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Fantasy Magical Life: Opportunities, Applications, and Challenges in Metaverses

Ashraf Darwish[1] , Aboul Ella Hassanien[2, 3]

[1]Faculty of Science, Helwan University, Egypt

[2]Faculty of Computer and AI, Cairo University, Egypt

[3]Scientific Research Group in Egypt (SRGE) www.egyptscience.net

aboitcairo@cu.edu.eg

Abstract. The Metaverse concept introduces new features to a variety of industries. Humans can interact with one another or with digital items in the Metaverse, a network of virtual settings. Communication will become augmented reality, which is more interactive than virtual reality, augmented reality and artificial intelligence are the tools that create things like the Metaverse with virtual factors, through which humans can coexist. Women today, through this technology, will buy a dress after finding themselves inside the monitor and measuring it. She doesn't need to buy a product without trying. The term Metaverse was developed to describe how the digital revolution affects every area of daily life. The Metaverse is the internet access system based on Virtual Reality (VR) and Augmented Reality (AR) glasses. It is seen as the next-generation mobile computing platform that will be extensively utilized. The main purpose of this paper is to provide a comprehensive study of the Metaverse with the enabling technologies such as digital twins, the Internet of Things (IoT), artificial intelligence (AI), and blockchain. Problems and challenges related to Metaverse in the virtual world are presented. This paper concludes that the Metaverse's future is the future of connectedness.

Keywords: Metaverse, augmented reality, virtual reality, avatars, artificial intelligence, computer vision, digital twins, Web 3.0

1. Introduction

The Metaverse might grow in various ways, dependent on an ecosystem of research, innovation, investment, and regulation. It is well recognized that attempting to forecast winners is unreliable. If the equation becomes a reality, it will most likely grow to include events we can't anticipate, and anybody who professes to know exactly what will happen lacks the resilience of curious optimism (MacCallum et al., 2019).

The proliferation of the Internet and social media apps have made technology and software more affordable and accessible, allowing for the creation of superior digital material represented via three-dimensional (3D) virtual worlds. The word "Metaverse" was initially used to describe an immersive 3D virtual world in a science fiction novel. In his novel Snow Crash, published in 1992, American science-fiction writer Neal Stephenson invented the word "Metaverse," The protagonists explore an online realm parallel to the actual world, interacting with digital avatars of themselves (Stephenson 1992).

The emergence of the Metaverse made it easier for people to communicate and engage on the Internet daily. As a result, the Metaverse has become a world in which physical reality and space have been greatly augmented. It's a synthesis of the real and physical universes that lets users conceive a plethora of digital mirrors of the actual world, both real and virtual, for several reasons (Diaz et al., 2020). Users do not need to move into the actual world to use the Metaverse system, and it maintains a constant link with the virtual world. Also, the avatar feature introduces the avatar, which is infinite in the virtual world, resulting in a more accurately defined environment since the form of the avatar is comparable to or better than that of 3D games. Individual users in the Metaverse own their avatars, which are analogous to their physical selves, allowing them to live an alternate existence in virtuality that is a metaphor for their actual realities of the publications of Metaverse in the last five years. Seventy-four publications were selected from the Web of Science Core Collection in the previous five years (2018-2022); refer to Table 1.

Table 1: Statistics analysis of the publications of Metaverse in the last five years. 74 publications selected from the Web of Science Core Collection in the previous five years

No.	Field: Web of Science Categories	Record Count (74 publications)	% of 74
1	Engineering Electrical Electronic	17	22.973%
2	Computer Science Information Systems	12	16.216%
3	Telecommunications	7	9.459%
4	Computer Science Theory Methods	6	8.108%
5	Computer Science Artificial Intelligence	4	5.405%
6	Computer Science Software Engineering	4	5.405%
7	Education Educational Research	4	5.405%
8	Education Scientific Disciplines	4	5.405%
9	Green Sustainable Science Technology	4	5.405%

10	Humanities Multidisciplinary	4	5.405%
11	Physics Applied	4	5.405%
12	Chemistry Analytical	3	4.054%
13	Chemistry Multidisciplinary	3	4.054%
14	Computer Science Cybernetics	3	4.054%
15	Dentistry Oral Surgery Medicine	3	4.054%
16	Engineering Multidisciplinary	3	4.054%
17	Environmental Sciences	3	4.054%
18	Imaging Science Photographic Technology	3	4.054%
19	Instruments Instrumentation	3	4.054%
20	Materials Science Multidisciplinary	3	4.054%
21	Art	2	2.703%
22	Business	2	2.703%
23	Computer Science Interdisciplinary Applications	2	2.703%
24	Environmental Studies	2	2.703%
25	Language Linguistics	2	2.703%
26	Management	2	2.703%
27	Optics	2	2.703%
28	Religion	2	2.703%
29	Architecture	1	1.351%
30	Automation Control Systems	1	1.351%
31	Communication	1	1.351%
32	Computer Science Hardware Architecture	1	1.351%
33	Cultural Studies	1	1.351%
34	Energy Fuels	1	1.351%
35	Engineering Industrial	1	1.351%
36	Engineering Manufacturing	1	1.351%
37	Ethics	1	1.351%
38	Geology	1	1.351%
39	Law	1	1.351%
40	Linguistics	1	1.351%
41	Medicine General Internal	1	1.351%
42	Multidisciplinary Sciences	1	1.351%
43	Nanoscience Nanotechnology	1	1.351%
44	Operations Research Management Science	1	1.351%
45	Psychology Applied	1	1.351%
46	Psychology Social	1	1.351%
47	Public Environmental Occupational Health	1	1.351%
48	Regional Urban Planning	1	1.351%
49	Theater	1	1.351%
50	Transportation Science Technology	1	1.351%
51	Veterinary Sciences	1	1.351%

This article examines existing infrastructures and technologies to provide an important perspective for constructing the Metaverse, defined by everlasting, shared, and 3D virtual worlds that conjoin to form a perceived virtual universe. The Metaverse's building blocks include AR and VR, Web 3.0 edge computing, Artificial Intelligence (AI), and blockchain technology. Other technologies, such as social networks, gaming, and virtual environments, are considered to realize the Metaverse. We identify the Metaverse's underpinnings and technological singularity from a technical standpoint.

