Artificial Intelligence (AI) in Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality (MR) Experiences: Enhancing Immersion and Interaction for User Experiences

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***Abstract*—The utilisation of Artificial Intelligence (AI) generated material is one of the most fascinating advancements in the rapidly growing fields of Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR). Two examples of how AI-generated material is revolutionising how we interact with AR, VR and MR are video games and training simulations. In this essay, we'll examine the intriguing potential of AI-generated content and how it's being used to the development of hybrid real-world/virtual experiences. Using this strategy, we acquired the information from primary and secondary sources. We surveyed AR, VR, and MR users to compile the data for the primary source. Then, utilising published papers as a secondary source, information was gathered. By elucidating the concept of context immersion, this research can lay the foundation for the advancement of information regarding immersive AR, VR, and MR contexts. We are able to offer recommendations for overcoming the weak parts and strengthening the good ones based on the questionnaire survey findings.**

***Index Terms*—AI, AR, VR, MR, Emersion experience**

I. Introduction

The utilization of Artificial Intelligence (AI) generated material is one of the most interesting advances in the rapidly growing fields of Virtual Reality (VR) Augmented Reality (AR) and Mixed Reality (MR). In this paper, we examined the intriguing potential of AI-generated content and how it's being used to the development of immersive experiences that meld the real and the virtual.

However, this shift has a unique set of difficulties. For starters, these immersive experiences require hardware and software capabilities. The continued advancement and incorporation of VR, AR and MR technologies appear to be going a long way toward influencing UX design in the future. As a result of these developments, designers will have new chances to create UXs that are even more immersive, dynamic, and compelling.

II. Literature Review

AR experiences are typified by multi-sensory stimulation, a high level of engagement, and vividness. Due to the characteristics of AR technology, AR experiences [1] are classified as embedded because they incorporate real-time product/service information into the current decision context, embodied, allowing for direct physical contact with a good or service, extended or shared, allowing for communication amongst peers and adaptable, being naturally malleable [2]. The current ecosystem of phones and computers may be replaced by AR as our primary interface to the digital world and portal to the met-averse [3]. A combination of AR, VR and MR does not just exist in the physical or virtual worlds [4].

III. Methodology

A. Data collection

We gathered the data from primary and the secondary sources. For the primary source we have got the data from AR, VR and MR users from questionnaires. Then, we have got the data from the existing papers as per the secondary source.

We have developed a google form questionnaire and shared among social medias such as LinkedIn, WhatsApp, Facebook etc. There are 36 responses were gathered. We have filter it to 30 data and used for the analysis section. The null values, irrelevant answers are the main reason to deduct the data. This study was also prepared using a qualitative technique called as systematic review, which looked at earlier research papers. Most of the necessary information was acquired from reliable sources. Especially the data are very similar to the questionnaire. The following TABLE I stated crucial criteria were assessed in order to narrow down the downloaded papers.

TABLE I
Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Empirical research	Literature survey or commentary
Reputed publishes (IEEE, Elsevier, etc.)	Non-reputed or low indexed articles
English Language	Other Language
Open access papers	Closed access papers
Recently published papers	Published before 2020

B. Data analysis

In order to thoroughly examine the effects of Virtual Environment (VE) experience on users, this study uses a mixed-methods approach that combines quantitative and qualitative methodologies. While the qualitative phase adds depth and meaning to the findings from previous studies, the quantitative phase enables a wide study of UX. For that we used statistical MS Excel (2016) and SPSS for the data analysis.

IV. Results

A. Questionnaire data collection

There are 36 data were collected via Google Forms. The despondences were collected and filter the data and got 30 samples for our analysis. Basic personal background information, a comparison survey of ”usability”, ”preference”, ”experience” and ”feedback” in relation to AR, VR, and MR users were all included in the questionnaire’s content.

TABLE II
The statistical results of participants in the questionnaire

	Frequency	Valid Percentage
Age		
Adults (18 – 64 years)	27	90
Adolescents (13 - 17 years)	3	10
Occupation		
Academic	23	76.67
Non-academic	07	23.33
Sector		
AR	16	53.33
VR	08	26.67
MR	06	20

TABLE II illustrates frequency (total number of participants) and percentage of participants in the questionnaire. Though age, occupation and related sector are the main content in this table. 90% of the adults (18 – 64 years) and 10% Adolescents (13 - 17 years) were participated. We have divided the occupation as academic and non-academic (industry). So, there 76.67% of academics and 23.33% of non-academics were contributed to this survey. According to the sectors AR gained 53.33%, VR acquired 26.67% and the MR acquired 20% of participants.

