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The Application and Challenges of Generative Artificial Intelligence in Game Character Creation

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Abstract:
As the game industry continues to develop, players are also increasingly demanding quality in game characters. In the traditional game character design process, there are some defects such as high cost, long cycle and limited diversity. In recent years, the breakthrough development of generative artificial intelligence (GenAI) provides a new technical path for the creation of game character. This paper systematically summarizes the application of GenAI in game character creation, and analyzes the specific role fields of Artificial Intelligence Generated Content (AIGC) in the process of creating game characters, including character concept design, modeling, character personality characteristics and story background design, etc. This paper briefly introduces the principles of relevant technologies and the current challenges they face, and deeply studies the application scenarios and development trends of these technologies in the development of game characters. Through systematic review, it provides some reference value for role designers, AI developers and related researchers.

Keywords: Generative Artificial Intelligence; Game Character; Artificial Intelligence Generated Content; Large Language Model.

1. Introduction

The rapid development of GenAI, especially in areas such as image generation and natural language processing, has demonstrated powerful performance, which has led to huge changes in the operation mode of a large number of industries. With the continuous development of deep models (such as generative adversarial networks GAN, large language models LLM, etc.),GenAI has been widely used in content creation, virtual world modeling and other aspects. In the game industry, the creation of game characters is particularly important, and the application of GenAI in character creation has gradually become one of the important application directions.

As the game industry continues to develop, creating realistic, personalized, and emotionally resonant game characters has become one of the core tasks

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in game development. This process also presents a huge challenge for character designers, and GenAI provides a new intelligent solution for the creation of game characters. The application of GenAI in the creation of game characters includes virtual modeling generation, background story text generation, character personality construction and other main fields. Game designers can use LLMs to design the story background and text features of characters. By collecting relevant papers in recent years, Penny Sweetser‘s research shows that existing results are mainly concentrated in the following directions: game AI, game development, game research and evaluation, and narrative generation. It is important to note that most studies have only applied LLM to the exploratory phase of different design processes in games [1].In addition, GenAI can be used to visualize the generation of characters. Game design is a creative process in which a large number of ideas are created, tested, evolved and even eliminated, with only a few solutions being implemented. The whole design process is iterative, emphasizing the optimization of the scheme through repeated testing and prototype making [2].However, for programmers, repeatedly developing prototypes to validate designers‘ ideas is a stressful, repetitive, and frustrating process—— They need to continuously iterate and improve solutions before tight deadlines. Once an idea is deemed unappealing, the entire codebase could be scrapped [3]. The iterative optimization of character prototypes in the process of character development can also be used to reduce the workload and improve efficiency with GenAI to reduce the burden on designers. The structure of this article is organized as follows: Part 2 will provide a concise overview of core technologies related to game character development in GenAI, based on the evolution of relevant research. Part 3 will detail practical applications and experimental analyses of GenAI in game character development. Part 4 will examine current limitations and challenges in this field, while outlining future directions and offering recommendations. Part 5 concludes the article with a comprehensive review of the content.

2. Related Research Results and Application Fields

In traditional game character design, the process is highly dependent on manual design by game workers. This method has a long working cycle, high cost, and is prone to spiritual limitations and other problems. In recent years, the development of GenAI has revolutionized the core process of this work, which can be divided into image generation technology and narrative and dialogue generation technology.

2.1 Image Generation

In the early exploration, the application of generating images based on generative adversarial networks (GANs) has been researched and developed, which can be mainly used to generate character portraits, conceptual sketches, etc. However, the main problem in the development of GAN model is that it always falls into mode collapse, which leads to the lack of sample diversity. Meanwhile, the instability of GAN model is also a challenge that researchers must face during the training process [4].In recent years, diffusion models have made breakthroughs in the field of random Gaussian noise and restored to its original state through denoising [5]. The architecture of the diffusion model is shown in Figure 1, which in this way produces high resolution, clear structure and rich detail images. Compared with GAN, the diffusion model has significant advantages in terms of generation quality, controllability and diversity. In general, the development of visual models such as GAN model and diffusion model has greatly expanded the possibility of game character creation. They can not only improve the efficiency and quality of design, but also provide intelligent solutions for the future development of this industry.

