Research Article

Journal of Primary Healthcare and Global Health

Virtual Reality is a Technology that is Developing Every Day

Siniša Franjić

Independent Researcher.

***Corresponding Authors**

Siniša Franjić,
Independent Researcher

Submitted: 10 Oct 2026; **Accepted:** 15 Oct 2026; **Published:** 2 Nov 2026

Citation: Franjić, S. (2026). Virtual Reality is a Technology that is Developing Every Day. *J Prim Health Glob Health 1*(2):1-4.

Abstract

Virtual reality and 3D printing are groundbreaking technologies that are becoming more connected. Virtual reality allows for the intuitive, spatial design of 3D models in real time, while 3D printing takes these virtual designs and creates real, tangible objects. This technology simulates a three-dimensional environment by using a blend of hardware and software. The simulation closely mimics reality, supported by modern AI algorithms that help bridge the digital and real worlds. These algorithms work by projecting both new and familiar elements onto mathematically defined surfaces. The outcome is a virtual environment that feels real to users.

Keywords: VR, AR, 3D Printing, Visualization, Health

Introduction

Since the advent of contemporary virtual reality (VR) and augmented reality (AR) technologies, there has been significant interest in the radiology sector, particularly within the medical 3D printing community, regarding how these technologies can be utilized for medical image analysis, surgical planning, medical education and training, communication, and VR-based treatments (Sutherland & La Russa, 2024). This interest primarily arises from the digital methods that offer true three-dimensional (3D) visualization as an option or supplement to medical 3D printing. Additionally, enhancements in immersive experiences, such as haptic feedback, are expected to play a more crucial role in the acceptance of these technologies for simulation and training purposes.

VR and AR applications in healthcare can be broadly classified into two main groups: "patient-as-user," where patients utilize the technology for therapeutic, educational, or communication purposes, and "clinician-as-user," where healthcare professionals utilize the technology to enhance their medical practice.

Telemedicine systems can be simply described as having three essential components: healthcare providers, those seeking medical services remotely, and the communication network along with diagnostic devices that connect the two (Li et al., 2024).

Healthcare providers, also referred to as the source of medical services, are usually found in major urban medical centers, rich in medical resources and diagnostic expertise, such as tertiary referral hospitals across the nation. Those seeking medical services remotely often come from institutions that do not have enough medical capabilities, home patients, patients isolated due to infectious diseases, or battlefield patients in locations where timely medical assistance is unavailable. Telemedicine primarily aims to connect these two groups. Thus, the final segment of the medical system includes the communication network and diagnostic devices that establish this link. The communication network can consist of traditional telephone lines, wireless networks, satellite communication, 5G technologies, etc. Meanwhile, diagnostic devices may encompass software and hardware, diagnostic tools, wearable technology, and virtual reality (VR) devices.

Applications

Additive manufacturing technologies are increasingly being adopted in medicine to enhance patient clinical outcomes (Di Bella & Mineo, 2022).

A 3D printing machine creates physical 3D parts by layering materials, mimicking a virtual cross-section. Various 3D printing technologies in the medical field can be grouped based on their manufacturing methods, which include stereolithography (SLA), fused deposition modeling (FDM), selective laser sintering (SLS), and electron beam melting (EBM).

The 3D printing technology holds great promise in addressing numerous design challenges. It has been effectively utilized in a range of surgical issues and has demonstrated potential to improve results, lower complications, and reduce surgery duration.

Medical additive manufacturing encompasses not just devices used within the body, but also many valuable indirect applications.

Direct applications focus on implantable devices, whether they are custom-designed or off-the-shelf items, particularly in areas like orthopedics, neurosurgery, maxillofacial procedures, and dentistry. They also extend to orthotics, including personalized busts, orthoses, and exoskeletons. A notable example is the creation of transradial prosthetics through 3D technology, which enables children who have lost limbs due to societal conflicts to receive affordable artificial limbs.

As for indirect applications, 3D printing can produce models that enhance understanding of the complex anatomy and pathology of patients, supporting education and surgical training. Additionally, it can create custom surgical instruments and cutting guides tailored to individual patients.

The most cutting-edge application involves bioprinting technologies (BT). In the fields of tissue engineering and regenerative medicine, BT offers an advanced automated platform for fabricating various biomaterials by precisely depositing cells and polymers in a planned manner. Typical uses include bioprinting constructs made from cell-laden materials, bone and cartilage tissues, skin tissues, blood vessels, and neuronal tissues.

