pavan[4]

[1] Department of Computer Science and Engineering, AIET, India, adithkotian2002@gmail.com

[2] Department of Computer Science and Engineering, AIET, India, 4al20cs008afran@gmail.com

[3] Department of Computer Science and Engineering, AIET, India, kinigoliashwin@gmail.com

[4] Department of Computer Science and Engineering, AIET, India, ishwarpavan4517@gmail.com

Received Date : December 1 , 2023 Accepted Date : December 29, 2023 Published Date : January 07, 2024

ABSTRACT

This paper provides a comprehensive review of augmented reality's (AR) applications in three key sectors currently witnessing a surge in AR adoption— entertainment, medicine, and retail. The study aims to underscore how AR enhances user experiences in these domains. The authors introduce AR, differentiating it from virtual reality, and discuss the requisite software and hardware technologies for implementing AR systems, along with various display types crucial for an enriched user experience. The paper also briefly touches upon the growth of AR in markets.

In the entertainment sector, AR is showcased for its impactful applications in multiplayer gaming, PC games, broadcasting, and media recordings, contributing significantly to an enhanced gaming and entertainment experience. Transitioning to the medical field, AR proves invaluable in clinical healing, medical training, clinical teaching, surgery, and post-clinical therapy, demonstrating its diverse applications in healthcare for professionals and improved patient outcomes.

The retail sector is explored, revealing how AR is reshaping advertising, marketing, fashion retail, and online shopping. AR's transformative role in providing engaging and interactive retail experiences, both in physical stores and online platforms, is discussed in detail.

The paper concludes by outlining potential future AR applications and conducting a thorough analysis of its merits and drawbacks in the current landscape. This in-depth review serves as a valuable resource for understanding the evolving role of augmented reality across diverse industries, shedding light on its transformative impact on user experiences.

Key Words : Augmented Reality (AR), Education, Entertainment, Gaming, Market growth, Medicine, Pandemic impacts, Retail, Virtual Reality (VR).

1.INTRODUCTION

Recent technological advancements have enabled unprecedented possibilities, such as creating virtual worlds or enhancing existing real objects and environments through various sensory modes[1]. Augmented Reality (AR) and Virtual Reality (VR) have the potential to revolutionize how we perceive entertainment, shopping, healthcare activities, education, and more. While VR and AR are often considered synonymous, they are notably distinct. AR, also known as mixed reality, involves overlaying virtual objects onto the real world, enhancing them through sensory inputs. In contrast, VR immerses the user in a completely artificial environment created through software [2]. The distinction forms the basis of virtual technology's operation, and the combination of both VR and AR is often employed to achieve specific objectives [3].

Although AR has been in existence for some time, it faced challenges that hindered its expected outcomes in the early days [4]. Investors hesitated to heavily invest in this field, assuming that augmented reality was not sufficiently developed to yield optimal results. However, many industries are increasingly recognizing the need to invest in AR to stay competitive, attract more customers with innovative experiences, as mentioned in ref. [5]. Gaming has been the primary application of AR since its early stages, but according to a 2016 report by Goldman Sachs, AR is projected to improve markets such as retail, healthcare, and real estate soon [6]. AR is utilized by various industries for product design, with a particular demand for immersive service prototyping in the service design sector. AR has also found applications in academics [7], aviation, military, and has significant potential to enhance various aspects of life, making them more enjoyable, convenient, and creative.

AR technologies are broadly categorized into hardware, mainly consisting of diverse displays and sensors, and software algorithms required to integrate the augmentations with the real world. These technologies find applications in various fields, including tourism and hospitality [8], education, medicine, retail, gaming, and entertainment. The paper discusses AR-based prototyping methods, where hardware integration is achieved by precisely mapping a functional hardware model onto a virtual display. AR displays encompass optical projection systems, screens, handheld devices, head- mounted displays (HMD) or head-up displays (HUD), and eye tap. The paper covers handheld AR systems that track optical markers in real-time, an optical projection system developed using a mouse for configuring data devices with AR displays, and HMD displays described as real-time three-layered interactive displays allowing free head movement and full body mobility, particularly useful for architects. The use of HUD is explored by incorporating it into a laminated windshield, patented for practical application. The study also delves into spatial AR, a subset of AR that does not require displays to operate, extensively explored in [9]. The authors of that study provided examples such as shader lights, iLamps, and mobile projectors, Being There, HoloStations, and smart projectors.

