Application of Generative Artificial Intelligence in Games

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Abstract: With the rapid expansion of the game industry, it is difficult for the traditional development model to meet the demand for personalised and real-time content. This study adopts information research and case study methods to study representative games using generative artificial intelligence (AIGC). Research results show that in game design, AIGC accelerates art generation, plot creation and scene construction; in game operation, it enhances user behaviour analysis, intelligent customer service and personalised recommendation; in game marketing, it achieves automatic advertising, social media content generation and user analysis. These applications significantly improve productivity, reduce costs, and optimise user experience. Based on these case-based findings, this paper puts forward actionable industry recommendations on technology integration, data governance, innovative applications and cost-effectiveness assessment.

Keywords: Generative Artificial Intelligence; Game Design; Game Operation; Game Marketing

1. Introduction

1.1 Research Background and Significance

With the booming development of the game industry, players' demand for diversity, personalisation and real-time content of game content continues to rise. The traditional game development model faces challenges such as high content creation cost, long update cycle, and difficulty in meeting the differentiated needs of players. The development of a 3A game often requires tens of millions or even hundreds of millions of dollars, which takes several years, and it is difficult to dynamically adjust the game content according to the real-time feedback of players. The emergence of generative artificial intelligence has brought new opportunities to the game industry. It can automatically generate game characters, scenes, plots and other contents based on algorithms, greatly reducing development costs, shortening the development cycle, and realising the personalised customisation of game content. Therefore, it is necessary to study the application of generative artificial intelligence in games.

Since the ChatGPT artificial intelligence released by OpenAI in November 2022, the large language model represented by ChatGPT has developed rapidly, and generative artificial intelligence (AIGC) has triggered another wave of technology. In recent years, the emergence of generative artificial intelligence has become an innovation in the game industry. And development provide a driving force. According to the Report on the Development of New Quality Productivity in China's Game Industry released in 2024, more than 99% of the interviewed game enterprises or departments have actively introduced AIGC research and development applications, but the current research focusses on the implementation of technology in education, medical care and other fields, or only at the technical level such as game development engine and graphic rendering. Generalised discussion. It is worth noting that there is still a significant gap in the systematic application research of AIGC in game design, operation, marketing and other practical scenarios. This research gap not only limits the industry's in-depth exploration of the commercial value of AIGC, but also hinders the practical breakthrough of game enterprises in terms of content production efficiency and user experience optimisation. This article takes games using AIGC as the research object, combines information research method and case research method, and reveals its reusable experience in the game industry by analysing the specific application cases of AIGC in games, in order to provide practical reference for the intelligent transformation of the game industry.

1.2 Research ideas, Frameworks and Contents

1.2.1 Research ideas

This research follows the logical path of "problem-analysing questions-promising". First of all, based on the actual difficulties faced by the game industry in terms of content production, operation efficiency and user maintenance, combined with the evolution and penetration status of AIGC technology, the core problem of this study is to clarify: how to systematically apply generative artificial intelligence to the design, operation and marketing of games to improve production efficiency. Rate, optimise user experience and release business value. Secondly, the theoretical basis of this research is built through the literature review of the development vein of generative artificial intelligence technology and its research status in various fields of games. Then, using the case analysis method, select representative game products at home and abroad, such as Egg Party, Ancient Crown, Against the Water Cold, Heroes Wars, etc., as research objects, and deeply analyse AIGC in game art generation, plot creation, intelligent customer service, user behaviour analysis, advertising creativity. Application practice in specific scenarios such as generation. Finally, based on the findings of case analysis, the application model, implementation path and notes with industry universality are distilled to form strategic suggestions that are meaningful for game enterprises.

1.2.2 Research framework

The overall framework of this research paper is as follows:

Introduction: Explain the research background, the pain points of the industry, the opportunities and research significance brought by AIGC, put forward research problems, and summarise the research ideas and framework of the full text.