This technology is also extensively utilized in drug screening and cancer research. It brings several benefits, such as accurate and controlled placement of cells, hormones, drugs, and growth factors. Moreover, it lays the groundwork for developing tissue constructs, organs, organoids, and organ-on-a-chip models that imitate natural counterparts.

AR and VR Technologies

Virtual reality is utilized to simulate complicated tasks in immersive environments, providing depth cues for activities like surgeries or maintenance tasks (Borovanska et al., 2020). Much like AR, VR can transform otherwise inaccessible experiences into achievable ones, enabling training for hazardous tasks in a secure setting.

By immersing users in a well-crafted narrative, VR helps engage them both physically and psychologically, facilitating motivation for behavioral and mental changes. This way, VR can recreate experiences in safe, controlled environments, allowing individuals to perceive body shapes they might not otherwise embody until they have undergone such experiences. This can greatly assist in encouraging personal transformation, shifting attitudes, and enhancing overall well-being, and is often used in obesity treatment.

VR has demonstrated significant potential in enhancing education by helping to connect theoretical concepts with practical applications, which can frequently pose logistical and ethical hurdles. It has proven to be at least as effective as conventional teaching methods. VR has been successfully used to simulate 3D interactive stereoscopic views of different neurosurgical approaches, which has shown to be an effective educational approach.

Virtual Reality and Augmented Reality represent significant advancements that have the potential to change how we care for people, particularly older adults (Cronin et al., 2021). Innovations in Artificial Intelligence may create personalized health and wellness messages to address challenges like remembering to take medications by providing targeted reminders. Additionally, integrating data from sensors could lead to better evaluations of individuals and their health.

For many of these innovations to succeed, social and structured protocols will be essential. New hiring practices and workflows will be necessary to handle the data and information generated by these advancements. A stronger focus on proactive, person-centered care aimed at improving outcomes and lowering costs will require a more effective use of community health workers and health behavior change coaches to connect both patients and clinical teams. One particularly fascinating, yet somewhat concerning, result of our heavy reliance on the Internet for shopping, communication, and education is that we all create a profile outlining our preferences, knowledge, and desires. By using data mining and natural language processing, it becomes possible to establish highly targeted and predictive personal insights. The information generated by consumers, along with widespread access to computing, might lead to timely nutritional advice, recommendations on over-the-counter medications, or suggestions that help prevent health issues, like locating the nearest flu shot or knowing when to start allergy medications. It is likely that leveraging these vast data sets, referred to as "big data," will reshape the personalization of medical care. Although predicting the future of consumer health informatics is largely speculative, it is evident that as long as partnerships between patients and providers remain strong, technology will play a crucial role in helping engaged consumers manage their health and address illnesses effectively.

AR and VR technologies vary significantly in terms of the sophistication of the experiences they offer (Sutherland & La Russa, 2024). With many experiences categorized under VR or AR, the effectiveness of these technologies might vary based on their technical execution. Previous attempts have sought to distinguish between different types of "advanced visualization" or mixed reality technologies, with one common framework being the reality–virtuality continuum, which illustrates a range from completely real environments to fully immersive virtual experiences.

The visualization capabilities found in today's advanced technologies can be better understood and categorized by examining three key traits, which we call the "advanced visualization continuum." This continuum is supported by different types of technologies: visualization or display technology, often through head-mounted devices (HMDs), helps achieve virtuality. Tracking technology enables perspective generalization, while structure-sensing technology allows for world cognizance. Virtuality can be described as the reality–virtuality continuum, reflecting how much of what the user sees is real versus virtual. Perspective generalization refers to the capability of visualizing virtual elements from any

user's viewpoint. A completely generalized perspective lets users explore virtual items in a consistent 3D space, allowing them to move around and view these items from different angles. In contrast, a completely fixed perspective keeps virtual elements stable in their position and orientation relative to the user. Lastly, world cognizance refers to a device's ability to recognize real-world structures and enables virtual objects to interact with these structures as if they coexist in the same physical space.

