

The application and impact of artificial intelligence in the field of animation as well as the existing disadvantage

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Abstract. This paper provides an in-depth look at the application and impact of Artificial Intelligence (AI) in the animation industry, while also pointing out the existing limitations. In recent decades, AI has been seamlessly integrated into all aspects of life, and the field of animation creation is no exception. AI has not only automated tedious tasks, increased efficiency, and lowered costs, but also revolutionized the traditional animation ecosystem by providing animators with entirely new ways of expression. With the rapid advancement of digital technology, AI has become a key driver of innovation and change, especially in creative industries. In the animation industry, the introduction of AI technology has not only reinvigorated the traditional craft, but also opened up unprecedented creative possibilities. This paper explores the specific applications of AI in animation production, such as automatically rendering the texture of animation to help animators complete repetitive tasks. Or the use of algorithms to assist in the production of special effects and color modification. Through the animation creator's description to complete the modeling, or through deep learning, machine learning generated large models to assist the character's behavioral design and so on. While AI brings many opportunities to the field of animation, it also comes with the challenge of ethical considerations and the risk of possible substitution of traditional technologies. the application of AI in animation has pushed the industry in the direction of greater efficiency, innovation, and personalization, and has also prompted us to think deeply about the combination of creativity and technology.

Keywords: Application; artificial intelligence; animation; disadvantage.

1. Introduction

In the last decade or so, human beings have been developing rapidly in various fields, but the field that has received the most attention has to be artificial intelligence. With the development and popularization of AI, it has started to penetrate into all kinds of things in our lives. The field of animation is one of the most popular among the young and old, and is full of creativity and imagination. Since the 1990s, the gradual arrival of paperlessness, digital and traditional animation art has been in a fierce collision, and now artificial intelligence in the field of animation in a far-reaching impact on the ecosystem. It simplifies cumbersome and complex tasks, increases efficiency and reduces costs, and inspires creativity and innovation while providing animators with many ways to express themselves that weren't available before. The applications of AI range from helping animation authors to automatically render, create special effects, and modify colors to complex modeling, motion design, expression design, and even personalized content creation, all of which make animation more interactive and immersive. While the current technology of AI brings more opportunities and possibilities to the field of animation, it also comes with a lot of difficult trade-offs for traditional technology and ethical considerations for the automated production of works. Overall, the application of AI in the field of animation has pushed the animation industry towards a more efficient, innovative and personalized direction, and has also triggered profound thinking about the combination of creation and technology [1, 2].

This paper will explore the application of AI in some animation fields and its impact as well as the existing shortcomings. First, this paper will review the specific applications of AI in animation production, including but not limited to: the design of animation and the special effects technology therein, the behavioral design of characters in animation and other aspects. Subsequently, this paper



will analyze the impact of artificial intelligence on the creation of animation, the impact of the dissemination of animation and other perspectives for discussion. However, due to the current and artificial intelligence technology still has many defects, as well as the current and artificial intelligence-related laws are not perfect, so the application of artificial intelligence technology in the field of animation is still facing many problems that need to be improved. Through in-depth research on the application and impact of artificial intelligence in the field of animation, we can better understand the significance of the combination of artificial intelligence and art to revolutionize the animation industry, and at the same time provide inspiration and reference for future technological development and innovation.

2. Artificial Intelligence for Creating Animation

Two years ago, according to foreign media reports, Dwango's Artificial Intelligence Laboratory showed animation master Hayao Miyazaki a short, animated movie generated entirely by artificial intelligence. The attempt, while technically quite a landmark, failed to win Miyazaki's approval and instead caused him displeasure. Miyazaki insisted that he would not use AI to create works of art, arguing that AI-generated works, which are nothing more than imitations and reproductions of existing works of art, lack the spiritual and emotional depth of human-created art. This stance of Miyazaki not only reflects his insistence on human art, but also hints at the limitations of current AI in art creation [3]. Nevertheless, this animated short film directed by AI can be regarded as a starting point for the application of AI in the field of animation, just like the defeat of Go master Lee Sedol by AlphaGo, which was full of controversy at that time, but undoubtedly opened a new chapter of AI in complex games. Similarly, the application of AI in animation production, although it is still in the exploratory stage, facing many challenges and limitations, but its potential and possibilities can not be ignored. From automatic rendering and special effects processing, to color adjustment, complex modeling, and even the design of character behavior, the intervention of AI has undoubtedly brought new tools and methods to animation production, greatly improving efficiency and broadening the boundaries of creation. However, as pointed out by Hayao Miyazaki, technological advances cannot completely replace the creativity and emotional expression of human artists, and the true essence of art lies in its unique perspective and profound emotions that can touch the hearts of people.

