What the Literature on Medicine, Nursing, Public Health, Midwifery, and Dentistry Reveals: An Overview of the Rapidly Approaching Metaverse

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Abstract— What is being done in the metaverse literature in a variety of health-related fields, including Medicine, Nursing, Public Health, Midwifery, and Dentistry, and what topics are explored in this literature? In this study, a content analysis of the studies linked with the term metaverse in all health-related literature is presented. The studies were carried out on the documents accessed in Web of Science and Scopus searches made with the words "Metaverse" and "metaverse" on 06/05/2022. For 312 papers, data was retrieved from the Scopus bibliometric database, and for 240 publications, data was retrieved from the Web of Science data source. In the field of health, there haven't been many direct studies on metaverse technology. This is because metaverse technology is made up of many different technologies that work together and are always getting better. Some of these technologies are augmented reality, social networks, virtual reality, blockchain technology, artificial intelligence, and avatar. The study also tells field researchers about metaverse studies that are important in the health sector and about changes in the literature as a whole. According to the research areas, the documents found had to do with the field of health, and only the researches in the field of health were evaluated. It is interesting to think about how metaverse technology will change scientific research, health services, and health-related processes. The study looks at the current state of the literature on metaverse technology, as well as the future of the field and what it can do. Virtual reality or augmented reality applications have defined themselves as augmented reality under the metaverse. These applications are most useful in critical situations in the health sector and in processes that are hard and must be done by trial and error. In addition to the tremendous advances in technologies (blockchain, computer vision, haptic devices, sensors, computer networks) with which metaverse technology is associated in recent years, the mechanical resolution of the sense of touch in the Nobel Peace Prize in physiology and medicine received in 2021 can be seen as one of the field's critical milestones. The growth of the field and past experiences show that many real-world applications can be moved to the metaverse universe in the future. One of the fields that will be affected the most by this interaction is health care.

Keywords— Health, medicine, nursing, midwifery, dentistry, metaverse.

I. INTRODUCTION

The health system does not appear to be sustainable in the future due to the strain produced by chronic illnesses, rising health-care expenses, a rapidly aging world population, an inadequate workforce in high-demand health-care services, and limited resources. Instead of traditional health services using cutting-edge technology, we need to be able to deliver health services from hospitals to our homes using cutting-edge technology. The Covid-19 outbreak has prompted significant changes in the world of medicine, encouraging patients to seek new ways to give remote care to patients outside of hospitals [47].

The following technologies are important and critical for the Metaverse architecture: augmented reality (AR), virtual reality (VR), user interaction, computer vision, artificial intelligence (AI), and blockchain, robotics and the internet of things, edge computing, computer networks, and hardware infrastructure [14]. With the technology it contains in health services and the huge breakthroughs in technologies that are its stakeholders, the metaverse, which has the ability to influence all sectors in some manner, may create a great shift and revolution.

Professionals in a variety of fields can utilize virtual and augmented reality technology to prepare for unusual events or to hone current skills and competences. The health industry is a critical area where this technology is being used extensively and effectively [14]. Governments in Europe, Asia, and America devote enormous resources to research and development [56]. The implementation of these technologies in education processes has grown in relevance, particularly in pandemic processes like as Covid 19. While face-to-face contact becomes more difficult as Covid-19 spreads, previously thought-to-be offline activities are changed into virtual reality and swiftly expand to education, medical care, fashion, and other industries [28].

Jeon [21] mentioned in his study that universities are making attempts to teach talents who will live in the fourth industrial revolution era, and they are developing comprehensive designs so that students may learn subjects based on societal needs and acquire problem-solving ability. They also mentioned that they are attempting to use the most effective teaching-learning approaches. In this regard, metaverse was employed for course practice in the anatomy course at Seoul National University, and students had the

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opportunity to investigate and practice the anatomy of the human body using VR and AR technology.

According to Türk et al. [49], the seeds of the metaverse were planted with the further development of technologies like virtual reality, augmented and mixed reality (XR), wearable technologies, blockchain, NFT, and the internet of things. They also said that creativity in the metaverse would be limitless. Also, one important thing we don't know about how the metaverse will be used is whether it will be one world or more than one. Facebook is already moving quickly in the direction of making its own metaverse environment. Google and Microsoft might do the same thing and build their own Metaverses. In Metaverse, each tech giant might have its own platforms, product family, and formations and product groups [1].

