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Metaverse

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ABSTRACT

The metaverse is a virtual world where users interact in 3D using avatars, and is often focused on social and economic connections. It is a combination of two words "meta" and "universe." It is considered as the next stage of the Internet, where people can connect with friends, work, play games, and shop. It is a cyberspace where people can interact in a physical space, and is built using advanced technologies such as virtual reality (VR), augmented reality (AR) headsets, and artificial intelligence (AI). In order to access the metaverse, users must have a computer, web browser, and an Internet connection. Users may also require the need for VR equipment to have a full 3D experience. It is used for a variety of purposes. This paper delves into what metaverse means, the uses and benefits to man, its challenges and possible solutions, and the way forward.

KEYWORDS: *Metaverse, virtual reality, augmented reality, 3D Internet, artificial intelligence, avatars, web browser, computer, internet connection, cyberspace*

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INTRODUCTION

The "metaverse" is a loosely defined term that refers to virtual worlds in which users represented by avatars interact [1], usually in 3D and focused on social and economic connections [1-4]. As at now, there is no consensus on the exact definition or features of the metaverse, but some common elements include a sense of immersion, real-time interactivity, and user agency [5]. Metaverse is a virtual world that mimics reality, where people can interact in real time across large distances, as well as a digital parallel universe that combines both the physical and digital worlds, and can be accessed through a browser, mobile app, or headset. The big difference between metaverse and other online platforms is that it is completely virtual and therefore immersive and not just text-based, as shown in Figures 1 and 2. That is to say that users can decide for themselves how they want to create their environment, from choosing an avatar to creating a 3D model for their virtual environment. The metaverse also represents the fact that our real and digital lives are becoming increasing intermingled. Currently, there no uniform definition of the metaverse, as it is only in the definition, development or construction phase. There are already metaverse platforms, but the "one, big metaverse" does not yet exist. No single entity owns the metaverse, but several companies are investing in creating metaverse-like experiences include Meta, Roblox, Epic Games, Google, Microsoft, and Unity Technologies, among others [6]. Facebook's parent company, Meta, has taken the lead in this movement, and is already investing gigantic sums in the transfer and realignment of its social media activities into a virtual space, as shown in Figures 3 and 4.

Metaverse will further lead to the digitalization of markets, but also as a space for the "cyber" in cyber-physical systems of the IIoT (Industrial Internet of Things), such virtual spaces could gain in importance and also drastically change business interactions [7].

HISTORY

The concept of a metaverse first appeared in science fiction in the 1950s, with early works such as William Gibson's novel *Neuromancer* and the 1982 film Tron. These stories described an immersive virtual world for humans to explore. Expanding this definition to "virtual reality," the French poet Antonin Artuad used the term as early as 1938 in his collection of essays

"The Theatre and its Double." The first real simulation was created in 1962 with "Sensorama," a machine that simulated the experience of riding a motorbike through New York City via a 3D film with a vibrating chair and even fans and smells.

After these early attempts at virtual reality, author Neal Stephenson coined the term "metaverse" in his bestselling 1992 novel *Snow Crash*, as shown in Figure 5, imagining a virtual multiverse in which people interact and experience shared virtual worlds in a dystopian future. Richard Garriott, a famed video game developer in 1997 used the term to describe an online role-playing game he was developing called Ultimate Online, which was a year later and is widely considered to be the first MMO (massively multiplayer online) game. The 3D online virtual world called "Second Life" was released in 2003, allowing people to create virtual worlds, interact with them, and exchange virtual goods. Three years later, Roblox was released, creating a hype for users who could easily create virtual worlds (from "blox" blocks) or use other user's virtual worlds to play in, which became a quick success.

As time went by, more and more technology companies started exploring the concept of virtual reality and create versions of this new digital world. In 2012, Oculus, the first low-cost 3D headset for the masses, was launched but two years later, in 2014, it was bought over by Facebook. With faster smartphones, Internet connections and devices, the emergence of platforms and games such as Pokemon Go, which combines AR and real-world gaming with the virtual game, or Fortnite, which now hosts over 250 million players in its virtual MMO game world, began.

