



Application of 3D Reality Technology Combined with CAD in Animation Modeling Design

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Abstract. Computer three-dimensional animation is a new type of animation with the development of computer software and hardware technology in recent years. Three-dimensional animation should apply the software of three-dimensional animation technology to establish a virtual world in the computer. In this virtual three-dimensional world, designers build animated character models and scene models according to the shape and scale of the objects to be represented. Then set the motion trajectory of the character model, the motion of the virtual camera and other animation parameters according to the requirements, and then assign specific materials to the model and add lights to the model. Then the computer can automatically calculate and generate the final continuous picture. Under this background, the research on 3D animation character shaping in this paper is to analyze and study the market situation from the standpoint of small-scale 3D animation companies (teams) with relatively weak technology, and through the author's own creative practice, this paper summarizes some principles for the design and production of 3D animation characters, and tries to improve the education system of 3D animation character design. It promotes the production and dissemination of 3D animation and distinct 3D animation characters. Starting with the comparative research method, this paper summarizes the differences of 3D animation character shaping from the comparison of the characteristics of 3D animation and traditional animation, and then summarizes the efficient ways and methods of how to shape 3D animation characters by combining practice with theory.

Keywords: 3D reality; CAD; animation modeling design; computer-aided

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1 INTRODUCTION

Successful commercial cartoons should have the following four conditions: 1, excellent touching story; 2, excellent character modeling; 3, fascinating plot and rhythm arrangement; 4, successful market operation. Good animated character modeling is the basis for the success of an animated film at the box office, even more than a story script [1]. The storyline of Disney Animation is not complicated, but its character design is so good that people may not remember the plot of these cartoons, but they remember Donald Duck and Mickey Mouse, which is the success of Disney. In many cases, the most important way to make money for animation is through the development of surrounding products, not the broadcast itself; broadcasting is largely advertising for surrounding products, and most of the surrounding products are developed based on the characters of cartoons. Therefore, the animation character has a special significance for the audience and consumers of animation products, which was proposed by Malik [2]. Compared with developed countries, the development of computer three-dimensional technology is much later, and there are considerable horizontal differences and problems [3]. There is no systematic understanding of computer three-dimensional animation image design and its application in various art fields. For its design and creation is mostly limited to scattered production, has not yet formed a complete cognitive system and systematic design and creation system. Therefore, Washburn et al. urged that we should pay attention to it in time and take corresponding measures to carry out corresponding research [4]. In addition, computer three-dimensional image design is a new direction of digital art, and the research and exploration of it has very important academic research value and research space. It complements and develops the creative theory and educational theory of digital art. Make the theoretical system of digital art more and more perfect [5].

Computer three-dimensional animation image design is the best combination point to study the relationship between art and technology. There have been many studies on the relationship between art and technology. Since the gradual separation of science and art in the process of industrialization, computer technology has recombined them. Haixia et al. proposed that the combination of technology and art is the strongest expression in the three-dimensional image design and creation of digital art, and technology is of considerable importance in computer three-dimensional modeling [6]. In the three-dimensional creation, only what kind of technology can create what kind of artistic effect, the artistic effect is based on technology. Technology plays a very important role in modeling, effect performance, especially in image shaping, expression and action as followed:

- 1) At the same time, artistry and aesthetics are also very important in creation, and art is an important factor in the transformation of technology into expression. CAD (computer aided Design) is a new technology formed with the rapid development of computer and its peripheral equipment and software. It is the crystallization of electronic information technology and industrial technology [7].
- 2) Through interactive graphic display, real-time construction, editing, transformation and storage of all kinds of geometric and topological information, CAD uses the application program to calculate and analyze the process, simulates, optimizes and determines the main parameters of the product, and uses graphic processing and animation technology to simulate and check the model. The computer automatically draws and outputs various forms of design results such as drawings and data, as well as data exchange.
- 3) And for CAM (computer aided manufacturing (computer aided manufacturing)), CAPP (computer aided process planning), CAE (computer aided engineering), PDM (product data management) and CIMS (computer integrated manufacturing system (as well as M R I P I (manufacturing resource management system), ERP (enterprise resource management system), Industrial information systems such as MIS ((Management Information system) provide basic data. CAD is the key and foundation of technological progress in modern industry. The emergence of "innovative design" technology is a great revolution of CAD

design technology. The idea is that as long as there is an innovative fuzzy concept, the idea can be expressed step by step through intelligent graphics, like building blocks and sculptures. Then through the visual drag-and-drop technology or accurate method for dynamic modification to achieve satisfactory and realistic design results by Cadwell et al. [8]. Innovation design is a flexible process, a process of innovation.

