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Research on User Experience Model Based on Mixed Reality Interactive Games

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Abstract

This paper proposes a user experience model based on mixed reality interactive games. The model combines the characteristics of user experience and mixed reality games, and through user surveys and the establishment of a user experience model, it verifies that sensory experience, interactive experience, emotional experience, and behavioral experience are the main factors in mixed reality games, which can provide guidance for the design of mixed reality games.

1. Introduction

1.1. Research Background and Significance

With the development and application of mixed reality technology, mixed reality interactive games have attracted increasing attention. As a new form of entertainment, mixed reality interactive games not only provide richer and more realistic game experiences, but also combine virtual and real worlds, breaking the spatial limitations of traditional games and providing players with more game choices and experiences.

Therefore, researching the user experience of mixed reality interactive games, designing better mixed reality interactive games, and enhancing user game experiences have become current research hotspots and challenges. Therefore, this study will explore issues related to the user experience of mixed reality interactive games based on a user experience model and provide valuable references and insights for the design and development of mixed reality interactive games.

1.2. Research Purpose

(1) To explore the characteristics and needs of user experience in mixed reality interactive games, as well as users' expectations and feedback on such games.

(2) To establish a user experience model based on mixed reality interactive games, in order to analyze and describe users' experiences and feelings in such games.

(3) To propose recommendations for the design and development of mixed reality interactive games based on the user experience model, in order to optimize user experience and improve game quality.

(4) To verify the effectiveness and feasibility of the user experience model based on mixed

reality interactive games, and provide scientific evidence for the design and development of such games.

Overall, this study aims to conduct in-depth research on the user experience model based on mixed reality interactive games, in order to explore relevant issues regarding user experience and provide guidance and reference for the design and development of mixed reality interactive games, further promoting the application and development of mixed reality technology in the gaming industry.

2. Literature Review

2.1. Definition and Characteristics of Mixed Reality Interactive Games

"Mixed reality is a combination of virtual and augmented reality, where real and virtual images are interwoven, allowing for interaction and manipulation of the real and virtual environments." [1] Mixed reality interactive games are a form of game that combines elements of the virtual and real world, using mixed reality technology to merge virtual elements with the real environment, enabling players to experience virtual game content in a real setting. The characteristics of mixed reality interactive games include:

(1) Fusion of virtual and real elements: mixed reality interactive games combine elements of the virtual and real world, superimposing virtual elements onto the real environment using mixed reality technology, allowing players to enjoy virtual game experiences in a real setting. Compared to other games, virtual reality takes you to another place, augmented reality shows information on top of the real world, while mixed reality adds more to the real world. [2]

(2) Strong interactivity: in mixed reality interactive games, players can interact with virtual elements, communicating with game content through various interactive methods such as touch, gestures, and voice, enhancing the interactivity of the game.

(3) Strong sense of reality: the scene of mixed reality interactive games is similar to the real world, combined with the integration of virtual elements, enhancing the player's sense of reality and immersion. In mixed reality, virtual crowds are embedded in the real world, and their dynamic behavior interacts with the real scene [3]. "Mixed reality games typically involve interaction with physical objects and environments, adding a sense of reality to the game. By integrating the physical and virtual, mixed reality games can also enhance the sense of presence - as if truly existing in the game world" [4].

(4) Innovation and diversity: the application of mixed reality technology enables games to present more possibilities and innovations, increasing the fun and attractiveness of the game. At the same time, the scene and content of mixed reality interactive games can vary in many ways, adapting to different settings and players' needs.

