

Study on Multisensory Information Fusion and Interaction Techniques in Experience Design and Optimization of Intelligent Game Systems

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Abstract. In recent years, with the rapid development of intelligent technology, multi-sensory information fusion and interaction technologies have received extensive attention in the field of intelligent games. These technologies have brought richer user experience to intelligent game systems, however, their optimal application in game design and their impact on game experience still deserve in-depth study. This study aims to investigate the application and optimization of multisensory information fusion and interaction technologies in intelligent game systems to enhance users' game experience. By outlining the basic concepts of multisensory information fusion and interaction technology, this paper analyze its role in intelligent games and how to optimize the design of intelligent game systems to achieve better user engagement and game experience. The experimental design and data collection section elaborates the research methods and data sources to lay the foundation for the experimental results and analysis. Through multiple experiments, this paper analyze the impact of multi-sensory information fusion and interaction technologies on the intelligent game experience, and how to optimize these technologies to enhance user engagement and enjoyment of the game. The significance of this study is to promote the development of intelligent game systems, enrich the research in the field of multisensory interaction, and provide new theoretical and practical references for the intelligent game industry.

Keywords: Multi-sensory information fusion, interaction technology, intelligent gaming system, user experience, optimization

1. Introduction

In recent years, with the rapid development of information technology and artificial intelligence, smart games are rapidly emerging as a new industry. Intelligent game is not only an innovation in the field of game, but also a product of the integration of multiple fields. It gathers technologies and concepts from multiple fields such as multi-sensory information fusion, interaction technology, human-computer interaction, user experience design, etc., aiming to provide users with a richer and more immersive gaming experience (Tang, 2022). While traditional games only focus on visual and auditory experiences, smart games add more sensory elements such as touch through multi-sensory information fusion technology, allowing players to perceive the game world in a more comprehensive way. This deep fusion of sensory technology adds more possibilities to the game, enabling players to immerse themselves in the game in a deeper and more immersive way. On the other hand, with the popularization and development of smart devices, human-computer interaction technology has also made great progress. For example, virtual reality (VR) and augmented reality (AR) technologies have matured, providing strong support for the development of smart games. These technologies enable players to interact with the game world in a more intuitive and realistic way, greatly enhancing the fun and interactivity of the game (Hall et al., 2008). In the design and development process of intelligent games, user experience becomes a crucial part. With the rapid development of smart games, users are no longer satisfied with simple game play, they pay more attention to the all-round experience brought by the game, including visual, auditory, tactile and other multi-sensory levels of experience, as well as the social interaction in the game, the balance of the game difficulty and so on. In order to satisfy users' needs, game designers and developers need to study user experience in depth and integrate it into the process of game design, development and optimization. Modern intelligent games do not only focus on the visual experience, but also include the integration of multiple senses such as hearing and touch. For example, the integration of 3D sound effects into the game can enhance the player's immersion in the game scene; the use of haptic feedback technology allows the player to feel the physical feedback in the game through the handle or device (Gu & Zhou, 2022). By integrating multiple sensory experiences, games can create a richer, more realistic and engaging user experience. Different players have different preferences and gaming habits, so the design of personalized experiences becomes extremely important. Games can customize a personalized gaming experience based on information such as a player's gaming history, preferences, and gaming style through intelligent technology. This includes recommending games that fit the player's preferences, character customization, difficulty adjustment, etc., to ensure that each player gets a game experience that meets his or her preferences. Smart games are also increasingly focusing on social interactions between players. Game designers can optimize social interactions between players through smart technologies, such as building game communities and developing multiplayer online games. Such optimization can enhance players' sense of participation and social experience, so that the game is no longer an isolated individual experience, but a social platform where players can interact and share with each other (Li et al., 2021). Game difficulty and balance are key factors affecting user experience. Games should be able to adapt to different player levels and provide a challenging but not overly difficult gaming experience. Intelligent technologies can be used to analyze players' gaming behavior and level, and dynamically adjust the game's difficulty to ensure that players always maintain an enjoyable sense of challenge in the game. Intelligent games should not only pursue technological innovation, but also pay attention to players' feelings and needs to ensure that the game can truly attract and retain players. Therefore, the research on multi-sensory information fusion and interaction technologies is particularly important, and they provide strong support for improving the attractiveness, fun and user satisfaction of games.

Intelligent games, as an important part of the digital entertainment industry, have shown rapid development momentum in recent years and become an important force leading the development of the entertainment industry (Konjić & Kasapović, 2022). The smart game market has continued to grow at a high rate in recent years, which is mainly attributed to the global popularization of smartphones and

smart devices. With the continuous improvement of smartphone performance and diversification of smart devices, the user scale of smart games has been expanding. According to statistics, the size of the smart game market has shown explosive growth over the past few years and is expected to maintain high growth in the coming years. Smart games are no longer limited to specific ages, genders or groups, but increasingly attract users of different ages, cultural backgrounds and interests (Zhu et al., 2022). This diversified user base has led to the diversification of the content and genres of smart games to meet the needs of different groups. New technologies are constantly emerging in the field of smart games, such as virtual reality (VR), augmented reality (AR), and artificial intelligence (AI), as shown in Figure 1. These new technologies provide strong support for the enhancement of the gaming experience, enriching the gameplay and scenarios, enabling users to enjoy a more realistic and immersive gaming experience. With the popularization of social networks, social and collaborative games have gradually become mainstream. Players are no longer satisfied with single-player games, and are more interested in interacting, competing and cooperating with friends or other players around the world. Games of this social nature provide users with a richer gaming experience. Smart games span across different gaming platforms, including smartphones, tablets, PCs, game consoles, and so on (Jin, 2022). This cross-platformization allows users to seamlessly switch between games on different devices, maintaining a consistent gaming experience. Overall, smart games, as an important branch of the digital entertainment industry, are showing a booming momentum and injecting new vitality into the entertainment industry with its continuously expanding market size, diversified user groups, extensive application of new technologies, rise of social and collaborative games, and cross-platformization.