In the animation image design, the animator has a large amount of labor, high cost, time-consuming, animation characters are pre-set, there is no autonomy by Agarwal [9]. To this end, researchers continue to learn from other areas of excellent knowledge to improve animation technology. In recent years, there has been a method to learn from the mechanism of biological evolution and the resulting computational intelligence to study animation image design, in order to promote the automation, intelligence and innovation of animation creation [10]. From the current research situation at home and abroad, there are more researches on product design and architectural design based on evolutionary computing, but less on animation image design. Animation based on evolutionary computing has become a hot issue in the current research. Experts and scholars at home and abroad have carried out research in this field from different aspects, and made some progress [11-13]. From the standpoint of small-scale 3D animation companies (teams) with relatively weak technology, this paper analyzes and studies the market situation from the standpoint of small-scale 3D animation companies (teams) with relatively weak technology. Through the author's own creative practice, this paper summarizes some design and production principles of 3D animation characters, tries to improve the education system of 3D animation character design, and promotes the production and dissemination of 3D animation and distinct 3D animation characters. Starting with the comparative research method, this paper summarizes the differences of 3D animation character shaping from the comparison of the characteristics of 3D animation and traditional animation, and then summarizes the efficient ways and methods of how to shape 3D animation characters by combining practice with theory.

2 DESIGN OF STATIC MODELING OF 3D ANIMATED CHARACTERS

2.1 Characteristics of Animation Technology Determine the Way of Animation Production

Today's animated films have evolved into technological competition: the hair edge treatment of *Monster*; the facial motion system of *Shrek*; the reflection shader and surface scattering light source in *Shrek 2*; the complex muscle system and enhanced 3D background processing technology of *Superman*; and the precision motion capture technology of *Polar Express*. Cartoons are becoming more and more beautiful with the development of technology. I believe anyone who has watched "*Superman Story*" can understand that the development of the animation industry can be said to be changing with each passing day, changing from year to year, and the audience's requirements for animation works are even more stringent, nothing more than because Pixar has nurtured the taste of the public.

There are many kinds of animation, such as hand-drawn two-dimensional animation, couple animation, paper-cut animation, ink animation and so on. Different artistic styles determine different means of expression, that is, the technical factors to realize animation. Once the technical way is determined, it also determines the specific design, production and other working methods in the process of animation. If you decide to make a 3D animation, it is necessary to decide which 3D software to choose after completing the design idea of the character and scene. Although foreign well-known 3D animation companies have engineers who specialize in software technology research and development, only a few companies have their own patented software or working platform (such as Blue Sky Studio Blue Sky Studios, they use the patented software CGI Studio to produce "*Ice Age 2*"), domestic companies or smaller production teams are very lacking in software research and development. Large companies with more strength will also have technology research and development departments, but most of the work is to study and apply research on the production of all kinds of existing software.

So at least several factors should be taken into account when choosing software. First of all, whether the selected software is the mainstream software, the use of more people, whether there are sufficient teaching resources and professional forums for users to learn and reference. Secondly, what are the technical difficulties in this 3D animation, and whether the selected software can solve all these technical difficulties? If not, the technical difficulties should be completed in several software. In this way, the compatibility between the software is very important. Then it is necessary to envision the 3D effect of the final rendering of the animation, and whether the selected software or plug-ins with this software can achieve the goal. Then there is the technical proficiency of the selected software. If the animation production time is not ample, it is necessary to choose software with relatively simple technical operation, more skilled and faster rendering time, often for the sake of time, funds and other factors. We have to give up some things in the production, of course, most of the time there will always be some small regrets after cartoon production, which is inevitable. When the 3D software for animation is determined, it is necessary to change the character from a planar design to a three-dimensional static modeling. The production platform of 3D characters in animation is composed of corresponding animation equipment and animation software on the interactive computer graphics system. Because the computer graphics language and system that make up each software are different, it determines that each software has its own characteristics in the specific operation. But the general character static modeling production ideas are basically the same. First, it is modeled and produced by the modeler, which establishes a three-dimensional solid model with reference to the drafts of the characters in the computer, and then endows the model with materials, mainly simulating the character's skin, clothing, hair, etc., with lighting settings at the same time. Through the distribution of lights to illuminate the whole scene to assist the performance of character texture. Then, beneath the appearance, we need to build the character's bone system and skin the character.

