

The interaction design methods of mixed reality systems are explored from the perspective of emotional design

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Abstract: With the continuous development and evolution of the new generation of technology, people's demand for emotional experience is also gradually increasing. In mixed reality systems, the integration of virtual elements and real elements can bring users a richer and more authentic sensory experience, which allows users to gain emotional resonance in the virtual world and thus improve emotional engagement. More specifically, mixed reality systems can drive people's emotional experiences by better mimicking the real world. This paper starts from three aspects of emotional design, takes people's physical experience as the design basis, studies the interactive design model of mixed reality space, and summarizes the user experience model of mixed reality system by analyzing the cognitive logic of mixed reality system in the interaction process, which is more conducive to clarifying the interactive objectives of mixed reality system. The interaction design method which is generally suitable for mixed reality system is summarized.

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Introduction

In recent years, with the continuous progress and development of virtual reality and augmented reality technologies, mixed reality systems have gradually become an important branch in the field of virtual reality. Mixed reality systems feature authenticity, interactivity, and richness. Based on the interaction method of mixed reality and through digital information presentation, not only can system performance be effectively enhanced, but also users' cognitive abilities can be expanded. By simulating different situations, people can make better decisions. So as to help improve people's problem-solving ability [Yan Keting, Shao Jiang, Liu Ke. Research on Human-Computer Interface Design for Mixed Reality [J]. Development and Innovation of Electromechanical Products, 2021, 34(01): 26-28.] To enrich the application scenarios of mixed reality systems and enhance the user experience, apart from breaking through technical difficulties, the pain points in usage are also an important aspect that cannot be ignored. How to make a more scientific layout of the mixed reality interface, achieve a truly effective combination of digital information and the real world, and improve the efficiency of users in locating and collecting information Especially in important fields such as healthcare, military, and national defense, it is of great significance to study the information interface presentation methods and scientific and efficient interaction methods of mixed reality systems, and to propose information presentation methods and interaction design principles that can better meet

people's needs.

I. Emotional Design Elements in Mixed Reality System Interaction

Mixed reality technology is an emerging technology that integrates virtual reality and augmented reality. In a mixed reality system, users can combine the real world with virtual elements through devices such as head-mounted displays or mobile phones to create a brand-new immersive experience. Emotional design involves introducing emotional elements (such as emotional design, image design, language style, etc.) into design to create products that are more in line with humanization. In mixed reality systems, emotional design can enhance users' experience and sense of participation, and improve the efficiency of using mixed reality systems. Among them, emotional elements, mood elements and cognitive elements are the three major elements of emotional design.

1.1 Emotional elements in mixed reality systems

In mixed reality systems, the emotional elements of users are of vital importance, including a sense of exposure, realism, and scene. Exposure refers to the emotions and reactions that users may experience when they are placed in a brand-new virtual and real mixed environment. The system can reduce users' exposure in an unfamiliar environment by providing targeted guidance and prompts. The virtual elements in a mixed reality system need to have sufficient realism so that users can quickly immerse themselves in the new environment. This sense of realism is determined by the strength of the connection between the real-world images and the virtual images. The generation of users'

sense of context is due to the fact that mixed reality systems may change in different situations and scenarios, which directly affects users' emotions and feelings. Vision and sound are important elements that constitute a scene. The visual and auditory information that players receive after entering a mixed reality system will have an impact on the emotional changes of users.

1.2 Emotional Elements in mixed reality Systems

Emotions are the most direct reflection of the system interaction experience and player behavior. After players enter the mixed reality system, although they are in the real world, they will continuously receive electronic information transmitted from the virtual world. During the experience process, users may experience emotions such as excitement, fear, happiness, and addiction. In a mixed reality system, users can interact and manipulate virtual elements in real time. This brand-new scene and experience will bring users a sense of excitement and thrill. Good visual and auditory stimulation can enhance the user's experience, while the opposite will make users feel bored and uninteresting. Some mixed reality systems create virtual "dangerous" scenes, such as horror games, etc. These immersive scene experiences can make users feel scared. Therefore, following moderate design principles can prevent scene design from exceeding the user's tolerance range and causing negative reactions. Interesting interactive elements can create a pleasant user experience and enhance users' sense of happiness. For instance, designing some suspenseful plots can make users feel that they have an adventurous spirit in the game, etc. Some successful mixed reality products, such as games and social media applications, often give users an addictive experience, constantly immersing them in the system.