Therefore, the future of animation creation should be a deep fusion of human artists and AI technology, utilizing AI to improve production efficiency and quality, but also retaining the creative thinking and emotional input of human artists. This fusion can not only promote the innovative development of animation art, but also ensure the emotional depth and humanistic value of the artwork. On this basis, exploring the prospects and challenges of the application of AI in the field of animation will help us to understand more comprehensively the relationship between technology and art, and how to maintain the core values of artistic creation in the rapidly developing wave of technology.

2.1. Artificial Intelligence helps create special effects techniques for animation

Currently the mainstream types of animation are categorized into two-dimensional animation and 3D animation, while 3D animation is mainly a kind of animation built on top of computer technology, so this article mainly discusses 3D animation. Special effects in 3D animation are mainly categorized into camera transitions (photography), lighting effects (lighting), interactive effects (performance), and spatial effects (scene) [4].

2.1.1. Lens transition effects (photography)

In the animation production of the last century, the creation of lens transitions and visual effects mainly relied on the animator's hand-drawing and intuitive perception, a process that was not only time-consuming and labor-intensive, but also extremely dependent on personal skills. Each lens transition and visual effect creation requires animators to carefully plan and repeatedly test to ensure

visual fluency and artistry, and although this method can create animation works with unique artistic styles, there are greater limitations in efficiency and consistency [5].

In contrast, today, 3D animation kind of shots are virtual perspectives simulated by computers, through AI to analyze a large amount of animation clips and photographic special effects data, through which the data to learn and recognize the patterns of various visual effects and transformation styles. This includes understanding how different camera angles, movements, and transition effects affect the audience's visual experience, generating a big data model. Assisting Animation Creators with camera placement, split-screen angles, and even providing camera ideas when the author is uninspired [6]. Additionally, AI transitions are a common tool used to create smooth visual transitions in animation. This tool uses machine learning to analyze the before and after images of an animation and generate keyframes when needed, allowing for a natural and seamless transition from one scene to the next. Of course, the Animation Creator can also adjust the parameters, such as frame rate, transition time, transition style, etc., to ensure that the effect of the transition is the same as what the Animation Creator needs, and this AI tool greatly reduces the workload of the original Animation Creator [5].

2.1.2. Lighting effects (lighting)

As far as the current 3D animation is concerned, the special effects of lighting is a very focused part, so AI is also quite good at this. As early as many years ago AI lighting technology has been applied in the animation production, such as the 2008 "Kung Fu Panda". This technique uses AI algorithms to automatically adjust and optimize lighting-related parameters, such as depth, normal (surface orientation), roughness, diffuse and specular reflections, and so on. This is achieved by learning a large number of lighting effects in real-world and virtual environments. Algorithms are able to analyze how different materials react to light to predict the best lighting settings for a given environment. There are also now advanced lighting techniques simulations such as AI that can recognize shadows and lighting and model volumetric light or volumetric shadows to make the image more realistic. Secondly AI has also made light-tracing techniques during rendering more prevalent, where AI uses algorithms to track the camera into the 2D view plane and return the path of the light source from the 3D scene to generate an image, a process that is reflected by objects with different reflectivity and blocked by various objects. All these interactions eventually merge into a very realistic light image [7].

2.1.3. Interactive effects (performances)

The realization of interactive special effects for individual models in animation using artificial intelligence is very innovative. Full-body motion capture implemented through tools such as the NVIDIA Vid2Vid Cameo, a technology that works by capturing the movements of real people and converting them into digital models. Specific sensors and cameras are used to capture the actor's movements, and then this data is converted into movements of the animated character. AI can be used to process and optimize this captured data to ensure smooth and natural movements [8]. In addition, 3D pose estimation is a technique for predicting human body poses by analyzing images or videos. AI algorithms are able to recognize the position and pose of various parts of the human body and maintain accuracy even in complex background or lighting conditions [9,10].