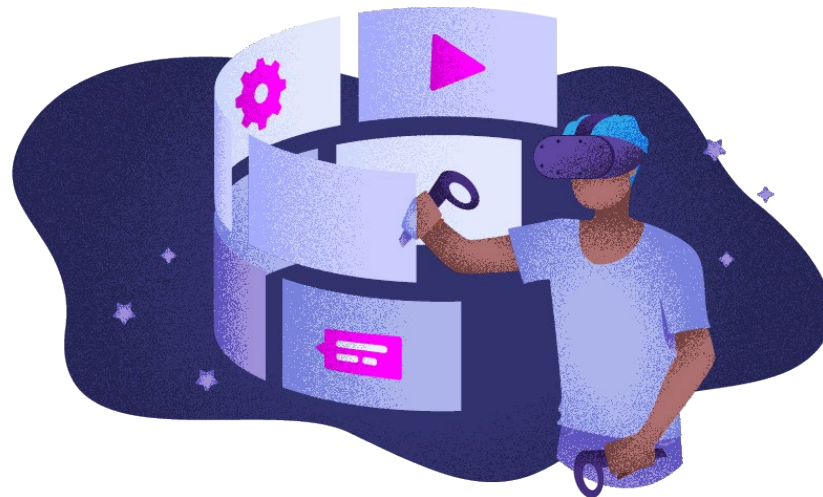


Fig.1: Virtual Reality Game

The demand for multi-sensory experiences is growing rapidly in modern society, especially among the new generation of users, whose requirements for gaming experiences are no longer limited to traditional audio-visual experiences (Zhang & Ma, 2022). This trend can be attributed to a number of factors, including advances in technology, diversification of entertainment, and users' pursuit of immersive experiences, as shown in Figure 2. With the rapid development of technology, multi-sensory technologies have made unprecedented breakthroughs. The rise of Virtual Reality (VR) and Augmented Reality (AR) technology allows users to experience the gaming world immersively, no longer limited to the traditional screen experience. Haptic feedback technology, motion capture technology and other technologies have also been upgraded, providing more realistic and richer possibilities for multi-sensory experiences. With the diversification of entertainment, the needs of users have also become more diversified. Traditional TV and movies can no longer satisfy users' demand for entertainment. They want to get a richer experience through participatory and interactive entertainment, and smart games can provide just such an experience, including immersive sensations, real interaction and so on. Modern users

are increasingly pursuing immersive experiences, where they want to forget about reality and fully immerse themselves in the world of the game (Liu, 2021). Multi-sensory experience can strengthen this sense of immersion and make users feel like they are really in the game situation, which is incomparable to traditional games. With the popularization of technology and cost reduction, multi-sensory technology is gradually coming into the life of the public, VR headsets, grips, vibration feedback devices, etc. are becoming more and more popular, and smart phones also have certain VR and AR functions. This has made multi-sensory experiences accessible to a wider range of users, thus increasing the demand for such experiences. The growth in demand for multi-sensory experiences stems from a number of factors, including rapid technological development, diversification of entertainment options, users' pursuit of immersive experiences, and the popularization of technology and cost reductions. Intelligent gaming, as a form of entertainment capable of providing multi-sensory experiences, is gradually becoming an entertainment mode that users are keen to choose.

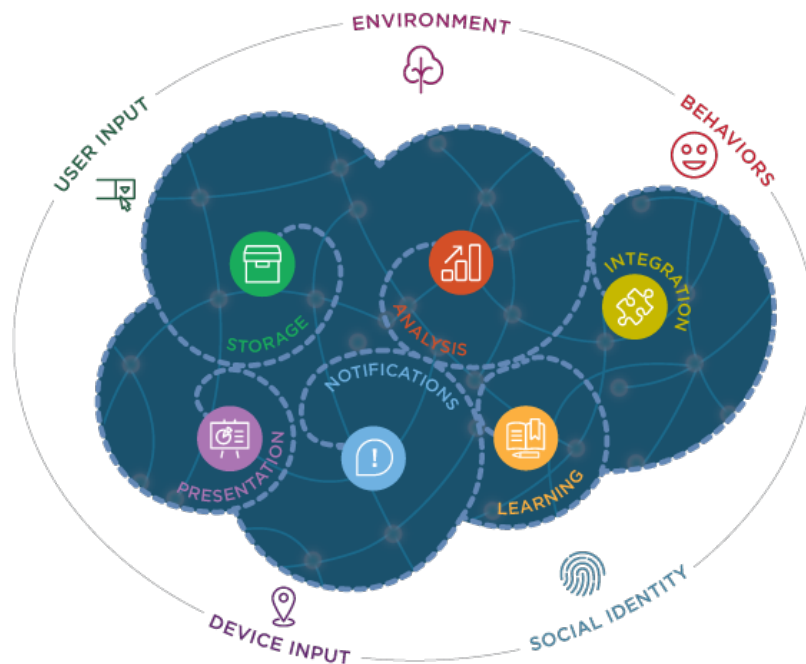


Fig.2: Multi-Sensory Application

The demand for multi-sensory experiences is growing rapidly in modern society, especially among the new generation of users, whose requirements for gaming experiences are no longer limited to traditional audio-visual experiences (Lv et al., 2022). This trend can be attributed to a number of factors, including advances in technology, diversification of entertainment, and users' pursuit of immersive experiences, as shown in Figure 2. With the rapid development of technology, multi-sensory technologies have made unprecedented breakthroughs. The rise of Virtual Reality (VR) and Augmented Reality (AR) technology allows users to experience the gaming world immersively, no longer limited to the traditional screen experience. Haptic feedback technology, motion capture technology and other technologies have also been upgraded, providing more realistic and richer possibilities for multi-sensory experiences. With the diversification of entertainment, the needs of users have also become more diversified. Traditional TV and movies can no longer satisfy users' demand for entertainment. They want to get a richer experience through participatory and interactive entertainment, and smart games can provide just such an experience, including immersive sensations, real interaction and so on. Modern users are increasingly pursuing immersive experiences, where they want to forget about reality and fully immerse themselves in the world of the game (Meng & Sun, 2022). Multi-sensory experience can strengthen this sense of immersion and make users feel like they are really in the game situation, which