Literature review: Systematically sort out the technological evolution of generative artificial intelligence, as well as the current situation and development trend of its domestic and foreign research in the three subdivisions of game design, game operation and game marketing, and point out the contributions and gaps of existing research.

Analysis of the application status of AIGC in the game industry: combined with specific cases, in-depth analysis in three dimensions: 3.1 Application of game design: focus on art asset generation, scene construction, automatic generation of plots and dialogues, etc. 3.2 Application of game operation links: focus on user behaviour analysis, personalised content recommendation, intelligent customer service and anti-plug-in, etc. 3.3 Application of game marketing: focussing on the automated generation of advertising creativity, social media content creation, user portrait construction and interactive marketing, etc.

Enlightenment and suggestions for the game industry: Based on the above analysis, targeted and operational development suggestions are put forward in terms of technical integration and process optimisation, data governance and privacy compliance, innovative application and experience deepening, cost control and effect evaluation.

1.2.3 Research content

The main content of this study focusses on the following three aspects:

The empowering role of AIGC in game design: study how to use AIGC tools, such as Midjourney, Ghostwriter and internal customised models, to accelerate concept design, prototype production and content production, and achieve a balance between creative stimulation and efficiency improvement.

AIGC's intelligent transformation in game operation: explore the application of AIGC in player data analysis, service automation, content dynamic optimisation, etc., how to improve operational accuracy, reduce manpower costs and enhance user stickiness.

Innovative application of AIGC in game marketing: analyse the strategies and effects of AIGC in generating personalised marketing materials, driving social communication, and achieving accurate user reach, and reveal how it reconstructs the game marketing paradigm.

2. Literature Review

2.1 Literature Review Related to Generative Artificial Intelligence

Generative artificial intelligence originated from the exploration of artificial intelligence in the mid-20th century. After basic theoretical research and algorithm model iteration, breakthrough progress has been made in recent years. Holland, J. H. (1975) developed the basic framework of genetic algorithm[1]. Since then, it has been used to optimise the solution of various problems, which has become one of the most important optimisation algorithms. Ian

Goodfellow (2014) proposed a generative adversarial network (GAN), an innovative model architecture composed of generators and distinguishers. The two compete with each other, so that the generation model can generate more and more realistic data, showing great Great potential has promoted generative artificial intelligence to enter the stage of rapid development[2]. Google (2017) proposed the Transformer architecture, which is based on the attention mechanism to realise parallel computing in natural language processing tasks, laying a solid foundation for the subsequent development of large language models[3]. OpenAI (2018) released the GPT-1 model, and then released GPT-3.5 and subsequent versions, showing strong language understanding and generation ability, and can complete a variety of complex tasks such as text generation, Q&A, translation, etc[4].

In China, domestic research in the field of generative artificial intelligence started a little later than abroad, but in recent years, it has developed rapidly and achieved a series of remarkable results. Zhang Fuanshi's team (2024) proposed an image generation improvement algorithm based on generating confrontation networks. By adjusting the training mechanism of generators and distinguishers, the algorithm effectively improves the stability of model training and alleviates the phenomenon of model collapse to a certain extent [5]. Chen Fan et al. (2024) introduced Gumbel-Softmax around the generative confrontation network (GAN), verifying that Gumbel-Softmax is better than the existing method in solving pattern crashes and generating high-quality output, providing a new perspective and effectiveness for improving GAN training [7]. Professor Wang Yuan and his team (2024) designed HG-PIPE, an efficient data flow architecture for the Transformer model [6][8]. Kaiyue Wen, Xingyu Dang, Kaifeng Lyu(2024) deeply analyses the optimisation path of Transformer structure under the information retrieval scenario, covering the stability optimisation of the word embedding layer, the relative improvement of position coding, attention Mechanism sparse design, etc [9]. However, in China, there are still some challenges in the development of generative artificial intelligence. In terms of basic research, compared with the top level of foreign countries, there is still a certain gap in the originality and theoretical depth of core algorithms in China, and there is still a lot of room for development.

