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Metaverse: A Survey on Frame Work and Virtual Ecosystem

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Abstract

The phrase "metaverse" refers to a virtual environment or cosmos where users may communicate with one another and other online characters in real time. Science fiction literature first introduced the idea of a metaverse, but as more immersive and interactive virtual worlds are now possible thanks to technological advancements like virtual and augmented reality, blockchain, and artificial intelligence, the concept is becoming more and more relevant today.

A metaverse is a communal virtual shared area where individuals may interact with each other and digital things in real-time.

It is often generated through the fusion of physically persistent virtual reality with virtually augmented physical reality. It refers to the idea of a world made up of digital space and data that exists outside of the physical realm and in which people may interact, work, play, study, and create together.

Virtual reality, augmented reality, and 2D and 3D web-based spaces are just a few examples of the various virtual settings that may make up a metaverse. A number of devices, including smartphones, tablets, PCs, and VR/AR headsets, can be used to access a metaverse experience. It's also possible for the metaverse to be decentralised, with certain regions of the world liviMetaverse, immersive internet, aung on various servers and being administered by various groups or people.

In order to comprehend how to create, run, and control such a universe, much study is being done on the grandiose and still-under-exploration idea of the metaverse. The advent of the metaverse may have a profound effect on society, possibly altering the way we do business, engage with one another, and even govern ourselves.

Since the nineties, when it first became extensively utilised, cyberspace has been expanding. We have created several social networks, video conferencing applications, and computer-mediated virtual worlds, incorporating VR Chat, augmented reality tools (such as Pokemon Go), and games using nonfungible tokens (e.g., Upland). Such virtual settings have provided us with access to a range of digital revolutions, although fleeting and unconnected. The word "metaverse" was coined to properly describe the digital transition that is going place in every aspect of our physical lives. The metaverse's primary component is defined as a vast, organised, and all encompassing system, a shared, permanent realm.

This survey article, the first attempt to provide a comprehensive framework assessing the most current virtual world advancements within the context of trying to cut technologies and virtual world ecosystems, emphasises the possibility for a digital "big explosion." The transition from the existing Website to the metaverse is made possible by technology. As a result, we thoroughly examine eight technological solutions: Blockchain, Extended Reality, Machine

Learning, Edge and Cloud Services, and Future Mobile Networks. In terms of applications, the metaverse's ecology allows the human users to live and relax themselves within a shared, lasting, and self-sustaining world. In light of this, we talk about six user-centric components: avatar, content creation, social acceptance, security and privacy.

As our final step, we provide a detailed research strategy for the metaverse's growth.

Introduction

The term METAVERSE refers to a hypothetical synthetic environment related to the real world. It combines the prefix "meta" (implying transcending) with the word "universe" to represent this environment. The science fiction book Snow Crash by Neal Stephenson, which was published in 1992 [1], is where the term "metaverse" first appeared. According to Stephenson's depiction in this book, the metaverse is a sizable virtual environment mimicking the real world. Pan Hui and LikHang Lee are students at KAIST in South

