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The Future of Metaverse in the Virtual Era and Physical World

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The Future of Metaverse in the Virtual Era and Physical World

Springer

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Preface

The notion of the Metaverse is profound. Originally used to describe Stephenson's vision of a fully immersive 3D virtual world in 1992, the phrase has since expanded to describe the real-world objects, characters, interfaces, and networks that create and interact with such worlds. The term Metaverse, a combination of the words meta and universe, describes a virtual universe in which avatars participate in political, economic, social, and cultural activities.

There is a history behind the rise of the Metaverse, and it involves several patterns in the exponential increase of technology's capacity and performance. As a robust Metaverse takes shape, it will influence the evolution of other fields of technology that might at first glance seem unrelated to the Internet. It's crucial to bridge the gap between the current metaverse's features, which are mostly Web 2.0 traits, and the forthcoming Web 3.0 traits.

There are key ways in which the Metaverse is apart from Augmented Reality and Virtual Reality. Metaverse stands out as a service with more long-term, meaningful content than Virtual Reality, which is why it's getting so much attention in the research world. In order to strengthen social meaning, it is crucial that the Metaverse provides a scalable environment that can support a large number of users.

The potential for the metaverse to greatly increase consumers' access to the market from emerging and frontier economies is quite exciting. Several technologies, such as always-on mobile connectivity, Artificial Intelligence, the Internet of Things, and blockchain technology with the use of virtual currency to bridge the gap between the virtual and the real worlds, are strengthening the metaverse.

In light of the currently available studies focusing on the metaverse, this field of study is still in its infancy. Consequently, more studies should be searched in the metaverse and its applications. Metaverse growth is still mostly uncharted by academics. As technology advances, it's possible that more of the Metaverse's capabilities will become available, and the virtual worlds will continue to get closer and closer to being a true universe. This book is an attempt to build a bridge between many cutting-edge fields that may help the metaverse advance. This book's secondary objective is to examine the most recent developments in the fields of the user interface, implementation, and application inside the Metaverse.

The contents of this book are divided into three parts. Part I is devoted to the Metaverse concept, history, origin, and applications. Part II is concerned with the role of emerging technologies such as Artificial Intelligence, the Internet of Things, and digital twins. Part III presents the role and use of cybersecurity such as blockchain, privacy, and security technologies.

The authors of this book would like to thank all authors of this book for their contributions and research studies.

Cairo, Egypt

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Metaverse and its Applications

Development of Cognitive Intelligent Mechanism for Sustainability of Bigdata: A Future Shape of Metaverse

Debabrata Datta and Madhubrata Bhattacharya

Abstract Metaverse is proposed as a mapping of virtual world to the physical real world using cognitive intelligence hybridized with artificial intelligence. Cognitive intelligence will be used to develop a meta brain of virtual world through mapping of functional state spaces and artificial intelligence will be shaping the intelligence of various functions due to which it will be possible to have transition from one state to other. Conceptual space of metaverse like other conventional spaces such as Hilbert space, Sobolov space and Euclidian space will be handling big data with full proof security like Blockchain. Cognitive intelligence and Artificial intelligence both when combined together will develop a general intelligence known as Artificial General Intelligence. Sustainability of big data may be an issue for future shape of metaverse but that will be achieved using Artificial General Intelligence. Human centric functional modeling using cognitive intelligence is described in detail in the chapter. Various devices that can be used for future shape of metaverse are demonstrated. Virtual reality, augmented reality, extended reality and mixed reality are backbones of future shape of metaverse and all these concepts are presented detail in the chapter.

Keywords Cognitive intelligence · Artificial intelligence · Metaverse · Big data · Virtual reality

1 Introduction

Industry of various sectors like healthcare, medical, education, agriculture, electronics and other engineering and scientific fields needs an innovative automation for handling big data with its sustainability property. The fulfilment of this objective is

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only possible when one understands the fundamentals of metaverse, a combination of meta and universe. Conceptually, the metaverse is a future generation technology that goes beyond our current universe. In 1992, Neal Stephenson used the word 'Metaverse' in Snow Crash [1], his science fiction novel, where humans in the physical world live in a parallel virtual world known as metaversethrough digital representation of users. But the technology was not fruitful enough to reinforce his thought and that is why it did not take any shape. In 2003, the virtual game 'Second Life' was developed, where a virtual world was introduced with all its social elements. Artificial intelligence (AI), Blockchain (BC), Extended Reality (XR), Virtual Reality (VR), Cognitive Intelligence (CI), Brain Informatics (BI) and Data Science (DS) have developed a new generation of technology. Among these methods AI, BI, CI and DS manifested great significance of big data processing to increase the immersive environment and empower the avatars to possess human like intelligence (e.g., Humanoid). Many researchers have done lots of studies on AI which are mainly focused on physical world. But for metaversethe AI should make people enable to navigatevirtual environment and real world with augmented reality.