2.2 Generative Artificial Intelligence Related Literature in the Field of Game Design

The exploration of generative artificial intelligence in the field of game design began at the end of the 20th century. Early foreign scholars mainly focussed on the basic elements of algorithms to generate games. Togelius, J and Schmidhuber, J.(2006) Use genetic algorithms to generate a simple game level structure, and optimise the difficulty curve of the level through continuous iteration [10]. However, limited by the computing power and algorithm maturity at that time, the diversity and complexity of the generated content are limited. Togelius (2008) further proposed to generate game levels through evolutionary calculation, which lays the foundation for subsequent research, but the generated levels are still obviously insufficient in terms of visual effects and interactive logic [11]. With the rise of deep learning technology, the introduction of generative adversarial networks (GANs) in 2014 brought new opportunities to game design. NVIDIA team (2018) uses GAN technology to generate high-quality game scene textures, which greatly improves the realism of the game screen. For example, it successfully generates a virtual city street texture with real light and shadow effects in the experiment, which significantly enhances the visual expression of the game scene [12]. The GPT-3 released by OpenAI (2020) can automatically generate coherent and creative plot texts according to the game worldview settings, providing an efficient solution for game narrative design, and being used in the development of some text adventure games [13].

In China, the research of generative artificial intelligence in the field of game design began in recent years. With the rapid development of artificial intelligence technology, it has gradually attracted wide attention from the academic community and the industry. Carry out exploratory research on generative artificial intelligence in the generation of game scenes in China. The research team of Peking University (2021) proposed a game scene generation algorithm based on the generation adversarial network (GAN), and found that the time to generate simple scenes using this algorithm was shortened by about 60%, which greatly improved the efficiency of scene construction [14]. The study also pointed out that by

optimising the structure of the generator and the discriminator and the training parameters, the quality of the generated scene and the fit with the overall style of the game can be further improved [15]. Scholars from Tsinghua University (2022) focus on the application research of generative AI in game character design. They used deep learning technology to build a game character image generation model based on the Transformer architecture [16-17]. Researchers at the University of Science and Technology of China (2023) used natural language processing technology and combined with the generative pre-training model to develop a system that can automatically generate game plots. Experiments show that the plots generated by this system can meet the diversified needs of players for game plots to a certain extent, saving a lot of plot creation time for game developers [18-21].

Although some progress has been made in the research of generative artificial intelligence in the field of game design in China, it still faces many challenges. On the one hand, the quality and stability of the generated content need to be further improved. Some generated scenes, characters or plots may have problems such as unreasonable details and mismatch with the overall style of the game. On the other hand, since game design is a complex process involving multi-field knowledge, how to realise the deep integration of generative artificial intelligence technology and game design process, so that technology can better serve creative expression, still needs to be studied in depth.

2.3 Relevant Literature on Generative Artificial Intelligence in the Field of Game Operation

Generative artificial intelligence in the field of game operation, foreign scholar Huang, Z. (1998) Trying to use simple clustering algorithms to classify the operation data of gamers, trying to find out the behaviour patterns of different types of players, but limited by the technical level at that time, the accuracy and practicality of classification were relatively limited [22]. With the passage of time, the development of machine learning algorithms has brought new opportunities to this field. Shmueli, G (2005) uses the decision tree algorithm to predict the player's willingness to pay in the game. By analysing the player's game duration, level improvement speed and other multi-dimensional data, the prediction model is built, although the generalisation ability of the model in the complex game environment is insufficient [23]. The DeepMind team (2015) uses deep reinforcement learning algorithms to let AI master game strategies through self-learning in Atari games and achieve performance beyond human players. This achievement inspires game operators to think about how to provide players with personalised game difficulty adjustment with similar technologies [24]. Gupta, A (2018) proposes a player behaviour generation model based on the generation confrontation network (GAN), which generates simulated player behaviour based on existing player data and is used for game testing and preview of new operational strategies. Experiments show that the simulated player behaviour generated by the model is highly similar to the real player behaviour [25]. Akoury, J (2020) has developed a game plot generation system based on Transformer architecture, which can generate plot branches in real time according to the game worldview and players' early behaviour. Research shows that in games that use this system to generate plots, the average game time of players is increased by 20%, and players' satisfaction with the game plot is increased by 15% [26]. Ubisoft's research and development department (2022) launched Ghostwriter, a text-generated artificial intelligence tool, which is used to create diversified dialogues for non-player characters (NPCs) in the game, enriching the realism and fun of NPC's interaction with players [27].

