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## ABSTRACT

## INTRODUCTION

## LITERATURE REVIEW

### Virtual Reality & Its Application

#### Introduction

The concept of virtual reality was first introduced by Ivan Sutherland in 1965 when he suggested: "make that (virtual) world in the window look real, sound real, feel real, and respond realistically to the viewer's actions" (Sutherland et al., 1965). With the introduction of this new technology, it gradually came into the public's view, and this type of research got an official name “virtual reality”. The term "virtual reality" was thencoined in the 1980s, with Jaron Lanier's description of Scott Fisher's work in the “VIEW” lab, the first multi-modal virtual reality implementations (Bryson, 2013). These terms are used in the computer community interchangeably and represent the same thing: VR and virtual environments (VE). These terms are used in the computer community interchangeably, and represent the same thing: VR simulates an interaction with the world in a virtual space (three dimensional computer) and gives an immersive experience to the person interacting with it (Slater et al., 1994). In this proposal I will refer to this class of technology as virtual reality.

In virtual worlds, it is the visual impressions conveyed by the computer that are delivered to the human senses through machine devices, the number of senses stimulated and the quality of the sensory stimulation determines the immersion in virtual reality (Sinclair et al., 1994, 64-66). Therefore this technology caused a wave of enthusiasm in its initial

development, but due to technical limitations, the high cost of equipment, the infrastructure at that time was not enough to support the user's expectations of VR, and no tech company dared to bring VR into the commercial market, VR saw a small explosion followed by an aborted death. But through the attempts of this generation of pioneers, in 2019, with the development of 5G, AI and other technologies to overcome the difficulties of VR technology[1] and the 2020 epidemic makes the user's demand for indoor entertainment increase, the VR industry is beginning to enter the Plateau of Productivity stage[2], and is integrated into the production and application of various Industries.

## Application

VR has been used in many sectors. With continuous development, its simple, direct interaction reduces the threshold of user operation, virtuality reduces the cost of the real world and avoids the risk (Mazuryk & Gervautz, 1996), so VR in the production and manufacturing (Choi et al., 2015; Ashish et al., 2017; Li, 2021; E et al., 2004; Yu et al., 2010), the field of education (Kang & Kang, 2019; Shim et al., 2003; Song & Lee, 2002; Wang et al., 2018; Bao, 2022), the military (Kot & Novák, 2018; J et al., 2023; Lotte et al., 2022; Kumar et al., 2016; Albert et al., 2017) and other fields have made great progress. At the same time, there is a focus on the use of VR in the disabled community, a group where the immersive capabilities of VR can be of real use, especially in disability-related healthcare.

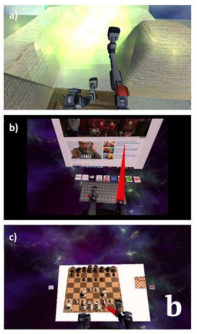
VR in the development of various fields, people are also concerned about the disabled group, the disabled is VR's immersive feature can really work, especially in the medical field.

In the medical field, especially in the fields of physiotherapy and psychology, the immersion of VR has had a positive impact on the mood and state of patients during rehabilitation. For example, in a study of children with cerebral palsy, Snider et al. (2010) found that although there was a significant difference in the physical functioning of the patients treated with VR therapy compared to non-VR therapy. In a study of children with cerebral palsy, although VR therapy was significantly different from non-VR therapy in treating patients' physical functioning, it did have potential benefits for children with cerebral palsy. In the field of psychology, exposure therapy can be safely conducted through virtual reality to direct anxiety and induce anxiety loss in patients with anxiety disorders (Krijn et al., 2004). At the same time, VR plays an important role for patients with physical functional deficits, e.g. VR has been highly successful in the treatment of phantom limb pain (PLP) by normalising the

[1] VR/AR development history vr development has gone through several stages: https://www.quanxiquan.cn/industry/vr/596.html
[2] Talking about VR Virtual Reality (I): the history of VR: https://www.zhihu.com/tardis/zm/art/26592125?source_id=1003

missing parts of the patient through a more varied and realistic vision (Murray et al., 2007; Mercier & Sirigu, 2009) and by improving the relationship between actual sensory feedback and predictive feedback (Elisabetta et al., 20185). Ambron et al. (2018) have explored the potential of VR for treating PLP in experiments with VR games and sensors, see Figures 1a and 1b. Each treatment dramatically reduces a patient's PLP and is cost-effective and simple to administer.

