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## Virtual and Augmented Reality in the Education of Medical Students

*Abstract:* Virtual reality (VR) and augmented reality (AR) technologies play an extremely important role in the healthcare sector, where their application allows for better diagnosis, treatment, and rehabilitation of patients. These technologies play a particularly important role in the healthcare sector, where their application allows for better diagnosis, treatment and rehabilitation of patients. The purpose of the study is to analyze scientific data on the use of virtual and augmented reality technologies in the education of medical students and in the practice of doctors. The role of VR and AR technologies in planning complex surgeries is particularly noteworthy, where they allow surgeons to pre-model interventions and receive visual cues in real time, reducing the trauma of operations and increasing their efficiency. In rehabilitation programs, VR and AR are becoming indispensable tools for physical and cognitive rehabilitation of patients, providing effective methods of restoring motor and cognitive functions. The author concludes that the use of VR and AR for mental health deserves special attention. Modern technologies make it possible to create safe and controlled environments for the treatment of anxiety disorders and PTSD, enabling patients to gradually adapt to stressful situations, reducing anxiety and improving their emotional state.

*Keywords:* virtual technologies, augmented reality technologies, medical students, patient rehabilitation, VR simulators.

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## Віртуальна та доповнена реальність в освіті студентів-медиків

*Анотація:* Технології віртуальної (VR) та доповненої реальності (AR) відіграють надзвичайно важливу роль у сфері охорони здоров'я, де їх застосування дозволяє забезпечити більш якісну діагностику, лікування та реабілітацію пацієнтів. Особливо слід виділити роль VR та AR технологій у плануванні складних операцій, де вони дозволяють хірургам попередньо моделювати втручання та отримувати візуальні підказки в реальному часі, знижуючи травматичність операцій і підвищуючи їх ефективність. У реабілітаційних програмах VR та AR стають незамінними інструментами для фізичної й когнітивної реабілітації пацієнтів, забезпечуючи ефективні методи відновлення рухових і пізнавальних функцій.

*Ключові слова:* віртуальні технології, технології доповненої реальності, студенти-медики реабілітація пацієнтів, VR-тренажери.

***Abbreviations:***

$AR$ is augmented reality,

$PTSD$ is a post-traumatic stress disorder,

$VR$ is virtual reality

## Introduction

VR and AR have become an integral part of the modern digital world. They are changing approaches to education, entertainment, and professional activities. They open up new opportunities for interacting with information, create intuitive tools for analysis, visualization, and training.

These technologies play a particularly important role in the healthcare sector, where their application allows for better diagnosis, treatment and rehabilitation of patients. The relevance of VR and AR in medicine is growing every year. They are becoming key elements of the digital transformation of healthcare systems, helping to overcome traditional barriers to doctor training, communication with patients, and the organization of treatment processes (*Kafes et al., 2024*; *Nelson & Bailey, 2020*; *Ferrari et al., 2019*).

One of the biggest advantages of augmented reality technology is the integration of digital information with data about the user's environment in real time. Using this method, it is possible to visualize physical reality supplemented or enhanced by computer-generated perceptual data, such as images, GPS data, audio or video signals (*Kwon et al., 2018*).

AR and VR technologies are closely related but fundamentally different from each other. Virtual reality provides full immersion with the creation of a three-dimensional world. It completely separates the user from physical reality (blocks signals from the outside world). Augmented reality allows you to keep in touch with the outside world and improve it (*Kwon et al., 2018*). Compared to it, AR technology allows using less bulky equipment.

AR technology was first used in medicine in the 1990s to preplan surgical interventions and evaluate large amounts of data generated during the intervention (*Williams & Thompson, 2021*). Currently, AR technology is one of the most promising digital health technologies, and interest in it is growing every year.

Thanks to VR and AR, healthcare professionals have access to innovative training methods. They allow to simulate real clinical situations, improving skills and raising the level of professional training of specialists. In turn, patients can receive individualized treatment and rehabilitation that were previously unavailable or ineffective. This makes VR and AR technologies not only useful but also necessary in the context of modern healthcare requirements.

The purpose of this study was to analyze scientific data on the use of virtual and augmented reality technologies in the education of medical students and in the practice of doctors. The use

of VR and AR technologies in healthcare covers a wide range of areas, including diagnostics, treatment, rehabilitation, and educational activities (*Table 1*).

## Results

One of the major aspects is their use for visualization of the patient's internal organs. This allows doctors to get a three-dimensional view of anatomical structures and pathological changes. Such capabilities significantly improve diagnostic accuracy, reduce the risk of errors, and provide a more detailed analysis of the patient's condition (*Kovalchuk et al., 2020*). Thus, in surgery, VR and AR are becoming indispensable tools for planning and performing complex operations. Thanks to these technologies, surgeons can pre-model surgical interventions, practice them in a virtual environment, and receive visual cues during surgery in real time. This helps to minimize trauma, reduce surgery time and improve treatment outcomes. In addition, these technologies contribute to the improvement of minimally invasive surgery methods, which is especially important in the context of modern requirements for the quality of medical care.

In dentistry, the main application of AR technology is in maxillofacial and oral surgery. In addition, AR software installed on smart glasses helps dentists to form crowns more accurately by overlaying real-time data from a dental scanner (*McGlynn & Asch, 2022*).

In psychiatry, virtual reality is used according to the principle that in order to understand a patient, you need to see the world through their eyes. For this purpose, a special program Mindscape by Viscira has been developed. It is intended not only for professionals but also for the patient's relatives, so that they can better understand how a person with productive symptoms of schizophrenia lives: thinking disorders, auditory hallucinations, and delusions (*Schneider & Sorkin, 2019*).

