# VIRTUAL REALITY IN REHABILITATION: AN OVERVIEW

**Abstract**

In the late 1980s, Jaron Lanier developed virtual reality (VR), a technology which allows users to interact with graphical Components in a variety of fields to be adaptable and imaginative. VR enhancing data visualisation, gaming, and immersive educational opportunities in rehabilitation for better motor and cognitive functions.

**Keywords:** Gaming, Neuroplasticity, Virtual reality, Rehabilitation, Neurorehab

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## I. INTRODUCTION

Jaron Lanier introduced virtual reality (VR) in the late 1980s. Information technology specialist Lanier created a virtual setting where users may interact with graphical elements. As it is vivid and interactive, virtual reality (VR) is capable of being utilised in a variety of industries, including informatics, education, rehabilitation, healthcare, entertainment, defence technology, and aerospace technology. In addition to assisting with data visualization and virtual prototyping in informatics, virtual reality also improves gaming and the construction of virtual worlds in entertainment. It also offers immersive learning experiences in education. VR is useful for teaching and simulation in the health and rehabilitation field. VR keeps being versatile, offers potential for innovation, and has a positive impact on healthcare as technology develops [1].

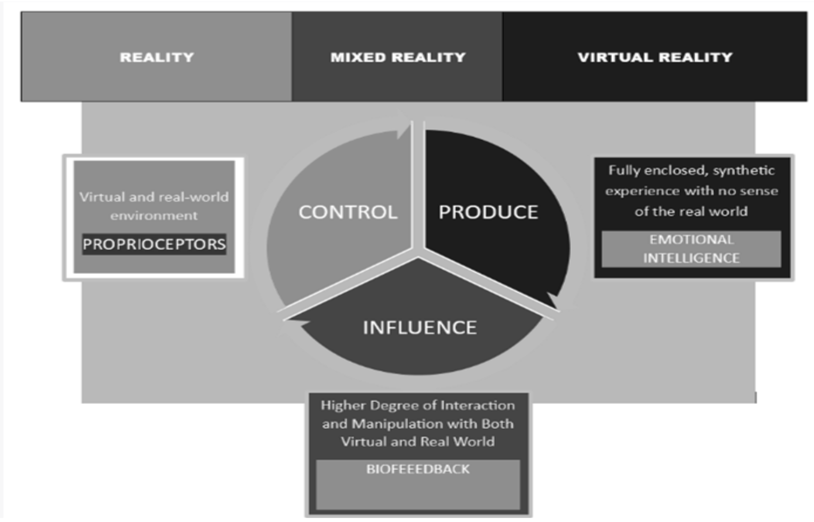


**Figure 1:** Components of mixed-ability users to participate in virtual experiences and its influence on joint sensation, emotional intelligence and biofeedback.

The figure illustration is showing when virtual objects or information are layered onto the virtual world, it enhances the user's interaction and perception. VR technologies allow participants to learn in the comfort of their personal space. For example, a worker can take advantage of VR at home to observe safety protocols or discover how to use a piece of equipment. Depending on the domain, VR training might provide learner privacy, which is crucial in situations when a participant could feel uncomfortable about his or her actions in a real-world training process due to the presence of observers [2].

## II. PRINCIPLE OF VR

**The following three principles are fundamental in VR rehabilitation:**

- Neuroplasticity and CNS Reorganization
- Motor Learning and its Application to Functional Recovery
- Virtual Reality and Functional Recovery

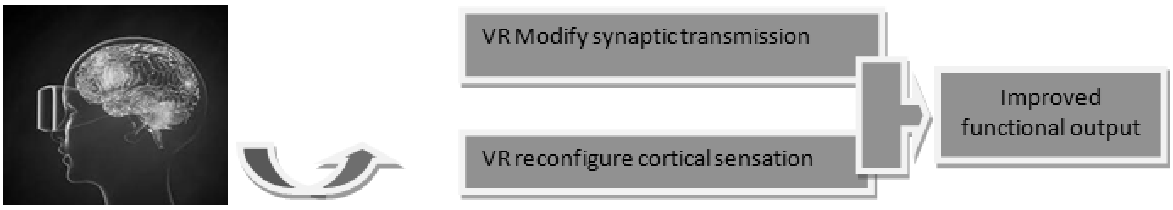


**Figure2:** Principles of VR

Researchers may offer multimodal stimuli with a high level of validity and ecological control while recording changes in subjects' brainactivity using functional magnetic resonance imaging (fMRI). VR systems take a variety of motor learning and neuroscience assumptions into account. VR based treatments have been successfully demonstrated to cause cortical reconfiguration and encourage the activation connections across of various neurala wide range of ages resulting in significant gains in some motor and functional functions, including gait or balance [3],[4]

By offering task-oriented practise and repetitive, acute yet variable difficulty, the games support a strong practice regimen. In certain VR games, there is a teacher option, which allows for "learning by imitation" via stimulating mirror neurons. The VR system also provides the option to use improved performance feedback that is constantly offered while performing a task. As a result, VR systems provide tailored training sessions that allow patients to practise useful skills in an entertaining environment. Virtual reality is aided by technology like head-mounted displays, gesture-sensing gloves, synthesised noises, and vibrotactile platforms that allow for the stimulation of many senses and active exploration of the virtual environment. Furthermore, certain VR paradigms are designed to respond to user movement [5].