Looking at the limitations of offline social activity during period of Covid-19 (2019–2020), the year 2021 is reported as the first year of the metaverse. In October 2021, Mark Zuckerberg rebranded Facebook as Meta because this social media generates a substantial amount of new data. Metadata is defined as a set of data that generates another set of new data. Mathematically, metadata if belongs to a universe, then it will create metauniverse or metaverse and following this concept of metaverse our life will change drastically. Big companies have started investing to create the metaverse technology. For an example "Activision Blizzard", a video game company is bought by Microsoft for $68.7 [2] billion for gaming expansion in the metaverse. In recent years an outburst of metaverse happened in 3D gaming. Virtual world has been built more creatively using improved big data storage, graphic processing unit-GPU and wireless network. AI has been deployed in different domain like neural interface, natural language processing etc. Layered architecture of metaverse can be organized into following seven layers [3] (see Fig. 1).

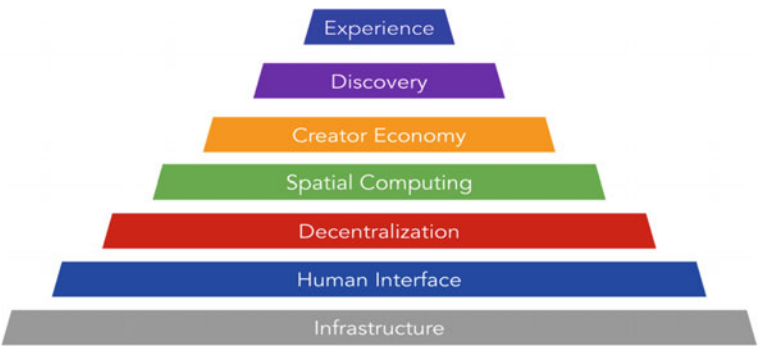


Fig. 1 Seven layers of metaverse platform

(a) Infrastructure: WiFi, data center, clould, CPUs, GPUs, 5G, 6G.
(b) Human Interface: smart watch, smart phone, smart glasses, display device (mounted on head), acoustic device.
(c) Decentralization: AI agents, block chain, edge computing.
(d) Spatial Computing: Virtual Reality (VR), Augmented Reality (AR), Extended Reality (XR), multitasking.
(e) Creator economy: E commerce, design tools, asset market.
(f) Discovery: avatar, virtual stores, advertising networks.
(g) Experience: learning, gaming, shopping, working.

Technically metaverse can be illustrated by a combination of information technology and big data. All the information and activities of the user in the metaverse are taken down as data. Number of users if increasesthen huge amount of data generation takes place which further establishes a big data network. With an appropriate route of security such as blockchain one can achieve the sustainability of big data and subsequently we can create a metaverse that can shape the future world. However, sustainability of big data is an issue for creation of metaverse. Conventional method of handling big data is not sufficient for its sustainability and for that reason an innovative intelligent technique that is combination of AI, BI and CI is proposing for creation of future metaverse. The data grows continuously and are processed by data processing technology with appropriate security using blockchain technology [4, 5]. Big data is defined as the set of five V's explaining each V as (a) volume of data, (b) velocity (rate at which data generates), (c) variety (text, image, numerical), (d) veracity (uncertainty of data) and (e) value (worth to analyze). Therefore, big data cannot be analyzed by conventional data processing tools due to its complexity, massive structureand diversity [6]. Analysis of big data generally needs three models such as (a) descriptive model, (b) predictive model and (c) prescriptive model (optimized). Sustainability of big data needs an intelligent model wherein cognitive intelligence along with artificial intelligence play a major role [7]. Therefore, neurogenerative machine learning techniques can be developed for future shape of metaverse. Data access, velocity and volume are taken care of by the storage technology. Quality of data is maintained by the cleaning part. Data analysis and visualization extract the values from the big data and accordingly human activities are predictively guided. The large amount of information may introduce specific difficulties which can be resolved by the big data technology. Thus big data has become essential to the victorious application of the virtual world. That is why basic thrust of this article is to present role of cognitive intelligence and artificial intelligence to sustain big data for creation of future metaverse. There have been several research works connecting metaverse with big data. Ooi et al. [4] explained the theories to express from the data outlook, the connectivity betweenthe real and virtual world. Cai et al. [8] illustrated the mathematics providing the solution to the computer and data intensive network in the metaverse. Smart phone data has been used to create metaverse by Park et al. [9]. A smart medical system is carried out by Yang et al. [10] which is formed on AI, Metaverse and data science.

