Application of AR/VR Technology in Agricultural Education: A Study

Pramod Kumar
Library Assistant, Rani Lakshmi Bai Central Agricultural University
Email - pramod9953@gmail.com, pramod.9953@nic.in

Abstract: *As we know we're living in the era of smart computing and advanced technology that influences many domains including the education sector too. In this paper we're trying to put some light on the adaptability of Augmented Reality (AR) and Virtual Reality (VR) technologies and their applications in agricultural education. Several studies revealed that the AR/VR have the potential to improve the student's skills, knowledge and process of learning. It can change the learning and teaching experiences in a very effective and attractive way. The aim of this paper is to present a brief introduction with respect to agricultural education and try to highlight some applications of these technologies in agricultural education.*

Key Words: *Augmented Reality, AR, Virtual Reality, VR, Agriculture, Applications, Visualization.*

1. INTRODUCTION:

In the last few years, the research community has been interested in adapting new technologies in education. One of the latest technologies which are explored and adopted by the education sector is Augmented Reality (AR) and Virtual Reality (VR). (Ghulamani & Zareen, 2018a) It brought a significant contribution to a classroom environment of these technologies from an instructional view that is majorly focused on students or learners. AR is an emerging technology which is used to feel a unique experience of the real world with the help of computer-generated content that mixes into our perception of the real world for a specific location or activities. It is not a new technology but demand in the education sector has been increasing over the last few years. The research community takes an interest to use this technology and its application in the education sector. The demand for ICT has increased rapidly after covid-19 pandemic and technical development helps to use this technology due to its effective and positive features and outcomes in the education sector.

2. LITERATURE REVIEW:

(Dunleavy et al., 2009) discussed that many researchers find the potential of AR/VR in promoting the benefits in the education sector to achieve great learning and teaching skills. (Hsieh & Huang, 2016) discussed that in some media reports, in August 2016 "Pokemon Go" was released in Taiwan. It was based on AR technology and the term AR Augmented became popular. (Milgram & Kishino, 2014) discussed that there is a wide range of AR/VR technology applications such as medical, military, business, education, entertainment etc. (Ghulamani & Zareen, 2018b) discussed that the AR/VR technology can be paired with smartphones of users which helps to enhance the teaching and learning experience. (Kencevski & Zhang, 2019) Describe that AR/VR technology has become a revolutionary change in the education sector because students are eager to learn new things that are related to ICT as ICT is now an important part of their life. (Lanzo et al., 2020) Describes the importance of the virtual environment as a teaching and learning tool in many educational fields such as engineering, computing, gaming etc. their findings show that the virtual classroom environment was much more beneficial than the traditional teaching-learning environment. There are many reports available that produce a positive effect of AR/VR in teaching-learning skills. (Phan & Choo, 2010) discussed that the growth of AR/VR increased in the last few years, some of the big names are associated with AR technology and its application in various sectors such as ARTool-kit, ARQuake, Google, Inglobe Technologies, Layar, metaio, nhow Berlin, Total Immersion, and Website. (Tlili et al., 2022) describe that education technology is starting to shift to the

