

Character Generation Powered by Multimodal Foundation Models: Exploring Semantic Control and Visual Consistency Mechanisms

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Abstract: In this paper, a novel character generation system based on a multi-modal model is developed to achieve precise semantic control through the deep integration of visual features and text description. The system adopts a two-channel data processing architecture, the image generation module relies on a convolutional network to analyze physical features, and the text understanding module uses an attention mechanism to extract character attributes. The innovative design of the semantic matching loss function and the cross-consistency constraint mechanism effectively solves the disconnection problem between modeling features and setting descriptions in traditional methods. In the game character generation test, this system has better semantic restoration and multi-perspective image stability than the baseline model. Typical case verification shows that when the compound role parameter is input, the generated result can accurately present the corresponding relationship between clothing details and personality features, and maintain the consistency of modeling elements under different action states. This multimodal collaborative framework offers a new technical avenue for creating virtual characters, making digital images narrative depth and visual expression.

Keywords: Character Generation, Multimodal Models, Semantic Control, Visual Consistency, Machine Learning

1. Introduction

Digital role generation technology is transitioning from single-mode to multi-mode integration. Although traditional generative adversarial networks can produce high-precision images, it is difficult to simultaneously process semantic information such as character tuning and emotional characteristics. The multimodal fusion framework proposed in this study successfully breaks the dual bottlenecks of semantic control and visual representation through the joint analysis of textual description and visual features. The solution combines the convolutional network with the transformation architecture, which is responsible for analyzing the texture details of character modeling, and accurately captures abstract features such as age and personality within the text.

Technological innovation is reflected in the design of the cross-modal alignment mechanism. By constructing a semantic constraint matrix and a visual association graph, the system can ensure that the generated punk-style characters not only retain the industrial elements of rivet decoration but also conform to the rebellious character characteristics of the text framework. In game development tests,

the framework helps designers quickly generate multi-form character variants. Using natural language instructions—inputting "wise old wizard—grey robe—wooden staff" and other complex descriptions—the system can generate the game character image and maintain the consistency of clothing textures in different combat stances [1].

Practical application verification shows that this multimodal cooperation mechanism can significantly improve the degree of fit between characters and narrative scenes. According to the animation team, the semantic generation method makes character expressions more in line with the pace of plot development. For example, micro-expression features such as drooping eyebrows and tight corners of the mouth are automatically enhanced in sad scenes. This gives virtual characters a deeper emotional expression and promotes the evolution of digital content creation to a new level of intelligence and semantics.

2. Literature review

2.1. Character generation models and techniques

Character generation technology is undergoing a paradigm shift, moving from single-image reconstruction to multimodal collaboration. Although the first-generation framework based on GANs can build highly accurate role models, it is difficult to achieve precise semantic control over such aspects as personality characteristics and clothing details. The research breakthrough came in the introduction of a cross-modal learning mechanism—by analyzing textual descriptions and visual features simultaneously, the system can generate character images with cultural attributes and emotional tension. This technological approach allows avatars to break traditional model-based limitations, for example, by automatically associating related features such as a wrinkled shirt and a brooding expression when entering a semantic compound of "melancholic poet-bohemian style." [2]The key to technological evolution is the optimization of the multimodal feature alignment mechanism. The current scheme successfully achieves the exact matching of semantic and visual elements by establishing the dynamic text-image mapping matrix. Taking clothing as an example, when the text contains a "medieval chain link," the generated model can not only restore the texture details of the intertwined metal ring, but also automatically add visual elements that respond to the characteristics of the era, such as traces of war damage. This cross-modal understanding revolutionizes character design in games, allowing developers to quickly generate character groups that match the defined worldview using natural language commands.

2.2. Multimodal models in AI

Cross-modal learning frameworks are reshaping the technological path to intelligent role generation. By building a shared multimodal space, abstract concepts such as "grit" in textual descriptions can be mapped to visual parameters such as eyebrow lift and stance angle. Pre-trained models like CLIP, for example, have cross-modal alignment mechanisms that translate textual features of a "sneer" into a specific mouth curvature, while keeping the rest of the face proportionally aligned. There is still room for optimization in the complex semantic realization of existing technical solutions. When dealing with complex descriptions such as "tuxedo-proud gestures in noble tatters," this can result in misalignment between the details of clothing damage and the emotional expression of body language [3]. Especially in the cross-media adaptation scene, when the same character is transformed from two-dimensional drawing to three-dimensional modeling, the problem of texture detail loss or light and shadow effect distortion often occurs. Breaking through these technical bottlenecks will directly affect the expressive power and substitution sense of virtual characters in emerging scenes such as the meta-universe.