In essence, augmented reality (AR) combines elements of virtual reality with the real world, blending the two environments (Pandey & Paul, 2019). This approach overlays virtual objects onto real-world items. AR systems are characterized by merging virtual reality with natural interactions in real time. The field of therapeutic rehabilitation is multidisciplinary and requires a variety of techniques to meet diverse needs. Computers play a vital role here, offering extensive therapeutic support by providing numerous services for disabled individuals in areas such as communication, independence, personal development, and social skills. Technology simplifies the work of therapists and clinicians in managing and treating disabled patients. A tailored treatment plan can be designed for each individual, enhancing both safety and effectiveness. Multiple parameters can be adjusted simultaneously to increase or reduce the difficulty levels for optimal results. Moreover, therapists can oversee the intervention and develop suitable treatment strategies. These capabilities are all thanks to advancements in technology. Virtual and augmented reality systems demonstrate how conventional hardware can create varied environments. As research and development continue, AR systems are becoming more widely used in clinical and intervention settings.

The main parts of an AR system include sensors, a processor, and a display device. Sensors collect information from the real world. For example, a camera can capture images from the environment, which can then be processed according to specific needs set by software programs based on the surroundings. Visual indicators, known as fiducial markers, help identify the position and direction of an object in relation to others. The processor analyzes the information collected by sensors, cameras, and other input tools. These processors are powerful enough to handle real-time data. Finally, the processed information is shown on the display device.

HMDs

Augmented and virtual reality head-mounted displays, or HMDs, can be categorized in various ways based on their form factors (Sutherland & La Russa, 2024). A key distinction among the different options available in the market is whether an HMD operates as a mobile device—meaning it is a self-contained, wearable item that handles tracking and visualization processing on its own—or if it is tethered to a computer, acting primarily as a display that shows images generated by a connected PC through either a wired or wireless connection. The early mobile VR systems were designed around encasing a smartphone within a plastic housing that featured lenses positioned between the user's eyes and the smartphone display. In these earlier models, the ability for positional tracking and image rendering was limited, relying heavily on the smartphone's internal hardware. Most of the commercially available augmented reality HMDs, like the Microsoft HoloLens, maintain a mobile design.

In virtual reality contexts, HMDs connected to computers equipped with powerful graphics cards continue to be favored for high-end simulations that require significant computational resources. For complex tasks, such as advanced visualization of medical images or high-resolution Final Anatomic Representations, mobile HMDs often lack the processing capability necessary to deliver a seamless and high-quality experience. Nonetheless, the latest versions of mobile VR and AR systems—such as the Meta Quest 3 and Meta Quest Pro—offer all-in-one HMDs with six degrees of freedom tracking, delivering increased computational power that can be appealing, sometimes economically, for applications that don't depend on intricate model details. For professionals with existing 3D labs hoping to enhance their 3D printing processes with mixed reality tools, mobile or standalone mixed reality platforms may integrate most smoothly into their current workflows, as end-users of 3D printed models typically expect to receive content directly, and might be hesitant to engage in workflows that necessitate traveling to a fixed VR station.

One notable emerging technology is cloud computing focused on mixed reality, using high-speed connectivity like 5G mobile networks for real-time remote image rendering. Although not widely implemented yet as of this writing, this technology has the potential to endow any type of HMD, whether mobile or not, with the advantages of high-end graphics processing.

Another crucial factor to consider is comfort, particularly when applications aim to keep users engaged for long periods. When choosing HMDs, factors such as size, weight, and fit are important for wearability, alongside ensuring optimal viewing experiences that cater to both vestibular and visual comfort. Some systems allow users to manually adjust lens positions to suit their interpupillary distance, while certain augmented reality systems automate this adjustment process.

Mixed Reality Techniques

Mixed reality techniques can greatly enhance training and education efforts (Sutherland & La Russa, 2024). The term "true 3D visualization" is different from "3D visualization," which has been defined in previous chapters as the total of various post-processing methods displayed on a 2D screen. True 3D visualization leads to a better understanding of anatomy and medical imaging. With virtual reality and augmented reality, users can create and interact with 3D models and even dynamic metadata, making these technologies powerful tools for developing and utilizing educational content. Advanced virtual reality-based surgical simulation platforms have been developed, offering a valuable addition to traditional cadaveric training.

Similar to 3D printing, mixed reality technologies can assist in planning complicated cases, where a better understanding of intricate 3D relationships can boost the confidence of the procedures being performed.

Augmented reality is particularly effective during surgical interventions, as virtual reality immerses users in a fake environment and thus obscures their view of the real world. As augmented reality technology progresses, we anticipate more reports showcasing how immersive visualization aids surgical procedures.

Mixed reality technologies are also applicable for interpreting medical images directly. Experiences using augmented and virtual reality can be designed to import medical images for use in radiology reporting. While it's important to consider image quality, due to variations in how images appear to users compared to standard displays, initial examples of image analysis in virtual and augmented reality show a strong agreement with traditional viewing methods.