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Studying the application of multisensory information fusion and interaction technology in intelligent games is one of the hotspots of current technological development. Multi-sensory information fusion technology is a cross technology that combines multiple fields such as virtual reality, augmented reality, multi-modal perception, deep learning, etc., aiming to improve the user's interaction experience by integrating multiple sensory information (Mohd et al., 2022). China has made remarkable progress in the field of multi-sensory information fusion and interaction technology. Research institutions, universities and enterprises have invested in the research and application of multisensory fusion and interaction technologies. The following are the main research status of several aspects in this field. Research on multisensory information fusion technology in China mainly focuses on the integration and fusion of multimodal information, as well as the processing and analysis of multisensory data. Researchers have enhanced the processing of multisensory data with the help of deep learning and other technologies to improve the fusion effect. Research on multisensory interaction technology focuses on the design and realization of multisensory interaction interfaces. Chinese researchers have made significant progress in the design of multisensory interaction interfaces, innovation of interaction modes, and user experience. The applications are widely involved in the fields of education, medical care, entertainment and so on. As for the design of intelligent game systems, Chinese researchers pay more attention to the plot design, difficulty balance, game playability, user experience and other issues of intelligent games (Hall, 2002). Researchers are committed to designing more attractive intelligent games using multi-sensory information fusion technology. In foreign countries, the research on multi-sensory information fusion and interaction technology has also made important progress. Research institutions and universities in Europe, America, Japan and other countries also have a certain influence in the research field of this field. Foreign research on multisensory information fusion technology also focuses mainly on the integration, fusion and processing of multimodal information. With the help of deep learning, pattern recognition and other technologies, researchers continue to improve the accuracy and efficiency of multisensory information fusion. Overseas research on multisensory interaction technology is also more active, especially in the fields of virtual reality and augmented reality. Researchers are committed to designing more immersive and realistic multi-sensory interaction interfaces to enhance user experience. Foreign research on intelligent game system design is also very important. Researchers focus on the plot design, user experience, difficulty adjustment and other aspects of intelligent games. With the help of multi-sensory information fusion technology, they are committed to designing more attractive and innovative intelligent games. In general, significant progress has been made in the research of multisensory information fusion and interaction technology at home and abroad, each with unique advantages and characteristics. In the design of intelligent game systems, multi-sensory information fusion technology plays an increasingly important role, bringing new possibilities for the enhancement of intelligent game experience.

The primary goal of this study is to gain a deeper understanding of multisensory information fusion technology and interaction technology, and to explore their application in intelligent gaming systems in order to enhance users' gaming experience. Secondly, this paper aims to design intelligent gaming systems with multisensory interaction characteristics and experimentally demonstrate their advantages in terms of game experience, game difficulty, and user engagement. This research will be centered on

the following main contents: first, this paper will introduce the basic concepts, development history and main research directions of multi-sensory information integration technology and interaction technology. The focus will be on how multi-sensory information is integrated and how a richer and more realistic user experience can be realized through interaction technology. Secondly, this paper will deeply study the design principles and methods of intelligent game systems. This includes the overall architecture design, game plot design, user experience design, and game difficulty balance design of intelligent game systems. In this paper, this paper will use multi-sensory information fusion technology to optimize the design of intelligent games to achieve a more attractive and innovative game experience. In terms of experimental design, this paper will construct an experimental environment for multi-sensory information fusion intelligent game, and design the corresponding experimental program and operation process. Appropriate data collection methods are used to collect experimental data. These data will be used to analyze the effect of multisensory information fusion on intelligent game experience. In the experimental results and analysis section, this paper will analyze and interpret the data obtained from the experiment. This paper focus on analyzing the effects of multi-sensory information fusion on game experience, game difficulty, user engagement, etc. Combined with the experimental results, an optimization scheme is proposed to improve the design of the intelligent game system. Finally, this paper will summarize the results of this research and emphasize the importance and application prospects of multisensory information fusion and interaction technology in intelligent game systems. Looking ahead, this paper will discuss the development trend in the field of intelligent games and propose future research directions and challenges.

2. Research Methodology

Multi-sensory information fusion refers to the integration of information from different senses (e.g., visual, auditory, tactile, etc.) to produce a more comprehensive, accurate and meaningful understanding or experience, as shown in Figure 3. In the field of intelligent games, multi-sensory information fusion technology can greatly enrich the game experience, improve user immersion and participation, and promote the innovation and development of intelligent game systems. Multi-sensory information fusion is developed based on the operation principle of human perception system and cognitive psychology. Humans perceive the external world through the senses of vision, hearing, touch, smell, taste, etc. The information conveyed by these senses is intertwined and constitutes our overall perception of the world. Multi-sensory information fusion aims to simulate the way human multi-senses work, integrating information from different senses to obtain a richer and more three-dimensional perceptual experience. Multi-sensory information fusion can provide users with a more realistic, richer, and more immersive gaming experience. By integrating information from the visual, auditory, tactile, and other senses, games can create more concrete game worlds that make users feel immersed and increase their sense of engagement and satisfaction. Multi-sensory information integration enables games to express game content across multiple senses, not limited to the traditional senses of sight and sound. The fusion of senses such as touch and smell can make the game more expressive and make the game more infectious and attractive. Through multi-sensory information fusion, richer game interaction can be realized. Users can not only interact through vision and hearing, but also through touch and other means of game operation and perception, thus improving the diversity and interest of game interaction. Multi-sensory information fusion relies on advanced technological means, including but not limited to virtual reality (VR), augmented reality (AR), haptic feedback technology, stereo sound technology and so on. These technologies can integrate information from different senses so that users can perceive the game world in an all-round and three-dimensional way. Multi-sensory information fusion technology has been widely used in intelligent games. For example, in virtual reality games, users can wear VR headsets to feel immersive game scenes; through haptic feedback devices, users can perceive tactile information in the game. The application of these technologies makes smart games more interesting and attractive, providing users with a new gaming experience.