This paper introduces the Metaverse approach, which lays the route for its realization. By looking at cutting-edge technology like AI, digital twins, virtual Reality, and augmented Reality as facilitators for the Metaverse's evolution. In addition, based on our evaluation, this paper highlights research difficulties and prospects, paving the way for the Metaverse's final stages.

This paper is organized as follows. Section 2 presents the origin and enabling technologies and foundations of the Metaverse. Section 3 describes different applications of the Metaverse. Section 4 presents the challenges and open problems. Section 5 concludes this paper and presents the future trends.

2. Metaverse: Basics and Enabling Technologies

2.1. Metaverse history

The Metaverse term was used to describe a fictitious world in which persons appear as avatars to mimic their interactions with other persons in various everyday circumstances.

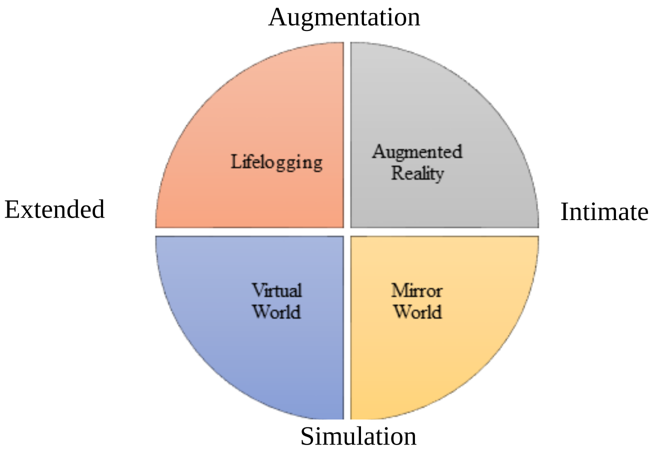

Fig. 1: How the Metaverse unfolds – lifelogging, augmented reality, virtual world, and mirror world

The Metaverse is a 3D virtual environment where people participate in computational social and economic activities. A hypothetical synthetic environment related to the physical world is described by combining the prefix "meta" (implying transcending) with the word universe (Kim 2014). The term "Metaverse" was originally used in Neal Stephenson's speculative fiction novel Snow Crash in 1992. The Metaverse is defined by Stephenson in this novel as a huge virtual environment that exists alongside the actual world and in which people communicate through digital avatars. One of AR and simulation and internal and exterior aspects is Metaverse's essential axes (lines). The four planes are AR, virtual world, lifelogging, and mirror world (Smart 2007), as shown in Fig. 1.

The Metaverse is not a new concept, having circulated for decades alongside the growth of the Internet and other technologies. The Metaverse is exploding, owing primarily to 3D gaming, fueled by hardware advancements (For instance, enormous data storage infrastructures and wireless networks, wearable sensors, and graphics processing units (GPU)).

A Metaverse platform includes seven layers, as shown in Fig. 2, which are infrastructure (5G/6G/Wi-Fi), Human interface (smart glasses/mobiles), Decentralization (AI/edge computing/blockchain), Spatial computing (AR/VR), Creator economy (E-commerce), Discovery (avatars) and Experience (game/social). The infrastructure layer is relatively broad and includes semiconductors, 5G / Wi-Fi, cloud, and data centers. The human interface layer includes the software and hardware that enable the link between the virtual world and the real world and establish connections between users. The decentralization layer includes blockchain that permits value exchange among software programs, autonomous identification, new disaggregating methods, and the bundling of information and currencies. It is a significant aspect of decentralization. In addition, all issues related to Artificial Intelligence (AI). The spatial computing layer considers the latest technologies, such as virtual reality, augmented reality, and 3D components. The Metaverse will move a huge amount of money between companies that become a part of it. This will require many design tools, asset markets, custom workflows, and e-commerce concepts and techniques to represent the creator economy layer. The next layer is the discovery layer that revolves around the "push" and "pull" through which people learn about new experiences, skills, and experiences. It is one of the most profitable ecosystems for many companies. In general, most discovery systems can be categorized as inbound. Users actively seek information about a trial or outbound as marketing activities that users have not specifically requested, even if they choose to participate. Finally, the experience layer refers to the dematerialization of physical space, distance, and objects in favor of abundant user-generated forms of interactive content.

2.2. Metaverse enabling technologies

The Metaverse platform was created by combining numerous modern technologies to provide users with a 3D immersive experience. There are recent emerging technologies that are included in the Metaverse environment. They can connect and cooperate with others in virtual worlds. Among such technologies as blockchain, AR/VR, and 5G/6G, AI, IoT, digital twins play a quiet but critical role in the creation and growth of the Metaverse. This section provides an overview of the most critical emerging technologies used in the Metaverse scenarios. Fig. 3 depicts the leading recent emerging technologies included in the Metaverse.