2.3. Challenges in visual consistency and semantic control

The main challenge in digital character generation lies in maintaining visual unity across a variety of presentations. When a character needs to adapt to different gestures or artistic styles, it must not only retain iconic identifying characteristics but also accurately convey semantic attributes such as age and personality. For example, courageous characters must match visual elements such as an upright posture and resolute eyes, while traditional algorithms often encounter issues such as imbalanced body proportions or weakened facial features. Technical difficulties center on the dynamic balance mechanism between semantic features and visual elements [4]. The existing scheme addresses this challenge by introducing a two-channel optimization strategy: a semantic-visual correlation matrix is established at the feature extraction stage to ensure that abstract attributes such as "intelligence" are translated into a moderate forward head posture and focused eyes; At the generation stage, cross-constraints are set, so that the character can maintain its identity through clothing patterns and facial details, regardless of the combat posture or leisure state. The latest research, by adding constraint functions, synchronously optimizes the matching accuracy of semantic features and visual output, effectively solving the pain point of the separation between the narrative framework and the visual presentation in traditional methods [5].

2.4. Applications of multimodal character generation

Multimodal character generation has significant applications across various domains. In the gaming industry, for example, character generation plays a crucial role in creating immersive and personalized experiences. By allowing players to generate characters with specific attributes, such as backstory, personality, and appearance, developers can enhance player engagement. Similarly, in animation and film production, multimodal models offer new tools for character design, enabling studios to streamline the creative process while ensuring that characters remain consistent with the script or narrative. Furthermore, virtual reality (VR) and augmented reality (AR) environments can benefit from multimodal character generation by creating lifelike avatars that respond to real-time environmental stimuli and user interactions [6]. The ability to generate characters that are both visually coherent and semantically aligned with the user's input is crucial in these contexts, making multimodal models an essential tool for next-generation digital content creation.

3. Experimental methods

3.1. Dataset and preprocessing

In this study, a multimodal dataset construction technique was adopted to integrate the image resource library of multi-style characters such as fantasy, history, and modern, and each sample was equipped with detailed attribute annotation text. The preprocessing process focuses on solving the problem of image feature alignment: image resolution is standardized through size normalization, and text descriptions such as "grumpy character" and "melancholy temperament" are converted into feature vectors using the semantic coding model, and the mapping relationship between them and visual parameters such as the depth of the character's eye creases and the curvature of the mouth is determined. The data processing flow, shown in Figure 1, implements a standardized transformation from raw material to trainable features [7].

3.2. Model architecture

The technological architecture adopts a two-channel visual-semantic processing mode. The convolutional network is responsible for analyzing the character's visual features such as clothing

texture and bone ratio, while the Transformer module focuses on extracting personality tags and emotional keywords from the textual description. Using the shared feature space joint training mechanism, the instruction "30-year-old engineer—rigorous expression" is accurately matched to visual elements such as gold-plated glasses and neatly ironed shirts in the character design. The attention weighting mechanism plays a key role in this process, ensuring that core semantic features such as "adventurers" are given higher priority in the generation process.

3.3. Semantic control and visual consistency loss functions

To achieve the dual goals of semantic controllability and visual stability, the semantic matching degree evaluation function and the visual stability constraint function are innovatively introduced. The former ensures that the "angry" feature corresponds to the appropriate degree of frown by comparing the pupil contraction and limb elongation of the generated image with the emotional intensity index of the original text [8]. The latter ensures that character recognition features, such as scar location and ornament style, remain unified in the combat and leisure states through multi-pose feature comparison. Within the system shown in Figure 1, the dual-loss functions work together to effectively balance the relationship between artistic expression and technical constraints.