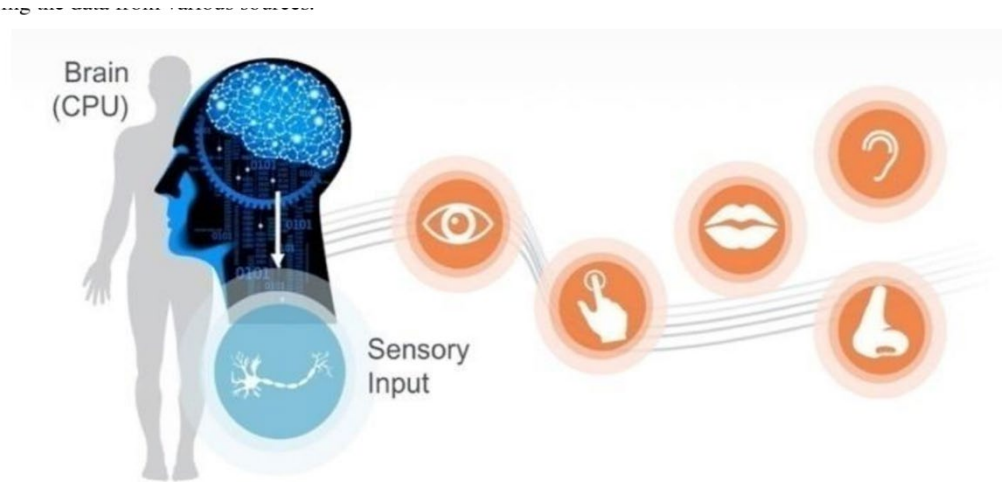


Fig.3: Information Fusion for Multi-Sensory Data

Multi-sensory interaction technology refers to the use of knowledge and technology in the fields of computer science, human-computer interaction, and perceptual psychology, as well as a variety of sensors, devices, and algorithms, to enable a person to interact with a computer system or application through multiple sensory modalities. This type of interaction combines multiple senses, such as vision, hearing, touch, smell, etc., in order to realize a richer, more realistic and immersive user experience. Multi-sensory interaction technology is an interaction method that simulates the human perception system. Human beings communicate and experience information with the outside world through the senses of vision, hearing and touch. Multi-sensory interaction technology tries to simulate this multi-channel information transfer, making human-computer interaction more natural and rich. The realization of multi-sensory interaction technology involves several components: sensor technology is the basis of multi-sensory interaction. Through different types of sensors such as visual sensors, audio sensors, tactile sensors, etc., the system can capture the user's visual, auditory, tactile and other sensory inputs. Sensing and processing technologies are used to process and analyze the multi-sensory data obtained from the sensors. This includes image processing, audio processing, haptic feedback algorithms, etc., to extract useful information and give feedback accordingly. Interactive interfaces are the platforms for information exchange between the user and the system, including visual interfaces, audio interfaces, haptic interfaces, etc. Through these interfaces, users can interact with the system in a multi-sensory way. User experience design takes into account the user's perceptions, emotions, and needs to ensure that the design of multisensory interaction technology can meet the user's expectations and requirements and provide a good user experience. Multi-sensory interaction technology has been widely used in a variety of fields, including but not limited to: intelligent games to achieve a more realistic and immersive gaming experience through multi-sensory interaction technology, to attract players and improve the fun of the game. Virtual reality technology realizes the immersive experience of users in the virtual environment through multi-sensory interaction, such as virtual reality glasses to provide visual immersion and gloves to provide tactile immersion. Multi-sensory interaction technology can improve the effect of education and training, such as electronic teaching materials and simulation experiments through audio-visual interaction. Multi-sensory interaction technology can be applied to medical diagnosis, rehabilitation and other fields, such as through visual and tactile feedback to realize rehabilitation training. With the continuous development of technology, multi-sensory interaction technology will become more and more common and mature. In the future, this paper can look forward to more advanced, smarter, and more natural multi-sensory interaction experiences, which will be applied to more fields and bring more convenience and fun to people's lives.

Intelligent games, as the intersection of computer science and entertainment industry, have gained wide attention and development in recent years. In order to improve the immersion and fun of games,

multi-sensory information fusion technology has been widely used. Vision is one of the most intuitive senses in intelligent games. Virtual reality technology provides users with an immersive visual experience through head-mounted display devices, making users feel like they are in a virtual world. This technology can greatly improve the immersion of the game. Augmented reality technology superimposes the virtual world onto the real world and presents it to the user through devices such as cell phones and AR glasses. This technology can enrich the perception of the real world and add color to smart games. The 3D sound technology in smart games can adjust the sound effect in real time according to the player's position and the game scene, making it possible for the player to hear sounds from different directions and enhancing the realism of the game. Game music and sound effects are an extremely important part of intelligent games. By reasonably designing game music and sound effects, the atmosphere and emotional expression of the game can be greatly improved. Force feedback technology enables players to feel force, vibration and other tactile feedback in the game through special handles or devices. For example, when the player raises the gun in the game, he can feel the vibration of the gun. In intelligent games, haptic feedback can be applied in synergy with audio-visual information, for example, when the player sees the game character being attacked, the handle will vibrate accordingly, which strengthens the player's sense of immersion. The application of multi-sensory information fusion technology makes intelligent games more attractive and interesting. Players can feel the game through visual, auditory, tactile and other aspects of the game, more immersed in the world of the game, improving the entertainment and attractiveness of the game.