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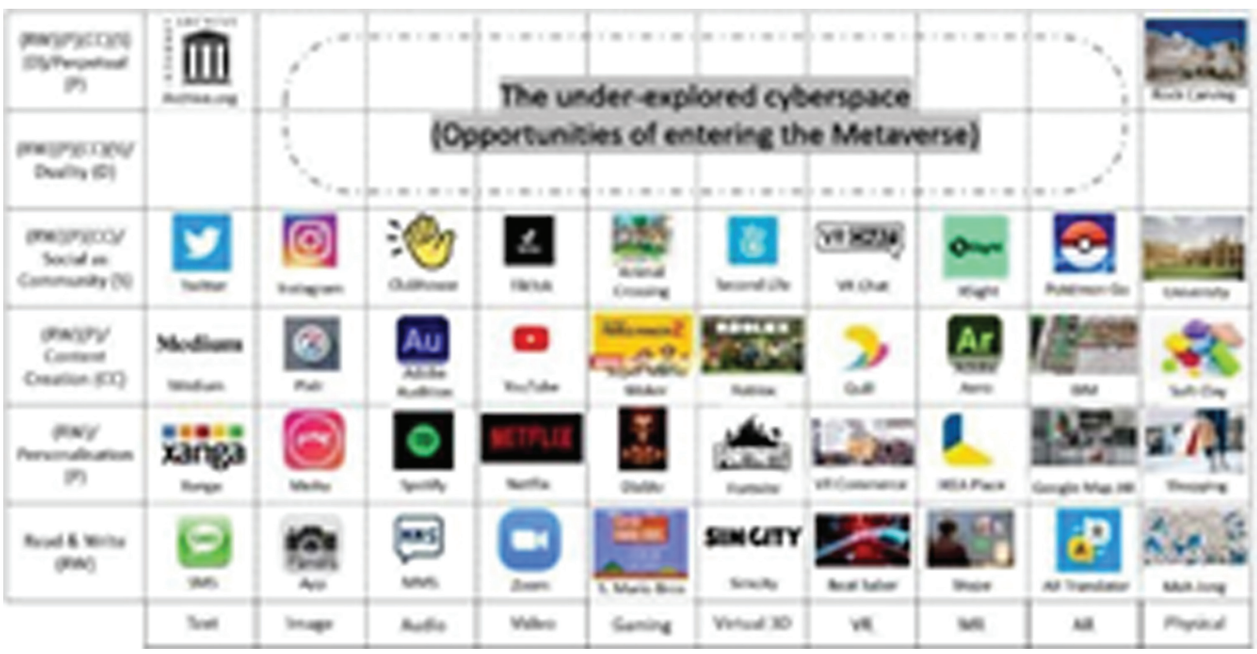
We propose a "digital twins-native continuum" based on duality, as depicted in Fig. 1. This metaverse vision depicts three stages of evolution. We begin with the idea of "digital twins" when our real settings are digitalized and have the ability to periodically reflect changes to their virtual equivalents. The "many" virtual worlds created by digital twins, which are digital recreations of the physical world, are said to be produced by the physical world, and "digital natives" are people who use their avatars to create new things in these virtual worlds. It's crucial to keep in mind that because of their limited interaction with one another and the outside world, these virtual worlds will initially have information silos. Then, slowly emerging from a wide landscape,they will gradually come together.

The final stage of the coexistence of physical-virtual reality, which is related to surreality, is the eventual merger of the digitalized physical and virtual worlds. The peculiar requirements of the metaverse, a permanent 3D virtual cyberspace where users communicate via digital avatars, are produced by such a connected physicalvirtual environment. Since its introduction, the phrase "metaverse" has been used to describe a computergenerated universe. Examples include "lifelogging" [2], "collective space in virtuality" [3], "embodied internet/ spatial internet" [4,"a mirror world," and "an omniverse": an environment for collaborating and simulating events [6].

In this article, the term "metaverse" refers to a virtual setting that combines the physical and digital universes. The fusion of extended reality and internet technology makes this possible (XR). The RealityVirtuality Continuum, which Milgram and Kishino [7] suggested, states that XR, which includes augmented reality (AR), mixed reality (MR), and virtual reality, mixes digital and physical features to varying degrees (VR). The metaverse scene from Snow Crash depicts similar contrasts between the real world and a reproduction of digital environments. Every user in the metaverse has a unique avatar that acts as a representation of their physical being and allows them to live a distinct existence in a virtual world that serves as a metaphor for their actual reality.

The three stages that the metaverse must go through to attain this duality are digital twins, digital natives, and lastly the coexistence of physical and virtual reality, or more specifically, surreality. The three phases' relationships are shown in Figure 1. Large-scale, extremely accurate digital representations and entities are referred to as "digital twins."

Fig. 2 shows that the information richness hypothesis and the transiencepermanence dimension are both present in the cyberspace environment of practical applications.