This paper conducts a comprehensive examination of AR applications in three sectors: gaming, medicine, and retail. Gaming has been the forefront of AR utilization, offering gamers significant creativity, innovation, and unique experiences. AR- enhanced games provide gamers with a more engaging and thrilling experience due to the interactive nature of the technology.

The application of AR in the medical industry has evolved over the years, proving beneficial for both doctors and patients. Patients can gain insights into their diseases through AR, and the technology can be used in complex surgeries, assisting surgeons with precise procedures. AR has also made inroads into the retail sector, with several companies investing in AR to create applications and immersive experiences to promote and sell their products. Both in-store and online AR technologies have significantly transformed the way people shop. Various segments of the fashion industry impacted by AR and undergoing retail transformations are discussed in this paper. AR has influenced our lives in ways previously unimaginable. It can be argued that AR is the future of gaming, retail, and medicine. The expansion of AR technology in these three sectors and its acceptance by the public are analyzed in this review. Surveys were conducted, and feedback from various users was examined to understand their perspectives on the new technology.

2. AR IN ENTERTAINMENT

Cutting-edge technologies like AR [10,11] are poised to influence the future of entertainment. The widespread availability of mobile devices has allowed the entertainment industry to reshape how individuals engage with activities such as games, sports, tours, and performances. AR seamlessly blends real and virtual worlds in 3D, providing an interactive experience.

Beyond redefining traditional gaming, AR is already enhancing multimedia presentations and videos. Its applications extend to a broader range of entertainment fields, transforming activities like music listening and travel. Point of interaction and visualization technology, along with key enabling technologies, are being combined to achieve diverse and immersive points of interaction [12]. AR can also collaboratively deliver personalized information to each user, and it enhances broadcasting in sports, shows, and events by highlighting or incorporating relevant information.

Ivan Sutherland pioneered the first complete AR system with rudimentary graphics [13] and a substantial Head-Mounted Display (HMD). Consequently, AR's integration into the entertainment industry has made significant strides, evident in recent hits like location- based gaming. AR fundamentally alters user interaction, allowing individuals to explore the outdoors and turn everyday objects like books into AR-enhanced experiences, breaking free from the limitations of non-AR experiences confined to screens.

Most AR theater setups comprise software components running on the device, such as local game control and user tracking. Server connectivity, often necessary in scenarios with shared resources, location-driven games, and continuous synchronization, is also employed [14]. While each system has its unique architecture, real-time performance can be achieved using cloud computing [15]. The data and workflow flowchart, specifically tailored for AR mobile systems, is illustrated in Figure 1. Figure 2 outlines three main sections in each architecture: layers facilitating the integration of diverse hardware, application container, a runtime environment containing application logic, including navigation and assembly, and a workflow abstraction layer, where all computational tasks occur, whether on the device or in the cloud [16]. The outcomes of these tasks are integrated into real systems and presented on displays, interacting with users.

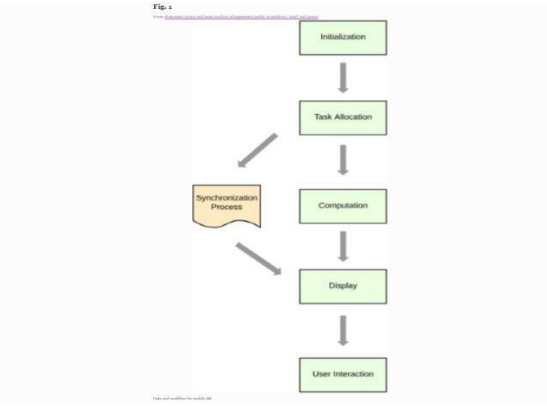
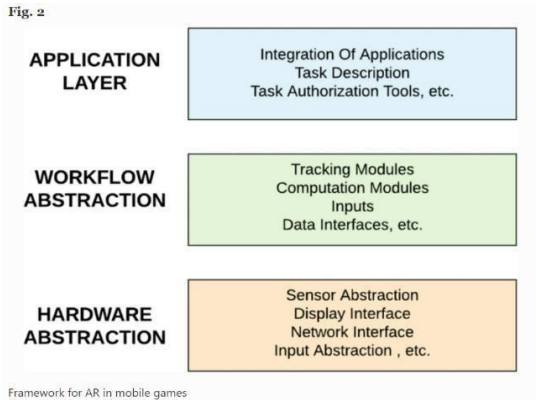