There are also corresponding studies in this field in China. The research team of Peking University (2016) uses the support vector machine algorithm to predict the loss tendency of popular domestic mobile players. By analysing the player's login frequency, consumption amount and other data, it builds a loss prediction model, which provides a basis for game operators to formulate retention strategies in advance [28]. Lv Tangjie (2023) pointed out that in the daily operation stage, AI anti-plug-in technology can quickly identify abnormal behaviour players by analysing the behaviour data of players in the game. As an effective supplement to traditional anti-plug-in technology [29], the research team of Shanghai Jiaotong University (2016) uses traditional machine learning algorithms to analyse the login data and payment data of players, and an attempt was

made to build a player churn prediction model. It was found that the decision tree algorithm had a certain effect in predicting player churn, which provided a theoretical basis for game operators to detect potential lost players in advance and formulate targeted retention strategies [30].

2.4 Generative Artificial Intelligence Related Literature in the Field of Game Marketing.

The research and application of generative artificial intelligence in the field of game marketing. In 2013, foreign scholars Smith and others proposed for the first time to use machine learning algorithms to analyse player behaviour data to generate personalised game recommendation content on this basis, which opened up the segmentation of generative artificial intelligence in the field of game marketing. Explore [31] . However, at that time, it was limited by the performance of the algorithm and the amount of data, and the generation effect was relatively limited. Jones team (2018) used GAN technology to generate new posters with similar attractions by analysing a large number of promotional posters of successful games [32]. In the experiment, the new posters were more effective than traditional posters in attracting user clicks. Thanguturi (2018) uses natural language generation technology to design a system that can automatically generate news reports from structured data. Although it generates sports news, its method is also applicable to the automatic generation of game press releases and social media publicity copy, providing a feasible technical path to improve the efficiency of content output. [33]. Relevant studies point out that by optimising the training data and parameters of the generated model, the generated content can be more suitable for the preferences of the target audience. Green and other researchers (2023) developed a dynamic game marketing activity generation system based on reinforcement learning. The system can monitor players' behaviour in the game, feedback on social media and market dynamic data in real time, and dynamically adjust marketing activities, such as limited-time discounts, new role trial activities, etc [34].

In terms of game marketing of domestic generative artificial intelligence, Wang Hong'an and other scholars (2022) proposed an advertising generation model that integrates generative adversarial network (GAN) and reinforcement learning in view of the pain points of high cost of traditional game advertising production and low user matching. The model generates diversified advertising ideas through GAN, and uses reinforcement learning to dynamically optimise advertising content based on user interaction data [35]. Li Minghui and other scholars (2023) built a game marketing copywriting generation system based on the Transformer architecture. The model realises the automated generation from the core selling point of the game to the personalised copywriting by pre-training the game field corpus of 120 million words [36]. Zhuang Shaobin et al. (2024) designed a multi-modal generation model based on the attention mechanism, which can automatically generate short video scripts, graphic posters and other contents according to real-time hotspots [37].

3. Existing Use

At present, generative artificial intelligence (AIGC) has achieved deep penetration and preliminary application in many key links of the game industry, showing its significant potential in improving production efficiency, reducing development costs and optimising user experience. According to Gamma Data (CNG) and industry research, more than 99% of game companies or departments have introduced AIGC technology through various channels such as external procurement, open source projects or independent research and development. Its application is mainly reflected in the three links of game design, operation and marketing.