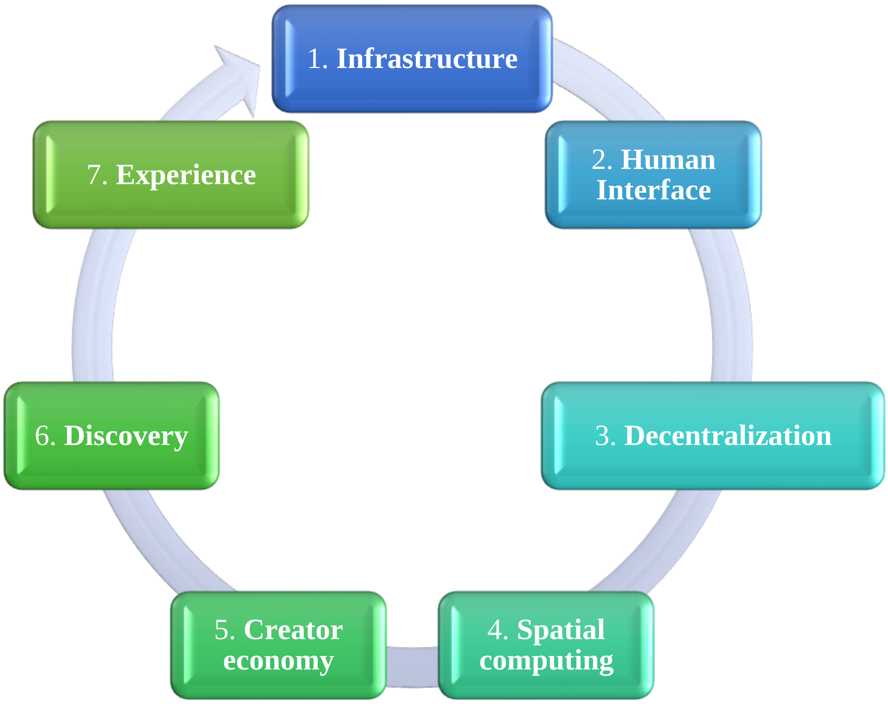

Fig. 2: The seven layers of Metaverse

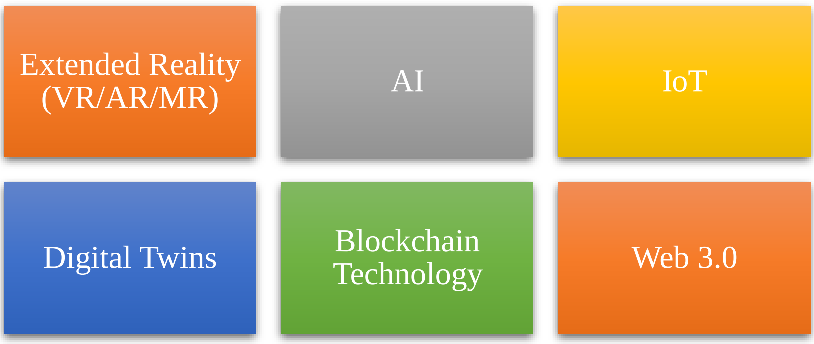

Fig. 3: Emerging technologies for the Metaverse

2.2.1. Web 2.0 vs Web 3.0

The World Wide Web (WWW) is in the middle to late stages of the Web 2.0 innovation curve, where the transition from desktop to mobile computing. A Web 2.0 is defined by the number of users, the utility-like nature of mobile, desktop apps and services, and low to no distribution costs. It's important to discuss the main features of today's Metaverse between Web 2.0 and the emerging Web 3.0 characteristics. Table 2 highlights the key Metaverse features between the two technologies (Technical Report 2022).

Table 2: Web 2.0 vs Web 3.0 (technical Report 2022)

Features	Web 2.0	Web 3.0
Defintion	The second generation of Internet services also ensures dynamic content with high responsiveness to user input.	Peer-to-peer interactions are at the core of a new networked commerce and community generation.
Time	Web 2.0 (2005-present)	Yet to come
Platform characteristics		
Organizational structure	Centrally management Decisions are based on adding shareholder value	Society is governed, generally by a Decentralized Autonomous Organization (DAO) Original tokens are issued, and participation in governance is enabled User consensus upon which decisions are based
Data storage	Centralized	Decentralized
Payment's infrastructure	Centrally managed by central banks, institutions, and other financial networks	Run by smart contracts There is no central control and no middlemen for payment.
User Interaction		
Digital assets ownership	Leased within the platform were purchased	Owned through non-fungible tokens
Digital assets portability	Locked within platform	Transferable
Content	Sharing Content	Consolidating Content
Activities	Socialization Multi-player games Game streaming Competitive games (e.g., esports	Play-to-earn games Experiences Same activities as Web 2.0, see box on left)
Identity	In-platform avatar	Self-sovereign and interoperable identity Anonymous private-key-based identities
Commercials		

Business model	Digital giants and service providers own customer data, which is used to drive revenue.	It works through decentralized protocols – the building blocks of blockchain technology and cryptocurrency
Payments	In-platform virtual currency (e.g., Robux for Roblox)	Cryptocurrencies and tokens
Content revenues	Platform or app store earns 30% of every game purchased; 70% goes to the developer (example model)	Peer-to-peer; developers (content creators) directly earn revenue from sales Users/gamers can earn through play or participation in platform governance Royalties on secondary trades of NFTs to the creator
Examples		
	Second Life Roblox Fortnite World of Warcraft	Wolfram Alpha The Sandbox Somnium Space Siri Cryptovoxels

2.2.2. Extended Reality (VR, AR, MR)

Based on Milgram and Kishino's Reality Virtuality Continuum (Milgram et al., 1995), the latest current continuum has featured new branches of parallel realities that trend to physical realities. Human users can interact with the Metaverse via various worlds in digital and physical domains. Extended reality includes the most frequently mentioned form of Metaverse technology. The merging of the physical and digital worlds using headsets and devices where we can enter virtual worlds and interact with 3D avatars in communities with the contribution of extended reality and with the possibility of using mixed and augmented reality to bring digital content into the real world or changing the way we interact with everything from maps to retail experiences.

(A) Virtual Reality (VR)

VR has the advantage of having completely synthetic sights. Commercial VR headsets include standard user interface techniques such as head tracking and tangible controllers. As a result, users are immersed in completely virtual settings, interacting with virtual items using user interaction techniques (Kelly et al., 2021). As distant video conferencing technology enables face-to-face interactions but is still not as successful as meeting face-to-face for collaboration, VR technology might replicate and replace human interactions and collaborative work. Shop in an immersive and engaging experience using VR technology such as a headset or VR glasses with controllers to join and engage with other people. Although VR is still in its infancy, it is apparent that it will expand to support more than simply entertainment and social applications. This technology provides a good platform for improved sharing and connection with others. We may construct my "avatar" in VR by selecting hair and clothes that resemble my look and style, then visit an imaginary digital world to discover ourselves in our digital room made by the people themselves. Assume you are in your area or virtual workspace when someone contacts you from anywhere globally to join them in solving an issue or reviewing a new concept. Leave your current virtual area and enter the new one to meet that individual in an immersive environment that encourages collaborative working. Because the VR headset is a high-powered computer and communication device that you wear on your head, it will almost certainly eliminate the need for a laptop and a mobile phone. On the other hand, to attain widespread acceptance, VR devices will need to provide great user experiences, such as fewer software issues, better and smaller form factors, and higher quality images and sound. Users can enter the Metaverse through VR, bridging the apparent divide between the digital and physical world. VR, an alternate digital world that may be used as headphones and consumer options for traversing 3D interactive and social situations, is projected to evolve when the Metaverse emerges over the next few years. With Metaverse, humans will be able to explore new areas and make experiences more accessible to everybody by using virtual replicas of people, objects, and landscapes. For several personal and business reasons.

