Technological Roadmap of the Future Trend of Metaverse based on IoT, Blockchain, and AI Techniques in Metaverse Education

Md Ariful Islam Mozumder*, Ali Athar*, Tagne Poupi Theodore Armand**, Muhammad Mohsan Sheeraz*, Shah Muhammad Imtiyaj Uddin*, Hee-Cheol Kim*

* *Department of Computer Engineering/Institute of Digital Anti-Aging Healthcare/u-HARC, Inje University, South Korea*

arifulislamro@gmail.com, ali.athar1401@gmail.com, poupiamand2@gmail.com, sherazmohsin257@gmail.com, imtiyaj.dream@gmail.com & heeki@inje.ac.kr

***Abstract*— Metaverse is defined as a collection of technology gadgets and metaverse connected to IoT, Blockchain, Artificial Intelligence, and all the other tech industries including educational. In particular, the big success of the metaverse in the recent era is in the educational sector, metaverse resolved many difficulties in the education domain. Especially, in the situation of covid 19 people continued there all the educational things virtually using metaverse technologies. At this moment it was only a sector that was not hampered by the reason of covid 19, everyone did their educational work online instead of offline. Metaverse uses artificial intelligence and IoT technology to build a digital virtual world where you can safely and freely engage in social and educational activities that transcend the limits of the real world, and the application of these latest technologies will be expedited. In this paper, we are going to introduce the future of the metaverse, including its history, explanation, and shared features. Then, we will describe what technologies the metaverse is using and metaverse potentiality in education, the metaverse in education is clearly defined, and a detailed framework of the metaverse in education is proposed, along with in-depth discussions of its features.**

***Keywords*— Metaverse education, Artificial intelligence, Mixed reality, Metaverse, Virtual Education.**

Manuscript received on December 26, 2021. This research was supported by the MSIT (Ministry of Science ICT), Korea, under the National Program for Excellence in SW, supervised by the IITP (Institute of Information & Communications Technology Planning & Evaluation) in 2022 and a follow-up of the invited journal to the accepted & presented paper entitled " Overview: Technology Roadmap of the Future Trend of Metaverse based on IoT, Blockchain, AI Technique, and Medical Domain Metaverse Activity" of the 21th International Conference on Advanced Communication Technology (ICACT2022).

Md Ariful Islam Mozumder is pursuing his Ph.D. in the Institute of Digital Anti-Aging Healthcare at Inje University, 50834 South Korea. (E-mail: arifulislamro@gmail.com).

Ali Athar is pursuing his Ph.D. at the Institute of Digital Anti-Aging Healthcare at Inje University, 50834 South Korea (E-mail: ali.athar1401@gmail.com).

Tagne Poupi Theodore Armand is pursuing his Ph.D. at the Institute of Digital Anti-Aging Healthcare at Inje University, 50834 South Korea (E-mail: poupiamand2@gmail.com).

Muhammad Mohsan Sheeraz is pursuing his Master's in the Institute of Digital Anti-Aging Healthcare at Inje University, 50834 South Korea (E-mail: sherazmohsin257@gmail.com).

Shah Muhammad Imtiyaj Uddin is pursuing his Master's in the Institute of Digital Anti-Aging Healthcare at Inje University, 50834 South Korea (E-mail: imtiyaj.dream@gmail.com).

Hee-Cheol Kim, Department of Computer Engineering/Institute of Digital Anti-Aging Healthcare/u-HARC, Inje University, South Korea (corresponding author, phone: +82-10-8957-6296; fax: +82-55-324-3906, E-mail: heeki@inje.ac.kr).

I. INTRODUCTION

TECHNOLOGY is rapidly changing the way we interact with the physical world around us. The Metaverse is a virtual shared space that everyone can access. Since the late 1990s PC internet boom that gave birth to eLearning, the education sector has advanced significantly. Microlearning was introduced by the second wave of mobile computing and social media through shorter, video-based learning on demand. Now, according to industry observers, the third computing era has arrived [1]. Metaverse of digital 3D areas where we interact as lifelike avatars will take the place of flat, static pages on PCs and mobile devices. You're never alone in the metaverse, an embodied internet [2]. The metaverse is "always on" and allows for social interactions with peers, unlike a Zoom call that is planned and ends when you're done. This change has significant effects on developing skills and learning. In essence, the metaverse would consolidate disparate virtual worlds into a common and lasting digital place [3]. The metaverse can also be considered a collection of all future virtual and augmented reality experiences as well as the interactions that IoT, AI, and machine learning will enable between the virtual worlds and the physical world. The potential for employing a metaverse for education has been made possible by the steadily developing applications of a metaverse in many fields, including gaming. Before examining the options, it is crucial to comprehend the metaverse's fundamental ideas because they can support instructional applications. The technological possibilities connected to each educational facet of the metaverse can give a clear idea of how the metaverse can alter education. Here is an example of how the metaverse might support learning and education. Firstly, Augmented reality is used in education, secondly, Lifelogging is used in education, thirdly, mirror world and education, and the big one is virtual reality in education [4, 5].

On the other hand, the gateway to the metaverse is virtual reality (VR) headsets. VR headsets completely immerse the senses and provide an unparalleled sense of embodied presence [6]. Users can freely roam around a 3D scene and interact with the environment with their hands, exactly like they would in real life. VR activates the motor center of the

