

# Research on Scene Features of Mixed Reality Game Based on Spatial Perception - Focused on "The Fragment" Case Study

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## ABSTRACT

This article combines literature and empirical research based on space perception theory and the case study of mixed reality game "The Fragment." It is concluded that the mixed reality scene under space perception has a three-level visual definition. This definition carries out a corresponding level analysis of the scenes of the "The Fragment" game and draws up the constituent factors of the mixed reality game scene characteristics. Finally, through questionnaire data investigation and analysis, it is verified that the three factors of virtual reality coexistence, human-computer interaction, and local serviceability can better explain the characteristics of mixed reality game scenes. At the end of the study, it is concluded that the definition of three levels of visual hierarchy and the constituent factors of mixed reality game scenes can provide reference and help for other mixed-reality game designs and a brief description of future research plans.

**Key words:** Space Perception, Mixed Reality, Game Scene, The Fragment, HoloLens

## 1. INTRODUCTION

### 1.1 Research background

With the development of science and technology, game forms and carriers are becoming more and more diversified. As newer game forms, virtual reality games and augmented reality games have developed more maturely. Mixed reality games are also growing in the game field. With the most mixed reality game characteristics, "The fragment" have attracted the attention and love of many game enthusiasts since its launch. However, there is very little research on mixed reality game scenes. From the perspective of spatial perception (visual, auditory, touch, smell, taste), the theory of thesis research on game scenes is also a perspective worth exploring.

The game scene has incomparable importance and advantages in the game so that the game can show the game effect in a specific scene space. The combination of virtual and reality of mixed reality games gives game scenes unlimited creative freedom. Mixed reality is the fusion of virtual information and physical information. The core of human processing information pays more attention to the perception of information. How to use spatial perception to process game scenes: This study focuses on the layout of the scene and the real environment, presentation, the method of interaction, the relationship between people and game information, etc.

### 1.2 Research purpose

The purpose of this research: First, by decon-

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structuring the mixed reality space perception, analyzing the visual composition hierarchy of mixed reality under space perception, and then analyzing and studying the "The Fragment" game to Clarify the constituent factors of mixed reality game scene characteristics under spatial perception. Verification of the constituent factors can help the design of mixed reality games, give full play to the spatial perception characteristics of mixed reality, and enhance product popularity. It also provides constructive suggestions for game developers and operators to improve the experience of game players.

### 1.3 Research methods

The paper will be studied through the following steps (Fig. 1).

- 1) Read relevant literature to determine the theoretical basis for spatial perception, mixed reality, and games.
- 2) Hierarchical information based on the spatial perception of mixed reality to determines the hierarchical composition of visual space.
- 3) Analyze the corresponding level of the scenes of "The Fragment" of the mixed reality game and draw up the constituent factors of the mixed reality game's scene characteristics.
- 4) Through player questionnaire survey and data analysis, determine whether the constituent fac-

tors of mixed reality game scene characteristics are valid.

## 2. THEORETICAL CONSIDERATION

### 2.1 The concept of space perception

"Space perception refers to the individual's perception of the distance, shape, size, orientation, and other spatial characteristics of objects in the space in which they are located. It is an important clue for observing the relationship and changes of objects in space." in [1]. Space perception is the coordination of multiple sensors. The products of activities include the activities and interactions of vision, hearing, touch, movement, etc. The visual system plays a leading role, and spatial perception shapes perception, size perception, distance perception, depth perception, position perception, and so on.

This research mainly involves "visual space perception" and "auditory touch space perception." Visual space perception is the use of eyes as receptors to perceive information in the space environment. The background and arrangement of objects can make people's eyes produce depth perception, which is an essential clue to observing objects' space depth relationship. "The dexterity of vision is partly or only that it can be used at will

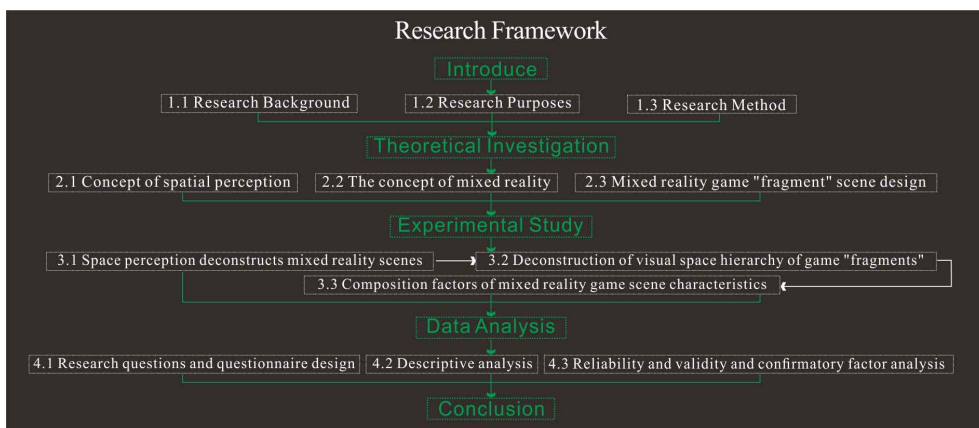


Fig. 1. Research Framework.