(B) Augmented Reality (AR)

Beyond the confines of VR, AR provides alternate experiences to human users in their physical surroundings to improve our physical world. Theoretically, computer-generated virtual content may be delivered via various channels of perceptual information, including audio, sights, haptics, and smell (Schmalstieg et al., 2016; LaViola 2017). The early concept of AR systems focused solely on visual upgrades to organize and display digital overlays on top of our actual environment. A bulky see-through display, as seen in early work in the 1990s (Feiner et al., 1993), did not address user mobility, requiring users can interact with 2D interfaces and textual by using physical controls.

Since the first study, significant research efforts have been undertaken to better users interact with digital objects in AR. It is vital to emphasize that the digital objects from the Metaverse, superimposed in front of the user's actual environment, can allow human users to blend the concurrent operations. As a result, one of the primary issues in linking human users in the real world with the Metaverse is ensuring smooth and lightweight user interaction with these digital objects in AR. AR will be present in all our living spaces, for example, annotating instructions in a new location and highlighting things based on user situations. As a result, we may anticipate that the Metaverse will be integrated with the urban environment via AR, with digital entities appearing in obvious and tactile ways on top of various actual items in metropolitan settings. That is to say. AR users operate in actual contexts while communicating with their virtual counterparts in the Metaverse.

(C)Mixed Reality (MR)

There is no widely accepted definition of Mixed Reality (MR), but it is critical to have a name that defines the alternating reality that sits between the two extremes of AR and VR. Six working definitions (Speicher et al., 2019) can be summarized, which include the conventional concept of MR in the reality–virtuality continuum's middle area (Milgram et al., 1994), MR as an alternative for AR (Lopes et al., 2018), MR as a type of collaboration (Reilly et al., 2015), MR as a combination of AR and VR (Ohta et al., 2015), MR as an environmental alignment (Roo et al., 2017), and a version of AR (Yue et al., 2017). The six definitions listed above are widely seen in MR literature. The research community sees MR as a bridge between AR and VR, allowing users to engage with virtual elements in real-world settings. It's worth noting that MR objects can collaborate with other tangible items in various physical situations if they have significant environmental knowledge or situational awareness capability. In many studies that draw more linked and cooperating linkages among real spatial entities, user interaction entities, and virtual ones, MR is considered a stronger form of AR (Gardony et al., 2020).

2.2.3. Artificial Intelligence

AI has demonstrated the critical need to process large amounts of data to improve immersive experiences and enable virtual agents to have human-like intelligence. The Metaverse will construct scalable and accurate virtual worlds by combining augmented and AR/VR, AI, and blockchain. Facebook is now well-known for its AI research and cutting-edge AI algorithms. Content analysis, self-supervised voice processing, robotic interfaces, computer vision, whole-body posture assessment, and other fields of AI study are all part of the company's AI research.

AI applications are now far more frequent than you may expect. AI plays a significant role in consumer-facing applications, including face recognition, natural language processing, quicker computation, and various other under-the-hood activities. It was just a matter of time until AI was used to augment VR to create better immersive environments. AI can quickly sift massive amounts of data to develop insights and drive action. Users may use AI for decision-making (as most corporate apps do) or combine AI with automation for low-touch activities.

The Metaverse will construct scalable and accurate virtual worlds by combining VR with AI and blockchain. Facebook is now well-known for its efforts in AI and advanced AI algorithms. For example, a user's 2D photos or 3D scans, for example, can be analyzed by an AI engine to produce a very realistic simulation display. Another example is digital humans, which are Metaverse-based 3D versions of chatbots. They're not perfect replicas of other people; rather, they're AI-enabled Non-Player Characters in a video game who react and respond to your activities in a VR world. It is built entirely with AI technology; digital humans are essential to the Metaverse. Also, one of the primary ways digital humans use AI is language processing. AI can assist in deconstructing natural languages such as English, convert them into a machine-readable format, do analysis, generate a response, convert the results back into English, and send them to the user. This procedure takes a fraction of a second, just like a genuine discussion. Users worldwide can access the Metaverse since the findings can be transformed into any natural language using AI training. It's vital to remember that the Metaverse is a very young field of study and operation and that AI implementation may run into issues. Many advanced ML algorithms with supervised learning and reinforcement learning have been adopted in 5G and future 6G systems for challenging tasks such as automatic resource allocation. Using sensor-based wearable devices and other human-machine interface gadgets, simple human gestures and complicated actions may be evaluated and identified based on learning ML and DL models. The authors of (Thien 2022) presented a comprehensive survey on AI-based solutions for Metaverse in six technological aspects: machine vision, natural language processing networking, blockchain, neural interface, and digital twins, all of which have Metaverse potential.

2.2.4. Blockchain technology

Now, most things are digitized, including digital twins of entities, physical systems, user avatars, a large-scale map, a fine-grained map of different regions, and everything in the world connected to the Metaverse. This giant data to centralized cloud servers is impossible due to limited network resources. Meanwhile, blockchain technologies are rapidly developing to be applied to a data storage and sharing system while ensuring centralization and security (Lee et al., 2020).

Blockchain is a digital ledger that uses encryption to store a list of tracked assets and recorded transactions integrated into a corporate network. Blockchain can deliver real-time, shareable, and transparent data stored in an immutable, impenetrable ledger that only authorized network participants may access (Gadekallu et al., 2022). Orders, payments, accounts, and other transactions may be tracked on a conventional blockchain network. A vast quantity of data (e.g., movies and other digital items) is captured by VR devices in the Metaverse, sent through networks, and stored in data centers without any security or privacy protection methods, making them a vulnerable target for cyberattacks. In this context, blockchain, which has various distinct qualities, presents a possible answer to Metaverse's security and privacy challenges.

Furthermore, many of the creative events and activities provided by service providers to users will result in a massive number of in-Metaverse objects that should be recorded and monitored via transparent blockchain transactions utilizing smart contracts. Blockchains can be applied to the data storage system to ensure decentralization and security in the Metaverse. How to store the huge amount of data digitized and collected from different types of user data is a critical problem in the

Metaverse Traditional data storage system usually adopts centralized architecture, which requires all data to be transferred to a data center with a high storage capacity is essential, usually, what would be expensive. Moreover, sensitive information may be embedded in this data, leading to potential privacy leakage issues. As a distributed database, blockchain is sufficient to deal with these issues. Users with blockchains can create data blocks and collaboratively validate and record transactions in the Metaverse environment.

