

Analysis of Interaction Methods in VR Virtual Reality

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Abstract. Virtual Reality is a new revolution in interaction. As a super technology that can trick the human brain, Virtual Reality is widely used in healthcare, education, business, medical, entertainment and industry. In the field of VR, developers are committed to giving users a full and realistic interactive experience, for example by transmitting the senses of touch, smell, sight and hearing to the user's brain and restoring the user's perception of the real world first-hand. This requires not only powerful technology, but also sophisticated interaction design. Many VR giants are currently working on various technologies and systems to enhance the user's interaction experience in the virtual world. This article analyses three of the main interaction methods (motion capture, eye tracking and haptic feedback) and their associated device products and provide a brief comparison and summary of them. Although the interaction methods in VR are not yet unified and the various virtual reality devices on the market have their own flaws, with more and more players getting involved and the rapid development of technology, it is not difficult to judge that in the near future virtual reality interaction devices will explode like a rocket.

Keywords: Virtual Reality; Interactive Experience; Motion Capture; Eye Tracking; Haptic Feedback.

1. Introduction

Virtual reality, also known as virtual environments, is a technology that uses computers to create a virtual three-dimensional environment in a simulated way that imparts visual, auditory and tactile sensations directly to the user, making it seem as if the user is in the environment. The principle is to use the various functional modules of a computer to interact with individual devices to achieve a three-dimensional environment formed by the computer system and the wearable device. The concept of virtual reality was developed before 1950, when Stanley G. Weinbaum described in detail virtual reality technology based on haptics, smell and holographic goggles in his science fiction novel *Pygmalion's Spectacles*. Then in 1968, Ivan Edward Sutherland created the first ever virtual reality and augmented reality head-mounted display system. Today, technology is advancing at a rapid pace and VR technology is being used in a wide range of fields such as business, healthcare, entertainment, education and industry to name a few [1].

3D games, or three-dimensional games, have always been dedicated to giving players the most realistic sensory experience, and virtual reality technology plays an important role in the development of today's 3D games. The application of virtual reality technology in gaming is very promising, with 3D games in the adventure, action, racing, shooting and role-playing genres. With the development of technology, virtual reality games with realistic experiences now occupy a huge market. Virtual reality games are a completely different experience to traditional 3D games, going beyond the keyboard and mouse, as the player becomes one with the character through a wearable device, allowing for a truly realistic sensory experience. Virtual Reality technology offers a level of interactivity, immersion and conceptualization that transcends reality, giving virtual reality games a unique appeal.

VR virtual reality technology has brought about a new revolution in the way people interact, moving from interface to space, with a strong emphasis on immersion. Today, VR interaction is still in the discovery and development stage, with a variety of interactive devices on the market that are not yet unified and still have their own shortcomings [2]. The current development of virtual reality technology has indeed greatly enhanced the gaming experience of some simple and small games, but there is still a lot of room for development for some large gaming projects with extremely complex game mechanics and environments. Industry experts say that virtual reality technology has expanded

the gaming market and that interaction technology will become key against the background of convergence of hardware devices in the market. Excellent interactive experience will become the main differentiating competitiveness of such games. Therefore, it is increasingly important to have a leading understanding and application of interaction models when creating high quality large-scale VR game projects.

This paper will focus on the interaction model of VR virtual reality technology and its application in the VR industry. Today's virtual reality is no longer purely game-centric, but a virtual world experience with a realistic feel. The virtual reality devices used by users can greatly affect the level of immersion and interaction experience. The immersion provided by the virtual reality devices on the market is provided by three main system technologies. These system technologies provide the complete immersion and broad interaction for virtual reality. Secondly, the important experiential needs of the user in a virtual reality environment include the immersive experience, the audiovisual experience, the interactive experience and the device experience. The assessment of the three interaction modalities mentioned in the text in terms of experience requirements determines the user's overall interaction experience in a virtual reality environment. This paper then briefly summarizes these five broad VR interaction styles. At the same time, it also provides an inventory of related products or technologies, which will hopefully bring some inspiration and help to VR developers and practitioners.