The next phase of metaverse hype began in 2021, when Facebook renamed itself "Meta" and Microsoft released its "Mesh" platform – of which both of them are trying to get businesses to use VR and virtual worlds for meetings, workshops, and more, as shown in Figures 6 and 7. The trend has continued, with new hardware and software produced each year, making VR headsets lighter, with better resolution, faster hardware and, most importantly, cheaper. Metaverse history is also shaped by technological innovation as technological breakthroughs have been closely linked to the development of the metaverse. Each step in the early experiments in virtual reality to the development of the internet infrastructure in the evolution of technology was a precursor to the current metaverse, vis-à-vis:

Early virtual reality experiments: In the 1960s, Ivan Sutherland, a pioneer in computer graphics, created the first VR headset.

Birth of the internet: The advent of the internet in the late 20th century was a pivotal movement for the metaverse. As global connectivity expanded so did the possibilities for creating interconnected virtual spaces. The Internert provided the necessary infrastructure for the development of early virtual worlds and online communities.

Graphical user interfaces: The introduction of graphical user interfaces (GUIs) to computers made digital environments more accessible and visually appealing. This advancement was crucial to the development of early virtual worlds, where users could navigate and interact with graphical elements.

Massively Multiplayer Online Games (MMOGs): The late 1990s and early 2000s saw the rise of MMOGs such as Ultima Online and World of Warcraft. These games introduced large-scale virtual environments in which thousands of players could interact simultaneously, offering a glimpse of the potential of the metaverse for social interaction and collaboration.

Virtual reality hardware development: The resurgence of interest in VR technology in the early 21st century, led by companies such as Oculus, brought significant improvements in VR hardware. More affordable and sophisticated headsets enabled a more immersive and accessible virtual experience; pushing the boundaries of what was possible in the metaverse, as shown in Figures 8 and 9.

Augmented and mixed reality: Alongside VR, augmented reality (AR) and mixed reality (MR) technologies began to emerge. These technologies blended digital content with the physical world, opening up new possibilities for the metaverse to expand beyond purely virtual environments.

Advances in networking and cloud computing: The growth of high-speed internet and cloud computing has been instrumental in supporting the complex data and processing requirements of the metaverse. These technologies enable seamless, real-time interaction and collaboration in virtual spaces, regardless of geographic location [8].

THE DEVELOPMENT OF VIRTUAL REALITY TECHNOLOGY

The earliest virtual reality (VR) experiments can be traced back to the 1960s, when the computer scientist Ivan Sutherland developed the first headset, the Sword of Damocles. It was in the 1990s and early 2000s that VR technology started to gain momentum with the rise of VR gaming and entertainment. With more advanced computing power and graphics capabilities, VR gaming became a more immersive and interactive experience, allowing players to enter

virtual worlds and interact with them in real time. Especially the entertainment industry saw the potential of VR, creating virtual experiences such as theme park rides and movies, and erotic films and pornography were one of the early adopting industries.

Recent years saw the VR industries experienced a significant resurgence, with the emergence of companies like Oculus, Microsoft (with its Hololens product), X-Box, and Playstation. VR headsets were developed and expanded the reach and capability of VR, making it not only a tool for gaming and entertainment but also for business and industry, from training simulations to virtual product demonstrations. VR has become a powerful tool changing how many companies operate [8].

THE MODERN METAVERSE CONCEPT

Ever since Facebook changed its name to Meta in 2021, the modern Metaverse has been a constant "buzzword" in the technology industry. This has led to a surge of investment in the metaverse space, with blockchain companies attempting to link their ideology to the metaverse. However, these efforts are yet to add much real value to the space, as the concept of "limited land" or "limited goods" does not apply in digital space, making it unscalable [8]. Nevertheless, the growth of VR/AR platforms and social VR experiences has continued to accelerate, with companies such as Microsoft and Meta (with Oculus) offering business solutions and early virtual classrooms, and virtual worlds such as the revamped Second Life platform and others.

It should be noted that the current state of the metaverse is still in its infancy, and while adoption has been slow due to limited computing power, bad experiences, expensive hardware, and also technical limitation that only a few users can be in the same room together before the system reaches its limit. This is just a tip of the iceberg, as several technological challenges need to be overcome for the metaverse to reach its full potential. This includes the development of haptic sensors, improved VR headsets (lighter weight, better resolution, more computing power), smaller processors that can fit into glasses or VR headsets, and the overall computing power (servers) to create large-scale, high-resolution persistent worlds for millions of users [8].