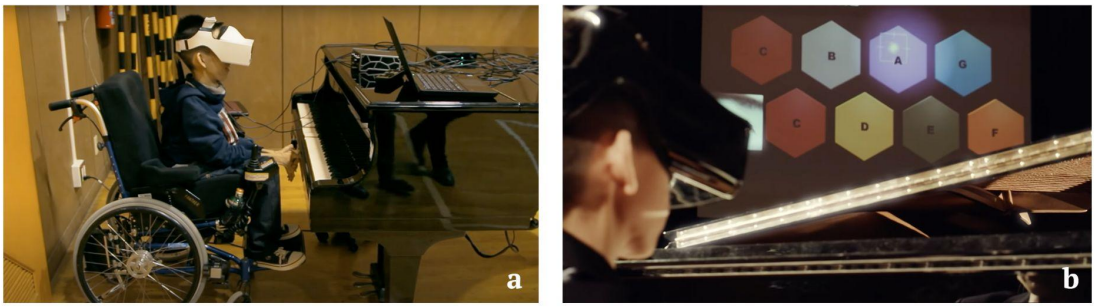

Participant is using the VR system




Participants' view of the VR system

**Figure 1: The Hardware and Software Demonstration of the VR system for the treatment of PLP (Ambron et al., 2018)**

Meanwhile, in the field of entertainment, where VR is well suited, the entertainment experience for people with disabilities has not been neglected. Researchers from the Italian Institute of Technology have engaged and played an acoustic archery game by using sound instead of traditional vision to allow blind people to orientate and move themselves in the game space (Davide et al., 2021). Eye Play the Piano is a joint project between the University of Tsukuba's Special Needs Education School for the Physically Challenged and FOVE, see Figures 2a and 2b. Eye tracking technology allows people with disabilities to play the piano through their eyes.




Practising playing in Eye Play the Piano

Real-time user interface at the performance

**Figure 2: A student with disabilities playing the piano in Eye Play the Piano**
**(University of Tsukuba's Special Needs Education School for the Physically Challenged & FOVE, n.d.)**

## VR & Movies

As VR continues to advance across different sectors, it has emerged as a valuable asset for those with disabilities. However, despite VR's potential, the realm of film in the entertainment industry has shown limited research focused on accommodating VR for people with disabilities. This scarcity of research can be attributed to the ongoing exploratory stage of VR film, which brings forth numerous opportunities and challenges yet to be fully addressed.

### Virtual Reality & Film

In recent years, film industry has been trying to create a new film narrative medium by using VR, at present, both in the form of simulated cinema viewing environments (Virtual Reality Cinema) and user immersed in experiencing the film world.

Virtual cinema viewing is an experience in which the user can simulate viewing a film in a real film environment (cinema, drive-in theatre, etc.) by wearing a VR device, see Figure 3. It mainly by drops the film content into a virtual viewing environment created by VR. This approach changes the viewing environment for the viewer rather than the film itself, so the focus of this paper is on the latter, i.e. .

**Figure 3: Current visual effects in VR analogue cinema: CINEVR (CINEVR, n.d.)**

One of the earliest VR short films was Henry[3] from Oculus, see Figure 4. Most of the works on the market today that immerse users in the world of cinema are actually based on CGI and game environments that focus on the entertainment and exploration of the participants, and most of the VR movies produced by the studios are vr games based on the story of the film, such as The Spider-Man: Homecoming, Fantastic Beasts and Where to Find Them. Fantastic Beasts and Where to Find Them, and Assassin's Creed.

**Figure 4: Youtuber wears VR device to watch the VR movie: Henry (Nathie, 2018)**

Cinematic virtual reality (CVR) is a form of virtual reality film that has been proposed in recent years, and is available to users using head-mounted displays (HMDs) or other VR devices (John, 2017). In terms of filming, the CVR uses a camera to capture real-time images, more like film (Miriam & Alex, 2018). In terms of narrative, 360-degree immersion in a virtual synthetic world (Mateer, 2017). The focus is more on "cinematic" or "narrative" based VR narrative experiences than adding more exploration and entertainment.

