Design and Application of Puzzle Game Narrative and Game Level Fusion Driven by Generative Artificial Intelligence

Man Wen[*]

Faculty of Humanities and Arts, Macau University of Science and Technology, Macau, China

*Corresponding author: 1207912016@qq.com

Keywords: Generative Artificial Intelligence; Puzzle Game; Narrative Design; Game Level Design; Narrative-Gameplay Integration; Player Immersion; Procedural Content Generation; Emotional Resonance

Abstract: With the rapid development of generative artificial intelligence technology, its applications in various fields have become increasingly extensive, and the gaming industry is no exception. As a game type cherished by players, the integration between narrative and levels significantly impacts the overall gaming experience. This paper focuses on the design and application of integrating narrative and game levels in puzzle games driven by generative artificial intelligence. It provides an overview of generative artificial intelligence and puzzle games, and then discusses the narrative design and game level design of puzzle games driven by generative artificial intelligence. It examines the design strategy for integrating both elements, discusses relevant application practices, challenges, and coping strategies, and offers an overview of generative artificial intelligence and puzzle games. Finally, conclusions are drawn, and future development trends are expected. It aims to provide a useful reference for the innovative development of puzzle games and promote the more efficient application of generative artificial intelligence in this field.

1. Introduction

In today's era of rapid technological development, generative artificial intelligence technology is profoundly changing the development patterns of many industries, with its powerful content generation capabilities. The gaming industry is one of them. Generative artificial intelligence can autonomously generate various types of content through algorithms and models, bringing new possibilities to game development. As a type of game that emphasizes logical reasoning, exploration, and discovery as core gameplay elements, the integration of narrative and game levels in puzzle games is key to improving game quality and player experience. Traditional puzzle games often rely on the experience and creativity of developers in narrative and game level design, but they often face problems such as content homogeneity and a lack of personalization, which makes it difficult to meet the growing and diverse needs of players. In this context, applying generative artificial intelligence to the integrated design of narrative and game levels in puzzle games holds significant practical implications. This study aims to explore the effective design methods and application paths for the integration of narrative and game level in puzzle games driven by generative artificial intelligence, sort out relevant theories and research results through the literature research method, and deeply analyze the successful experiences and shortcomings in practical applications with the help of the case analysis method. Additionally, the effectiveness of relevant design strategies is verified through experimental research methods. The innovation of the research lies in constructing a design framework for the deep integration of narrative and game levels driven by generative artificial intelligence, providing new ideas and methods for the development of puzzle games, and promoting the advancement of puzzle games in a more innovative and personalized direction.

2. Overview of Generative AI and Puzzle Games

2.1 Generative AI Technology

The core principle of generative AI is to learn the laws and features in the data through algorithm models trained on a large amount of data, and generate new content that is rational and innovative. Its commonly used algorithm models include generative adversarial networks (GAN), variational autoencoders (VAE), Transformers, etc. In the field of game development, generative AI has a wide range of application scenarios. For example, it can be used to generate visual content such as character models, scene environments, props, and items in the game, greatly reducing the workload of art design; it can also generate text content such as dialogue texts and task descriptions in the game to enrich the narrative of the game [1].

Generative AI has demonstrated numerous advantages in its applications. On the one hand, it can improve the efficiency of game development, quickly generate a large amount of content, and shorten the development cycle; on the other hand, it can create diverse content based on different needs, cater to the personalized requirements of players, and enhance the playability and replayability of the game. However, the technology also has certain limitations. The generated content may exhibit issues like logical incoherence and fluctuating quality, making it challenging to achieve the creative and artistic standards of human designers. Additionally, it is highly dependent on data and requires a substantial amount of high-quality training data. Figure 1 illustrates the three requirements of a successful generative AI model.
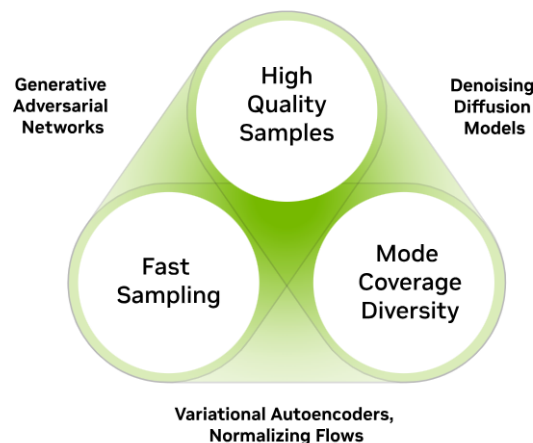

