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Sensory Stimulation and User Experience of Virtual Reality in Game Design

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Abstract. Virtual reality technology has the characteristics of strong immersion, realistic experience, and rich imagination. Therefore, virtual reality technology has also been applied in many fields. Currently, its main application is in the gaming field.As technology advances, the demand for immersion in virtual reality games by players continues to grow. Simple sensory stimulation and experience cannot meet the practical needs of current players, and the iterative upgrade of virtual reality game design is urgent. In light of this, Starting from the development and current research status of virtual reality games, this study sorts out the key elements of virtual reality game design, explores important design theories and methods, and ultimately explores and summarizes the current design methods of virtual reality games around the improvement of interaction design and user experience. It is hoped that through literature review and summary, it can provide reference and guidance for the future development of virtual reality games.

Keywords: Virtual reality games; Sensory Stimulation; Interaction and User Experience.

1. Introduction

Since its inception, virtual reality technology has exerted a profound influence on the evolution of human culture and society. Meanwhile, technological advancements have propelled revolutionary developments in contemporary art. Among various artistic disciplines, game art, recognized as the ninth art, has been at the forefront in harnessing the potential of virtual reality technology. This has given rise to more immersive art forms.

In traditional game design, interaction between players and the game world is often limited to the screen and controller, resulting in limited immersion in the gaming experience. However, the introduction of VR technology has completely transformed the landscape. It transcends the confines of physical space, enabling players to directly inhabit the game world and engage in real-time interaction with the virtual environment. This immersive gaming experience not only significantly heightens sensory stimulation for players, but also enables them to more profoundly comprehend and experience the emotions and information conveyed by the game. Furthermore, the integration of VR technology into game design offers numerous innovative possibilities Designers leverage VR to craft more intricate and immersive game environments, affording players a richer and more varied sensory experience within the game. Moreover, VR technology caters to individual player preferences and needs, delivering a more personalized gaming experience. These advancements not only diversify the expressive tools of game design but also bolster the market appeal and competitive edge of games.

However, the application of VR technology in game design also faces some challenges and problems. How to ensure the safety and comfort of players in virtual environments, balance the realism and playability of games, and effectively convey the story and emotions of games are all issues that designers need to consider and solve. Therefore, starting from the scientific technology of virtual reality, this article sorts out the origin and development process of virtual reality games, explores the design methods and concepts that urgently need to be developed in virtual game design, summarizes the specific methods of improving interaction quality and user experience in virtual reality games, in order to provide some useful references and inspirations for game designers.

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2. The Contemporary Development of Virtual Reality Games

The continuous development of information technology has gradually brought virtual reality headset devices from professional fields into the view of the general public. Virtual reality technology has gone through multiple key iterations since the first year of VR (2016). 5G network communication technology and continuously decreasing software and hardware costs have driven the development of the virtual reality industry. During the epidemic, people have reduced unnecessary offline activities and the use of virtual reality devices for home exercise has become a trendy lifestyle. Entertainment based virtual reality games have emerged, enriching the daily lives of modern people. This phenomenon has also driven more and more researchers to engage in research on virtual reality games.

In the 1980s, computer scientist Jaron Lanier and his team developed a glove that could recognize gesture interactions. In 1985, to promote this product, Lanier used 'virtual reality' to attract public attention at a press conference. Consequently, it is widely believed in academia and industry that he was the first person to use the term virtual reality [1]. As a result, the era of virtual reality has officially arrived. More and more virtual reality devices have been developed and applied to every corner of life. "Virtual reality" has gradually become the new darling of the Internet era.Although electronic game manufacturers are interested in the commercial prospects of virtual reality, there were limitations in software and hardware development capabilities. As a result, consumers and the market have not yet been able to accept the virtual reality head mounted displays of the 1990s. The commercialization of virtual reality headsets has encountered a bottleneck, and game manufacturers have had to take a step back to find feasible virtual reality solutions. Physical gaming devices were the mainstream product in the following period, so this stage is also known as the "VR winter" of head mounted devices [2]. In the field of arcade games, the DDR dance machine launched by Konami in 1998 brought motion sensing gaming devices into the sight of the general public. The somatosensory gaming devices in the field of home consoles were not widely popular until the new century. This shift marked a new era of interactive gaming experiences. In 2003, Sony released the EyeToy camera, which was paired with the PlayStation 2 gaming console and could capture images of users' physical movements. In 2006, Nintendo launched the gaming console Wii, which had built-in sensors on its controller that could recognize the user's hand movements. In 2010, Sony launched the PS Move camera for the PlayStation 3 gaming console, and Microsoft also installed a Kinect camera on the Xbox gaming console. These sensory gaming devices have found a balance between technological level and market demand, making them highly popular among consumers [3].