We have organized this chapter in the following way: The fundamental concept of metaverse and the requirement of big data to ornament it are explained in Sect. 2. Sustainability of big data using cognitive intelligence, human-centric functional modelling and artificial intelligence is described in the Sect. 3. In the Sect. 4 different devices needed to conceptualize the future shape of metaverse is presented. Looking towards the societal benefits as an application of future metaverse, paradigm shift in education pattern (changes in teaching and learning atmosphere) is clearly exhibited in the Sect. 5. Since virtual reality, augmented reality, extended reality and mixed reality are backbone of future shape of metaverse, the Sect. 6 presents their role and also discusses the limitations of virtual reality in the context of establishment of future metaverse.

2 Fundamentals of Big Data and Metaverse

Big data is defined as that dataset which possesses large volume, velocity, variety, veracity and value. Big data addresses the cost effective information for decision making. Handling of big data pertaining to various industries is essential to develop corresponding models which are mainly descriptive, predictive and prescriptive. Predictive models provide forecasting of data, especially in the domain of financial sector, climate change and geology. Prescriptive models are built using optimization techniques and these models can be implemented to execute decision making problem, risk management and risk mitigation problems. Characteristics of big data can be further written as: (1) Volume: it refers to the amount of data. Data size is being increased from bytes to Yottabytes. The sources of big data can be obtained either from internet or from sensors or from field survey, (2) Velocity: it refers to the speed of data capturing and data processing, (3) Variety: this refers to data of structured, unstructured and semi-structured variety, (4) Veracity: this refers to biases, noise and uncertainty of data and (5) Value: this refers to the value that big data can provide, and it relates directly to what organizations can do with that collected data. A schematic diagram of big data is a shown in Fig. 2.

Big data plays an important role to create metaverse. Basically, metaverse is defined as an online environment in which users use their 3D digital avatars to engage in virtual activities similar to real-world activities such as developing lands, owning digital assets, and even utilizing digital cash that can be converted into virtual or real transactions. In short, metaverse is basically virtual reality enabled 3D internet which is our future internet. It is obvious that concept of virtual reality (VR) and augmented reality (AR) is required to know to build metaverse because the technology behind metaverse is the combination of VR and AR that develops extended reality (XR), platform on which metaverse stands. Applications of metaverseare based on different layers which are shown in Fig. 3. A large amount of data is generated in every layer on which the connectivity between the layers depends. So the operation of big data is very important for the metaverse market [11]. Big data technology creates the junction between the real world and the virtual world. As both the worlds are integrating

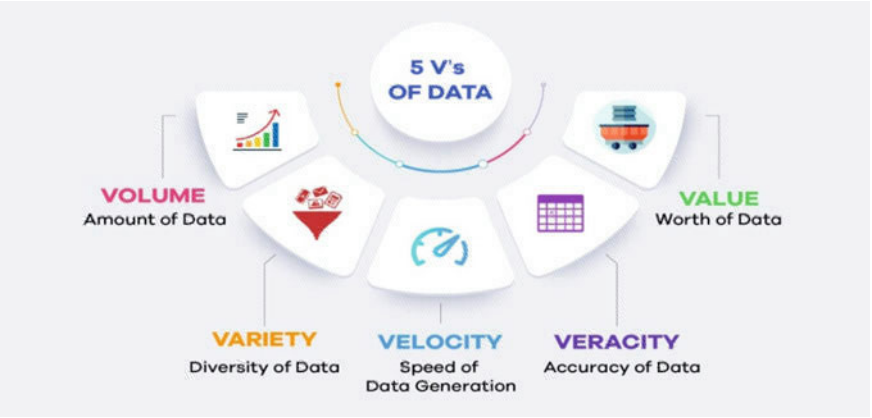


Fig. 2 '5 Vs' of Big Data

very fast, metaverse is emerging, too. Big data possess the following conditions to encounter the future metaverse. A typical market map of metaverse is as shown in Fig. 4.

Communication: Communication and storage can be combined with data using the technology of 5G and 6G [12, 13]. Related hardware and software that will surely be recommended by the metaverse era are big data, VR, AR, AI, cloud computing, block chain, cyber security etc.

