Computer-Aided Graphic Design for Virtual Reality-Oriented 3D Animation Scenes

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Abstract. This paper adopts a computer-aided virtual reality approach to conduct an in-depth study and analysis of the graphic design in 3D animation scenes. In this paper, a library of animation material ontologies is constructed, and the qualitative planning of animation scene materials is designed and implemented accordingly. Relying on the system knowledge base that has successfully supported the operation of 3D animation automatic generation system, this paper establishes an ontology library that describes the nature of animation materials for the first time, including two major categories: animation material composition and animation scene material sphere, in which the animation material composition category defines the basic characteristics of materials and scene material styles, including material type, base material, color, texture, picture, and scene style. The interconnectedness between digital sculpture and 3D character animation is derived by finding similarities in 3D technology applications, 3D space, artistic factors, and cultural factors. The first is the interoperability of the software, which solves the difficulties in the production of the two; the second is the convenience of creation, each frame of 3D character animation can be regarded as a digital sculpture scene, 3D character animation solves the problems of digital sculpture software weights and so on.

Keywords: virtual reality; 3D animation scene; computer-aided; graphic design
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1 INTRODUCTION

Three-dimensional animation, or 3D animation, is an emerging technology along with the development of computer hardware and software technology. 3D animation is automatically generated inside the computer based on a series of data, rather than simple external graphic input.

With the rapid development of digital film technology and computer graphics generation technology, film production has entered the digital era, and the whole process from production to projection of images has undergone a radical change. The digital film can use digital cameras to complete live-action shooting to obtain high-definition and high-fidelity audio and video files or carry out digital modeling and digital adjustment through virtual cameras, image graphics processing software, graphics video processing software, etc., to realize the process of associating live images with models, synthesizing and co-mingling dynamic images, and seamlessly editing images to obtain virtual images. Animation is a comprehensive art that combines many forms of artistic expression, including painting, photography, and literature [1]. Animation can portray people's inner thoughts more intuitively and show things that originally existed only in fantasy in real life. From the perspective of the animation production method, animation mainly contains traditional animation based on hand-drawn, computer animation with the computer as the main production tool, stop-motion animation through photography technology, and other animation production techniques. The traditional animation production method is transplanted from the traditional animation film production method, using the visual temporary film principle, a slow-changing, can reflect a continuous dynamic process of the still image, through the camera to shoot frame by frame editing, and then use the television broadcast system to make it move on the screen.

3D animation refers to the animation generated by the animator digitally modeling and manipulating, producing in virtual 3D space; using geometric data stored in the computer for performing calculations and drawing 2D images; creating polygonal meshes to give a visual appearance to 3D objects or 3D environments; manipulating vertices for control through a digital skeleton system, and using in combination with keyframes to create motion [2]. To sort out the technical and artistic characteristics of the development of 3D animation and its flux; to analyze the core issues involved in the artistic creation process of 3D animation; to analyze the importance and role of dimensional expansion and compression for the study of 3D animation art creation. With the above content as the entry point, the framework of the theoretical system of 3D animation art creation research is constructed. Digital media technology requires practitioners to be highly technical also requires them to have artistic penetration, both good artistic quality, and unique creative thinking. Technology is one of the economic boosters, the development of science and technology should be linked to people's needs, enhance the practical value brought by science and technology, to achieve further development of science and technology, so that science and technology play his energy.

Virtual Reality (VR) is a computer simulation system that allows the creation and experience of virtual worlds. It uses computers to generate a simulated environment, a multi-source information fusion, interactive 3D dynamic visual and physical behavior system simulation technology that immerses the user into the simulated environment. Current virtual reality technologies most often use virtual reality headsets or multi-projection environments, sometimes combined with physical environments or props, to produce realistic images, sounds, and other sensations, and to simulate the physical presence of the user in the virtual environment. In this paper, I will focus on virtual reality technologies based on head-mounted displays for creation and experience. The concept of animation is different from the general sense of cartoons, animation is a comprehensive art, it is a collection of painting, film, digital media, photography, music, literature, and many other art disciplines in one form of artistic expression. The standard definition of animation technology is to use frame-by-frame filming of objects and continuous playback to form a motion picture technology. No matter what the object is, if it is filmed in a frame-by-frame manner and played continuously to form a moving image when viewed, it is animation.