Figure 1: Flow Chart

Two primary types of AR systems are used for entertainment. The first relies on markers, utilizing image recognition technology. These markers, often black and white, are used to identify the augmented object. For instance, a phone's camera is directed at the marker's position; once identified, the required digital content is superimposed on the marker, overlaying the real object. The images are pre-coded into the system, simplifying their identification, and most AR applications in the market are



marker-based [17]. Snapchat, a widely popular app among the youth, is an example of a prominent marker-based application.

Figure 2: Framework for AR in mobile games

The second type is location-based applications, operating without markers. This technology utilizes Global Positioning System (GPS) or a digital compass to identify the user's location, replacing or merging real-world objects with augmented ones. Such applications enable users to discover nearby restaurants, locate their vehicles in parking lots, and are also employed in location-based games (Figure 3).

The continuous evolution of AR in entertainment opens new possibilities for user engagement. As the technology advances, AR applications are expected to provide even more immersive experiences, pushing the boundaries of traditional entertainment formats. Future developments may include enhanced storytelling through AR-driven narratives, personalized live event experiences, and the integration of augmented elements into everyday activities[18]. With ongoing research and innovation, AR is likely to play a pivotal role in shaping the future landscape of entertainment, offering users unprecedented levels of interactivity and enjoyment across various domains.

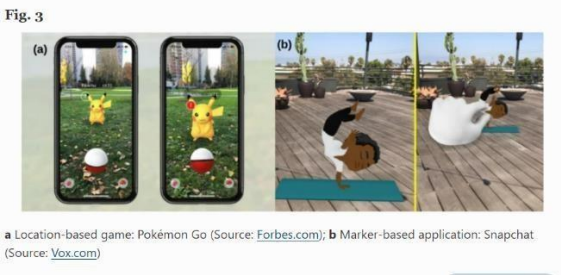


Figure 3: AR game Example

3. AR IN MEDICINE

This increased engagement of clinical students is particularly evident in the immersive experiences facilitated by VR, where users are fully immersed in a virtual environment through head-mounted displays (HMDs), stereo headphones, and high-resolution motion tracking systems. On the other hand, AR serves the purpose of overlaying digital models onto the real-world environment [19]. Utilizing 3D tablet displays primarily for user interaction, a practical study focusing on skull anatomy was conducted, evaluating the physical knowledge retention of clinical students through multiple trials with diverse illustrations.

Despite the evident benefits of both AR and VR in medical education, challenges such as the high cost of AR systems and the need for precise deployment must be addressed. As technological advancements continue, the integration of AR and VR in medical training holds the promise of revolutionizing how medical professionals learn and practice, offering innovative and interactive approaches that enhance the educational experience [20]. Further research and development in this field are crucial to unlocking the full potential of augmented and virtual reality in medical education and healthcare.

Moreover, the application of AR extends beyond medical education to the actual practice of medicine. Surgeons can leverage AR for complex as shown in Figure 4 surgical procedures, providing them with real-time, augmented information during operations. This aids in enhancing precision and decision-making, ultimately leading to better patient outcomes. Additionally, AR finds utility in post-surgical therapies, where patients can benefit from interactive and personalized rehabilitation programs [21]. The immersive and interactive nature of AR not only transforms medical education but also contributes significantly to advancing patient care and treatment methodologies. As the technology continues to evolve, the healthcare industry stands on the brink of a transformative era with the integration of augmented reality application.