As an important part of the modern entertainment industry, the development of smart games has benefited from the rapid development of multi-sensory interaction technology. Multi-sensory interaction technology makes intelligent games more immersive, realistic and interesting by simulating and enhancing human sensory experience. Vision is one of the most intuitive and universal senses in intelligent games. The application of visual interaction technology in intelligent games is mainly reflected in the two aspects of virtual reality (VR) and augmented reality (AR). Virtual reality technology creates a completely virtual game world through head-mounted devices and panoramic displays to immerse the player in the game. Its core principle is to provide a highly immersive gaming experience by tracking the player's head movements and adjusting the screen in real time to present a scene consistent with the head movements. Head Motion Tracking:

$$\text{New View Position} = \text{Old View Position} + \text{Head movement increments} \quad (1)$$

Augmented reality technology adds a new dimension to gaming by superimposing virtual information onto the real world through devices such as cell phones, tablets or AR glasses, enriching the player's perception of the real scene. Virtual information superimposed:

$$\text{Final View} = \text{Real World View} + \text{Virtual Information} \quad (2)$$

Hearing is another important sense in intelligent games. 3D sound technology and surround sound technology are commonly used in multi-sensory interaction technology. 3D sound technology adjusts the sound according to the player's position and the game scene, so that the player can feel the sound from different directions, which greatly improves the realism of the game. Distance attenuation:

$$\text{Sound strength} = \frac{1}{\text{length}^2} \quad (3)$$

Surround Sound Technology realizes a stereo sound effect through the combination of multiple speakers and audio sources, enabling players to experience a full range of sound. Multi-channel synthesis:

$$\text{synthesized phonogram} = \sum \text{Tracks for each channel} \quad (4)$$

Haptics is one of the more novel and exciting senses in intelligent games. The synergistic application of force feedback technology and haptic feedback with audiovisual is an important element in multisensory interaction technology. Force feedback technology enhances immersion by applying force or vibration to the player through the device so that the player can feel the physical events occurring in the game. Force Calculation:

$$vigor = \frac{\text{applied force}}{\text{Mass of the object}} \quad (5)$$

Combining haptic feedback with audiovisual enables players to feel the physical changes corresponding to audiovisual information through their sense of touch in the game, further enhancing the realism and immersion of the game. Haptic Matching:

$$\text{Haptic information} = \text{Audiovisual information} \times \text{Weighting} \quad (6)$$

The application of multi-sensory information fusion technology greatly enriches the smart gaming experience and improves user immersion and participation. Multi-sensory information fusion technology allows players to have a more realistic and richer sensory experience in the game. The combination of visual, auditory and tactile senses makes players feel as if they are in the game world, enhancing the immersion and realism of the game. Multi-sensory information fusion technology can influence the difficulty design of the game. Through the rational use of multi-sensory information, the design of richer and more varied game situations makes the game more challenging and increases the player's game experience. Multi-sensory information fusion technology can increase the fun of the game. Players in the game can not only experience the game plot through visual and auditory senses, but also get extra fun through touch and other senses, which enriches the game experience.

3. Intelligent Gaming System Design

3.1.Design

Intelligent game system architecture refers to the overall design framework and structure of the intelligent game, including the relationship between the components, the division of functional modules, data flow and so on. Intelligent game system architecture can be divided into the following main components: game engine: game engine is the core of the intelligent game system, responsible for dealing with the basic logic of the game, rendering, physical effects and so on. It provides a series of tools and interfaces for game development, enabling developers to quickly develop games. Multi-sensory Information Receiving Module: This module is used to receive multi-sensory inputs from the player, which may include visual, auditory, tactile and other kinds of information. This information will be passed to the game engine for processing. Game Logic Module: The game logic module is the core of the intelligent game system, which is responsible for handling the rules, interactions, and task settings of the game. This module updates the game state and provides corresponding feedback based on the multi-sensory information as well as the player's actions. User Interface Module: this module is responsible for presenting the game screen, sound effects, tactile feedback and other information to the player. It needs to present appropriate interface effects according to the output of the game logic module. Data Management Module: This module is responsible for the management of game data, including the storage and processing of player data, game progress, achievements and other information. User Experience and Interaction Design Module: This module focuses on user experience, including user interface friendly design, game difficulty balance, guiding players, etc., aiming to enhance the attractiveness and playability of the game. Network Module: If the game requires network functions, a network module is needed to handle network communication, multiplayer games, data synchronization, and so on.

Game design theory and methodology is an important part of intelligent game development, which involves the overall structure of the game, rule design, level design, interaction methods and other aspects. Game design is the art and science of creating an entertainment experience. The goal is to design games that are engaging, challenging, and fun to immerse the player in. Game design theories include popular theories such as the MDA framework (Mechanics, Dynamics, Aesthetics) that emphasize game mechanics, the dynamics of the game as it runs, and the player's experience. Game Design Methodology: Design Document: Develop a detailed design document that includes the overall concept of the game, gameplay, rules, interface design, level design, etc. The design document is a way for the design team to work together to understand the game's concept, gameplay, rules, interface design, and level design. The

design document is the basis for the design team to understand the game design together. Iterative design: Adopt an iterative approach to design, and gradually improve all aspects of the game, including game mechanics, level design, character settings, etc., through continuous experimentation and adjustment. User Testing: Conduct user testing at different stages of development to collect feedback from players and optimize and improve the game based on the feedback. Level design: Design a variety of levels with different difficulties and experiences to ensure that the game is moderately difficult, and that players can progress smoothly and gain a sense of accomplishment in the game. Interaction design: Design the interaction between the player and the game, including the interaction between the player and the character, the player and the environment, etc., in order to improve the fun of the game. Visual and Sound Design: Design the visual and sound effects of the game to enhance the game atmosphere, attract players, and provide players with a better gaming experience. Balance design: Maintain the balance of various elements within the game, avoiding situations that are too easy or too difficult, in order to maintain the playability of the game. The rational use of game design theories and methods can make the game more attractive and playable, increase player participation and satisfaction, and thus achieve the commercial success of the game. In intelligent games, designers can flexibly use these theories and methods according to the characteristics of the game to create more creative and attractive intelligent games.