Fig. 1 The three requirements of a successful generative AI model

2.2 The Development and Core Characteristics of Puzzle Games

Puzzle games have a rich history of development. Early puzzle games were quite simple, often taking the form of text adventure games. In these games, players input text commands to advance through the game, searching for clues and solving puzzles within the narrative described in the text. With the advancement of computer graphics technology, puzzle games have gradually transitioned into the graphical era, featuring more refined game graphics and increasingly complex and diverse puzzle designs. Entering the mobile Internet era, puzzle games have opened up new development opportunities with their convenient operation and varied gameplay, resulting in a large number of excellent mobile puzzle games emerging [2].

The core features of puzzle games are mainly reflected in the following aspects. In terms of gameplay, puzzle solving is the core. Players must solve various puzzles within the game through observation, thinking, and reasoning to advance the game's plot. In terms of content presentation, it often features a rich storyline and a unique worldview that guides players to continue exploring. The integration of narrative and game level is crucial to improving the quality of puzzle games. When the narrative is seamlessly integrated into game level design, players gain a better understanding of the story background and character motivations during puzzle-solving, which enhances game immersion; and the game level design can also be reasonably explained and guided through the narrative, making

the setting of the puzzle more logical and avoiding abruptness, thereby improving the player's overall gaming experience [3].

3. Design of Puzzle Game Narrative Driven by Generative AI

3.1 Narrative Generation Mechanism and Structural Innovation

Narrative generation models based on AI algorithms usually combine natural language processing technology and game logic rules to dynamically generate narrative content by analyzing players' behavioral data. For example, when a player makes a choice or completes a task in the game, the AI generates the corresponding subsequent plot and dialogue based on preset rules and training data. This dynamic generation mechanism enables the narrative content to closely follow the player's game progress, allowing players to feel the impact of their actions on the story's development and thereby enhancing their sense of participation.

AI technology breaks the limitations of traditional puzzle games' linear narrative and constructs a non-linear, multi-branching, innovative narrative structure. In the traditional narrative structure, players can only follow a fixed plot route and lack autonomy. Driven by AI, the game can create multiple plot branches and endings, and each player's choice may lead to a different direction in story development. For example, in an adventure puzzle game, the player's choice to cooperate or confront an NPC may trigger a completely different plot line, thereby experiencing different story content. This non-linear, multi-branching narrative structure greatly enriches the playability of the game and increases the player's willingness to replay.

3.2 Emotional Resonance in Narrative

Incorporating emotional elements into AI-generated narratives is key to enhancing players' emotional resonance. AI can understand players' preferences and emotional tendencies by analyzing their gaming behaviors, historical data, and other information, and then generate narrative content that meets players' emotional needs. For example, when AI detects that players are frustrated by the difficulties they encounter in the game, it may generate encouraging dialogues or plots to help players alleviate negative emotions; when players achieve success, it may generate celebratory scenes and dialogues to enhance players' sense of accomplishment and pleasure.

Additionally, AI can also enhance players' emotional resonance by creating characters with rich emotional depth. By giving characters unique personalities, background stories, and emotional expressions, they become more vivid and three-dimensional. Through interacting with these characters, players will gradually develop an emotional connection with them. Furthermore, the narrative generated by AI can create different emotional atmospheres, such as tension, suspense, and warmth, allowing players to experience rich emotional changes during the game and further enhance their immersion in the experience.

4. Generative AI-Driven Puzzle Game Level Design

4.1 Game Level Generation Technology and Difficulty Adjustment

Game level generation technology based on AI algorithms can automatically generate diverse and personalized game levels that adhere to the overall game style, difficulty requirements, and other parameters. The game generation process typically involves designing the game level layout, placing puzzle elements, and setting obstacles. In a room escape puzzle game, AI can create a room layout and puzzle combinations that match the player's skill level and historical completion times. For novice players, the AI generates simpler puzzles and more obvious clues. In contrast, for experienced players, it creates more challenging puzzles with hidden clues, catering to the diverse needs of different players [4].