Researchers emphasize four key factors for future studies on VR in neurorehabilitation: repetition, sensory feedback, individual motivation, and customization. Repetition is crucial for neuroplasticity, and VR-based therapies can provide adaptive training paradigms to optimize performance. Multisensory stimulation, which involves visual, somatosensory, and auditory feedback, is essential for brain restructuring. Individual motivation is crucial for adequate compliance with therapy, and VR simulations can create an engaging and motivating experience. Customization allows therapies to be adapted to each patient by modifying stimuli and environment parameters to maintain attention and avoid frustration [6].

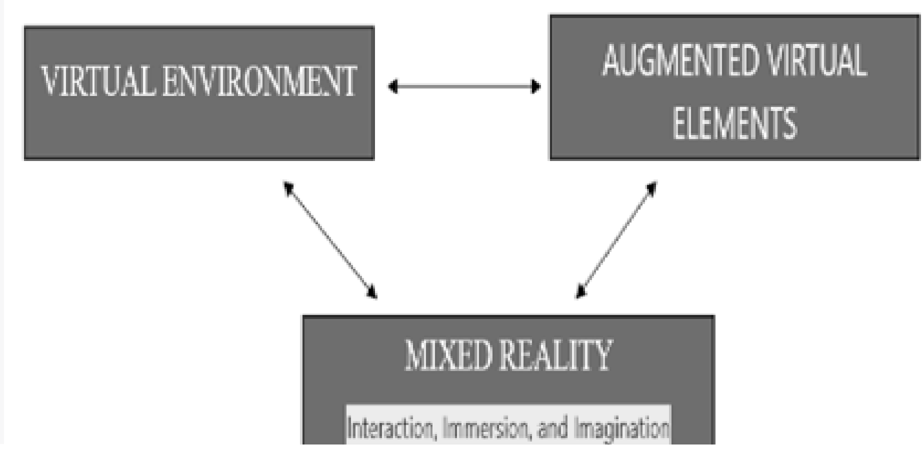


**Figure 3:** Interaction between virtual and real environment

## III. CLASSIFICATION OF VR

1. **VR with Feedback Focused Interaction:** A non-invasive EEG feedback system based on VR environment can be used as feedback provider rather then used as a primary treatment medium of therapy. This system converts EEG signals into motion and interaction. Virtual reality (VR) environments provide an excellent platform for visualizing the spatial and temporal aspects of brain electrical activity. The VR environment is constructed using the MS DirectX technique, which enables the creation of immersive and interactive virtual spaces. The system incorporates biofeedback training that focuses on the SMR component, enabling users to receive feedback on their brain activity and learn to regulate it within the VR environment. VR with EEG biofeedback can be used for patients with sleep disorders, attention deficit hyperactivity disorder (ADHD) [7].

2. **VR with Gesture-Based Interaction:** Gestures based VR can work on their spatiotemporal characters in two ways, static gestures and dynamic gestures. Static gestures involve a fixed hand posture at a specific moment and represent a single command without time-related information. Dynamic gestures, on the other hand, capture changes in hand posture over time, providing both spatial and temporal details. These gestures convey sequences of hand movements and offer insights into motion patterns. Example IREX System [8].

3. **VR with Haptic Based Interaction:** The intricate process of effortlessly connecting the aforementioned technologies to a SHP takes time and requires a lot of concentrated effort. Expert in the subject. This study demonstrates a highly automated method for creating SHP using engineering data that is already available. The complete SHP technology combines a Virtual Reality (VR) scene with a force feedback interaction device, known as a "haptic cell." Because the simulation includes masses and friction between the virtual models, it enables interaction with virtual objects that exhibit realistic behaviour. The haptic cell's size may be adjusted to accommodate positions requiring a larger or smaller interaction area. Additionally, force feedback is available in every contact position with the same precision. Using the SHP apparatus Plenty of technical. There must be implementations created: Developing a virtual environment through an approach:

Configuring the haptic interaction device. calculating the behaviour of the related model using physical simulations, Engineers can replace physical prototypes with haptic cells since digital spaces can be used for simulations. Example: Computer mouse, joysticks, haptic stimulatory gloves, touchscreen with vibration [9].