2. Motion Capture

2.1 Principles of Motion Capture Technology

Motion capture, also known as motion capture, is a technique for recording and processing the movements of people or objects. Its principle is to rely on optical 3D motion capture technology to accurately measure and record the trajectory or pose of an object in 3D space in real time, and to reconstruct it in virtual 3D space. Motion capture technology is widely used in film and television, healthcare, sports and artificial intelligence, among many other fields. In the film and television industry in particular, motion capture technology is often used in the production of CG for films and games. Motion capture technology can realistically imitate and reproduce the complex movements and expressions of real people, so it is often used to capture and record the movements of human actors and convert them into data for the production of 2D or 3D computer animations.

2.2 Immersive Experience with Full Body Involvement

In virtual reality-based games, a motion capture system is crucial in order to give the user a fully immersive experience. It is well known that most current VR devices only allow the user to have a partially immersive experience, that is because even though the user puts on the VR device and enters a virtual world, in this world the user can only see one of their hands and half of their arms. Often, the user has to manipulate the controls and press specific keys in order to control the character's actions. This mode of interaction is extremely non-intuitive, unnatural and inconsistent with the behavioral patterns of people in the real world, which is why VR devices are currently unable to achieve a higher level of immersion. Motion capture technology can solve this problem. When a motion capture system is added, the user's entire body can be mapped into the virtual world [3]. Whatever movement the user makes in the real world will be reproduced in the virtual world. Users no longer need to rely on controllers and can engage directly with objects in the VR game. This makes the VR experience very intuitive and immersive.

At a Dutch gaming company, developers have built a VR experience centre specifically for motion capture systems. Among other things, the optical motion capture system Qualisys can accurately track the player's movements and position. The developers had two waves of players playing a VR horror game together at the same time, in which players would be attacked and chased by zombies. One wave of players used regular VR equipment, while the other played in a VR experience centre equipped with a motion capture system. In the end, the players in the VR experience centre can enjoy

the fun that comes from walking freely, while the players wearing regular VR devices lose part of the immersion of the VR game as they cannot walk too far.

2.3 Consistency of Interaction Behaviour in Virtual Environments

The virtual reality motion capture systems on the market are extremely complex, requiring a large number of sensors, cameras and data processing equipment. The equipment is expensive and captures with high accuracy, so it is widely used in games and film production. The virtual simulation VR system from the French company TechViz enables a fully virtual user simulation environment [4]. The motion capture solution performs the simulation of the relevant environment and motion capture through devices such as VR headsets and joint trackers. As shown in Figure 1, (1) is the Perception Neuron wearable suit developed by Noitom and (2) is the MVN product launched by Xsens.

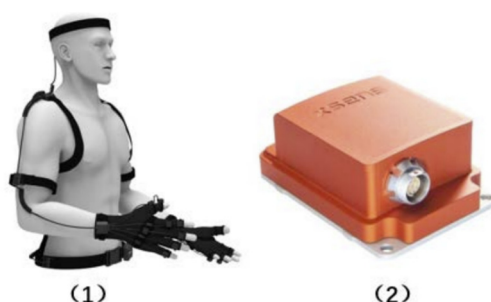


Fig 1. Motion capture devices on the market. (1) Perception Neuron wearable suit developed by Noitom; (2) MVN products launched by Xsens Company

Swedish optical motion capture product company Qualisys' motion capture system is able to rely on cameras to acquire recognition points on specific parts of the human body in order to complete the capture of the user's movements. The cameras are arranged in a ring around the room and produce a series of high-definition images by shooting at high speed. These images are compared and combined to obtain data on the marker points to capture the movement of each marker, as shown in Figure 2.



Fig 2. Qualisys OQUS 6+ series passive optical motion capture cameras.

As shown in figure 3, on the right is the marker information collected by the motion capture system, and on the left is the pose of the person wearing the tights with marker points.

