

# Virtual Reality in Cardiac Diseases: The Challenges and Applications

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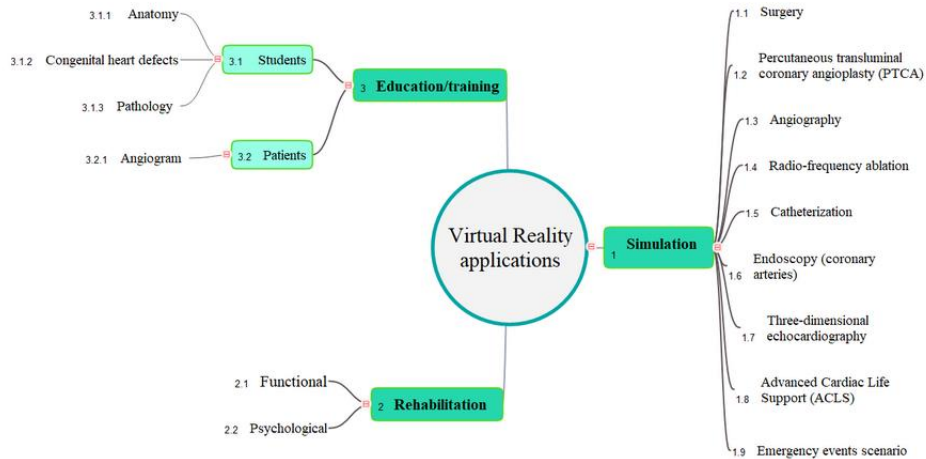
## 1. Introduction

Virtual Reality (VR) is a technology that allows users to interact with a simulated 3D environment. It does that by providing multisensory information, which allows users to immerse themselves in that environment. Various tools are used to create this sense of immersion, which include a head-mounted display helmet, a motion tracker in head-mounted display helmet, headphones, joysticks, wands, and data gloves.

In the last decade, the use of VR in health care has attracted the attention of many researchers, and this technology is being popularized in health care. The three essential characteristics of VR technology, including the ability to provide feedback, the interaction ability, and its immersive nature, have accelerated the use of this technology in health care. This technology can have various advantages compared to traditional technologies, which include aiding in acquiring knowledge and reducing costs, errors, and learning time. This novel technology is used in different medical fields, including rehabilitation, pain management in burn-injured patients, chemotherapy, and physical exercise. In applying this technology, cardiac diseases have not been excluded. Due to its engagement feature, VR can be used in cardiology as a tool to increase the motivation of patients. VR has many applications in cardiac diseases. The main applications of VR in cardiac diseases can be classified into three categories:

(1) simulation, (2) rehabilitation, and (3) education /training [1-7]. Each of these categories includes several sub-categories, as shown in [Figure 1](#).

Studies show that the use of VR in cardiac diseases can have many positive effects, including heart rate increment, pain reduction/management, a more extraordinary ability to walk, an increase in energy levels, an improvement in physical activity, and improvement in adherence and motivation [8]. The application of VR in cardiac diseases can provide many opportunities to patients and students, which can be mentioned as follows: achieving a haptic interface and real-time visualization of a beating heart for surgery simulation, reducing invasive vascular interventions, improving the safety of procedures on patients with simulation by VR, reducing the number of sessions necessary to reach cardiac rehabilitation goals, getting immediate feedback about the procedure, obtaining a clear picture of the results of the interventions, improving the skills of clinicians, increasing the patient's understanding and awareness, and increasing the preparedness of the patients [3-5, 7, 9, 10]. Despite the positive effects of this modern technology on cardiac diseases, its application has always faced challenges. These challenges can be divided into two general and specific categories, as presented in [Table 1](#).



**Figure 1.** VR applications in cardiac diseases

The challenges of using VR technology in cardiac diseases, if not considered, can lead to the non-use and failure of this new technology in this field. Solving

**Table 1.** Challenges of virtual reality in cardiac diseases

	Challenges	References
Specific	Patients' fear of negative effects of VR on pacemaker operation	[11], [12], [13]
	Vision problems	[13], [14], [3], [11], [12]
	Cybersickness (vertigo, headache, and nausea)	[15], [16], [3]
	High cost of hardware and software required in VR	[2], [1], [3]
	Slow and shaky tracking in VR	[3]
General	Lack of video signals in the headset	[3]
	Distraction of patients with sounds, smells, and bumping into objects	[3]
	Lack of required physical space	[3]
	Need for a frequent system restart, and delays due to sporadic glitches	[3]
	Problems associated with the application of VR for considerable numbers of users on a large scale.	[3]
	Technical issues, including unresponsive VR controllers, software updates, problems with the orientation of 3D environment to the real environment, and system freeze	[3]

these challenges can significantly impact using the mentioned technology in cardiac diseases. As a result, VR can be used in cardiac diseases, and investing in this technology can bring many advantages. However, the challenges related to the use of VR in cardiac diseases should always be considered and appropriate solutions should be applied to deal with them.

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