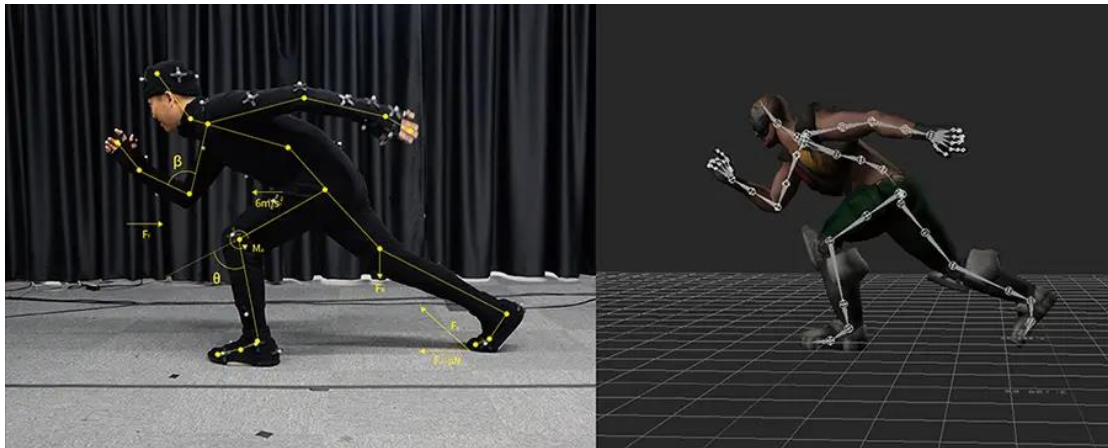


Fig.1 Motion capture technology and 3D estimation technology [11]

This is very critical for the accurate reproduction of character movements in animation, 3D collision estimation is also a very important function in animation, animation interactions often involve complex physical simulation, such as collision between objects (Figure 1). AI can be simulated through the physics engine for collision detection and response to ensure that the interactions in the animation look realistic and believable [11]. Before this, Animation Creators could only rely on their own modeling skills and physical experience in life to simulate actions or collisions, which requires a lot of skill, but now these AI technologies have greatly lowered the threshold of Animation Creator. Animation Creators can also use AI to implement creative animation projects, typically combining pose estimation and Vid2Vid Cameo software to map their own real-time movements or those of an actor directly onto a virtual character. This is especially important in animation production for live or real-time performances, enabling instant interaction and performance effects [12].

2.1.4. Spatial effects (scenes)

The creation of scenes in Animation Creators has always been an exhausting and unappealing task, as the Animation Creator has to spend a lot of time modeling a scene that looks reasonable, but the audience focuses on the performance of the characters in the scene, which leads to a lot of headaches for the Animation Creator, and many of the Creators choose to represent the scene by pasting a scene graphic in the background, which usually looks fake. Nowadays, the workload can be greatly reduced by generating scenes with AI, which can understand simple commands or descriptions such as "ocean" or "forest" through Natural Language Processing (NLP) techniques and generate complex 3D scenes based on these descriptions [13]. The principle behind this is deep learning networks, specifically Generative Adversarial Networks (GANs), which can learn a large number of images of a scene and generate new images or scenes based on the learned distribution. When these techniques are applied to 3D environments, AI can generate 3D models and environments with a high level of detail based on textual descriptions. Additionally, deep motion integration capabilities are a strong suit for AI, which refers to the ability of AI techniques to understand and simulate physical motion and actions in 3D space. This typically involves Motion Capture (MoCap) technology, in which AI algorithms can extract key motion data from 2D video and convert it into action for 3D models. For example, by integrating with 3D modeling software such as Blender, AI can help users convert the movements of an actual character into the movements of a 3D character, resulting in realistic motion effects in animated scenes. Automation is also a major advantage of AI in the processing of special effects in space. AI automates certain repetitive and time-consuming tasks, such as scene layout, detail sculpting, or motion matching, so that animators can devote more time and energy to creativity and artistic expression (Figure 2) [14].



