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Research of Simulation of Creative Stage Scene Based on the 3DGans Technology

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Abstract. *Aiming to the feature of the modern stage scenery, combined with 3DGANs technology, we make research into the creation of creative stage scenes to rapidly display problem scene design, reduce the cost of stage design and the data error of virtual and actual simulated effect of the stage. We improve the data of the creative stage scene at the beginning of the design to increase efficiency of the rehearsal stage to enable the simulation scene more intuitive to the displaying of the stage scene and provide the basis for dynamic management of the stage. In this paper, simulation of virtual reality stage scene will be realized through 3DGANs technology. Firstly, the stage data will be extracted and the data of the creative stage scene will be modified. Secondly, the data of the registration of 3D surface image data on the creative scene in the data will be modified by using genetic algorithm. Finally, the simulation experiments will be conducted by using 3DGANs technology to generate creative stage scenes. The results indicated that simulation of the creative stage scene generated by 3DGANs technology would synchronize with the real-time stage effect in which multi-thread processing can improve processor utilization, shorten the reading time of the video image data, effectively reduce the switching time between different tasks, improve the amount of the amount of throughput and concurrency system and to offer a key support for virtual simulation and dynamic management of stage creative scene based on the 3DGANs technology.*

Keywords: 3DGANs technique; Stage creative scene; Image data; Three dimensional space; The simulation analysis

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1. **Introduction.** 3DGANs technology is a three-dimensional generative network confrontation. It must be able to learn a new stage in the training stage and the next step is to generate new training scene and master the distribution of module stage creative scene. 3DGANs technology will be able to get a new stage scene randomly in the distribution of the module. In the stage scene module, there is a corresponding relationship between the random variables and the newly generated scene. The module distribution of the creative stage scene is made under normal distribution, you can get a creative scene generation network [1].

The stage scene design has a long history. In traditional stage design, only basic functional materials can be presented, such as scenery, props, etc., which is not highly related to stage performance, and lacks systematic research. With the continuous development of Western opera, drama, stage design performance has been paid more and more attention in the theater. The scene performance form of the stage design and the stage demonstration of the play actors become the key consideration for the designers and arts techniques and art design industry reaching greater span of multi-industry and multidisciplinary [2].

In recent years, with the continuous development of the stage scenes design technology and the domestic stage scenes continually updated in the creative platform, the requirements of the directors and audience for the artistic expression and visual experience of the creative stage scene are increasingly high. The continuous development of digital technology enhances the combination of stage design and engineering technology. The modern creative stage scenes continues to be digitized, systematized and intelligentized. The visual image processing function of the television makes the stage visual effect upgrade from two-dimensional to multidimensional space structure among which the three-dimensional stage space establish a simulation model by digital simulation technology [3][4] to let the planners restructure video and picture information and pretreat all the other information. Through the intelligent calculation and simulation, a virtual world which is extremely similar to the real world will be created and this virtual world with creative connotation can meet the needs of the new inspiration of the artists and can bring the audience more colorful emotional art, making the performance more shocking and the field experience very lifelike which reflects the depth of immersion and interaction [5][6].

The stage scene design not only plays a role in three-dimensional space design, but also extends and changes in the auditory dimension. This multi-dimensional stage creative mode and three-dimensional creative form create infinite imagination for designers. The stage design of the 2008 Beijing Olympic Games opening ceremony is mainly following the Chinese culture, adding to a variety of visual elements, the sphere projection technology, taking the elements such as the scene, stage movement, performance mode and audience experience into full consideration and gives us a visual and auditory sensory feast [7]. The stage design of the 2012 CCTV Spring Festival Gala was of bold innovation with the application of computer technology into a complete stage mechanical movement with a perfect connection to program design among which the 3D visual background and giant LED 180 degrees showing the audience a rich creative stage scene [8]. In 2013, Liu et al. [9] proposed the design and implementation of a dynamic stage digital simulation and control system, providing basis for stage control, building 3D rendering and control engine, and establishing dynamic three-dimensional simulation model of spatio-temporal architecture. With the full range of creative, nonlinear presentation, it enables the output of the data of the status, location of the simulation process of the creative stage art, with the precise control of the stage with high efficiency and strong reliability.