1.3 Cognitive Elements in mixed Reality Systems

In a mixed reality system, users' cognition is a key element for achieving effective communication. When users interact with the virtual reality world in a mixed reality system, they need to perceive, understand and manipulate virtual elements through sensory elements such as vision and hearing. For instance, using bright and saturated colors or interactively employing image elements can arouse users' interest and curiosity and enhance their sense of participation. During the process of system participation, users need to simultaneously perceive and process both the real world and virtual elements. Therefore, the learnability and memorability of the system are also important factors influencing the user's cognitive process. This includes how to enable users to quickly understand the basic operations of the system and how to slow down the speed of memory loss in subsequent use. The cognitive elements of users in mixed reality systems also include semantics. Semantics refers to a method of conveying information

and meaning through the symbols, labels, and symbols of elements. For example, in the search engine interface, setting the label of the search box to "Please enter search Content" can intuitively convey the function and usage method of this text box. Enable users to find the information they need more quickly. For instance, in the design of a shopping cart on an e-commerce website, designers can use the label "Confirm Purchase" on the button labels instead of common text labels such as "Submit" or "Confirm". This can enhance the context and accuracy of the purchasing behavior while reducing the rate of misoperation.

2. Cognitive Logic and User Emotional Experience Model of Mixed Reality Systems

The concept of interaction design was proposed by Bill Moggridge, one of the founders of IDEO. Its initial purpose was to combine computer software with user interface design. It was not until after the 1990s that the research focuses of interaction design gradually shifted to "human-centered" human-computer interaction. Mixed reality system interaction refers to the two-way information exchange between users and the mixed reality system. Users initiate requests through input actions (such as gestures, voice, clicks, etc.) to the mixed reality system, and the system feeds back to the users through corresponding prompts and operations. Mixed reality interaction design involves the interaction and information transmission between users and virtual elements, as well as between users and real elements, which are usually achieved through the combination of virtual reality technology and augmented reality technology.

2.1 Interactive cognitive logic

Mixed reality systems need to achieve the integration of the physical world and the virtual world. In terms of hardware, they mainly include hardware devices and sensor technology. Hardware devices typically include head-mounted displays, gloves, controllers, real-world cameras, etc. Sensor technology encompasses technologies such as visual tracking, positioning, and motion tracking, which can accurately track and measure users' movements in both real and virtual environments, thereby enabling the interaction between virtual elements and the real environment. The software of a mixed reality system includes applications and their basic framework, callback mechanisms, algorithmic technologies, etc. Among them, the more important ones include spatial positioning technology, virtual reality production tools, algorithm technology, user interface design and interaction modes, etc. Spatial positioning technology can provide precise spatial positioning, determining the position and direction of virtual elements in the user's real environment. Virtual reality production tools are

used to create virtual worlds and virtual elements. Algorithmic technologies, including computer vision, artificial intelligence, machine learning, etc., are used to achieve functions such as tracking, recognition, segmentation and modeling, as well as responses to user input interactions. User interface design and interaction mode refer to creating user-friendly interfaces and designing interaction modes that users like to enhance user satisfaction and usage efficiency.

The cognitive logic of a mixed reality system refers to how users perceive this system, including how users understand the virtual elements in the mixed reality system, how they interact with the virtual elements, and how they interact with the real world, etc. It mainly includes the following aspects

2.1.1 Spatial cognitive logic. The spatial cognition of a mixed reality system refers to how users understand the position, size, direction, distance and other features of virtual entities in a mixed reality environment. In a mixed reality system, virtual elements and real elements can interact and integrate. Users' spatial cognition includes spatial layout, spatial interaction and spatial perception. Firstly, the virtual elements in the mixed reality system need to be closely integrated with the real-world elements, enabling users to accurately perceive the relationship between the two. Secondly, users will interact with both virtual and real elements, such as making and receiving phone calls, taking photos, viewing maps, and interacting with virtual characters. Users will capture information such as the position, dynamics, and shape of each element. Finally, the design of mixed reality systems also needs to pay attention to users' perception and understanding of virtual and real elements, and carry out designs such as the combination of virtual and real and automatic switching in aspects like vision, hearing, and touch. For example, in MR Games, optimizing aspects such as sound, light, and color based on users' perception abilities and habits can enhance their cognitive feelings.

2.1.2 Interaction logic. Mixed reality system interaction refers to the interaction between users and elements in both virtual and real environments when using the system and the completion of corresponding tasks through system feedback. Its interaction is diverse and flexible, enabling various interaction methods such as gesture recognition, voice recognition, touch, and eye-tracking. At the same time, it can also be similar to hardware devices and Changan's technology, achieving control over the virtual world through physical interaction in the real world. The interaction of mixed reality systems features high precision and real-time performance. It needs to respond quickly and accurately to the operations input by users and provide clear feedback in a timely manner to ensure that users can correctly understand the system behavior.