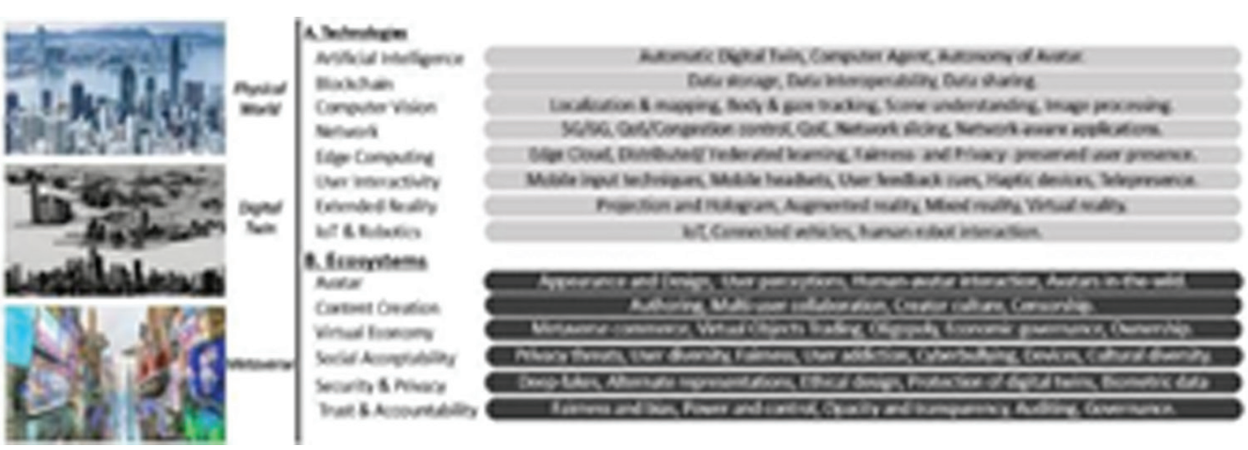
A few of the current uses include CAD for dangerous procedures supported by robots, intelligent city planning, industrial systems assisted by AI, and CAD for product design and building architecture. The creation of original content is the main goal of the second step, which comes after building a digital replica of the real world. Participants in digital works that might be represented by avatars in virtual worlds include content creators. These digital works might have links to their analogous physical works or they might just exist online. Interconnected ecosystems in culture, economy, and law (such as those governing data ownership) may be able to retain these digital inventions in the interim [15]. These ecosystems enable the creation of both material and immaterial contents and are comparable to the current rules and laws in contemporary society [16].

The study of these apps is still in its infancy, and it mostly focuses on the user interface's input methods and content creation tools [17]–[20]. The metaverse may develop into a persistent, autonomous virtual environment that coexists and communicates with the real world in its third and final stage. The result is that a variety of real-time activities can be carried out by an infinite number of concurrent users across many virtual worlds using the avatars, which serve as stand-ins for actual human users [9]. Unexpectedly, users can generate material and broadly distribute it throughout virtual worlds thanks to the metaverse's ability to facilitate connectivity between platforms that represent a variety of virtual worlds.

For instance, while maintaining their gameplay and identity, an user can develop content in a game like Roblox2 and then transfer it to another platform or game like Minecraft1. Through a variety of channels, including as content, avatars, computer agents interacting with smart devices in the metaverse, robotics, headmounted wearable displays, or mobile headsets, the platform can interact with the real world more deeply (like the Microsoft Hololens3).

One can contend that we already exist in the metaverse given the various theories of computer-mediated universe(s) stated above. We look at various cases to show that, even taking into account the threestage metaverse development roadmap, this is only partially accurate.

With the exception of GPS data, the Earth 3D map4 offers picture frames of the real world, but social networks only permit users to publish words, photos, and videos with a constrained number of user interaction options (such as liking a post). Video games are becoming more visually appealing and high-quality. Users can enjoy stunning visuals and realistic ingame physics in games like Call of Duty: Black Ops Cold War, which offers a sense of realism that closely reflects the real world. The largest user-created 3-D environment, according to speculation, is the 18-year-old virtual reality called Second Life.



Users can create and customise their own 3D settings and live lavishly in such a virtual environment.

The incompatibility of video games is still a problem. VRChat6 and Microsoft Mesh7, two innovative technologies that make use of virtual surroundings, provide enhanced interactions that mimic virtual settings for social gatherings and online meetings. These virtual venues, nevertheless, are ephemeral; after gatherings and meetings, they disappear. Virtual goods have also been introduced into augmented reality (AR) games (like Pokemon Go '8) without taking the ideas of digital twins into account. Figure 2 provides another evidence of the enormous distance between the metaverse and the contemporary internet. Superseding relationships can be seen in both the Left-to-Right (e.g., Text Image) and Bottom-to-Top (e.g., Read and Write(RW) Personalisation) axes.