Fig. 2 The effect of directly generating scene modeling through images in Lucid dreamer[14]

2.2. Artificial Intelligence Helps Design Character Behavior in Animation

The technology of designing action behaviors with artificial intelligence is now very developed, and in this article, we will mainly discuss the two mostly used ways, namely intelligent motion capture technology and large model deep learning technology.

2.2.1. Motion Capture Technology

Motion capture technology is a kind of technology which is used to wear cameras, sensors and marking points on the human body, and capture the data from the sensors and convert the human body's movement trajectory into a digital model. This real and convenient data is applied to the character design of animation to form smooth movements. Motion capture technology is usually divided into two parts: acquisition and processing. In the acquisition stage, the person being captured wears sensors and marks sensing points at key locations, and performs the movement. The capture device will record the actor's limb position, movement direction, movement speed and other movement information. In the processing stage, Animation Creator will import the captured data into professional software for data processing, deletion, filtering, translation and so on. The processed data can be directly used for the design of character models in animation [15]. The application of motion capture technology in animation production brings many advantages, the most significant of which include improving the authenticity and natural smoothness of animation character movements. Compared with traditional handmade animation production, motion capture technology is able to capture the nuances and complexity of human movements, thus reproducing highly realistic character movements and expressions in animation. This technique is especially suitable for projects that require highly realistic simulation of human or creature dynamics, such as the game 'Death Stranding' in which all the action-based CG animation is done by this technique (Figure 3) [16].



Fig. 3 CG animation in Death Stranding [16]

2.2.2. Deep Learning Based Behavior Prediction Technique

Deep learning technique is a learning technique based on artificial neural network. Firstly the prediction of character actions is a common function of deep learning techniques in character behavior design. Methods mainly include Recurrent Neural Networks (RNN) that are good at processing time series data or data of continuous actions [17]. In animated character action design, this feature is widely used to generate coherent and natural action sequences. The core of RNN lies in its memory-capable neurons, which are able to retain information from the previous moment and utilize it in the processing of the current moment. This memory function makes RNNs particularly good at understanding and predicting temporal dependencies in action sequences, i.e., how subsequent actions are affected by the previous series of actions. In practice, the animator first needs to provide a set of action sample data, which can be obtained from live action capture, historical animation clips, or other action databases. These sample data are fed into an RNN model, which is trained to predict action sequences by learning the action sequences and temporal associations in the samples. After the training is completed, when it is necessary to design the actions of an animated character, the animator can provide one or several initial actions to the RNN model, and the model will predict and generate subsequent action sequences based on these initial actions and their internally learned action sequence patterns. This process not only greatly improves the efficiency of animation production, but also ensures the coherence and naturalness of the animated character's movements, especially in the design of complex or prolonged action sequences (Figure 4) [11].