2.2 Comic Style and Realistic Style of 3D Animated Characters

There are many similarities between 3D animation character modeling and two-dimensional animation character modeling, such as exaggerated shape, expression, action and so on. The difference between them lies in the planarization and dimensionality of the body. 3D animation characters can be roughly divided into two styles: one is comic style, the other is realistic style. Cartoon style is relatively common, "Bug team", "Toy Story", "Ice Age" and so on all belong to this style of 3D animation. Their character modeling is similar to three-dimensional cartoons, on the one hand, the character cartoons, but cannot focus on the pursuit of complete reality, but the mixture of abstraction and reality. For example, the toys in Toy Story have realistic clothes and fabrics, but the details such as facial features and the texture of their hair have been simplified. The unique expression of each character is designed to be close to the stylization of symbols, which greatly expands the freedom of character expression, and can freely control the structure, proportion and volume relationship of each part of the character. Make the shape closer to the "essence" of the character.

Realistic 3D animation character modeling does not only refer to all the objects that exist in the real world, but also includes objects that once existed or imagined by people to make them "real". The comparison between cartoon style and realistic style can be shown in Figure 1. One of the most difficult is to simulate real-life 3D characters, such as the 3D characters in final Fantasy, which must make the audience feel "real" in terms of scale, structure, skin texture and clothing. What is different from the cartoon style is that the virtual "reality" and space sense created by the realistic style can "deceive" the audience's eyes to the maximum extent, enter the virtual world and be fascinated by the virtual "real" characters. This is the charm of realistic 3D animation.

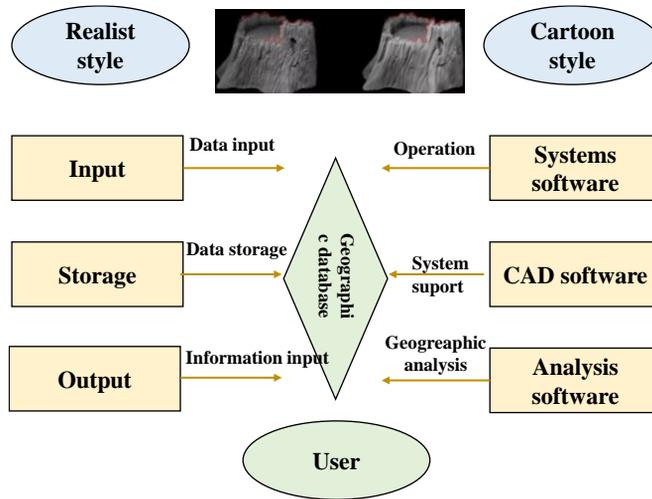


Figure 1: A comparison between comic style and realistic style.

2.3 Initial Posture of Static Modeling of 3D Animated Characters

In order to create lifelike 3D animation characters, each character must be fully studied. First of all, the "Noumenon" of the modeling is found from the description of the characters in the script, the performance state of the characters in the film, the collocation relationship with other characters, the emergence of the scene, and so on, and the basic elements of the modeling are determined by referring to a certain object or some parts in the objective reality to make sure that the basic elements of the modeling are shown in Figure 2. These are related to the needs of role performance and the embodiment of its special personalization state. After determining the basic character modeling elements, the initial sketch design is carried out, which is the same as the two-dimensional animation. The emergence of computer technology is undoubtedly the most revolutionary breakthrough, but 3D animation does not mean that all steps are done by computers.