2 RELATED STUDIES

At present, there are still many drawbacks and problems in the use of VR technology in movie production, mainly involving immature technology, too high production cost, slow market

penetration, and even many cottage and homogeneous products, and the design of small cost game plot scenes in the market at present is biased, which affects the real experience of users. 3D animation automatic generation system receives the SMS sent by users, and then, according to the SMS, after receiving the SMS from users, the 3D animation generation system gets the result of word classification and extracts the information, then after qualitative planning and quantitative calculation, it generates a 3D animation that matches the SMS and sends it to the SMS receiver. The qualitative planning layer transforms the Chinese SMS content into an abstract description of the animation content, and outputs a series of readable and modifiable qualitative description statements; the quantitative computation layer reads the qualitative description language, generates an animated scene in Maya software, and modifies the scene accordingly according to the qualitative description statements, and outputs a quantitative description language containing all quantitative information of the animation. Pang et al. achieved a stylized effect based on traditional practices in technical illustration, using illumination models with simultaneous luminance and hue changes to indicate surface orientation, and preserving extreme light and dark for edge lines and highlights [3].

Yavuz and Demir [4] pointed out the occupation of the real world by virtual technology and the challenge to the concept of reality, and then launch a critique of documentary aesthetics. On this basis, Denerel and Anil [5] proposed the ontological problem of film aesthetics in the digital age and point out that digital film aesthetics should provide a platform for the development and legal basis of all audiovisual arts and aesthetic norms of digital media, and then start a comprehensive reconstruction. Gao et al. [6] pointed out that the new digital technology has made a breakthrough in the representation of the real material world and transformed the aesthetic hypothetical acceptance and hypothetical performance forms, and elaborate on the regression of film aesthetics under the new technological conditions, and then discuss the expansion of the aesthetic form by interactive film and the possibility of creating "poetic film" by cell phone film. Akpan et al. [7] started a revolution in virtual 3D modeling, and now the influence of 3D character animation has spread all over the world. With the development of modeling technology, the digital sculpture is also gradually emerging.

Unlike traditional animation, virtual reality interactive animation is characterized by a combination of immersion and interactivity. It provides users with visual, auditory, tactile, and other sensory simulations so that they can observe things in 3D space in a timely, unrestricted manner as if they were in space. There is no accepted clear definition of virtual reality animation, but the author has researched through literature and interview data of related professionals and found that animation works delivered based on virtual reality medium are being widely referred to as virtual reality animation. VR has diverse forms and animation is divided into various types, but this paper is limited to discussing VR animation interactive based on head-mounted display devices narrative design.

3 ANALYSIS OF COMPUTER-AIDED GRAPHIC DESIGN IN 3D ANIMATION SCENES OF VIRTUAL REALITY

3.1 Computer-Aided Virtual Reality Design

The interactive narrative form of virtual reality animation is a narrative built on the presentation form of virtual reality media technology. Unlike some other new media art forms that are digital presentations of traditional art forms, the interactive narrative of VR animation places more emphasis on the audience as the core, and by opening the interactive behavior of the audience, it can allow the audience to participate in the story and influence the direction of the story content. By analyzing the qualities of virtual reality media technology, the interactive narrative text of VR animation is a textual matrix composed of images, sounds, videos, and other elements. The interactive audiovisual narrative, immersive experience narrative, and participation narrative brought by virtual reality become important components of the interactive narrative form of VR

animation, which will be sorted out and divided from these three progressive levels of interaction in the following. We can more often assign interactive properties to the picture or sound so that the audience can selectively receive the audiovisual language [8]. Although the audiovisual elements in the virtual reality environment are mostly added to the story by the creator beforehand, the audience can change the order of the audiovisual narrative through interaction, thus changing the development process and plot direction of the story. For example, in the same indoor space, three TV sets are placed and the audience can turn them on randomly, and different TV contents will guide the audience to different storylines. Although this kind of non-linear interactive audiovisual narrative is not unique to virtual reality animation, the author believes that compared with interactive audiovisual narratives in other media, the interactive audiovisual narratives in virtual reality environments tend to be more like the audiovisual perceptions of people in the real world. Through this, we can learn more from and observe people's natural interaction behavior in real life when creating the interactive audiovisual language of virtual reality animation.