metaverse as some of the major companies show their interest in this area to make it easy to use and to get the faith of the education sector to create a new market.
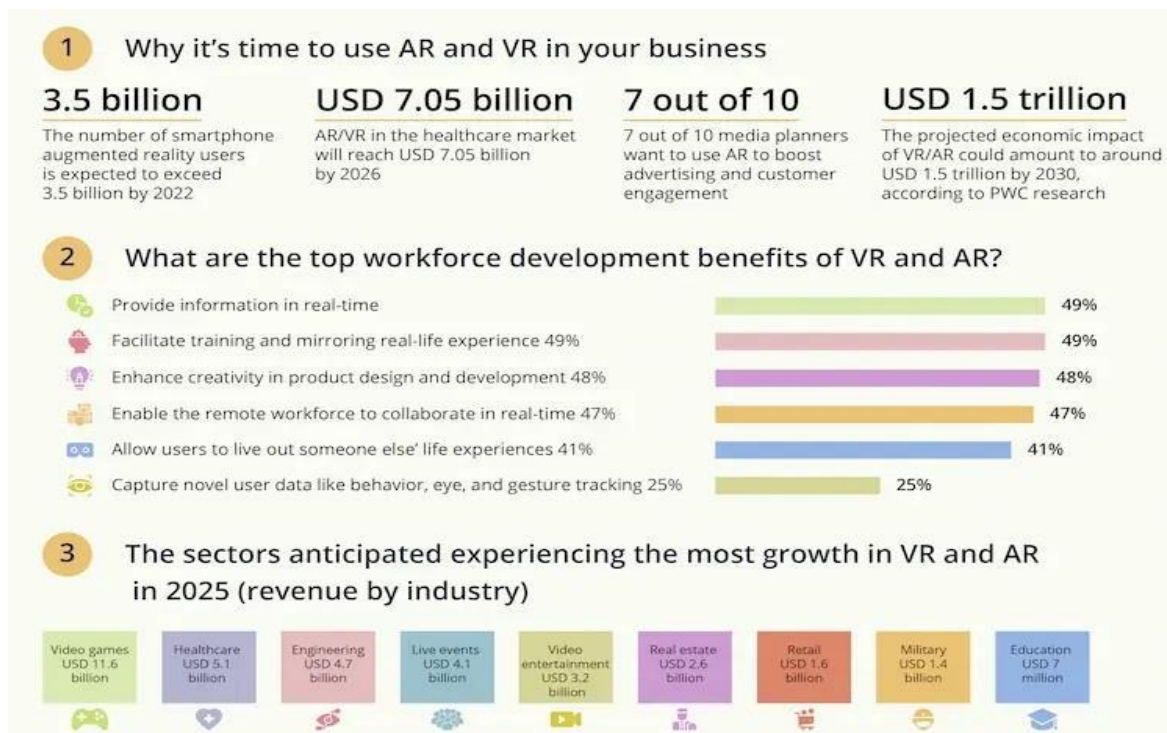
Augmented reality: Augmented reality (AR) is an interactive and emerging technology that is a combination of real-world and computer-generated content such as text, images, audio, videos, and 2D and 3D objects. AR content is integrated with multiple sensory modalities, such as visual, auditory, haptic somatosensory and olfactory. (Cipresso et al., 2018) The 'Augmented Reality' term was introduced by Boeing employees in 1990 (Akçayır & Akçayır, 2017). Sutherland knows as the pioneer in AR development and heads the research of the Sword of Damocles system, which is generally known as the first prototype of the AR head-mounted display (HMD) (Feng Zhou et al., 2008) Azuma 1997 published the first paper on AR and proposed a definition of AR that was widely adopted by researchers (Azuma, 1997). The definition of AR in the report says that AR is a system that includes three elements: a combination of the real-world and virtual world, real-time interaction and 3D-based tracking and positioning of virtual and real objects (Wu et al., 2013).

Virtual reality (VR): Virtual reality (VR) is a different technology if we compared it to Augmented Reality, it is a simulated experience with the help of pose tracking and 3D near-eye display to give an immersive experience to the user and feel of a virtual environment (Akbulut, A.; Catal, C.; Yıldız, B. On the effectiveness of virtual reality in the education of software engineering. Comput. Appl. Eng. Educ. 2018, 26, 918–927.) The term 'Virtual Reality' was first introduced by Greenback in 1963 and Teleyeglasses describe the composition of VR equipment. As the 'Metaverse' concept is popular nowadays, VR attracted the attention of all types of users around the world (Lanier, J. Virtual Reality: The Promise of the Future, Interact. Interact. Learn. Int. 1992, 8, 275–279.).

3. APPLICATION OF AR/VR IN AGRICULTURE EDUCATION: There is so many sectors where AR/VR applications are used widely worldwide a few of them are mentioned below:

Gaming: As shown in figure 1, the total revenue by gaming will reach 2.4 bn US dollars by 2024. As we discussed above the first AR-based game was 'Pokémon GO' besides Pokémon GO there are many other games that are based on AR such as The Walking Dead: Our world, Ingress, Zombies Run!, Harry Potter: Wizard Unite etc.
E-Commerce and Retail: There are several AR-based apps in the market that allow you to interact with their products and provide the experience of personalized shopping such as Home Depot, Lowe's Vision, GAP, IKEA place etc.