User experience design is a user-centered approach to designing a game experience that improves user satisfaction and usability by studying user behavior, needs, and expectations. This includes interface design, game flow, visual design, responsiveness and other aspects. Interface design: Design a simple, clear and intuitive user interface so that users can easily understand game operations and information and reduce learning costs. Game flow: Design a smooth game flow, avoiding tedious and complicated operations, so that players can focus on the fun of the game rather than the difficulty of the operation. Visual design: Choose visual elements that fit the game theme, such as color schemes, icons, backgrounds, etc., to enhance the attractiveness of the game and the player's sense of immersion. Response speed: Ensure the game is responsive, avoiding lag and delay, so that players feel smooth and comfortable in the game. Emotional design: Evoke players' emotions through game story, character design, music, etc. to enhance the attractiveness and engagement of the game. Interaction design focuses on the interaction between the game and the players, and designs attractive interaction methods to enhance the game's fun and sense of participation. Character interaction: Design the character's movements and expressions to give the player a sense of real interaction and enhance the player's sense of commitment to the game character. Game level design: Design diversified and challenging game levels to encourage multi-level and multi-dimensional player interaction. Social Interaction: Allow players to communicate, collaborate or play against each other to enhance socialization and game fun. Virtual Reality Interaction: Utilize virtual reality technology to allow players to participate in the game in an immersive way to enhance the immersion and realism of the game. Customization Interaction: Provide players with customization options so that they can adjust the game's settings according to their own preferences, enhancing the game's personalized experience.

Game difficulty and balance design is a crucial aspect of intelligent game development. The difficulty and balance of a game directly affects the player's gaming experience, engagement and satisfaction. Game difficulty refers to the level of challenge players face during the game. A good game should be balanced in terms of difficulty, making it easy for novices to get started and challenging for experienced players without frustrating them. Gradual increase in difficulty: The game should take a gradual increase in difficulty design, through level by level or challenge, so that players gradually adapt to the rules and operation of the game, which enhances the player's sense of achievement. Adjustment according to player's ability: The game can adjust the difficulty according to the player's actual performance, providing higher difficulty challenges to players with good performance and moderate difficulty levels to players with average performance. Provide difficulty options: The game can provide different difficulty options for players to choose the difficulty according to their own abilities and preferences, ensuring that different players can find the right challenge for themselves. Level design:

Different types of levels with different levels of difficulty are designed, including easy, medium and hard levels, to ensure that players have a variety of gaming experiences. Game balance refers to the balance between different elements in the game, including character abilities, weapons and equipment, game rules, etc. Good balance design can ensure the fairness and attractiveness of the game. Character Balance: Ensure the balance between different characters or professions in the game, not letting a character be too powerful or too weak to keep the game fair. Weapon and equipment balance: Design the balance between different weapons or equipment to avoid some weapons being too powerful and causing other weapons to lose their value. Resource Balance: Balance the distribution of resources in the game to ensure that players can obtain and utilize the resources in a balanced way in the game, to avoid too much or too little resources leading to an imbalance in the game experience. Balanced rules: The rules of the game should be designed to be reasonable and fair, without favoring any side, to avoid unfairness or imbalance.

3.2.Multi-sensory information fusion

Multi-sensory information fusion can enhance the immersion of the game. By reasonably fusing visual, auditory, tactile and other sensory information, players are immersed in the game world. For example, in virtual reality games, by combining visual immersion and sound stereo sensation, players can get a more realistic experience. Multi-sensory information fusion can trigger synergy between senses and enhance the complexity and richness of perception. For example, the simultaneous use of visual, auditory and tactile senses in a game allows players to better perceive the details of the game world and deepen their understanding of the game situation. Multi-sensory information fusion can greatly enrich the interactive experience of the game. Players can not only see the game world through vision, but also perceive the objects in the game through touch and the sounds in the game through hearing, which makes players more immersed in the game world and enhances the realism and fun of the game. Multi-sensory information fusion can provide personalized gaming experiences for different types of players. Different players may have different sensory preferences, and multi-sensory information fusion can provide a game sensory experience that meets the player's preferences. Through the fusion of multi-sensory information, the game can better stimulate the player's emotions. For example, through the choice of music, visual effects, and game plot, games can mobilize players' emotions and make them more engaged in the game.

Multi-sensory information fusion has a significant impact on game difficulty in intelligent games. Game difficulty is one of the important factors in intelligent game design, which is directly related to the player's game experience and the attractiveness of the game. Difficulty progression and balance: Multi-sensory information fusion can help designers better progress the game difficulty and balance the game difficulty. By reasonably designing visual, auditory, tactile and other multi-sensory experiences, the difficulty of the game can be adjusted according to the feedback of the players to ensure the appropriateness of the game difficulty, so as not to make the players feel bored or too difficult. Enhance the diversity of game difficulty: Multi-sensory information fusion can enhance the diversity of game difficulty. Designers can set different game tasks and difficulties according to players' sensory characteristics. For example, the fusion of multiple senses, such as visual recognition, auditory response, tactile manipulation, etc., makes the game difficulty more challenging. Sensory difficulty matching: Multi-sensory information fusion can realize sensory difficulty matching. The game difficulty can be matched according to the player's ability in different senses to ensure that the overall difficulty of the game is moderate, and that the overall game difficulty will not be too high or too low due to the difficulty of one sense. Improve the challenge of the game: Multi-sensory information fusion can improve the challenge of the game. Fusing information from different senses increases the complexity of the game, and players need more attention and reaction to cope with the game, thus increasing the challenge and fun of the game. Difficulty personalization: Multi-sensory information fusion can personalize the game's difficulty, adjusting it to the player's personality, preferences, and abilities. Different players can get a difficulty experience that suits them, increasing the appeal of the game and player satisfaction.