How to use 3DGANs technology to generate simulation of creative stage scenes is directly related to the authenticity of creative stage e scenes. At present, GANs technology has become a key research topic of relevant scholars, and has been paid wide attention and made research by more and more practitioners in many fields. In this paper, 3DGANs technology is used to generate simulation research of creative stage scenes. The purpose is to integrate virtual reality, process simulation and 3D technology to make research into the virtual reality and dynamic management of creative stage scenes based on 3DGANs technology. Through the extraction and the revision of the creative stage scene data, the simulation of 3DGANs creative stage scenes, it realized real-time synchronization of the simulation results of creative stage scene and the actual stage scene based on virtual 3DGANs technology and offer a key support for the realization of the simulation of creative stage scene and dynamic management.

2. The establishment of the creative stage scene model.

2.1. Scene creation module.

1. The inverted interface of the stage model: the function is to pour the actual stage into the stage creative scene model and complete the 3D space modeling of the stage model.
2. The module of realistic modeling: the function is to complete the setting of 3D stage space model building materials, decoration materials, transparency and so on, and render realistic rendering to the stage creative scene model.
3. Virtual environment creation module: the function is to complete the setting of the audience, the stage setting such as environment, the sky, the weather and so on.
4. The external interface of stage model: the function is to convey the stage virtual simulation data and real-time information. The virtual simulation system can complete the simulation process and further render and control the stage scene simulation results and scene flow data.

2.2. Stage creative scene management module.

1. Model rendering: through the actual stage simulation data to control the rendering mode, such as stage state variables, model completion schedule, model completion sequence and so on.

2. Virtual environment: rendering control based on stage lighting model, scene environment, weather condition and stage creative scenes, and completes the creation of virtual environment.
3. Dynamic virtual: dynamic simulation and animation rendering based on the dynamic model of the stage model and the actor's route behavior, such as the rise and fall of the stage, the route of props in the stage and the transformation of props.
4. Perspective and roaming: the enlargement and reduction of the completed perspective, the scaling of the control interface, and the dynamic viewing of stage 3D, and the view control based on the stage route, so as to realize the multi perspective dynamic browsing of the stage creative model.

2.3. **Data management module.** Through the data access and management platform of database management module management stage, complete the setting of user registration, user access permissions, login window and verification code, accomplish the multi department collaborative work management, scene data access and the operation permission management module.

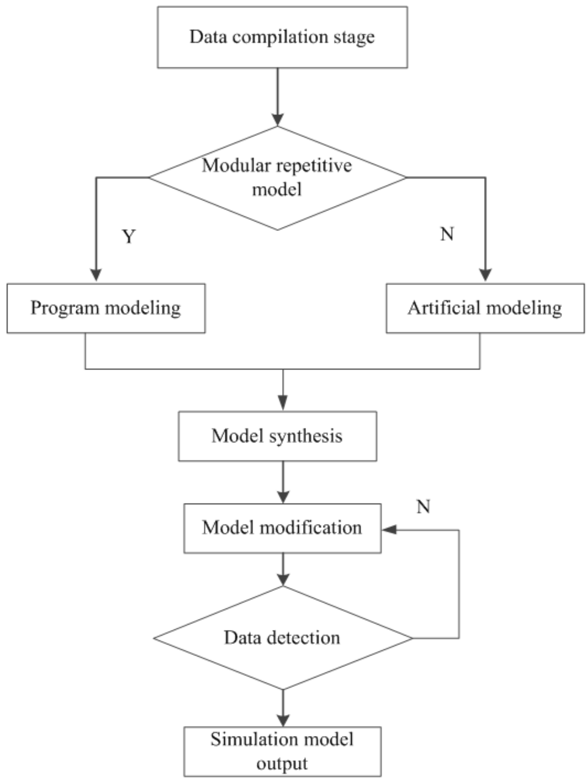


FIGURE 1. Process of setting up stage creative scene model

3. **Research on stage scene data.**

3.1. **Stage data extraction.** In the 3D stage, there are six dimensions of movement in each module, that is, three independent dimensions and three dimensions of self attitude change, the three dimensions of self attitude change using Euler angles to represent, not independent of each other. But if the attitude change is mapped to its own coordinated system around three axes the rotation ,it would be independent of each other and has nothing to do with the rotation order. In the three-dimension model of the stage creative scene, the change dimension of the module itself is represented by the Euler angle.

In the process of modeling, all data extraction is created according to the actual stage structure, so the different position and posture change of stage is composed of multiple single dimensions, and the extraction of multiple single dimension data simplifies the data processing [10, 11].

