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Psychological Approach based on Virtual Reality (VR) For Creating Successful Encounters to Improve Mobility for People with Disabilities

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Abstract: There are many untapped potentials for people with disabilities in VR environments, but there are some difficulties as well. Allowing impaired users to customize the VR environment and use alternative input devices is a huge step in removing these barriers and improving their VR experiences. As VR gains prominence in a few years, makers ought to consider into account the needs and viewpoints of people with disabilities, such as including them throughout the designing process, while developing encounters and tools that's truly available for a broad variety of customers. A solution must be made available to a group of people in order to improve their standard of life; it is not sufficient to merely come up with innovative ideas and physiological improvements. This would represent a significant advancement to those more over a million disabled people who may possibly gain from VR. With this study, we hope to highlight current developments in access-improving VR methodologies. We anticipate that our study will serve as an inspiration for scholars interested in working in this area in the months to come.

Keywords: VR, AR, realistic activities, physiological effects, rehabilitation, fantasies

1. Introduction

Both Augmented reality (AR) and Virtual Reality (VR) have advanced from the realm of fantasies into the mainstream [1-2]. Virtual and augmented reality's (even though rapidly expanding) use cases include a wide range of industries and fields, which include but are not restricted to leisure and gaming, medical care, travel, building and construction, and a number of others [3-4]. Advocates of VR say it's a levelling tool because it gives everyone access to previously inaccessible environments and activities [1]. The majority of experts in the field see a bright future for virtual reality. The market research group IDC predicted in 2018 than worldwide expenditure on virtual reality and augmented reality will soar to $18.8 billion in 2020, nearly tripling from 2019's expected expenditure of $10.5 billion. IDC also predicts that by the year 2023, the virtual reality market would have grown by 77% yearly. From the construction industry to the property market, virtual reality has many potential applications. To provide a single instance, specialists in the area of advertising have identified 13 ways in which virtual reality may revolutionize the field of marketing. Giving consumers the option to "try before they buy," whether that be putting on a piece of clothes or putting an item of furnishings in their virtual home space. According to IDC, by 2023, the three most common commercial uses of virtual reality will be in

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the areas of employee education, industry upkeep, and showroom displays. By 2023, $20.8 billion will be spent annually on virtual and augmented reality by consumers. New VR technologies are being released at the same time as discussions about people with impairments and inclusion are rising to the forefront. The CDC reports that 24 percent of American adults, or 61 million individuals, live with some kind of impairment. Senior citizens (those aged 65 and above) have a disproportionately high rate of disability (12% in 2000; projected to rise to 21.0% by 2030). The positive aspect is the fact that VR may often improve accessibility for persons with impairments by providing new ways to communicate and connect [5-8]. VR programmers may help people with impairments appreciate VR in the same way as (or better then) the real world by incorporating realistic signals throughout a broad range of perceptions [9-10].

2. Comparative Study

This section deals with addressing the challenges of the following types of disabilities using VR. They are classified as Visual disabilities, Motor disabilities and hearing disabilities.

2.1. Virtual reality (VR) as a potential to assist in the rehabilitation of individuals having for disorder

2.2.1 Postural balance improvement

A lifetime incidence of up to 80%, LBP, or low back pain, is among one of the most prevalent musculoskeletal problems [11-12]. While the condition is often self-limiting and cures on its own about 6 weeks, 20% of instances may proceed to chronic low back pain (CLBP), which places a bigger strain on the economy and health [13]. However, CLBP is challenging to cure and linked to several mechanical alterations [14]. Age is a significant factor in determining balance, although LBP may still only contribute for 9% of the difference in balance [15].