Storage: Data will be stored in a decentralised process for unchallenging expansion, trouble free execution, standardized storage [14] and multi-copy consistency. Some applications need huge storage like AR, VR, streaming. This requirement will increase significantly in future digital world. Therefore the role of big data in metaverse is clearly visible.

Computational power: The computational power is very important as the conventional computation techniques are insufficient to fulfil the huge demand of the future.

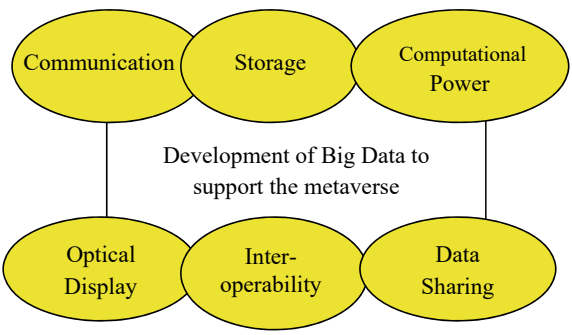


Fig. 3 Six aspects of big data to support the metaverse

Fig. 4 Market map of the metaverse [11]

Thus metaverse needs computational power urgently where big data ensure the guarantee. The evolution of big data computing power will increase data interaction with which the creation of the metaverse will be accelerated [15].

Interoperability of data: In the metaverse the user creates their digital avatars to create their identity. These avatars can move across different platforms. This experience can be achieved uninterruptedly by data interoperability [16]. In other words in the metaverse an entity will collect the data and the data will move across multiple platforms. In metaverse different sub-metaverses exist. Data should be able to share information across the sub-metaverses to provide the users seamless experience [17].

Optical Display: The presentation of contents in the metaverse is important. For this purpose AR/VR devices, ultra HD, high speed accuracy of data transmission play important role. AR/VR need image processing and display. With the help of cloud storage and cloud computing, the development of cloud VR and AR can be promoted. This will greatly reduce the requirements for terminal equipment and make the equipment portable and easy to carry. In addition, cloud servers equipped with cloud storage and cloud computing technologies can make dataintensive and computing-intensive tasks more efficient and orderly [15].

Data sharing: Useful information can be provided to the service providers by sharing the data in the metaverse. Marketing and advertising people analyse the behavioural data to save the operational cost. Marketing developers improve the product based on user feedback. The consumers store a large amount of sensitive data in the metaverse. Secure data sharing system is required for the information exchange. Therefore blockchain based decentralized framework of data management is more appropriate for the metaverse [18].

3 Sustainability of Big Data

All over the world every day millions of digital data are generated for its post use by various scientific, industries and administrative companies. This large volume of data as collected, processed and utilized to discover the knowledge behind it is called Big Data. It is evidenced that big data is undoubtedly an important source of information for the private sector. Big Data plays a vital role in sustainable growth from the societal and institutional sphere. Basically, we need to transform big data into sustainable form. Now the question is which technology can be implemented for sustainability of big data?

To answer this question, let us first define Sustainability. Sustainability can be defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs." Sustainability is based on four features namely social, environmental, economic and cultural. The social aspect ensures the requirement to serve ourselves and others with respect. Environmental sustainability is to save the environment to maintain the nature and lives on the earth. Economic sustainability maintains the requirement to use the in hand resources in its best possible way for the value addition to human lives. Diversity and values are shared and nurtured by the cultural aspects.

Sustainable development by big data is possible due to its generation or collection, verification and correlation with information on social elements (light intensity per household, telephone calls, social networks activity, use of transport, etc.). Nowadays, there are several examples of the use of Big Data applied to sustainable development: The range and diversity of heterogeneous data is expressed in terms of variety. Velocity implies the speed with which the data are being gathered. Veracity portrays the truth or conformity of the data [19, 20]. The variability can be considered explaining the continuous changing characteristics of the data. With the technological growth the efficiency of creating and sharing information has significantly enhanced from 0.3 exabytes in 1986 to 65 exabytes in 2007 [21]. Almost everything depending on technology is now influenced by the bigdata analytics. Sustainability issues are not exceptions.

The objective of the application of big data to the environment is to achieve a better world for all. It has already become a powerful drive for observing and managing sustainable development. Big data can also help to ensure environmental and economic viability in the supply chain by establishing most efficient transit between raw material allocation, production areas, warehouses and customers. In the same way, the movement path of forklifts and other vehicles can be timely updated in the most efficient way through the real time monitoring of stock despatches thereby minimising fuel and energy consumption [22].