From text through image, music, video, gaming, virtual 3D worlds, virtuality (AR/MR/AR, following Milgram and Kishino's Reality-Virtuality Continuum [7]), and finally the real world are displayed on the x-axis in decreasing order of information richness. Between transience (Read and Write, RW) and permanence, the y-axis depicts user experience (Perpetual, P). To illustrate this superseding relationship in the y-axis, we highlight a number of examples. The user experience is the same as the user advances to the Read & Write level. Any time someone uses Zoom to send an SMS or make a call, they have the same experience as every other user before them. Users can tailor their exploration of online

resources like Spotify and Netflix thanks to personalization.

When a player reaches a new level, they can actively participate in content production. For instance, Super Mario Marker enables users to design original game levels (s).

Under the conditions of personalization and content growth, the cyberspace becomes a social community once a significant number of user interaction records are still present.

But as far as we know, there aren't many practical applications that can achieve the highest degrees of duality and perpetual motion (according to the concepts mentioned above in Figure 1).

Other technologies, such as those unrelated to the Internet, social networks, gaming, or virtual environments, should be taken into account in order to realise the metaverse. The emergence of augmented reality, virtual reality, highspeed networks, edge computing, artificial intelligence, and hyperledgers is the foundation of the metaverse (or blockchain).

We define the metaverse's guiding principles and its approaching technological singularity from a technical perspective. In order to provide a critical viewpoint for the development of the metaverse, which consists of eternal, shared, concurrent, and 3D virtual locations concatenating into a perceived virtual universe, this essay evaluates the existing technologies and technical infrastructures. The article makes three contributions.

1) In order to realise the metaverse, we provide a technological base.
2) The article illustrates the mismatch between cutting-edge technology and the needs for building the metaverse by examining cuttingedge technologies that are enabling the establishment of the metaverse, such as edge computing, XR, and artificial intelligence.
3) Based on our review, we suggest research potential and challenges for the metaverse's latter stages. The goal of this work is to present the first in-depth analysis of the metaverse from both a technological and ecological perspective. The main themes for the issues that are addressed in the technological and ecological contexts are covered in the survey study's keywords, as shown in Figure 3's summary of the survey paper.

Before placing our review article in Section II in accordance with the most recent survey(s) and significant studies, we first describe our justification in the following section. As a result, we talk about our metaverse paradigm while considering both technological and environmental concerns.

Ideas' Sources and Similar Work

Science fiction has long explored the idea of a "metaverse," but it has only lately gained popularity thanks to Internet businesses and specialists in augmented reality and virtual reality.

The concept that new and more immersive forms of human connection, communication, and expression might be made possible by technological advancements is at the heart of the many different reasons why a metaverse might be created. New prospects for social interaction, business, education, and entertainment would be made possible by these developments, which would go beyond the bounds of the physical universe.

Regarding related work, there are several active projects and initiatives that are concentrated on developing various elements of a metaverse. For instance, businesses like Facebook, Google, and Microsoft are making investments in the creation of augmented reality and virtual reality technologies that may be utilised to produce immersive metaverse experiences. Platforms for the production and dissemination of metaverse apps and experiences are being developed by other businesses, like Epic Games.

There are also research groups focused on various aspects of the metaverse in fields like computer science, computer graphics, human-computer interaction, and others that aim to provide the metaverse with the technological foundational elements it needs to exist, including: spatial computing, distributed systems, open standards, and more.

Additionally, a number of metaverse research initiatives have been put up recently, frequently taking inspiration from already-existing virtual worlds like Second Life and massively multiplayer online games like World of Warcraft.

In general, the goal of the work being done in the field of metaverse is to develop a new kind of digital environment where individuals may engage and interact with virtual things and other people in a way that is more immersive, permanent, and seamless than what is now achievable.

Persistence is a key notion in the metaverse, which describes how the virtual environment and its contents will continue to exist and be available to users even when they are not signed in. This will provide a more seamless experience and give users the option to resume their previous metaverse activities.