Virtual reality technology and film space scene design are two completely different concepts, they come from different fields, one is computer technology and the other is film and television art, but the final presentation of both is to serve people or can be said more directly in the visual and even human interaction with the virtual environment to bring people better service. VR virtual technology is the use of software to generate a realistic virtual space, film, and television space scenes designed by the producer according to their script fictional world of film, in this point is the common link, virtual reality technology in the film and television space is more of a fusion of technology and art, as shown in Figure 1.

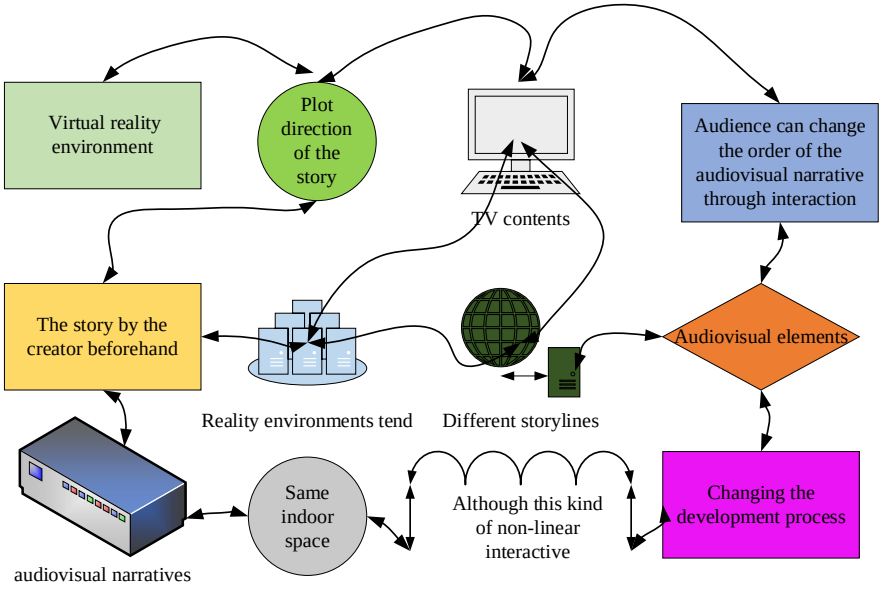

Figure 1: Structure of computer-aided virtual reality technology.

The so-called two-dimensional, that is, only the X, Y coordinate axis of the plane. Built-in scenes but the human brain through the eyes to see the movie picture, after processing, we can produce three-dimensional sense, this thing through the picture has different contours and depth of field, light, and shadow changes, and make us produce the illusion. It is because of this illusion, we can enjoy photos, movies, our world is colorful. We understand the three-dimensional world (the world we live in) is also mainly through the eyes to judge and perception, and the eyes are through the

light to identify, which can explain why we see the two-dimensional film can produce a three-dimensional sense, is because the film screen is an active luminous body, and we can produce and receive similar light changes from the three-dimensional world, so we can make us feel real. There is a great similarity in visual effect with virtual reality technology equipment experience, but virtual reality technology equipment has more room for progress in human interaction compared to the former. When viewing 7D films and television works, you will feel as if you are in the real world, but the user's main feeling is not the first perspective, but the third perspective, virtual reality technology is to experience the dimensional world from the first perspective.

To address the model penetration problem in the scaling bias method, this chapter proposes an optimization method of normal offset flattening to effectively reduce and avoid the penetration display problem. The uniform stroke algorithm based on depth compensation is proposed for the rendering effect of a large near and small stroke. Finally, the performance and effect of the uniform stroke algorithm are compared and evaluated with various other stroke algorithms based on quantitative indexes and performance parameters. When the normal bias method is used to draw the inner contour of the doll model, the depressions, such as the eye sockets, are drawn with subtle black defect contours. The normal direction near the depressions is not always the same as the view direction, so there is a wrong rendering effect for some internal contours after the bias stroke. Because of the contour line width, offsetting the model points along the normal vector direction can cause model penetration problems.

$$0 \le y^{'} \le \frac{1}{\sqrt{t^2 - 1}} \tag{1}$$

The algorithm calculates the similarity of two texts by comparing the text length and edit distance. The calculation rule is shown in Equation (2), and Edit Distance (a, b) denotes the edit distance between strings a and b.

