International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 06 | Jun 2023 www.irjet.net p-ISSN: 2395-0072

Exploring the Potential Benefits and Challenges of the Metaverse: A Future Research Agenda

M.Vasuki [1], A. Karunamurthy [2], T. Amalraj Victoire [3] M. Vishwa @ Survesvar [4]

[1] Associate professor, Department of Master Computer Application, Sri Manakula Vinayagar Engineering College, Pondicherry-605 107.
[2] Associate professor, Department of Master Computer Application, Sri Manakula Vinayagar Engineering College, Pondicherry-605 107.
[3] Professor, Department of Master Computer Application, Sri Manakula Vinayagar Engineering College, Pondicherry-605 107.
[4] Student, Department of Master Computer Application, Sri Manakula Vinayagar Engineering College, Pondicherry-605 107.

Abstract - *The metaverse is a nascent technology that fuses augmented and virtual reality, culminating in a seamless interaction between the physical and virtual realms. This innovation holds the potential to revolutionize multiple industries, spanning marketing, education, and healthcare. However, apprehensions exist concerning the possible impact of metaverse's widespread adoption on matters such as privacy, bias, and disinformation. To tackle these concerns and furnish policymakers and practitioners with insights on the metaverse's possibilities and obstacles, the paper recommends a future research plan. Despite the dearth of requisite technology and infrastructure to fully unleash the metaverse's potential, the paper underscores the need for sustained research and development to brace for its likely transformative effect on society.*

Key Words: **Metaverse, Virtual reality, Revolutionize, Privacy, Research plan, Transformative effect.**

1.INTRODUCTION

The "metaverse" is a term that originated in science fiction and refers to a hypothetical version of the internet that creates a single, universal, and immersive virtual world. This virtual world is facilitated through the use of virtual reality (VR) and augmented reality (AR) headsets, and is focused on social and economic connections. While the term was first introduced in 1992, recent interest in metaverse development has been linked to the concept of Web3, a decentralized iteration of the internet.

Metaverse development is heavily influenced by advances in virtual reality technology, as the demand for immersion continues to grow. However, concerns around privacy, user addiction, and user safety have been raised, drawing parallels to the issues faced by social media and video game industries. Despite these challenges, components of metaverse technology have already been developed within online video games such as Second Life, Active Worlds, and The Palace.

Popular games like Habbo Hotel, World of Warcraft, Minecraft, Fortnite, and VR Chat are also described as part of the metaverse, while Roblox has employed significant usage of the term in marketing. Massively multiplayer online games often incorporate social interaction and 3D virtual environments, which are important aspects of the metaverse that is being developed. In recent years, major technology companies have made significant investments in the metaverse. In 2017, Microsoft acquired Artspace VR and subsequently integrated virtual reality avatars and virtual meetings into their Microsoft Teams platform. In 2019, Facebook (now called Meta Platforms) introduced Facebook Horizon, a virtual reality social world. Later in 2021, the company's chairman, Mark Zuckerberg, announced their dedication to building a metaverse. The company faced criticism around user safety and a $10 billion loss in its metaverse development department. In February 2023, Zuckerberg announced the company's pivot away from the metaverse to focus on AI.

As the metaverse continues to evolve, ongoing research and development are necessary to address concerns and inform policy makers and professionals about the potential benefits and challenges of this emerging technology. While the full potential of the metaverse is yet to be realized, it has the potential to transform various industries, including marketing, education, and healthcare.

Another important aspect of the metaverse is the use of digital currencies and blockchain technology. In many metaverse platforms, users can buy, sell, and trade virtual assets using cryptocurrencies or other digital currencies. Non-fungible tokens are also commonly used to track ownership and provenance of digital assets within the metaverse. This has created a new market for digital art, where rare or unique items can sell for millions of dollars.

The potential applications for metaverse technology are vast and varied. One proposed use is for improving work productivity by creating immersive virtual environments for

remote work and collaboration. Interactive learning environments could also be created, allowing for more engaging and personalized education experiences. E-commerce is another sector that could be transformed by the metaverse, as virtual storefronts and product displays could provide a more interactive and engaging shopping experience.

Mass-audience interaction is also a promising application for the metaverse, as it could allow for large-scale events and performances to take place in virtual spaces, reaching audiences from all over the world. Healthcare and therapy could also benefit from metaverse technology, with virtual environments providing a safe and immersive space for treatment and rehabilitation. Real estate and fashion industries could also leverage the metaverse to create virtual showrooms and tours, providing customers with a more interactive and engaging experience. Despite the potential benefits, there are also concerns around the impact of the metaverse on society. Privacy, security, and user addiction are just a few of the issues that need to be addressed as the technology develops. Ongoing research and development will be crucial in ensuring that the metaverse is developed in a responsible and beneficial way.