THE CORE ATTRIBUTES OF THE METAVERSE

The core attributes of the metaverse according to Venture capitalist Matthew Ball in his essay is that the metaverse will [7]:

- Be constant
- Be synchronous and live
- Not set an upper limit on the number of concurrent users
- Be a fully functioning economy
- Be an experience
- Offer unprecedented interoperability/combinability of data, digital objects/assets, content, etc., across all these experiences
- Be populated by "content" and "experiences" created and operated by an incredible variety of contributors, some of whom may be independent individuals, or informally organized groups, or commercially oriented companies.

NFTs IN THE METAVERSE

The Non-fungible tokens (NFTs) are unique digital assets that prove ownership or authenticity for specific items or pieces of content, such as art, music, in-game items, videos, and more, as shown in Figure 10. Stored on a blockchain, each NFT is distinct and verifiable, making them for representing unique, one-of-a-kind items. However, unlike cryptocurrencies like Bitcoin or Ethereum, which are fungible and can be exchanged on a one-to-one basis, NFTs are not interchangeable, ensuring the security and transparency of ownership.

The metaverse is an expansive virtual space or 3D internet that leverages NFTs to shape its digital economies and creative landscapes. In this virtual environment, NFTs enable digital goods' creation, ownership, and trade, from virtual real estate to unique avatar accessories. The integration of NFTs enhances the metaverse by facilitating new forms of economic activity and creative expression, making it a dynamic hub for innovation and community engagement [9]. The following distinct characteristics set NFTs apart from fungible cryptocurrencies, which are [9]:

- *Non-fungible:* Fungible cryptocurrencies can be exchanged; but for NFTs, each asset has a digital signature that makes exchanging one for another impossible.
- *Indivisible:* NFTs cannot be divided into smaller units like cryptocurrencies. An NFT must be bought, sold, and owned as a whole. This feature is crucial for maintaining the integrity of digital assets, ensuring that a unique item remains whole and its value is preserved.
- *Unique:* Every NFT has unique properties that distinguish it from other tokens. These properties are often encoded into the token's metadata, which contains detailed information about the asset's attributes, history, and provenance.

- *Ownership verification:* NFTs use blockchain technology to publicly and immutably record ownership, making verifying who owns an item and tracing its ownership history easy.

Furthermore, to better explain the characteristics of NFTs, it is worth understanding "CryptoKitties," a blockchain-based game that was developed by Canadian studio Dapper Labs, where users can collect, breed, and trade digital cats as non-fungible tokens. Each CryptoKitty is unique and has its own distinct genome, which determines its physical traits.

Some use cases of NFTs in the metaverse: NFTs have found practical use cases in the 3D Internet across industries by revolutionizing the approach to digital ownership and monetization, as in the following examples:

- Virtual events and experiences, where NFTs allows organizers to tokenize access and sell them as unique digital assets, e. g. tickets to virtual concerts, conferences, and exhibitions, where each NFT can also include perks like exclusive content or merchandize.
- Gaming and virtual assets: Blockchain-based video games use NFTs to represent tradable in-game items, allowing payers to own, sell, and trade virtual assets like skins and collectibles. In the traditional video games, a centralized authority controls the distribution, ownership, and aspects of in-game assets. In the case of NFTs in the metaverse, the users have complete control over their virtual items and can potentially use or trade them on another platform.
- Digital identity and personalization: In conventional cases, identity verification relies on centralized databases prone to hacking. On the other hand, NFTs offer a unique and secure way to manage and monetize digital identities and personal brands within the 3D internet, by creating a unique, verifiable digital proof of identity on the blockchain that can be used for authentication in various scenarios, like while transacting online or accessing digital services.
- Education and knowledge sharing: In the education sector, NFTs are being used to tokenize educational content, allowing educators to create, distribute, and monetize their courses and materials in a decentralized and secure manner. The tokenization of educational assets means that educators can turn their expertise and educational resources into NFTs, making them exclusive and tradable items on digital platforms. NFTs can also create secure and tamper-proof certificates for learners to showcase their credentials authentically.