Artificial intelligence, virtual reality, augmented reality, the internet of things, edge computing, etc. are some of the technologies that will make it possible for metaverse technology to be used in health services. These technologies are used in many fields, such as education, research, patient care, rehabilitation services, and clinical applications. There are many opportunities for metaverse integration, and it will be beneficial [55]. Virtual reality and augmented reality are becoming more important every day, so it's important for health professionals to talk about them. Also, it's clear that studies that include current technologies and show how they relate to and help the field will be useful for professionals, students, trainers, and researchers in many health fields, such as medicine, dentistry, nursing, and midwifery. In the study, health studies are focused on metaverse technology, and its possible effects on health education and areas of use are looked at in depth. The study is thought to be important because it will show what the current state of metaverse technology is in the field of health. People are interested in how it will affect health processes from a scientific research point of view, and they want to know what the future holds for the field and what opportunities technology can bring.

II. METAVERSE DEFINITIONS AND METAVERSE PLATFORMS

The metaverse, according to Koo [23], is the virtual replication of reality. It has progressed a step beyond cutting-edge technology that allows individuals to have lifelike experiences in virtual reality and the virtual world produced by computers, according to Lee and Kwon [29]. According to Werner et al. [53], the notion of metaverse adds many new characteristics to medical field communication and is a network of virtual spaces where individuals and digital objects may interact. According to Ball [4], he tracked the evolution of the metaverse through eight components: hardware (*f:*1), networking (*f:*2), compute (*f:*3), virtual platforms (*f:*4), interchange tools and standards (*f:*5), payments (*f:*6), metaverse content, services, and assets (*f:*7), and user behaviors (*f:*8).

In the model designed by Radoff [41], metaverse layers include infrastructure (5G, wifi 6, 6G, cloud technologies, etc.), human interface (mobile devices, virtual reality tools, wearable devices, smart glasses), decentralization (edge computing, microservices, blockchain, etc.), spatial computing (augmented reality, virtual reality, motion recognition, spatial mapping, etc.), producer economy (design tools, digital exchanges, commerce), and exploration (agents, ad networks, stumbling blocks) (games, theatre, socializing, shopping, etc.). The seven strata of the metaverse.

The Metaverse is an aesthetically rich virtual environment with a lifelike quality in which individuals may work, play, shop, and interact. It is a network of three-dimensional virtual environments centered on social interaction. A virtual platform that allows developers to construct everything from virtual reality to augmented reality is known as a metaverse platform. Metaverse is a technology category that has gone a long way, and its growth is rising because to investments from major technology firms such as Meta Platforms, Microsoft, and Epic Games [52]. Metaverse is a virtual reality platform built on the blockchain [40]. Metaverse is a network of 3D virtual worlds that use technologies like VR and AR to connect people [42]. Virtual reality or augmented reality applications have identified themselves as augmented reality under the metaverse, notably in important places in the health sector, in procedures that are difficult and critical to perform via trial and error approach.

The metaverse market is expected to expand from $45.5 billion in 2019 to $1.5 trillion in 2030 [1]. Decentraland, The Sandbox, Cryptovoxels, Somnium Space, Roblox, Bloktopia, and Meta Platforms are seven firms that pioneered the advent of the Metaverse and secured the market's quick expansion [54]. Roblox, for example, is a popular platform among both children and adults, with over 20 million games produced on it. The Ethereum blockchain powers Decentraland, a 3D virtual reality realm [36]. It is collaborating with a number of partners from the entertainment, banking, gaming, real estate, and Hong Kong film sectors to develop the SAND money and a virtual Mega City in Sandbox [42].

III. DIGITAL HUMAN

Humanization of AI, useful AI applications, and the creation of autonomously animated digital individuals are all examples of digital humans [46]. Digital people are intended to integrate with any knowledge base, NLP, or other data source. Digital people are lifelike AI-powered humans that can see, hear, and comprehend you, your workers, patients, or clients, allowing them to reproduce "genuine" human exchanges. In addition, digital persons are used as customer service agents, sales concierges, financial advisers, brand ambassadors, digital influencers, customer support representatives, and healthcare consultants. It is used in a variety of industries, including banking, finance, education, real estate, the public sector, entertainment, healthcare, retail, telecommunications, and software technology. Furthermore, 88% of people who engaged with the artificial person thought the digital human was natural. 89% of users said they would prefer digital customer assistance from a human [50].

It is an excellent output for the metaverse world's reality perception, and it may also be expressed as a high-level avatar that is creative and extremely near to reality perception. The fact that this technology is becoming more prevalent is very encouraging.

