

Applications and Possible Challenges of Healthcare Metaverse

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Abstract— A Metaverse is a world in which users can virtually interact with each other. It is a mixture of both augmented reality (AR) and virtual reality (VR), where users can perform different activities that give them a feeling of the real world. Overall, the metaverse is redefining the mode of our communication. The rapid modernization of technology has transformed all industries in the market, including the healthcare sector. After the announcement of the metaverse by the CEO of META, Mark Zuckerberg, the metaverse has received massive attention from the medical industry. Overall, the metaverse is considered a huge game changer in the medical industry in 2022 and 2023. With productive opportunities in the medical industry, metaverse technology is one of the most profitable and promising technologies. Metaverse is a modern technology that can address multiple issues in the healthcare industry, including virtual health and fitness, mental health, health access without geographical limitations, and connection with friends and family members. In this study, we summarize the use of the metaverse and its future directions in the healthcare industry. We also elaborate on the main challenges that might be faced when using metaverse technology in the future.

Keywords— AR, VR, Healthcare, Metaverse.

I. INTRODUCTION

Health is one the most important factors for people living in a country and it is highly dependent on the healthcare systems of that country. However, it is very difficult to make progress in healthcare without mitigating its challenges. Using manual and traditional methods of treatment is very expensive and time-consuming, so we need advanced technology to deliver health services remotely. In the last 3 years, Covid-19 has encouraged patients to get treated remotely [1].

Metaverse technology is more convenient for the patients as well as for the doctors as compared to traditional methods because it is more interactive, immersive, and recreational. Metaverse gives an environment to all its stakeholders in the virtual world with the help of other technologies such as artificial intelligence, blockchain, augmented reality (AR), virtual reality (VR), and telepresence [2]. Using a mixture of all these technologies, metaverse will provide a cost-effective and more efficient healthcare environment. By using the internet people can experience and feel human emotions virtually. So, the metaverse is a complete package of the social and economic structure of both the virtual and realworld [3].

Metaverse can be helpful to medical staff in curing different types of diseases using modern techniques. The first use of augmented reality was performed by the Johns Hopkins Medical lab in the mid of 2020. They underwent surgery for the fusion of six vertebrae of the spine of a patient who was facing back pain. During the entire process, they used seethrough eye displays, which helped them project anatomy images similar to X-ray vision [4, 5]. Metaverse can increase the productivity and efficiency of surgical procedures by converting CT scans into a 3D restoration, which helps surgeons focus and insulate the functional parts while performing important and serious operations [6]. The metaverse can also play an important role in the field of plastic surgery, where virtual avatars can precisely predict the results of possible plastic surgeries. Metaverse platform helps surgeons to perform simple to complex surgeries, such for example removing brain tumors and performing complex spinal surgeries [7]. In the field of radiology, the metaverse helps radiologists to see clearer and more dynamic images, resulting in precise disease findings and correct decisionmaking. Moreover, a radiologist from different parts of the world can collaborate and train each other to enhance their capabilities in 3D medical images to provide better treatment results. Metaverse dashboards provide an opportunity for doctors and nurses with an opportunity to visualize and meet their patients. Patients, On the other hand, patients can receive extra care by providing their updated information to the doctors, as compared to other traditional methods of treatment [8].

After the outbreak of Covid-19, remote healthcare services receiving extra attention from all the medical stakeholders and metaverse is the best candidate for them, because it has a greater potential to provide more advanced and modern technologies to its user's thanas compared all other remote healthcare services [8]. In a metaverse environment, while using AR glasses, patients can communicate live with their doctors and receive suggestions and timely treatment [9].

Metaverse can also provide an excellent learning environment for medical students and doctors. Using AR, medical staff can learn and obtain a virtual experience of different types of surgeries. Most famous medical colleges and universities prefer the use of AR, VA, and artificial intelligence methods to train their students and staff by simulating complex real-time methods and giving them a chance to learn ground-level features and information about the human structure.