ISBN 979-11-88428-10-6

brain and develops muscle memory. VR can train anything, from farming skills to firefighting, in the same way that a flight simulator trains pilots for emergency landings. Spatial training, such as using the hands and body for tasks that are too dangerous, expensive, inconvenient, or simply impossible to practice in real life, is one skill that plays to the strengths of the metaverse [7]. In a safe and controlled environment, scenarios for normal and abnormal operations, emergency response, challenging work environments, critical procedures, and high-consequence events can all be practiced until they become second nature. It's a catch-all term that refers to the entire digital and virtual world [8]. It's the convergence of physical, augmented, and virtual reality in a shared online space. Metaverse's core branches are Healthcare, Entertainment, Military, Real estate, Manufacturing, and Education. Within a metaverse, each user has their perspective on the virtual world, with the underlying environment presenting a consistent state to all users [9, 10]. Metaverse Virtual Reality (VR) and Augmented Reality (AR) are invading healthcare, medicine, and innovative technologies based on AR and VR is emerging to improve education and training as well as processes and procedures [11]. VR is a technology that substitutes one's vision of the physical world with a digitally produced scene using software and headgear devices [12]. AR is a technology that combines the digital and physical worlds. It uses computer vision techniques such as object recognition, plane detection, facial recognition, and movement tracking to recognize real-world surfaces and objects [13]. The term "mixed reality" refers to a combination of augmented and virtual reality. Using VR, AR, and MR technology doctors make their dream smart digital operation theatre healthcare, where everyone can watch live patient operation which looks like real operations [14]. Unlike games, the virtual environment of a metaverse is not fixed and can be modeled and altered by some or all the users who inhabit it. Each user's avatar can be enabled to portray the personality of the owner. This allows long-term changes to the environment to be retained in perpetuity. It also allows users to form relationships by proxy, with each avatar being used to convey a user's in-world persona [15]. The metaverse, a 3D digital environment that combines the real and virtual worlds, has been hailed as a significant trend in future education [16]. The Metaverse has gained the industry's attention and much research has been going on in the area. Researchers are motivated and technology is speeding in various R&D groups. Researchers are trying to integrate existing technologies from all application areas into the metaverse to build up a complete virtual world full of immersive experiences very similar to real life [17]. Sadrone proposed a user perspective of the medical education learning process in the metaverse. According to him, human avatars and connected devices can be used in a pre-defined environment virtual environment to perform a specific learning activity [18]. Bokyung explained the potential of education in the metaverse following the four types of the metaverse roadmap (Virtual Reality, Augmented Reality, lifelogging, and the minor world) [19]. They suggested some applications of a metaverse in education highlighting an example of an AR T-shirt that could assist students to examine the human body and a spinal surgery platform already develop in a hospital in Seoul (South Korea) that enhance student capacity undergoing the learning process. Muhammet DAMAR revealed the features of the metaverse in the medical field through a systematic review [20]. Such a study could help to enhance understanding of the integration of novel techniques in the metaverse thus enhancing the understanding process. Mozumder et al. [21] proposed a framework integrating smart healthcare facilities in the metaverse. This framework can be implemented and serve as an educational tool for those desiring to gain knowledge in the medical field. The possibility to carry out the virtual task in the metaverse and access some distance learning using avatars make the teaching/learning process more real using human avatars and will serve as a strong pillar for education in general. Sun Huh [22] recently studied the arrival of the metaverse in medical training in Korea by comparing its effect to the current computer-based testing system for the Korean Medical Licensing Examination. Amina et al. suggested in their study [23] a hybrid Structural Equation Modeling and Machine Learning model for the prediction of user's desire in using metaverse for medical education. Education in the metaverse offers many advantages and drawbacks. [24] presents some of these advantages and drawbacks through a literature review. This study is a guideline for those interested in education using the metaverse thus important to education. Effective education with a practical demonstration can be achieved in the metaverse by using a combination of metaverse-enabling technologies.

Contributions: This paper aims to conduct a systematic literature review of the metaverse in education and the framework for this. The contributions of this article are as follows.

- We introduce a technological overview of the Metaverse for education, which reflects the interlinkages between the Metaverse and education.
- We discuss applications for metaverse education that will contribute to the development of the Metaverse.
- We provide an approach to state-of-the-art metaverse education.
- We highlight some key challenges and future directions based on our in-depth review, as well as some recommendations for the Metaverse in future education.

Roadmap: In Section II, we briefly introduce the key origin of the Metaverse. Then, we discuss the Metaverse techniques in Section III and put together the explanation, features, and framework of the metaverse in education in Section IV. Furthermore, in Section V, we provide potential uses of the metaverse in education in the future of the Metaverse in education. After that, we mention some challenges of the metaverse in education in Section VI and we conclude this paper with discussions and potential future research in Section VII.

ISBN 979-11-88428-10-6

II. PRIMITIVE METAVERSE TO ORIGIN OF THE MODERN METAVERSE

The metaverse history begins with a 30-year-old dystopian sci-fi book titled Snow Crash, written by Neal Stephenson [25]. Metaverse technologies are not necessarily new. Their origins trace back centuries to rudimentary sensory illusions and, more recently, to advancements in computing in the late 20th century. For decades, XR and 3D technologies have contributed to advancements in medicine, chemistry, and engineering, among other fields. Back then, these technologies were incredibly expensive, bulky, and served an industry-specific purpose. Today, with the availability of high-resolution mobile screens, accurate motion sensing devices, and highly efficient mobile processors, XR is poised to make the jump from industry laboratories to our living rooms, offices, and classrooms [26]. Metaverse is a compound word combined with "meta-" (beyond; transcending) and "verse" (the root of "universe," cosmos; the whole world), which denotes a new virtual universe created beyond the real world. The term "metaverse" was first coined in the 1992 cyberpunk science fiction novel Snow Crash written by American novelist Neal Stephenson (Stephenson, 1992; Joshua, 2017).

The novel depicts people using virtual reality technology and digital avatars of themselves to explore an online, digital world. In this world, the characters can walk down the street, and visit shops, offices, amusement parks, and other forms of entertainment. Events in the metaverse can sometimes impact people in the real world of the novel. For the metaverse to even be possible, there must be virtual reality (VR) technology. As such, the history of this technology plays a role in metaverse history too.

Over the next three decades, the metaverse concept was more vividly depicted in science fiction movies, such as ready player one, lucy, and the matrix. At that time, the metaverse envisioned by films, could not come into being. In this decade, the rapid progress of emerging technologies, such as wearable devices and three-dimensional (3D) photography, has helped people to get access to the virtual world. In March 2021, the sandbox game roblox was listed in New York under the halo of "the first stock of the metaverse"; in October, Facebook proclaimed it rebrand scheme and changed its name to "Meta." Since then, extensive efforts have gradually been carried out by countries across the world to make it a reality. This sleeping "lion" was truly awakened [16].

III. *METAVERSE TECHNIQUES*

The Metaverse contains elements of all four scenarios. In the same way, as a mirror world map inside a virtual world, a heads-up display AR system, or an object or user lifelog inside a mirror or virtual world, their technologies substantially overlap [27]. There are also more general overlaps between the scenarios. **Error! Reference source not found.** shows the technological roadmap of Metaverse.

A. Communication Computing Infrastructure

The manufacturing field has been evolving rapidly with the help of IoT Technology and metaverse core-stream also working as an IoT device. Fig. 2 shows the IoT and Internet for Metaverse. According to our study, 43% of manufacturing companies reveal that VR will become mainstream in their organization within the next two to three years, with AR also working on industrial applications rather than consumer software. Metaverse is the next version of the internet and most companies already using 5G and 6G for developing their infrastructure.