VR is also used in exposure therapy to create virtual environments that can mimic real-life situations that a patient may fear or find challenging. Exposure therapy is one of the most effective treatments for anxiety disorders, and virtual reality is a safe and controlled way to show patients their fears (*Liu & Zhang, 2020*).

In addition, virtual reality treats phobias. With the help of AR apps, such as Spiderworld by HITlab, patients with arachnophobia can see virtual spiders running on their hands. In a moment of panic, a person can simply turn off the app and make sure there is no real threat. In turn, the SnowWorld app makes it possible to throw snowballs at penguins in a "winter" environment. This reduces the pain of those who have suffered burns (*Moore & Saito, 2019*; *Pellegrino et al., 2019*).

PTSD is a type of nervous disorder that affects millions of people around the world. This disorder can occur for any reason, such as war. VR allows you to create specially designed environments that simulate real-life situations, helping patients gradually face their fears or traumatic memories in a controlled environment. This approach helps to reduce the intensity of symptoms and develop coping mechanisms.

The process of training medical professionals with VR is extremely important. For example, Weill Cornell Medical College (New York, USA) has a virtual reality room with a simulator for surgeons. The system is equipped not only with a graphic headset but also with tactile feedback. The doctor feels the mechanical impact on the organs of the "patient". With the help of such a simulator, it is possible to acquire the skills necessary for successful operations at a much lower

cost (*Petrov et al., 2022*).

Thus, virtual and augmented reality are actively changing the medical field, offering new opportunities to improve the quality of medical services. Their use has led to significant improvements in the diagnosis, treatment, and rehabilitation of patients.

The role of VR and AR technologies in planning complex surgeries should be highlighted, where they allow surgeons to pre-model interventions and receive visual cues in real time, reducing the trauma of operations and increasing their efficiency.

Another important aspect is the use of VR and AR for training medical professionals, which allows them to train in conditions close to real life without risk to patients, thereby improving the level of professional training of doctors.

## Conclusion

*Thus*, in rehabilitation programmes, VR and AR are becoming indispensable tools for physical and cognitive rehabilitation of patients, providing effective methods of restoring motor and cognitive functions.

The use of VR and AR for mental health deserves special attention. Modern technologies make it possible to create safe and controlled environments for the treatment of anxiety disorders and PTSD, enabling patients to gradually adapt to stressful situations, reducing anxiety and improving their emotional state.

## Conflict of interest

The author declares that there is no conflict of interest.

## References:

Ferrari, V., Klinker, G., & Cutolo, F. (2019). Augmented reality in healthcare. *Journal of Healthcare Engineering*, 932–1535.

Kafes, A. Y., Çiller, A., & Şakiroğlu, M. (2024). Virtual reality supported intervention program for trauma symptoms of individuals who experienced an earthquake: An effectiveness study. *Noro Psikiyatr Ars*, *61*(1), 15–23.

Kovalchuk, O. I., Bondarenko, M. P., Okhrei, A. G., Prybytko, I. Y., & Reshetnyk, E. M. (2020). Features of the use of immersive technologies (virtual and augmented reality) in medical education and practice. *Morphology*, *14*(3), 158–164. (In Ukr.)

Kwon, H.-B., Park, Y.-S., & Han, J.-S. (2018). Augmented reality in dentistry: A current perspective. *Acta Odontologica Scandinavica*, *76*(7), 497–503.

Liu, S., & Zhang, Z. (2020). Enhancing the quality of healthcare delivery: A review on the role of virtual reality and augmented reality in medical applications. *Journal of Healthcare Engineering*, 1–11.

McGlynn, E. A., & Asch, S. M. (2022). The application of virtual reality in healthcare: Current status and future directions. *Healthcare Management Review*, *47*(3), 180–189.

Moore, D. T., & Saito, S. (2019). Immersive Technologies in Healthcare: Virtual Reality and Augmented Reality Applications. *Computers in Biology and Medicine*, 111, 1–7.

Nelson, R. S., & Bailey, C. (2020). Exploring the Effectiveness of Virtual Reality for Pain Management: A Systematic Review. *Journal of Pain Research*, *13*, 227–236.

Pellegrino, G., Mangano, C., Mangano, R., Ferri, A., Taraschi, V., & Marchetti, C. (2019). Augmented reality for dental implantology: a pilot clinical report of two cases. *BMC Oral Health*, *19*(1), 158.

Petrov, V. F., Shchur, O. V., Yaremkevych, R. V., Marina, V. N., & Bochar, V. T. (2022). Emergence of virtual reality technologies and their introduction into medicine. *Health of the Nation*, *4*(70), 134–138. (In Ukr.)

Schneider, E. C., & Sorkin, D. H. (2019). Augmented reality: A new horizon in healthcare. *Current Medical Research and Opinion*, *35*(1), 55–61.

Williams, M., & Thompson, L. (2021). Augmented reality for medical training. *Medical Simulation Review*, *34*(2), 123–135.

## Appendix

Table 1. Main areas of VR and AR application in healthcare

| Direction | Description |
|---|---|
| Diagnostics | Using VR and AR to visualize internal organs, improve diagnostic accuracy, and reduce the risk of errors. |
| Surgery | Simulate operations in a virtual environment and apply real-time prompts during operations. |
| Personalized treatment | Adapting medical procedures to individual patient needs using VR and AR. |
| Rehabilitation | Physical and cognitive rehabilitation of patients through interactive games and virtual exercises. |
| Educational simulations for healthcare professionals | Training of medical professionals in near-real conditions using VR and AR to practice emergency situations. |

Source: developed by the author on the basis of research by the group of O.I. Kovalchuk (*Kovalchuk et al., 2020*).