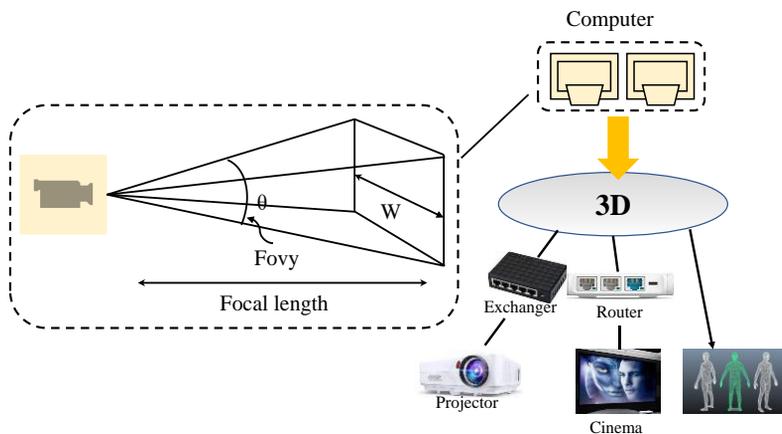


Figure 2: Static modeling of 3D animated characters.

According to the author's creative experience, there will be a lot of problems when creating bones in the back. Because 3D animated characters do not have to take into account the center of

gravity and balance of the body, the author's experience is to change the arm from flat lift to slightly downward drop at an angle of about 50 degrees with the body, and the elbow joint of the arm and the knee joint of the leg bend a little angle. Fingers together in a naturally relaxed state palms rush down, feet still open some distance. This initial posture avoids the convergence of the back arm and leg bones during the alternating process of IK and anti-IK. Because of the computer graphics operation mode of 3D software, even if the character exaggerates the model, it will not break, but in order to avoid the deformation of the material map caused by the stretching of the edge of the joint, when wiring, it is necessary to encrypt the edges of the model according to the body structure at the shoulder, armpit, elbow, knee and other joints. The initial pose of the 3D character basically shows the sex, age and physical condition of the character, and the character bones can be built only after the initial posture is completely determined. There is a lot of room for modification of the model, just like kneading plasticine, but once the dynamic relationship such as IK is created between skeletal chains, there is no way to modify it, so the initial static pose of the character must be strictly checked before building the skeleton.

2.4 Corresponding Modeling Method

Since its birth, 3D animation software has been changing in the ideas and methods of modeling and the operation mode of software model. The development of software has changed from the integration of functions to the separation of functions. The functions of all kinds of software tend to be more single, more concise, more professional and more profound. In any case, there are many principles in modeling animated characters. According to the author's practice, the elements of 3D animation character model can be divided into hair, head, eyes, mouth and teeth, limb torso and clothing accessories. According to the different animation style or the definition of animation quality, the hair of the character does not have to use the hair function in the software to simulate the real situation. If the animation is of high quality and the character is an animal or monster, the simulation of hair is very important. However, the use of hair will take up a lot of software resources, hair carding, shape, dynamic control is also very difficult, rendering of the computer configuration requirements are also very high. In general, smaller teams, companies, or individual works should try to avoid using the software's own hair to simulate. Or directly use ordinary models to create an approximate hair shape, which is mostly used in simple cartoon characters.

A cartoon or minimalist character cannot have a finger but a flaky or spherical alternative hand. The relationship between the character's torso and clothing is also different. If you want to make clothes that flutter and wrinkle with the movement of the body, you can build a model of the limbs and torso, and use appropriate modeling methods, such as patches, to make clothes on the character. Then setting the dynamics and collision parameters will have the effect of simulating real clothes. "Ratatouille" is the way it works. But this method is as energy-consuming as hair, and it is also not suitable for animated short films and small production teams. It's time for a change of thinking, that is, using clothes instead of the body, sleeves instead of arms, pants instead of legs, shoes instead of feet, this method is also very good, such as SIGGRAPH's award-winning short film "Fallen Art", without the shaking clothes, the character looks like the whole and highlights the artistic style.

3 MATERIAL AND LIGHT

3.1 Shaping of the Artistic Characteristics

After the 3D animation character static model is built, it presents a plain color model without color distinction, just like a puppet animation model just wrapped in clay. Next, we need to add different materials and maps to each part of the character model, and then add light to further shape the artistic characteristics of the character, which is a process that makes the character fresh and surprising at the same time. As shown in Figure 3, the material is based on the model and completely displays the 2D design in the 3D space; the material and lighting cooperate with each

other to create color and atmosphere; the material provides visual elements for the later stage, and the material is an important link between the preceding and the next in the production of the project.