$$EditRatio(a,b) = 1 + \frac{EditDis\tan ce(a,b)}{a-b} \tag{2}$$

The material implementation method based on image guidance needs to know the final shape of the scene in advance and select suitable example images according to the scene content, which is extremely limited for diverse scenes and does not match with the current situation that the 3D animation automatic generation system changes the scene by adding models every time it generates animations; the data-driven method needs to prepare a large amount of data with good effect as training data set in advance, and it takes a long time to calculate each model individually when applying. The data-driven approach requires a large amount of data with good effects to be prepared in advance as training data set, and it takes a long time to calculate each model individually when applying. Combining with the actual situation of the 3D animation automatic generation system, this paper proposes a scene material planning method based on Semantic Web technology, by constructing a material ontology library to portray various properties related to material and realize automatic planning of 3D scene material according to SMS text.

After the data matching is completed, we manually check and correct the association between classes to ensure the data quality. We only compute entity names of similar lengths to reduce the number of matching calculations between entities, as shown in Figure 2. It is worth noting that there are still some entities in the animation knowledge base that cannot be semantically associated with DBpedia, and the reasons for this are: many expertise in the animation knowledge base describing the means of animation generation do not have entities in DBpedia that can accurately match with them, such as available space, model deformation, camera and other related classes, entities, and attributes.

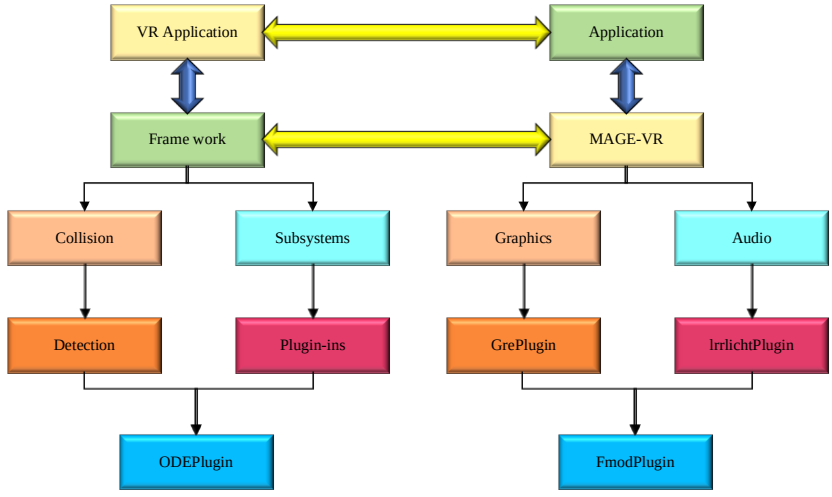

Figure 2: Virtual Reality Framework.

This part of data is often not a direct means of representation of SMS content but appears as auxiliary information in the plot planning, such as available space describing the placement of models in the scene, and layout knowledge describing the relative position of model placement. This part of the data can no longer be matched and will have no impact on post-plot planning.

$$P^{'} = \left(x\frac{\cot\dfrac{FOV}{2}}{Aspect}, \mathrm{y}\frac{\cot FPOV}{3} \right) \tag{3}$$

The corresponding feature vectors are constructed to extract the training samples. Then, the corresponding training scenarios are designed and simulated by the traditional fluid simulation method to collect training data and build the overall training set. After the training set is constructed, the data is trained by the deep neural network model designed in this chapter to finally obtain the projection step solver.

$$\Delta t \nabla \cdot \nabla p_n = \nabla \cdot u_n^f(x) \tag{4}$$

$$\nabla \cdot u(x(i,j)) = \left(\frac{\partial u_x(i,j)}{\partial x}, \frac{\partial u_y(i,j)}{\partial y} \right) \tag{5}$$

The method collects many images related to indoor scenes, and after each image is labeled according to the model type and material information, it is used as the driving data for training to achieve the purpose of planning materials for different models in the scene.