[3] Henry(2015 film): https://en.wikipedia.org/wiki/Henry_(2015_film)

Interactions of CVR are varied, ranging from 360-degree video (where only the viewing position can be selected) to interacting with film characters, depending on the plot. Examples include *VR Noir*[4] and the short documentary *Collisions*[5]. But unlike traditionally planned films shot with cameras, 360-degree films will be shot with the viewer instead of the camera, and the free viewing position will make it easy for the viewer to be drawn in by irrelevant content and miss out on the main storyline, and the traditional film editing model no longer applies, so cvr is going to be a revolution in the field of cinema, and much of the existing language of cinema will no longer be valid (Ding et al., 2018).

## Challenges

Currently, with the VR technology advancing at a rapid speed, the distinction between VR films and VR games has blurred. The relatively recent proposal of CVR has led to limited cases and studies in this area. As such, much research in this field has been focusing on the narrative aspect, a crucial element that can help to differentiate between VR films and VR games. Further exploration in this field is necessary to clarify and distinguish these two mediums.

The main narrative problems faced by VR films are: 1. How to guide viewers to pay attention to the main elements of the story, 2. How to choose the viewers' viewing roles (participant or bystander), 3. How to choose the right position for viewers, character actions, and story elements in the virtual space, 4. Balancing spatial and temporal story density, 5. Story density. 5. New Framing methods. 6. New Editing methods, etc. One of the main challenges is how to guide the audience's attention to the main elements of the story, and the existing research can improve this problem in several ways. The existing ways of directing attention are gazes, motion, sound, context, perspective, contrast, lighting, signs and signals (Gödde et al., 2018), among them 3D sound is a widely used technique in CVR, but due to the loss of hearing, 3D sound can not be perceived well by deaf people. Therefore, the guidance of deaf people's attention in vr film is a very important issue, deaf people's sensory responsibility has undergone a compensatory shift, deaf people's sensitivity of the other senses is far more than normal people (Arla et al., 2014), so that other senses, such as ear stimulation instead of 3D sound to guide the deaf people's attention (Mirzaei et al., 2020).

[4] VR Noir: https://newcanvas.co/project/vr_noir/
[5] Collisions: https://www.barbican.org.uk/collisions

## Music & Presence in Movies

The most important point of VR film is the sense of immersion, to increase the audience's sense of immersion is mainly through the technology of VR and the design of the film, VR technology can be achieved through the audience to experience being in the virtual world to achieve a sense of immersion, in the design of the film, the CVR and the traditional film in the shaping of the atmosphere of the film has a lot of commonalities and differences.

### Ways to create presence

The immersion of a film is largely dependent on the creation of the film's atmosphere, and traditionally films have relied on mise en scène, the foremost among the unquestioned contributors is mise en scène. The foremost among the unquestioned contributors is mise en scène, which consists of Set design, Lighting, Space, etc.[6]. These visual elements are the mainstay of the film's atmosphere, and this part of the methodology doesn't differ much between the effects created in VR films and traditional films.

Besides Mise en scène, the more important ones are: Camera Moves, for example, in one film, "apparently aimless camera movements enhance the claustrophobic atmosphere. In a silent film, tinting colours a film's spaces when "the atmosphere is carefully defined". In a silent film, tinting colours a film's spaces when "atmosphere is carefully sustained with the yellow candlelight, the gold dawn, the pink firelight, the deep blue of the night. blue of the night. " (Brownlow); Music, most pertinent is ambient sound or mood music. which not only drives the viewer's mood, but also has the effect of linking multiple clips together (Nisbett, 2003).

Since the viewer's perspective in a VR film is the camera, the design of the original film about the camera changes. Michael Gödde et al. in their study proposed how to guide the viewer's attention during the viewing of VR films by testing and recording the viewer's behaviours and attentions in cinematography, staging and editing methods (Gödde et al., 2018).

### Music in Movies

Music is undoubtedly the most important component of a film's atmosphere. In addition to music, sound effects are also a factor that adds to the experience and immersion during the viewing process (Bullerjahn & Güldenring, 1994). But for deaf people, they will lack the auditory part of the immersion when watching a film. However, according to existing research, even though the visual material of a film already conveys a great deal of emotion,

[6] Mise-En-Scène: https://en.wikipedia.org/wiki/Mise-en-sc%C3%A8ne

the music has an additional effect on top of it. In the case of film characters whose expressions are neutral, the emotions conveyed through music alone, such as happiness, anger, fear, etc., can influence the audience's interpretation of the film character's emotions. And music doesn't necessarily need to appear at the same time as the film picture to affect the audience's understanding, music can come in earlier or later, but playing music before important episodes will allow the audience to enter the immersive experience earlier (Meinel & Bullerjahn, 2022). It becomes important to compensate for the immersive viewing experience of the auditory part of the deaf.