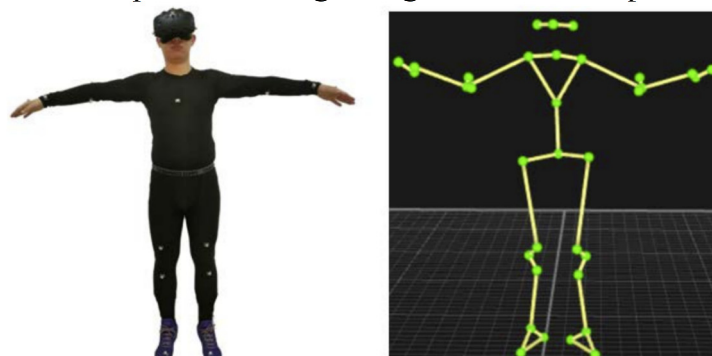


Fig 3. Marker space capture diagram

The whole VR system works with the Unity3D simulation system, Qualisys optical motion capture system and HTC VIVE headset system, the workflow of the system is shown in figure 4.

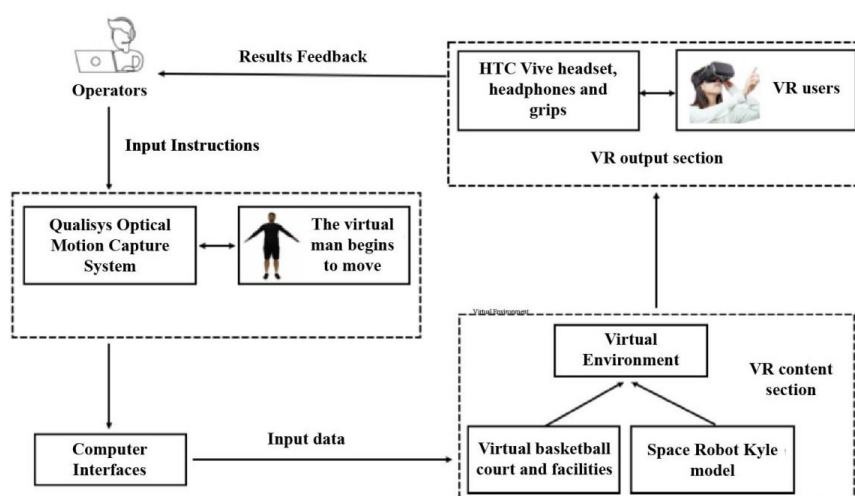


Fig 4. Hardware and soft facilities configuration of VR system

Optical motion capture technology can accurately capture real human movement, which allows the user to observe the actions performed by the avatar in the virtual world in a virtual environment. Although visually the user can have an immersive experience, there is a lack of research and experimentation on the consistency of the observed behaviour with the real movements of the user in reality [5]. Consistency of behaviour in virtual environments is important in interactive experiences. To explore behavioural consistency, experts recruited testers to conduct experiments to evaluate user throwing behavior in Qualisys' virtual reality system. The consistency of the interaction behaviour was analyzed by observing the throwing process and the results, as shown in Fig5 and 6. Based on the experiments, experts found that throwing accuracy was lower in VR compared to the real world. This is due to the fact that factors such as velocity factors and movement trajectories do not have the same impact in virtual reality and real environments. These findings will provide an important reference for future research on motion interactivity experiences in VR.

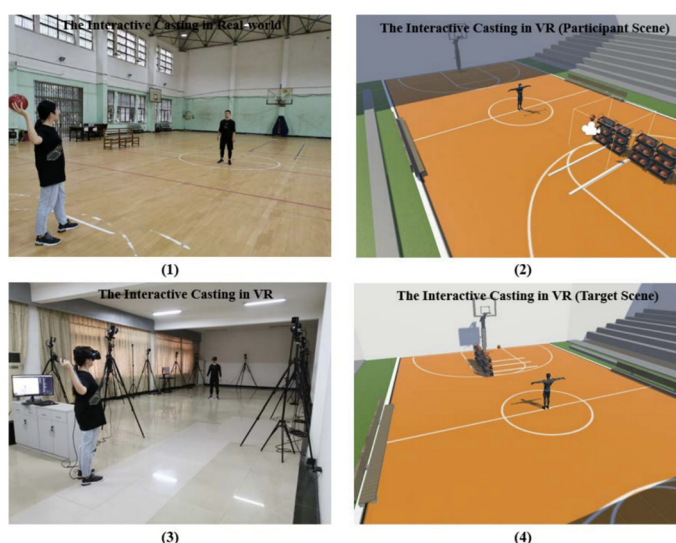


Fig 5. Experimental setup for consistency assessment of interactive throwing behaviour in real environment (1) and virtual environment (3,2,4). Where (2) shows the scenario used by the participant; (3) shows the participant and the avatar being interacted with in VR; (4) shows the scenario used by the avatar