Against the backdrop of rapid progress in computer technology, many technology giants have taken the lead in achieving the commercialization and commercialization of virtual reality technology. In terms of virtual reality games, thanks to the bold attempts of game production companies, major gaming companies such as Nintendo and Sony are also actively implementing the technology transfer of virtual reality to games [4]. As a result, a large number of high-quality virtual reality games have emerged. From virtual boy to No Man's Sky, and then to Half life Alex, these high-quality virtual reality games all boast of the increasing maturity of virtual reality games .

3. Research on Sensory Stimulation in Virtual Reality Games

Generally, the revolutionary aspect of virtual reality technology is embodied in the "immersive" experience. To enhance the user experience, it is crucial to manage the sensory stimulation provided by virtual reality devices. By fine-tuning touch, vibration, temperature, and other factors, this paperaim to refine the user experience, delivering exceptional sensory pleasure.

3.1. Immersive Sensory Experience

There are two important generalizations in virtual reality, namely Immersion and Presence. Mel Slater defines immersion as the objective level of sensory realism provided by virtual reality, while Presence is the user's subjective psychological perception of the system [5]. According to the division, virtual reality includes immersive and non-immersive. Users can experience complete presence in immersive

virtual reality. This categorization helps us understand the different approaches to creating immersive experiences [6]. Immersive virtual reality systems can be traced back to Dr. Ivan E. Sutherland's HMD system in 1965 which was the first fully functional helmet mounted display that emerged in the 1970s [7].

As a result, research on virtual reality technology has gradually become mainstream, and more and more scientists are paying attention to this popular technology.Regarding the implementation technology of immersive virtual reality, Doug A. Bowman and Ryan P. McMahan from Virginia Tech University believe that in visual immersion, there are perspectives, visual range, display size, display resolution, stereo vision, head based rendering, lighting realism, frame rate and refresh rate, etc [8]. In their research, the benefits of immersive systems were explored .

Most studies suggest that in an immersive virtual reality environment, people are completely immersed in the virtual environment. They can experience a wonderful feeling of presence, which is a subjective experience that other media do not possess. One of the major characteristics of immersive virtual reality is the sense of presence, which is different from immersion. Presence refers to the feeling that exists in a virtual environment, that is, in an external world that is different from oneself. It is a psychological state, a subjective psychological feeling, and presence does not refer to a characteristic of the virtual or physical environment [9].

As Johan Huizinga said in his book "Homo Ludens Study of the Play Elements in Culture", "It is autonomous (Free), actually free (Freedom); games create order, and games are order. Games bring a temporary and limited perfection into an imperfect world and chaotic life, and have a tendency towards beauty. It is endowed with the highest noble quality that this papercan perceive in things: rhythmic harmony and harmony [10]. Thus, the immersion created by virtual reality and the emotional impact of games on humans have a high degree of consistency. Consequently, in the process of designing virtual reality games, shaping immersion and catering to human emotions is crucial.

3.2. The Way to Shape Immersion

3.2.1. Application of Embodied Cognitive Theory

The theory of embodied cognition holds that "cognitive processing is influenced by the body, including the brain, and the body's..."Morphological structure, sensory system, motor system, and the nervous system that represents the body all affect people's cognitive processing" [11]. Body movements, the environment one finds oneself in, and bodily sensations can all alter cognitive attitudes and even influence emotions. These theories offer a theoretical foundation for the design of virtual reality games. However, the current application of embodied cognition primarily remains theoretical, with notable gaps in experimental and practical applications. Hence, future designs of virtual reality games could enhance the application of embodied cognition theory, fostering substantial advancements in virtual reality gaming.

