

**VIRTUAL AND AUGMENTED REALITY IN THE TRAINING OF VASCULAR
SURGEONS AND SURGICAL PLANNING**

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Abstract: At present, virtual reality (VR) and augmented reality (AR) technologies are rapidly developing, creating innovations across various fields. This article provides a comprehensive analysis of the theoretical foundations, practical applications, and future prospects of these systems. Virtual reality is a technology that allows the user to be fully immersed in a digital environment, while augmented reality enriches the real world with digital elements.

The article discusses the use of these technologies in scientific research, education, medicine, architecture, design, and other areas. It also analyzes the technological challenges of VR and AR systems, ways to improve user experience, and recent advances in hardware and software.

An in-depth analysis of system capabilities and future development prospects is presented.

Keywords: Virtual reality, medical modeling, therapy, medical technology, rehabilitation technologies, medical education, augmented reality diagnostics, augmented reality, systems, technologies, user experience, research, development, future.

Introduction

In recent years, virtual and augmented reality technologies have revolutionized not only the gaming and educational industries but also the field of healthcare. Thanks to innovative solutions, medical practice has become more effective, safe, and interactive. Virtual technologies are widely used in many fields — from surgical simulations to psychotherapy. This paper analyzes the main directions of the application of virtual technologies in medicine, their advantages, and the challenges that arise. It also examines the technological prospects of healthcare. Virtual and augmented reality have become some of the fastest-growing areas of modern technology, creating new applications, opportunities, and challenges.

Main Section

Virtual Reality

Virtual reality immerses users in a fully digital environment, enabling interactive learning and engagement. Typically, VR systems use special headsets, controllers, keyboards, touch screens,

or even wearable suits. These technologies allow users to enter and navigate through a completely new digital world. The main goal of virtual reality is to give users the ability to interact naturally and fully with a simulated environment.

Augmented Reality

Augmented reality enhances the real world with digital elements by adding virtual objects, images, or sound to the user's physical environment. AR systems allow users to interact with the real world while adding layers of information, such as data, navigation hints, or 3D models. Such systems are commonly used with smartphones, tablets, AR glasses, and other devices.

Applications of VR and AR Technologies

1. Education and Training

Virtual and augmented reality are transforming education. Through these technologies, students can study historical events, biological processes, and other disciplines in an immersive environment. For example, medical students can explore human anatomy in 3D using VR. AR, on the other hand, enriches the real educational environment with interactive visualizations — for example, for geography or chemistry lessons.

2. Medicine

In medicine, virtual and augmented reality are used in diagnostics, rehabilitation, and surgery. VR systems enable simulation of surgical operations, allowing surgeons to test different approaches before performing real procedures. AR assists in analyzing medical data in real time — for instance, displaying patient information and vital signs over a real surgical field, enhancing accuracy and efficiency.

Technological Challenges and Future Prospects

1. Technological Challenges

The main technological issues of VR and AR systems are related to high hardware requirements and the difficulty of ensuring optimal user experience. VR demands high-quality graphics and real-time rendering, requiring powerful computational resources. AR, in turn, must precisely align virtual elements with the real environment and maintain interactive responsiveness.

2. User Experience

To enhance the user experience, interactivity and usability must be improved. Interfaces should be made more intuitive, and VR/AR equipment more comfortable for extended use. Providing a seamless and immersive experience is essential for broader adoption in medicine and education.

Conclusion

Virtual technologies are revolutionizing modern medicine. They improve the efficiency of education, diagnostics, treatment, and rehabilitation. However, large-scale implementation requires close cooperation between healthcare systems, technology developers, and researchers,

as well as significant investment and testing. In the future, virtual and augmented reality will make medicine more precise, convenient, and patient-centered.

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