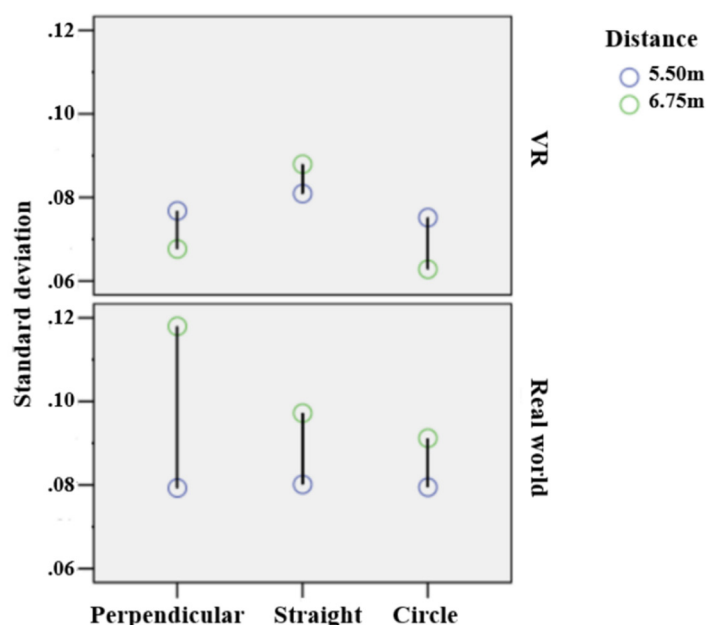


Fig 6. The standard deviation of throwing accuracy for different combinations of factors

3. Eye Tracking

3.1 Principles of Eye Tracking Technology

Eye tracking is the process of measuring eye movements at the point of gaze or in comparison to the head. There are a number of methods for measuring eye movements. The most widely used design is currently a video-based eye tracker. As the viewer sees a stimulus, the camera focuses on one or both eyes and records the eye movements. Most modern oculomotors use the pupil centre and infra-red/near infra-red non-collimated light to produce the corneal reflection (CR). The vector between the pupil centre and the corneal reflection can be used to calculate the point of gaze or direction of gaze on the surface of an object. The technique is widely used in visual system research, psychology [6], human-computer interaction, product design and other fields. With the increasing maturity of eye tracking and virtual reality technology, more and more virtual reality games are incorporating eye tracking, and the interaction of the game becomes more immersive. Eye tracking allows players to be more responsive to their environment. In addition, users can create and explore virtual spaces more easily by gazing. The director of Meta's virtual company Oculus has said that eye tracking will be an important part of VR technology, but he has also said that eye tracking will not work for 100% of users due to the vast differences in human biology, especially astigmatism and pupils.

3.2 A More Realistic Virtual Image

In the real world, apart from language, most communication between people relies on eye contact. From a social point of view, the real world cannot be separated from eye contact. When people enter the virtual world, the lack of attention perception greatly limits players' expression and interaction. If players are able to perceive and respond to each other's eyes, the sense of separation between on and off screen is reduced. At this point, the player is no longer a third-person observer, but a real character. It helps to increase the immersive experience of a virtual game. For example, in a criminal investigation game, players can look deep into the eyes of suspects and observe their micro-expressions during interrogation. In solitaire games, players can use their eyes to indicate their next move. In horror games, players can stare at monsters and interact with them.

In the Metaverse concept, in the future people could live in an artificial 3D virtual world with social connections [7]. People could create their own avatars and interact intimately with NPCs or other players on the other side of the world, as shown in figure 1-7. With the help of eye tracking

technology, avatars have anthropomorphic non-verbal movements such as blinking, squinting, gazing and pupil dilation. Some of the user's emotions, such as happiness, surprise, fear, sadness, etc., can be determined from the eyes, and these emotions are reflected directly on the avatar's face. The player can look into the eyes of other avatars when interacting with them and observe their expressions, which makes the interaction more natural, without even realising that they are artificial or fictitious.