Material production through the object color, texture, bump, highlight, translucency, reflection and other attributes to show the object vision, smell, touch and other sensory information, so that 3D animation characters more real, more vitality. Solid artistic foundation, keen observation, comprehensive technical production ability, accurate grasp of animation style. In the two-dimensional animation, the material of the character's skin and clothing cannot imitate the real situation, basically through color, pattern and simple light and shadow to show the relationship between the character's body and clothing, rarely showing texture.

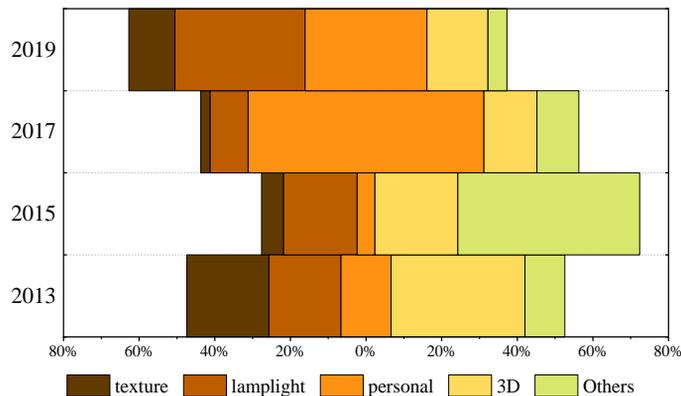


Figure 3: Construction of 3D space by materials and lights.

3.2 Dynamic Shaping of 3D Animated Characters

The modeling of 3D animated characters is not only static, but also the complete shaping of 3D characters combined with changes in facial expressions and movements. Animation is a process from static to dynamic. After the static modeling of 3D animated characters is completed, the next step is to animate. This part is very important, because animation is an art of movement, which takes action as the main means of expression.

It is necessary to use exaggerated and deformed techniques and rich emotional facial and physical movements to virtualize the modeling characters to perform the story. Reflect the character, emotion, psychology, and further use dynamic modeling to shape the artistic characteristics of the character. First of all, it is necessary to master the basic theory of animation, the law of movement, from a simple movement to a performance full of personality and emotion is a process from shallow to deep, step by step. Facial expression is undoubtedly the most intuitive part of depicting the psychological emotions of 3D characters, and it is the focus of shaping the characters. In two-dimensional animation, the expression of the character mainly depends on exaggerated and deformed lines.

Usually, the main purpose of the exaggerated ratio of the cartoon character's head and hands and feet is to fully display the character's expression and body language, so that the audience can fully understand and feel the character's performance. Bring the audience into the storyline to share the joys and sorrows with the characters. (3) the expression of the character and the movement of the body are limited in many aspects, especially when the stretching is produced by the point, line and surface on the model. Therefore, the expression of the three-dimensional character needs more exquisite consideration, design and performance under the restriction of technical conditions to make the emotion and emotion get the most perfect display. Excellent animators are not only experts in the use of software technology, but also excellent actors, keen observation is very necessary, in-depth analysis, good at performance is more important. The

action design of the character refers to the design of the motion state of the character in the animation, which includes the character positioning, action feature positioning and so on.

Action design must make the most characteristic format according to the movement process of different roles, so that the character of each character can be fully reflected. The action design of the character refers to the design of the motion state of the character in the animation, which includes the character positioning, action feature positioning and so on. Action design must make the most characteristic format according to the movement process of different roles, so that the character of each character can be fully reflected. Action design includes the following main contents. The correct understanding and reasonable application of the body structure of 3D animation characters will directly affect the rationality of character design.

A good 3D animated character design should stand up to scrutiny in structure. In the two-dimensional animation is through the plane lines to draw the body, especially the realistic style of animation should basically follow the character, animal body structure, angle, perspective, but it is impossible to be very rigorous. Some wrong structure and perspective relations may not be detected in plane animation, or inaccurate perspective and body stretching have a certain sense of visual beauty. However, in 3D animation, the changes of character movements and facial expressions are controlled by the internal skeletal system, so the character's skeletal system should be designed and built in accordance with the characteristics of the character's body structure, which will lay a good foundation for the later production of facial expressions and movements. For example, when designing a 3D character of a robot type, the structure at the rotation of each joint should pay special attention to rationality and need to draw a detailed structure diagram. When designing monster characters, we should learn from the anatomical structure of real creatures in life, such as the naughty little lamp in the opening of Pixar.