1.1 Related works

The article titled "Virtual Reality and Augmented Reality in Industry 4.0: A Survey of Benefits, Applications, and Challenges" written by Farid Meziane and colleagues offers a comprehensive assessment of the advantages, uses, and challenges associated with the integration of virtual and augmented reality in the context of Industry 4.0. Through a thorough review of relevant literature, the authors analyze recent developments in virtual and augmented reality technologies, and explore how these technologies can be leveraged in various domains of Industry 4.0, such as manufacturing, logistics, training, and maintenance.

In the article titled "The Metaverse: A Collective Virtual Shared Space" authored by John C. Smart, the concept of the metaverse is explored as a virtual space that allows individuals to interact and engage in various activities together. The paper traces the history and progression of the metaverse, from its origins in science fiction literature to its current state with the latest developments in virtual and augmented reality technologies.

The article also addresses the challenges and issues related to the metaverse, such as data privacy, security, and the risk of addiction and isolation. The author proposes that these concerns can be addressed through deliberate planning and regulation, and stresses the importance of ethical considerations during the creation and implementation of the metaverse. Additionally, "Metaverse: The Future of Immersive Social Networks," authored by Sajjad Hussain, is an article that examines the metaverse as a possible future for immersive social networks.

Michael Cowling and Christian Willems' article, "The Future of Virtual Reality and Augmented Reality in Education and Training," examines the possible uses of virtual reality (VR) and augmented reality (AR) in the field of education and training. The authors contend that these technologies can transform conventional teaching and training methods by providing immersive and captivating experiences. The article explores several ways in which VR and AR can be utilized in education, such as virtual field trips, simulations, and interactive learning opportunities.

"Giovanni Maria Troiano et al.'s article, "Social Virtual Reality: Trends and Research Agenda," offers an extensive analysis of the present trends and future research agenda for social virtual reality (VR). The authors contend that social VR has the potential to revolutionize social interactions, communication, and collaboration in a virtual environment. The article provides an overview of the current state of social VR, including the different platforms and applications currently available. Additionally, the authors explore the challenges and opportunities of social VR, including the necessity for immersive and captivating experiences.

2. Findings Trend in Publications

Since its inception, research on the metaverse has been growing steadily. While the first relevant paper was published in early 2007, it was not until 2019 that publications on the topic began to increase significantly. This trend continued to rise until 2021, which coincided with Mark Zuckerberg's announcement of Facebook's rebranding to Meta. These developments suggest that the metaverse is still a young and rapidly evolving research field.

This trend was so popular in the month of October 2021 when Mark Zuckerberg told that Facebook is rebranding to Meta. The metaverse is still in the research field and it's keeps on evolving in the research field.

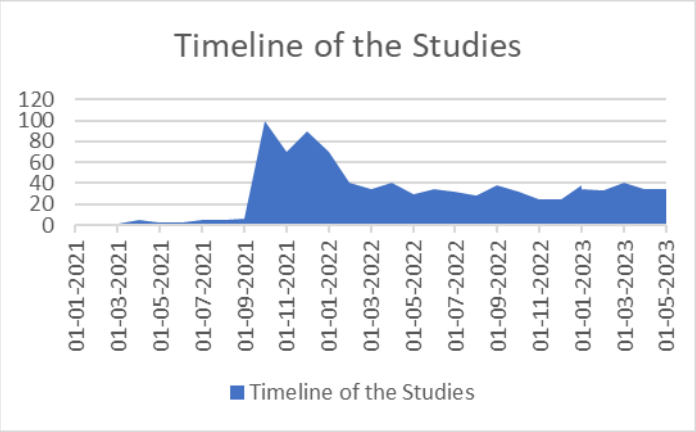

Chart -1: Publication Trends

3. Research Themes and Areas

The study's findings can be organized into different research categories and plotted on a two-dimensional space based on relevance (centrality) and development (density). The resulting map classified the metaverse research themes into four groups: motor themes, niche themes, emerging themes, and basic themes.