According to the state, North America flourish in the global healthcare market in the metaverse, and because of the existence of many metaverse-concentrating companies, it has the potential to dominate other countries. Companies can make more profit by investing in the metaverse field because of the great healthcare infrastructure and easy integration of AR-VR devices [5].

Many researchers have explored the field of the metaverse. We have summarized these studies in the table given below.

TABLE 1. RELATED WORK IN HEALTHCARE METAVERSE

Paper	Contribution
[11]	How metaverse can be helpful to increase the performance and outcomes of education, medical care, monetization, fitness, and collaboration in the field of healthcare.
[12]	Scope of a metaverse in the field of healthcare using AR/VR technology.
[13]	Metaverse potential in healthcare using artificial intelligence and other smart intelligence devices.
[14]	Use of metaverse to enhance the outcomes of telemedicine, telesurgeries, and personalized care.
[15]	Brief description of the scope and possible challenges of a metaverse in the healthcare sector.

The rest of the paper is organized as follows: sector 2 explains the application of the metaverse in the field of the metaverse. Section 3 elaborates on possible challenges of the metaverse in the healthcare sector. Section 4 explains the conclusion and future work.

II. APPLICATIONS OF HEALTHCARE METAVERSE

Metaverse has a great potential in the field of healthcare. It can be used in many applications some of them have been explained below. Moreover, Figure 1 illustrates the applications of healthcare metaverse.

A. Content Creation

There are several means which produce the data on daily bases as “the statistics say people on the internet created 2.5 quintillion bytes of data every day in 2022”. As content generated from other tools helps to make many decisions in the metaverse healthcare sector, the whole of the sector depends upon the data. They decide on behalf of the data and suggest any treatment or medication. When most people start using a metaverse environment for treatment, data will rapidly increase and help medical specialists make decisions on different diseases.

B. Enhanced Medical Visits

Metaverse provides a platform through VR using this environment, and doctors can easily interact with each other without facing any hurdles or problems. They can easily communicate through this virtual environment and discuss any treatment process and medication outcomes. People who have cardiac issues should undergo virtual consultations rather than physical visits. Depressed people or those who have any mental or physical issues can take the services of a psychologist through this environment without showing their identity, and many other patients with other diseases can discuss with their physician, specifically those who live in remotes areas, and it