4 DESIGN OF EXPRESSIONS AND ACTIONS OF 3D ANIMATED CHARACTERS

4.1 Comparison with Traditional Animation

If the artistic language of 3D animation wants to develop better, on the one hand, it needs the progress of its own technology, on the other hand, it is necessary to draw lessons from and absorb the traditional artistic expression language, techniques and artistic effects of animation, especially the artistic expression of dynamic performance. Only in this way can we avoid the common "rigid, rigid and simple" artistic effect of 3D animation creation in the past, as shown in Figure 4. From the current point of view, the reference and absorption of traditional animation artistic expression and artistic effect is mainly reflected in the rhythm, speed and exaggeration of the action. Take Madagascar as an example, the film absorbs a lot of the acting rules of traditional Disney animation.

In straight forward movements, 3D characters do not need to set the main pose in advance. Free acting, motion capture and dynamic simulation all belong to this type. In recent years, the number of frames and realism of 3D animation have improved significantly, as shown in Figure 5. Animators in the actual modulation of animation more use pose-to-pose method, it decomposes the motion of 3D animation characters into a series of key poses, and then let the software automatically interpolate to calculate the middle process, so as to get smooth motion. In the practice of animation creation, the author feels that the way of pose-to-pose animation is simple and clean, but generally speaking, it is too cartoonized and modeled, and usually brings out some superfluous follow movements, which is not suitable for realistic 3D cartoons. However, for experienced animators, the choice of any way is to achieve a more perfect effect.

4.2 Features of 3D Technology

In the dynamic modeling of 3D animation characters, in addition to absorbing and drawing lessons from traditional animation, more effective dynamic modeling of animated characters is to make full use of 3D animation technology to absorb and learn from the experience.

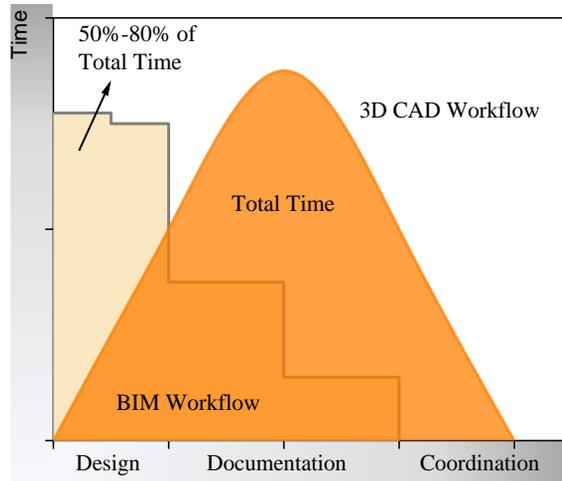


Figure 4: Comparison between traditional Animation and 3D Animation.

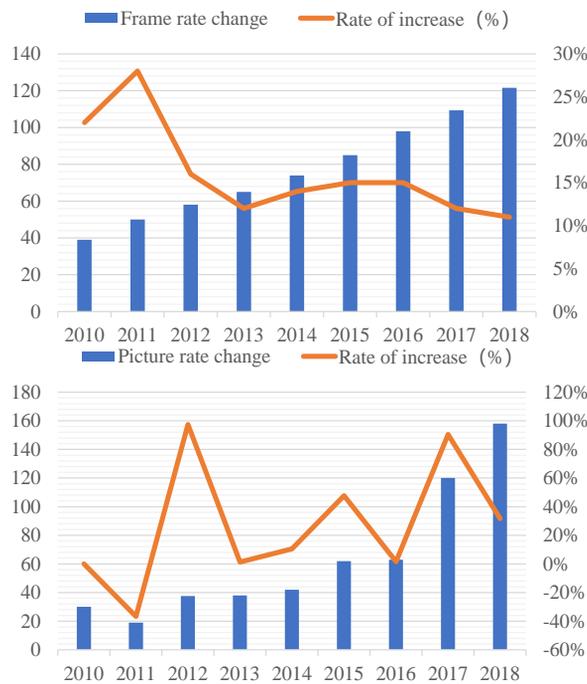


Figure 5: The improvement of the number of frames in Modern 3D Animation.