2.2.5. Internet of things

According to Vailshery (2021), the total number of IoT-connected networks and devices globally will be around 30.9 billion by 2025, a significant increase from the 13.8 billion projected in 2021. At the same time, the variety of engagement modes is growing. As a result, many experts feel that combining IoT and VR/AR/MR for multi-modal interaction platforms might engage user experiences. This allows interaction systems to blend the agent's real-world context with immersive AR material.

The increasing availability of smart IoT devices in our daily lives opens new options for creative services and apps that can enhance the quality of life. However, most small IoT devices cannot support physical interfaces for proper user engagement. Because it is hard to carry a bundle of controllers for several IoT devices, users can get rid of physical controllers. AR can show consumers the IoT data flow of speakers and smart cameras, alerting them to potential risks in the user-IoT interaction. As a result, consumers may utilize AR visualization platforms to handle their IoT data. The AR/VR/MR-directed IoT engagement solutions are classified using various essential concepts.

2.2.6. Digital twins

Digital twins, MR, and self-driving systems are at the heart of a great surge of innovation that benefits our customers. Critical for enterprises' digital transformation, the IoT is becoming more widely used. And data, which is one of the key benefits of the IoT, is critical to creating digital twins, which will increasingly arise in real-life circumstances ranging from asset management to climate change mitigation.

The utility of digital twins has been depicted in simulation for years. The digital twin, for example, replicates not just the design and construction of a product but also how it will function over time. As a result, digital twins' enigmatic existence has been inextricably linked to artificial Reality and VR, making it difficult for many to comprehend their applications.

As a digital representation of real-world things, a digital twin may synchronize operational assets, processes, and systems with the actual world and perform other routine tasks like monitoring, visualizing, analyzing, and forecasting (Tao et al., 2019). Because digital victories are at the heart of how the virtual and physical worlds interact based on IoT devices and sensors (Chen et al., 2021), any modification in the actual world will not be accepted in the digital world. With these distinguishing characteristics, digital twins are discovered as one of the Metaverse's essential building sectors and serve as the doorway for users to join and enjoy services in the virtual world by making precise replications of reality, including functioning and structure. Digital twins have helped create virtual copies of health patent files, carry out coordinated activities for health professionals, and develop a comprehensive drug regimen for patients with identical diseases at different stages. Elayan et al., (2021), for example, provided a data-driven-based digital twins architecture that was explored to increase health diagnostic performance and promote improved health operation in intelligent health applications.

3. Metaverse Applications

This section describes some applications that are related to the Metaverse. Most Metaverse research is directed toward marketing and investment goals, focusing on social usefulness. Metaverse frequently serves games and various other domains. Fig. 4 describes some essential applications of the Metaverse.

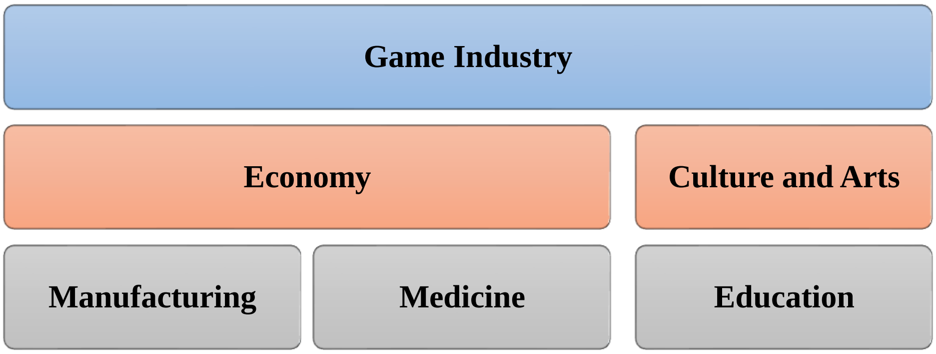

Fig.4: Examples related metaverse applications

3.1. Manufacturing in metaverses

As part of the current stage of the industry 4.0/5.0, digital transformation in manufacturing has been taking place, with digital connections between systems and machines to study better and comprehend physical things. Unlike digital transformation, which uses digital processes to improve the physical world, the Metaverse develops a virtual environment transposed into the physical world based on real interaction and persistence. The Metaverse for manufacturing may considerably update digital operations in the present digital revolution by cooperatively embracing cutting-edge technology such as AI and digital twins. Shorter product lifecycles and an increase in the number of product variants are the primary drivers of high costs for the upgrades and production system reconfigurations in manufacturing, especially for machine learning-based frameworks that take a lot of time and computing resources for new data gathering, data preprocessing, and model learning. A symbiotic human-machine learning architecture (Doltsinis et al., 2018) was combined with a reinforcement learning technique to address the difficulties above. This approach also included human exploration to reduce data noise and improve the quality of autonomous decision-making systems. Quality control is essential in today's manufacturing processes. Thanks to intelligent data-driven condition supervision techniques, it has lately gotten a lot of attention; nonetheless, they ran into certain challenges due to various operating conditions and jobs and applications.

3.2. Economy in metaverses

Millions of people from all over the world now are playing online games, where players can interact with each other's in a virtual environment, either using their existing physical identities or virtual identities that aren't remotely linked to the players' physical identities. The number of users is increasing exponentially, and we are most likely on the cusp of new development as big as the Internet itself. No surprise, enabling in-world cash to be swapped for the currency of the real world is far-reaching repercussions for the strategy of world operators. Making transactions in Metaverses greatly broadens the scope and size of economic operations and the setting in which they take place to show how the Internet facilitated electronic commerce. Landscape and Metaverses entail broadening the conventional classification by introducing a new element for business-to-business transactions. Transacting in Metaverses greatly broadens the scope and size of economic operations and the setting in which they take place. Metaverses, like the Internet, entail expanding the conventional' taxonomy by introducing a new dimension for business-to-business interactions.

3.3. Game industry in metaverses

Gaming has long been an important area in the Metaverse, with ML and DL transforming and redefining the game across several systems, from consoles to PC and smartphones. Video games are becoming more realistic and stunning. Users may enjoy stunning visuals and in-game mechanics. According to the three-stage Metaverse, the game-based Metaverse can provide countless chances. It may eventually lead to virtual settings that are similar to the present one in the real world. Roblox has 50 million games and a total monthly use duration of 3 billion hours. People spend more time than social networking services. In Metaverse world, games are the most prevalent platform. Aside from merely focusing on interests, there are approaches to simplifying challenging jobs using games. As money and personal information are extensively utilized in the Metaverse, a blockchain-based game has grown popular.