3.2 3D Animation Scene Graphic Design Experiment

Concept design is an important part of the pre-design work of 3D animation, usually including the design content of characters, scenes, props, and other aspects. It needs to reflect the complete creative intention to provide guidance and reference for the subsequent production process. In traditional 2D animation, scene-setting and character sets are independent work sessions, because the shape and color of 2D scenes and characters are determined at the same time when a drawing

is completed. It can be directly applied to the subsequent animation keyframe drawing guidance, the role of the drawing is to standardize the work standard [9]. The scenes and characters of 3D animation must go through 3D production after completing the design draft, which is transformed from 2D flat graphics to 3D three-dimensional modeling. The final modeling results need to be combined with the camera settings, color rendering need to be combined with the material and lighting settings. Character and scene drawing link in the three-dimensional animation pre-process play a role for the designer and the producer of the intention between the transfer, guide the subsequent link of re-creation.

The completion of the concept design is a process from vague to clear, as the designer's thinking progresses, from the initial idea to the final picture presentation requires repeated deliberation and trade-offs. The creator is required to choose the fastest way of expression to capture the fleeting creative inspiration. Real-world information is analyzed and processed, subjective processing and changes are integrated, and representations and feelings are recorded through skilled to instinctive technical means, which is a highly condensed process. In the early stages of creation, the perceptual way of thinking dominates, and the results of the analytical processing of the rational mind are gradually added with the degree of depth. At the early stage of this process, inspiration capture and creative experimentation are the primary purposes, and the technical process of creation needs to be simplified to improve the efficiency of creation. Therefore, concept design is mostly carried out utilizing painting, both traditional material painting, and digital painting. The art of painting deals with the dimensions of the real world as hierarchical relationships, and the thought process and expression method of advancing from outline to structural refinement are also more suitable for the initial purpose of creation, as shown in Figure 3.

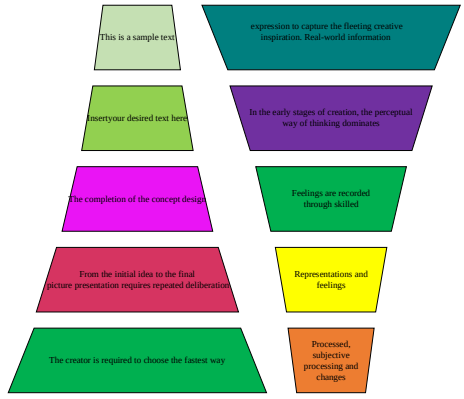

Figure 3: 3D animation scene design steps.

Need to express the aesthetic and scientific intent of the creative design, should have certain expertise related to the design content. The support, analysis, and reconstruction of information is an important work that cannot be ignored in design. When the design drawings play a guiding role for the subsequent work, it is often necessary to provide relevant real photo information as a supplement to the local details, to elaborate art effects, structural descriptions, texture examples, and other key content. For example, the focus of the scene atmosphere category is on the hierarchical relationship of the scene environment, color shading; the focus of the character design category is on the physical outline of the character, proportional relationship, important details; the focus of the prop design category is on the rationality of modeling changes and structure. There will also be a considerable amount of concept art to show the world view set information and atmosphere reinforcement, to deepen the understanding of the overall project.

Based on the principle of real construction of three-dimensional scene in the creative expression of the link there are the following disadvantages: from the local to the overall construction of the way difficult to the overall control of the picture, production time costs, and high technical costs of investment, not easy to quickly adjust [10]. Although some 3D artists in individual creation rely on profound spatial modeling thinking, artistic quality, the technical ability can use 3D tools to complete the work of conceptual design. But most 3D animation creation is a group creation process, the complexity of technical links will magnify the individual ability differences, it is difficult to standardize and unify.

The model acquisition method of 3D scanning data is to collect data from real objects and accurately restore the shape and structure of the object through 3D scanning equipment as a reference or basis for further modeling corrections. Image data generation is a more eclectic model data input means, the multi-angle pictures of the object according to the 3D modeling of the key points and structural location of the standard definition by computer computing generation. Software production is the most common way, its most significant technical characteristic is to achieve zero material based on the creation. This way and the objective world do not necessarily depend on the link, not subject to the constraints of known modeling, is the most flexible and versatile way to obtain the model. Mainstream three-dimensional software is equipped with modeling functions. Its modeling principle is the combination of point, line, surface, and body changes, and the traditional painting and sculpture modeling concept has a close connection, as shown in Figure 4.