3.2.2. Multi Sensory and Multi-Dimensional Interaction

Famous game designer Chris Crawford believes that "interactivity is the selling point of computer games" [12]. In the real world, people engage with the world in a multi-sensory and multi-dimensional manner. By "multi-sensory," this papermean that this paperperceive information from the real world through our visual, tactile, auditory, olfactory, and gustatory senses.Additionally, to attain optimal immersion and allow players to fully immerse themselves in the virtual world, it is essential to enhance with output modalities such as touch, taste, and smell, facilitating multi-sensory interaction. Thus, beyond the conventional methods of mouse and keyboard, individuals can engage with the virtual world in a naturally intuitive manner.

4. Interaction and User Experience in Virtual Reality Games

4.1. Interactive Design of Game Interface

UI interaction is a widely existing concept that involves not only information exchange between humans and machines, but also various fields between humans and machines. It can be defined as the sum of all information interactions involved in the design, reflecting the relationship between humans and machines, providing people with a convenient and effective communication channel.Through virtual reality technology, the people can seamlessly integrate the real world with the virtual gaming world. To realize this, this paper must develop an effective human-computer interaction interface that not only provides the visual pleasure of the virtual world and immerses us in it, but also embodies the functionality, simplicity, convenience, and interactivity of the real world.

In the actual design process, the interactive experience should be expressed as intuitively and naturally as possible. This helps players get started without much learning, reduces learning costs, and enhances their experience and immersion through natural interaction.

4.2. Creating an Interactive User Experience

Interactivity is one of the important characteristics of virtual reality technology [13]. At present, the vast majority of game works on the market that use virtual reality technology only reflect a small amount of interactivity through helmet free observation of the scene, as well as simple HUD interaction through controller clicks. However, these interactions still remain in the aspect of one-way input, and the initiative of the user only lies in choosing which direction of visual signals to input and corresponding option boxes. However, these interactions cannot generate a tangible sense of contact with the virtual world, and can only be considered as primary stage interactions.

Compared to previous simple interactions, genuine virtual reality interaction design should extend beyond the immediate immersive experience provided by virtual reality technology. It should encompass various elements of game animation, such as lighting, sound, physical interaction, and emotional exchange, to gradually envelop the audience in the plot and story, inviting them to participate and enhancing their experience of the narrative. Deliver our intended messages to the audience with precision and vividness, ensuring that they not only engage with the experience but also reflect on it long after. This approach aims to create a lasting impact and a deeper connection.

5. Conclusion

After exploring the sensory stimulation and user experience of virtual reality in game design, the following conclusions were drawn from the study:

Firstly, virtual reality technology enhances game design and player experience by enriching interaction methods and plot transmission with its unique immersive experience. Innovative designs such as body action interaction, space creation and control allow players to participate more deeply in the game, enhancing its fun and challenge. At the same time, through virtual reality technology, the transmission of game plot and story emotions is more realistic and touching, allowing players to deeply immerse themselves in the game world and generate resonance.

Additionally, while reviewing current research, it has been found that the construction of the theoretical system for virtual reality game design includes urgently to-be-developed and applied theories such as embodied cognition and multidimensional interaction. These theories aim to simulate real-world operations, enabling users to interact with the virtual environment in a natural and intuitive manner. This interaction enhances playability and deepens immersion. The theory emphasizes integrating sensory stimuli—visual, auditory, and tactile—to create a comprehensive, three-dimensional gaming world. Given this, the significance of the interactive interface becomes apparent. An excellent interface can deepen user immersion, going beyond mere real-life simulation. The design of virtual reality game interfaces should prioritize user physical experience and comfort,

guaranteeing smooth gameplay and a continuous user experience, while preventing discomfort and dizziness during gameplay.

In conclusion, virtual reality technology has revolutionized game design, significantly elevating sensory stimulation and user experience for players. Moving forward, as technology continues to advance and innovate, virtual reality will assume an even more pivotal role in game design, delivering even more thrilling and immersive gaming experiences to players.

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