Internet

The foundation for connectivity is the Internet. Although the internet is currently making progress very rapidly,

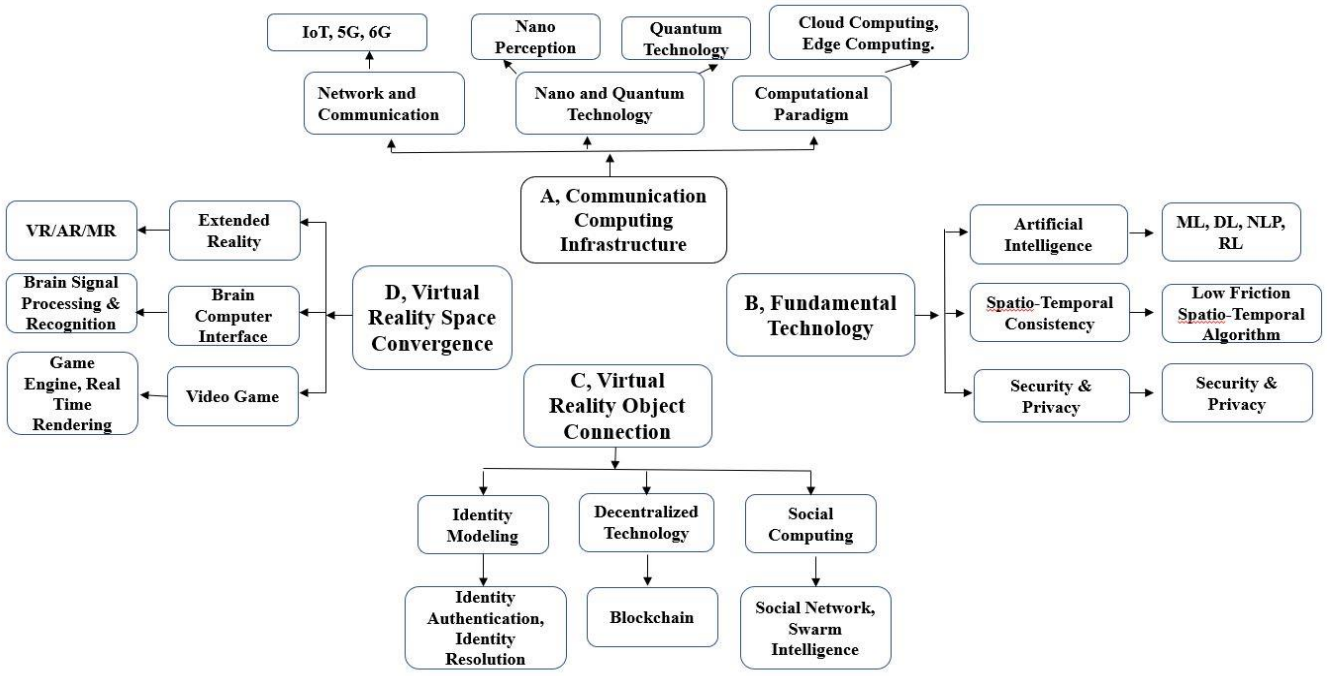

Fig. 1. A Complete Technological Roadmap of Metaverse

ISBN 979-11-88428-10-6

researchers are constantly making many innovations in internet technology, such as 5G and 6G technology [28].

Infrastructure

There are hardware components that help us to have authentic experiences. In addition to nano and quantum (Nanotechnology can improve the performance of sensors or actuators) components, the technologies to form the metaverse are also in this layer. Content-On this layer, we will have medicine, healthcare, games, and applications that help users immerse themselves in one or more different worlds, for the most vivid experiences. Metaverse-when the lower layers develop to a certain extent, we will have a true Metaverse [29].

Metaverse services can be used without modifications, either to access services in the existing cloud environment, where all services are provided by centralized servers over the internet or to access services hosted in the decentralized edge computing deployments, shown in Fig. 3.

B. *Fundamental Technology*

The metaverse is defined as a virtual space where users can interact with 3D digital objects and 3D virtual avatars of each other in a complex manner that mimics the real world, and hold thing developed using artificial intelligence techniques. Fig. 4 shows the five AI phases in the Metaverse.

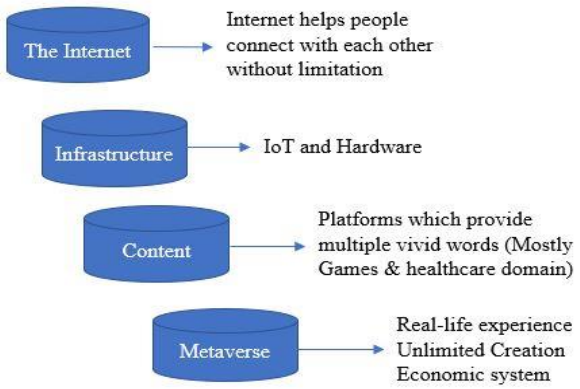

Fig. 2. IoT and internet for metaverse

Fig. 3. Edge computing in the metaverse

Accurate Avatar

Users are at the centre of the metaverse, and the accuracy of your avatar will affect the quality of your and other participants' experiences. An AI engine can evaluate 2D user photos or 3D scans to create a simulated reproduction that is extremely lifelike. To make the avatar more dynamic, it may plot a range of facial expressions, emotions, hairstyles, aging features, and so on.

Digital Humans

Digital humans are 3D versions of chatbots that exist in the metaverse. Digital humans are built entirely using AI tech and are essential to the landscape of the metaverse. From NPCs in gameplay to automated assistants in VR workplaces, there are myriad applications, and companies like Unreal Engine and Soul Machines have already invested in this direction. Multilingual accessibility- AI can help break down natural languages like English, convert them into a machine-readable format, perform analysis, arrive at a response, convert the results back into English and send it to the user.

Fig. 4. Five artificial intelligence use cases in the metaverse

The best part is that, depending on the AI's training, the results might be translated into any language, allowing users from all over the world to access the metaverse. Expansion of VR and AR- With new input, human feedback, and machine learning reinforcement, AI's output will improve with time. AI will be able to complete the task and produce results nearly as good as humans. AI is being trained by companies like NVIDIA to develop complete virtual worlds. This breakthrough will be instrumental in driving scalability for the metaverse, as new worlds can be added without the intervention of humans using AI ensemble VR and AR. Intuitive Interfacing- AI can also assist in human-computer interactions (HCI). When you put on a sophisticated, AI-enabled VR headset, its sensors will be able to read and predict your electrical and muscular patterns to know exactly how you'd want to move inside the metaverse.