for consciousness, but also that it is an indispensable thing in thinking work." in [2]. Regarding the perception of space and vision, it can also be obtained from the auditory organs. In terms of distance, the sound intensity is mainly used as a clue; the sound source's location must be determined based on binaural auditory clues.

## 2.2 The concept of mixed reality

Mixed reality is to use a camera with a spatial depth analysis function to detect and scan the real scene in all directions and to establish real-time 3D model information in the kernel to construct a digital model of the whole scene to determine the fixed position of the superimposed digital information, reaching almost The effect of absolute position stabilization, through the head-mounted display device, you can watch the interface windows, animated images and other digital virtual information floating in the air and closely connected with the real objects. The virtual digital objects coexist with the physical reality environment and interact in real-time to achieve the visual experience of holographic images. "Mixed reality is the result of combining the physical world with the digital world. Mixed reality is the next evolution in the interaction of humans, computers, and the environment, and it unlocks the possibilities previously limited by our imagination." in [3]. "This new reality is based on advancements in computer vision, graphical processing power, display technology, and input systems." in [4].

"HoloLens is the most advanced and first mixed reality glasses. It is a pair of helmet-mounted glasses using the windows 10 system." in [5] (Fig. 2). This product is currently the most iconic in mixed reality technology. One is to mix the holographic image with the real environment through a translucent screen. The holographic digital image exists in a relatively fixed position in the instant scene like a real object, and the visually felt holographic image is like a natural scene. Part of it



Fig. 2. HoloLens glasses.

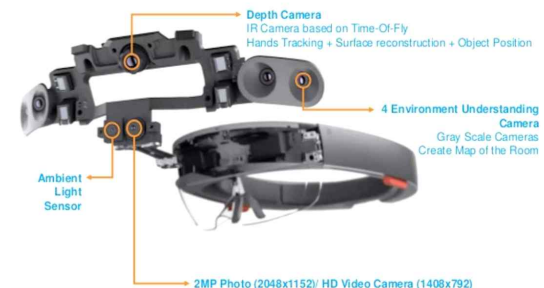


Fig. 3. HoloLens Structure diagram.

presents the illusion of a physical pure three-dimensional image (Fig. 3).

## 2.3 "The Fragment" Scene Design of Mixed Reality Game

This article mainly studies a game of HoloLens mixed reality—"The Fragment" This game is a puzzle-solving game developed by French developer Asobo Studio for HoloLens. The game gives full play to the advantages of the mixed reality combination of virtual and reality Kind of interaction. It is the most representative game of mixed reality and the game that best reflects mixed reality characteristics.

HoloLens will scan and identify according to space they are located and perfectly blend the real scene with the virtual background. The player is in the game space, which is a space that he is very familiar with and exists (Fig. 4). "In any form of a game, it is necessary to simulate the real-world characteristics of real-time air conditions, in which the script is expanded." in [6]. Microsoft's Kudo

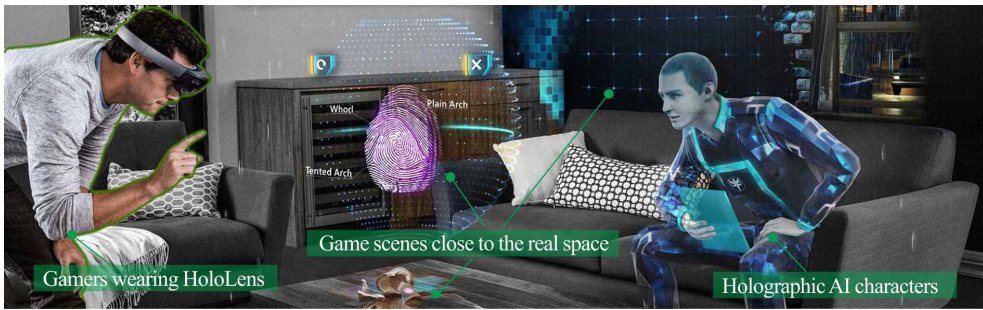


Fig. 4. Screenshot of the game combining virtuality and reality.