1 Why it's time to use AR and VR in your business

3.5 billion	**USD 7.05 billion**	**7 out of 10**	**USD 1.5 trillion**
The number of smartphone augmented reality users is expected to exceed 3.5 billion by 2022	AR/VR in the healthcare market will reach USD 7.05 billion by 2026	7 out of 10 media planners want to use AR to boost advertising and customer engagement	The projected economic impact of VR/AR could amount to around USD 1.5 trillion by 2030, according to PWC research

2 What are the top workforce development benefits of VR and AR?

- Provide information in real-time — 49%
- Facilitate training and mirroring real-life experience 49% — 49%
- Enhance creativity in product design and development 48% — 48%
- Enable the remote workforce to collaborate in real-time 47% — 47%
- Allow users to live out someone else' life experiences 41% — 41%
- Capture novel user data like behavior, eye, and gesture tracking 25% — 25%

3 The sectors anticipated experiencing the most growth in VR and AR in 2025 (revenue by industry)

Video games USD 11.6 billion	Healthcare USD 5.1 billion	Engineering USD 4.7 billion	Live events USD 4.1 billion	Video entertainment USD 3.2 billion	Real estate USD 2.6 billion	Retail USD 1.6 billion	Military USD 1.4 billion	Education USD 7 million

Figure 2. Future and generated revenue forecast to use AR and VR in business. (Alsop, 2019)

Real Estate: AR helps the buyer and owners to sell their property or rent out their properties via several apps available in the market such as Vera, RealAR, MagicPlan, etc.

Tourism: Hotel booking, sightseeing, hospitality, transport modes etc are involved in tourism, so AR gives the opportunity to travellers to experience the best-sited place without visiting the place. There are many apps which offer this experience such as Zumoko, Jasoren, iBoson etc.

Education: According to Figure 1, The share of VR in education will be 700 million US dollars by 2025. Due to the Covid-19 pandemic, the usage of ICT in the education sector increased rapidly and gave us a new regime in teaching-learning practice. In this situation, AR/VR work efficiently when there is a need for social distancing. Now students and teachers both are familiar with and enjoy their sessions online.

Healthcare: The use of AR/VR in the healthcare industry is huge. AR/VR can help students of the medical field or doctors to operate on patients virtually in a virtual operation theatre and virtual organ modeling to teach medical students and healthcare professionals to sharpen their skills and minimize medical issues in the future. Ultra high-definition 4K cameras, displays and advanced video gaming technology provide a golden path for utilizing AR/VR technology in the healthcare industry to offer simulation capabilities and a detailed organ map.

4. APPLICATION OF AR/VR IN AGRICULTURAL EDUCATION:
As we discussed above, the utilization of AR/VR in different fields such as gaming, e-commerce & retail, interior design, real estate, tourism, healthcare and education. If we talk about the application of AR/VR in agricultural education then we find it can give significant support to the students, researchers as well farmers to accomplish day-to-day tasks (Joshi, 2020). As we know that the demand for food and agricultural products is increasing day by day as our population increases. We also witnessed how agricultural products saved the entire world during the period of the Covid-19 pandemic. The agriculture sector is solely responsible to save the people and our economy too. We noticed that the demand for agricultural education has increased in the last few years. Agricultural education is not a closed-room study, students in this field spend 70 percent time in fields to record their trial data day by day. Students could use AR/VR to observe and feel the real-time experience of any location, soil, crop, weather condition etc. to sit in any place. If any situation occurs once again like Covid-19 then AR/VR fill the gap of practical real-time experience with social distancing. Students can check the fertility of their trails to select the particularly suitable crop they want to sow in their trail farms. Students can inspect their entire farm visually from a single dashboard, they can monitor the overall production quality and detect the unwanted pest or infections (Liu et al., 2013). AR can provide the facility of training to new students who are not aware of the traditional work culture of farming, they can get familiar at the initial stage of their curriculum through the immersive AR/VR e-learning environment (Cupiał, 2011). It gives the opportunity to operate and learn the most sophisticated tools and equipment to reduce the chances of any injury or accidents. It will also offer to learn remotely the complex tools used in farming by any professional who is an expert in using such types of complex tools (Nigam et al., 2011).

5. ADVANTAGES:
There are so many advantages of using AR/VR in education, a few of them are mentioned below:

- It increases the grasping power of the student and knowledge retention.
- Students can engage without getting bored and excited to learn new things.
- It will show improved teaching-learning outcomes.
- Students are more focused on their lessons.
- It will open up new opportunities and ease of accessibility for students.
- It will improve the understanding of complex and conceptual subjects.
- It will also improve the communication and collaboration skills of students.