Moreover, AI can adaptively adjust the difficulty of the game level in real time according to the player's skill level and game progress. During the game, the AI will continuously collect data, such as the player's puzzle-solving speed and the number of errors, to analyze the player's skill level. When

it is found that the player can easily complete the current game level, the difficulty of the subsequent game level will be appropriately increased. Conversely, when the player fails in a certain game level multiple times, the game level difficulty will be reduced, or more clues will be provided. The real-time difficulty adjustment mechanism ensures that the player is always in a moderately challenging state, avoiding boredom due to the game's simplicity and losing interest due to its difficulty.

4.2 Optimization Strategy for Game Levels

AI offers a significant advantage in optimizing the layout of game elements. By utilizing algorithms, it can develop an ideal arrangement for puzzles, clues, and obstacles, resulting in a more balanced and engaging game experience. For example, in a maze puzzle game level, AI can design a complex and regular maze structure using path planning algorithms, so that players must employ logical thinking during the exploration process and experience the enjoyment of exploration.

AI can also optimize the layout of game level elements according to different narrative needs. The elements in the game level are closely integrated with the narrative content, so that the game level is not only a place to solve puzzles, but also a carrier of narrative. For example, in a puzzle game set in an ancient civilization, elements such as the architectural style and mural patterns in the game level can reflect the narrative content of the game. By observing these elements, players can gain a deeper understanding of the game's historical background and storyline, thereby enhancing their overall gaming experience [5].

5. Design Strategies for Integrating Narrative and Game Level

5.1 Principles, Methods and Case Analysis of Integration

The fusion design of narrative and game level must follow some basic principles. The first is the principle of logic. The narrative content and game level design must fit each other. The setting of puzzles and the layout of game levels should conform to the development logic of the narrative, and there should be no contradictions. The second is the principle of consistency. The overall style and worldview of the game should be consistent across the narrative and game levels, allowing players to immerse themselves in a unified game world. The last is the principle of interactivity. The narrative should guide the player's game level exploration behavior, and the puzzle-solving process within the game level should also promote narrative development and foster a good interactive relationship [6].

There are many ways and techniques to achieve the fusion of narrative and game level. It is recommended to present the narrative content through the game level environment, such as adding some historical relics, documents and materials to the game level, so that players can understand the background of the story during the exploration process; puzzle design can also be combined with narrative plots to make the puzzle-solving process a key link in promoting the development of the story. Taking the puzzle game Forgotten Temple as an example, the game utilizes generative AI to achieve the deep integration of narrative and game levels. In the game, the layout of the temple game level explored by the player is generated by AI according to the narrative progress, and the puzzles in each part are closely related to the story background of the part. For example, in the part that tells the story of the temple guardian, the puzzles are mostly related to guarding and testing. After the player solves the puzzle, the corresponding narrative plot will be triggered, allowing them to understand the guardian's story. This fusion method enables players to naturally immerse themselves in the game's narrative while solving puzzles, thereby enhancing the overall gaming experience.

5.2 Player Experience Feedback and Evaluation

Collecting feedback through player testing is an important way to evaluate the integration of narrative and game level. We can employ a variety of methods, including questionnaires, interviews, and behavioral observations. In the questionnaire, you can set questions about narrative coherence, game level and narrative fit, immersion, etc., and let players rate and evaluate; interviews can be conducted in-depth with some players to understand their specific feelings and suggestions about the game; behavioral observations can record players' operating behaviors, dwell time, expression

changes during the game process to analyze the players' gaming experience [7].

Based on this feedback information, we can conduct a comprehensive evaluation of the actual impact of integrating narrative and game levels. If most players believe that the narrative and game level are not closely integrated, resulting in a disconnect, then we need to re-examine the methods and principles of integration design and adjust the relevant content accordingly. If players feel that the puzzle setting of a certain game level does not align with the narrative plot, we need to modify either the puzzle or narrative content of that game level. By continuously collecting player feedback and optimizing it, we can make the integration of narrative and levels more reasonable and natural, thereby enhancing the player's gaming experience.