According to Bickmore et al. [6], strong communication and quality relationships between healthcare personnel and their patients are increasingly acknowledged as a significant component in enhancing not just patient satisfaction but also treatment outcomes across a wide range of healthcare disciplines. Relational agents have been employed with a variety of patient demographics for health education and behavior modification interventions [5-6], and they are also used in the hospital bedside patient education system [7]. They claim that people suffering from depression are more

comfortable communicating with an avatar than with a real person [7]. Many studies have shown that a good therapist-patient connection has a favorable influence on results, particularly in psychotherapy [6].

This concept, originally known as relational agencies, is now known as digital humans in the metaverse world. With its more human-like aspect, digital human, which develops on top of relational agency technology, has usage areas in many different sectors such as augmented reality, electronic commerce, customer relations, which may concern every sector, as well as health, education, film, fashion, and game sectors. Furthermore, he can continue to serve as a guidance and psychiatric counselor in the metaverse by assisting students with a wide range of challenges encountered during their educational processes, such as digital human, virtual, and augmented reality technology.

Avatars are a key stakeholder technology in the metaverse supply chain. This is the digital person, a concept that has just emerged in avatar technology. It can communicate with digital human, particularly through various communication modes such as desktop, mobile, tablet, or kiosk. A digital human is an application that simulates a person's attitude, behavior, and motions. Digital natives are not just concerned with language. They can give you sentiments of enjoyment, empathy, and genuineness. It can grasp the meaning of words by understanding the tone of voice and facial expressions of users, much like a person. They can then employ their natural human tone of voice and body language. As digital chatbots, digital people may be deployed. Torre [48], particularly the top ten list of the greatest businesses generating digital persons and/or avatars that take human-computer interaction to a new level, are as follows: REBLIKA - The Character Company (https://reblika.com/), Synthesia (https://www.synthesia.io/), UneeQ (https://digitalhumans.com/), Soul Machines (https://www.soulmachines.com/), Th3rd (https://3dsaas.com/), Twindom (https://web.twindom.com/).

IV. METAVERSE TOOLS, HAPTIC DEVICES, HOW THE 2021 NOBEL PRIZE RECEIVED AFFECTS

In addition to the tremendous technological advancements (blockchain, computer vision, haptic devices, artificial intelligence, virtual reality, augmented reality, sensors, computer networks) associated with metaverse technology in recent years, the 2021 Nobel Peace Prize in physiology and medicine for the mechanical resolution of the sense of touch can be viewed as one of the most significant milestones. Many real-world applications will be able to be translated to the metaverse environment in the future, as demonstrated by the fact that the field has progressed and benefited from prior experiences. The healthcare industry will be one of the areas most affected by this relationship.

A haptic device is a device that lets the user and the computer share information in three dimensions. With this device, the user can not only see an object in a virtual environment, but also touch it. At the same time, this device makes it possible to get data from a real object and use it in a virtual one. Today, the use of haptic devices is growing in business, education, and medicine. This is happening at the same time that virtual reality technology is getting better. With this technology, which has a lot of potential for use in medicine, complex changes that used to have to be done by hand can now be done (operations that do not accept mistakes in neurosurgery). For all haptic applications, virtual reality modeling languages like FreeForm, Concept, Mimics, and so on have also been made. With these new developments, haptic devices can be used in more situations [3].

The 2014 Nobel Prize in Physics was awarded to three American and Japanese scientists who invented blue light emitting diodes (LEDs). In the early 1990s, academicians Isamu Akasaki, Hiroshi Amano, and Shuji Nakamura created the first blue LEDs. This enabled the production of a new type of brilliant, energy-efficient white lighting and color LED displays. In the 60 years after the first physics Nobel Prize was awarded, the prize that has had the greatest impact on daily life is without a doubt the prize for relativity [38].

What occurred in 2021, for what did the Nobel Prize go, and how will this invention impact the future of the metaverse? David Julius and Ardem Patapoutian provided the mathematics and formula for the perception of reality through the sense of touch in 2021. David Julius is an American physiologist who discovered "a heat-sensitive sensor in the skin's nerve endings". The molecular biologist and neurologist Ardem Patapoutian discovered "a unique class of sensors that respond to mechanical stimulation in the skin and internal organs". Both findings elucidated "how heat, cold, and touch may trigger impulses in our nervous system," which is crucial to several physiological processes and diseases. Temperature heat pain (core body temperature, inflammatory pain, neuropathic pain, visceral pain, protective reflexes) and touch proprioception (mechanical pain, urination, respiration, blood pressure, skeletal remodeling) were used to describe this case [11].