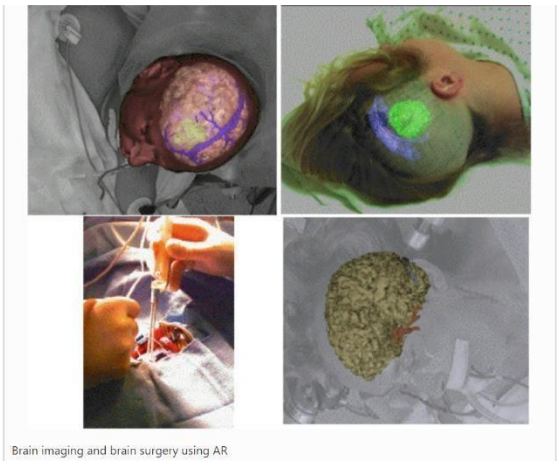
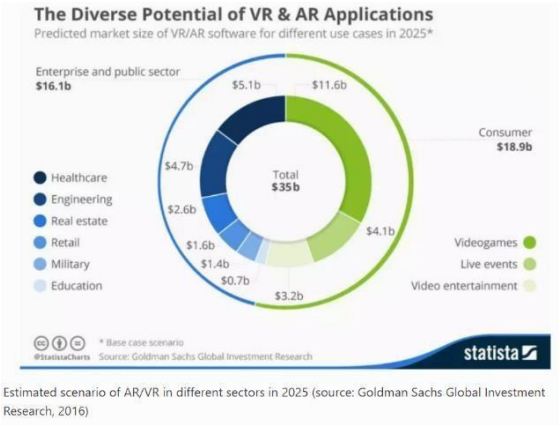


Figure 4: Brain Imaging & surgery using AR

4. APPLYING AR IN FIGHT AGAINST COVID-19 CRISIS

During the global COVID-19 pandemic, the virus has impacted lives worldwide, resulting in numerous fatalities and widespread disruptions. To mitigate its effects, various countries implemented lockdown measures, leading to economic challenges, business closures, and educational institutions shutting down. In response, researchers and innovators have proposed technological solutions to aid society during these challenging times. For instance, there have been proposals for reshaping medical education [22], and studies [23] have explored the monitoring of hospitals and clinics using technological methods. Augmented Reality (AR) emerges as a valuable tool in navigating life during this crisis. Google's AR application, Sodar, exemplifies this by promoting social distancing, ensuring individuals maintain a safe distance of 2 meters from each other. As the world anticipates the easing of lockdown measures and a return to outdoor activities, AR applications like Sodar can continue to play a crucial role in promoting public health and safety.



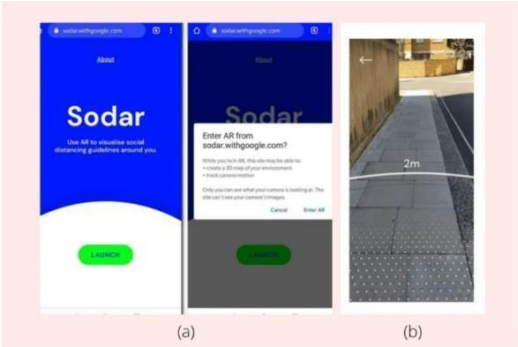
Estimated scenario of AR/VR in different sectors in 2025 (source: Goldman Sachs Global Investment Research, 2016)

Figure 5: Estimated scenario of AR/VR in diff sectors

5. CHALLENGES AND FUTURE SCOPES

Despite the numerous challenges, Augmented Reality (AR) holds vast potential to revolutionize various industries. Overcoming these obstacles could empower AR to transform entire markets. Its applications span diverse sectors such as education, healthcare, military, construction, automotive, travel, retail, art, and architecture [24]. (Figure 5) As a cutting-edge technology, AR is poised to reshape organizational business strategies. In an increasingly competitive market, businesses that provide high-quality products and exceptional service are trusted by consumers.