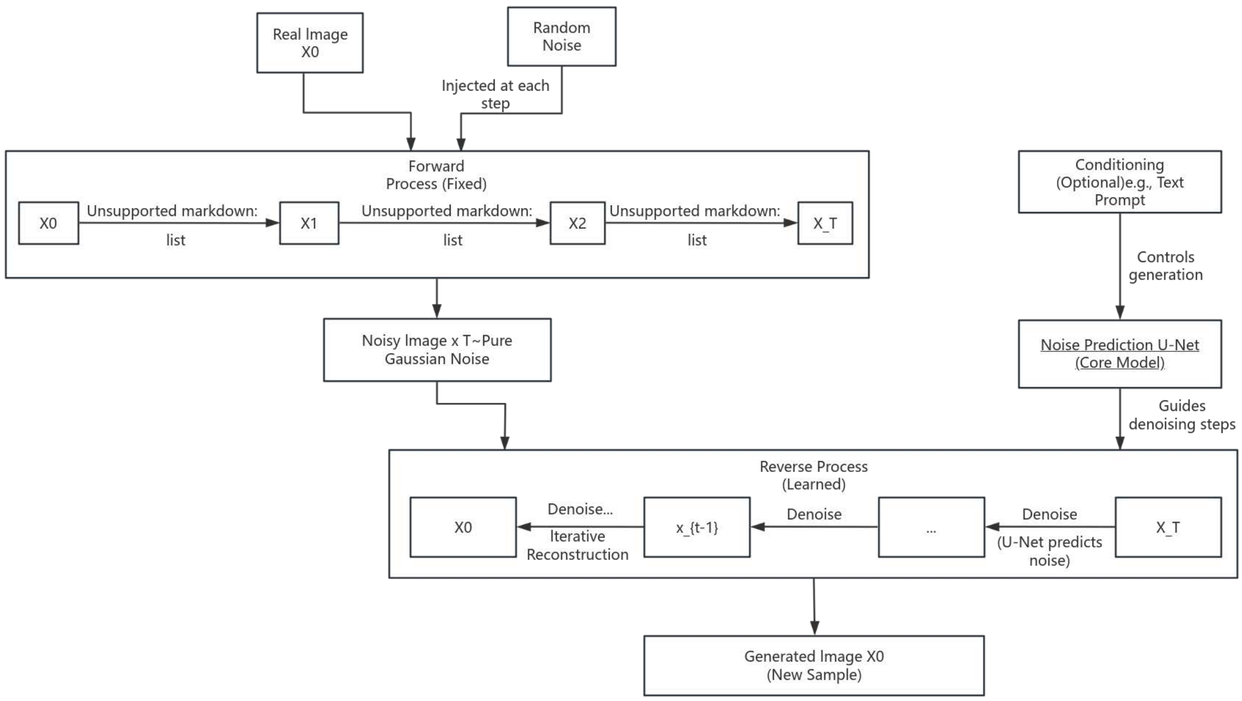

Fig. 1 Diffusion Model Foundational Architecture

2.2 Narrative and Dialogue Generation

In the creation of game characters, GenAI can not only contribute to the field of graphics, but also help with text work. In recent years, the rapid development of LLM has made it possible to apply them in the field of game character creation. By generating rich and diverse story backgrounds, character Settings and dialogue scripts for game characters, LLM can improve the level of narrative dialogue and make the character image more layered. By building an emotionally resonant narrative, the virtual world‘s game characters are made to feel real, further enhancing the immersion and improving the player‘s experience. At the same time, LLM can also collaborate with image-generation GenAI to integrate it into the entire game character production process. The current LLM also faces some challenges. It may generate some biased false information, which may be aggressive and controversial. Therefore, the application of LLM in game character development also needs human inspection and correction [6].