2.2. User Experience Theories and Models

User Experience (UE) economy is the fourth stage of the economy, following the product economy, commodity economy, and service economy [5]. UE refers to the psychological feelings established by users during the process of using products (including material and immaterial products) or enjoying services. It involves all aspects of interaction between people and products, programs, or systems, including emotions, preferences, cognitive

impressions, physiological and psychological reactions, behavior, and achievements [6]. In terms of the components of user experience, Bentley et al. believe that performance, satisfaction, and emotion are three factors that jointly determine the user experience of a product [7]. Schmitt studied user experience from a psychological and sociological perspective and proposed a sensory, emotional, thinking, behavioral, and associative user experience evaluation system [8]. Some scholars believe that user experience is a dynamic concept, which is the cumulative process of memory of various feelings, perceptions, emotions, and emotional states formed by users in the process of interacting with products [9].

Regarding the user experience of games, game story, expectation, rhythm, immersion, attractiveness, usability, and challenge are key elements of the design of online game user experience. Among them, game usability (easy to learn and use) is the foundation of user experience design, which affects the immersion of the game and the overall evaluation of the player [10]. The user experience of the game consists of four elements: sensory experience, interface information experience, playability experience, and added value experience [11]. In addition, under the trend of experience economy, games should capture users' psychological factors and allow players to experience sensory and psychological feelings [12]. They should also connect virtual and real worlds, enabling players to freely create game content, which is the inevitable trend of future game industry development [13].

This article constructs a mixed reality interactive game experience model based on the characteristics of mixed reality interactive games and drawing on Schmitt's UE framework. The model consists of four primary elements, including sensory experience, interactive experience, behavioral experience, and emotional experience, and 18 secondary elements (Figure 1).

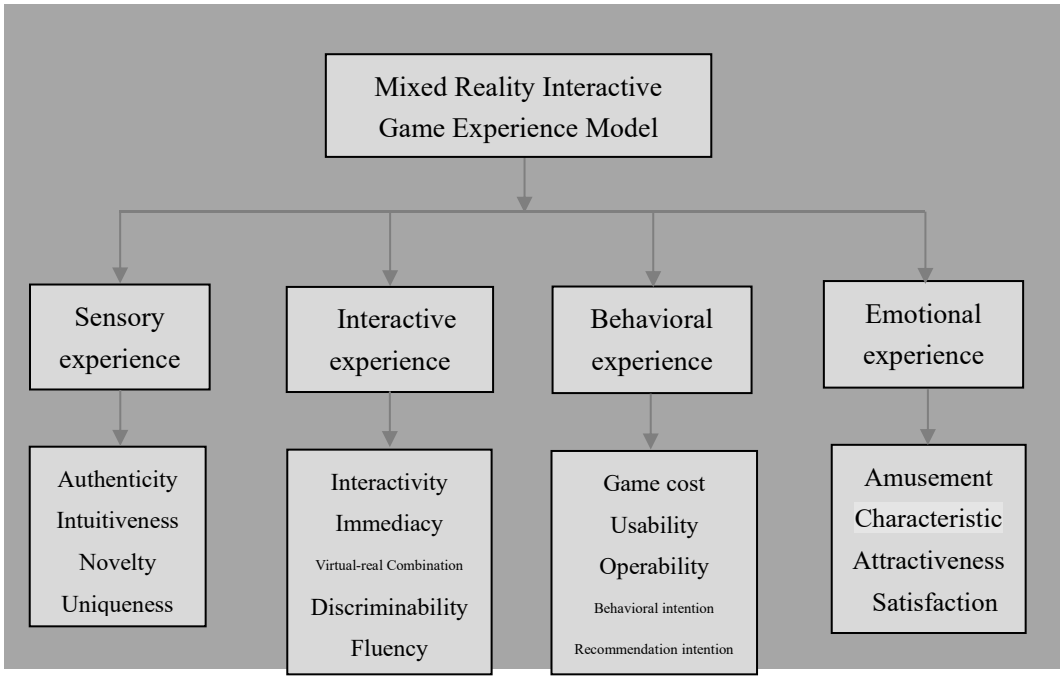

Figure 1 Mixed Reality Interactive Game Experience Model

3. Empirical Study

3.1. Questionnaire Design

A relevant experience questionnaire was designed through the establishment of the experience model (Table 1), consisting of 18 secondary element items corresponding to the Likert five-point scale survey. The survey was mainly conducted through the professional questionnaire platform "Wenjuanxing" to distribute electronic questionnaires. The survey lasted for half a month, with a total of 210 questionnaires distributed. After manual and machine screening, questionnaires with incomplete or false information were excluded, and a total of 186 valid questionnaires were collected.