Fig 7. Simulation of the user's avatar in the Metaverse

3.3 Deep Interaction and Intent Analysis

A number of well-known eye tracking developers have now launched several eye tracking devices for virtual reality, such as the German company Ergoneers. They have added Dikablis eye-tracking technology to their head-mounted displays, which is able to track the user's vision in real time, and have conducted usability tests and experiments with gaze-based interactions, among other things, as shown in the fig 8-9 below.



Fig 8. Virtual reality eye-tracking device Dikablis HMD



Fig 9. VR headset with integrated Dikablis eye tracking camera

Eye-tracking technology can bring additional benefits beyond a more realistic virtual image. Eye tracking can be applied at an analytical level by capturing data on the user's gaze points, such as what the user is looking at and how long the user is looking in each direction, to analyses whether the user is paying attention to important information and cues and whether the user's attention is being drawn to unintended parts of the environment [8]. As shown in figure 10, eye tracking analysis can be used to assess whether an interface or environmental element is being used to its full potential, so that interaction studies can be carried out to improve the design of visual cues. In addition, eye tracking is also well suited to analyzing user intent by collecting their gaze points and incorporating this technology into VR game interactions. For example, a horror game developer is working on a haunted house exploration game. Traditionally, horror developers spend a lot of time editing script sequences to design Jumpscare when the player enters a specific area or touches a specific mechanism, but when eye tracking technology is added to VR games to analyses point-of-gaze interactions, the interactions are triggered immediately by the player simply gazing in a specific direction, making the game experience more natural. Eye tracking technology uses data from the point of gaze to determine the player's intent to trigger the game's Jumpscare or cue directly, which not only enhances the player's interaction experience, but also reduces the development effort and workload for game developers.



Fig 10. Heat map showing the most frequently viewed parts of the scene by users

4. Haptic Feedback

4.1 Principles of Haptic Feedback Technology

Haptic feedback technology stimulates the user's sense of touch through a range of actions such as vibration and force to reproduce the sense of touch for the user. Haptic feedback is common in product interaction and is used in a variety of everyday products, such as vibration feedback on mobile phone touchscreens and buttons, haptic feedback on car steering wheels and door handles, and so on. With the rise of virtual reality gaming, haptic feedback technology is also playing an important role in the gaming industry. Wearable devices equipped with haptic feedback systems can immersivity simulate the environment and feel of the virtual world for players, making them feel as if they are actually in the virtual world. In reality, physical actions are performed through haptic feedback from the environment, such as picking up an object, sitting in a chair, typing on a keyboard and so on. Without haptic feedback, many actions need to be repeatedly confirmed visually, which not only makes them less efficient but also increases the number of invalid actions. This greatly affects the interaction experience [9].

4.2 Comparison and Analysis of Haptic Feedback Devices

There are three main types of haptic feedback devices on the market today: handheld devices, wearable devices and array feedback devices. As shown below, figure 11 is the HTC Vive Hand Controller, a VR handheld haptic feedback device; Figure 12 is the Gloveone, a VR wearable glove device; And figure 13 is the NormalTouch and TextureTouch prototype devices proposed by

Microsoft Research in 2016. In a virtual reality environment, handheld devices can effectively render the user's movement commands or object collisions in a virtual scenario. Currently the most widely used module for handheld devices is the vibration motor, which is found in many of the virtual reality accessories that have been released on the market. These devices are better able to calibrate the user's movements, but have the disadvantage of being less free for the user. The haptic experience of wearable devices is much freer and more flexible than that of handheld devices. Current commercially available wearable devices are mainly exposed skeleton gloves that produce skin stimulation for the user, thus simulating the haptic experience in a virtual scenario. Such devices have the ability to generate non-visual information by stimulating the skin with Braille-like dot stimulation. Wearable mobile devices are one of the most promising developments for future haptic devices, with a more natural and immersive interaction experience than handheld devices and not as counter-intuitive as handheld devices. In addition to these two types of haptic devices, there is also a third type of feedback device, the array feedback device. In addition to being used in VR, array feedback devices are also commonly used in human-computer interaction. Microsoft's TextureTouch, released at UIST 2016, simulates haptic simulation in real time through a 16-unit array, allowing for a better user experience in a limited space. However, the current usage pattern of the array feedback device is still based on handheld devices, and the presentation and commercialization of the device still requires continued research.