3.2. **Data correction in the stage creative scene.** The motion state is not linear turning stage with acceleration and deceleration stage of mechanical motion, it is a change with slow process, so the rise stage linear movement, descending movement can be represented by a linear function, and at the transition point movement began to stop and start to rise, rise to drop down and to rise be represented by quadratic function fitting. The velocity in the stage ascending motion and the descending movement is equal to that of the maximum velocity of the transition point. The formula is expressed as follows:

$$at_b = \frac{H_m - H_b}{t_m - t_b} \tag{1}$$

The formula (1) H_m is half the stage motion time, t_m half the stage motion time, and a the acceleration for the stage to change speed, H_b which is the total distance at the end of the speed change movement. By the way H_b we can get the transition point of the stage movement H_0, the formula is as follows:

$$H_b = H_0 + \frac{1}{2}at_b^2 \tag{2}$$

The point of departure for the stage movement H_0 is the starting point.

t_m half of the stage movement time, so the whole stage movement time $t = 2t_m$, through the relationship between the distance and the acceleration, time can be obtained the following calculation formula:

$$at_b^2 - att_b + H_f - H_0 = 0 \tag{3}$$

H_f the overall journey of stage movement. The formula (3) can be derived from the time calculation formula of the variable motion.

$$t_b = \frac{t}{2} - \frac{\sqrt{a^2t^2 - 4a(H_f - H_0)}}{2a} \tag{4}$$

And the formula for calculating the linear velocity of the stage ascending motion and the descending motion:

$$V = \frac{ta - \sqrt{a^2t^2 - 4a(H_f - H_0)}}{2} \tag{5}$$

In the calculation formula (4) and formula (5), the value of acceleration of variable motion should meet the following requirements, otherwise the calculation of t_b and V would be incorrect.

$$a \geq \frac{4a(H_f - H_0)}{t^2} \tag{6}$$

Accurate calculation of the acceleration at stage lifting is the key to the controlling of the whole stage movement. When the stage is in a variable speed, the acceleration a is invariable, the number of times that the stage changes is n, then the actual motion total time formula is as follows.

$$T_r = \sum_{i=1}^{n} \frac{|H_{fi} - H_{0i}|}{v_i} + \frac{v_i}{a} \tag{7}$$

$$T_d = \sum_{i=1}^{n} \frac{|H_{fi} - H_{0i}|}{v_i} \tag{8}$$

The formula (7) subtraction formula (8) can get the motion delay time value:

$$\Delta T = T_r - T_d = \frac{\sum\limits_{i=1}^{n} v_i}{a} \tag{9}$$

When the stage is designed, ΔT the delay time of the motion can be measured actually, so we can calculate the acceleration a when the stage is made by the above formula.

During the calculation of the acceleration a of the stage, the design time t_d of the stage motion is similar to the revised design speed.

$$V = \frac{at_d - \sqrt{a^2t^2 - 4a(H_f - H_0)}}{2} \tag{10}$$

The whole process includes all required data of variable motion stage rise and fall. The delay of the stage motion and the actual exercise time can be solved by registration of the revised data and to better enhance the stage motion effect and the safety of the actors.

4. **Registration of 3D surface image data in stage.** In the virtual generation of scenes, the most important technology is the registration of 3D surface image data. After modifying the stage data in the 3.2 quarter, fitness function is chosen as the registration standard and be measured. Genetic algorithm is applied to the registration of the 3D surface image of the corrected data [20]. First, we need to design the fitness function [19]. Fitness, in a sense, is a kind of similarity, therefore taking the registration similarity approximation as the standard, it is necessary to collect mutual information of the two surface registration, which the mutual information expression is a difficult task and needs other constraints to cooperate. This thesis adopts the stage of three-dimensional image matching points z between the average value D_{aver} of the gap surface with the error directly from the normal surface D_{aver} and D_{sum} as the fitness function.

$$Ax + By + Cz = D \tag{11}$$

$$D_k = \frac{|Aa + Bb + Cc - D|}{\sqrt{A^2 + B^2 + C^2}} \tag{12}$$

$$D_{sum} = \sum_{k=1}^{n} D_k \tag{13}$$

$$D_{aver} = \frac{D_{sum}}{n} \tag{14}$$

Among them, a, b, c is the real physical coordinate x, y, z value for the outside world. D_{aver} represents the distance beyond the error. n is the number of feature points to be displayed in the 3D image. The smaller the absolute value of D_{aver}, the better the matching effect. Conversely, the matching effect is worse.