Particularly, the 18 to 64 years adults, academic and AR users are the majority participants among others. When considering the experience in VE the total number of results (N=30) and the data were divided into two.

According to the TABLE III the most of the participants have the good impression on the VE usage. Because they were choose many positive experience scenarios rather than the negative ones. For example 16 participants (53.33%) were selected ”This experience was making me feel incredibly well”. Meanwhile 5 participants (16.67%) were marked “I was struggling to keep track of time”. The majority academic and non-academic participants were selected the positive scenarios. Then we can make a decision like the users are having emersion experience while using VE.

TABLE III
THE STATISTICAL RESULTS OF PARTICIPANTS IN THE QUESTIONNAIRE

NO		Academic AR	Academic MR	Academic VR	Non-aca AR	Non-aca MR	Non-aca VR	Frequency (N=30)	Valid percentage (%)
1	"This experience was making me feel incredibly well."	6	3	4	2	1	-	16	53.3
2	"When I took actions, the virtual environment responded"	6	4	3	1	1	1	16	53.3
3	"Being in this virtual world was fun for me"	7	4	3	-	-	1	15	50
4	"I love the virtual word rather than the real world"	6	3	3	1	1	1	15	50
5	"I could look at things from different angles"	4	3	3	1	1	-	12	40
6	"Using vision, I was able to actively survey the virtual environment."	4	3	2	1	-	-	10	33.3
7	"I was able to closely inspect objects"	4	2	2	1	-	1	10	33.3
8	"The controls for my movement in the virtual environment (gamepad or keyboard) seemed natural."	1	2	4	-	1	1	9	30
9	"I localized the virtual environment's sounds correctly."	3	2	2	-	1	1	9	30
10	"I believed I had complete control over my behaviour."	3	2	3	1	-	-	9	30
11	"I thought I was having a thrilling moment,"	4	2	2	1	-	-	9	30
12	"Time moved more slowly than usual,"	5	2	1	-	-	-	8	26.7
13	"I correctly recognized the virtual environment's sounds"	1	2	3	-	1	-	7	23.3
14	Time seemed to fly by.	3	1	2	-	-	1	7	23.3
15	At the conclusion of the encounter, "I felt skilled in moving and interacting with the virtual environment"	2	2	1	-	-	1	6	20
16	"The visual display quality kept me from completing the tasks I was supposed to"	1	1	2	1	-	-	5	16.7
17	"The controls on the gamepad or keyboard keep me from completing the tasks I've been given"	3	-	2	-	-	-	5	16.7
18	"I thought I had it under control"	-	3	1	-	1	-	5	16.7
19	I was struggling to keep track of time.	2	1	1	1	-	-	5	16.7
20	"I became nervous while in the virtual setting"	1	2	1	-	-	1	5	16.7
21	"I felt natural in my interactions with the virtual world."	1	1	1	-	-	1	4	13.3
22	"I knew what to do at every step,"	1	1	1	-	-	-	3	10

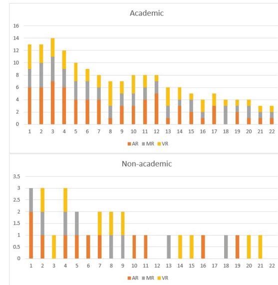

Fig. 1. Reliability data of academic and non-academic participants.

Fig. 2 column charts shows graphical representation of the academic and non-academic participants in experience in the VE usages. The vertical axis shows the frequency (N=30) and horizontal axis signify "S NO", which represent the scenarios. According to the deep analysis, there are 13 scenarios (NO 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 13, 16, 21) are engaging with extreme immersion experience of VE. In order to that from the total number selection (68), 48 particularly AR academic participants. So, the 70.59% is the percentage. Also MR academic were selected 32 over 46 responses to the particular scenarios. This about 69.56% of the total value. Then, in the last section of the VR in the academic has 9/11. That delegating 72.34% of the overall view. When it comes to the non-academic section AR participants selected 7/8, MR selected 7 over 10 and finally VR selected 7 over 10. These responses are 81.81%, 87.5% and 70% respectively.