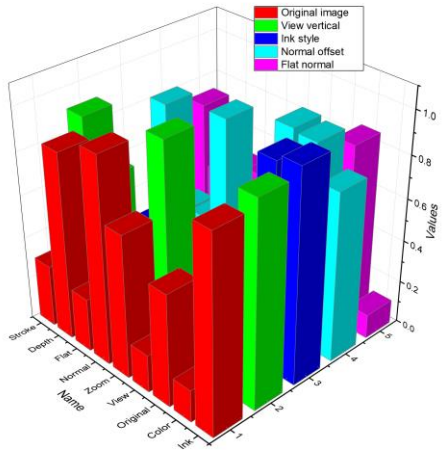

Figure 4: Edge algorithm contour stroke point coverage response count.

Due to its production purpose of the precise requirements determine the realization of this way is less efficient. Digital sculpture modeling is a more popular three-dimensional modeling method in recent years, its characteristics are the greatest restoration of the production characteristics of the real three-dimensional modeling, and combined with the technical advantages of computer modeling and efficiency advantages, in the ultra-high surface number (usually millions) of polygons based on carving and shaping, modeling creation process is intuitive and efficient, due to its application of the technical aspects of the closest to the traditional art field of thinking. Since the technical aspect of its application is closest to the way of thinking and operating habits in the traditional art field, it can relatively shorten the technical transformation cycle and is welcomed and favored by the artist class. However, due to the high number of polygons, the works created by this method cannot be directly applied to the final industry but must be refined and information transferred through the subsequent technical process, which can be divided into baking the model structure texture and model topology reproduction according to the difference of application fields.

The production of 3D models for non-real rendering effects is like that of real rendering models, but there are key differences that need to be understood and analyzed in the pre-production stage. The simulation of 2D artistic effects cannot be achieved by removing light and shadow changes alone. Precise perspective changes generated by motion can still convey the three-dimensional sense of objects, and 3D models simulating 2D visual effects need to pay attention to the generalization of transition structures to avoid unnecessary interference details. The performance of visual lines will include contour lines, structure lines, trim lines three categories, in the model production, have the corresponding special treatment to match the different effect requirements, and even the use of space extrusion of the three-dimensional model flat to avoid camera perspective caused by lens distortion, but also effectively reduce the contour lines due to changes in angle caused by the flicker of the line.

4 ANALYSIS OF RESULTS

When we use 8.62 billion sets of training data directly as the training set to train the designed deep convolutional neural network model, it takes more than 52 hours to converge the loss function value to 2.5e-4, but when using principal component analysis to downscale, i.e., 4.96 billion sets of optimized training samples for deep learning. The same convergence accuracy is achieved in only 30.5 hours. Moreover, the values of max-error and mean-error are almost the same for different datasets, as shown in Figure 5.

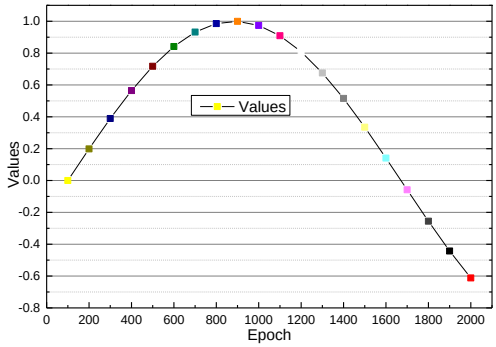

Figure 5: Model learning curve.

The anthropomorphic representation is no longer limited to simulated pseudo-images but goes on to embody its powerful vitality in the expression of fluid moving images. The virtual world as a reality simulation describes the external relations of the story world, and the virtual in turn constructs internal relations in the story world as narrative potential, constituting the textual world of the virtual realist film, thus the virtual world has an independent ontology and self-contained virtual system relative to the real world, and the story characters enter multiple possible worlds, temporarily replacing physical reality and entering the virtual life of the narrative universe. The interactive virtual life in the story presents two different kinds of utopian imagination: the satisfaction, identity and attachment to adventure, wandering, entertainment and access to various resources that are not available in life as a psychological compensation for the real dilemma, which are used to adjust people's various psychological demands in the face of real life, or the alternative pessimistic future of the inevitable end times of the four-dimensional human beings caught in the digital utopia. It is used to express the overcoming or awakening effect of technocracy on the alienation of human beings, and to highlight people's search for mobile, blurred and semi-mechanical self-identity and their search for social connection in the digital existence.