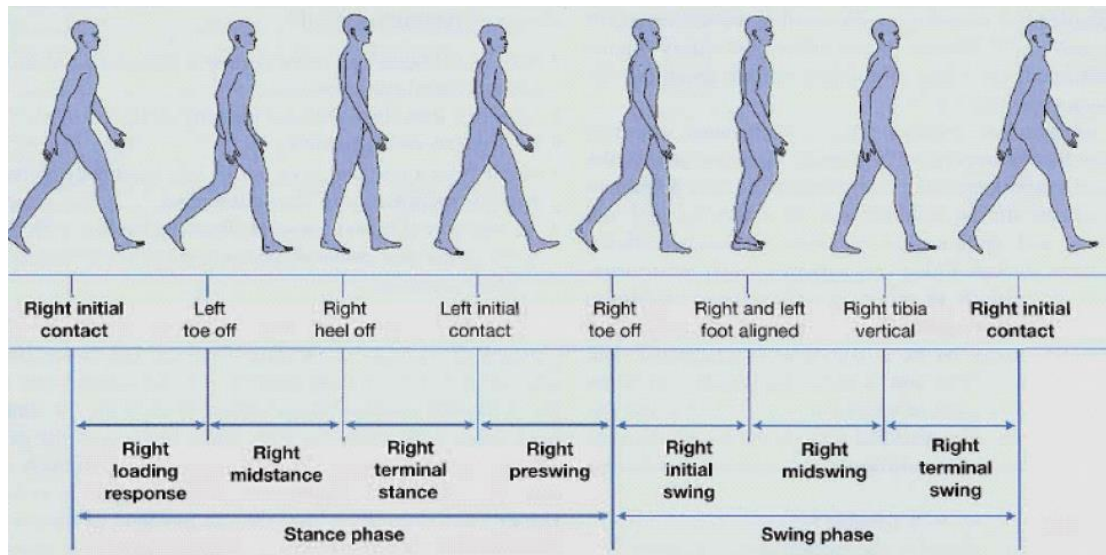


Fig. 4 Human gait [11]

In addition, an important advantage of RNN models is their tunability. Animators can adjust model parameters such as duration, intensity, and speed of actions as needed to generate action sequences that meet the needs of a particular scenario. This flexibility makes RNN an indispensable tool in animation production, especially in projects that require highly dynamic and complex motion design.

2.2.3. Natural Language Processing Techniques

Natural Language Processing (NLP) is a very popular technology in AI recently, which uses AI to recognize the sentence structure of human expressions, including recognizing sentence structure, including lexical annotation (nouns, verbs, etc.) and syntactic dependencies, in order to understand how the structure and components of the sentence are related to each other. And to understand the meaning of the sentence, including lexical disambiguation (determining the exact meaning of polysemous words) and denotational disambiguation (identifying the specific meaning of pronouns such as "he" and "she") [17]. The text-based analysis extracts the emotional tendencies, character traits, and relationships between the characters to design the characters, or to design their movements and expressions based on the results of the analysis, thus increasing the expressiveness and drama of the characters. In addition, this technique can also be used to generate animation scripts. By training Natural Language Processing models, these models can generate script ideas that fit the logic and character traits based on Animation Creator's descriptions or what the viewers want to see, which largely reduces the pressure of screenwriters to write scripts [13].

3. The Impact of Artificial Intelligence on Animation Creation

3.1. Low-end repetitive work will be replaced by artificial intelligence

In the field of animation production under such a penetration of artificial intelligence, some of the tasks with high repetitiveness and low creative requirements will be gradually replaced by artificial intelligence, resulting in the transformation or reduction of some jobs [18]. However, this change has also given rise to new career opportunities. Taking speech synthesis technology as an example, Google's WaveNet is able to analyze the human voice and its dubbing content, use deep learning to generate speech waveforms, and generate coherent and naturally smooth speech, such as being able to mimic a cv's voice line for character dubbing. Such technology not only makes voice adjustment more convenient, but can also be applied to the dubbing of animation. Similarly, animation post-processing, visual effects and lighting effects can also be processed and optimized through AI technology, reducing the reliance on manual labor.

Nonetheless, since the final aesthetic value of the artwork still needs to meet human aesthetic standards and perceptual needs, the role of human experts in this process is indispensable. For example, when AI performs speech synthesis, Animation Creator needs to make careful adjustments to AI's output according to specific animation scenes and situations to ensure that the emotion and tone of the voice fit the scene. Similarly, AI-generated animation and light effects need to be reviewed by the art director or director and further refined by the technical team to ensure that the work meets the aesthetic expectations of the human audience.

According to a study by Robert Atkinson, president of the Information Technology and Innovation Foundation (ITIF) in the U.S., while the development of technology has led to the disappearance of some jobs, it has also created new ones. Since the 1950s and 1960s, technology has created six new jobs for every 10 jobs eliminated, the highest ratio in history. This suggests that while technology has changed the shape of traditional careers, it has not reduced the demand for the jobs themselves. In the beginning stages of AI, professionals in animation and design will not be completely replaced, but rather shifted to assisting AI in the learning and decision-making process or being responsible for the aesthetic evaluation of the final work. This shift highlights a central point: while technology has transformed specific professions, it has not diminished the need for the work itself [5].