This percentage calculated though the following formula:

$$P = EESE/TNSS * 100 \qquad (1)$$

P denotes to percentage, EESN is Extreme emersion scenario selection and TNSS is Total number of scenario selection.

TABLE IV
THE STATISTICAL RESULTS OF PARTICIPANTS IN THE QUESTIONNAIRE

Challenges of VE	Academic AR	Academic MR	Academic VR	Non-academic AR	Non-academic VR	Non-academic MR
Cost	1	4	5	2	2	2
Health issues	2	3	-	1	-	1
Integration	1	1	2	1	1	-
Security	2	2	-	1	1	-
Training	1	-	3	-	-	-

Conferring the TABLE IV it displays the major challenges of the VE and academic and non-academic contributors' answers or selections in the discipline of separate technologies. The users advised to select the challenges.

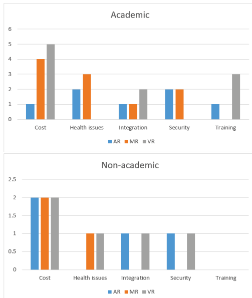

Fig. 2. Challenges selected by academic and non-academic participants.

According to the Fig. 2, the vertical axis shows the frequency (N=30) and horizontal axis signify major challenges. So that, from the total number selection (39), mainly 16 participants were selected "cost" as a major problem during the use of VE. The academics were 10 (62.5%) and the non-academic were 6 (37.5%). The 41.03% is the percentage when it compares to overall selection. Next, 7 participants selected "health issues" as a problem. MR academic were selected 32 over 46 responses to the particular scenarios. It is about 17.95% entire selection. Especially, the academic participants has 71.42% while non-academic has 28.57% selection. Then, for the "Integration" and "security" issues, there are 6 participants were selected simultaneously. And also it is about 66.67% and 33.33% percentage of the selection for both issue. Finally, there are 4 users were selected "training" as a problem. In this sense, the academic participants having 10.26% of selection and unfortunately non-academic has no selection. Moreover, we can take "cost" is the major problems among others.

B. Existing paper data collection

According to the TABLE V it columned as reference, sector, VE, importance to connect with VE, advantages and drawbacks. Almost we have reviewed 13 previously published papers for this section. There are 6 papers were related to the academic. Meanwhile 7 papers were closed to non-academic. When

TABLE V
DATA FROM THE EXISTING RESEARCH PAPERS

Ref	Sector	VE	Importance	Pros	Cons
[5]	Non-Aca (Real estate)	AR & VR	VR – 3600 images, 3D	Help for informed decisions	Cost
[6]	Non-Aca (Theme park)	AR & VR	Development of theme parks	Increase the immersion	-
[7]	Aca (medical education)	AR	3D representations	3D representation	Cost
[8]	Aca (Storytelling & VR)	VR	Aim to enhance storytelling	Decision-making	-
[9]	Aca (Students Concentration & Creativity)	VR	Improve student concentration & creativity.	improvement of teaching	cannot reflect the impact of AI teaching
[10]	Non-academic	MR	create MR without in-depth knowledge	Accessibile, reusabile, flexibile, integration, collaboration	Learning curve, dependency, complexity, maintenance
[11]	Non-Aca (Health care)	VR	automotive manufacturing	Efficient, simulation, collaboration, training	Costs, integration, technical limitations
[12]	Non-Aca (Health Care)	AR	Enhanced Patient Experience	Improved patient comfort	Latency, technical requirements
[13]	non-Aca (Manufacturing & Assembly)	VR	Efficient user-friendly assembly assistance	Dynamic & adaptive assembly instructions, User-friendly, efficiency	Technical issues, cost, training, dependency, privacy concern
[14]	Aca (Education)	AR & VR	allows students explore different places	improved spatial abilities	cost, health issues
[15]	Non-Aca (video game)	AR and VR	Immersive realistic gaming experience.	social interaction with other players	cost, health issues
[16]	Aca (Education)	VR	VR distance education simulated	enhance learners' cognitive, practical skills	health issues
[17]	Non-Aca (Marketing & brand experiences)	VR and AR	allow users to interact with VE	deliver realistic and accurate product information	Technical challenges