3.1 Sustainability of Big Data Using Cognitive Intelligence

Cognitive intelligence is nothing but human mental capability and understanding through thinking and experiences. Knowledge generation using existing information is the main physics of cognitive intelligence. It also includes other cognitive activities such as awareness, learning, recollection, judgment and reasoning. It can be said that cognitive intelligence is the ability of the human brain to digest information and form intelligence and meaning. Hence, measuring cognitive intelligence is crucial for organizations or industry handling big data for various types of jobs including recruitment and performance evaluation in the domain of teaching and learning, as it determines whether an applicant has the proneness to perform well at work that needs significant intellectual ability. It is said that cognitive intelligence uses practical knowledge that already exists and grows with implementation and experiences. Cognitive Computing facilitates detailed guidance towards building a new class of systems that learn from experience and derive insights to unlock the value of big data. Cognitive computing is the creation of self-learning systems that use data mining, pattern recognition and natural language processing to mirror the way the human brain works. The purpose of cognitive computing is to create computing systems that can solve complicated problems without constant human oversight. Today's cognitive computing solutions build on established concepts from artificial intelligence, natural language processing, ontologies, and leverage advances in big data management and analytics. Cognitive systems are rightly being hailed as the new era of computing.

Cognitive reasoning is the ability to analyse and perceive any given information from different perspectives by breaking it down into manageable components and structuring the information in a logical order. Therefore, if information is bundled in the form of a big data, cognitive reasoning will allow us to identify the partitioning of big data with respect to the problem in hand. Cognitive reasoning can be defined as an integral part of cognitive ability and is linked with an individual's ability to analyse facts rapidly, with transparency of thought and the ability to disregard unimportant information. Thus, to measure this reasoning, organizations should conduct cognitive reasoning tests. This is to infer whether a person can use logical steps to understand given information to assess what could be true or must be valid from the given data and directives. Cognitive function is defined as multiple brain-based activities that enable mankind to perform any given task. It involves the use of knowledge, information and reasoning to connect and understand information and derive meaning out of it.

Analysis of data by humans can be a time-consuming activity and thus use of advanced cognitive systems can be utilized to crunch this enormous amount of data [23]. As per Brian Krzanich (2016) "AI is based on the ability of machines to sense, reason, act and adapt based on learned experience" [24]. AI based system works on the rules and parameters that are fed inside it whereas a cognitive computing based system works by intercepting the command and then drawing inferences and suggesting possible solutions. In fact, cognitive computing is an AI based system that enables it to interact with humans like a fellow human, interpret the contextual

meaning, analyse the past record of the user and draw deductions based on that interactive session. Cognitive computing helps humans in making decisions whereas AI based systems works on the concept that machines are capable of making better decisions on behalf of human. Cognitive computing is a sub-set of AI and anything that is cognitive is also AI. Data are captured from different sources, such as, mobile phones, web browsers and is stored in different data arrangements. These structured as well as unstructured data and their origins are difficult to be managed by the standard, conventional analysis and storage. A cost-effective decent software for big data analysis named Hadoop provides scalability, flexibility, accessibility, parallel processing as well as authentication. With the rise of the rate of development of data, machine learning methods are used for the automation of analysis of data like sentimental analysis (SA). The two important Vs that is velocity and volume of the data are huge, so the gap between the analysed data and the unprocessed data increases. This gap can be reduced by the advantage of a Big Data analytic solution. There are two Big Data processing outlook in SA: (i) batch processing, which is static and extremely controlled structure, that uses a distributed file system to store the data and after that a distributed computation structure is utilized. (ii) Interactive streaming data processing. For example, Apache Spark collects data as "streams" and the streaming data is processes through in-memory computational processes like Resilient Distributed Datasets (RDDs) [25]. Both Supervised and Unsupervised methods are used for SA which takes out essential data from the text data for helping the decision-makers. The disparity of the sentiment is effectively defined by Supervised method but for this purpose a huge number of labelled data are needed which is very difficult to achieve. On the other hand unsupervised methods, not being superior, can process data which are not so called labelled. Methods based on the support vector machine (SVM), Naïve Bayes (NB) and decision tree (DT) displayed better performance in SA. Like the classification problems, appropriate feature set selection is very important in this case. Some of the features extensively used in SA are word2vec, Parts of speech, Term Frequency (TF), Term Frequency Inverse Document Frequency (TF-IDF) etc. The use of a particular feature with a particular classification model shows particular outcome. Even so, a true classifier is not suitable for tweets and an integration ensemble or voting of many classifiers reveals superb efficiency for SA [26].