Decentralization, or the idea that the metaverse wouldn't be run by a single body and instead be based on open standards and a decentralised architecture, would be another important feature. This would allow anyone to take part and build on top of the system. Additionally, this permits increased scalability, security, and privacy.

In order to enhance the sensation of presence and social interactions, there has also been an increase in interest in developing more realistic avatars for the metaverse. These avatars should accurately reflect the user's personality, behaviours, and expressions.

The concept of using the metaverse for more useful purposes is yet another intriguing and significant feature. In recent years, it has been investigated how to use the metaverse as a tool for online learning, virtual events, and distant work.

The Metaverse is a place where all kinds of digital experiences, interactions, and material take place, so there will be a tremendous quantity of data to manage, process, and analyse. This will provide new problems in areas like big data, artificial intelligence, and machine learning.

In conclusion, the creation of the metaverse is a multidisciplinary endeavour that calls for advancements in technology, design, and user experience as well as a profound comprehension of the social and economic ramifications of such a place.

XR and Metaverse Connection

A broad term known as "extended reality" (XR) refers to numerous digital technologies used to produce immersive experiences that can mimic or improve features of the actual world. There are three of these technologies: mixed reality, augmented reality, and virtual reality (MR).

The phrase "metaverse" describes a fictitious world in which individuals may communicate with one another as well as with virtual items and places in a

common digital setting. It is frequently viewed as the internet of the future, where users would be able to engage in a variety of activities and communicate socially with others.

As they may be used to generate and fill the virtual environments and experiences within the metaverse, XR technologies are anticipated to play a significant part in its development. While AR may be used to superimpose digital data and objects onto the actual environment, VR, for instance, can be used to build entirely immersive virtual worlds. MR may be used to smoothly merge the actual and virtual worlds such that they coexist in the same area.

XR technology may be used to enable other activities within the metaverse in addition to building the virtual environments and experiences that make it up. For instance, users can connect with others who are also present in the metaverse by using VR headsets to completely immerse themselves in virtual surroundings, such as games or social spaces.

In the actual world, AR may be utilised to create interactive and context-aware experiences, for instance in the ecommerce, educational, and entertainment industries. People may engage with both the actual and digital worlds in a seamless way because to MR.

Other technologies, like blockchain, which may be used to build secure and decentralised networks for storing and exchanging information and assets inside the metaverse, are also significant to the development of the metaverse. Furthermore, developments in fields like artificial intelligence and machine learning can contribute to the creation of more responsive and lifelike virtual people and settings inside the metaverse.

It's important to remember that the idea of a metaverse is still at the conceptual stage, and many experts think it will be years, if not decades, before the metaverse becomes a reality. In order to make the metaverse a secure environment for people to communicate and engage in, several legal and ethical concerns still need to be resolved.

Parts of XR: 1)Virtual Reality

An immersive, interactive simulation of a three-dimensional environment using computer technology is known as virtual reality (VR), and it may mimic or improve some characteristics of the actual world. Most often, a VR headset is used to view these simulations. This device has a display and a number of sensors that follow the user's head motions and alter the visual perspective appropriately.

When wearing a VR headset, users may interact with a computer-generated environment via hand-held controllers, vocal instructions, or even body motion tracking. The environment being mimicked might be wholly artificial or entirely realistic, based on actual places or entirely created by computers.

VR technology has been applied to many different fields, including as research, education, and entertainment (such as video games and movies), as well as training for the military and medical professions (such as studying the effects of virtual environments on human behavior). In addition, it's employed in treatment for things like physical recovery, cognitive therapy, and exposure therapy for phobias.

In addition to the applications I outlined before, VR technology is also being employed in industries like architecture, product design, and real estate. Using VR, architects and designers may construct virtual representations of their structures and goods and provide customers or other stakeholders an immersive experience. Virtual reality (VR) technology in real estate enables prospective buyers to take virtual tours of homes before they are constructed, giving them a realistic feel of the size and layout, which can be useful for distant or foreign purchasers.

Tourism and travel are another industry where VR technology has showed potential. With VR, individuals may explore locations that are challenging or impossible to visit in person, such as the deep sea or other planets, as well as iconic monuments, historical sites, and other tourist spots.