6. Application Practice and Challenges

6.1 Application Cases and Effect Evaluation

The well-known puzzle game AI: The Somnium Files is selected as a successful case for analysis. The game utilizes generative artificial intelligence technology to integrate narrative and game levels. In the game, the AI dynamically generates various dream scenes and corresponding narrative content based on the player's choices and progress in the investigation. The puzzle of each dream scene is closely related to the investigation clues of the case and the character's inner world. In the process of solving the puzzle, the player gradually uncovers the truth behind the case and the character's secrets. The application of generative AI has made the narrative and game levels of the game very closely integrated, greatly improving the player's gaming experience. Judging from the feedback from players and the game's sales, it has received widespread acclaim, which fully demonstrates the positive role of generative AI in promoting the integration of narrative and game levels.

6.2 Challenges and Coping Strategies

Generative AI faces some technical challenges in its application in puzzle games. For example, AI-generated content may have logical loopholes, resulting in incoherent narratives or unreasonable game-level puzzle settings. To address this issue, the training of AI models can be refined to enhance their logical reasoning capabilities. Additionally, after AI generates content, professional game designers can be hired to review and refine it to ensure the content's quality. The low diversity and innovation of AI-generated content are also significant issues. In this regard, more diverse training data can be introduced to encourage AI to engage in cross-border learning and enhance its innovation capabilities.

In terms of creativity and artistry, AI-generated content often lacks the unique creativity and artistic sense of human designers. To address this problem, AI-generated content can serve as a source of creative inspiration, and designers can perform secondary creation and processing, combining the efficiency of AI with human creativity to create content that is both novel and artistically valuable. At the same time, an evaluation standard for AI-generated content should be established, and evaluation should be conducted from the aspects of creativity, beauty, and emotional expression, to guide AI in generating content that meets artistic requirements.

Furthermore, ethical and legal issues should not be ignored. AI-generated content may raise copyright issues, such as instances where the generated content is similar to existing works, which could lead to infringement disputes. Therefore, when using generative AI, it is necessary to ensure the legality of the training data and avoid using copyrighted content. It is necessary to clarify the ownership of intellectual property rights for AI-generated content and to formulate relevant regulations and agreements. Additionally, AI-generated content may contain inaccurate or misleading information, including violent content. In this regard, it is necessary to strengthen the review and filtering of AI-generated content, establish and improve content supervision mechanisms, and ensure the health and positivity of game content.

7. Conclusion

This study focuses on the design and application of fusing narrative and game levels in puzzle

games driven by generative artificial intelligence. Through the analysis of relevant technologies, design strategies, application practices, and challenges, the following results are obtained. Generative artificial intelligence has brought revolutionary changes to the narrative and game-level design of puzzle games. Its dynamic generation mechanism and innovative structure make the narrative more diverse and the game level more personalized and challenging. The fusion of narrative and game levels plays a crucial role in enhancing player immersion and the overall gaming experience, while player feedback and evaluation provide a valuable basis for optimizing the design. Application practice demonstrates that the application of generative artificial intelligence in puzzle games is feasible and effective; however, it also faces challenges in various aspects, including technology, creativity, ethics, and law.

The impact of generative artificial intelligence on the integrated design of narrative and game levels in puzzle games is multi-dimensional. The advancements in generative artificial intelligence technology not only enhance the efficiency and quality of game development but also transform how players engage with games and their overall experience. As this technology continues to evolve, its application in the realm of puzzle games will become increasingly extensive and in-depth. It is expected that smarter and more creative AI models will emerge to achieve seamless integration of narrative and game level, bringing players a more immersive and personalized gaming experience. Moreover, cross-domain integrated applications will also become a trend, such as combining virtual reality (VR) and augmented reality (AR) technologies to further expand the gameplay and expression of puzzle games. During the development process, it is crucial to continuously tackle technical challenges, find a balance between AI and human creativity, follow ethical and legal guidelines, and promote the healthy and sustainable growth of generative artificial intelligence in the realm of puzzle games.

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