2.1.3 Visual logic. The visual logic of a mixed reality system refers to the process of visual information interaction between users and the real world and the virtual world in a mixed reality scene. The visual logic of mixed reality mainly combines the presentation of virtual information with that of real information to form an overall effect of the integration of virtual and real. The visual logic of mixed reality systems mainly includes the following aspects: First, high realism. Mixed reality systems have a high degree of authenticity and can blend real objects with virtual ones to create a more realistic feeling and effect. The second is the balance between realism and virtuality. A mixed reality system needs to strike a balance between the real world and the virtual world to ensure that the feeling and effect of mixed reality are outstanding. The last aspect is progressive visual adaptation. Mixed reality systems involve users' acceptance of new environments. The design should strive to create a better space for people to gradually adapt to visual changes and present more virtual elements along the way.

2.1.4 Perceptual logic. The perceptual logic of a mixed reality system refers to the user's perceptual ability and experience of the mixed reality world, including the acquisition of sensory information, perception of human movement, spatial cognition, etc. The combination of the visual logic and perceptual logic of the mixed reality system can achieve the comprehensive presentation, perception and interaction of the mixed reality system. The perceptual logic of mixed reality systems mainly includes the following aspects: Firstly, the establishment of spatial cognition and spatial concepts. Mixed reality systems need to use sensor technology, visual tracking and spatial positioning technology and other means to enable users to perceive and understand the characteristics such as the position, distance, direction and size of virtual and real objects in space, thereby establishing spatial cognition and concepts. The second is motion perception and dynamic simulation. Mixed reality systems need to enable users to perceive the motion relationship between virtual objects and real objects, establish dynamic models, and thus allow users to have a deeper understanding of the relationship between the virtual and the real. Finally, there are tactile and auditory feedback. Mixed reality systems need to convey more abundant sensory information to users through technical means such as tactile and auditory feedback, thereby better guiding user behavior and cognition.

2.2 User Experience Model

A User Experience Model refers to an abstract model that describes users' perception, cognition and behavior through the analysis and modeling of the user experience process. It describes the emotional,

cognitive and behavioral feedback generated by users during the use of products or services, and provides a user-centered design approach. Bernd H. Schmitt studied user experience from the perspective of psychosociology and proposed a user experience evaluation system that encompasses senses, emotions, thoughts, behaviors, and associations. Liu Jinhong, An Zhenzhen, Zhang Yamin. Research on the Construction of User Experience Model for Augmented Reality Interactive Games [J]. Journal of Publishing Science, 2015, 23(02): 85-88. The user experience model of a mixed reality system can be divided into three major parts: sensory experience, interactive experience and behavioral experience.

2.2.1 Sensory experience

Users interact with computer-generated three-dimensional models in real scenes by wearing sensing devices, creating sensory impressions such as visual, tactile and auditory ones. The comfort, immersion and authenticity of sensing devices are important factors affecting user experience [Yang Suixian. Interaction Design and Experience under the Background of Internet + Intelligent Design [J]. Packaging Engineering, 2019, (16): Front Insertion 2-front Insertion 3, 1-13.] Comfort refers to the control factors that affect the wearing experience of display devices, such as thermal management, ergonomics, etc. Immersion and authenticity refer to the real-time processing and interpretation capabilities of the system and equipment for the user's environment. Among them, field of view range, depth of field, pixel density, etc. are all important indicators for measuring the immersion that the system brings to users. In terms of vision, users can see and interact with virtual elements in a mixed reality system. For instance, they can visit a museum with mixed reality glasses, experience the scene of primitive people living in caves, observe various animals in real time, and even in a closed space, it feels as if they are in nature. In terms of auditory experience, mixed reality systems can provide users with more realistic sounds to match the scenes they are experiencing. In many mixed reality scenarios, sound has become one of the key elements that enrich the experience. In terms of tactile experience, mixed reality systems can simulate touch sensations through technologies such as vibration feedback and tactile feedback, allowing users to perceive a more comprehensive experience through hand interaction and body-sensing operations. For instance, a mixed reality manufacturing factory can be projected onto the user's hand by laser, giving users the feeling of picking up the entire factory for an experience. In addition, some mixed reality systems have begun to pay attention to the olfactory experience of the users. Mixed reality games or exhibitions can make users feel more engaged through different scents and flavors.