Fig 11. HTC Vive Hand Controller, a handheld haptic feedback device in virtual reality



Fig 12. Gloveone, a wearable glove device under virtual reality

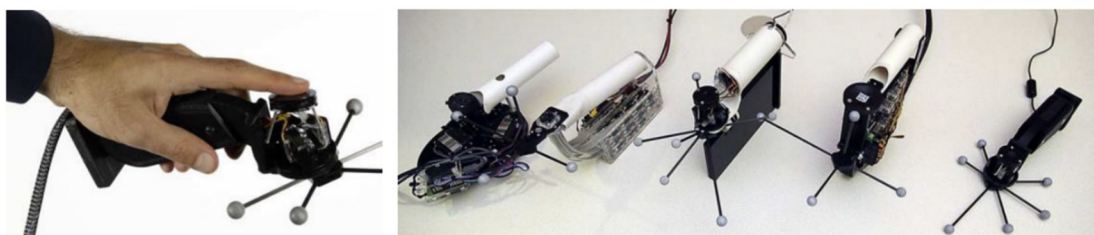


Fig 13. The NormalTouch and TextureTouch prototype devices proposed by Microsoft Research

4.3 Tactile and Force Feedback Research

Most of the current operating equipment equipped with haptic feedback systems is aimed at the hands, and the vast majority of haptic feedback is only at the vibration level. This is because people have a large number of sensory neurons distributed in their hands and therefore the hands are the most sensitive to touch [10]. However, in the developer's view, vibrational feedback from the hands alone does not allow for a good simulation of the complexities of the virtual world. In order for players to have a fully immersive experience, whole-body haptic feedback devices are needed. This is because the most appealing aspect of the VR world is that the player is in a realistic virtual world, and the most realistic experience can only be delivered if the player interacts with the whole world with their whole body. Experts say that in the real world, the human sense of touch is very sensitive and people can quickly identify most objects by touch. With the existing technology in VR, it is very difficult to achieve a high precision simulation of the sense of touch on the limbs. If a full-body interactive force feedback device needs to be built, a new advanced physics engine is needed for the software and a full set of interactive exoskeleton devices with good walking support equipment to simulate various postures is needed for the hardware. Figure 14-15 are the first version of the hardware demo that the developers are working on, which is still very rough.



Fig 14. The first version of the hardware demo in production, which is still very rough

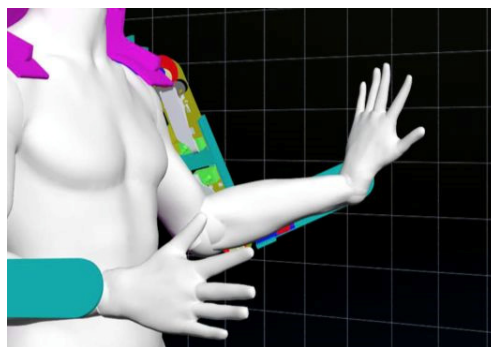


Fig 15. Prototype equipment under commissioning

In addition, the vast majority of haptic feedback is currently limited to vibration. Generally speaking, vibration is a good cue to give the user force feedback in a virtual environment. In the real world, however, when a user touches an object, it is easy to understand the general shape of an object through haptics. In the virtual world, it is very difficult to do this with vibration alerts. In fact, vibration reminders do provide better force feedback to assist with reminders, but their ambiguous tactile content makes the interaction experience much less enjoyable. When users perform some complex and more precise operations in VR, the ambiguous vibration feedback may instead interfere with their attention and affect their interaction experience.