THE FUTURE OF THE METAVERSE

The metaverse has a bright and exciting future even in the midst of uncertainty. It has the potential to be a transformative technology, but with many challenges need be addressed to make it a reality. A few of the identified challenges/solutions are [8, 10]:

- The issue of content moderation: Ensuring a safe and welcoming environment, as content moderation is essential to prevent harassment, hate speech, and inappropriate behavior. Solution: AI-driven content moderation tools are being developed to monitor and enforce community guidelines. Users are to report problematic content, which is then reviewed by human moderators to maintain a positive virtual atmosphere.
- Concerns about identity theft and protection (i. e. privacy and data protection) for users to feel confident in the Metaverse.
- Security concern as a result of hacking, malware, and other forms of cyberattacks.
- Solution: developers are to incorporate robust encryption and authentication mechanisms into metaverse platforms, with blockchain technology to enhance security.
- The dystopian potential need to be recognized [11].
- Ethical AI: AI-driven NPCs and virtual entities in the metaverse must behave ethically and avoid perpetuating biases or discriminatory behavior.
- Solution: The creation of AI algorithms that align with ethical guidelines and well tested to minimize unintended consequences.
- The potential for addictive and escapist behavior, leading to loss of productivity and meaningful human connections that can cause declining fertility rates and shrinking populations. VR "hangover" is a known phenomenon, and people can as well experience post-VR sadness (digital addiction and health issues).

Solution: Metaverse platforms are implementing features like time limits and notifications to encourage responsible usage, and education on digital wellness.

- Interoperability: Due to different vendors and developers using different approaches to interoperability, making it difficult for systems and businesses to work together.

Solution: Initiatives like the Open Metaverse Interoperability Group (OMIG) aim to create a unified framework for shared avatars, objects, and experiences.

- Immersive design: Designers need to create an immersive experience while keeping it simple.
- Technological challenges: Major advances in technology and large capital investments are needed to create a genuine virtual world.
- Amplifying biases i. e. biases like gender, race, and ideology.
- Scalability: As the metaverse expands, handling of massive influx of users and content becomes increasingly complex. Scalability is vital to ensure a seamless experience for all participants.

Solution: Cloud computing and edge computing technologies can be leveraged to provide the necessary infrastructure for a scalable metaverse. Decentralized and distributed systems can help distribute the load efficiently.

- Economic models: Creators, developers, and users need be rewarded for their contributions by the use of economic models which is a puzzle.

Solutions: The emerging solutions are the blockchain-based tokens and non-fungible tokens (NFTs). They enable creators to monetize their content, and users can earn or trade digital assets within the metaverse.

- Metaverse laws and regulatory frameworks will bring regulatory challenges on legal and jurisdictional complexities, such as questions about taxation, intellectual property rights, and virtual asset ownership.

Solution: Collaboration between governments, industry stakeholders, and legal experts is crucial to create a balanced and globally recognized regulatory framework that addresses metaverse-specific issues.

- Digital inclusiveness: Not everyone has access to the required technology, high-speed internet, or the skills needed to navigate a virtual world.

Solution: To bridge the digital divide through partnership with educational institutions to promote digital literacy and efforts to develop metaverse experiences that can run on less powerful devices or through web browsers.

- Environmental impact: The metaverse's energy consumption and the increasing popularity of virtual reality (VR), could contribute to a significant environmental footprint.

Solution: The adoption of sustainable practices, and energy-efficient data centers and hardware. In addition is the exploration of eco-friendly VR technologies and renewable energy sources.

With these challenges notwithstanding, investments in the metaverse continues to grow, as more technologies are developed, as it has the potential to be a game changer for many industries. It is also not known yet if a dominant player will emerge in the metaverse, the future will surely tell. Furthermore, the use of digital twins to create replicas of cities or buildings will play a greater role, and as well as in traffic planning, data analysis, smart city planning and other use cases that primarily involve the virtual reality space.

The governments in the future will play a critical role in the metaverse, hence their need to be proactive in managing this technology (as a positive force for change and not a source of harm), since it has the potential to have a significant impact on legislation, taxation, citizenship and social impact.