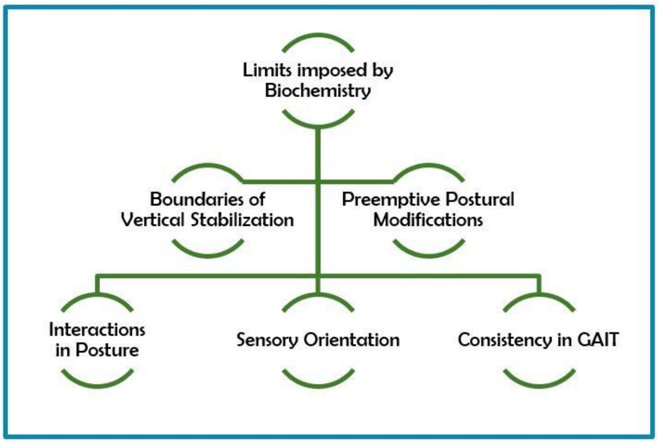

Figure 1. Phases of improvements in Postural balance impairments

Although it is generally accepted that consistent exercise (training) enhances balance and posture in fit young and older individuals, the ideal physical activity (i.e., the one most likely to result in significant posture improvements) and the setting in which it is performed have yet to be explored and identified for every demographic group. The best changes likely rely, in particularly, on gestural circumstances (body posture, movement, and gesture used), as well as material conditions (kind of sports equipment's used, the kind of environment—stable or dynamic).

In actuality, in healthy young and older participants, the worldwide postural improvements generated by training are the aggregate of the changes associated to each learned postural task, rather than being transferred across various learned and unskilled postural tasks. The whole spectrum of postural challenges faced in individual physical practise for each group should be included in ideal training programmes, according to the state of the science.

The most successful way for enhancing postural balance to far have involved the strategy of adopting incremental postural balancing activities with various levels of difficulties and instabilities, however it shouldn't be regarded as the method of reference. Instead, it needs to be viewed as an addition to the approach depending on certain postural tasks. A three-step intervention plan (generic, directed, and specific/ecological training) is suggested for both young and elderly persons. For postural balance to be improved in the best possible way, several factors still need to be investigated and perhaps revised in further research.

Exercise treatment is useful for treating patellofemoral pain (PFP), according to mounting research. However, it has been noted that the gains are not long-lasting, indicating that the existing procedures may not account for all necessary functional variables to offer a steady recovery. Postural control may be a characteristic that is overlooked in PFP therapy methods. It is unknown, nevertheless, if this population has balance issues or how postural control affects pain and function throughout rehabilitation regimens.

2.2.2 GAIT improvement

Over six months following a stroke's start, or in the chronic stage, survivors of stroke frequently experience a long-term persistent and debilitating impairments, particularly with regard to the impairment of motor functions. Additionally, muscular coordination is frequently impaired following a stroke, which results in abnormalities in balance and gait. Balance issues and aberrant GAIT patterns are two of among the most prevalent signs in the chronic stage of a stroke, even among individuals with autonomous motor functioning. These deficiencies have a detrimental effect on the people' quality of life by severely impeding their participation in everyday tasks of routine. They also suggest a higher risk of falling and a higher probability of being admitted to a hospital or nursing home.