V. CURRENT METAVERSE PLATFORMS IN HEALTHCARE

Virtual, augmented, and mixed reality (XR) technologies have the potential to improve the quality and delivery of health education. Utilizing these technologies allows healthcare workers to practice in a secure environment without worry of adverse effects. It gives inexpensive interactive learning at a high level to its consumers [32]. Metaverse has significant potential for use in clinical treatment. Real-time guidance can be offered in the surgeon's field of view via immersive simulations of surgical procedures. By delivering information in the sterile region of the operating theatre, augmented reality will boost surgical precision and adaptability. Metaverse will enable collaborative medical operations and concurrent teaching, training, and planning [47]. Thanks to the Metaverse environment, several healthcare service applications may be successfully digitalized and implemented on various platforms. Future integration of XR applications in service delivery by health institutions with the metaverse will enable institutions to notice possible problems early and conduct proactive reviews to avert harm [55].

Consideration is given to how the metaverse may be utilized in the future to enhance, improve, and possibly transform health care. Collaboration, education, clinical care, wellbeing, and profit are the five topics discussed [47]. According to Sandıkçı [44], when virtual reality is applied to health, this technology will have a prominent position in the health industry. It is also anticipated that it would generate a substantial market in the health industry. They added that as time goes, technical advancements would reduce expenses, allowing for more work to be done in this field.

Hawks and Krasniansky [17] categorized digital health applications in the metaverse environment into two categories.

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The first is immersive environments (virtual or hybrid worlds that health care providers and patients interact with for educational, assistive, or therapeutic purposes), and the second is digital twins (representations of real-world entities that exist in virtual worlds and can be manipulated to gain insights) for healthcare decision making. In the healthcare profession, three immersive environments are instructive (Embodied Labs, Giblib, Health Scholars, Osso VR), assistive (Augmedics, Thirdeye, Vicarious Surgery), and therapeutic (Applied VR, BehaVR, Floreo, Luminopia, OxfordVR, Tripp, XRHealth). specified in the title Also, digital twin, muscle groups and organs (Siemens Healthineers, Virtonomy.io), individuals (Babylon, Bio Twin), and populations (Unlearn).

The usage of augmented reality in the health industry has a considerable influence on the training and development of future medical professionals' skills and knowledge bases. In the health care industry, the metaverse has several applications. Patient education, mental health, pain management, medical testing, surgery (remote surgery, telepresence, augmented reality surgery), therapy (treatment planning), medical marketing, medical education (3D human models for education), and illness awareness are examples (virtual patients, medical education) It is accessible for use in therapy, psychotherapy through virtual reality, haptic-assisted rehabilitation, preventative medicine, and patient education, as well as in real-time e-surgery learning, training (architectural design for healthcare facilities), and institutional medical domains [37].

VI. METHODOLOGY

On June 5, 2022, Web of Science and Scopus were used to gather data. When the words "metaverse" and "meta verse" were used in searches on Web of Science and Scopus, 312 documents were found in the Scopus bibliometric database and 240 documents were found in the Web of Science bibliometric database. The data that was gathered was filtered bibliometrically based on the areas of research, with a focus on the health field. A full evaluation of the content of research in the field of health was done. For the study's discussion, Google Scholar was used to look up metaverse and related ideas, and related articles were used in the article. Google Scholar is also used because the number of publications found through Web of Science and Scholar resources is lower than expected. Through Google Scholar, more recent and more publications on the metaverse have been found.

The study presents an assessment of the global work done in the field of health in virtual reality and augmented reality. The research questions we focused on in our study;

- Is the metaverse a utopia and a current technology that has the potential to rapidly affect all professions in the health sector (such as medicine, nursing, public health, midwifery, dentistry)?

- What are the digital platforms that exist in our daily lives and what kind of applications and scientific studies have been carried out in the health sector?

- What kind of scientific discussions are held in scientific publications published in journals scanned by Web of Science and Scopus?