## The Deaf & Movies

The ‘deaf’ does not mean no hearing but a loss of hearing so severe that speech cannot be processed by hearing alone (Darrow, 2006). Depending on the level of hearing loss in deaf people, there are different ways of replacing the deaf people sound part of the viewing experience, below are a few well-researched methods:

**Hearing Aids/Cochlear Implants** are the two main ways of helping hearing-impaired and deaf people to use their hearing that are currently available, with hearing aids being suitable for people with sensorineural hearing loss, depending on the degree and type of hearing loss. Cochlear implants are used for people who are profoundly deaf, but whose hearing centres are functioning well, and allow them to "hear" sounds as close to normal as possible. However, the effect depends on the performance of the cochlear implant and is usually expensive (Slobodzian, 2009).

**Caption** is another widely-used tool. Often in films there is music or sound effects that drive the plot, but are not given in the film by adding subtitle notes, it can help developers to understand the plot. E.g. weird sounds in a horror film would be noted as "strange sounds", otherwise the deaf would be confused by the reactions of the main characters in the film. The disadvantage of traditional subtitles is that the deaf and hard of hearing people will spend more time on reading subtitles than normal people, existing edited subtitles can alleviate this problem (Szarkowska et al., 2011).

**Compensatory Plasticity -** Deaf people have a processing advantage for tactile and vibrotactile stimuli because of the compensatory shift that occurs with the loss of hearing, and deaf people will replace hearing with other perceptual modalities, however the research that has been done has not been able to show an increase in visual sensitivity after auditory deprivation (Fine et al., 2005), however, deaf people have superior motor visual processing to those who are not hearing impaired (Armstrong et al., 2002). This is reflected in the fact

that deaf people will allocate more visual attention to the periphery, and it is also possible that the advantage in motor visual processing is due to the signers' learning of sign language, which makes it easier for them to pay attention to body and hand movements (Neville & Lawson, 1987).

Also **tactile stimuli** elicit activation of the stimulated auditory surface layer in deaf people, when the deaf hand receives a vibratory stimulus, the activation of the stimulated auditory cortex for deaf participants deaf to discriminate the vibratory tactile stimulus is greater and more extensive than in normal hearing participants (Auer et al., n.d.; Levänen et al., 1998). Levänen et al. showed that deaf have an enhanced ability to discriminate suprathreshold frequency changes in vibrotactile stimuli (Levänen & Hamdorf, 2001), which would support an enhanced ability of deaf people to perceive vibrotactile music, for example Deaf participants can distinguish not only between timbres (Russo et al., 2012), but also between the same pitches and phonemes (Ammirante et al., 2013). Music: Not Impossible is a wearable technology, see Figure 5, they use this principle to enhance the experience of deaf and hard of hearing concert goers by vibrating the sound of the concert onto their skin (not impossible Labs, n.d.).

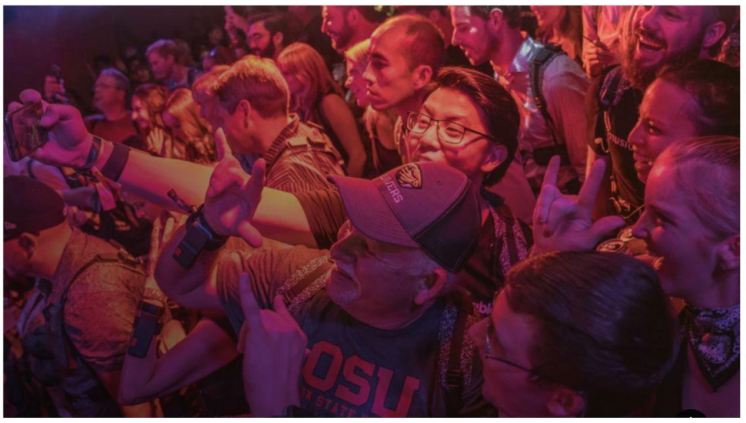



**Figure 5: Music: Not Impossible official presentation images from the live show (not impossible Labs, n.d.)**

# METHODOLOGY

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