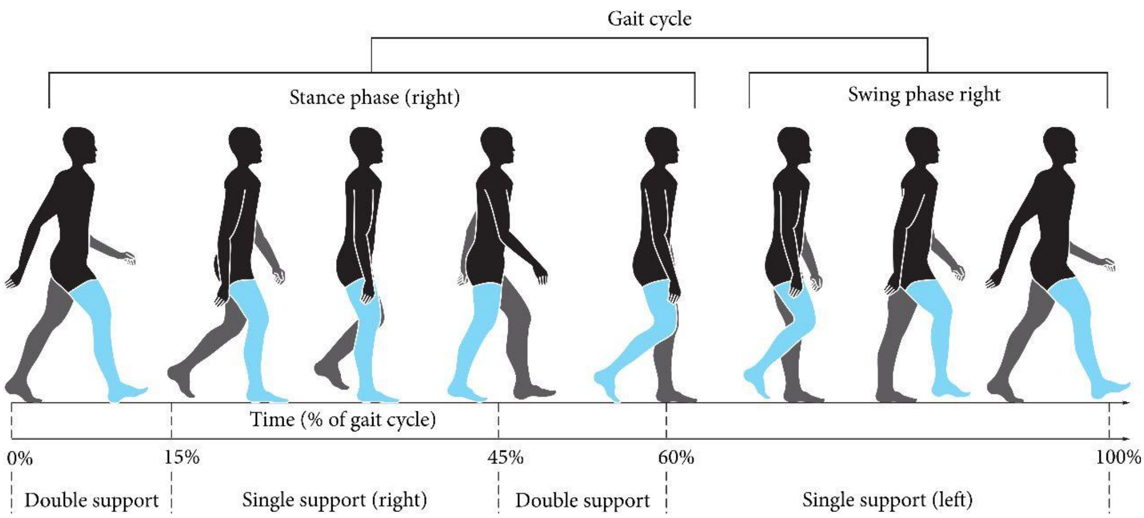

Figure 2. GAIT phases [15a]

As shown in Figure 2, the Gait cycle (GC) consists of two separate stages: the stage of stance, which occurs while the foot is in touch with the floor, and the swing phase, which happens once the foot is off the ground. The first 60% of the GC is considered the stance phase, while the last 40% is considered the swing phase. Aside from the initial and final 10% of the stance phase being double stance (both feet touching the ground), the remaining 90% of the stance phase is single stance (just one foot touching the ground). There are also three stages to the swing period: the beginning of the swing, the middle of the swing, and the end of the swing [15a].

The stability and balance of a person's gait are frequently described using synthesised metrics. Some of them are used to explain how Parkinson's disease, also known as PD, affects the gait. Similar indicators are seldom utilised for comparing the people affected by PD before and after ingesting levodopa (referred to as the OFF and ON conditions, respectively), and this might lead to conflicting results.

Gait stability and harmony [16] are reflected in artificial measures such the Harmonic Ratio, Jerk Ratio, Golden Ratio, and Trunk Displacement Index. All metrics were shown to increase significantly following levodopa, with the exception of the Jerk Ratio. The only change that had a direct association with the motor improvement as determined by the medical scale UPDRS-III (Unified Parkinson's disease Rating Scale-part III) was the improvement of the Trunk Displacement Index.

Artificial indices can be helpful in identifying motor changes brought on by levodopa therapy, but only a few among them strongly correspond with those changes.

After experiencing a stroke, natural recovery often slows down, with the first six months being believed to be the most important period for mobility recovery. This does not imply that people with chronic stroke shouldn't start intensive rehabilitation for motor recovery six months later. According to the findings PNF-based exercise therapy improves walking and balance speed in patients within six months following a stroke.

2.2.3 Risk of Falls Disease

In immersive virtual reality (IVR), each of the user's senses are triggered by artificially created sensations and feedback in a digital, three-dimensional environment. This kind of technology is an effective resource which has previously shown promise in the treatment of Parkinson's disorder (PD). Individuals with Parkinson's disease (PD) have an increased likelihood of falling, and response times as well as processing speed may be indicators of neurological damage, instability of posture, and dementia.