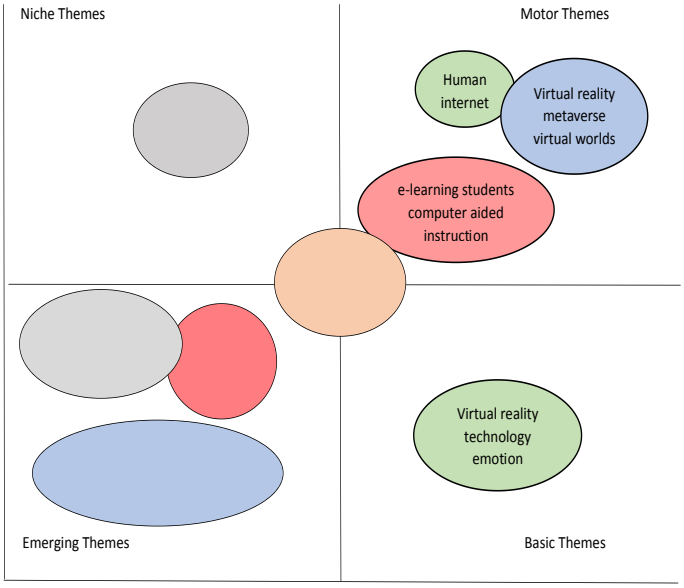

Fig -1: Research Themes and Areas

The areas with the highest concentration of research were motor themes and emerging themes. The research findings have categorized the metaverse research themes into four groups, represented in a two-dimensional space according to their relevance degree (centrality) and development degree (density). Motor themes, located in the upper-right quadrant with strong centrality and high density, denote well-developed and relevant areas of academic investigation that can drive future research. The study's primary outcome reveals that metaverses have been explored as "virtual reality" and "virtual worlds". The metaverse's potential as a virtual world that can be useful for "e-learning", "computer-aided instruction" and from a "human" perspective represents another relevant aspect of the academic analysis.

Basic themes, situated in the lower-right quadrant with low centrality but high density, comprise topics relevant to research but are general. However, they still have the potential to be rapidly developed through further studies to address research gaps and provide more comprehensive insights. These themes include "virtual reality technology" (as in the precedent quadrant) and "emotion" as a synthesis of marketing and consumer behaviour.

Emerging themes, located in the lower-left quadrant with low density and low centrality, represent topics such as "COVID-19" and "key technology" such as "5g mobile communication system". In addition, "sustainability", "sustainable development", and "economic and social effects" have been reported in this area. Niche themes, positioned in the upper-left quadrant with high centrality and low density, consist of highly specialized topics that could be significant for future research, such as "education", "medical", and "medical education".

Lastly, the metaverse can be realized by utilizing augmented reality and other emerging technologies, as evidenced by the intersection of the two axes.

4. Discussions

4.1. Metaverse Technologies

The paper highlights the metaverse as a convergence of various technologies discussed in the literature. While established technologies like virtual reality and virtual worlds form the "motor themes" that constitute the foundation of the metaverse, researchers are also delving into new and emerging technologies like 5G mobile communication, blockchain, digital twins, and the internet of things, which form the "emerging themes" that pave the way for the metaverse's future growth and development.

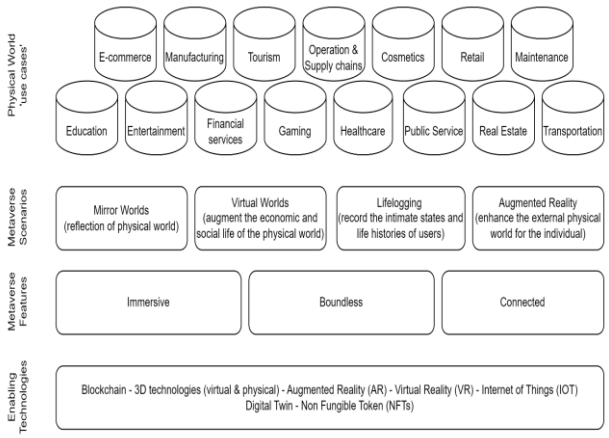

Fig -2: Metaverse Technologies

In the years to come, the metaverse presents a range of opportunities, with access requiring multisensory interactions with various technologies. These include virtual environments, immersive technologies for digital objects and people, and virtual, augmented, mixed, and extended reality (VR, AR, MR, and XR), which enable the creation of the metaverse and immersive digital experiences. VR technology provides users with connected experiences, while AR overlays digital information on the physical environment. XR, which encompasses VR, AR, and MR, is used for virtual commerce (v-commerce) to create computer-mediated indirect experiences.