The selection in genetic algorithms is mainly to pick out the best matching results in a large number of matching results. When the matching results are all known, the matching results need to be selected to find the basic data of the best matching results. Because the selection criteria are usually selected according to a characteristic parameter value as a threshold value, the relevant parameters need to be calculated reasonably before selecting, and the fitness parameter is selected in this paper. According to the principle of genetic algorithm, the result of selection will be the best result in the matching result, so the number of reasonable matching will increase greatly. There are more options. This paper designs a roulette selection algorithm, which is simple in operation and low in time complexity. In order to choose the most appropriate results, the number of choices is completed in several rounds. 0-1 direct non - integers are generated randomly, and the results of the next selection will be determined according to the selected results. The first round random number is 0.4, then the fourth results are calculated. If the random number is 0.2, then the second results are calculated.

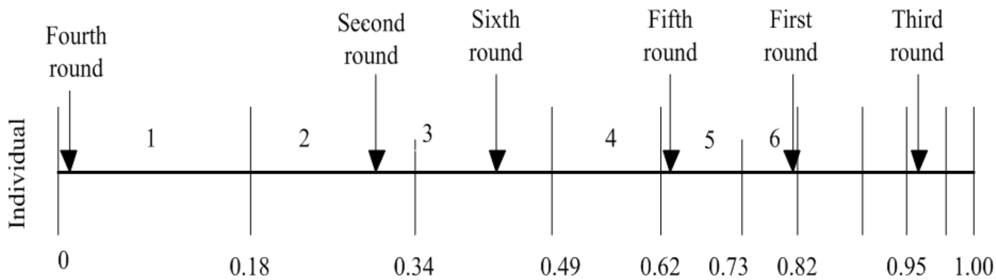


FIGURE 2. Roulette selection

In selecting the appropriate data, it is necessary to have cross operation. So called crossover operation is the certain results to make the results and make up a new result to follow a certain probability. It aims to produce the next generation of operation of the new data, with the search capability of genetic algorithm greatly increased. The selection of the combination of probability P_c has a great influence on the whole algorithm. If the selection is not good, it is not likely to have the algorithm converge. The larger P_c, the more combination of new results, the more likely with collapse of the algorithm and distortion of the results. The smallerP_c, the less o combination of new results, but with serious influence toward the operation speed in the later period. Therefore, it is very important to select a reasonable probability in the genetic algorithm. In order to solve this problem, the calculation method of probability selection is as follows:

$$P_c = \begin{cases} P_{c1} - \frac{(P_{c1}-P_{c2})(f'-f_{avg})}{f_{\max}-f_{avg}}, & f' \geq f_{avg} \\ P_{c1}, & f' < f_{avg} \end{cases} \tag{15}$$

In the formula, the f_{avg} represents the fitness value of the stage matching results, the $f_{\max}$ represents the maximum value, and the f' represents the larger fitness values compared to the two results. In the upper form, P_{c1} and P_{c2} are computable.

The location of the intersection is 5, as shown in Figure 3.

In the process of mutation operation, the whole process is similar to the cross process, and also depends on the size of the probability P_m, which affects the result of the whole algorithm. If P_m is too large, the randomness of the whole search process will greatly increase, making the algorithm lose the meaning and become a pure random process. Once P_m is too small, the searching will be greatly slowed down. Therefore, the calculation results of the mutation probability are also very important. In order to solve this problem, the adaptive mutation probability can be used, and the calculation expression is as follows:

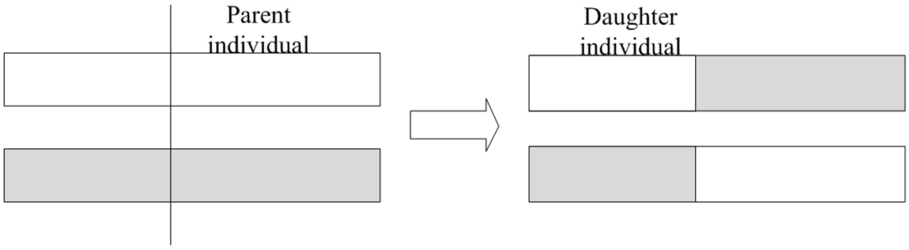


FIGURE 3. Single point crossover

$$P_m = \begin{cases} P_{m1} - \frac{(P_{m1}-P_{m2})(f_{mas}-f)}{f_{\max}-f_{avg}}, & f \geq f_{avg} \\ P_{m1}, & f < f_{avg} \end{cases} \tag{16}$$

In the formula, the f_{avg} fitness is the result of the average calculation, the $f_{\max}$ is the maximum, and the f is a single value.