Spatio-Temporal Algorithm

Spatio Temporal AI algorithm is a collection of digital tools, models, and methods that can be deployed to increase people's understanding of how, where, and why people locate and move in metaverse virtual cities. It also enables people to develop new virtual procedures for designing and managing the future metaverse virtual city so that it can become more sustainable, equitable, and efficient [30].

Metaverse Security and Privacy

Since the data and avatars of users of the Metaverse platform are located on different servers around the world, Metaverse handles different personal data processing in each country using AI techniques [31].

C. *Virtual Reality Object Connection*

Identity Modelling

Digital identity and personalization in the metaverse are your unique avatar, with the rise of Web 3.0, crypto wallets will also play a role in defining our identity. In a wallet, we might find traces of someone's gaming preferences and love

ISBN 979-11-88428-10-6

for digital art. These unique avatars are a way to give your digital identity visual representation in 3D worlds: they are your identity in the metaverse.

Decentralized Technology

Every single piece in the metaverse embraces the core concept, shown in Fig. 5.

- **Decentralized Computation:** Decentralized computation- in a metaverse virtual reality, everything is data and everything happening is computing. Decentered computation gathers all the powers together to provide all the calculations people need to build their perfect world. The computation will be efficient and accurate.
- **Decentralized Storage:** Inside the metaverse, we have land, space, energy, power, buildings, medical healthcare materials, and many more. Everything is safe here for the reason of metaverse data storage is fully decentralized, it is owned by everyone, it is managed by everyone, and everyone together will ensure its existence like the metaverse will build upon it. Also, we will have full features on the data: everyone will be confident that the data won't be modified by others because of storage decentralization.
- **Decentralized Database:** It will provide a solid base for metaverse citizens to organize their data so they can use them to build anything that they can imagine enriching the universe. And at the same time, they will have full confidence that the data is always there for us.
- **Blockchain:** To ensure the decentralized nature of the metaverse, blockchain is the core of all the infrastructure. Blockchain will ensure the decentralized data, decentralized database and decentralized computation is fully trustful and ensure only the citizens of the metaverse have ownership of everything in the virtual space.

Social Computing

Metaverse social computing included avatar description, avatar identification, avatar interaction, and avatar organizational work.

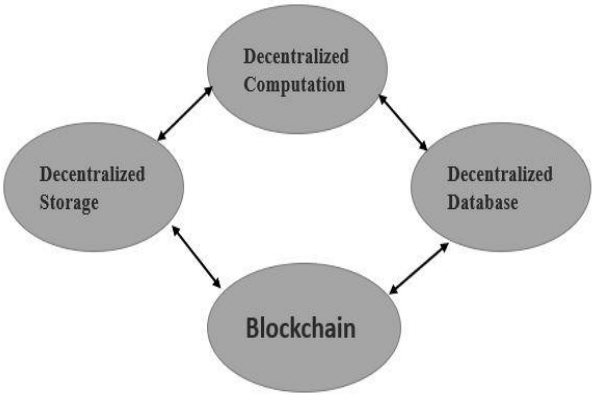

Fig. 5. Metaverse decentralized technology

D. Virtual Reality Space Convergence

Metaverse Extended Reality

Since the data and avatars of users of the Metaverse platform are located on different servers around the world, Metaverse handles different personal data processing in each country using AI techniques. Fig. 6 shows the extended reality in Metaverse [32].

- **Virtual Reality:** It is a technology that substitutes one's vision of the physical world with a digitally produced scene using software and headgear devices. While wearing full-coverage headsets, you are entirely cut off from your surroundings and the actual world. A computer-generated virtual environment is reflected by the LCD screens inside the lenses of these headset devices, and your viewpoint is replaced.

- **Augmented Reality:** It is a technology that blends the digital and real worlds. It uses computer vision to recognize real-world surfaces and objects using technologies such as object recognition, plane detection, facial recognition, and movement tracking, among others. The computer then overlays computer-generated data like graphics, sounds, images, and messages on these previously recognized planes.

- **Mixed Reality:** It is a hybrid of augmented reality and virtual reality. It's also known as Hybrid Reality since it incorporates both real-world and digital aspects. While MR is primarily a technology for combining the physical and virtual worlds, the most appealing technology is the lifelike interaction between users and digital items. These three technologies are also used in the healthcare domain.

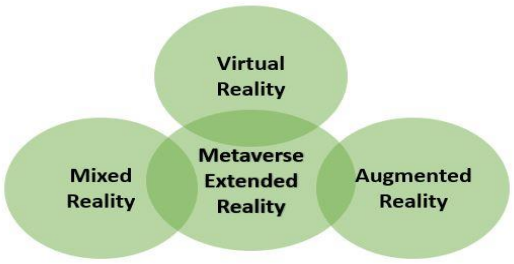

Fig. 6. Metaverse extended reality

Brain-Computer Interface

Since the data and avatars of users of the Metaverse platform are located on different servers around the world, Metaverse handles different personal data processing in each country using AI techniques [33].

- **Acquisition:** These signals are acquired from the brain and then amplified and tuned, and noise is removed to convert the input signal into a format that can be digitized and sent to a system that can be further interpreted.
- **Feature Extraction:** This step involves extracting certain characteristics and footprints that indicate the presence or absence of a particular intent. These characteristics can be time-triggered EEG or ECoG response amplitudes and latencies, power within specific EEG or ECoG frequency bands, or firing rates of individual cortical neurons, etc.
- **Feature Interpretation:** In this step, the characteristics obtained in the previous steps are analyzed, and a conclusion is made as to what may be the intent of the user. Since the human brain is extremely fast and complex, these translation algorithms must be dynamic and adaptive to new signals and features in real time.

ISBN 979-11-88428-10-6

- **Output:** The output can be experienced in various forms like visual outputs, including moving of cursor on the screen or changing of channel, audio outputs may change the volume of a device, etc.

Real-Time Rendering

Real-time rendering is a field of computer graphics focused on analyzing and producing images in real-time. Metaverse video game platform uses real-time rendering for metaverse avatars, because of avatar realistic-ness. 3D rendering is the process of producing an image based on three-dimensional data stored on our computer. It's also considered to be a creative process, much like photography or cinematography, because it makes use of light and ultimately produces images. With 3D rendering, computer graphics convert 3D wireframe models into 2D images with 3D photorealistic, or as close to reality, effects. Rendering can take from seconds to even days for a single image or frame [34].