Blockchain technology plays a critical role in providing a decentralized infrastructure for the metaverse, ensuring data quality, privacy, and security, and enabling a complete economic system in which virtual goods can become physical objects. Artificial intelligence (AI) also plays a significant role, automating the metaverse ecosystem, and ensuring reliable infrastructure, facilitating user interaction, and supporting content creation. The internet of things (IoT) connects the real world to the internet via computing devices for sensing and communication, allowing for efficient replication of the physical world in the metaverse. The combination of immersive technologies and IoT is known as XR-IoT (XRI), creating a hyper-connected environment and improving human-to-object and human-to-human relationships.

Finally, digital twins create a virtual twin of real-world objects, predicting their expected behavior using real-world data. This technology is used in the metaverse to mirror the real world onto the virtual world, enabling the collection of data to create simulations that model how products, processes, or services would perform in the real world and provide solutions to unresolved issues.

4.2. Using Bionic Contact Lenses

A metaverse refers to a virtual world where people can interact with each other and engage in various activities. Bionic contact lenses are a type of advanced contact lens that can display digital information directly on the user's eye. This means that people can access information and interact with the virtual world without needing a separate device. In simpler terms, the concept of a metaverse using bionic contact lenses involves creating a virtual world that can be accessed through smart contact lenses, allowing people to engage with it in a more seamless and immersive way.

Bionic contact lenses have the potential to enhance the immersive experience of the metaverse by enabling users to seamlessly access virtual environments and interact with digital content. With these lenses, users can view virtual objects and information that appear as if they are overlaid on the real world, resulting in a blended reality that blurs the distinction between physical and virtual worlds. In simpler terms, the use of bionic contact lenses in the metaverse could provide users with a more realistic and seamless experience by allowing them to interact with virtual content as if it were part of their physical environment.

Bionic contact lenses could have a valuable application in gaming and entertainment within the metaverse. By using the lenses, players can access virtual reality games and experiences, where the game world merges effortlessly with the real world, offering a highly immersive experience. Furthermore, these lenses can also serve as a means of presenting information regarding live events such as sports or concerts, where users can access real-time stats or view virtual replays of the action. By using the lenses, users can access virtual meeting spaces, where they can interact with colleagues or clients in an entirely immersive environment. Additionally, the lenses can display virtual whiteboards or other collaboration tools, making it simpler to brainstorm and share ideas. In simpler terms, the use of bionic contact lenses in the metaverse can revolutionize the way people communicate and collaborate, by allowing them to enter virtual meeting spaces and engage with one another in a more immersive and interactive manner.

The idea of a metaverse using bionic contact lenses is both thrilling and promising as it could transform our interaction with digital technology and with one another. Although there are technical and ethical hurdles to be tackled, the creation of such technology can bring us closer to achieving a fully immersive virtual universe. In simpler terms, the concept of a metaverse using bionic contact lenses holds immense potential to transform the way we perceive and interact with digital content and others, and despite the challenges, it could lead to a more complete and dynamic virtual reality.

4.3. Metaverse Areas of Application

The metaverse's immersive characteristics are significant in stimulating various companies to innovate their business model. The integration of various technologies makes the metaverse applicable in different areas, including consumer goods, healthcare, hospitality, education, retail, gaming, and entertainment. Scholars have conducted in-depth research on the metaverse's different application areas, with some being established research topics, while others are emerging or decreasing in relevance.

As a "motor theme," the metaverse has immense potential in technology-enhanced education and learning, enabling immersive experiences, collaboration, and interaction. Examples of metaverse applications in this field include laboratory simulations, procedural skills development, AR-based training, language learning, and management systems. In the manufacturing industry, the metaverse can assist in training employees on safety precautions, participating in risk scenario simulations, and facilitating product and process development.

Further "emerging themes" relate to consumer goods and services, with fashion labels and retail chains utilizing the metaverse extensively. They leverage metaverse technologies to develop new products, host virtual events, collaborate and partner, and enhance the customer experience through virtual shopping, try-on, and digital twin stores and showrooms. In the hospitality and tourism sector, companies are employing the metaverse to create virtual tourism experiences, such as virtual flights, hotel experiences, destination visits, and tours, while also enhancing real-life customer experiences and attracting new visitors.

The healthcare sector represents a "niche theme" for scholars, with the metaverse's applications primarily focused on clinical condition prevention and treatment, education, training, and research. The metaverse is a crucial technology in empowering medical students' skills and knowledge, and different technologies, such as digital twins, can monitor patients' health conditions directly at home, connecting the real world with the virtual world.