3.2 Cognitive Intelligence in 'Human-Centric Functional Modelling'

In the subsection, we have presented the role of cognitive intelligence for sustainability of big data which is basic ingredients for conceptualizing a virtual world to represent the physical world and this specific thought will give the shape of future metaverse. Therefore it is mandatory to discuss the knowhow of cognitive intelligence shaping humanoid (3D platform of various actions of humans as functions).

In other words we can say that conceptual spaces like Hilbert space, conventional Euclidian space, Sobolov Space, etc., can be formulated by functional state spaces where the main focus will be to develop the necessary mapping from one state to another state, and here the state will be represented as action of any human through cognition. So we can propose at this stage that future shape of metaverse will be based on "Human-Centric functional models (HCFM)" which will be formulated using cognitive intelligence. In this context, the concept of "state space" has been applied as a semantic approach by Bas C. van Fraassen, the philosopher [27] and later on, it is applied to all general sciences even for modelling a physical world. A state space is defined as 'the set of all possible configurations of a system' [28] whereas HCFM [29, 30] is defined as a model of human perception that explains the system to have a set of observable functions φ_i via which the change in functional state from "p" to "q" i.e. $\varphi_i(p) = q$ [31] will take place. The physical universe when visualized into a virtual universe using the mapping of states through various actions (functional) rather human cognition, we can say that we have achieved metaverse or we have created metaverse and that is our future shape of metaverse. Therefore the metaverse can be taken as a functional state space traversed by the consciousness and cognition of the universe. Graph is basically a network and using this nomenclature of network concept, the cognitive functional state space is explained by a directed graph with nodes (represent functional states) and the nodes are joined by edges (represent the reasoning processes) via which the transition takes place from one state to another. HCFM uses this graph network to express every possible concept connected by every possible reasoning process. A complete semantic model can be formulated provided the diagram of the functional state space of the cognitive system (the conceptual space) represents the complete human meaning of each concept and each reasoning process. If a conceptual space is to be represented as a "complete" semantic model, a number of assumptions come into the representation. One of the assumptions is that the meanings are to be self-contained in the region of the space and they should be carried through nodes and their links as shown in the Fig. 5.

With respect to the conceptual structure of metaverse can be as a combinatorial model of the real and a virtual world, the details of the world can be determined by the computation power that further calculates the speed of interaction between the worlds. This new concept of future metaverse shaping can be addressed as entanglement between physical and virtual world and hence it can be stated that the future of the metaverse will be related to quantum computing. But the speed of accessibility of stored data brings the limitations. So conventional quantum computing is not really appropriate for certain problems, particularly for which a large volume of input data is needed. The representation of metaverse as a functional state space, using HCFM may radically accelerate research in quantum computing to be explored.