Table 1 experience model

Primary Elements	Secondary elements	Item
Sensory Experience	Novelty	AR games are very innovative and eye-catching.
	Intuitiveness	The images formed by AR games are very vivid and intuitive.
	Authenticity	The combination of virtual and reality in AR games has a strong sense of realism.
	Uniqueness	The way of playing AR games is different from others.
Interactive Experience	interactivity	AR games have further deepened my level of interaction with the game.
	Immediacy	AR games provide timely feedback on my actions and operations.
	Fluency	The transition of real-life scenes in AR games is very natural.
	virtual-real combination	. AR games integrate virtual gameplay and real-life environments seamlessly.
	Discriminability	The game has a high level of adaptability and recognition rate for real-world scenes.
Behavioral Experience	Behavioral intention	I will continue to play AR games in the future.
	Recommendation intention	I will recommend more people to play AR games.
	Usability	AR games are easy to understand and use (in terms of gameplay, content, and rules).
	Game cost	Game devices and props affect my experience with AR games.
	Operability	Simple gestures and actions are sufficient for operation.
Emotional	Novelty	AR games are a trendy way of gaming.

Experience	Amusement	AR games are more fun than ordinary games.
	Satisfaction	AR games give me a greater sense of achievement and satisfaction.
	Attractiveness	AR games have a great appeal to me.

3.2. Data Analysis

3.2.1. Reliability and Validity Test

Before conducting confirmatory factor analysis, reliability and validity tests were conducted on the data of the research questionnaire. According to the data (Table 2), the Cronbach's alpha coefficients of each factor in the questionnaire data were all above 0.8. The Cronbach's alpha coefficient of the total scale was 0.969>0.7, indicating that the reliability of the questionnaire data was very high. From the data (Table 3), the KMO value of the questionnaire data was 0.915, and the Bartlett sphericity test value was 6387.115, with a significant probability P=0.000<0.01, indicating that there was correlation between the questionnaire variables and the conditions for factor analysis were met, and the next step of data analysis could be conducted.

Table 2 Cronbach's alpha coefficients test results

Variable	Cronbach's alpha	Number of items
Sensory Experience	0.908	4
Interactive Experience	0.973	5
Behavioral Experience	0.975	5
Emotional Experience	0.917	4
Total Scale	0.969	18

Table 3 KMO sample detection and Bartlett sphere test results

KMO and Bartlett's test		
Kaiser-Meyer-Olkin Measure		0.915
Bartlett's sphericity test	Approximate Chi-Square	6387.115
	Df	153
	Sig.	0.000

3.2.2.Confirmatory Factor Analysis

According to (Table 4), the X2/df value is 1.214, which is less than 3; the RMSEA is 0.021, which is less than the standard level of 0.08, indicating a good fit. GFI=0.836, AGFI=0.917, NFI=0.913, IFI=0.935, CFI=0.936, TLI=0.927, and all fit indices basically meet the general standards, indicating that the confirmatory factor analysis model established in this study is effective and matches well with the collected data.

Table 4 Table Model Fitting Index

	Standard Values	Statistic

X2/df	<3	1.214
GFI	>0.8	0.836
AGFI	>0.8	0.917
NFI	>0.9	0.913
IFI	>0.9	0.935
CFI	>0.9	0.936
TLI	>0.9	0.927
RMSEA	<0.08	0.021