3.1 Game Design

In game design, AIGC is widely used in art generation, plot script creation and scene construction. For example, NetEase's "Egg Party" launched the "Universal Generator", which supports the direct generation of corresponding 3D models through text input, such as "classical brown cabinet", which greatly improves the efficiency of prototype design and iteration. Nexters uses Midjourney to generate 2D art resources in Heroes Wars, shortening the production time of 10 game illustrations to 4–5 hours and reducing the cost of character development by about 40%. In addition, Ghostwriter, an AI tool developed by Ubisoft, can automatically generate the first draft of the dialogue according to the personality and background description of NPC, which can

effectively assist the large-scale creation of plot content.

3.2 Game Operation

In the game operation link, AIGC is mainly used for user behaviour analysis, intelligent customer service and content recommendation. NetEase's "Ancient Crown" is connected to the Qiyu intelligent customer service system, which can automatically solve about 80% of players' inquiries, with a problem-solving rate of 93.6%, which significantly saves manpower costs. Tencent applies AIHelp to deal with account abnormalities and activity consultation problems in Arena of Valour, which improves the efficiency of customer service processing by 80% and saves manpower costs by more than 50%. At the same time, AIGC can also analyse player behaviour data, realise personalised content recommendations and activity guidance, and enhance user stickiness.

3.3 Game Marketing

In game marketing, AIGC has been used for creative advertising generation, social media content creation and user portrait construction. For example, Krafton uses AIGC to realise the automated advertising production process of "Wensheng Tu-Tusheng Video" in the marketing of PUBG, which significantly shortens the creative landing cycle. The Fifth Personality cooperates with Wanxing Technology to launch an AI video creation tool, which allows players to integrate personal images into game scenes and generate personalised content to promote social communication and brand interaction. In addition, "Against Water Cold" analyses players' dialogue preferences through AI large models, realises the dynamic adjustment of NPC interaction strategies, and promotes the immersive social experience of "thousands of people and thousands of faces".

4. Suggestions

Based on the current practice of generative artificial intelligence in the game industry, this article puts forward the following suggestions for peer reference and reference.

First of all, in terms of technical integration and process optimisation, it is recommended that game enterprises establish a systematic AIGC tool access and training mechanism. In combination with your own development needs, you should choose suitable AIGC tools, such as Midjourney, GPT series models, industry-customised AI systems, and organically embed them in art, narrative, testing and other links to form an efficient creative process of "human-computer collaboration". At the same time, it is necessary to pay attention to the skill improvement of the internal team and cultivate composite talents who both understand game design and have AI application ability.

Secondly, in terms of data governance and privacy protection, game companies should strengthen the compliance collection and structured processing of user behaviour data to provide high-quality input for AIGC model training. When using AIGC for user portrait analysis and personalised recommendation, we must follow relevant laws and regulations, clarify the boundaries of data use, ensure the privacy and security of players, and avoid legal and reputational risks caused by data abuse.

Thirdly, in terms of innovative application and experience deepening, it is suggested that the industry should not only assist in generation, but also explore the application of AIGC in in-depth interactive scenarios such as gameplay innovation, dynamic narrative, and intelligent NPC. For example, we can learn from the AI-driven NPC in "Reverse Water Cold" to realise the interaction mode of "dynamic co-creation" to enhance the immersion and replay value of the game. At the same time, at the marketing level, we should encourage the use of AIGC to generate interactive and personalised content to improve user participation and brand loyalty.

Finally, in terms of cost control and effect evaluation, enterprises need to establish an input-output evaluation system for AIGC projects and clarify the cost-saving indicators and quality improvement standards of each link. It is recommended to verify the effect through pilot projects such as the AIization of single-function modules, and gradually promote it to the whole process to avoid blind investment. At the same time, we should pay attention to the copyright and ethics of the content generated by AIGC, establish and improve the content review mechanism, and ensure that the output content is in line with the orientation of culture and values.

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