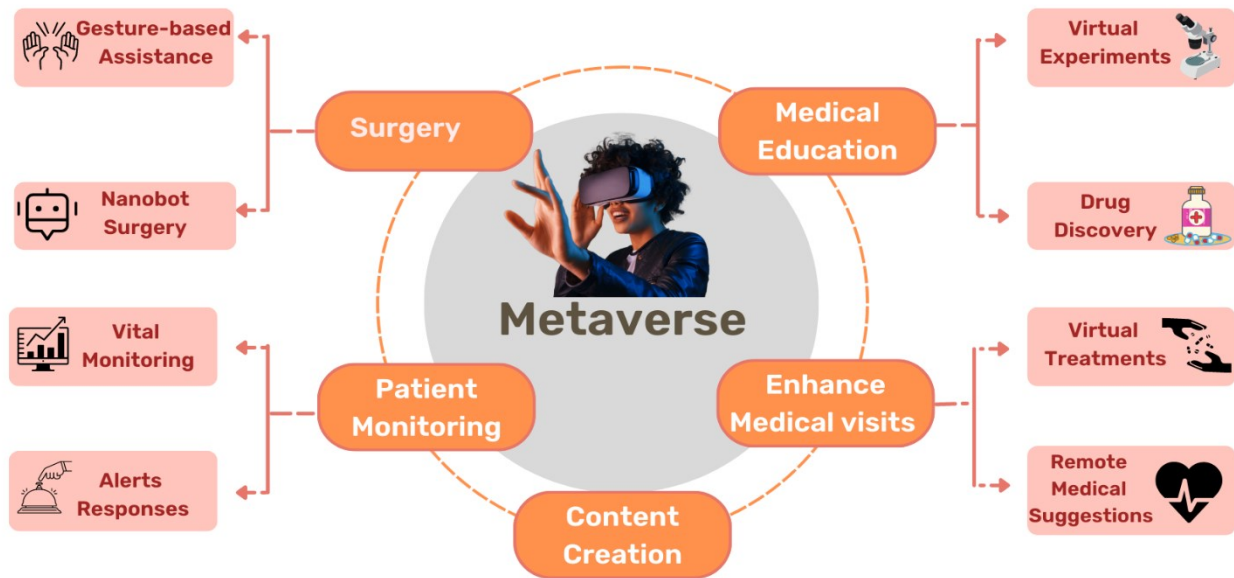


Figure 1. Applications of Healthcare Metaverse

hard for them to go to the hospital. They can easily perform basic body tests such as blood pressure, body temperature, heartbeat, and a few others, and receive telemedicine [10, 11].

C. Surgeries

Metaverse is becoming an important technology in the medical sector, particularly in surgery. During covid-19 when most medical professionals have been stuck to performing surgeries and trying to find new alternative solutions. During this time, SNU Bundang Hospital's smart operating room made this possible, and they achieved their big goal using metaverse VR. It contains six lenses in a virtual reality camera that shoots 360° in all directions, a high-resolution camera, and fluorescent imaging equipment. Surgeons did lung surgery through this smart room considering the best achievements and this smart operating room gets appreciation from whole over the globe [12].

D. Medical Education

There have been several new developments in every field during the pandemic. Many new tools have been invented and introduced by companies for virtual education. A metaverse environment also provides such an environment for students or researchers in any field to communicate and interact with each other in the virtual environment. Specifically, it is more beneficial for medical students who have a tough routine in clinical jobs and are unable to attend conferences, workshops, and other related events [11, 12]. There are also some other major changes in the medical teaching mode, most practically performed through the virtual patient. It also makes it easy for medical students to gain practical experience.

E. Patient Monitoring

During the pandemic period, most people receive remote medical treatment and suggestions from medical experts by using different social media channels [13-15]. Patient monitoring is still a big challenge during covid-19, but metaverse provides an environment where interactions between doctors, patients, and their families can virtually connect. Even if a patient's family lives anywhere around the globe, they can discuss their health condition with their physicians. They all discussed the improvement and further treatment procedures through this virtual environment. Their family members can play a better role in the overall improvement of the health condition of their patients [16].

III. POSSIBLE CHALLENGES IN THE HEALTHCARE METAVERSE

Although the metaverse is going to change the world with its potential and scope, there are some challenges and issues that should be considered while implementing the metaverse, specifically in the healthcare industry. Figure 2 summarizes the possible challenges and issues in the healthcare metaverse.

A. Deepfakes Spoofing Attacks

In the metaverse, the big problem of deep fakes has differentiated the originality of data. It is important to understand the value of real content, which displays whether the

data belong to the original patient, or some other person stole or gets the same data and tries to present some other data.

Spoofing attacks directly affect the originality of healthcare databases. However, it is very important to present the real data in the metaverse because it is crucial for the sufferer and difficult for a medical specialist to differentiate between the data [17]. It directly affects patient data integrity and the diagnosis process. As diagnosis is an important procedure in determining the type of disease and medications to be provided accordingly, if there is any ambiguity in detection, the outcome of the medication may cause a large loss [17].

B. Information Leakage Issues

Different virtual healthcare medical service providers gather data from different patients in numerous ways. On behalf of this digital content, medical specialists provide treatments in a much better way through a metaverse virtual environment [17]. Recent research on virtual reality and augmented reality found that the metaverse can be used for diagnostic and surgical processes and relief of pain, stroke, anxiety, depression, fear, cancer, and a few other diseases, with better results [4]. The communication between doctors and patients is through VR, so they both exchange information with each other through metaverse, so it is still a big risk for a patient because they do not have data integrity. However, hackers or attackers can steal their personal information at any point, which may lead to negative consequences when proceeding with medical treatment through the metaverse platform [17].