Additionally, teleconferencing and remote collaboration are being done with the use of VR technologies. No matter where they are physically, it enables users to connect in virtual spaces and engage in realistic interactions with real-world and virtual items. This may be especially helpful in fields where team members may be spread geographically, such engineering, construction, and product design.

It's important to remember that VR technology is continually developing and getting better. Developments in computer graphics, tracking systems, and display technologies have made VR experiences more immersive and realistic. Additionally, the price of VR equipment is coming down, making it more affordable for both individuals and businesses.

Augmented Reality

A technique known as augmented reality (AR) overlays computer-generated pictures, movies, sounds, or other data on top of how a user sees the actual environment. AR uses digital content to improve or supplement the user's actual surroundings, as opposed to virtual reality (VR), which generates a wholly fabricated world for the user to experience.

Marker-based and markerless AR are the two primary types. In marker-based AR, the display of digital material must be triggered by the usage of particular visual markers or tags, like QR codes. Markerless AR, on the other hand, does not require markers and instead integrates digital material into the user's surroundings using a variety of data sources, including GPS, sensor data, and computer vision.

AR is being used in a number of industries, including education, entertainment, and business. Anatomy models that students may examine in 3D are only one dynamic and engaging learning experience that can be made with augmented reality in education. AR may be utilised in the entertainment industry to create interactive experiences, such as those seen in mobile games, theme parks, and live events. In the workplace, AR may be applied to projects like training, product visualisation, and maintenance.

Retail, advertising, and e-commerce are some industries that employ AR technology. Retailers make advantage of AR to improve the shopping experience, including putting items on and seeing furniture in a space. Companies in the advertising and e-commerce industries utilise augmented reality to give customers engaging and immersive experiences, such as by employing augmented reality to exhibit items in a virtual setting.

It's important to remember that AR technology is still in its infancy and that, as it develops and becomes more accessible, it is anticipated to have a huge influence on numerous sectors. It's also anticipated that it will be combined with other technologies, such 5G, AI, and the Internet of Things, to provide consumers a more seamless and natural experience.

Mixed Reality

The phrase "mixed reality" (MR) refers to a range of technological advancements that combine the actual and virtual worlds, enabling the development of settings and experiences that are "mixed" between the two. MR may smoothly combine the virtual and real worlds, allowing them to cohabit in the same environment, and is frequently thought of as a combination of both augmented reality (AR) and virtual reality (VR).

Depending on how much the user interacts with and is immersed in the actual environment, there are many forms of MR.

Augmented Reality (AR) occupies the lower end of the spectrum and offers users with digital data and virtual items that are superimposed over their perception of the actual world.

Virtual Reality (VR), at the upper end of the spectrum, fully removes the user from their surroundings and immerses them in a digital environment.

There are differences in the centre of the spectrum, such as:

Augmented virtuality (AV), which combines the real and virtual worlds, allows users to walk around and interact with a virtual environment while displaying some of the real-world components.

By giving it more context and information, Enhanced Reality (ER) aims to improve how the user perceives the real world.

MR is employed in a variety of industries, including gaming, entertainment, training, and manufacturing. MR may offer more engaging and immersive game experiences. In the workplace, MR may be utilised to help with duties like product visualisation, maintenance, and training.

Multiple industries, including gaming, entertainment, training, education, and business, use MR. With MR, gaming may provide more engaging and immersive experiences. In the workplace, MR may help with duties like training, maintenance, and product visualisation.

The Framework

Various frameworks are being created or suggested to assist direct the construction and administration of the metaverse. These frameworks can aid businesses, developers, and other stakeholders in understanding the potential and difficulties related to the metaverse. They often include a wide variety of subjects, including technology, governance, and economics.

The Metaverse Roadmap, created by Mark Kingdon and Andy Rifkin, is one example of a framework for the metaverse. It defines a number of technological, commercial, and policy milestones that must be attained in order to produce a seamless and immersive metaverse experience. The roadmap offers a thorough blueprint for developing the metaverse, covering governance, infrastructure, and user experience.