3.2. People should be involved in more valuable animation creation

In today's world where artificial intelligence is integrated into animation production, monotonous jobs are replaced by AI, making the role of humans in creation more important, especially in areas that require deep creativity and personal expression. The essence of art lies in the free expression of one's personal understanding and feelings about life, which cannot be achieved by AI models trained on big data, as they lack the free will to create truly unique works of art. Therefore, artists and creators should engage more deeply in artistic activities that require innovation and personalized expression, making full use of human creativity. This will not only help them stand out, but also ensure that they maintain an edge in working with AI. Art creators need to continuously improve their aesthetic appreciation and artistic skills to develop a unique creative style. In addition, they should adopt cross-disciplinary and comprehensive thinking, merging elements from different styles, cultures and disciplines to make innovative attempts. For example, *Spider-Man: Across the Spider-Verse*, an animated movie, has successfully incorporated such elements as retro dot-matrix style, black-and-white Noir style, ink and ink sketch style, 2D animation style, and 2D animation style in a modern American cartoon style. Noir, ink, and 2D animation styles, and combines these art forms in a way that is comfortable for the viewer. This kind of cross-border integration is exactly the area that is difficult for AI to reach, as most AI systems still rely on human guidance to carry out their work.

The ultimate aesthetic value of a work of art needs to be in line with human aesthetic standards, thus requiring human experts to fine-tune and review the AI's output to ensure that the work meets the aesthetic needs of the audience. While technological developments have changed certain professions, they have not reduced the overall demand for work. With the assistance of AI, professionals can be freed from repetitive tasks and focus on more creative tasks, thus enhancing the innovation and artistic level of the industry as a whole(Figure 5) [19].

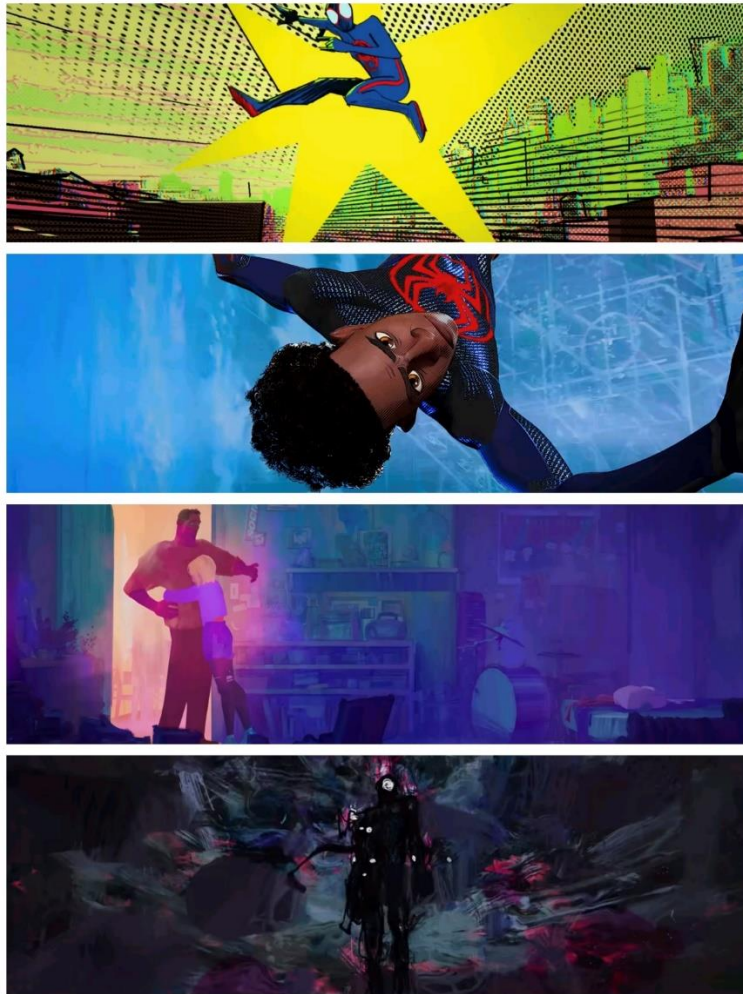


Fig.5 Different painting styles in Spider-Man: Across the Spider-Verse [19]

3.3. The Impact of Artificial Intelligence on Animation Communication

Although online news, novels, advertising and other industries have begun to widely apply artificial intelligence technology for user information collection and analysis

and accurate communication and other aspects of the business, but the animation industry is still dominated by the traditional form of communication. This is because animation communication involves multiple media such as TV, movies and the Internet, and the core animation products still take theatrical animation films, BD discs and animation derivatives as the main way to make profits. However, with the transformation and upgrading of animation media and the progress of AI technology, the application of AI technology in the process of animation dissemination will become a development trend [18].

