UDC 004.946

# STRUCTURE AND APPLICATION OF VIRTUAL REALITY HEADSETS: MODERN TECHNOLOGIES AND FUTURE PROSPECTS

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**Annotation.** This article is a comprehensive look at virtual reality (VR) headsets. It shows in details how they are designed and where they are used, drawing on data from several sources. The paper provides an overview of the current technologies used in VR-headsets and discusses the future directions of this field. It considers both the physical device of the headset (hardware) and the software that enables its operation and interaction with the user. Special attention is paid to the relationship between hardware and software components, as well as the theoretical foundations underlying the creation and functioning of virtual worlds.

**Keywords**: virtual reality, VR headsets, modern technologies, future prospects, device structure.

***Introduction.*** Virtual reality (VR) technology has evolved extensively over the past decade. It is developing very fast and new developments are constantly emerging. VR is being transformed from a niche innovation into a widely used tool across various industries such as education, healthcare, gaming and entertainment, aerospace, etc.

Rapid advancements in display technology, computational power, and sensor accuracy have significantly enhanced the performance and accessibility of VR systems, making them an integral part of modern human-computer interaction.

The purpose of this paper is to explore the structure and functions of virtual reality headsets, their current applications, and the future prospects of virtual reality technology. Researchers have described both theoretical and practical aspects of virtual environments [1].

***Main part.*** Virtual Reality is a 3-Dimensional computer generated environment that gives the user the experience of being present in that environment. It provides the effects of a concrete existence without actually having a concrete existence. It is a new form of human - machine interaction by which one can interact with full visual immersion [2]. VR headsets are made up of important components. One important part is the optical system, which includes high-resolution displays and lenses that adjust the user's field of view (shown in Figure 1).

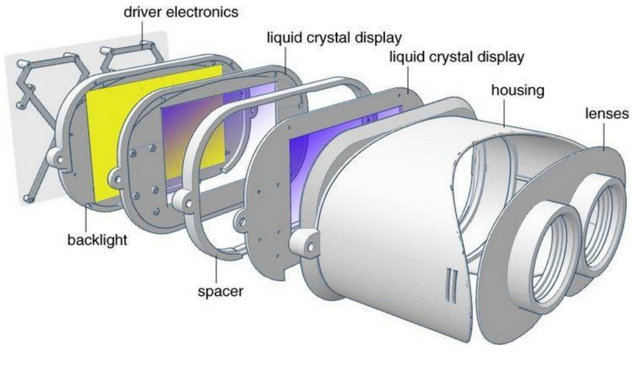


Figure 1 – The internal structure of Light Field Stereoscope, the progenitor of modern VR headsets

*A VR headset* is a head-mounted device that enables users to interact with digital content in a simulated environment. It comprises several components, including: *display screens*: the most crucial element of a VR headset, which acts as the user’s window into the virtual world. Most VR headsets use OLED or LCD displays with high refresh rates and resolutions to create smooth visuals; *lenses*: placed between the eyes and display screens, helping to focus light rays from the screens directly onto each eye. They also adjust the focal length, making it easier for people with varying visual acuity to use VR headsets; *motion sensors*: VR headsets have built-in motion sensors, including accelerometers and gyroscopes, which detect movement. These sensors are crucial in tracking the user's head movements and rendering them into the virtual environment; *audio system*: a good audio system is essential for creating an immersive experience in a VR headset. Most models have built-in headphones or earbuds that provide 3D spatial sound, making the virtual world feel more realistic.

Modern headsets are equipped with motion tracking sensors that allow users to interact with the virtual environment. In addition to head-mounted displays (HMDs), other devices such as haptics, controllers, vests, omnidirectional treadmills, tracking technologies, and optical scanners for gesture-based interaction are gaining importance in the field of virtual reality.

At the moment, improving resolution, refresh rates and reducing blurring in virtual reality is one of the main areas in which virtual reality technology developers are working. New displays with high resolution and high refresh rates provide a more realistic experience. OLED displays have improved image stability and reduced motion blur [1].

Recent research in neurorehabilitation has focused on how VR environments can facilitate recovery from brain injury. A human-centered design approach was used to develop immersive VR training tailored to the cognitive and motor abilities of patients with acquired brain injury. Their study emphasizes the potential of virtual reality not only to teach motor skills, but also to adapt the level of sensory stimulation according to individual needs. By integrating multimodal feedback into neurorehabilitation using virtual reality, therapists are able to increase patient engagement and promote improved treatment outcomes. For example, the use of vibrotactile cues to control movements combined with audio cues to reinforce correct actions can provide additional sensory input, which in turn promotes learning and recovery [4].

Virtual reality in the educational field has been the subject of much research emphasizing on increasing student motivation and improving learning outcomes. Practitioners have demonstrated that VR is effectively applied to create complex simulations, providing students with a unique immersive learning experience. Although initial adoption was limited by high costs and technological barriers, recent advances in the field have made virtual reality more accessible and interactive.

Integrating multimodal feedback into VR learning has the potential to significantly enhance the quality of the educational experience. Imagine, for example, virtual lab experiments with haptic feedback or historical research using spatial audio - such elements can make understanding learning concepts more natural for students. This approach is not only in line with constructivist learning principles, but also creates more engaging and closer-to-reality simulations of life situations [4].

***Conclusion.*** We analyzed the latest developments in multimodal feedback for virtual reality. Research demonstrates that combining vibrotactile and audio cues with visual VR systems can significantly improve the quality of interaction and outcomes for users. In the field of neurorehabilitation, multimodal approaches pave the way for more personalized and effective training programs. In education, they can be a powerful tool for increasing student engagement and deepening the learning process. Future research should focus on improving multimodal systems and assessing their long-term impact in different applications [1, 3, 4, 5].

## ***References***

1. *Langacker R. W. (1999) Virtual Reality. Studies in the Linguistic Sciences, 29(2).*

2. *Parth Rajesh Desai. A Review Paper on Oculus Rift-A Virtual Reality Headset. International Journal of Engineering Trends and Technology (IJETT) – Volume 13 Number 4 – Jul 2014, page 175.*

**3.** *Beese, N. O., Dümke, L., Döll, Y. N., Reinhard, R., Spilski, J., Lachmann, T., & Müller, K. (2025) Feel me, hear me: Vibrotactile and auditory feedback cues in an invisible object search in virtual reality. Behaviour & Information Technology.*

4. *Cucinella, S. L., de Winter, J. C. F., Grauwmeijer, E., Evers, M., & Marchal-Crespo, L. (2025) Towards personalized immersive virtual reality neurorehabilitation: A human-centered design. Journal of NeuroEngineering and Rehabilitation, 22:7.*

5. *Kavanagh, S., Luxton-Reilly, A., Wuensche, B., & Plimmer, B. (2017) A systematic review of Virtual Reality in education. Themes in Science and Technology Education, 10(2), 85–119.*