Table 5 confirmatory factor analysis table

Factor	Item	standardization Factor loading(λ)	Reliability coefficient(λ^2)	measurement error($1-\lambda^2$)	convergent validity		Cronbach's Alpha
					CR	AVE	
Factor1 Sensory experience	A1	Novelty	0.974	0.026	0.881	0.652	0.808
	A2	Intuitiveness	0.553	0.447			
	A3	Authenticity	0.542	0.458			
	A4	Uniqueness	0.541	0.459			
Factor2 interactive experience	B1	interactivity	0.998	0.002	0.974	0.882	0.940
	B2	Immediacy	0.958	0.042			
	B3	Fluency	0.697	0.303			
	B4	virtual-real combination	0.966	0.034			
	B5	Discriminability	0.792	0.208			
Factor3 Behavioral experience	C1	Behavioral intention	0.937	0.063	0.975	0.887	0.942
	C2	Recommendation intention	0.857	0.143			
	C3	Usability	0.933	0.067			

	C4	Game cost	0.883	0.117			
	C5	Operability	0.824	0.176			
Factor4 emotional experience	D1	Characteristic	0.980	0.020	0.925	0.758	0.871
	D2	Amusement	0.583	0.417			
	D3	Satisfaction	0.535	0.465			
	D4	Attractiveness	0.931	0.069			

According to (Table 5), the factor loading values are all greater than 0.7, and the reliability coefficients are all greater than 0.5, with corresponding measurement errors all less than 0.5. All data indicate good indicator reliability, and the sensory experience, interactive experience, behavioral experience, and emotional experience as variables can well explain the questionnaire items.

The CR values are all greater than 0.6, indicating a strong correlation between the questionnaires and a strong explanatory power of the latent variables set for them, as well as good internal consistency. The AVE values are all greater than 0.5, indicating a strong overall explanatory power of the latent variables for item measurement. The Cronbach's Alpha values are all above 0.7, indicating very high questionnaire reliability and data reliability.

From the various data, it can be seen that the coefficient indicators of the measured variables are all good, and the four hypothesized factors of sensory experience, interactive experience, behavioral experience, and emotional experience are the main factors that can reflect the user experience of mixed reality games.

From the factor loading values and CR values of each variable in the factor analysis, it can be seen that the impact of each factor on its corresponding common factor, that is, the user experience element, is ranked from large to small as follows: iinteractive experience - interactivity, virtual-real combination, immediacy, discriminability, fluency; behavioral experience - behavioral intention, usability, game cost, recommendation intention, operability; emotional experience - novelty, attractiveness, Amusement, satisfaction; sensory experience - novelty, intuitiveness, Authenticity, uniqueness.

3.3. Conclusion

Through the model construction and validation, it can be found that in mixed reality interactive games, players value interaction experience the most, followed by behavioral experience, and then emotional and sensory experience. Therefore, in the process of developing and operating mixed reality interactive games, game developers and operators should focus on three aspects to improve the user experience of game players.

First, game development and promotion should target the emotional needs and experiences of game players. From the analysis results, it can be seen that the factors of fun and satisfaction have relatively low factor loading values, indicating the need to improve these factors. Therefore, in the development and operation of augmented reality interactive games, in addition to ensuring outstanding program design and paying attention to the rational appeals of the game, it is more important to highlight the emotional appeals of the game product and

its ability to bring emotional benefits to players, conveying the spiritual attributes of mixed reality game products and their symbolic significance and expressive ability, promoting their additional value, and establishing a deep emotional connection between game players and the game, satisfying their emotional experience needs.

Second, game development should pay attention to sensory experience. The most significant feature of mixed reality is the combination of virtual and real scenes, but according to the current analysis results, the factors of sensory experience have relatively low factor loading values, and improvement is also needed. Enhancing game realism and leveraging the unique features of mixed reality technology can differentiate it from other games and showcase its uniqueness.

This study conducted theoretical and empirical research on the user experience of mixed reality interactive games, established a user experience model, and conducted empirical research. Due to the limitations of subjective and objective conditions, there are still some shortcomings in this research. In the future, further research will be conducted to gain a more comprehensive understanding of the user experience of mixed reality interactive games.

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