IV. EXPLANATION, FEATURES, AND FRAMEWORK OF THE METAVERSE IN EDUCATION

A. Definition of the metaverse in education

In the last few decades, the study sector has undergone effective changes. Resembling the motion with the rapidly evolving technological environment and educators have also elevated their education systems, from word-of-mouth illustrations and blackboard drawings or designs to digital intellectual classes. Today's lectureship practices aim only at students' lessons and focus on making a fascinating and immersive situation where they can get concepts better. Many educators and researchers introduced providing various future agendas and effectuation scenarios in their educational practices and increasing interest in the educational landscape may stalk from a mass range of possibilities together with the virtual space that offers real-like representations of interest that possibly enhance the social view of teaching and knowing. However, the term is comparatively new and there is a need to test the state-of-the-art exploration of Metaverse and this is where this learning steps into. Fairly speaking, the metaverse will qualify many students to become fully immersive multimedia environments that leverage both the anatomical and numeral worlds. For example, in a geometry class, students might know geometric equations by watching and manipulating geometric shapes in a VR sphere whilst at the same time hearing an expert mathematician provide context and lead. Education will become more decentralized and metaverse programs will go out as students increasingly seek immersive, interactive, and monumental online learning environments. Virtual education activities will increasingly involve game mechanics and game design elements, such as competition, points, and rewards. As gamified elements become more immersive and fascinating, they are likely to become more exoteric with children and young society. One instance is Virtual Reality (VR) and which enables the source of immersive learning experiences that can help raise student realization of a subject and also enables users with VR headsets to become involved in an array of real-world or fictional environments. Another radical metaverse technology is Augmented Reality (AR). With AR, one can overlay images, videos, and sounds onto an existing environment to "augment" a real-world continuity. A transformative third associated with metaverse technology is artificial intelligence (AI). Artificial intelligence enables computers to make tasks commonly associated with human knowledgeable processes and it creates dramatic variation in the workplace, as computers replace human labor, however, AI in the study has been largely limited to teaching software that purpose to make curriculum amendment more individualized for students. The most important benefit of the metaverse is that it allows the community to put in with one another while obeying online practical medical courses, unlike the current one-way study. Healthcare will fulfill it in medical learning for simulation education rather than learning dissemination. For instance, advanced skills and interactions need extra technology in metaverse-based medical education, to be successful. Surgery, for example, requires not just an understanding of the metaverse but also the use of instruments that need skillful very strong abilities.

B. Metaverse's applications in education

Metaverse is doing outstanding in the educational domain, also educational ultra-digital revolution started with the metaverse. It starts with making a digital identity instead of a physical identity, it's doing all the educational activities like a real offline world. In this section, we are going to explain the applications of a metaverse in Fig. 7.

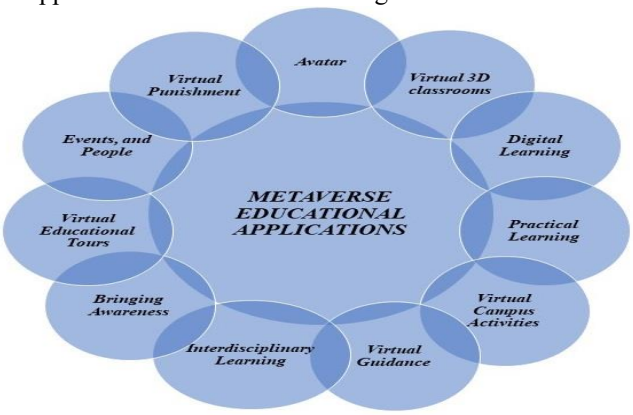

Fig. 7. Metaverse educational applications

Avatar

Avatars are virtual representations of a person or a physical object. You are not limited by the environment, a particular region, or any feature of physicality. A metaverse avatar gives you the ability to look however you want in any environment [35]. On the metaverse, there are two types of avatars, full body avatars, and VR avatars. Building a user avatar for an institutional primary requirement for the metaverse education process to start the learning or teaching process [36].

Virtual 3D classrooms

Through eLearning, education may be facilitated whenever and anywhere. However, the advantages of traditional classrooms cannot be equaled or duplicated in a distance learning setting. This gap between actual and virtual schools can only be filled by a virtual 3D classroom or Metaverse. The students can create their virtual personas and participate in class with other students in a 3D virtual

ISBN 979-11-88428-10-6

environment. The Metaverse also provides a wealth of options for experiential learning [37].

Digital learning

When smart classes were added to school education curricula, they enhanced students' learning with video projection on various subject topics. The metaverse aims to make these classrooms a notch smarter by allowing students to fully immerse themselves in such videos, helping them experience all the content more closely [38]. Moreover, it provides a space for them to experiment, fail and learn from their failures in subjects that require practical experiments. Even physical classes can use such 3D virtual learning to achieve desired learning outcomes.

Practical Learning

It is possible to combine or exchange ideas from various fields to better understand them with Metaverse. For instance, computer science, mathematical formulas, and many other topics can better support physics concepts, resulting in more comprehensive learning [39].

Virtual campus activities

Students can participate in various events and activities like competitions, sports, educational groups, and much more, like attending courses with other students in a virtual setting. Students can make It gives the impression of being physically present on campus and actively participating in events [40].

Virtual Guidance

In the physical education system, learners faced difficulties with the absence of a trainer, and metaverse solved the guidance absence problem. Using meta-avatar, Virtual Reality (VR) and Augmented Reality (AR) instructors can instruct the learner on time in Metaverse education [41]. Education is no stranger to this new reality and the potential for teachers and students is unlimited.

Interdisciplinary learning

The metaverse has the potential to solve subject barriers and encourage interdisciplinary study. In the metaverse, the learner can learn interdisciplinary subjects and topics from their subject-wise instructors like the physical education system [42]. Also, interdisciplinary corporate departments can do their real-time pieces of training and meetings with clients or employees.

Bringing awareness

Metaverse can increase learners' awareness, by making various types of instant announcements, video content, and a documentary on any topic within a short time and it is also possible to reach the learner within a short period. In that case, guidance will approach awareness to contain [43]. Students will not just take-home theoretical awareness knowledge.

Virtual Educational tours

In the metaverse educational world, students can take necessary short tours from other classrooms with permission. The metaverse aids in students' expanding their horizons and widening their worldviews by enabling them to visit any location of their choice in a virtual setting within minutes [44].

Events, and people

In the virtual environment of the metaverse, educators might invite well-known individuals or sources of wisdom and information to speak to students about their diverse life experiences [45]. They can go to interesting lectures, conferences, and symposiums. They can also hold festivals and other types of events to assist them to renew their brains.