3. Related Applications and Specific Analysis

3.1 Character Concept Design

In the beginning of a game character design, it is necessary to build a basic concept of a character, and GenAI is a powerful tool that can support and simplify this process. The LLM can generate a large number of rich texts to inspire the designer‘s inspiration, including the basic characteristics of the characters, the story background, the ability setting and so on. These elements can help character designers be more productive, avoid a certain amount of inspiration depletion, and provide them with continuous motivation. The recent emergence of a large number of LLMs such as ChatGPT, with their advantages of text refinement, data structuring and the ability to innovate based on existing information, has great application potential in the field of game character creation. By integrating and further parsing the information input by users, this kind of model can not only effectively manage the data related to character attributes and story, but also provide valuable inspiration for game character design and interaction [7].
Game Plot is an intelligent assistant based on LLM [8]. This AI-powered platform is specifically designed for game development and narrative creation. By leveraging natural language processing (NLP) and GenAI technologies, it empowers developers to efficiently craft and refine game narratives, character dialogues, world-building systems, and quest texts. The operation interface is shown in Figure 2. Users simply enter keywords or initial ideas, and Game Plot automatically outputs structured story outlines, detailed plot developments, and diverse character Settings, greatly improving the efficiency and creative diversity

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of game text creation. The platform supports integration with art and development tools, and is an efficient aid for narrative design in games. Overall, GenAI has become an indispensable part of character concept design. In the future, with the development of technology, human-machine collaboration will be more closely, bringing more possibilities for game character art creation.

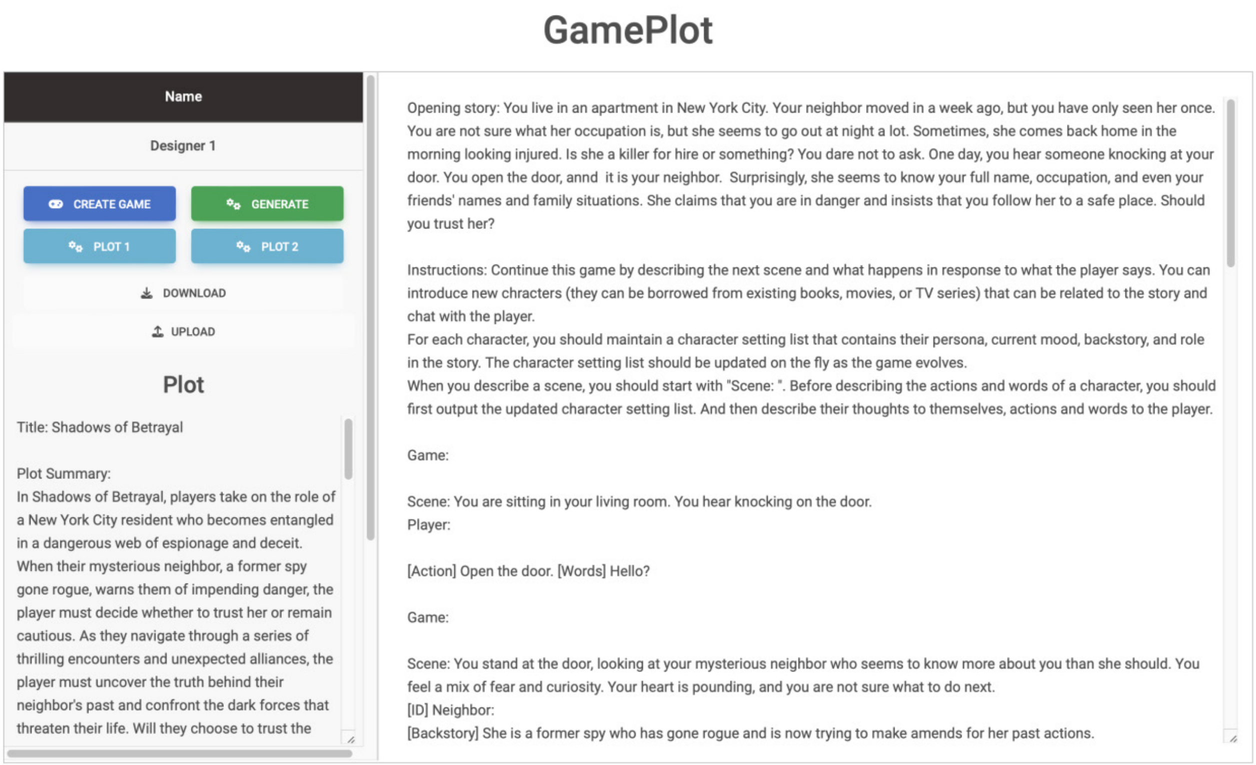

Fig. 2 An illustration of the GamePlot design room

3.2 Modeling in terms of images

With the help of GenAI, the graphical modeling and design of game characters can also be simplified. After the conceptual prototype design of the character is completed, it is necessary to further improve its image modeling.With the help of GenAI, it can complete a series of processes from text to image, from image to modeling.