C. Establishing Trust Between Stakeholders

It is fundamental to ensure a fast, efficient, and trusted cross-platform for taking any service; however, when any person wants to take any medically related service, they must want to ensure that their stakeholders will interact with them physically or remotely. While taking any other online services, users do not e.g., to think about the service or share their little information with any facility, but while taking medical services specifically through a metaverse environment, they need a trusted medical service provider organization that ensures that they make their data in safe hands. However, if data are not secure and are under the access of any other organization or person, they can make changes in content. If any part of the data changes, they cannot properly diagnose the disease, which may affect the service provider and directly affect the metaverse [17].

D. Legal and Regulatory Challenges

Owing to the advancement of technology, most people prefer to use services that save their time and are easily accessible to them; likewise, a metaverse environment for the healthcare domain is a faster way to diagnose their disease and get their medicine. As the metaverse grows rapidly in the healthcare sector, healthcare providers, insurance, and pharmaceutical companies provide efficient services to patients, causing regulatory challenges. Metaverse does not have any specific rules or regulations for any domain that gives freedom to every

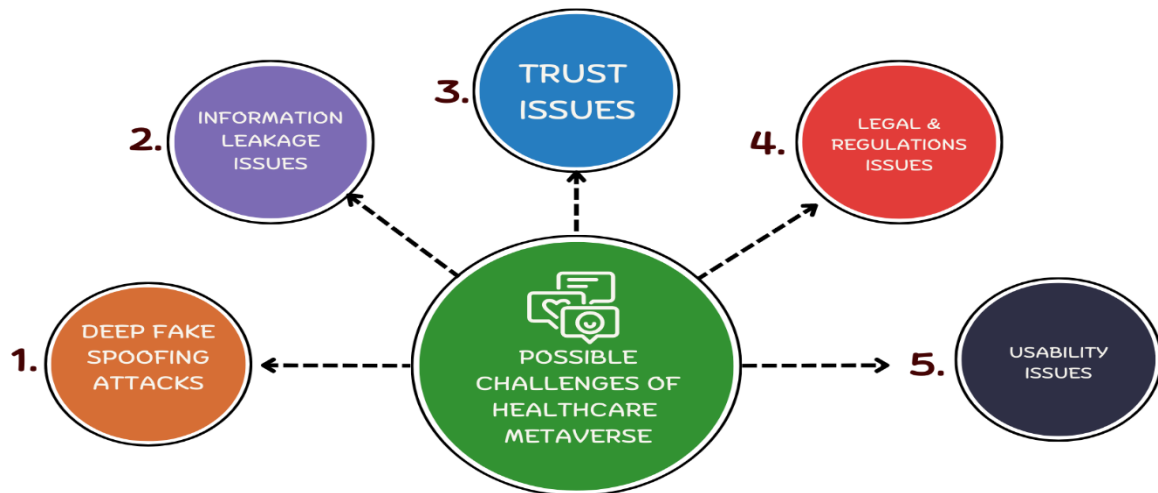


Figure 2. Possible Challenges of healthcare metaverse

stakeholder. They must ensure and define proper policies to act against all illegal actions in a virtual environment [12].

E. Usability Among the Visually Impaired Population

There has been a rapid increase in the use of meta verse environments for a couple of events; however, it is challenging in the healthcare domain for low-eyesight or blind people because it is very difficult for them to get any sort of benefit from this virtual environment or take the facility of treatment from the metaverse [15].

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IV. CONCLUSION

The healthcare industry is progressing daily. Every healthcare organization wants to provide a secure, responsive, and rapid environment for its stakeholders to compete in the healthcare market. Telemedicine has attracted people very rapidly in the past few years, specifically during the pandemic period. People prefer remote examination and treatment to traditional and manual treatments. In this paper, we briefly provide an overview of the healthcare metaverse, its applications of the healthcare metaverse, and its possible challenges in the healthcare industry. In the future, we can further explore healthcare metaverse, and we can see how much the metaverse has the potential for its application in a specific field of healthcare. We can try to minimize the possible threats and challenges of the healthcare metaverse in the future.

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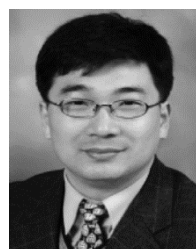
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