Tsunoda said: "This game explains some unexpected things about mixed reality. When your living room is used as the setting of a story, the information that happens in this space will make you have memories similar to reality." in [7]. In mixed reality games, players can move freely in the scene because of reality. The scene is your own home; you can see your hands and feet, It not only has a strong sense of substitution, but also the real familiar environment which can give the game an immersive and safe experience.

Put on the HoloLens device to enter the game interface. When the game starts, you need to scan the scene first to perform the real scene's three-dimensional importance and position. HoloLens uses the SLAM (Simultaneous localization and mapping) technology based on depth information. After the scene scanning is completed, the reconstruction Saves the information. If you want to continue to use this scene next time, reload it to play the game (Fig. 5).

### 3. EMPIRICAL RESEARCH

#### 3.1 Spatial perception deconstruct mixed reality scenes

The mixed reality game scene is the process of presenting the scene and information in the space. Therefore, in the design process, we need to think about the combination and layout of the scene and the real scene, presentation, and the way of interaction. We must also think about the scene and people in the space—the relationship between real objects, people, and virtual objects.

In designing mixed-reality game scenes, the introductory game scene presentation rules are clarified by deconstructing space perception. The game scene is set from the visual laws to have three visual space layers: resident interface layer, follow surround layer, and mixed reality layer (Fig. 6). Clearly express the scene information level to understand the design of the scene, and combine the information presentation methods between different levels to form the final game scene design. The distribution of information in the real space also

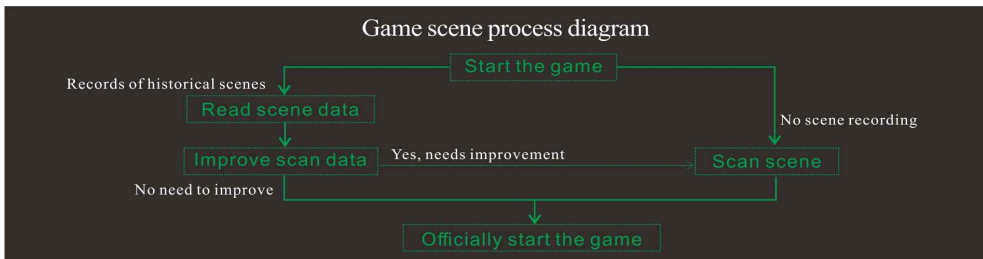


Fig. 5. Game scene process diagram.

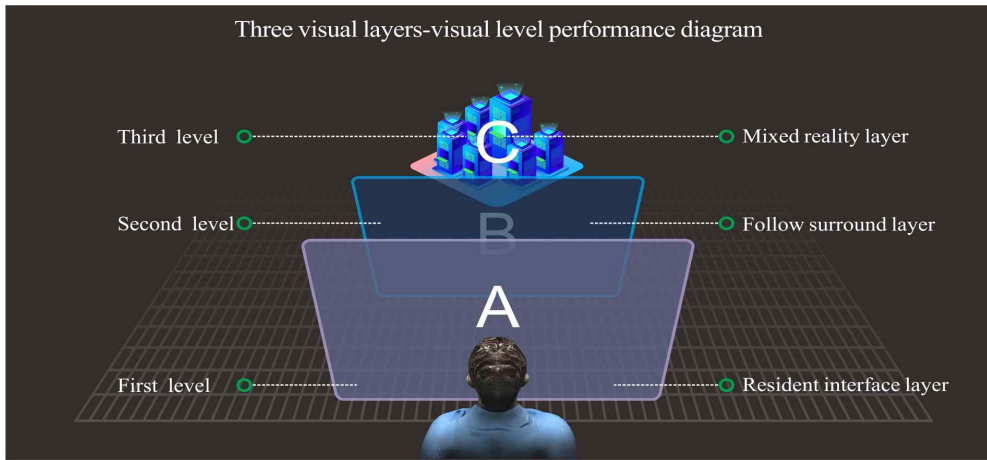


Fig. 6. Three visual layers-visual level performance diagram.

has the essential location characteristics of the difference between physical and virtual information. For users, the position of information in spatial perception can be divided into relative positioning of information to people and relative positioning to objects.

The three-layer visual space method solves how the game scene merges with the real space and conveys information, but the auditory space in the game scene is the primary way to bring game interaction. Interaction based on spatial perception is divided into the following four categories: gesture interaction, voice interaction, visual interaction, and hand-held device interaction; in different game scene designs, different interaction methods can be used, or multiple interaction methods can be set in a game (Fig. 7).