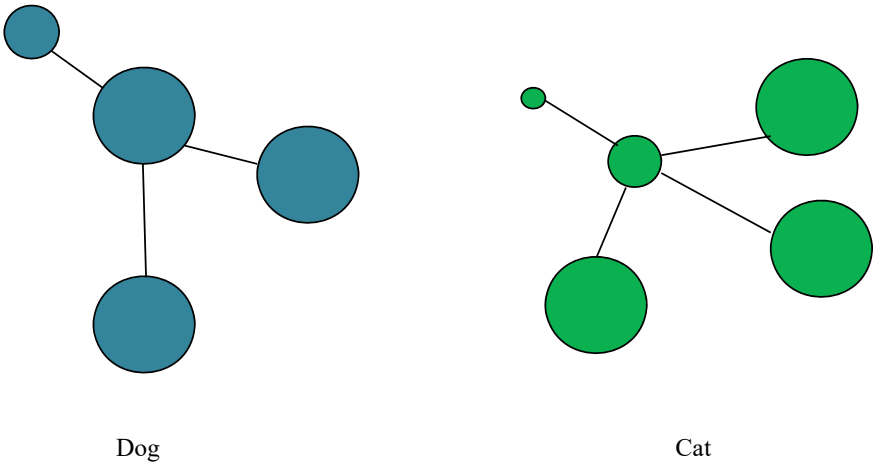


Fig. 5 Conceptual depiction of meaning

3.3 Artificial Intelligence for Sustainability of Big Data

Artificial intelligence plays a big role for sustainability big data. AI based metaverse is defined as multiple hybrid-platform worlds (a shared digital 3D world) that allows users to experience a comprehensive immersive sensation with interactive and synergic activities. In this case various types of objects, user identities, and digital commodities can be exchanged between virtual worlds and even reflected into the real world. A metaverse platform consists of many layers (see Fig. 6) which are (a) Infrastructure (5G, 6G, WiFi, cloud, data center, central processing units, and GPUs), (b) Human interface (mobile, smart watch, smart glasses, wearable devices, head-mounted display, gestures, voice and electrode bundle), (c) Decentralization (edge computing, AI agents, blockchain, and microservices), (d) Spatial computing (3D engines, VR, augmented reality (AR), XR, geospatial mapping, and multitasking), (e) Creator economy (design tools, asset markets, Ecommerce, and workflow), (f) Discovery (advertising networks, virtual stores, social curation, ratings, avatar, and chatbot), (g) Experience (games, social, E-sports, shopping, festivals, events, learning, and working).

Future shape of metaverse will be completely based on CI and AI. Progress of future metaverse will be driven by AI powered blockchain, XR/VR, and 5G and guided by CI for cognition. In this context, quantum computing will ease the speed of computation due to superposition principle of qubits structure and entanglement. However, there will be an uncertainty regarding the influence and effective contribution of AI in shaping metaverse. The reason behind this is it is neither introduced in a creative way like XR/VR nor explained attractively on social media as blockchain. No existing work provides a complete review of the role and application of AI in the metaverse.

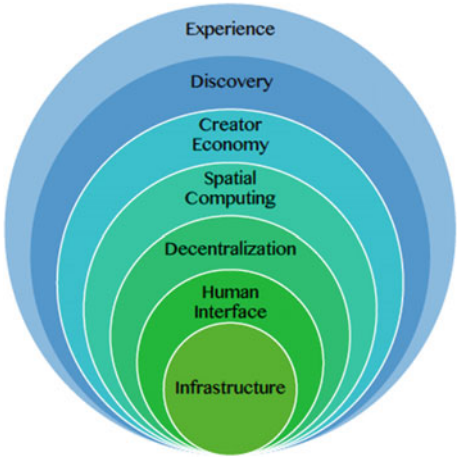


Fig. 6 Seven layers of a metaverse platform

If AI is combined with technologies like AR/VR, networking and block chain, it is possible to create an assured, scalable, and pragmatic digital worlds on a reliable platform in the metaverse. The importance of AI is undoubtedly very clear in improving the performance and to assure the reliability, if the seven-layer metaverse platform is taken into consideration. Many modern machine learning algorithms in the 5G and upcoming 6G systems, can be merged with reinforcement and supervised learning to perform different rigorous tasks like monitoring efficient spectrum, allocation of automatic assets, to prevent attack, to detect network fault, estimation of channel, traffic off-loading etc. Analysis of both simple and complicated human activities can be possible using wearable gadgets based on sensor mechanism and other man–machine interaction gadgets based on machine learning and deep learning models. Therefore the real world activities of users' are extrapolated into the virtual worlds and the users are allowed to control their digital identities (avatars) for interaction in the metaverse smoothly. These avatars recreate many emotional expressions adopted from the real world, such as facial impressions, movement of body, other physical interactions, other than speech recognition of speech and thought analysis, which are controlled by AI in terms of accuracy and processing speed.

It is true that VR/AR/XR technologies empower the user to enter in the metaverse, with immersive gadgets, such as glasses, head-mounted displays, gloves, but AI is a vital technology which is responsible to create the virtual world beautiful. This also generates a flawless and smooth virtual-reality sensation to users. The process of content creation is also facilitated by AI, for example, NVIDIA has introduced GANverse3D, an AI module, which enable users to take photographs of objects and then virtual replicas are made. Many procedures based on deep learning have been suggested for building 3D objects which includes human body parts also. Software (e.g., PyTorch3Dlibrary from Facebook AI and Tensor RT from NVIDIA) as well as hardware (e.g., GPUs) both are available for excellent accuracy while presenting real time processing. Very recently the AI research super cluster (RSC) has been

introduced by Meta. It is believed that it is one of the fastest AI supercomputers to accelerate AI research and may be served for creating the metaverse. Furthermore, better deep learning models can be developed with the help of RSC from the huge amount of heterogeneous data for different applications. As a result, RSC driven outcomes and successes are to be used to create the metaverse platform, in which AI will play an important role.