Figure 2 show that the market of AR/VR in education will touch the 300 billion US dollars cap by 2024.
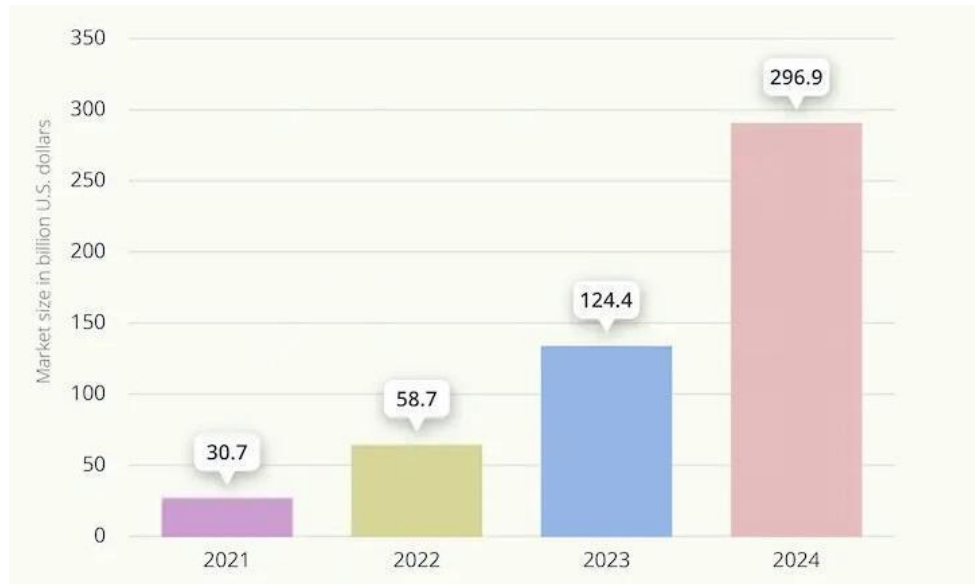

Figure 2. AR and VR market size worldwide from 2021 to 2024 (Alsop, 2019)

6. DISADVANTAGES: There are some disadvantages too but they can be improved near future, some of them are mentioned below:
● Current cost of installing AR/VR is high.
● AR/VR technology needs technically sound personnel who operate it.
● Students should have good knowledge of ICT equipment and their use.

7. CONCLUSION & FUTURE WORK: The paper tries to put some light on the use of AR/VR technologies in the different fields and the field of education. We've discussed that the use of AR/VR technology in the education field can enhance the teaching-learning process, thinking, grasping power, understanding of complex theory and case studies etc. in students. It can be an effective tool for knowledge transfers and support the student in a positive direction. It can give the utmost output in the field of education when a situation like covid-19 happens. It makes schooling more attractive, interactive and efficient as students of agriculture can observe the 3D model of any far field, crop, weather etc and experience their virtual presence. The major disadvantages of AR/VR are the high cost that can be managed with the latest technology development and the dropping of the price of processors and ICs in the market. As India introduces the 5G network technology, 5G is set to make device connections faster, more efficient, and minimize delays which boosts up the usage of AR/VR in the field of education too. Researchers put their focus on how these devices can be more user-friendly and how they become a part of the education system along with conventional education systems. There is good potential in AR/VR technology if researchers take more interest in this technology then definitely it will become a new boom in the field of education.

REFERENCES:
1. Akçayır, M., & Akçayır, G. (2017). Advantages and challenges associated with augmented reality for education: A systematic review of the literature. *Educational Research Review*, *20*, 1–11. https://doi.org/10.1016/j.edurev.2016.11.002
2. Alsop, T. (2019). XR/AR/VR/MR technology and content investment focus worldwide from 2016 to 2019 [Data website]. *XR/AR/VR/MR Technology and Content Investment Focus Worldwide from 2016 to 2019*. https://www.statista.com/statistics/829729/investments-focus-vr-augmented-reality-worldwide/

3. Azuma, R. T. (1997). A Survey of Augmented Reality. *Presence: Teleoperators and Virtual Environments*, *6*(4), 355–385. https://doi.org/10.1162/pres.1997.6.4.355

4. Cipresso, P., Giglioli, I. A. C., Raya, M. A., & Riva, G. (2018). The Past, Present, and Future of Virtual and Augmented Reality Research: A Network and Cluster Analysis of the Literature. *Frontiers in Psychology*, *9*, 2086. https://doi.org/10.3389/fpsyg.2018.02086

5. Cupiał, M. (2011). Augmend Reality in Agriculture. In *V International Scientific Symposium: Farm machinery and process management in sustainable agriculture, Lublin, Poland, 23-24 November 2011* (pp. 23–24). Department of Machinery Exploitation and Management in Agricultural Engineering.