BENEFITS OF METAVERSE

Some of the benefits of metaverse include the following [5, 12, 13]:

- Connectivity: It allows people from all over the world to interact with each other, which could lead to new communities, friendships, and business partnerships (i.e. for enriched socialization).
- Remote working: It allows people to work remotely more effectively, efficiently, and creatively, using technologies such as cloud computing, AR, and 3D modeling. Users can as well collaborate and communicate with colleagues and clients across distances and time zones, and access various tools and resources.
- Improved Education: The metaverse can improve learning experiences by offering (users) students more accessible, flexible, and interactive forms of education, such as online courses, simulations, and experiments (to watch live experiments), visit historical sites, museums, and ecosystems. Users can also learn from experts and peers, as well as explore different topics and cultures.
- Virtual tourism: People via metaverse can experience travelling without physically visiting the destination.
- Healthcare: It can help with rehabilitation and therapy by creating immersive experiences. It can as well allow healthcare providers to reach a global audience.
- Better collaboration: It allows people to interact with each other through avatars, that can help foster collaboration and teamwork skills.

- Virtual market: The metaverse allow people to attend virtual events, such as artist's live performances (i.e. enhanced entertainment) and business meetings.
- Freedom of expression
- Economic opportunities
- Metaverse gaming.

CONCLUSION

Doubtlessly, the metaverse is potentially capable to be a game changer to almost everything we know. The metaverse as the next step in the evolution of the digital space will not only allow users to create "information" but to also experience it, and possibly even to live in this created reality without the need for a physical world. Therefore, the potential of the metaverse to shape the future is said to be immense, while overcoming the challenges are very crucial for its successful realization. Through collaboration, innovation, and the commitment to user well-being, the metaverse can evolve into a transformative and inclusive digital real, which could offer new possibilities to impact on the way we live, work, play, and connect in the years or decades to come.

These challenges will provide open doors to opportunities for growth and progress that will ultimately shape the metaverse into a more vibrant and equitable space for all. More information can be obtained from the books [14, 15].

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Figure 1. Metaverse

Source:https://www.google.com/imgres?q=images%20on%20metaverse%20by%20wikipedia&imgurl=https%3A%2F%2Fupload.wikimedia.org%2Fwikipedia%2Fcommons%2Fc%2Fc6%2FSecond_Life_11th_Birthday_Live_Drax_Files_Radio_Hour.jpg&imgrefurl=https%3A%2F%2Fen.wikipedia.org%2Fwiki%2FMetaverse&docid=yABxf1sB0AwzcM&tbnid=oq3svCksNfBTzM&vet=1&w=1920&h=1003&hcb=2&ved=2ahUKEwjhrZ6pk_eKAxXafqQEHdzKDngQM3oECBkQAA

Figure 2. Metaverse

Source:https://www.google.com/search?sca_esv=a7f8fa7ff1536eeb&sxsrf=ADLYWIJXnAlO4GhvIQhNdGfki6SbNwW4IA:1736924315972&q=images+on+metaverse+by+wikipedia&udm=2&fbs=AEQNm0Aa4sjWe7Rqy32pFwRj0UkWd8nbOJfsBGGB5IQQO6L3JzWreY9LW7LdGrLDAFqYDH32tgteNhtZOxnGezgnEGc8k4dQgIn4td5_IKOvJAVYNMpBG_vzv09_z3ozdsV1574v_l4gmjMdaDFLpg9ELpUCM3lLnYw1mpVTSmqh03mtH24pA&sa=X&ved=2ahUKEwjYweumk_eKAxVoU6QEHWscFH0QtKgLegQIFRAB&biw=1036&bih=539&dpr=1#vhid=4H_eh371kgbTCM&vssid=mosaic

Figure 3. Meta platforms

Source:https://www.google.com/search?sca_esv=a7f8fa7ff1536eeb&sxsrf=ADLYWIJXnAlO4GhvIQhNdGfki6SbNwW4IA:1736924315972&q=images+on+metaverse+by+wikipedia&udm=2&fbs=AEQNm0Aa4sjWe7Rqy32pFwRj0UkWd8nbOJfsBGGB5IQQO6L3JzWreY9LW7LdGrLDAFqYDH32tgteNhtZOxnGezgnEGc8k4dQgIn4td5_IKOvJAVYNMpBG_vzv09_z3ozdsV1574v_l4gmjMdaDFLpg9ELpUCM3lLnYw1mpVTSmqh03mtH24pA&sa=X&ved=2ahUKEwjYweumk_eKAxVoU6QEHWscFH0QtKgLegQIFRAB&biw=1036&bih=539&dpr=1#vhid=CW-GLabPczdbuM&vssid=mosaic