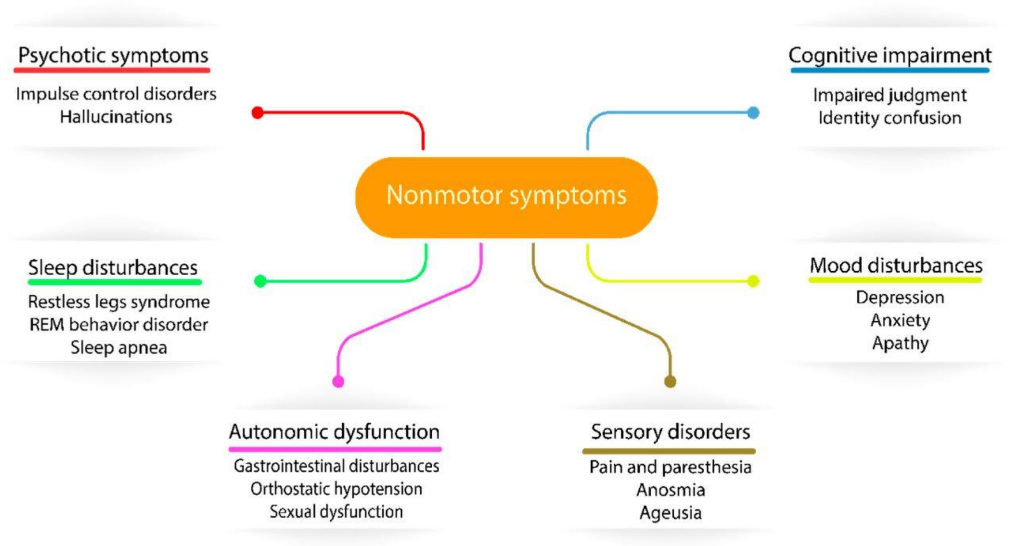

Figure 3. The wide variety of non-motor symptoms experienced by people with PD [17]

autonomic disorders, insomnia, and cognitively impaired neuropsychiatric signs, are all manifested by the malfunction of the aforementioned the nerves (Figure 3), indicating that PD is an illness that is complicated conveying either motor or NMS. Most people with Parkinson's have at least one NMS, and the prevalence of these symptoms tends to rise as the illness advances. Given the present state of clinical diagnosis, NMS are one of the most troublesome aspects of illness detection and therapy in PD [17].

Older people must address their pain since it can lead to dangerous situations like falls. Although there isn't strong proof for neurological pain, opioids are useful for pain that is nociceptive. But the danger of falling can be increased by both pain and narcotics. Assisting doctors in prescription and stopping opioids for older patient’s attempts to summarise the body of information on the opioid-related fall risk in older individuals, including the pharmacokinetics and pharmacodynamics.

Opioid usage raises the risk of falling due to sleepiness, hypotension, and hyponatremia brought on by mild opioids. Drugs such as Opioids should, if feasible, be prescribed in modest doses, taking into account the genetic variance in their metabolism. All opioids have medically significant side effects, and falls are one of them. The likelihood of falling may vary by dosage and is higher for powerful opioids.

Older persons who are prone to falling are especially at danger. Regular assessments of pain and the need for opioids are necessary to lessen the risk of falls. If the clinical scenario permits, reducing prescriptions or switching to a lower dose or safe alternatives must be taken into consideration. Deprescribing should be carried out by progressively lowering the amount of medication while simultaneously evaluating and monitoring the discomfort and symptoms of withdrawal. Before prescribing opioids, especially to elderly patients who are at a greater risk of falling, it is vital to consider the hazards and rewards.

Data is frequently processed slowly as a result of the cognitive impairment inherent with PD. The illness can begin to show signs as early as its initial stages [17a], and these signs may include deficiencies in speed of processing and concentration, cognitive rigidity, and amnesia. Reductions in time to response and computation speeds have been noted by some writers [18] as indicators of instability in posture and gait freezing because they make turning harder [19]. People with Parkinson's disease (PD) have a substantially greater risk of falling than their healthy counterpart’s do, with some prospective studies revealing approximately between 45 percent and 68 percent of PD patients fall annually [20-21].

2.2. Physiological effects of games and other activities on disabled individuals.

Numerous VR applications have a great deal of promise for helping those who have issues with communication. It is possible to enable and support continuous instruction in interpersonal and practical interpersonal abilities using digitally simulated settings that are specially designed to be secure. This virtual world could make it possible for people with difficulties with communication to participate in VR and communicate just with the surroundings, a clinician, and/or a generated by computers and set avatar—a replica of a person—to provide a novel and extremely inspirational rehabilitation tool [22].