6. Dunleavy, M., Dede, C., & Mitchell, R. (2009). Affordances and limitations of immersive participatory augmented reality simulations for teaching and learning. *Journal of Science Education and Technology*, *18*(1), 7–22.

7. Feng Zhou, Duh, H. B.-L., & Billinghurst, M. (2008). Trends in augmented reality tracking, interaction and display: A review of ten years of ISMAR. *2008 7th IEEE/ACM International Symposium on Mixed and Augmented Reality*, 193–202. https://doi.org/10.1109/ISMAR.2008.4637362

8. Ghulamani, S., & Zareen, S. (2018a). *Educating students in remote areas using augmented reality*. 1–6. https://doi.org/10.1109/ICOMET.2018.8346350

9. Ghulamani, S., & Zareen, S. (2018b). Educating students in remote areas using augmented reality. *2018 International Conference on Computing, Mathematics and Engineering Technologies (ICoMET)*, 1–6. https://doi.org/10.1109/ICOMET.2018.8346350

10. Hsieh, M., & Huang, K. (2016). Augmented reality is so fun! A new technology application combining virtuality and reality. *Taipei City, Sung Gang, Taiwan, ROC*.

11. Joshi, N. (2020, June 29). Can augmented reality help agriculture grow? [Technology Blog]. *Can Augmented Reality Help Agriculture Grow?* https://www.allerin.com/blog/can-augmented-reality-help-agriculture-grow

12. Kencevski, K., & Zhang, Y. (2019). VR and AR for Future Education. In Y. Zhang & D. Cristol (Eds.), *Handbook of Mobile Teaching and Learning* (pp. 1–16). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-41981-2_136-1

13. Lanzo, J. A., Valentine, A., Sohel, F., Yapp, A. Y. T., Muparadzi, K. C., & Abdelmalek, M. (2020). A review of the uses of virtual reality in engineering education. *Computer Applications in Engineering Education*, *28*(3), 748–763. https://doi.org/10.1002/cae.22243

14. Liu, M., Li, X., Lei, X., & Wu, S. (2013). Research of Mobile Augmented Reality Technology Applied in Agriculture. *Proceedings of the 2013 International Conference on Advanced Computer Science and Electronics Information*. 2013 International Conference on Advanced Computer Science and Electronics Information, Beijing, China. https://doi.org/10.2991/icacsei.2013.78

15. Milgram, P., & Kishino, F. (2014). A Taxonomy of Mixed Reality Visual Displays. IEICE Transactions on Information and Systems. *IEICE Transactions on Information and Systems*, *7*(9), 1321–1329. https://doi.org/10.1.1.102.4646

16. Nigam, A., Kabra, P., & Doke, P. (2011). Augmented Reality in agriculture. *2011 IEEE 7th International Conference on Wireless and Mobile Computing, Networking and Communications (WiMob)*, 445–448. https://doi.org/10.1109/WiMOB.2011.6085361

17. Phan, V. T., & Choo, S. (2010). Interior design in augmented reality in environment. *International Journal of Computer Applications*, *5*(5), 16–21.

18. Tlili, A., Huang, R., Shehata, B., Liu, D., Zhao, J., Metwally, A. H. S., Wang, H., Denden, M., Bozkurt, A., Lee, L.-H., Beyoglu, D., Altinay, F., Sharma, R. C., Altinay, Z., Li, Z., Liu, J., Ahmad, F., Hu, Y., Salha, S., … Burgos, D. (2022). Is Metaverse in education a blessing or a curse: A combined content and bibliometric analysis. *Smart Learning Environments*, *9*(1), 24. https://doi.org/10.1186/s40561-022-00205-x

19. Wu, H.-K., Lee, S. W.-Y., Chang, H.-Y., & Liang, J.-C. (2013). Current status, opportunities and challenges of augmented reality in education. *Computers & Education*, *62*, 41–49. https://doi.org/10.1016/j.compedu.2012.10.024