3.2.1 Text to Image

The AI model of text to image can transform the designed character prototype text into 2D images. This type of model bridges the gap between natural language and visual images, enabling AI automation processes to be fully connected. Based on this process, tools for GenAI are designed by Sketchar et al. It aims to simplify the role design process and eliminate communication barriers between designers and illustrators [7].Its core functions include AI automatically generating character sketches, style migration and coloring, and quickly generating a variety of artworks based on keywords. The workflow is shown in Figure 3.Sketchar is based on GenAI algorithms such as GAN and diffusion models. By analyzing a large amount of artistic data, it can understand the user input and automatically output original images that meet the set requirements. The use of GenAI has greatly improved creative efficiency and style diversity, enabling users to achieve high-quality character concept design and art creation without having a deep painting foundation. Game designers use these tools to stimulate their creativity, simplify their workflow, and reduce stress.

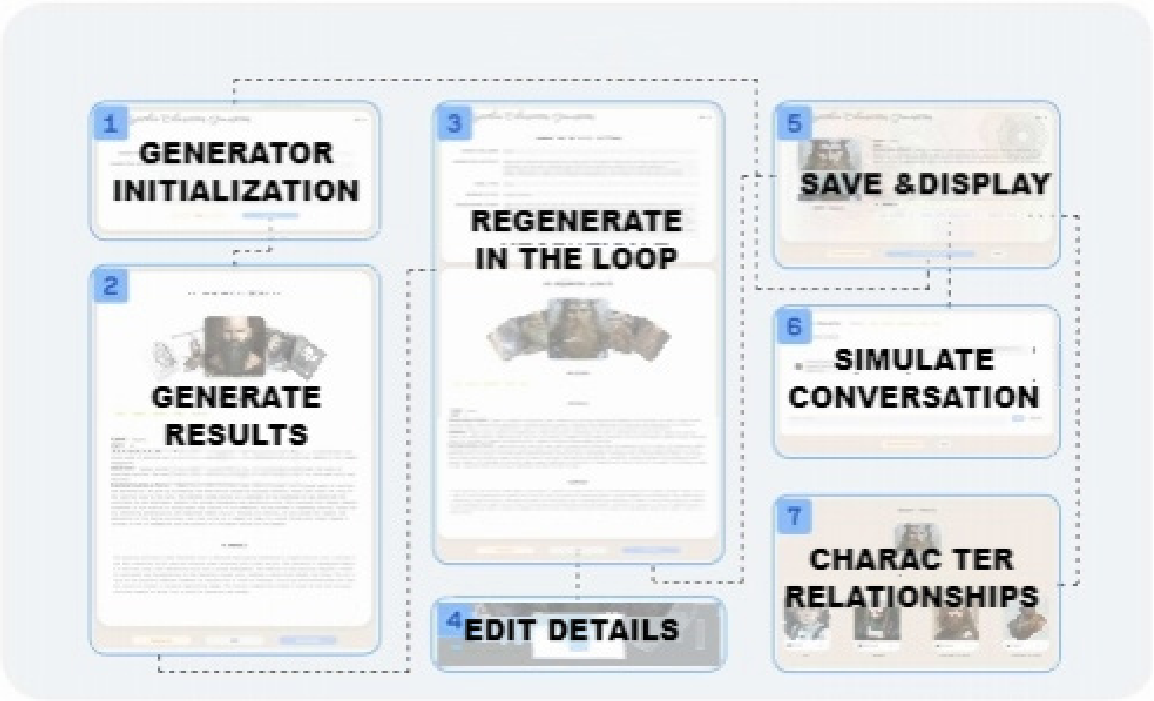

Fig. 3 Workflow of Sketchar

The author selects a comparative experiment to deeply analyze the generative AI of text-to-image generation.