4.4. Sustainable Development

Scholars are exploring the potential impact of the metaverse on sustainable development, as well as its economic and social effects. The metaverse has the potential to affect resource management, governance, quality of life, social interaction, and cultural heritage conservation and preservation.

Smart urbanism and the contributions of the metaverse to smart cities are a recent area of study, with a focus on environmental, economic, and social sustainability goals. While the metaverse has the potential to decrease demand for physical infrastructure, minimize waste, enhance accountability and transparency, and ensure more equitable access to services, concerns have emerged around energy consumption and carbon emissions of compute-intensive transactions. Despite the substitution of physical goods with digital ones and replacing a real-world presence with virtual interactions, the carbon footprint of the metaverse is an area of concern.

Another area of concern for scholars is the metaverse's ethical, moral, human, and cultural influence on the quality of human social interactions. The absence and confusion of corresponding moral norms can conflict with the ethical norms of society, and scholars are exploring the potential impact of the metaverse on the quality of life.

5. Conclusion

The metaverse is a concept that has fascinated people for many years, offering the vision of a fully realized virtual world that is interconnected with the real world and completely immersive and interactive. Recent advances in virtual and augmented reality technology make the development of a metaverse more feasible, with the potential to transform how we interact with each other, the environment, and digital technology. The opportunities presented by a metaverse are limitless. Users could engage in virtual experiences that are impossible in the real world, such as exploring distant planets, participating in realistic simulations, or experiencing events and places that are no longer accessible. A metaverse could also provide new possibilities for entertainment, socialization, education, and work, enabling people to collaborate and connect with others from around the world in unprecedented ways. However, the development of a metaverse also presents numerous challenges. Technical issues, such as creating a system that can handle millions of users and deliver a seamless experience, are significant obstacles that must be overcome. Privacy concerns and ethical considerations, including data ownership, user safety, and regulation, must be addressed to ensure that a metaverse is accessible and secure for everyone. The metaverse is an exciting and ambitious concept with boundless possibilities that require a collaborative effort from various industries and experts to create a virtual world that is safe, accessible, and beneficial to all. As technology continues to advance, the metaverse will continue to evolve and captivate and inspire people, promising a future where digital and real-world experiences blend seamlessly.

REFERENCES

[1] Meziane, F., Mokhtari, M., & Medjden, S. (2020). Virtual reality and augmented reality in industry 4.0: A survey of benefits, applications, and challenges. Journal of Industrial Information Integration, 17, 100123. https://doi.org/10.1016/j.jii.2019.100123.

[2] Smart, J. C. (2019). The Metaverse: A collective virtual shared space. Journal of Virtual Worlds Research, 12(2). https://doi.org/10.4101/jvwr.v12i2.8308.

[3] Hussain, S. (2021). Metaverse: The future of immersive social networks. Journal of Ambient Intelligence and Humanized Computing, 12(8), 7857-7867. https://doi.org/10.1007/s12652-021-03282-4.

[4] Cowling, M., & Willems, C. (2019). The future of virtual reality and augmented reality in education and training. International Journal of Innovation in Education and Learning, 1(3), 161-169. https://doi.org/10.1504/IJIEL.2019.101843

[5] Azuma, R., Baillot, Y., Behringer, R., Feiner, S., Julier, S., & MacIntyre, B. (2001). Recent advances in augmented reality. IEEE Computer Graphics and Applications, 21(6), 34-47.

[6] Billinghurst, M., & Duenser, A. (2012). Augmented reality in the classroom. Computer, 45(7), 56-63.

[7] Bimber, O., & Raskar, R. (Eds.). (2019). Spatial augmented reality: Merging real and virtual worlds. A K Peters/CRC Press.

[8] Bowman, D. A., & McMahan, R. P. (2007). Virtual reality: How much immersion is enough? Computer, 40(7), 36-43.

[9] Chiang, T. H. C., & Chen, M. C. (2019). Investigating the antecedents and consequences of virtual reality experiences: A brand experience perspective. Journal of Business Research, 96, 298-307.

[10] Cruz-Neira, C., Sandin, D. J., & DeFanti, T. A. (1993). Surround-screen projection-based virtual reality: the design and implementation of the CAVE. In Proceedings of the 20th annual conference on Computer graphics and interactive techniques (pp. 135-142).

[11] de Oliveira, R. A. (2019). Virtual and augmented reality in marketing: A systematic literature review and research agenda. Journal of Business Research, 100, 547-558.