3.4. Education in metaverses

The Metaverse is a type of imagined universe with increasing digital areas, allowing for a more engaging atmosphere in education process settings. Several educational systems undertook research using the Metaverse as their central theme.

Researchers employed Metaverse in the education sector, adopting a problem-based approach, where professors and students may find alternative answers for the problems in the imagined world utilizing 3D courses and avatars. Metaverse contains distinguishing features that distinguish it from other instructional tools such as Persistence and Corporeity. In the virtual environment, users may engage with each other via a virtual learning platform. The interactivity element, which makes this environment more effective, establishes a novel scenario of education of independent and collaborative learning, allowing access to all accessible resources. In education, the Metaverse concentrates on designing real-world experiments in which the Metaverse approach is utilized as a tool to address problems. As a result, the authors of (Akour et al., 2022) sought to explore factors that have an impact on Metaverse system adoption in the Gulf region, evaluating the amount to which how perceived utility and simplicity of use impact Metaverse system acceptance and personal inventiveness By focusing on perceived observability, compatibility, and complexity, the goal is to build a correlation between user happiness and Metaverse activity.

Instead of conventional classes, the higher education sector may benefit from various strategies by creating a service for teachers, staff, and students to communicate in a flexible setting with no limits. With the press of a mouse, students may connect with teachers in a digital world. In this way, Metaverse can serve to embrace higher education by transforming it into a virtual environment in which instructors, learners, and learning methods may engage in hybrid and collaborative classrooms.

In education, the problem-based learning technique has been utilized successfully to meet diverse learning outcomes such as technology, engineering, and materials engineering (AlQudah et al., 2021). This strategy is used in the Metaverse scenario, where learners face challenges and must propose solutions. The students will be in a virtual environment where avatars do everything for them; hence, the learners must use their skills in the virtual setting. Instructors in the Metaverse system provide their pupils with inadequate difficulties comparable to those encountered in real life. The students, acting as avatars, investigate the problem to develop appropriate answers.

The Metaverse module can be integrated with AI technologies and collaborative learning platforms, which are utilized to improve educational methods and learning styles. Recent research has focused on a variety of themes, including differences in student views in different nations throughout the world and gender disparities. These researchers concentrated on blended learning, in which the use of social media is important in assessing the teaching process. To effectively deploy all these techniques, researchers have proved a need for new tools that measure the growth of learners' performance and contribution; hence, they utilize eye-tracking methods to analyze how learners digested texts and visuals while reading.

3.5. Medicine in metaverses

The Metaverse concept brings numerous new aspects to healthcare field communication. The Metaverse is a platform of virtual worlds where individuals may interact with one another and digital things. In the context of healthcare, the prefix "meta" refers to the virtual world, whereas the suffix "verse" refers to the physical world. Researchers recommended Metaverse in Healthcare as a Medical Internet of Things (MIoT) assisted by AR and/or VR glasses.

Yang et al., used Metaverse in Medical applications. This new approach is expected to enhance complete healthcare and illness treatment and prevention, as well as to update the present diagnosis and treatment paradigm, which differs between physicians and hospitals, resulting in unequal standards comparable to handcraft manufacturing. In Medicine, the Metaverse is internet access using AR and VR glasses, becoming more widely recognized as the next-generation mobile computing platform. Metaverse in Medicine can be considered the MIoT, which can be facilitated by VR and AR glasses. MIoT provides a framework for developing the Metaverse in Medicine in this setting. Metaverse has recently been used in Medicine by utilizing holographic construction and emulation and VR integration and connectivity. To address practical issues, we propose incorporating the notion of complete perception into holographic architecture and Metaverse emulation because recent research has demonstrated that it can meet the Metaverse's demands in Medicine. Some fundamental technologies have been established in healthcare sectors, such as photoconductive, force-sensitive, sound-sensitive, radiation-sensitive sensors, and gas-sensitive. Also, the use of computed tomography (CT), ultrasound, electrocardiography (ECG), and biochemical tests to evaluate kidney or liver function, and positron emission tomography-computed tomography (PET/CT). This technology allows for the monitoring system of physiological, pathophysiological, and biochemical changes in the body and all settings, allowing for a complete perspective of health. Consequently, physicians and patients can join the Metaverse with their digital twins and practice Metaverse medicine via VR connection (Yang 2022).

3.6. Culture and arts in metaverses

Museum exhibition strategies are continuously evolving today. While focused on visitors' museum experience, modern exhibition methods integrate a range of digital technologies to deliver exhibition information to allow people visiting to better comprehend the items on show. However, the bulk of such solutions relies on one-way information delivery. Museums are inadequate as experiencing locations due to a lack of engagement with visitors and the usage of lighting that clearly distinguishes actual and virtual worlds. The digital world has drastically impacted the traditional concept of the museum. While the classical museum encouraged analog contents maintenance procedures, the contemporary museum contributed to the formation of photographs and other instructional content away from objects and the development of exhibition methods. The internet era could see the birth of a digital exhibition environment in which digital material developed. The digital era has so merged virtual and on-site museum locations while also altering the whole museum area through the employment of omnipresent technology. Together with museum functional changes, the content of museum exhibitions has shifted toward the growth of experiencing space. It refers to a physical display place. Museums must now figure out how to maximize visitors' experiences beyond the physical features.

AR may be accomplished in the Metaverse environment by concentrating on a specific artifact and delivering information about that thing. In this context, a virtual world refers to a spectator's direct or indirect experience of a tale associated with the item. Lifelogging refers to logs of ordinary happenings carried out by viewers while using the service. Log analysis will assist in determining the spectator's behavioral traits and, using big data analysis, planning the distribution of customized material to the spectator. The mirror world is a replica of the real world. The mentioned museum exhibition experience content service can integrate all Metaverse features; hence, the material can be referred to as Metaverse exhibition content. As fresh material, information utilized in the Metaverse or logs generated by the Metaverse can be contributed. It can be delivered by mobile or online, or it can aid in creating a cyber museum exhibition environment that gives viewers tailored information. Like Google's Art Project, visitors to a museum can tour exhibition rooms, see immersive material, and obtain basic knowledge in cyber-mode (Choi et al., 2017).