Experimental theme: Comparative experiment of text to image generation [9]

Table. 1 Dataset Information

Dataset Name	Dataset Size
YFCC 100M	15 GB
MS-COCO	25 GB
CUB Dataset	1.1 GB
Oxford-102	0.32 GB
KTH Action Recognition	2.2 GB
UCF Sports	1.7 GB

Table. 2 Experimental results

Model Name	Inception Score	Frechet Inception Distance
CogView	32.2	23.6
Discrete Variational Autoencoder	23.6	30
AttentionGAN	4.58	19
GAN	17	23
LSTM + GAN	16	21
VQ-VAE	18.2	23.6
DF-GAN	5.10	19.32
MirrorGAN	4.54	20
StackGAN + BERT	4.44	37.7
CycleGAN + BERT	6	28

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Table 1 shows the six data sets used in the experiment, and Table 2 shows the ten different models compared in the experiment. Three evaluation indicators are mainly used for comparison:

Inception Score (IS): evaluates the quality and diversity of images generated by GAN, using a pre-trained model to evaluate the generated images.

Frechet Inception Distance (FID): An inspired distance metric designed to evaluate the performance of image generation models. By introducing the Frechet distance, it compares the feature distribution of real images and generated images produced by pre-training models. The lower the FID value, the higher the image quality.

Mean Opinion Score (MOS): A subjective assessment of the quality of the generated image pair, in which participants are asked to rate various aspects of the generated image, quantifying user satisfaction to assess the fidelity and quality of the generated image.

According to the research and analysis, although CogView combines cognitive theory and deep learning methods, its autoregressive generation mechanism leads to slow speed, and the introduction of VQ-VAE causes image blur; dVAE has the risk of information loss due to discretization process, which limits the expression ability of the model; Although the architecture based on GAN (such as AttnGAN, LSTM+GAN, etc.) can capture multi-scale features, its overall performance is still inferior to StackGAN. Among them, CycleGAN+BERT is limited by insufficient training time and unoptimized hyperparameters; DF-GAN is highly sensitive to hyperparameters and relies on pre-training models, resulting in insufficient generation diversity; MirrorGAN's basic text embedding technology restricts the integration effect of STEM modules; The improved VQ-SEG improves the image quality at the expense of the perceptual accuracy of specific regions. In this experiment, the researchers determined that the StackGAN model performed best, showing a dual advantage in visual diversity and image quality, and was able to better utilize the advantages of the data set than other models [9].

This experiment makes a quantitative comparison of various text-to-image models and concludes that StackGAN performs the best. It has certain reference value for researchers and related practitioners. Meanwhile, it is suggested to further optimize StackGAN and explore its potential application scenarios.

3.2.2 2D Image to 3D Modeling

The technology of converting 2D images into 3D modeling has been continuously developed, mainly using diffusion model and CLIP model to complete. However, the traditional method has many defects such as low efficiency and polyhedron problem [10]. This paper introduces a 3D model generation method based on character illustration proposed by Ningxin Yan and Takahiro Yakoh [10]. The method framework is shown in the figure4 below.