Recognizing this, many companies are likely to adopt AR to deliver personalized experiences, attracting a broader customer base. The anticipated rise of mobile AR technology is expected to foster greater social acceptance, facilitated by widespread familiarity with smartphones. Moreover, AR's utility in addressing challenges, such as those posed by the COVID-19 crisis, underscores its versatility. While Goldman Sachs projected the AR/VR landscape in 2025 in Figure 6 (2016), the current global circumstances and potential post-lockdown scenarios suggest continued hesitancy in freely using entertainment, retail, and healthcare facilities. This underscores the need for AR to provide immersive experiences across various fields, challenging the accuracy of Goldman Sachs' 2016 predictions for AR/VR in 2025.



a Launch of sodar application; **b** 2-m radius being displayed after camera is pointed toward area

Figure 6: Sodar Application

6. CONCLUSION

The dynamic landscape of Augmented Reality (AR) continues to evolve, promising even more sophisticated entertainment possibilities beyond conventional digital media as ongoing research propels the development of future AR systems. The technology's distinctive ability to enhance interaction and elevate content quality creates a platform for truly personalized experiences, captivating users across diverse fields. Despite its existence for a considerable time, AR has yet to be fully embraced in everyday activities such as retail and medicine, mainly due to concerns surrounding technology implementation, social acceptance, and usability challenges. However, the prospect of overcoming these hurdles holds the promise of redefining the gaming landscape through enriched real-time content.

In the medical domain, AR stands poised to revolutionize surgical procedures, medical training, and post-surgical treatments, presenting a transformative paradigm for healthcare professionals. Beyond the realms of medicine, consumers actively seeking innovative solutions for improved shopping experiences are likely to wholeheartedly embrace AR, creating exciting opportunities for businesses to reimagine customer engagement. Our focus extends to the exploration of current AR implementations, shedding light on their significance in the ongoing process of pandemic recovery and their role in providing users with unprecedented technological experiences across diverse domains.

Recent technological advancements underscore the continuous evolution of AR, exemplified by applications like Pokémon Go, a gaming phenomenon employing location-

based features through GPS, and Snapchat, a marker-based application utilizing image recognition in AR. This diversity highlights the adaptability of AR applications to various contexts. Numerous AR- based software development kits, including Unity and AR Toolbox, offer developers flexible solutions, considering factors such as cost, platforms, image recognition technology, and 3D tracking and recognition capabilities. Furthermore, the contributions of tech giants like Google and Android to this landscape, with AR development kits like Google AR Core and AR Spark studio, underscore the collaborative efforts shaping the expanding market base of AR systems. In essence, the significance of a comprehensive review providing insights into three major fields employing AR systems cannot be overstated, as it reflects the transformative potential of AR across industries and its pivotal role in shaping the technological landscape of the future.

Looking ahead, the trajectory of AR's development points toward a future where the technology becomes seamlessly integrated into various facets of our daily lives. As AR systems continue to advance, overcoming current challenges, their applications in education, military, construction, automotive, travel, art, and architecture are poised to redefine industry practices. Organizations keen on staying competitive in an increasingly dynamic market are recognizing the pivotal role of AR in providing unparalleled user experiences, leading to a surge in its incorporation. The ongoing market competition underscores a shift toward customer-centric approaches, where companies harness AR to offer personalized interactions and attract a broader consumer base.

The expected rise of mobile AR technology is particularly noteworthy, poised to gain widespread social acceptance. Familiarity with operating smartphones positions users to seamlessly adapt to this technology, making it a more accessible and user-friendly innovation. Considering the contemporary scenario, characterized by lingering concerns from the COVID-19 pandemic, people may still exhibit reservations toward freely using entertainment, retail, or medical facilities. In this context, AR emerges as a transformative tool, capable of delivering fully immersive experiences to users across various fields, thereby addressing potential hesitations and fostering a renewed sense of engagement. It is pertinent to revisit and reassess the predictions made in 2016, such as those by Goldman Sachs, given the current global landscape. The impact of the pandemic has underscored the need for innovative solutions, positioning AR as a technology not just for the future, but for the present challenges as well. As we navigate this evolving technological frontier, the significance of continued exploration and understanding of AR's multifaceted applications remains paramount