considering academic section the reference [7] is represents 3D representations to be integrated with real environmental stimuli. AR make use of smart phones, tablets, or other devices to achieve a highly stimulating learning environment and hands-on immersive experience. Then, reference [8] aim to enhance storytelling in VR by inducing emotions through AI characters in environment inspired by realistic events. Improve student concentration and creativity stated in reference [9]. In order to that reference [12] including enhanced patient experiences. Then, [14] is providing without leaving the classroom, VR enables students to visit other locations, cultures, and historical sites, while AR may improve spatial awareness and foster empathy. In the reference [16], it claims that VR distant learning has grown more simulative as a result of the ongoing interactive updating of technologies like AI, VR/AR, big data, 5G, cloud service, and marginal computing. As per the non-academic section, reference [5] VR - 3600 photos, immersive 3D space tours, and interactive property tours provided for real estate field. Theme park development potential in keeping with current trends in the reference of [6]. In [10] reference MR applications made by content specialists without in-depth understanding of the underlying technology [11] has. On the other hand, reference [13] Efficient and user-friendly assembly assistance in the context of shorter product life cycles in the context of manufacturing sector. Immersive and realistic gaming experience were stated in the reference of [15]. Experiential brand immersion and users may engage with virtual surroundings using VR and AR technology, which improves their brand experiences in reference [17].

When considering the advantages of academic papers, remote learning and interactive simulations spotted in reference [7]. Then, reference [8] allow us to create realistic emotional states decision-making process. Effectively and unequivocally contributes to the improvement of teaching in reference [9]. In order to that reference [12] including through immersion, improved spatial abilities, increased motivation, and the ability to provide cost-effective virtual field trips. Then, [14] is include enhanced learning outcomes through immersion, improved spatial abilities, increased motivation, and the ability to provide cost-effective virtual field trips. In the reference [16], immersive experiences, simulate real-world environments and processes, enhance learners' cognitive and practical skills, and improve academic achievement and learning motivation. Overall, the main advantages of all of these references were to give immersion experience to the user in respect to different technologies. As per the non-academic section, reference [5] Help them make more informed decisions about whether a property is a right fit for them. Increase the immersion of visitors and increase the satisfaction of the experience in reference [6]. In [10] reference The technology democratizes the creative process by enabling content specialists to develop MR applications without being MR experts. The framework encourages problem-solving in certain domains, enabling the development of customized MR experiences. [11] VR makes it possible to quickly create and test car prototypes in a VE, cutting down on the time and expense of physical development.

Reference [13] Assembly instructions may be updated in real-time using AR, ensuring they are always up to date. User interfaces that are intuitive and tailored to certain user groups enhance usability. By speeding up the assembly process and decreasing manufacturing time, AR can result in cost savings.

When considering the disadvantages of academic papers, cost is the main challenge that spotted in reference [7]. The technology cannot fully reflect the impact of AI and VR technology on teaching effect in reference [9]. In order to that reference [12] The UX can be impacted by latency in AR interactions, particularly in applications like healthcare where real-time synchronization is essential. Then, [14] is include restricted accessibility, pricey equipment, and the possibility of motion sickness or discomfort for certain people. In the reference [16], difficulties with duplicated information, increased cognitive demands, physiological discomfort for learners, and potential safety concerns with simulations. As per the non-academic section, reference [5] cost is the identified major problem. In [10] reference learning curve, dependency, complexity, maintenance, limited and flexibility stated as problems.

V. Comparison of the Results

The majority of the academic and non-academic people are concluding that they have using AR, VR and MR technologies to gain the immersive experience which proved in the TABLE II and fig. 2. They stated 72.11% of the participants were identified that they are having extreme immersion experience through VE.

Focusing on the disadvantages, the primary data were specified that 41.03% of the users having cost issue. In order to that other issues were heath, integration, security and training. So, it is 17.95%, 15.38%, 15.38%, and 10.26 % respectively. "Cost" is identified as a major problem in the previous papers too. In this sense, academic papers, references [7], [8], [9], [12], [14], [16] and non-academic papers [5], [6], [10], [11] , [13], [15] and [17] were specified "cost" as main issue. But also they mentioned heath, integration, security and training issues as well. Also they identified other problems such as learning curve, dependency, complexity, maintenance, limited, flexibility, technical limitations, content development, maintenance, and support as a major problems.

VI. Conclusion

In this paper, we looked at the fascinating possibilities of AI-generated content and how it's being used to the creation of VR, AR and MR experiences. The act of collecting accurate data from many sources and analyzing it to find trends, opportunities, and answers to research problems as well as to weigh potential repercussions is known as data collection. The extent of context immersion was also examined utilizing the special questionnaire. We are able to offer solutions for overcoming the weak areas and bolstering the strong points based on the findings of the questionnaire study. We collected information for the following step of our investigation from previously released research articles. More case studies will be used to completely analyze the suggestions to enhance immersion and interaction for UX.