Virtual Punishment

To avoid unexpected behavior and violence from the students, teachers can make rules as an unwritten regular punishment on metaverse like- addressing discipline issues fast, putting distractions away, treating the avatar like more than a person, making a dress code (Avatar dress code), add visual cues to lessons, decide on signals, hold class wherever teacher can hold students' attention, and create a question parking lot [46].

C. *The framework of the metaverse in education*

How metaverse distinguishes a physical education system

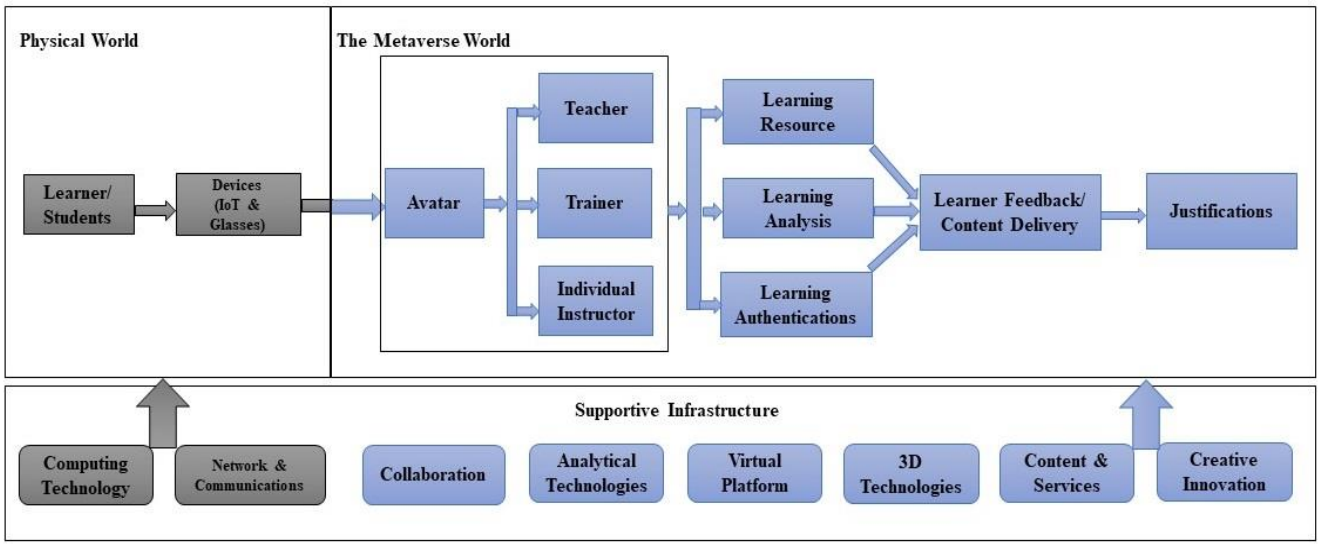

Fig. 8. The Metaverse educational framework

ISBN 979-11-88428-10-6

and a metaverse education system we can understand with our approaches figure. We approach a metaverse education system with **Fig. 8**.

The development of the metaverse appears to be directly related to the maturity of technologies; in other words, the implementation of the metaverse in education heavily depends on modern technology. As a result, a variety of supportive technologies can be used in education to build the metaverse's educational framework, which provides important support for the elements both in the actual world and the metaverse.

With the collaboration of digital technologies metaverse makes its education system like physical education, some issues more beneficial from physical education system. By the wearable device (VR, glasses, etc) learner joins the metaverse as an avatar, and after that learner will learn from his guide avatar (teacher, trainer, or individual instructor). The learner will learn from learning resources, and they will give their learned (what they learn) guidance. Finally, the guidance avatar will monitor all the learner activities on the metaverse. Computing technology such as edge computing, cloud computing, distributed computing, and others that we mention in the metaverse technique section, can support learners in storing, using, and synchronizing learning data more correctly, effectively, and flexibly. The development and operation of the metaverse requires high-speed networks like 5G or 6G and strong wireless connectivity. The metaverse can maintain fluency, stability, and low latency for data transfer, scene display, instant feedback, and user connection with the help of high-speed networks. Incorporating analytical tools in the metaverse can aid in measuring, tracking, gathering, and analyzing learner-learning data. Metaverse makes a virtual platform with its features and technologies which makes easier metaverse education system for learners and guidance. 3D technologies such as 3D modeling or 3D reconstruction create the shape and appearance of real objects and will make metaverse education a reality. Learners can find content for their study in the metaverse platform more than in the physical world. In metaverse education, world learners can communicate with each other's within a short time to discuss their ideas, and with that, they can increase their innovative productivity.

V. THE POTENTIAL FOR EDUCATION IN THE METAVERSE

The Metaverse is an online virtual environment that allows for immersive learning in higher education and is accessible from any location at any time [47]. It works with real-time networking and collaboration. The metaverse allows users to choose their digital avatars. It offers a virtual environment that is simple to access from anywhere. Hence saving money on transportation and logistics. A notable economic burden it takes off from institutions is setting up costly labs, equipment, and auditoriums. A professor can concurrently address live and virtual audiences to the metaverse. This can become a transactional intellectual property that can be made available in various formats in the metaverse. With the aid of artificial intelligence, metaverse academics can be repackaged and served to diverse audiences according to their needs.

In the Metaverse, school buildings with all the facilities can be developed to be more prosperous, and more attractive of course, which will be comfortable and enjoyable for the learners. Metaverse has the benefit of making digital communication more approachable by providing new aspects. Applications in education can enhance education quality with limitless experience. Teachers can back up their classes on the cloud and students can access them easily in their necessary time.

A. Challenges of the metaverse in Education

The metaverse transforms the education system physically to metaverse education, in a way that still metaverse has some challenges. With Fig. 9, we explain some challenges for the metaverse education system.

Fig. 9. The Metaverse educational challenges

Significant Costs and Time

In maximum usable cases, the metaverse provides a low-cost learning system, on the other hand, building the many types of laboratories in metaverse education is highly cost able. Many institutions can't afford it.

Lack of Rural Access

To build metaverse tech giants using updated technology and for using it users need high-speed networks like- 5G or 6G. In Africa and Asia, many countries do not have internet availability in their rural areas, and due to the lack of rural access millions of learners can't use metaverse education.

Adapting New Environment

As we maintain many rural areas, millions of users don't easily take new technologies instead of their regular usable things, they are feeling comfortable with their old technological environment.