Today, the use of haptic feedback is still very limited. While the three current VR giants, Oculus, Sony and HTC Vive, all use virtual reality grips as a standard mode of interaction, haptic feedback remains an additional consumer application for highly specialized games or deep players. Haptic feedback technology has considerable potential to improve the VR experience though, and although it is still difficult to achieve high precision haptic anamorphism with today's technology, developers are working hard in this direction.

5. More Interactions

In addition to motion capture, eye tracking and haptic feedback, there are many other modes of interaction in VR games, such as gesture tracking, myoelectric simulation, voice interaction and more.

5.1 Gesture Tracking

Gesture tracking refers to the ability to interact and control a device by making simple gestures without touching the device. This technology is widely used in mobile applications, where users can control the screen and browse content with a simple gesture such as a wave of the hand. Gesture tracking technology can dynamically track gestures in real time, which plays an important role in VR gesture interaction, giving users a more natural and fluid virtual reality experience. Silicon Valley company Synaptics, which developed the 3D gesture interaction module Fingo, is the first company to implement gesture tracking on mobile. In addition to Synaptics, there are a number of other major US tech companies working on gesture tracking, such as Intel's all-in-one virtual reality solution Alloy project, Oculus' all-in-one virtual reality headset Santa Cruz, and HTC's recently launched Vice tracker, to name a few. There are two ways in which gesture tracking technology can be used for interaction in the VR industry today. One is the use of optical tracking, which allows gestures to be used as an interaction mode for mobile VR. Since optical tracking has the advantage of low threshold and flexibility, users do not need to wear a device. However, the limited field of view of mobile VR makes gesture tracking not only cumbersome and unintuitive to use, but also the feedback mechanism is almost non-existent, which makes the interaction weak and only good interaction design can compensate for the user's interaction experience. The second is to wear data gloves over the sensor. Data gloves are able to track the movement of the user's fingers or even the entire hand to enable gesture tracking. Compared to optical tracking, this method has a feedback mechanism, but the user cannot disengage from the clumsy device. And as a peripheral device, it has extremely limited use cases. There are still many problems with current interactions with gesture tracking, but there are no absolute technical barriers to these problems. In the future, highly simplified data gloves may be developed with a smarter interaction experience, such as rings, bracelets, watches and so on. These could provide both feedback mechanisms and full flexibility. In the current field of virtual reality, gesture tracking technology is still in its early days and is not yet mature, but this technology has unique interaction advantages and in the future gesture tracking technology will shine in the field of virtual reality [11].

5.2 Voice Interaction

Voice interaction is one of the most important means of interaction in the VR era, allowing users to use their natural voice to talk to other people in the virtual environment, and to use their voice to perform actions and even influence other objects in space. The first feature is called Parties, a simple chat system, similar to Playstation and Xbox's game chat, which allows users wearing the headset to talk to other people in a virtual environment. The second feature is called Rooms, which is a new way to interact with others in mobile virtual reality. As the name suggests, the room is essentially a virtual space where users can chat and interact with friends. The objects in the room are interactive with the user, for example the user can sit in front of a giant virtual TV and watch videos on Youtube or sit at a table and play simple games with friends. oculus' aim with both features is to encourage people to interact in virtual environments and to make people realise that virtual reality is not just an immersive,

game-based experience, it can also be a way of life. Even if people are separated by great distances in the real world, they can still come together to watch videos or party to pass the time. Secondly, in terms of interaction modes, objects in the room are interacted with by tapping on the side of the Gear VR headset, without relying on gesture tracking, motion capture or any type of controller. This is a very interesting attempt by developers who are trying to use virtual reality technology to change people's social experiences and social habits. While this development currently falls short of getting people to use this virtual social interaction for extended periods of time, it is still a powerful first step towards a digital and virtualised social experience, a mode of social interaction that will most likely make VR truly mainstream in the future.

6. Comparing the Quality of Interactive Experiences with Virtual Reality Technologies

The comprehensive user experience of VR is closely related to various elements such as the display screen of the device, the audio-visual experience, immersion and interactivity. The specific experience requirements indicators are shown in the table 1.