References

[1] S. Joshi, M. Sharma, R. P. Das, J. Rosak-Szyrocka, J. Żywiołek, K. Muduli, and M. Prasad, "Modeling conceptual framework for implementing barriers of ai in public healthcare for improving operational excellence: Experiences from developing countries," *Sustainability*, vol. 14, no. 18, p. 11698, 2022.

[2] L. Zarantonello and B. H. Schmitt, "Experiential ar/vr: a consumer and service framework and research agenda," *Journal of Service Management*, vol. 34, no. 1, pp. 34–55, 2023.

[3] S. Chenna, "Augmented reality and ai: Enhancing human-computer interaction in the metaverse," *Available at SSRN 4324629*, 2023.

[4] M. Rashid, P. Choi, K.-R. Kwon, S.-G. Kwon, and S.-H. Lee, "Emergence of the metaverse: How blockchain, ai, ar/vr, and digital transformation technologies will change the future world," 2022.

[5] I. Miljkovic, O. Shlyakhetko, and S. Fedushko, "Real estate app development based on ai/vr technologies," *Electronics*, vol. 12, no. 3, p. 707, 2023.

[6] M. Kim, "Discussion on the use of new technologies such as artificial intelligence (ai) and virtual reality for the development of theme parks."

[7] P. Dhar, T. Rocks, R. M. Samarasinghe, G. Stephenson, and C. Smith, "Augmented reality in medical education: students' experiences and learning outcomes," *Medical education online*, vol. 26, no. 1, p. 1953953, 2021.

[8] G. M. Pyjas, J. Weinel, and M. Broadhead, "Storytelling and vr: Inducing emotions through ai characters," *Proceedings of EVA London 2022*, pp. 198–204, 2022.

[9] Q. Rong, Q. Lian, and T. Tang, "Research on the influence of ai and vr technology for students' concentration and creativity," *Frontiers in Psychology*, vol. 13, p. 767689, 2022.

[10] P. Grimm, M. Haller, V. Paelke, S. Reinhold, C. Reimann, and R. Zauner, "Amire-authoring mixed reality," in *The First IEEE International Workshop Agumented Reality Toolkit,*. IEEE, 2002, pp. 2–pp.

[11] L. Kobayashi, X. C. Zhang, S. A. Collins, N. Karim, and D. L. Merck, "Exploratory application of augmented reality/mixed reality devices for acute care procedure training," *Western Journal of Emergency Medicine*, vol. 19, no. 1, p. 158, 2018.

[12] A. Vidal-Balea, Ó. Blanco-Novoa, P. Fraga-Lamas, and T. M. Fernández-Caramés, "Developing the next generation of augmented reality games for pediatric healthcare: An open-source collaborative framework based on arcore for implementing teaching, training and monitoring applications," *Sensors*, vol. 21, no. 5, p. 1865, 2021.

[13] A. Neb, D. Brandt, R. Awad, S. Heckelsmüller, and T. Bauernhansl, "Usability study of a user-friendly ar assembly assistance," *Procedia CIRP*, vol. 104, pp. 74–79, 2021.

[14] Y. Sharrab, N. T. Almutiri, M. Tarawneh, F. Alzyoud, A.-R. F. Al-Ghuwairi, and D. Al-Fraihat, "Toward smart and immersive classroom based on ai, vr, and 6g," *International Journal of Emerging Technologies in Learning (Online)*, vol. 18, no. 2, p. 4, 2023.

[15] I. Tiwari, D. Solankar, and R. Khande, "Virtual and augmented realms: the evolution of video games with vr and ar technology," *Vidhyayana-An International Multidisciplinary Peer-Reviewed E-Journal-ISSN 2454-8596*, vol. 8, no. si7, pp. 545–561, 2023.

[16] P. Li, Z. Fang, and T. Jiang, "Research into improved distance learning using vr technology," in *Frontiers in Education*, vol. 7. Frontiers, 2022, p. 757874.

[17] J.-Y. Zeng, Y. Xing, and C.-H. Jin, "The impact of vr/ar-based consumers' brand experience on consumer–brand relationships," *Sustainability*, vol. 15, no. 9, p. 7278, 2023.