Virtual reality, or VR, could represent an exciting opportunity for the provision of sensory interventions and to cope with issues like depressive disorders, anxiety, sensory processing, individual health, and adaptive behaviours due to the impacts of games. A variety of actions for tackling sensory challenges have been looked into. Shortcomings in perception affect how the brain organises and processes data collected by the senses, as well as how the brain interprets and uses the data to facilitate involvement in daily activities. These issues can vary from under-responsiveness, wherein a person processes sensory data longer than other people, to over-responsiveness, wherein an individual records sensory data more quickly and strongly.

Immersive virtual reality (VR) is a novel approach for designing experiences and treatments with improved accessibility [23]. With VR, producers can create a massive ecosystem of individualised, immersive, generated by computers stimulus that may affect the two main senses of sight and hearing [24], and people are able to experience them. In order to recreate actual touch interactions, recent VR games also include haptic input via vibrating hand controllers [25]. In contrast to physical rooms, virtual reality sensory rooms do not require a specific, separated place, which would incur additional expenditures and upkeep.

When utilising VR with a head-mounted display (HMD), there were concerns raised about deployment safety and control [23][26]. Research have shown that cybersickness may have harmful effects on a variety of individuals, including autistic individuals (both children and adults) [26] and older and younger persons lacking disabilities [27]. Individuals with and without impairments have reported utilising VR with an HMD with a variety of issues [26][27]. Despite these possible challenges, VR may provide consumers with greater accessibility because of simple setup on-demand, portable devices, and the ability to add additional components for higher throughput.

In adults, low back pain (LBP) is the leading cause of impairment worldwide. Low back pain affects over 80% of the population at some point in their lives.

The fear-avoidance hypothesis is a theory that attempts to clarify the progression from acute to subacute to persistent low back pain. Those who experience less anxiety as a result of suffering are better able to go about their everyday lives while making gains throughout the recovery process. VR is a useful discomfort diversion that may be utilized to stop the fear cycle. By immersing themselves in a virtual environment, patients could be able to carry out their bodily therapy without even realizing it was happening. In general, it is going to contribute to less discomfort and better functionality. The use of VR as a treatment to enhance motor skills and lessen the sensation of pain has been shown to be successful. For chronic pain relief, an immersive virtual reality experience is superior to the currently available non-immersive VR therapies for LBP treatment. Severe discomfort in clinical operations, including burn treatment, has been reduced with the use of immersive virtual reality.

It is possible to classify LBP virtual reality games under two broad categories: (1) workout corrections and (2) client motivation. The player's actions are often visualized as those of an avatar (virtual body) in games designed to improve poor form. The MV of encouragement for patients' games is indirect, though. Without really seeing the participant's body, and they were able to utilize their motions to affect the virtual world.

As a diversion method for alleviating varying degrees of pain, numerous virtual worlds were developed. All of the planned VR systems have made use of a VR headset as the system's output device, raising the user's sensation of immersion and, by extension, pain alleviation. The computer mouse has been the most often used input device in [28].

In order to help burn victims heal, the popular "SnowWorld" virtual world was created. In order to alleviate patients' discomfort during burn treatment procedures, "SnowWorld" has been demonstrated to be useful.

In the RabbitRun video game, you take charge of a rabbit that is strolling through a village street. It hops from platform to platform in search of treasure. The constantly changing presentation of barriers and money adds a welcome aspect to surprises and keeps gamers on the edge of their seats. Avatars serve as the means of communication paradigm, while a third person, fully immersive camera viewpoint serves as the viewpoint. Figure 4 depicts the general layout of the game's setting [28]. The player's main objective throughout the course of play is to stay away from a variety of hazards. As can be seen in (Figure 5), there are four distinct types of obstructions: (a) tall road obstacles, (b) shorter roadway hurdles, (c) blocks of concrete, and (d) vehicle delineators. At the beginning of the activity, the rabbit is seen ambling aimlessly down a hamlet road. The Rabbit may hop over or roll under obstacles on the route. It will swerve left and right to avoid the curbs. The Rabbit must turn to the left or right in order to squeeze among the road markers. Utilizing four low back pain (LBP) rehabilitative workouts, the player directs the Rabbit. The research and a discussion groups comprising four physiotherapists were used to choose what activities to include. (Figure 6) depicts the four movements, which are as follows: (a) forward leaning (trunk flexion), (b) backwards stretching (trunk extend), (c) medial bending, and (d) trunk spin. For example, if a player has to shift the Rabbit of the left or right to prevent hitting a brick block and they will need to complete a lateral flexibility workout.