Addiction

There are two sides to every coin. On the one hand, users find it simpler to engage in immersive engagement with higher quality, which can eventually lead to "cyber-syndrome," which refers to the physical, social, and mental issues that affect people because of excessive interaction with the internet. The XR experience, on the other hand, exposes learners to a variety of visual and aural stimuli that can make their brains work harder.

ISBN 979-11-88428-10-6

Privacy and Security

To gain a comprehensive grasp of users' thought processes and behavioral patterns, the Metaverse corporations will unavoidably gather enormous volumes of personal privacy information from users. There is little doubt that the data gathered will be unique. Due to this, these businesses are forced to obtain recognition for the protection of personal data and maintain programs that always comply with other criteria. We believe that the Metaverse education system has flaws that need to be fixed in the future, namely the full life cycle of user data collecting, storage, and management [48].

VI. Conclusion

To sum up, the educational metaverse has a lot of advantages. Immersive learning, improved skill sets, upskilling based on requirements, increased knowledge accessibility, and cost savings are only the tip of the iceberg. The metaverse's virtual classrooms and hands-on learning will change the education sector. Compared to current educational technology, the existence of the metaverse is a novel idea in the context of education. As already mentioned, the metaverse offers numerous potential advances for education. More significantly, the ongoing interest in the metaverse even points to the trend and course of future schooling. Therefore, it can be assumed that soon, an increasing number of educational academics will actively engage in studies of the metaverse in education. In this research, we explain metaverse technologies that are related to the metaverse education system. In the middle of this study, we discuss many applications which are working with metaverse education. At the end of this paper, we proposed a framework with its explanation for metaverse education.

Acknowledgment

This research was supported by the MSIT (Ministry of Science ICT), Korea, under the National Program for Excellence in SW, supervised by the IITP (Institute of Information & Communications Technology Planning & Evaluation) in 2022.

References

1. Lee, L.-H., et al., *All one needs to know about metaverse: A complete survey on technological singularity, virtual ecosystem, and research agenda.* arXiv preprint arXiv:2110.05352, 2021.
2. Dionisio, J.D.N., W.G.B. III, and R. Gilbert, *3D virtual worlds and the metaverse: Current status and future possibilities.* ACM Computing Surveys (CSUR), 2013. **45**(3): p. 1-38.
3. Duan, H., et al. *Metaverse for social good: A university campus prototype*. in *Proceedings of the 29th ACM International Conference on Multimedia*. 2021.
4. Mozumder, M.A.I., et al. *Overview: technology roadmap of the future trend of metaverse based on IoT, blockchain, AI technique, and medical domain metaverse activity*. in *2022 24th International Conference on Advanced Communication Technology (ICACT)*. 2022. IEEE.
5. *What is the metaverse?* ; Available from: https://www.chathamhouse.org/2022/04/what-metaverse?gclid=Cj0KCQiA14WdBhD8ARIsANao07hroC9KNnM26sJ-iAMvzaDed-fvaDh4_1Pe2mDp2MdQ8qzAKhVZnEcaAhjxEALw_wcB.
6. Murray, J.H., *Virtual/reality: how to tell the difference.* Journal of Visual Culture, 2020. **19**(2): p. 11-27.
7. *Metaverse Vs. Virtual Reality: A Detailed Comparison*. Available from: https://www.blockchain-council.org/metaverse/metaverse-vs-virtual-reality.
8. Ayiter, E. *Further dimensions: Text, typography and play in the Metaverse*. in *2012 International Conference on Cyberworlds*. 2012. IEEE.
9. Lege, R. and E. Bonner, *Virtual reality in education: The promise, progress, and challenge.* Japan Association for Language Teaching Computer Assisted Language Learning Journal (JALT CALL Journal), 2020. **16**(3).
10. Claudio, P. and P. Maddalena, *Overview: Virtual reality in medicine.* Journal of Virtual Worlds Research, 2014. **7**(1).
11. Han, Y., et al., *A dynamic resource allocation framework for synchronizing metaverse with iot service and data.* arXiv preprint arXiv:2111.00431, 2021.
12. *Virtual Reality in Education*. Available from: https://www.classvr.com/virtual-reality-in-education/.
13. *Augmented Reality In Education: A Staggering Insight Into The Future*. Available from: https://elearningindustry.com/augmented-reality-in-education-staggering-insight-into-future.
14. Suzuki, S.-n., et al., *Virtual Experiments in Metaverse and their Applications to Collaborative Projects: The framework and its significance.* Procedia Computer Science, 2020. **176**: p. 2125-2132.
15. Eckert, M., J.S. Volmerg, and C.M. Friedrich, *Augmented reality in medicine: systematic and bibliographic review.* JMIR mHealth and uHealth, 2019. **7**(4): p. e10967.
16. Zhang, X., et al., *The metaverse in education: Definition, framework, features, potential applications, challenges, and future research topics.* Frontiers in Psychology, 2022. **13**.
17. Trunfio, M. and S. Rossi. *Advances in Metaverse Investigation: Streams of Research and Future Agenda*. in *Virtual Worlds*. 2022. MDPI.
18. Sandrone, S., *Medical education in the metaverse.* Nature Medicine, 2022: p. 1-2.
19. Kye, B., et al., *Educational applications of metaverse: possibilities and limitations.* Journal of Educational Evaluation for Health Professions, 2021. **18**.
20. Damar, M., *What the literature on medicine, nursing, public health, midwifery, and dentistry reveals: An overview of the rapidly approaching metaverse.* Journal of Metaverse, 2022. **2**(2): p. 62-70.
21. Huh, S., *Application of computer-based testing in the Korean Medical Licensing Examination, the emergence of the metaverse in medical education, journal metrics and statistics, and appreciation to reviewers and volunteers.* Journal of Educational Evaluation for Health Professions, 2022. **19**.
22. Almarzouqi, A., A. Aburayya, and S.A. Salloum, *Prediction of User's Intention to Use Metaverse System in Medical Education: A Hybrid SEM-ML Learning Approach.* IEEE Access, 2022. **10**: p. 43421-43434.
23. Stanoevska-Slabeva, K., *Opportunities and challenges of metaverse for education: a literature review.* EDULEARN22 Proceedings, 2022: p. 10401-10410.
24. Chengoden, R., et al., *Metaverse for Healthcare: A Survey on Potential Applications, Challenges and Future Directions.* arXiv preprint arXiv:2209.04160, 2022.
25. *A brief metaverse history: from where it started, to today*. Available from: https://www.parkersoftware.com/blog/a-brief-metaverse-history-from-where-it-started-to-today/.
26. Pimentel, D., et al., *An introduction to learning in the metaverse.* Meridian Treehouse, 2022.
27. Mystakidis, S., *Metaverse. Encyclopedia, 2 (1), 486-497*. 2022.
28. Anderson, J. and L. Rainie, *The metaverse in 2040.* Pew Research Center, 2022.
29. Zhou, Y., et al., *Self-powered sensing technologies for human Metaverse interfacing.* Joule, 2022. **6**(7): p. 1381-1389.
30. Amato, F., F. Guignard, and A. Walch. *Wind of change: predicting wind potentials for the energy transition*. in *EGU General Assembly Conference Abstracts*. 2021.
31. Di Pietro, R. and S. Cresci. *Metaverse: Security and Privacy Issues*. in *2021 Third IEEE International Conference on Trust, Privacy and Security in Intelligent Systems and Applications (TPS-ISA)*. 2021. IEEE.
32. *The Metaverse and Extended Reality*. Available from: https://www.pacteraedge.com/metaverse-and-extended-reality.
33. Bernal, S.L., et al., *When Brain-Computer Interfaces Meet the Metaverse: Landscape, Demonstrator, Trends, Challenges, and Concerns.* arXiv preprint arXiv:2212.03169, 2022.
34. *How AI and Real-Time Rendering Engines Will Transform Immersive Metaverse Experiences*. Available from:

ISBN 979-11-88428-10-6

https://accelerationeconomy.com/metaverse/how-ai-and-real-time-rendering-engines-will-transform-immersive-metaverse-experiences/.
35. *An Introduction To Avatars In The Metaverse*. Available from: https://geekyants.com/blog/an-introduction-to-avatars-in-the-metaverse/.
36. Wasmuth, H., *" Thinking as someone else"-Using Avatars in teacher education and the challenge to think and act as someone else.* Global Education Review, 2016. **3**(4).
37. Southgate, E., et al., *Embedding immersive virtual reality in classrooms: Ethical, organisational and educational lessons in bridging research and practice.* International Journal of Child-Computer Interaction, 2019. **19**: p. 19-29.
38. Dahan, N.A., et al., *Metaverse Framework: A Case Study on E-Learning Environment (ELEM).* Electronics, 2022. **11**(10): p. 1616.
39. Jeon, J.H., *A study on education utilizing metaverse for effective communication in a convergence subject.* International Journal of Internet, Broadcasting and Communication, 2021. **13**(4): p. 129-134.
40. Jovanović, A. and A. Milosavljević, *VoRtex Metaverse platform for gamified collaborative learning.* Electronics, 2022. **11**(3): p. 317.
41. *Teaching in the metaverse is much closer to being in the classroom than in an online session*. Available from: https://dobetter.esade.edu/en/technology-virtual-reality-education.
42. Areepong, T., P. Nilsook, and P. Wannapiroon. *A study of a metaverse interdisciplinary learning community*. in *2022 Research, Invention, and Innovation Congress: Innovative Electricals and Electronics (RI2C)*. 2022. IEEE.
43. Shanmugam, A. and P. Balasubramanian, *Students Awareness about Online classes during the Pandemic of Covid 19 with Special Reference to Affiliated Colleges of Manonmaniam Sundaranar University, Tirunelveli.* Library Philosophy and Practice, 2021: p. 1-17.
44. Çaliskan, O., *Virtual field trips in education of earth and environmental sciences.* Procedia-Social and Behavioral Sciences, 2011. **15**: p. 3239-3243.
45. Bale, A.S., et al., *A Comprehensive Study on Metaverse and Its Impacts on Humans.* Advances in Human-Computer Interaction, 2022.
46. Sidin, S.A. *The Application of Reward and Punishment in Teaching Adolescents*. in *Ninth International Conference on Language and Arts (ICLA 2020)*. 2021. Atlantis Press.
47. Inceoglu, M.M. and B. Ciloglugil. *Use of Metaverse in education*. in *International Conference on Computational Science and Its Applications*. 2022. Springer.
48. Xi, N., et al., *The challenges of entering the metaverse: An experiment on the effect of extended reality on workload.* Information Systems Frontiers, 2022: p. 1-22.

Md Ariful Islam Mozumder was born in Bangladesh 1992, received his BSc in Computer Science & Engineering from the World University of Bangladesh, and an MS degree in Artificial Intelligence from the Inje University South Korea in 2022. Currently, he is pursuing his Ph.D. in the Institute of Digital Anti-Aging Healthcare from Inje University. He has previously worked on multiple real-life projects related to computer vision and data sciences. His research interest aligns with Computer Vision, Artificial Intelligence, Metaverse, Signal Processing, Algorithms, Blockchain, and Medical Image Processing.

Ali Athar was born in Pakistan 1988, received his MS degree in Software Engineering from the National University of Science and Technology (NUST) Pakistan in 2017. Currently he is pursuing his Ph.D. at the Institute of Digital Anti-aging and healthcare at Inje University. His research interest's area includes Metaverse, Text mining, Image Processing, Deep Learning, and Machine Learning.

Tagne Poupi Theodore Armand was born in Cameroon 1992, received Msc in information System and networking at ICT university USA Cameroon Campus in 2021. Currently, he is a Ph.D. research scholar at the Institute of Digital Anti-aging and healthcare at Inje University. His research interest's area includes Metaverse, Image Processing, Deep Learning, and Machine Learning.

Muhammad Mohsan Sheeraz was born in Pakistan 1996, received his BS in Computer Science from Government College University Faisalabad of Pakistan in 2019. Currently, he is pursuing his Master's in the Institute of Digital Anti-Aging Healthcare from Inje University. His research interest area is Blockchain in healthcare.

Shah Muhammad Imtiyaj Uddin was born in Bangladesh 1994, received his BSc in Computer Science & Engineering from the World University of Bangladesh in 2017. Currently, he is pursuing his Master's in the Institute of Digital Anti-Aging Healthcare from Inje University. His research interest's area includes Computer Vision, Machine Learning, and Deep Learning.

Hee-Cheol Kim BSc at the Department of Mathematics, MSc at the Department of Computer Science in SoGang University in Korea, and Ph.D. at Numerical Analysis and Computing Science, Stockholm University in Sweden. He is a professor and Head of the Institute of Digital Anti-aging Healthcare, Inje University, South Korea. His research interests include Medical Image Processing, Anti-Aging Healthcare Computing, Human Computer Interaction, Software Engineering, Machine learning, Metaverse, Bio Informatics.

ISBN 979-11-88428-10-6