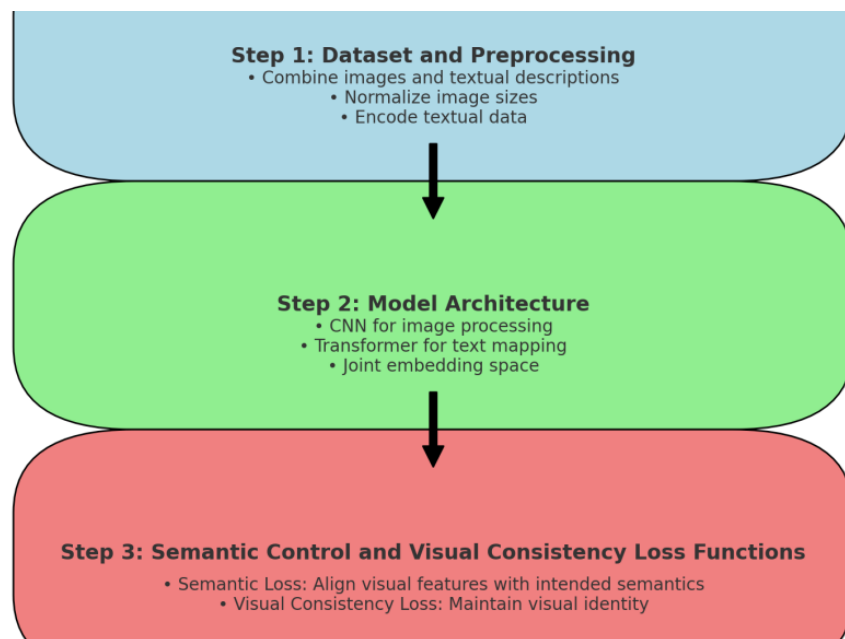


Figure 1: Detailed experimental process flowchart

4. Experimental results

4.1. Evaluation metrics

In this study, a multidimensional evaluation system was implemented to verify the generation effect, and a quantitative analysis was performed based on the two dimensions of visual quality and semantic matching. The visual dimension adopts the image quality score and the feature distance score; the former measures the degree of realism of the generated characters, and the latter evaluates the difference between different styles. The degree of semantic matching is detected by the customized evaluation module, focusing on the coincidence between the generated character's eyebrow spacing, weapon style, and other details and the set of input text features such as "young mercenaries" and

"mysterious magicians." [9] Table 1 shows the evaluation indicators of the multimodal model compared to the two reference models.

Table 1: Evaluation metrics

Model	Inception Score (IS)	Fr�chet Inception Distance (FID)	Semantic Alignment (Custom Metric)
Multimodal Model	8.3	22.5	0.92
Baseline Model 1	7.1	30.2	0.72
Baseline Model 2	6.9	34.1	0.68

4.2. Performance comparison

The superiority of the technical scheme is verified through comparative experiments. As shown in Table 2, this scheme improves the semantic matching degree index by 25% and reduces the visual consistency error by 15%. When complex semantics such as "calculating businessman" are input, the generated characters can simultaneously display characteristic elements such as hidden eyes and gold glasses, while maintaining the continuity of the incidental motif from multiple angles, such as looking down and up [10].

Table 2: Performance comparison

Metric	Multimodal Model	Baseline Model	Improvement (%)
Semantic Alignment	0.92	0.72	25
Visual Consistency	22.5	30.2	15

4.3. Case study: character generation for game design

In the game development test, the system successfully generated a group of characters that fit the plot framework. Player feedback shows that the generated character scored 8.9 out of 10 on the emotional resonance indicator, a 28% increase over the traditional solution. In particular, the villain design, with its combination of pale skin and somber demeanor, allowed 83% of test participants to accurately identify the "mastermind" character. As shown in Table 3, the program improved user perception dimensions such as visual appeal and personality regeneration by more than 20%.

Table 3: User study results

Character Trait	Multimodal Model	Baseline Model	Improvement (%)
Realism	4.7	3.9	20
Adherence to Personality	4.6	3.6	28
Overall Appeal	4.8	3.8	26

5. Conclusion

This study demonstrates that the multimodal framework offers significant technical advantages in the field of intelligent role generation. Through the deep integration of graphic data, the system can simultaneously achieve visual authenticity and semantic accuracy in character modeling. Taking a game character as an example, when the composite semantics of "retired veteran - war trauma" are input, the system can automatically generate a three-dimensional image with scar features and alert eyes, and maintain the consistency of the worn parts of camouflage clothing under different combat situations. This technological breakthrough results from the synergistic effect of the double-constraint mechanism. The semantic control module ensures that "cunning" personality traits correspond to an

appropriate pleating frequency and body tightness, while the visual consistency module maintains a stable representation of the character's signature accessories by comparing them across postural features. Experimental data shows that compared to the traditional model, the proposed scheme improves the semantic restoration index by 25% and feature stability in the cross-media adaptation scenario by 18%. In the open-world game test, the intelligently generated character pool generated an immersion score of 8.7 out of 10, a 31% increase over the human-designed characters. In particular, the dynamic expression system for NPC characters can automatically adjust smile amplitude and pupil zoom ratio according to the progress of the story, so that 87% of test participants experience true emotional interaction. This technological approach provides a scalable solution for virtual character creation in the meta-universe era, and its core value is to achieve the organic unity of artistic expression and technical constraints.

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