4. **Immersive Interactive Virtual Reality System**: Users of immersive systems can observe virtual evidence in all directions (i.e., they have an infinite field of regard, FOR), even if the field of view (FOV) is often narrower than the users' visual field. Immersion is related to the system's fundamental characteristics that give this experience. The degree of presence that a system may evoke increases with its level of immersion. The sensorimotor contingencies (SCs) that immersive systems allow have been used to categorise them. The movements one can take to change their gaze direction by shifting their head or eyes, or to bend over to view below something, are examples of SCs. A VR system's capacity to handle standard SCs determines the degree of immersion it can sustain [10].

## IV. FUNCTIONING OF VR

Typically, there are three stages to VR training: task analysis, training scenario sketching, and implementation. The task analysis, which forms the basis for the creation of any training objectives, is one of the first procedures that should be undertaken before training. The most well-known and frequently employed ones are cognitive task analysis (CTA) and hierarchical task analysis (HTA). While CTA is primarily concerned with handling unanticipated events, HTA outlines "goals," which are made up of several units. The goal of scenario sketching, also known as scenario design, was to gather thorough descriptions of how people carry out a job. Software, tool development, procedural creation and hardware constitute the foundation of the third stage.

While modeling and simulations are currently the key elements of VR training software, 3D modeling is equally crucial for developing virtual training settings. For those who may not have any experience or expertise in 3D modeling, there are many resources available, including 3D models, 3D scenes, and sample projects on the asset establishments of Unity and Unreal. 3D models, virtual surroundings, and gaming-level designs are all examples of virtual content that is frequently created using procedural generation techniques. The advancement of VR technology is intimately tied to the growth of VR training. Before the development of consumer-grade VR technology, many training tasks were carried out using one of the following:

1. Window (computer) systems, which offer a portal into an interactive 3D virtual world;
2. Mirror systems, which allow users to see themselves moving in a virtual world through a projection screen; or,
3. Vehicle systems, in which the user enters what appears to be a vehicle while using controls to simulate movement.
4. Cave Automatic Virtual Environment (CAVE) technologies let users enter an area where big screens are all around them, virtually enveloping them in a continuous space [11].

 

## V. TECHNIQUES AND INSTRUMENTS USED IN VR REHABILITATION

Head-mounted apparatus, like helmets, goggles, or glasses, enables users to experience sight and sound within virtual environments. This technology, pioneered by Ivan Sutherland in 1968, is currently a critical component of virtual reality. Commercially available headsets offer high-quality experiences.


**Figure 4:** Pictorial representation of virtual reality gaming

Trackers are devices that can be attached to users or objects to detect movements of the head or hands. They utilize electromagnetic or optical methods to convert these movements into position and orientation data, which the computer then uses to display the corresponding viewpoint. Binocular Omni-Orientation Monitors (BOOMs) have gained popularity as an alternative to head-mounted devices. They provide stereoscopic viewing and can be easily shared among multiple users without requiring extensive customization. Gloves are another type of input equipment that incorporate fiber optics along the joints of the hand. They measure the flexion and extension motions of major upper limb (UL) joints and include a tracking system to determine the relative position of UL joint. Tactile facilities in virtual environments encompass various sensory experiences such as pressure devices, small pins, temperature devices, scents, and simulated tastes. Body suits can also be used in a similar manner as gloves. Navigation devices, such as treadmills and bicycles, allow users to move within virtual environments. These navigation devices heighten the sense of immersion and presence in virtual environments by enabling physical movement and interaction, delivering a more engaging and realistic experience compared to traditional input methods. Treadmills enable simulated walking or running by providing multidirectional movement, while bicycles combine physical exercise with virtual reality by translating pedalling actions into virtual movement [12].

## VI. THERAPEUTIC USES OF VR

The goal of virtual reality is to create a world that is immersive and participatory. When users feel that the paradigm faithfully replicates the actual scenario that it aims to replicate, they are able to fully enjoy VR. The participant may interact with the VR world in a more lifelike and intuitive way because to this dynamic interaction. A sensor bar or camera records the patient's movements, which are duplicated in everyday activities to help with motor therapy in virtual reality rehabilitation programmes for the medical field. In order to play the game successfully, the patient is required to make movements that build muscles, activate the brain, enhance sensory response, and improve focus, balance, motor coordination, motor control, and gait efficiency [13]. VR has the potential to be an effective tool for the anxiety, panic and agoraphobia and psychiatric community [14]. Vestibular rehabilitation (dizziness, labyrinthitis, vertigo), Gait, static and dynamic balance training, reduce fall risk in Parkinson's disease [15]. Functional activities of upper limb, Equilibrium and non-equilibrium coordination [16].

## VII. CONCLUSION

Devices that simulate virtual reality are useful in creating therapies that improve patients' motor function, postural balance and overall quality of life. The variety of virtual reality interface devices helps in creating therapies in entertaining manner which is planned. The central nervous system therapeutically and sensory systems (visual, vestibular, and kinesthetics) use interaction and immersion in virtual worlds as input mechanisms to change the feedback to joints and muscle for better brain functioning and functional outcomes.

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