3D animation technology has many characteristics in shaping the expression and action of dynamic modeling of 3D animation characters. First, there will be a significant improvement in picture quality, as shown in Figure 6. In addition, resources and materials can be reused.

4.3 Realization of Character Expression and Action By 3D Technology

This means not only the tedious and inefficient work, but also the cost for the managers of 3D animation companies. Motion capture technology is particularly important at this time. Motion capture technology can timely detect and record performers' limbs, facial expressions and even the

trajectories of cameras and lights in three-dimensional space, digitize them, and give data to 3D character models in animation software.

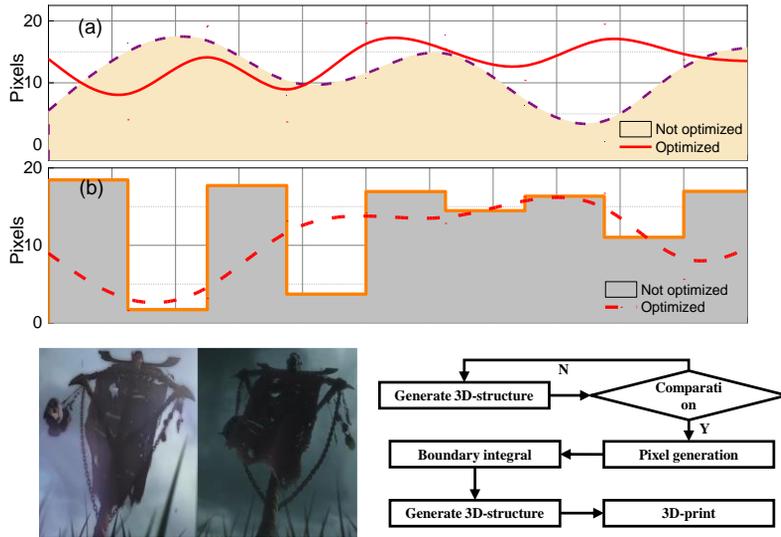


Figure 6: The improvement of picture quality brought about by 3D technology.

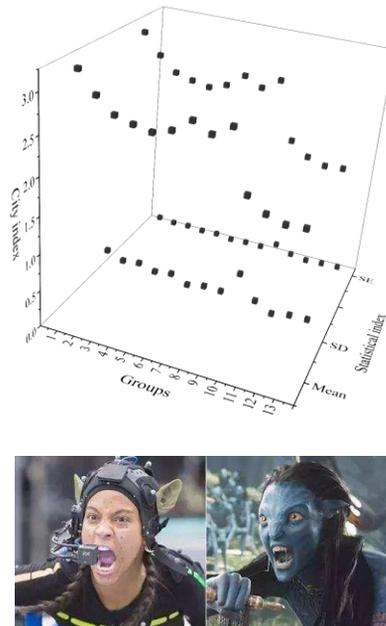


Figure 7: 3D technology to capture the expression and motion of a character.

So that 3D characters can make the same movements and expressions as performers. Of course, motion capture is not omnipotent, like the characters in European and American cartoons, it is difficult to achieve exaggerated deformation without manual adjustment. Of course, the source of any exaggerated action is the regular action of a real person. First use motion capture to organize

the real action into an action library, and then adjust it manually as needed. This method is faster and saves resources as shown in Figure 7.

5 CONCLUSION

There has been a method to learn from the mechanism of biological evolution and the resulting computational intelligence to study animation image design, in order to promote the automation, intelligence and innovation of animation creation. From the current research situation at home and abroad, there are more researches on product design and architectural design based on evolutionary computing, but less on animation image design. Animation based on evolutionary computing has become a hot issue in the current research. Experts and scholars at home and abroad have carried out research in this field from different aspects, and made some progress. From the standpoint of small-scale 3D animation companies (teams) with relatively weak technology, this paper analyzes and studies the market situation from the standpoint of small-scale 3D animation companies (teams) with relatively weak technology. Through the author's own creative practice, this paper summarizes some design and production principles of 3D animation characters, tries to improve the education system of 3D animation character design, and promotes the production and dissemination of 3D animation and distinct 3D animation characters. Starting with the comparative research method, this paper summarizes the differences of 3D animation character shaping from the comparison of the characteristics of 3D animation and traditional animation, and then summarizes the efficient ways and methods of how to shape 3D animation characters by combining practice with theory.

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