Figure 4. Meta quest pro

Source:https://www.google.com/search?sca_esv=a7f8fa7ff1536eeb&sxsrf=ADLYWIJXnAlO4GhvIQhNdGfki6SbNwW4IA:1736924315972&q=images+on+metaverse+by+wikipedia&udm=2&fbs=AEQNm0Aa4sjWe7Rqy32pFwRj0UkWd8nbOJfsBGGB5IQQO6L3JzWreY9LW7LdGrLDAFqYDH32tgteNhtZOxnGezgnEGc8k4dQgIn4td5_IKOvJAVYNMpBG_vzv09_z3ozdsV1574v_l4gmjMdaDFLpg9ELpUCM3lLnYw1mpVTSmqh03mtH24pA&sa=X&ved=2ahUKEwjYweumk_eKAxVoU6QEHWscFH0QtKgLegQIFRAB&biw=1036&bih=539&dpr=1#vhid=e-9Mgg8HcGJJCM&vssid=mosaic

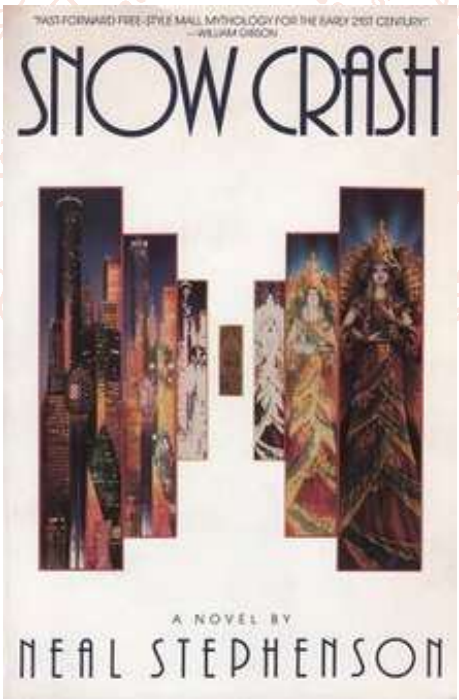

Figure 5. Snow Crash

Source:https://www.google.com/search?sca_esv=a7f8fa7ff1536eeb&sxsrf=ADLYWIJXnAlO4GhvIQhNdGfki6SbNwW4IA:1736924315972&q=images+on+metaverse+by+wikipedia&udm=2&fbs=AEQNm0Aa4sjWe7Rqy32pFwRj0UkWd8nbOJfsBGGB5IQQO6L3JzWreY9LW7LdGrLDAFqYDH32tgteNhtZOxnGezgnEGc8k4dQgIn4td5_IKOvJAVYNMpBG_vzv09_z3ozdsV1574v_l4gmjMdaDFLpg9ELpUCM3lLnYw1mpVTSmqh03mtH24pA&sa=X&ved=2ahUKEwjYweumk_eKAxVoU6QEHWscFH0QtKgLegQIFRAB&biw=1036&bih=539&dpr=1#vhid=is68ZZgvis68ZZgvKPWHcM&vssid=mosaic

Figure 6. Virtual Reality

Source:https://www.google.com/search?sca_esv=a7f8fa7ff1536eeb&sxsrf=ADLYWIJXnAlO4GhvIQhNdGfki6SbNwW4IA:1736924315972&q=images+on+metaverse+by+wikipedia&udm=2&fbs=AEQNm0Aa4sjWe7Rqy32pFwRj0UkWd8nbOJfsBGGB5IQQO6L3JzWreY9LW7LdGrLDAFqYDH32tgteNhtZOxnGezgnEGc8k4dQgIn4td5_IKOvJAVYNMpBG_vzv09_z3ozdsV1574v_l4gmjMdaDFLpg9ELpUCM3lLnYw1mpVTSmqh03mtH24pA&sa=X&ved=2ahUKEwjYweumk_eKAxVoU6QEHWscFH0QtKgLegQIFRAB&biw=1036&bih=539&dpr=1#vhid=OVJfB-qV9QJ4wM&vssid=mosaic