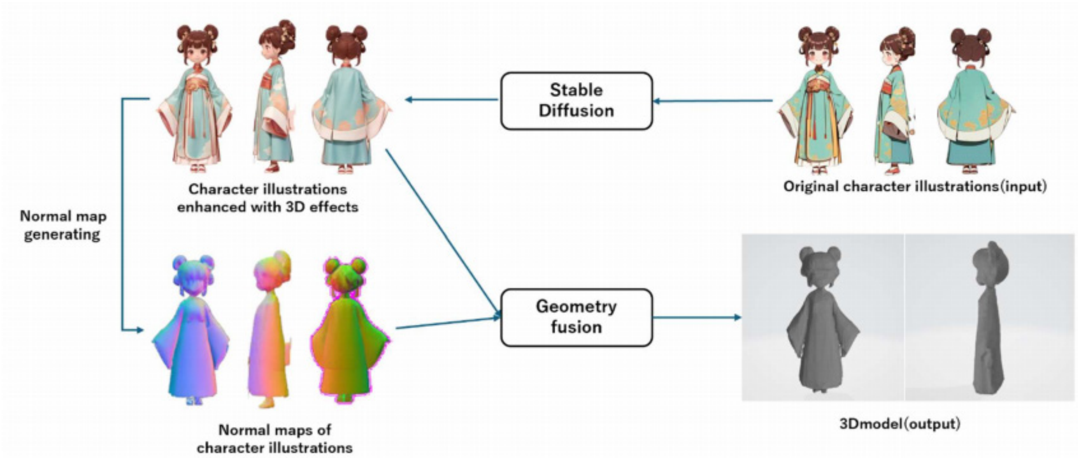

Fig. 4 Method framework

As shown in the figure4, this method adopts a three-stage processing process [10]:

The first is the three-dimensional information enhancement stage, through the diffusion model to pre-process the hand-drawn illustration, to solve the problem of three-dimensional information loss caused by artistic processing; The second stage is the generation of normal map, based on the improved cross-domain diffusion model to generate multi-view normal map; Finally, in the grid reconstruction stage, RGB images and normal map data are fused to generate the final model through neural implicit SDF optimization.

Through the innovative design of three-level processing process, this method effectively solves the geometric inconsistency problem existing in single-view method while maintaining the artistic style, and provides a new technical path for game character modeling.

Overall, GenAI is driving the continuous development of high-quality character design, profoundly changing the creative process and content production of game character art design, and bringing more innovative space to the industry.

4. Current limitations and Challenges and Recommendations

Although generative AI shows great potential in areas such as game character art design and 3D reconstruction, it still faces many limitations and challenges.

4.1 Prejudice and Misinformation

While GenAI simplifies the workflow, it is also prone to introducing biases in human society, such as racial discrimination and stereotypes about different groups of people. These messages have a bad orientation and are likely to have a negative impact on social atmosphere and the growth of teenagers. GenAI is also prone to generating a large amount of false information, which brings social risks. Therefore, the current generation of AI needs to be further strengthened under supervision and learning to ensure that its behavior is ethical. At the same time, legal constraints should be strengthened to avoid the use by criminals.

4.2 Unstable Quality and Low Efficiency

At present, the application of GenAI in game creation is not mature, and its quality is not stable enough to be prone to errors. Some game industry respondents said that the technology is not yet mature, there are many limitations of the technology, and the model needs to be trained for a long time before it can be used [11].In the future development of this field, it is necessary to further address the integration between generated content and the actual design process of game characters, improve model efficiency and practicality, and promote the application of technology in real production processes.

4.3 Impact on Traditional Design and Artistic Industries

Maden et al. pointed out that GenAI is bringing a huge impact to the traditional art and design industry, and a large number of practitioners are at risk of being replaced by AI, and the industry competition is becoming more and more fierce [12]. At the same time, copyright issues in the production of content are also a key topic of discussion in this field. Current laws are not clear on whether AIGC constitutes infringement. Because of the ambiguity of the terms, and because most of its training data comes from the Internet, most AIGC applications are in a legal gray area. In addition, the ownership of content created by users on AIGC platforms has also been hotly debated, and such copyright disputes may cause damage to the rights and interests of content creators. Through in-depth research, it is found that this legal ambiguity may become a stumbling block restricting the development of AIGC [11]. In the future development of this industry, it is essential to improve legal constraints. The formulation of relevant laws and regulations to regulate industry behavior can make the healthy development of the industry.

5. Conclusion

This paper conducts a systematic analysis on the application of GenAI in game character creation. Through sorting out the relevant technical principles, it is divided reasonably, and the application scenarios are divided into several levels for specific analysis and introduction, and relevant experimental results are cited to assist the analysis. Finally, the current limitations and risks in this field are analyzed, and some suggestions are given. It shows that GenAI has potential applications in providing inspiration for game character design, assisting image modeling work, and improving work efficiency. However, current technologies still have some limitations and challenges in terms of stability, efficiency and integration with actual workflow. In the future, with the continuous improvement of algorithm optimization, multimodal fusion and human-machine collaboration mechanism, GenAI is expected to show greater potential in more fields such as games, film and television, digital content, etc., helping the industry to continue innovation and development.

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