Another illustration is The Metaverse Stack, a project that intends to create an open and decentralised metaverse by creating a collection of open-source software tools and protocols that programmers may use to create decentralised apps and services for the metaverse.

In addition, "The Metaverse" by Adam D.

Arvidsson and Emiliano Gandolfi proposes a framework for the metaverse, highlighting the significance of developing an open and decentralised platform as well as constructing a metaverse that is inclusive and accessible to all.

Anthony D. Webster's "Designing for the

Metaverse: A Framework for Virtual World Design" It offers a thorough method for designing virtual worlds, taking into account the creation of virtual worlds, characters, and interactions.

These are only a handful of the numerous current projects, organisations, and research teams creating frameworks and recommendations for metaverse development. To guarantee that the metaverse is beneficial to society as a whole, it must be developed in a way that is inclusive, accessible, and respects individual privacy and liberty.

User Interactivity

An important feature of the metaverse is user interaction, which describes how users may communicate with one

other and interact with virtual items. This might include a variety of activities including speaking, mingling, working together, playing games, and more. A key feature of the metaverse is user interaction, which enables users to interact with the virtual environment and other users in a simple and straightforward way.

User engagement is possible in the metaverse in a variety of ways. One of the most typical ways is by using virtual reality (VR) and augmented reality (AR) technologies, which let users see, hear, and interact with the virtual world in a way that is comparable to the actual world. Users will be able to engage with one other and virtual items in real time by using these technologies to build immersive and interactive virtual worlds.

Utilizing 2D and 3D web-based environments, which can be accessed by a number of gadgets including PCs, cellphones, and tablets, is another technique to encourage user interaction. Even though they may not be as immersive as VR/AR, these kinds of environments nevertheless permit some degree of engagement, such as text and voice conversation, object manipulation, and other interactive aspects.

Furthermore, improvements in natural language processing, machine learning, and artificial intelligence (AI) are essential in enhancing user interaction in the metaverse because they enable virtual characters to engage in natural conversation, comprehend natural language commands, and adapt to users' preferences, resulting in a more seamless and personalised experience.

In general, user interaction is a key component of the metaverse, and platforms, apps, and technology should all be developed so that users may engage with the virtual environment and one another organically and effortlessly.

Metaverse Merits Benefits

A "metaverse" is a term used to describe a shared virtual environment where users may communicate and interact with virtual items and experiences. The advantages of such a location can include:

Enhanced social relationships might result from people being able to communicate with one another in a common virtual area regardless of where they are physically located.

Accessibility: People with physical impairments or those who live in distant locations could have easier access to the metaverse's social and educational possibilities.

The metaverse would provide individuals new ways to express themselves and come up with new kinds of entertainment.

New chances for trade and business: Companies might create a presence in the metaverse, perhaps reaching new consumers and developing new types of commerce.

The metaverse would enable virtual learning experiences and simulations, opening up new possibilities for education and professional training.

It's important to note that additional technological development in the fields of virtual reality, augmented reality, and other related fields is required in order to build the metaverse as it is envisioned in science fiction.

Conclusion

In summary, the metaverse is a proposal for a virtual environment where users may interact with each other and digital things in real-time, fusing the real and virtual worlds. It is a developing industry that makes use of cutting-edge technologies including blockchain, artificial intelligence, augmented reality, virtual reality, and more.

The idea of the metaverse is still in its infancy, and a number of alternative frameworks are being put up or built to aid in its formation and administration. These frameworks can aid businesses, developers, and other stakeholders in understanding the potential and difficulties related to the metaverse. They often include a wide variety of subjects, including technology, governance, and economics.

In addition, a key component of the metaverse is user interaction, which describes how users may communicate with one other and interact with virtual things. This can encompass a variety of activities, including as speaking, interacting with others, working together, playing games, and more. A key feature of the metaverse is user interaction, which enables users to interact with the virtual environment and other users in a simple and straightforward way.

It's critical that the metaverse be treated with a long-term perspective, taking into account ethical, social, and legal factors, as it is a complicated idea that is still in its early phases. User interaction should be at the heart of this vision since it is the fundamental experience for users and a necessary element for the metaverse to realise its full potential. The development of the metaverse should seek to offer an inclusive, accessible, and safe virtual environment for everyone.