VII. RESULTS AND DISCUSSION

A. Thorough Review of Web of Science and Scopus

The research fields of our 240 Web of Science pages are as follows; computer science (f:82), engineering (f:46), education educational research (f:30), business economics (f:20), communication (f:16), psychology (f:16), art (f:11), arts humanities other topics (f:11), science technology other topics (f:11), chemistry (f:8), environmental sciences ecology (f:8), information science library science (f:8), telecommunications (f:8), imaging science photographic technology (f:6), physics (f:6), cultural studies (f:4), materials science (f:4), public environmental occupational health (f:4), social sciences other topics (f:4), dentistry oral surgery medicine (f:3), geography (f:3), government law (f:3), instruments instrumentation (f:3), linguistics (f:3), optics (f:3), public administration (f:3), religion (f:3), energy fuels (f:2), operations research management science (f:2), philosophy (f:2), architecture (f:1), automation control systems (f:1), dermatology (f:1), general internal medicine (f:1), geology (f:1), health care sciences services (f:1), music (f:1), social issues (f:1), sociology (f:1), theater (f:1), transportation (f:1), veterinary sciences (f:1).

It is seen that the research areas where the studies are concentrated are mostly computer science, engineering, education educational research studies. A total of ten papers were discovered in the fields of public environmental occupational health (f:4), dental oral surgery medicine (f:3), dermatology (f:1), general internal medicine (f:1), and health care sciences services (f:1). The year that the associated investigations were conducted vigorously was 2022 (f:7). This review of the literature indicates that health researchers will enhance their interest in the metaverse in the literature in recent years.

312 documents were discovered on Scopus. On Scopus, 13 different papers (medicine:7, health professions:3, dentistry:2, nursing:1) have been reached. The documents are listed in the following order; computer science (f:201), engineering (f:78), social sciences (f:67), mathematics (f:37), arts and humanities (f:35), business, management and accounting (f:32), decision sciences (f:18), physics and astronomy (f:16), psychology (f:14), materials science (f:13), economics, econometrics and finance (f:11), environmental science (f:8), medicine (f:7), chemistry (f:6), energy (f:5), biochemistry, genetics and molecular biology (f:4), chemical engineering (f:4), neuroscience (f:4), earth and planetary sciences (f:3), health professions (f:3), dentistry (f:2), agricultural and biological sciences (f:1), multidisciplinary (f:1), nursing (f:1), veterinary (f:1).

The materials retrieved from both bibliometric data sources were largely in the form of letters, proceedings, and editor notes rather than articles. The number of papers in the field of health on the metaverse is 13 on Scopus and 10 on Web of Science. Furthermore, six studies retrieved from Web of Science were indexed by Scopus. As a result, the total number of articles found in the two databases is 17. However, more exams revealed that a thorough investigation was conducted on technologies that are stakeholders in metaverse technology. In recent years, this scenario has just lately begun to establish identification with the metaverse term and grouped under an umbrella with engagement via social media or network.

B. Evaluation of Publications Obtained on Web of Science

Ifdil et al. [19] stated in their study that the metaverse has become a popular topic of conversation, that mental health professionals can take advantage of the opportunities on it, and that virtual reality in the metaverse for future mental health assistance professions can be an alternative solution to the COVID-19 pandemic's mental health challenges.

Using the bibliometric technique, Liu et al. [30] examined the methods and outcomes of treatments for post-traumatic stress disorder, anxiety and fear-associated disorder, nervous system disorders and related medical problems, which are the four primary study fields of VR-assisted therapy. He underlines the health care potential of VR, highlighting its advantages of customization, compatibility, affordability, accessibility, incentive, and ease. He also notes that VR-assisted therapy is useful for a range of medical disorders. These benefits enable the incorporation of VR technology into a number of therapies and assist conventional therapies in overcoming the constraints of physical variables that are significant in the context of the present coronavirus disease 2019 (COVID-19) epidemic. In addition, they asserted that the capabilities of VR will facilitate the realization of the Health 4.0 goal and even the exciting future Health Metaverse vision.

According to Locurcio [31], a feeling of presence (the student's perception of being there) has traditionally been seen as crucial for successful learning and proper patient care. In view of the recent two years of mandated social isolation, he suggested that possibly the 'old' telemedicine experience might be upgraded to be more immersive. Additionally, he stated in his research that dentistry education in the metaverse is an extension of the internet that enables people to communicate with one another and their surroundings. They observed that this engagement is also possible through the use of various technologies, such as virtual reality (VR) and augmented reality (AR). He emphasized that despite the fact that these situations may appear remote from our regular educational activities or exclusive to research facilities, they are a reality for solving complex scientific issues.