Figure 4. A Rabbit game [28]

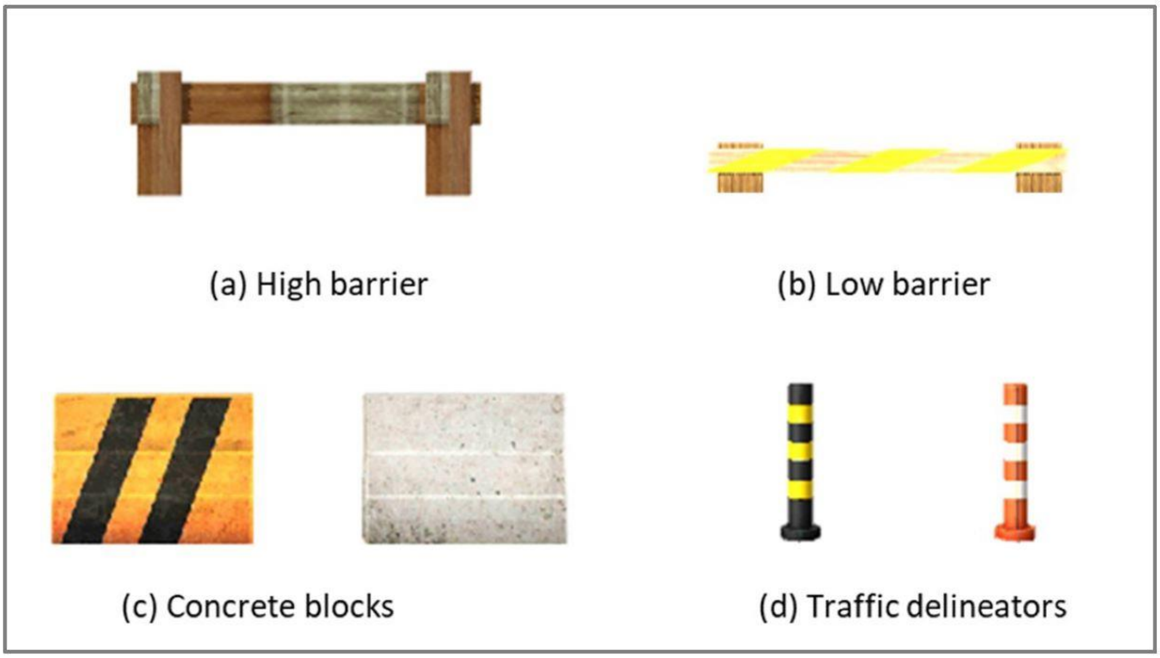

Figure 5: Game obstacles [24]