Printing Process

The flow of 3D printing techniques is quite consistent across various methods (Quodbach, 2019). Initially, a desired object is crafted using a computer-aided design (CAD) program. Although almost any shape can be created, it's important to approach the final dosage form with careful thought. The top priority is to ensure it can be administered safely and effectively. After the design is finished, it's saved, typically in an STL file format, which stands for stereolithography. During this saving process, the surface of the object is triangulated, turning it into a 3D representation. This means all details of the original object, such as color or material properties, are lost, except for the surface. Since the surface is shown only through variously sized triangles, it's crucial to select triangulation settings wisely to preserve important surface features. The STL file is then loaded into the printer software, where essential print settings are chosen, including print temperature, layer height, scaling, infill pattern and density, and print speed. The infill refers to the method used to fill the shapes of a printed object. Typically, objects aren't printed solid but rather as hollow structures featuring varying infill to maintain mechanical strength and ensure safe handling. The design of this pattern and the fill amount can be adjusted. Before printing begins, the object must be sliced into layers. 3D printing doesn't build the object up from the center; instead, it creates it by laying down thin layers one at a time until complete. During slicing, the object gets divided into these layers, and a control code for the printer's movement, known as G-code, is generated. This G-code is sent to the printer, which then starts the printing process. While these initial steps are similar across many printing techniques, the specific processes can vary widely. In the case of methods relevant to pharmaceuticals, layers may be formed using inkjet systems, extrusion, or electromagnetic radiation. To grasp the potential of these techniques, it's important to understand their technological differences, which will be discussed in the following sections.

Conclusion

There's no doubt that virtual reality is set to shape the future of technology, with constant advancements happening each day. VR began with basic motion simulation systems but soon concentrated on the gaming industry, allowing users to see, hear, and feel a virtual environment as if they were truly there. In addition to gaming, VR is making significant strides in science and medicine, enhancing quality of life and assisting in the diagnosis and treatment of numerous common diseases.

References

1. Sutherland, J., & La Russa, D. J. (2024). Augmented and virtual reality in medicine. In F. J. Rybicki, J. M. Morris, & G. T. Grat (Eds.), 3D printing at hospitals and medical centers: A practical guide for medical professionals (2nd ed., pp. 377–382). Springer Nature Switzerland. DOI: https://doi.org/10.1007/978-3-031-42851-7_22
2. Li, J., Tian, Y., & Zhou, T. (2024). Healthcare information systems: Progress, challenges and future directions. Shanghai Jiao Tong University Press; Springer Nature Singapore. DOI: https://doi.org/10.1007/978-981-97-9551-2
3. Di Bella, S., & Mineo, R. (2022). The engineer's point of view. In C. Zoccali, P. Ruggieri, & F. Benazzo (Eds.), 3D printing in bone surgery (pp. 39–40). Springer Nature Switzerland. https://www.scribd.com/document/681311382/3D-Printing-in-Bone-Surgery
4. Borovanska, Z., Poyade, M., Rea, P. M., & Buksh, I. D. (2020). Engaging with children using augmented reality on clothing to prevent them from smoking. In P. M. Rea (Ed.), Biomedical visualisation (pp. 59–94). Springer Nature Switzerland. DOI: https://doi.org/10.1007/978-3-030-43961-3_4
5. Cronin, R. M., Jimison, H., & Johnson, K. B. (2021). Personal health informatics. In E. H. Shortliffe, J. J. Cimino, & M. F. Chiang (Eds.), Biomedical informatics: Computer applications in health care and biomedicine (5th ed., pp. 383–384). Springer Nature Switzerland. DOI: https://doi.org/10.1007/978-3-030-58721-5
6. Pandey, V. K., & Paul, S. (2019). Overview of medical electronics for physically disabled. In S. Paul (Ed.), Biomedical engineering and its applications in healthcare (pp. 101–102). Springer Nature Singapore. DOI: https://doi.org/10.1007/978-981-13-3705-5
7. Quodbach, J. (2019). Modulating drug release from 3D printed pharmaceutical products. In M. Maniruzzaman (Ed.), 3D and 4D printing in biomedical applications: Process engineering and additive manufacturing (pp. 186–187). Wiley-VCH. DOI: https://doi.org/10.1002/9783527813704.ch8

Copyright © 2026 Siniša Franjić. This article is licensed under the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author(s) and source are appropriately credited.