Table 1. A comprehensive user experience comparison of VR interaction modes

Interaction patterns/experience requirements indicators	Immersion Experience	Audiovisual Experience	Interaction experience	Equipment Experience
Motion capture	Motion capture for full body interaction; Virtual human behavior is realistic	No lagging; Reduced vertigo	Plenty of freedom; Precise operation	Poor real-time performance of some systems, with large delays and lags
Eye Tracking	Large field of view; Natural eye interaction	Reduced vertigo	Sensitive eye movement tracking	Reduces fatigue
Tactile feedback	Increasing tactile perception	/	Fast vibration loading	Wearable glove devices offer more freedom than handheld devices
Gesture tracking	Not intuitive enough	Limited view of some equipment	Low threshold and flexible operation	Comfortable to wear
Voice interaction	Spatialised sound effects	Audio and video synchronisation	Inefficient acceptance of voice; More suitable for one-way instructions	Portable

The table1 shows that both motion capture and eye interaction offer excellent immersive, audio-visual and interactive experiences. Depending on the principle of motion capture, there are a variety of different devices such as mechanical, acoustic, electromagnetic, optical and inertial navigation motion capture devices. However, mechanical motion capture systems are too inconvenient to use and are very restrictive in terms of the obstruction of movement. Acoustic motion capture systems are less real time and have a significant delay and lag in capturing movements. Electromagnetic motion capture systems have strict environmental requirements, and the presence of metal objects in space can easily cause electromagnetic field distortions that affect the accuracy of the device [12].

Optical motion capture devices and inertial navigation devices are therefore more commonly used on the market. They are not affected by environmental interference, have high capture accuracy, can track head and body movements, and display the user's complete movements in real time. However, due to the high cost of the systems and their high price, they are more commonly used in research applications. Secondly, both haptic feedback and gesture tracking offer a better interaction experience, with vibration feedback giving a better immersion experience and optical gesture tracking having a low threshold and being flexible enough to allow users to leave behind clumsy devices to interact with the virtual environment. Finally, in a virtual environment, the user's main experience comes from looking around, constantly discovering and exploring. The user experience is more natural if the user can communicate by voice in the virtual world, due to the fact that voice is one of the primary ways of expressing information in natural human-human interaction. Three-dimensional virtual speech makes ubiquitous and timeless in space, enabling intelligent recognition of speech wherever the user is. However, voice interaction is not suitable for some complex scenarios with heavy interaction, as voice information is less efficient than other interaction methods and is more suitable for one-way commands.

7. Conclusion

This paper has analyzed five interaction modes that are currently used in VR, namely motion capture, eye tracking, haptic feedback, gesture tracking and voice interaction. In fact, so far, the interaction modes in VR are still being explored, and there is not yet a very mature and universal means of control interaction. The five interaction methods mentioned above have their own merits, but their shortcomings cannot be ignored. Motion capture, for example, is expensive and requires a lot of time to put on and calibrate, so it is only used in special situations such as research. Eye tracking, for example, is a technology that many VR manufacturers are working hard to develop and use, but it is still far from mature. Then there's gesture tracking and voice interaction, which are relatively less widely used. One of the major pain points of gesture tracking is that there is no feedback, and it is difficult for users to feel that their actions are working. For voice interaction, first of all, the machine's understanding of human language is a big problem, simple speech is fine, but complex speech is very difficult. And whether the machine can accurately execute the command after understanding is another big issue.

For users, the most effective and natural interaction modes in VR are motion capture and eye tracking, because even if they don't speak the language, they can still communicate with others through their eyes and body language. In the real world, eye and body movements are also the most intuitive and natural, which is why they can be used in most interaction scenarios.

Finally, some perspectives on virtual reality, which today requires VR headsets, data gloves, data suits and 3D sensors to enable people to interact freely with objects in the virtual world. Therefore, portable, lightweight and low-cost small data wearables such as watches and rings will be the main research direction in the future. Secondly, virtual reality technology relies heavily on the development of human-computer interaction, and the technology has now preliminarily addressed the reading of data and feedback nerve signals from the human brain. It is believed that in the near future, developers will realize the prospect of enabling people to enter virtual environments automatically and freely through the neural system, which will allow users to be fully integrated into the virtual reality world.

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