4 Metaverse Devices

Metaverse is a virtual domain to be explored which will offer people to be engaged with activities which are not possible in the real world. In future possibilities are huge and some extreme creative ideas are on the table already. Even people are trying to sell virtual land in the metaverse. Big companies are already interested in it. Businesses are ready to accept its potentialities though it is in a budding stage. Some VR gadgets are also ready to enter within the virtual realm. One can use a variety of devices with an input system, a screen and an appropriate processor. It is true that people can access metaverse through smart phones and computers but not in the fully hypnotic way. For the mesmerizing sensation specific metaverse devices are needed to be immersed fully in the world as they provide something special that adapt people's expectations. VR eye glasses or AR gear actually feeds the metaverse into the user's field of vision. Then the user can interact with the digital domain using the specific input devices. Some of the metaverse gadgets are (Fig. 7).

Fig. 7 (i) Oculus Rift CV1 VR Headset, (ii) Oculus Quest

4.1 VR Metaverse Gadgets

1. Oculus Rift & Oculus Quest

Oculus Rift is a VR headset which is planned to work with a PC for processing. On the other hand Oculus Quest 2 is a headset that works on the android system which is rebranded as Meta Quest 2 (Fig. 8).

2. Valve Index

Valve Index is a second generation VR headset manufactured by Valve. The headset is designed in such a way that skin contact is reduced. A fabric lining inside prevents sweat and thus infections from microorganisms. The Valve Index controllersconsist of a touchpad, a joystick, a menu button, two face buttons and a trigger. Controllers are allowed to track hand and finger position, movement by 87 in-built sensors and a perfect representation of the use's hand is created in the virtual reality. The Valve Index is wired device with a head mounted display. It needs external stations for tracking and wired computer interface thus it not so called 'user friendly'. But the graphics quality it provides is excellent (Fig. 9).

3. Play Station VR2

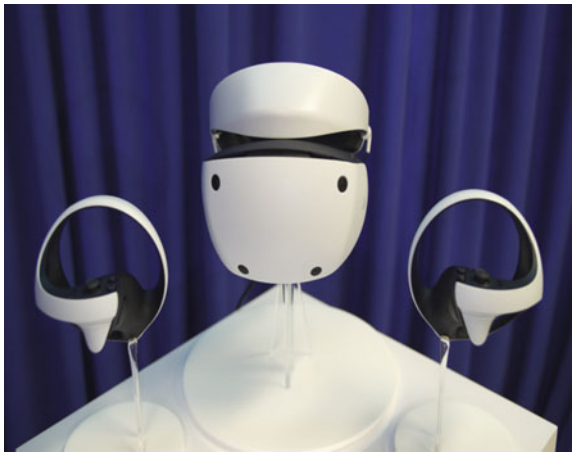
Play Station VR2 (PSVR2) is an approaching VR head set for the PlayStation 5 (PS5) home video game console (Figs. 10 and 11).

VR2 uses the cable connection that connects with PS5. For the effective immersion and sensitivity eye-tracking is used in PSVR2 which is supported by 3D audio and sensory function for high end in-game activities. PlayStation 5 has been announced in 2019 as next in line to PlayStation 4. It was released on 12.11.2020. In August 2021, a hardware revision of PS5 has been done.

Fig. 8 Meta Quest 2 Headset

Fig. 9 Valve Index VR Kit

Fig. 10 PlayStation VR2



4.2 AR Metaverse Gadgets

1. HoloLens

Micrisoft'sHoloLens is one of their most important ventures for augmented reality. It handles lots of optical sensors, microphones, cameras. Another significant feature "Holographic Processing Unit" is present in HoloLens making it one of the best metaverse devices for Augmented Reality. This is a premature project, hand motions are yet to improve. Microsoft Hololens 2 are the next generation devices for working

Fig. 11 PlayStation 5

Fig. 12 HoloLens by Microsoft

with AR/VR (mixed reality) contents with an increased angle of view and more immersion. The users are allowed to interact with holograms (Figs. 12 and 13).

2. Epson Moverio

The Epson Moverio is AR smart glasses with Si-OLDED display with extraordinary vision clarity. It offers 34° wide field of vision, fully HD, high contrast and high resolution. The Moverio BT-300 weigh 20% lighter compared to its predecessor, making it the lightest AR headset in the world. It works on the android system. This is the advantage as well as disadvantage at the same time of the gadget. The disadvantage is that the system must adopt the software, and the disadvantage is that the application of android is not that complicated.

3. Haptic Gloves and bodysuit

Haptic gloves will launch a tactile experience to the virtual realm. It contains a series of soft motors motors, actuators, sensors and other tech wizardry which will allow users to grip and touch virtual objects while interaction in the metaverse. Meta-owned Reality Labs are working to reproduce a range of real-world sensations like