### 3.2 Deconstruction of visual space hierarchy of game "The Fragment"

Through the concept of three-layer visual space, the visual space level analysis and deconstruction of the mixed reality game "The Fragment" is carried out. The first is the resident interface layer, the "The Fragment" game's entry interface, and the game's relevant interface. This visual level is mostly set for data-type information such as game instructions. Because of the importance of the information, it is usually concise and clear. The interface design is not so rich in colors (Fig. 8).

Follow the surrounding layer from the "The Fragment" game scene. It refers to the virtual characters or instructions that often appear around the player during the game, which will move with the person, and perceive the virtual characters or the virtual characters from the visual space. The



Fig. 7. Four Used Interactive Way.





Fig. 8. Game Screenshot.

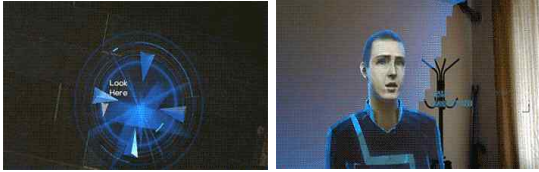


Fig. 9. Game Screenshot.



Fig. 10. Game Screenshot.

instructions are very close to the player and will help during the game (Fig. 9).

The mixed reality layer is the main spatial scene of the game. The "fragmented scene of the game" is composed of virtual information and the real environment. After scanning and modeling the physical scene through pre-scanning, it perfectly fits the real scene's site and objects to achieve the integration of virtual reality and reality—the realm. Players need to explore the scenes of the mixed reality layer to find clues to the game (Fig. 10).

The deconstruction of the game scene in the three-layer visual space provides a clear understanding of the game and provides a reference for the design of other mixed reality games. Different visual levels have different design requirements and plans. For this kind of deconstruction rules, Mixed reality game design is more vivid, and players can get a better gaming experience.

### 3.3 Composition factors of mixed reality game scene characteristics

The three-layer visual space deconstructs the game scene and extracts the characteristics of the mixed reality game scene. The specific summary of the experience generated by vision has the following points: 1) Coexistence of virtuality and reality 2) Human-computer interaction 3) Locality service (Fig. 11). It is the main constituent factor of the mixed reality game scene characteristics based on spatial perception.

Coexistence of virtuality and reality: refers to the fusion of virtual information and real scenes—the same perspective of virtual objects and real space form an experience of spatial depth perception. Moreover, the virtual and real scenes will interact. The virtual objects will have the camera's perspective and spatial depth contrast with the real space, thereby producing the experience of spatial perception depth. Namely: the fusion of virtual and real space, the interaction of virtuality and reality, and the stimulation of spatial capabilities.

Human-computer interaction: through the use of

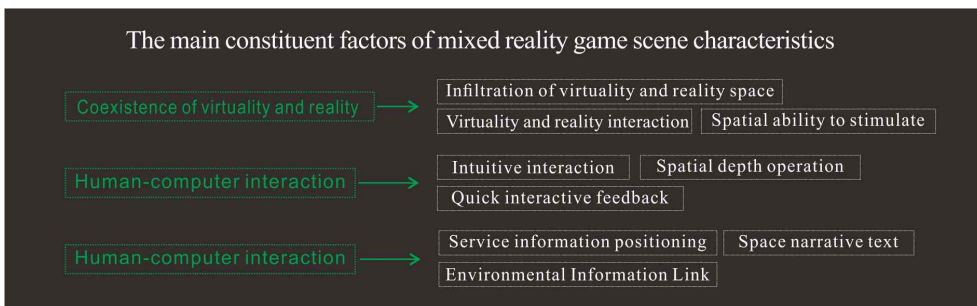


Fig. 11. The main constituent factors of mixed reality game scene characteristics.

HoloLens equipment to interact with virtual scenes and information, it is different from other forms of game interaction. Mixed reality game interaction pays more attention to the feedback of perception in-depth and audiovisual space. Users can interact with virtual objects through intuition Interaction, resulting in non-perceptual human-computer interaction. Namely: intuitive interaction, deep spatial operation, rapid interactive feedback.

Locality service: Mixed reality has technical service for SLAM positioning, which can locate the scanned scene in real-time and fit the current physical scene to produce a real situation. The user will have familiarity and immersion, which can also be regarded as spatial interaction and penetration. With narrative methods, the game is also connected to the current environment information. Namely: service information positioning, spatial narrative text, and environmental information link.