Figure 7. Virtual reality applications

Source:https://www.google.com/search?sca_esv=a7f8fa7ff1536eeb&sxsrf=ADLYWIJXnAlO4GhvIQhNdGfki6SbNwW4IA:1736924315972&q=images+on+metaverse+by+wikipedia&udm=2&fbs=AEQNm0Aa4sjWe7Rqy32pFwRj0UkWd8nbOJfsBGGB5IQQO6L3JzWreY9LW7LdGrLDAFqYDH32tgteNhtZOxnGezgnEGc8k4dQgIn4td5_IKOvJAVYNMpBG_vzv09_z3ozdsV1574v_l4gmjMdaDFLpg9ELpUCM3lLnYw1mpVTSmqh03mtH24pA&sa=X&ved=2ahUKEwjYweumk_eKAxVoU6QEHWscFH0QtKgLegQIFRAB&biw=1036&bih=539&dpr=1#vhid=eRfUhpFZx636ZM&vssid=mosaic

Figure 8. Immersion (virtual reality)

Source:https://www.google.com/search?sca_esv=a7f8fa7ff1536eeb&sxsrf=ADLYWIJXnAlO4GhvIQhNdGfki6SbNwW4IA:1736924315972&q=images+on+metaverse+by+wikipedia&udm=2&fbs=AEQNm0Aa4sjWe7Rqy32pFwRj0UkWd8nbOJfsBGGB5IQQO6L3JzWreY9LW7LdGrLDAFqYDH32tgteNhtZOxnGezgnEGc8k4dQgIn4td5_IKOvJAVYNMpBG_vzv09_z3ozdsV1574v_l4gmjMdaDFLpg9ELpUCM3lLnYw1mpVTSmqh03mtH24pA&sa=X&ved=2ahUKEwjYweumk_eKAxVoU6QEHWscFH0QtKgLegQIFRAB&biw=1036&bih=539&dpr=1#vhid=u85bYJxDK_BWHM&vssid=mosaic

Figure 9. Extended reality

Source:https://www.google.com/search?sca_esv=a7f8fa7ff1536eeb&sxsrf=ADLYWIJXnAlO4GhvIQhNdGfki6SbNwW4IA:1736924315972&q=images+on+metaverse+by+wikipedia&udm=2&fbs=AEQNm0Aa4sjWe7Rqy32pFwRj0UkWd8nbOJfsBGGB5IQQO6L3JzWreY9LW7LdGrLDAFqYDH32tgteNhtZOxnGezgnEGc8k4dQgIn4td5_IKOvJAVYNMpBG_vzv09_z3ozdsV1574v_l4gmjMdaDFLpg9ELpUCM3lLnYw1mpVTSmqh03mtH24pA&sa=X&ved=2ahUKEwjYweumk_eKAxVoU6QEHWscFH0QtKgLegQIFRAB&biw=1036&bih=539&dpr=1#vhid=UYZWeDRKqomYPM&vssid=mosaic

Figure 10. Non-fungible token

Source:https://www.google.com/search?sca_esv=a7f8fa7ff1536eeb&sxsrf=ADLYWIJXnAlO4GhvIQhNdGfki6SbNwW4IA:1736924315972&q=images+on+metaverse+by+wikipedia&udm=2&fbs=AEQNm0Aa4sjWe7Rqy32pFwRj0UkWd8nbOJfsBGGB5IQQO6L3JzWreY9LW7LdGrLDAFqYDH32tgteNhtZOxnGezgnEGc8k4dQgIn4td5_IKOvJAVYNMpBG_vzv09_z3ozdsV1574v_l4gmjMdaDFLpg9ELpUCM3lLnYw1mpVTSmqh03mtH24pA&sa=X&ved=2ahUKEwjYweumk_eKAxVoU6QEHWscFH0QtKgLegQIFRAB&biw=1036&bih=539&dpr=1#vhid=zhrUGzJcO60S8M&vssid=mosaic