[12] Freeman, J., Avons, S. E., Meddis, R., Pearson, D. E., & IJsselsteijn, W. A. (2000). Using virtual environments for teaching social understanding to 6 adolescents with autistic spectrum disorders. Journal of Autism and Developmental Disorders, 30(6), 569-585.

[13] Liarokapis, F., Mourkoussis, N., & White, M. (2019). A systematic literature review of augmented reality in education: trends and challenges. Journal of Educational Technology & Society, 22(2), 136-152.

[14] Gabbard, J. L., & Hix, D. (2016). User-centered design and evaluation of virtual environments. Computer, 49(5), 53-59.

[15] A. Karunamurthy , T. Amalraj Victoire , M.Vasuki , V. Lawrence Britto . "Managing IoT Devices with Routing Information Protocol" A Journal for New Zealand Herpetology 12 (02), 2643-2651.

[16] Milgram, P., & Kishino, F. (1994). A taxonomy of mixed reality visual displays. IEICE Transactions on Information Systems, 77(12), 1321-1329.

[17] Ni, T., Rau, P. L. P., & Liang, J. C. (2019). The effects of virtual reality on learning outcomes: A meta-analysis. Educational Research Review, 27, 244-260.

[18] Papagiannakis, G., & Singh, G. (2019). Augmented reality for cultural heritage: A review of the state-of-the-art. Journal on Computing and Cultural Heritage, 12(4), 1-37.

[19] Shang, J., Li, J., & Du, L. (2019). The effects of virtual reality on customer experience: A tourism perspective. Journal of Travel Research, 58(7), 1142-1158.

[20] Slater, M., & Sanchez-Vives, M. V. (2016). Enhancing our lives with immersive virtual reality. Frontiers in Robotics and AI, 3, 74.

[21] A, Karunamurthy, & Aramudhan, Dr. M. (2019). Predictive Health Analytic Model in Federated Cloud. In International Journal of Recent Technology and Engineering (IJRTE) (Vol. 8, Issue 2, pp. 2093–2096). Blue Eyes Intelligence Engineering and Sciences Engineering and Sciences Publication - BEIESP. https://doi.org/10.35940/ijrte.b2309.078219.

[22] Troiano, G. M., Simões, R., Karapanos, E., & Gouveia, R. (2021). Social virtual reality: Trends and research agenda. Computers in Human Behavior, 123, 106926.

[23] Lee, K. M., Jung, Y., & Kim, J. (2022). The Future of Augmented Reality in Education: A Systematic Review of the Literature. Educational Technology & Society, 25(1), 77-92.

[24] Bhatti, Z. A., Ashraf, M. W., Afzal, H., & Jamil, M. (2021). Augmented reality-based learning: a systematic review and future directions. Interactive Learning Environments, 1-23.

[25] Erdoğan, S., & Yılmaz, R. M. (2021). A systematic review on the use of virtual reality in mathematics education. Education and Information Technologies, 26(1), 1107-1125.

[26] Liu, S., Luo, Y., Liu, Q., Wu, T., & Yang, J. (2021). Virtual Reality in Marketing: A Systematic Review. Journal of Interactive Marketing, 54, 91-107.

[27] Yu, W., Huang, Y., Lu, Y., & Huang, D. (2020). A review of the applications of virtual reality in construction engineering education. Advances in Civil Engineering, 2020.

[28] A. Karunamurthy, et.al. "Intelligent Outlier Detection for Smart Farming Application using Deep Neural Network," 2022 IEEE 2nd International Conference on Mobile Networks and Wireless Communications (ICMNWC), Tumkur, Karnataka, India, 2022, pp. 1-5, doi: 10.1109/ICMNWC56175.2022.10031638.

[29] Lee, H., Jung, T., & Lee, K. H. (2020). The role of virtual reality in tourism research. Journal of Travel Research, 59(3), 473-488.

[30] Kar, S., Das, P., & Bera, S. K. (2020). Augmented Reality in Manufacturing: A Review. Procedia Manufacturing, 47, 609-616.

[31] Maldonado, M., & Ramírez-Gómez, Á. (2020). Review of augmented reality for museum exhibitions. Virtual and Physical Prototyping, 15(3), 256-268.

[32] Xie, X., Li, Y., & Yu, Y. (2020). Virtual reality in healthcare: A comprehensive survey. International Journal of Environmental Research and Public Health, 17(21), 8021.