In his research of dentistry in the metaverse, Kurian et al. [24] predicted that dentistry will play a larger role in medical health applications inside the metaverse technology in the near future. Soon, we may have dental telehealth chats in a virtual metaverse where avatars provide patients with dental guidance. With x-ray or three-dimensional photographs of the canal morphology, we can even observe in your live view that you have performed a root canal, implant placement, and the exact position of the implant and bone during surgery. Kurian et al. [25] stated that greater accessibility is one of the most significant benefits of metaverse technology and that it can provide convenience in accessing dental health for people with limited means, with the added benefit of participating in sessions from anywhere in the world without incurring travel expenses. It also gives an advantage for upgrading teaching models, since several dental education situations may be created.

While Google Earth carried the mirror world function, Second Life assumed the virtual world function. The researchers assessed the viability of a useful project, such as managing emergencies and disasters in real time with Second Life and Google Earth and developing emergency/public health virtual situation rooms. It enables users to perceive, interact with, and even traverse the created world utilizing the

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implemented applications. The strategy of connecting the three-dimensional environment and the virtual world in such platforms would pique the interest of many applications in the near future [8], particularly in light of Mark Zuckerberg's declaration and the renaming of his firm to meta.

According to Boulos et al. [9], the joy of living in a three-dimensional virtual environment is identical to the pleasure of living in the actual world. Additionally, they claimed that in this virtual environment, two people/avatars may readily identify and value one another's presence. They indicated that they can gain insight into the capabilities of others. Researchers analyzed ways to create Web GIS applications for infectious disease surveillance using period-appropriate technology.

Hassouneh and Brengman's [16] study found that social virtual world users spend millions of dollars on virtual goods and services, yet there are significant security, safety, and privacy issues. Using metaverse technology, Lee & Kwon [29] was experimentally evaluated on alpha generation users who test and purchase cosmetics face-to-face in the cosmetics sector. The objective is to leverage the metaverse as a significant marketing tool by understanding the changing demands of customers in huge markets, such as the cosmetics sector.

C. Evaluation of Publications Obtained on Scopus

In his study, Koo [23] explains that the coronavirus pandemic has made it difficult to provide medical education across international borders, and in particular, it has become nearly impossible to observe surgeries in order to observe and learn about high-tech medical equipment from other countries. In Korea's smart operating room at Seoul National University Bunag Hospital, they conducted an educational practice research in lung cancer surgery utilizing the metaverse and augmented reality. In their study, they described a metaverse training session held in Korea and discussed the potential future applications of this technology in the medical industry. Combining AR and VR, this training session is an example of XR implementation. Due of Covid-19, they added, students have less opportunities to work directly with patients, and it is difficult to provide appropriate surgical instruction using existing video conferencing tools such as Zoom.

In their study, Kim [22] found that such a high level of interest in a technology that has not yet been deployed is an extremely rare and singular occurrence. It is believed that the fast growth of information technology over the past several decades has convinced society that the metaverse could be established quickly. Virtual reality (VR), augmented reality (AR), spatial network, and immutable token (NFT) are among the metaverse's fundamental principles. With the use of special wearable equipment, Metaverse aims to create a virtual three-dimensional realm that resembles the actual world in appearance and feel, and to allow several individuals to interact in this space.

In his study, Huh [18] analyzed the use of computer-based testing in the Korean Medical Licensing Examination on the metaverse. According to them, the popularity of augmented reality, lifelogging, mirror world, and virtual reality has grown dramatically in recent years.

In their study to explain the possibilities and limits of the metaverse for educational applications, Kye et al. [28] classified metadata as augmented reality, lifelogging, mirror

world, and virtual reality. Virtual reality is the most active and widely utilized technology in metaverse type education among the four related types. The most recent phase of non-face-to-face communication has been marked by the regular use of virtual reality, which may be accessed regardless of location or distance. In addition, he argued that the metaverse is a new sector of social communication with limitless possibilities.

For contemporary subjects such as metaverse systems, virtual reality, and contactless systems, it is crucial to comprehend head movement. In their study, Ionut-Cristian and Dan-Marius [20] give a review of the technical literature on head motion monitoring systems based on inertial sensors published during the last decade. This paper provides a summary of available head motion tracking systems utilizing inertial sensors. The related literature has applications in various fields, including medicine, entertainment, health monitoring, and sports education, for the recognition and classification of human activity, which occupies an important place in the metaverse, as well as the determination of head movement and activities via wearable devices.