First of all, the platform push is very important, the audience contact animation more, under the influence of animation also spread. ai big data push just can not complete this task. For example, bilibili's personalized recommendation system is a famous example of big data application. bilibili uses big data algorithms to analyze its huge user viewing data, including when users watch, what content they watch, on what devices they watch, and how they pause and skip while watching. This data is analyzed in depth to facilitate an understanding of individual user preferences and to provide personalized viewing animation recommendations for each user accordingly. Especially in the mobile Internet environment, animation audiences leave personal information and search traces on various ticketing sites, video sites, and review sites, and AI technology can capture this information and build audience databases. Accordingly, it can evaluate the orientation of the audience and build up their animation consumption preference, so as to obtain an accurate audience portrait.

In terms of publicity strategy, AI technology can better formulate and implement, and even replace human beings to complete the creative marketing work.

The data mining technology of AI mines, collects and analyzes the speeches and comments of the audience on animation texts on the Internet and social media, extracts the key information therein, and obtains the audience's basic knowledge of the animation, so as to carry out the targeted publicity strategy. For example, in "The Descent of Nezha", the creators analyzed the audience's comments on Nezha and came up with the basic mentality of "young people in an anxious state of mind want to change their destiny through struggles", which was condensed into the core concept of "My destiny is mine, not God's". And this is the starting point of marketing, which not only echoes the inner needs of the audience, but also sublimates the theme of the movie from the ideology, thus obtaining a better communication effect. In addition, according to user analysis, AI technology can also recommend different promotional content to different users in different media at the same time, and realize real-time interaction. For example, according to the keywords of "funny, humor" searched by users recently, it can recommend funny animation advertisements in the appropriate advertising positions of the mobile apps they often use, or the funny version of the same animation trailer. Therefore, AI based on audience analysis can recommend precise content to precise audiences at precise times and through precise media.

The AI based on audience analysis can introduce precise content to precise audiences through precise media at precise time, thus realizing the innovation of animation publicity strategy [5].

4. Deficiencies arising after the application of artificial intelligence in the field of animation

After artificial intelligence technology is integrated into the field of animation production, it also causes a lot of trouble for various reasons. Because the laws on artificial intelligence are still imperfect, and AI is trained from existing data, AI will sometimes inevitably be too similar to other works when assisting in the creation of works. For example, now the world's largest illustration website Pixiv has been suffering from AI-generated images, AI-generated images are very good-looking in the eyes of the layman, and only a few minutes to generate a lot, which leads to a lot of the original artist is no longer in the spotlight, and even drafts have been maliciously stolen, used to train AI models (Figure 6).

And with the popularization of AI, the development of the animation field may become uneven, first of all, 2D and 3D animation acceptance of AI is not the same, at present, AI can only assist 3D animation on many levels, 2D animation is still mostly traditional production techniques. Secondly the high cost and complexity of AI may make it difficult for smaller studios and independent artists to adopt it. This can also lead to reduced opportunities for artists to be directly involved in the creative process.



Fig.6 AI painted Artoria and hand drawn Artoria in the original work [17]

5. Conclusion

This article provides an in-depth analysis of the widespread use of artificial intelligence (AI) in the animation industry and its far-reaching impact on the industry, as well as pointing out some of the limitations and challenges in the application of AI technology. From automated rendering, special effects production, color adjustment to complex character modeling and behavioral design, the article discusses in detail how AI can improve the efficiency of animation production, reduce costs, and broaden the boundaries of innovation. However, the article also mentions that the application of AI technology is accompanied by moral and ethical considerations, as well as the threat of possible substitution of traditional handmade arts. The concluding section emphasizes that future animation creations need to find a balance between human creative thinking and the advantages of AI technology in order to promote the overall development of the art of animation. While the future of AI in animation is promising, it is crucial that it maintains the core human values of creative activity while bringing more innovation to the industry.

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