2.2.2 Interactive experience

Interactive experience refers to the interaction and experience process between users and mixed reality systems, including users' control and adjustment of virtual and real objects, as well as their interaction with others. Control experience: In mixed reality scenarios, users can control virtual elements through gestures, voice, and body postures, etc., to complete the changes and adjustments of the scene. For instance, in mixed reality games, users can control the movement and actions of game characters with gestures, and complete the changes of game scenes by adjusting body postures and voice commands. Including operation experience, social experience, display experience, etc. The operational experience of a mixed reality system is the feedback and response of users during the interaction process. For instance, when touching the screen, the system will emit sounds or vibrations to enliven the interaction experience. For instance, when users are in the positioning system, they can interact with the system by looking at the map and listening to instructions to better understand their location and destination information. Mixed reality systems also offer new social experiences, including interacting with other users, sharing information and supporting each other in a virtual space. For instance, in mixed reality social applications, users can interact with friends through virtual avatars and voice chat, enjoying a more diverse social experience. Meanwhile, the mixed reality system provides users with scenarios to showcase themselves. For instance, users can use the mixed reality system to appear in a virtual environment and display their image and brand. For instance, by presenting the body postures of athletes in a mixed reality environment, users can better experience the athletes' performances and also gain opportunities to communicate with others.

2.2.3 Behavioral experience

The operability, learnability and ease of use of the system are also important factors affecting user experience. The operation mechanism of the mixed reality system should follow the people-oriented design concept, fully considering the physiological structure, living habits and behavioral habits of the human body. The user behavior of mixed reality systems has the characteristic of combining the virtual and the real. Users are simultaneously in both the real world and the virtual world, and can receive signals and information from two different attribute worlds at the same time. Therefore, the system is required to correctly handle the relationship between virtual and real things, including the physical positional relationship between objects, user action prediction, and timely interactive feedback. The physical positional relationship between virtual and real objects includes distance, perspective, occlusion relationship, etc. This relies on the system's

environmental scanning in the early stage and the 3D position tracking function in the later stage to be realized. While scanning the real space, existing objects are marked, and virtual objects are projected onto the surface of the objects or float in front of them, allowing players to easily discover and smoothly interact with them. Incorrect positional relationships can affect the speed and experience of interaction. When setting the position for virtual image projection, the system should make reasonable predictions about the user's subsequent actions. Different action trajectories and action methods correspond to different interaction trigger methods.

3. Emotional Design Methods for Mixed Reality Systems

Emotional design theory refers to a design theory that integrates emotional experience into product design. Its aim is to create positive user emotional experiences through product design, thereby enhancing the product's appeal and the seamless nature of user experience. Emotional design aims to elevate product design from merely functional requirements to emotional and social ones, helping designers create more immersive user experiences. Emotional design theory focuses on people-oriented principles, emphasizing user experience and emotional responses, and paying attention to users' feelings and feedback towards the system. In mixed reality systems, due to the mixture of some virtual elements and real elements, it is easy to cause user confusion. Therefore, user experience design is particularly important. Emotionalization theory divides design into three levels based on people's brain activities, namely the instinctive level, the behavioral level and the reflective level [Ma Zenghui. Research on Mobile Terminal Interaction Interface Design Based on Users' Subconscious Behaviors [D]. Zhengzhou University of Light Industry,2016.] People's emotions are multi-faceted. When people encounter a product, the true experience encompasses all three levels and rarely involves only one level. The three levels of design in mixed reality system design can be reflected as visual design, interaction design and experience design.

3.1 Instinctive layer design based on vision, hearing and touch

The instinctive layer design in mixed reality systems refers to a layer designed to achieve an excellent user experience and make the mixed reality system more in line with users' natural behavioral habits. The design of the instinct layer needs to take into account both the usability and efficiency of the product, including interface design, control design and virtual reality world design. The interface design should conform to users' usage and visual habits, enabling them to quickly find the functions they need in the mixed reality system.

At the same time, it should also be aesthetically pleasing and user-friendly. The information of the mixed reality interface has multi-source data sources. It has real-time and dynamic characteristics in terms of information features. It features overlap, multi-dimensionality and spatiality in the way information is presented. [Yan Keting, Shao Jiang, Liu Ke. Research on Human-Computer Interface Design for Mixed Reality [J]. Development and Innovation of Electromechanical Products,2021,34(01):26-28.] Control design should be based on users' natural behaviors and movements. In mixed reality systems, users' body movements, gestures, and motion trajectories should be appropriately considered. Virtual world design needs to take into account the detailed experience of users, making virtual items, characters and other visual elements not only static but also capable of presenting all-round dynamic effects, similar to objects in the real world.

The main purpose of the instinct layer design is to make the mixed reality system more in line with the principles of humanized design, allowing users to complete the operation of the system more quickly and conveniently without spending too much time and energy learning how to use it when using the mixed reality system. Meanwhile, the instinctive layer design is also a crucial layer in user experience design, which can enhance users' favorable impression and desire to use the mixed reality system.