3.7. Smart cities in metaverses

Smart cities collect important information about inhabitants' needs through video cameras, social media IoT and other sources. City local councils must judge which services to eliminate, supply, and enhance based on input obtained automatically from people. Smart cities will offer smarter interactive benefits to individuals via the Metaverse network by utilizing more digital tools and cutting-edge technology (Kohli et al., 2022). Environmental data (weather, air quality, traffic status, energy usage, and parking spaces) are fully recreated in the virtual world for a user-friendly interface. Using the Metaverse's platforms and systems, numerous smart services, such as utility payment and smart home control, could then be carried out in the virtual world, including intelligent transportation systems, smart lighting of the streets, smart community portals, and automatic automaticity portals parking systems, and surveillance systems. Nowadays, these technologies' real effects and value to smart cities are limited; nevertheless, the Metaverse can work as a catalyst to spread the display of smart services in residents' daily lives. Furthermore, AI has demonstrated a significant role in achieving automated and intelligent smart services (Mohammadi et al., 2018).

3.8. E-Commerce in metaverses

Regardless of the unpopularity of VR devices among mainstream customers, various consumer businesses have been diving into the digital world to offer more pleasurable and smooth purchasing experiences for which E-commerce has been incorporated into the Metaverse. Many companies have taken baby steps toward creating something new by combining digital storefronts capable of bringing the best physical and online purchasing with no difference in user experience (Riedl 2021).

Moreover, virtual purchasing may provide a distant direct experience of static objects, in which avatars represent users, roam around businesses in a 3D simulated environment and interact with virtual cashiers/sellers enabled by VR and AI technologies. Customizing the customer experience is gaining traction among shops for business survival and income development. It is now possible to do it simply in the Metaverse by using AI-based purchasing behavior analytics.

4. Problems, Challenges, and Open Problems

Despite the new possibilities that the Metaverse ecosystem may facilitate, it will have to deal with the issue of the possible unauthorized disclosure at an earlier phase when the ecosystem is still starting to take shape, rather than having to wait for the future, when the problem is so deeply embedded in the ecosystem that any remedy to solve privacy concerns will necessitate a complete redesign. For example, the third-party cookie-based marketing ecosystem, where the primary aim was to design for delivering utilities, is an instance of this issue. The entire income system was predicated on cookies, which follow users to give customized adverts, and it was too late to address privacy concerns. Creating a verified privacy method would be one of the most important challenges to address to get societal acceptance. The privacy paradox, in which users actively divulge their information, is another facet of privacy hazard in the context of societal acceptability. Users don't pay much attention to how other parties use their public data in this respect. Still, they have extremely strong negative reactions when the discrepancy between their real use and perceived use of data becomes obvious and excessively contrasted. Many individuals, for example, knowingly provided their data on Facebook.

Internet-connected items, such as wearables, enable monitoring and data collection. These devices gather various data, including personal details such as user behavior (e.g., habits, decisions). This data can be viewed in many ways. Most of the time, such as in smart buildings, we are unaware of such ubiquitous and continual recording, and as a result, our privacy may be jeopardized in ways we cannot predict. In many cases, consumers accept the benefits in exchange for the potential privacy and security concerns associated with utilizing these smart gadgets or services.

The Metaverse may be viewed as a digital version of what we perceive in our worlds, such as streets, buildings, and persons. However, the Metaverse may create things that do not exist in reality, such as massive concerts attended by millions of people. The Metaverse may be viewed as a social microcosmos in which players (those who use the Metaverse) can engage in realistic social behavior. Individuals' privacy and security perceptions might reflect their specific behavior in this environment.

As the future moves into the Metaverse, some key issues are addressed. In the following, some important issues and challenges are described.

4.1. Hardware and software

While the Metaverse closely matches the actual world in terms of technology, some experiences are best enjoyed in real life. In terms of software, programs created in the Metaverse without coding serve as the foundation for high compatibility in the Metaverse environment. However, as the software grows more complex, it runs up against the complexity limit in a complicated system.

4.2. User diversity

The Metaverse must be accessible to all community members, regardless of ethnicity, race, age, or religion, including children, the elderly, and those with disabilities. Various materials may exist in the Metaverse, and we must guarantee that the contents are acceptable for a wide range of users. Furthermore, it is critical to consider customized content presentation before users and increase the fairness of recommendation systems to reduce biased content and, therefore, influence user activity and the decision-making process.

4.3. Fairness

In the Metaverse, many virtual worlds will be created, and each virtual world may have its own set of laws to control user behavior and activities. As a result, the time and effort required to manage and maintain such virtual worlds would be immense. It's crucial to note that autonomous systems in virtual worlds rely on AI algorithms. to respond to the dynamic changes in virtual items and avatars. This emphasizes the relevance of user impressions of machine learning algorithms' fairness, i.e. perceived fairness. Individual or collective results that are unfavorable to them might be disastrous. Metaverse designers should create channels to collect the voices of various community groups and work together to create solutions that promote justice in Metaverse ecosystems.

4.4. Cyberbullying

Cyberbullying is defined as misbehavior, including sending, uploading, or spreading unpleasant, damaging, false, or malicious material about victims in cyberspaces, most seen on social media. The Metaverse is considered to be massive cyberspace. As a result, cyberbullying in the Metaverse might be an unavoidable societal danger to the ecology. Authorities will propose that some virtual worlds in the Metaverse be stopped working since the Metaverse will not be able to function indefinitely.

4.5. Social issues

Cultural acceptance of devices linking individuals to the Metaverse, which refers to the public's or bystanders' acceptance of such technologies as mobile AR/VR headsets, requires additional examination. Furthermore, the user protection of mobile headsets may negatively influence users and onlookers, resulting in a breakdown of user experience in virtual worlds. Only a few studies have been done on the social acceptability of virtual worlds, but none have been done on digital twins or the Metaverse. Social media platforms have been unable to offer consumers from various populations on a single platform until now. We must plan for the user design of cross-generational virtual worlds based on the failed scenario, especially when considering the Metaverse with dynamic user cohorts in a unified environment.