The healthcare industry is already utilizing augmented reality (AR) resources and has much to gain from this future technological development [10,51]. Werner et al. [53] reported that Metaverse has begun to be used in fetal medicine and gynecology, and that the study's objectives range from the ability to view an imaging array of two-dimensional cross-sections to a collaborative navigation within a three-dimensional organ by training experts from different fields in multidisciplinary discussions that occur in real time and across geographic boundaries. They indicated that they intend to include variable features.

According to Werner et al. [53], metaverse has tremendous potential as a digital tool to assist students in enhancing their collaboration with multidisciplinary teams and comprehension of difficult prenatal abnormalities and gynecological diseases. Therefore, it has a useful application as a teaching aid.

Liao and Kang [57] stated that, smart care has been a trend in care facilities and households in recent years, and ambient assisted living (AAL) has been a subject of rising scholarly attention in the last decade, paralleling societal aging and the proliferation of internet and mobile technology. They also noted that at the extreme of AAL is "above science", a situation in which human functions are heavily superseded by scientific technologies, which not only jeopardizes the health of older people, but also exacerbates the progression of dysfunctions by ignoring their desire for self-esteem and autonomy. As a result, the goal of AAL should be to develop a web ecosystem rather than a linearly clustered mix of computerized instruments.

VIII. STRENGTHS AND LIMITATIONS

Korean studies were met often throughout the study. The appraisal of these conversations in the literature is insufficient at this time owing to translation issues. In addition, when the document type of the research was reviewed, it was discovered that there was an abundance of letters and editorials. These materials are of a generic nature and do not contain exhaustive information about the evolution of the subject or a particular advancement in the area. Although this circumstance makes the search for the field appear vigorous,

the quality of the resulting documents is unclear. This might be due to the issue being current.

IX. DISCUSSION, CONCLUSION AND RECOMMENDATIONS

In the study, field researchers were supplied with information regarding metaverse studies in the health sector and general trends in the literature. According to the study fields, the received papers were correlated with the field of health, and only the health-related research was evaluated. Virtual reality or augmented reality apps have characterized themselves as augmented reality inside the metaverse. These applications are prominent in the health care industry and in procedures that are difficult and crucial to implement via trial and error. In addition to the tremendous advances in many related technologies (blockchain, computer vision, haptic devices, sensors, computer networks) in recent years, the mechanical resolution of the sense of touch awarded the Nobel Peace Prize in Physics in 2021 is one of the most significant milestones for the field. Many real-world applications will be able to be transferred to the metaverse environment in the future, based on prior experiences and the field's evolution. It is believed that this breakthrough, which was awarded the Nobel Prize, would boost the perception of reality in the metaverse universe and the level of reality perception recorded by haptic technologies in particular. Health might also be considered one of the industries that will be most significantly impacted by this connection.

The constantly expanding need for health employees, along with the quick opening of new departments and programs to fulfill this demand, necessitates the improvement of the skills and capabilities of newly graduated health professionals. The infrastructure and opportunity afforded by Metaverse technology give significant prospects for enhancing the education of health care workers. Specifically, augmented reality technology has evolved as a vital utility, serving as the metaverse's equivalent of virtual reality and augmented reality technology. The majority of the results from the examination of Scopus and Web of Science databases point in this direction. It has been found that metaverse investigations are typically focused in the health literature alongside augmented reality or virtual reality research, or as simulation-based studies. This condition is supported by Damar and Turhan Damar's [14] evaluation of augmented reality and virtual reality studies in nursing, which is one of the most significant fields in the health industry. According to them, there are several researches on patient and student education, particularly in the field of nursing. The ultimate objective of these research is to give students with instructional information that enhances their learning processes as frequently as required by their field of study. In addition, technology contributes significantly to the acquisition of expertise and competence. This contribution is accomplished via monitoring their behaviors and identifying potential process faults.

According to Yilmaz et al. [55], intense usage of metaverse apps can lead to a variety of unfavorable consequences, including virtual addiction, social isolation, behavioral problems, and increased worry and stress. In his study, Kuş [26] asserts that although metaverse technology offers various solutions and opportunities in the fields of education, cultural production, the economy, and collaboration, it also carries with it a number of concerns and potential threats, similar to those posed by previously

developed technologies. He identified these risks as the quickly advancing technology, profit-driven technical efforts, humanity's failure to adapt to these advancements, and the testability and quality of material in the virtual and social worlds.