REFERENCES

1. Shah G, Shah A, Shah M (2019) **Panacea of challenges in real-world application of big data analytics in the healthcare sector.** J Data Inf Manage 1(3):107–116.
2. havan SR (2016) **Augmented reality vs. virtual reality: differences and similarities.**
3. Gandhi M, Kamdar J, Shah M (2020) **Preprocessing of non-symmetrical images for edge detection.** Augment Hum Res 5(1):10.
4. Patel D, Shah Y, Thakkar N, Shah K, Shah M (2020) **Implementation of artificial intelligence techniques for cancer detection**. Augment Hum Res 5(1):6.
5. Leena Lakra P, Verma P (2017) **Augmented reality in marketing: role and applications.** 8(11):74–81..
6. Parekh V, Shah D, Shah M (2020) **Fatigue detection using artificial intelligence framework.** Augment Hum Res 5(1):5.
7.. Lee K (2012) **Augmented reality in education and training.** TechTrends 56(2):13–21.
8. Nayyar A, Mahapatra B, Le DN, Suseendran G (2018) **Virtual reality (VR) & augmented reality (AR) technologies for tourism and hospitality industry.** Int J Eng Technol 7(2):156–160.
9. Huang ZP, Li WK, Hui P, Peylo C (2014) **CloudRidAR: a cloud-based architecture for mobile augmented reality. Paper presented at 2014 workshop on mobile augmented reality and robotic technology-based systems.** ACM, Bretton Woods, June 16 2014.
10. Butterworth J, Davidson A, Hench S, Olano MT (1992) **3DM: a three dimensional modeler using a head-mounted display. Paper presented at the 1992 symposium on interactive 3D graphics.** ACM, Cambridge, June 1992.
11. Talaviya T, Shah D, Patel N, Yagnik H, Shah M (2020) **Implementation of artificial intelligence in agriculture for optimisation of irrigation and application of pesticides and herbicides.** Artif Intell Agric 4:58–73.
12. Jha K, Doshi A, Patel P, Shah M (2019) **A comprehensive review on automation in agriculture using artificial intelligence.** Artif Intell Agric 2:1–12.
13. Azuma R, Baillot Y, Behringer R, Feiner S, Julier S, MacIntyre B (2001**) Recent advances in augmented reality.** IEEE Comput Graph Appl 21(6):34–47.
14. Sutherland IE (1968) **A head-mounted three dimensional display.** Paper presented at the fall joint computer conference. ACM, San Francisco December 9-11, 1968.

15. Herbst I, Braun AK, McCall R, Broll W (2008) **TimeWarp: interactive time travel with a mobile mixed reality game. Paper presented at the 10th international conference on human computer interaction with mobile devices and services.** ACM, Amsterdam, 2-5 September 2008.

16. Sukhadia A, Upadhyay K, Gundeti M, Shah S, Shah M (2020) **Optimization of smart traffic governance system using artificial intelligence.** Augment Hum Res 5(1):13.

17. Shah K, Patel H, Sanghvi D, Shah M (2020) **A comparative analysis of logistic regression, random forest and KNN models for the text classification.** Augment Hum Res 5(1):12.

18. Carmigniani J, Furht B (2011) **Augmented reality: an overview. In: Furht B (ed) Handbook of augmented reality.** Springer, New York. 1

19. Patel D, Shah D, Shah M (2020) **The intertwine of brain and body: a quantitative analysis on how big data influences the system of sports.** Ann Data Sci 7(1):1–16.

20. Panchiwala S, Shah M (2020) **Comprehensive study on critical security issues and challenges of the IoT world.** J Data, Inf Manage.

21. Moro C, Štromberga Z, Raikos A, Stirling A (2017) **The effectiveness of virtual and augmented reality in health sciences and medical anatomy.** Anat Sci Educ 10(6):549–559.

22. Goh P, Sandars J (2020) **A vision of the use of technology in medical education after the COVID-19 pandemic.** MededPublish, pp 1–8.

23. Ting DSW, Carin L, Dzau V, Wong TY (2020) **Digital technology and COVID-19.** Nat Med 26(4):459–461.

24. Agarwal C, Thakur N (2014) **The evolution and future scope of augmented reality.** Int J Comput Sci Iss 11(6):59–66