3.2 Behavioral layer design based on immediate interactive feedback

The behavioral layer design in a mixed reality system refers to the design involving user behavior, operation, and feedback in the mixed reality system. The design of the behavioral layer needs to take into account the process, responses and feedback of the interaction between the mixed reality system and users, as well as the needs and expectations of users. Including operation design, feedback design and state design. The operation design needs to take into account the natural behavioral habits of users and design gestures and movements suitable for the mixed reality system, such as head rotation, gesture operation, etc. At the same time, the convenience and reliability of operation also need to be taken into consideration, enabling users to interact with the mixed reality system more naturally. Feedback design needs to promptly inform users of their operation results, allowing them to immediately know whether the operation was successful and reducing operational errors and unnecessary operations. The degree of trust people has in a product depends on its conceptual model and the feedback obtained from it [Chen Yuehong, Wang Shuoyao. Analysis of Visual Psychological Cognition and Emotional Design in UI Design [J]. Art Design Research,2021,No.94(02):74-79.]. Therefore, feedback

design also needs to consider the diversity and pertinence of feedback methods. So that users can have a clearer understanding of the results of various operations. State design needs to take into account the state changes during the user operation process, as well as the state interaction between the system and the user. Single-modal signals are difficult to fully represent users' design intentions due to their limited information throughput. This drawback can be effectively overcome through multi-modal fusion [Niu Hongwei, Hao Jia, Cao Beining, Long Hui, Zhang Feifan, Wang Guoxin. Multi-modal Intelligent Interaction Framework and Implementation for Product Concept Design [J]. Computer Integrated Manufacturing Systems :1-22.

3.3 Reflective layer design based on user experience

The design of the reflection layer in a mixed reality system refers to the design involving aspects such as user experience and user feedback in the mixed reality system. It mainly involves in-depth analysis of the problems and pain points that users encounter during the use of mixed reality systems, and provides corresponding improvement plans and solutions. The design of the reflection layer typically includes user research, user feedback, and user testing iterations. Mixed reality systems need to understand user needs, behavioral patterns and usage habits through user research, and at the same time, they need to identify and analyze the problems and pain points encountered by users. This requires the development team to possess professional user research capabilities and skills in order to better understand users. User feedback is an indispensable part of a mixed reality system. The development team needs to promptly collect and analyze the feedback submitted by users, identify the problems, propose solutions, and implement them quickly. Mixed reality systems need to undergo multiple tests and iterations in order to continuously improve and optimize the system, correct problems and defects, and enhance the system's usability, security, ease of use and user experience.

The design of the reflection layer is crucial for mixed reality systems as it enables the development team to better understand user needs and the evolving trends of those needs, promptly collect feedback, and continuously improve and refine the mixed reality system to better meet user demands and enhance user experience and satisfaction. Meanwhile, the design of the reflection layer can also provide more comprehensive data support and analysis, offering more commercial value and development space for mixed reality systems.

Conclusion

The guiding role of emotional design in the interaction design of mixed reality systems is extremely important. To achieve a better user experience and emotional

response, the interaction design of mixed reality systems needs to follow the principle of humanized design, strengthen the consideration of users' emotional needs, pay attention to design details and improve the user experience. Specifically, the interaction design of mixed reality systems should be carried out in the following ways. First, enhance the usage scenarios, especially for users operating in a mixed reality environment. The design should revolve around the usage scenarios. This requires the development team to have a deep understanding of user needs and usage habits, and adjust the system design based on this information. Secondly, it is important to offer diverse interaction designs. For different users, providing various interaction designs is very important. The design plan should have a certain degree of flexibility so as to be able to meet the different usage requirements of users. In addition, attention should be paid to users' psychological responses. By deeply exploring users' needs and psychological experiences, the theory of emotional design can be flexibly applied to enable the interaction design of the mixed reality system to stimulate users' emotional responses and enhance their emotional experience and aesthetic sense. Finally, iterate and respond to users' opinions and suggestions: The interaction design of a mixed reality system should be continuously iterated and optimized. The development team should promptly collect user feedback and opinions and make timely adjustments to enhance the ease of use, usability and user experience of the mixed reality system.

In conclusion, the ultimate goal of mixed reality system interaction is to achieve natural instinctive interaction, enabling users to rely on intuition rather than learning guidance to easily utilize the system to achieve their goals. This requires a combination with users' usual behavioral habits and patterns. By applying the theory of emotional design, the design team can better start from a humanized perspective, tap into creative potential, make the use of mixed reality systems more in line with people's intuition, and enhance user experience and satisfaction.

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