Furthermore, we must evaluate the user acceptability of avatars, or digital copies of people, at distinct times. In addition, the Metaverse, which is viewed as a massive digital environment, will be powered by a vast number of computational resources. As a result, the Metaverse has the potential to use a lot of energy and pollute the environment. Considering that the Metaverse must not deprive future generations, developers should consider green computing while designing the Metaverse. Environmental protection and accountability may influence user affection and views towards the Metaverse and the number of active users and even opponents. As a result, sourcing and creating the Metaverse using data analytics based on sustainability indices will be required if the Metaverse is to be widely adopted.

4.6. Trust

Many social issues, like loneliness, might be solved by a Metaverse environment. Users are likely to dedicate time to their adventures in virtual surroundings. They would expose themselves to others by disclosing their behaviors. This can present another limiting factor.

4.7. Accountability

Accountability is considered one of the most important factors in realizing the Metaverse ecosystem's full potential. Although technological advances have made pervasive computing a reality, many potential advantages will not be fulfilled without people getting acquainted with and accepting the technology. Accountability is critical for trust since it pertains to the duties, incentives, and methods of redress for people who design, implement, manage, and provide services.

Another facet of accountability in the Metaverse universe is how users' data is managed, such as the user's position and surroundings, instead of standard smart gadgets. The Metaverse universe should encourage the data reduction principle to address this issue. Only the smallest amount of user data required for the fundamental function is gathered. The zero-knowledge concept, in which systems maintain user data only for as long as it is needed.

4.8. Ethical issues

Second life has started in the United States. Furthermore, the Metaverse has the potential to grow to global proportions, posing various issues in protecting users across such a vast range. Thus, it adheres to US privacy and security rules. Regulations are enforced in this environment using code and regular monitoring of participants (e.g., conversations, logs, chat). This can assist Metaverse developers in banning users who others have reported. However, as we can see, this is similar to some forms of government. This management will be responsible for decisions such as imposing limits on a banned player. This lack of management can conflict with the Metaverse experience, yet the Metaverse can devolve into chaos without global governance.

So, there are confront global difficulties of Metaverse legislation and governance to provide some authority over the virtual environment. It is expected that the next Metaverse will adhere to previous approaches in compliance with the legislation. In the Metaverse, users may build neighbors that follow certain rules. Users, for example, can designate zones that are only accessible to other users who share similar interests. Moreover, Blockchain technology can compel Metaverse users to follow certain rules, with accompanying penalties.

4.9. Scalability

A common platform designed for a recent Metaverse to be scalable. Some recent works have used AI to optimize certain areas in a manufacturing system. There are several solutions for tackling scalability issues in the Metaverse, such as balancing workload in online games to reduce reaction time and unsupervised translation of 3D models between the Metaverse and real-world surroundings. However, some solutions are constrained, for example, in games, especially when the game environment becomes complex. Therefore, there is still a need to work to accelerate the data accessing speed, and scalability is a challenge to be solved.

5. Concluding Remarks and Future Trends

The Metaverse is on its way, and it will be a major thing. It will drastically alter our way of life. Therefore, this study presents the Metaverse concept and the most recent emerging technologies. Furthermore, this study has studied the role of new technologies such as AI in the Metaverse's basis and its potential to improve user immersion in the virtual world. The essential principles of the Metaverse and AI methodologies and the function of AI in the Metaverse have been presented. Several key technological features, such as digital twins and blockchain, and several application areas, such as games, smart cities, healthcare, and manufacturing, have been highlighted. Most contemporary Metaverse initiatives restrict users' ability to explore, own, and change items in the virtual environment. With the aid of AI, people will be able to build hyperreal objects and content easily and fast in the future. Users can continually combine hyperreal things (e.g., plants, bodies, animals, automobiles, buildings, and other inanimate objects) to create new experiences and inspire creativity. As a result, combining VR with AI-based content development can provide total immersion in alternate realms. AI products should be affordable to the general public and offer user-friendly interfaces in this context. Furthermore, ethical problems of user-generated Metaverses must be thoroughly investigated, with limitations and regulations established between third-party companies, to reduce hazards and detrimental threats to persons and society when users synthesize the contents of hyperreal media.

The Metaverse is a shared virtual area where people can interact with each other in a digital world. Users live in such a place as tangible virtual pictures, as if they were living in a parallel universe to the actual one. Such modern technology will help to design the next immersive Internet. The Metaverse progresses from reality concept depends on VR/AR/MR as an essential intermediary stage. Users can engage with digital overlays using mobile user interaction techniques. Invisible computing interfaces enabling ubiquitous user engagement with virtual worlds in the Metaverse can be achieved by designing mobile approaches in body-centric, miniature-sized, and delicate ways.

The impact of AI, particularly deep learning, provides significant progress in Metaverse automation for operators and designers and delivers greater advantages over conventional techniques. Moreover, there is a lack of AI to streamline user operation and improve the immersive experience. Existing AI models are often quite deep and need huge compute capabilities, making them unsuitable for resource-constrained mobile devices. As a result, building efficient AI models is required. Blockchain uses proof of work as its trust method, compels members to spend time-solving puzzles to ensure data security. However, the verification procedure for encrypted data is slower than traditional techniques. Computer vision enables computing systems to comprehend visual information about users' actions and environment. Computer vision algorithms can be used to create a more trustworthy and realistic 3D virtual environment in the Metaverse. An interaction system in the Metaverse must comprehend increasingly complicated contexts, particularly the merging of virtual things with the actual world. As a result, we expect more accurate and computationally effective spatial and scene comprehension algorithms to be used for the Metaverse in the near future.

In virtual surroundings, users would depend on avatars to represent themselves. While available technology can record characteristics of our physical appearance and build an avatar automatically, the omnipresent and real-time controls of avatars with mobile sensors are still not available for us to mobilize avatars in the Metaverse. In addition, more research studies are needed to improve the avatars' micro-expression and nonverbal expressiveness.

Digital twins will be used fundamentally in the future years, thanks to the involvement of developing technologies and the gradual expansion and refinement of the environment. Because of the availability of powerful computing devices and intelligent wearables, the digital future will be more interacting, living, embodied, and multidimensional. However, numerous obstacles must be overcome before the Metaverse can be fully incorporated into the physical world and our daily lives. Because of the limited number of existing research works, the study of the Metaverse is still in its beginnings. As a result, more scientific research studies for building Metaverse should be increased in the future.

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