Despite the fact that metaverse technology provides security in terms of the technologies it contains (such as edge computing and blockchain), security in the virtual economy, and confidence in the safe storage and presentation of data, it is believed that it will always contain such insecurities due to its commercial nature. In addition, this notion has been more popular [34-35] after the advent of Facebook's creator, Mark Zuckerberg [13]. However, Facebook's record is troublesome owing of the issues it has already produced for its users [15,39]. The focus of the study is on the realm of health and metaverse technologies. Consequently, there is little doubt that the quality-sensitive nature of data protection in this field is considerably greater. For healthcare organizations, private/proprietary blockchains, which require authorization to join the network, are preferable than public blockchains, according to Mamun [33].

In their work, Hawks and Krasniansky [17] emphasized their excitement about the metaverse's potential to minimize the load on patients' actual lives by expanding access to therapeutic settings and modelling probability prior to care choices. They were particularly interested in how these solutions might strengthen linkages within virtual communities, reduce obstacles to social isolation for the elderly and disabled, and facilitate participation in research.

According to Bickmore et al. [6], there are several reasons for adding emotional and relational communication behaviors in health-oriented computer systems, each of which is discussed in turn. As with human-human interactions, these communication behaviors are essential for enhancing patient satisfaction and health outcomes. Second, the growth of patient-centered technology presents previously unimaginable prospects for healthcare. Systems that can carefully listen to patients, instill confidence and provide knowledge, negotiate daily treatment regimens, and are accessible from home can be built. In addition, it is possible to design systems that can track a patient's hospitalization and provide access to both the practical and emotional parts of human care. Education and communication research can utilize technologies that accurately replicate the communication behavior of healthcare practitioners in certain regions.

Although metaverse technologies are not yet mainstream in the field of digital health, there are signs of early investment and innovation. For instance, in the United States, eleven digital health programs incorporating VR or AR technology have been allocated $198 million. This is about 1 percent of overall health expenses. In 2020, 93 million dollars will be provided to this region through eight agreements [17]. Digital healthcare of numerous applications and environments in the industry (Embodied Labs, Giblib, Health Scholars, Osso VR, Augmedics, Thirdeye, Vicarious Surgical, Applied VR, Behavr, Floreo, Luminopia, Oxfordvr, Tripp, Xrhealth, Siemens Healthineers, Virtonomy.Io) can be viewed as solid evidence that the field will become much more prevalent in the future.

Metaverse technology is seen as crucial and helpful, particularly in studies where student repetition is difficult but where accurate student interaction is vital in a probable

situation. According to Zheng et al. [56], their work in the realm of virtual reality falls into two broad categories. First, research to develop certain vocations or passions, such as virtual product design and surgical simulation. Second, attempts to create and improve the technology itself, such as haptic feedback devices, take the shape of high-quality, pleasant screens and quick, precise three-dimensional viewers.

Due to its superior three-dimensional imagery, virtual reality systems are ideal for medical imaging, training, and pre-operative planning. Virtual reality technologies are suited for clinical application in instances when physicians do not need to see the patient or his environment directly since users' eyes are entirely covered [2]. It will have several educational applications in nursing and other health-related fields. Kyaw et al. [27] describe virtual reality as a technology that enables the user to explore and alter computer-generated real or artificial three-dimensional multimedia sensory environments in real time in order to get clinically applicable information.

In their study, Riva [43] noted that there is a great deal of research on virtual reality or augmented health in the field of health, and that there has been a steady increase in the use of virtual reality in health services as information technology has improved and costs have decreased over the past ten years. Nonetheless, important clinical databases Medline and Psycinfo indicate that research in the field of virtual reality is growing quickly.

Mozumder et al. [37] proposed metaverse technology in their work for smart healthcare facilities. It can be suggested that countries such as Turkey, which make important infrastructure investments in the field of health, should give more importance to smart healthcare facilities in the health sector and take initiatives in order to benefit more from the possibilities of metaverse technology.

Yilmaz et al. (2022) claimed that the application of technologies intended for use in the metaverse may demand a high degree of specialized training and that the development of these technologies in the field of health requires a thorough health personnel training. The addition of metaverse technology lectures to the curricula of professions that teach health professionals, such as nursing, medicine, midwifery, and dentistry, is another option. Many courses, such as extended reality, health application areas, and virtual reality application development, can be added to the curriculum. This will assist the adaptation of health professionals to new technologies, which have the potential to hit the market quickly.

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