Based on the original cell phone animation system, the main work accomplished in this paper is to add the automatic material planning and generation for the whole animation scene and all the

models in the system. Previously, in the SMS animation obtained by the cell phone 3D animation automatic generation system, all the scenes retain the material effect determined at the time of modeling, i.e., the same animation scene is presented with the same visual effect in different SMS. Due to the limited number of scenes in the animation scene library, it is easy to have the same scene applied in different SMS, which causes visual effect fatigue. For this reason, different material planning for the same scene in different SMS can make the animation scene have more expressions and enrich the animation expression effect, as shown in Figure 6.

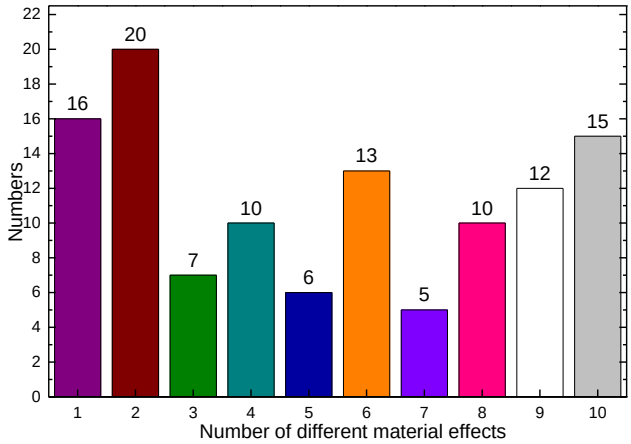

Figure 6: Experimental statistical results of material planning diversity.

In this subsection, to demonstrate the diversity of material planning effects, 60 open SMS messages were randomly selected from the valid SMS messages described in the previous subsection, and each SMS message was run 10 times, and the material planning results of 600 SMS runs were counted as shown in Figure 7. In Figure 7, the x-axis is the number of different material effects obtained by testing one SMS 10 times, for example, 17 SMS got 7 different material effects, accounting for about 28.3% of the total SMS; 81.7% of the SMS got more than 5 different material effects. Overall, the material planning system has a strong diversity.

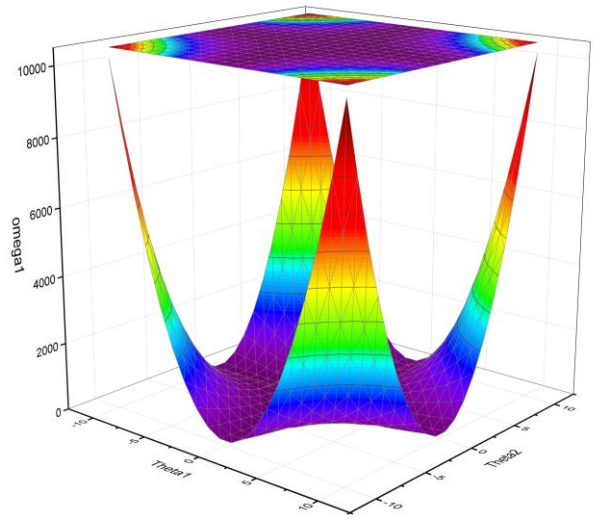

Figure 7: Schematic of phase space.

The main features of virtual reality interactive experience are a strong sense of presence, friendly interactivity, multi-perception, and autonomy of the virtual reality world. In the process of film and TV scene production, actors usually perform in the green room or blue screen while the director can see the final composite scene in the side computer through virtual reality technology, which is a strong sense of presence.

5 CONCLUSION

An ontology library of animated scene materials is constructed, and the qualitative planning of animated scene materials is designed and implemented accordingly. Relying on the system knowledge base that has successfully supported the operation of the 3D animation automatic generation system, this paper establishes for the first time an ontology library that portrays the nature of animation materials, defines each basic property of materials and the scene material style. The creators should not stick to the traditional narrative but should try more interactive forms based on narrative, after all, let the audience experience a good story is the original intention of virtual reality animation creation. Although the virtual reality animation industry is still in the early stage of development, the industry will produce more perfect works with the innovation of technology and the improvement of creators' narrative design practice and theoretical level, from which the audience will get more natural interactive and emotional experience.

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