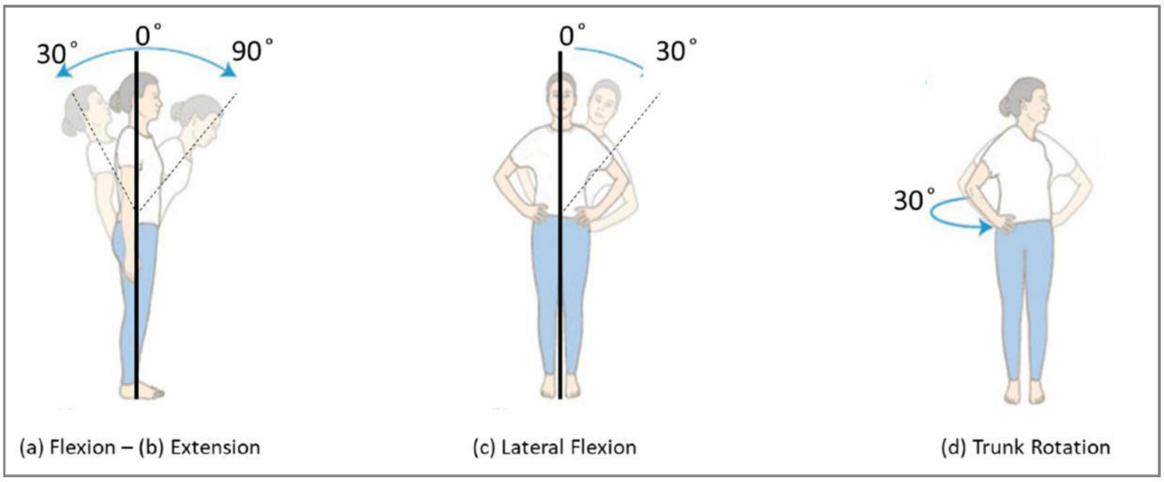

Figure 6: Four rehabilitative activities that must be completed before beginning playing the game [24]

3. Challenges

VR has the potential to greatly improve the standard of existence for many people who are blind or visually impaired; however, each user is different, so what functions effectively to someone may present difficulties for another. Magnifying the picture in virtual reality (VR) might make matters worse for persons with visual impairments, such as having tunnel vision or poor peripheral sight. "Magnification for people with tunnel vision can be a bad thing," says ophthalmology professor Gary Rubin. They can only see via a narrow aperture, and increasing the size of that aperture reduces the field of view.

Individuals with vision impairments might also have trouble performing some operations in a virtual reality setting, such as increasing the dimensions of words or adjusting the brightness surrounding text and the backdrop. Individuals with hearing loss may miss important information in virtual reality games and other activities that rely on auditory cues. People with hearing loss may be at an expense or feel left out of VR experiences that prominently include real-time audio communication. Current virtual reality (VR) hardware prevents users from accurately simulating the hand movements required to communicate in language signs like American Sign Language (ASL). Virtual reality systems, for instance, can't tell when a user is separating their fingers to make a V or W in American Sign Language. As a result of all these obstacles, ASL-speaking VR viewers have filmed the ways in which sign language is adapting in VR.

Unintentionally excluding persons with motor impairments, many virtual reality games and experiences assume expectations about the user's movement or movement capabilities. Individuals with motor impairments may not be able to participate in certain virtual reality settings because they need head or body motions which are challenging or impossible to perform. Many virtual reality settings prohibit the use of non-standard devices like gamepads or motion controls, exacerbating the issue. Users with motor impairments may need more time to complete time-sensitive activities. Some persons with neuromuscular problems may have difficulty using virtual reality (VR) head-mounted screens that are positioned across the front of the head.

4. Discussion and Future Scope

People with impairments have a lot of unexplored possibilities in VR settings, but there are also certain challenges. A big step toward eliminating these obstacles and enhancing virtual reality (VR) adventures for individuals who are disabled is to allow them to personalize the VR surroundings, incorporating the utilization of alternate input controllers. Producers should consider the requirements and perspectives of those with impairments, including involving them in the creation interpret, to create applications and experiences that are truly open to a broad variety of consumers as virtual reality (VR) grows in popularity in the not-too-distant future. Around the identical moment as issues regarding individuals with disabilities and inclusiveness are becoming more prominent, new virtual reality (VR) tools are being developed. The good news is that VR can frequently increase mobility for people with disabilities by giving them new options to interact and communicate. By adding genuine signals over an extensive spectrum of views, VR developers may enable persons with disabilities to enjoy VR in the exact same way as (or better than) the actual world. Healthcare providers along with other communication partners may benefit from VR-based interventions that encourage immersive and interactive instruction. This will allow these interpersonal collaborators to develop and practise meaningful interactions with people who have difficulties communicating in a secure setting. The efficacy and security of medical care for persons with communication disorders may be enhanced, if effective, by virtual reality instruction that focuses on better interaction between patients and providers in medical settings.

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