## 4. DATA ANALYSIS

### 4.1 Research questions and questionnaire design

Based on the conclusions drawn from the empirical research, design corresponding question-

naires for data analysis to check whether the three factors of virtual reality coexistence, human-computer interaction and locality service can represent the constituent factors of mixed reality game scene characteristics based on spatial perception. The characteristics of the three main factors are subdivided, and related questionnaire questions are set. The questionnaire (Table 1) uses a Likert five-level scale.

### 4.2 DESCRIPTIVE ANALYSIS

The electronic version of the questionnaire is mainly distributed through the professional questionnaire survey platform "Questionnaire Star," and targeted surveys are used to sample and distribute only people who have played MR games. A total of 125 questionnaires are distributed. After manual and machine investigations, the information has been excluded. A total of 117 valid questionnaires were returned for original and incomplete questionnaires.

Among them, 84 were male users, and 33 were female users, with the male and female ratios being 71.79% and 28.21%, respectively. Analyzing the users' academic qualifications, it is found that

Table 1. Questionnaire.

Item	Factor	Subdivision	Question
1	Coexistence of virtuality and reality	Infiltration of virtual and real space	Perfect integration with the current physical scene
2		Virtual and real interaction	Virtual characters can be related to real scenes (e.g. sitting on a sofa)
3		Spatial ability excitation	Use physical scenes to set up different game objects
4	Human-computer interaction	Intuitive interaction	Easy to enter the game operation
5		Spatial depth operation	Audiovisual interaction has a strong sense of three-dimensional space
6		Quick interactive feedback	Quickly click on virtual objects
7	Locality service	Service information positioning	Can quickly identify the current physical scene
8		Space narrative text	Set up different storylines according to the actual scene
9		Environmental Information Link	Can be associated with real objects during the game

users with a high school degree and below accounted for 30.77%, users with a bachelor's degree accounted for 41.03%, and users with a master's degree or above accounted for 29.06%. In the age group, users aged 18–25 accounted for 28.21%, users aged 26–30 accounted for 23.93%, users aged 31–40 accounted for 38.46%, and users over 41 accounted for 9.4%.

#### 4.3 Reliability, validity, and confirmatory factor analysis

It can be seen from the data in the following table that the factor loading is more significant than 0.7, the reliability coefficient is also greater than 0.5, and the corresponding measurement errors are all less than 0.5. The data show that the index has good reliability, the coexistence of virtuality and reality, human-computer interaction, and locality. The service can better explain the questionnaire items.

The CR values were 0.935; 0.825; 0.879, all greater than 0.6, indicating that the questionnaire items contained in the three factors have a strong correlation and right internal consistency. The AVE values are 0.829, 0.611, 0.710, respectively, all greater than 0.5, indicating that the comprehensive explanatory ability of item measurement is strong, and the three factors can better explain the main

factors studied. The values of Cronbach's Alpha are 0.931; 0.828; 0.865, which are all above 0.7, indicating that the questionnaire's reliability is very high, and the reliability of the questionnaire data is also very high.

It can be seen from various data that the coefficient indicators of the measured variables are right. The three factors of virtuality and reality coexistence, human-computer interaction, and locality service are the main factors that can reflect the characteristics of mixed reality game scenes based on spatial perception.

## 5. CONCLUSION AND FUTURE WORK

Based on space perception theory, the paper constructs a three-layer visual-spatial definition of mixed reality game scenes. This definition can play a critical reference and help in the development of mixed reality game scene design. Besides, the mixed reality game scene's composition factors determined by the three-layer visual space definition fully reflect the characteristics of the mixed reality game and provide essential data support for the later study of the mixed reality game player experience.

Future work: 1) Based on the confirmatory factor analysis of this research, in the future, we will further study and analyze the relationship between

Table 2. Analysis table.

Factor	Item	standardization Factor loading ( $\lambda$ )	Reliability coefficient ( $\lambda^2$ )	measurement error( $1-\lambda^2$ )	convergent validity		Cronbach's Alpha
					CR	AVE	
Factor1 Coexistence of virtual and real	A1	0.861	0.741	0.259	0.935	0.829	0.931
	A2	0.935	0.874	0.126			
	A3	0.933	0.870	0.130			
Factor2 Human-computer interaction	B1	0.813	0.661	0.339	0.825	0.611	0.828
	B2	0.743	0.552	0.448			
	B3	0.788	0.621	0.379			
Factor3 Locality service	C1	0.813	0.661	0.339	0.879	0.710	0.865
	C2	0.915	0.837	0.163			
	C3	0.846	0.716	0.284			



the characteristics of mixed reality game scenes and the player's immersive experience. 2) In the later stage, mixed reality game development will be carried out. In addition to game scenes, game development will involve analysis and research of interface, characters, and storylines.

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