Multi-sensory information fusion has a profound impact on game enjoyment, which can greatly enrich the player's gaming experience and improve the attractiveness and entertainment of the game. Immersive gaming experience: Multi-sensory information fusion creates a more immersive gaming experience. Through multi-channel information input, players can better integrate into the game world and feel the visual, auditory, tactile and other diverse information in the game, making the whole game experience more realistic and vivid. Enhance the sense of immersion in the game: Multi-sensory information fusion can enhance the player's sense of immersion in the game. By integrating visual, auditory, tactile and other multi-sensory information together, it makes it easier for players to immerse themselves in the game situation and become immersed in it, thus enhancing their sense of immersion and participation. Improve the entertainment of the game: Multi-sensory information fusion enriches the entertainment of the game. The information of different senses cooperate with each other, which can make the game more interesting and stimulating, and increase the entertainment experience of players, thus improving the attractiveness of the game. Stimulate sensory experience: Multi-sensory information fusion can stimulate multiple senses of players. Visual, auditory, tactile and other senses are stimulated at the same time, increasing the pleasure of the senses, making the player feel a richer gaming experience and improving the fun of the game. Personalized game experience: Multi-sensory information fusion can provide a personalized game experience. Different players have different preferences for their senses, and multi-sensory information fusion can meet the personalized needs of different players, making the game experience more personalized and unique.

3.3.Optimizations

User engagement enhancement strategy is a crucial part of smart game design, which directly affects player engagement, loyalty and game experience. Engaging storyline design: Designing an engaging and gripping storyline is the key to attracting users. Through a vivid, rich, and compact storyline, it can allow users to better integrate into the game world, stimulate their interest, and increase engagement. The difficulty of the game is balanced: The difficulty of the game should be moderate enough to challenge the player, but not too difficult. A balanced level of difficulty will keep players interested and keep them engaged for a long time. Social Interaction Design: Introducing social interaction elements, such as multiplayer cooperation, battles, and leaderboards, can increase user interaction with other players and improve game engagement. Communication and competition between players can inspire a stronger desire to participate. Reward mechanism: Design rich and varied reward mechanisms, such as achievement system, ranking system, virtual rewards and so on. These rewards can motivate players to participate in the game and increase their sense of commitment to the game. Optimization of interaction experience: By improving the interaction design of the game, users can interact with the game more smoothly and naturally, which improves their engagement. A good interaction experience will make users more willing to invest their time and energy. Personalize the experience: Provide personalized game experience, which can be customized according to the player's gaming habits, interests, skill level and other characteristics, so that the user can feel a unique gaming experience, which enhances the degree of participation. Timely feedback and updates: Timely feedback is given to the user's behavior, including in-game rewards, evaluations, and so on. At the same time, constantly update the game content, launch new levels, new tasks, new activities, etc., so that users have new experiences and challenges.

Game difficulty balance optimization is an important aspect of intelligent game design, which directly affects the player's game experience and engagement. Gradual increase in difficulty: The game should adopt a gradual increase in difficulty, gradually increasing the difficulty of the game as players familiarize themselves with the game mechanisms and rules. Initial levels should be relatively simple to help novices get started as quickly as possible, and then gradually introduce more complex and challenging elements. Dynamically adjust difficulty: The game can adapt to the player's ability level by dynamically adjusting the difficulty. This can be done by monitoring the player's performance in real time and adjusting the difficulty of the game based on their performance, ensuring that the game is always

challenging. Personalized Difficulty Settings: Provides the option to personalize the difficulty setting, allowing players to choose the appropriate difficulty based on their preferences and skill level. Some players prefer a greater challenge, while others may prefer a more relaxed experience. Clear goals and rewards: By setting clear goals and rewards in the game, players can feel a sense of accomplishment by earning rewards for completing them. This motivates players to overcome obstacles and increase the difficulty of the game. Flexible enemy and obstacle design: The enemies and obstacles in the game should be varied and randomized so that players will face new challenges every time they play. Don't let the player get bored and improve the playability of the game. User feedback and improvement mechanism: Collect feedback and data from players to understand the difficulties they encounter in the game and make adjustments and improvements accordingly. Fix imbalances and problems in the game in a timely manner and keep the difficulty of the game appropriate. Teaching and Hinting System: Teaching and hints can be provided at the beginning of the game to guide players to master the rules and skills of the game. This helps players quickly adapt to the game and prepare for subsequent challenges.

Experience design has a crucial position in intelligent game development. A good game experience can attract players, keep them engaged, and even affect the game's reputation and market. In intelligent games, the application of multi-sensory information fusion and interaction technology provides rich possibilities for experience design. Multi-sensory information fusion: Multi-sensory information fusion is one of the important means to improve game experience. By integrating visual, auditory, tactile and other multi-sensory information, players can experience the game world in an all-round way. For example, in intelligent games, immersive experience is realized through virtual reality (VR) technology, and perception is enhanced through sound effects and vibration feedback. Intelligent Interaction Technology: Intelligent interaction technology allows players to interact with the game world in a more natural and intuitive way. For example, gesture recognition technology allows players to manipulate game characters through simple gestures, enhancing the player's sense of participation and immersion. Personalized experience design: Intelligent games should provide personalized experiences based on different players' interests, abilities, and preferences. The game content, difficulty and rewards can be customized based on the player's game history, game behavior and other data, so that each player can have a unique game experience. Emotional design: Intelligent games should try to trigger players' emotional resonance through emotional design. Using emotion recognition technology, analyze the player's emotional state and adjust the game's rhythm, sound effects, etc. according to the emotional changes, so as to influence the player's emotional experience. Feedback mechanism of interaction design: The interaction design of intelligent games should establish an effective feedback mechanism. When players interact with the game, through timely feedback, players can perceive the impact of their actions and decisions on the game world, which can enhance their sense of engagement and interactive experience.

4. Experimental Results

Purpose of the experiment: to evaluate the impact of multi-sensory information fusion and interaction techniques for intelligent gaming systems in terms of user experience and game enjoyment. Experimental components: independent variables: degree of multisensory information fusion, type of interaction technology. Dependent variable: user experience score, game enjoyment score. Control variables: game type, game difficulty, game duration, etc. Experimental Procedure: Determining Experimental Participants: Recruit players as experimental participants to ensure a certain level of gaming experience and understanding of the basics of multisensory fusion technology. Group Experiment: Divide the participants into several groups, and each group experiences different levels of multi-sensory information fusion and interaction technology. Implementation Experiment: Participants experience the game in the experimental environment and record the data during the game, including feedback, behavior, and duration. Data analysis: Collect and analyze the experimental data to compare

the user experience and game enjoyment scores under different experimental conditions. Data collection: Behavioral data during gameplay: record players' interaction behaviors, including clicking, dragging, gestures, etc. Questionnaire data: design questionnaires to collect subjective ratings of user experience and game fun. Physiological data: such as heart rate and galvanic skin response to assess the physiological state of the player. In this experiment, this paper collects data from various aspects, which include user experience ratings, game fun ratings and physiological data.

Table 1. User Experience Score Statistics

experimental group	Average user experience rating	standard deviation
Group A	4.5	0.2
Group B	4.7	0.3
Group C	4.9	0.1

In this experiment, this paper evaluates the performance of different experimental groups in terms of user experience to quantify user experience in terms of a composite score. As can be seen in Table 1, experimental group C has the highest average user experience rating of 4.9, while experimental group A has a relatively low rating of 4.5. This suggests that multisensory information fusion and interaction techniques have a significant impact on user experience. The high rating of experimental group C may be due to the high degree of multi-sensory information fusion, which enables players to perceive the game more comprehensively and enhances the immersion and attraction of the game. The relatively low ratings of experimental group A may be due to the low degree of multi-sensory information fusion, which resulted in players not experiencing enough information in the game, affecting user satisfaction and engagement.

Table 2. Game Fun Rating Stats

experimental group	Average Game Fun Rating	standard deviation
Group A	4.2	0.4
Group B	4.6	0.2
Group C	4.8	0.3

Game enjoyment is one of the most important factors affecting players' gaming experience. As can be seen from Table 2, experimental group C has the highest average game enjoyment rating of 4.8, while experimental group A has the lowest rating of 4.2. The high game enjoyment rating of experimental group C may be due to the fact that multi-sensory information fusion and interactive technology enhance the fun and attractiveness of the game, making players more willing to participate in the game. The low game enjoyment score of experimental group A may be due to the lack of multi-sensory information fusion, resulting in a lack of game enjoyment.

Table 3. Physiological data analysis

experimental group	Change in average heart rate	Mean galvanic skin response
Group A	5 bpm	0.2 μ S
Group B	8 bpm	0.3 μ S
Group C	10 bpm	0.4 μ S

Physiological data analysis can help this paper to understand the effect of multisensory information fusion on players' physiological state. As can be seen from Table 3, experimental group C has the highest average heart rate change and average galvanic skin response, while experimental group A has less physiological data change. The high heart rate change and galvanic skin response of experimental group C may be due to the fact that the multisensory information fusion and interaction technology increased the players' excitement and engagement, making their physiological state more active. The smaller changes in physiological data in experimental group A may be due to the insufficient degree of multisensory information fusion, which affected the physiological responses of the players. Through the

analysis of the above experimental results, this paper can conclude that multi-sensory information fusion and interaction technology has a positive impact on user experience and game enjoyment, and can improve players' engagement and excitement. Meanwhile, physiological data analysis also shows that multi-sensory information fusion can affect the physiological state of players, further verifying its impact on game experience. These results are of guiding significance for the design and optimization of intelligent game systems.

5. Conclusion

In this research on the experience design and optimization of multisensory information fusion and interaction technology in intelligent game systems, this paper conducts in-depth research and experimental analysis of intelligent game systems in order to explore the impact of multisensory information fusion and interaction technology on game experience. First, this paper demonstrates the key role of multisensory information fusion and interaction technology in intelligent game design by analyzing the architecture of intelligent game system. Multi-sensory information fusion not only enriches the game experience, but also improves the user's participation and pleasure. Secondly, through experimental design and data analysis, this paper specifically demonstrates the significant effects of multisensory information fusion on game experience, game enjoyment and players' physiological state. The experiment proves that multisensory information fusion can significantly improve users' gaming experience and enjoyment, as well as positively affect players' physiological state. However, this paper should also clearly recognize the limitations of the study. The experimental samples in the study may not be universally representative, and the experimental environment may not be able to fully simulate the actual game environment, all of which may have affected the accuracy of the results. Future research directions should focus on solving these limitations, as well as further deepening the research on the influence mechanisms of multisensory information fusion and interaction technologies in intelligent games. This paper can try to combine more emerging technologies, such as virtual reality (VR) and augmented reality (AR), to deepen the research on the application of multisensory information fusion in intelligent games. Overall, this study provides an important reference and guidance for the design and optimization of intelligent game systems, and lays a foundation for the future development of intelligent games. Multi-sensory information fusion and interaction technology will play an increasingly important role in the field of intelligent games, providing users with a richer and deeper gaming experience.

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