It is necessary to judge the final result in the process of matching the surface image data. When the calculation is to a certain extent, the matching process must be terminated to ensure the convergence of the algorithm. In the process of experiment, we can see that most of the algorithm can complete the computation in a small number of iterations, so we can complete the setting of relevant parameter values with the number of times. For example, when the maximum iteration number is set to 50 times, and the iteration algorithm terminates, D_{aver} takes the minimum value, which indicates that the mutual information between the two surfaces reaches the maximum, that is to achieve the best registration.

5. **Simulation of creating stage creative scene by 3D GANs Technology.** After the best registration of 3D surface image data matching, the 3D GANs technology is used to simulate the scene of the creative stage. In 2016, Reed S and Akata Z proposed Generative Adversarial Nets (GANs) [12], that is, the transformation from text to image synthesis [18]. The article describes in detail how to use GANs to transform text into image. The generative model (generative model G) and discriminant model (discriminative model D), G model to capture the source data and random distribution, D model is the function of the input data source selection, D model selection is the real data input again to the G model to capture, repeated replacement aim to optimize the distribution of data continuously, finally G model detected the source data, the output data [13][15].

3D GANs optimizes the stage creative scene model. It's a game of opposite game. It uses Natural Language Processing to understand the description in input, generates network to output an accurate and natural image, and expresses text. The final purpose of video and image output is able to be very similar to the actual stage effect, and it is difficult to distinguish the authenticity from the reality, that is to say, the similarity between virtual and reality is increasing. The process is as follows:

1. Generation model analysis

   The input stage creative scene information is mapped to the new sample data, when the total number of samples generated by the target is in the form of:

$$Z = \{z_1, z_2, ..., z_n\} \tag{17}$$

   The key features of each stage creative scene can be represented by a set of keywords:

$$W^* = \{W_1, W_2, ..., W_i..., W_n\} \tag{18}$$

Then the i feature item weight of the stage creative scene theme j can be expressed as:

$$w_j^i = \frac{tf_j^i \times \log(N/n_j)}{\sum_{i\in d}\left[tf_i^d \times \log_n(N/n_j)\right]^2} \tag{19}$$

In the format: tf_j^i is the frequency of the feature t in the stage creative scene theme j; n_j is the number of j for the stage creative scene. On this basis, the K-means method is used to partition and cluster the sample space, and generate closer to the actual sample data set. The distance between the two sample points is:

$$d(i,j) = \sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2 + ... + (x_n - y_n)^2} \tag{20}$$

The average distance between the sample points is as follows:

$$D_{ist} = \frac{1}{C_n^2}\sum d(i,j) \tag{21}$$

C_n^2 is the number of combinations of two points out of the n sample point. The known stage of creative scene information mapping for the total new sample data, among which the sample density of z_i denoted by $dens(z_i)$, the density parameter is q, the connection path of 2 data points between p_{ij}, the number of data linking the 2 data path for l, capturing the probability distribution of actual training sample density can be expressed as:

$$dens(z_i) = \sum_{j=1}^{n} \frac{1}{\min\limits_{p_{ij}} \sum\limits_{k=1}^{i-1} q^{d(x_k, x_{k+1})} - 1} \tag{22}$$

2. Discriminant model analysis

After determining the probability distribution density of the actual training samples, whether the sample data is sampled from the training set or the sample set is discriminate, the stage creative scene feature is optimized, and the index value corresponding to the stage creative information and scene is determined.

$$index = (row - 1) * n + col - 1 \tag{23}$$

Among them, $index$ is the index value corresponding to the stage creative information and the scene with the starting value 0, and row the horizontal creative information for the stage. col provides creative information for the stage, and n is the number of stage in the creative scene.

The following is the example of the construction of creative stage scene, by discriminating the real samples and the generated samples, the output value of the stage creative scene is calculated when the real sample x is input, the formula is as follows:

$$\begin{cases} souX = (col - 1) * dexW \\ souY = \frac{(Height_{\max} - height)}{P_n} + 0.5 \end{cases} \tag{24}$$

Among them, $souX$ is abscissa, $souY$ is ordinate, $dexW$ is image width, $Height_{\max}$ gets the maximum range of stage innovation information, $height$ gets stage innovation scene, latest data and P_n projection screen specification.

When the input generation sample is $G\left(z_i\right)$, the formula of the output value of the stage creative scene is as follows:

$$\left\{\begin{array}{l} dexX=\left\{\begin{array}{ll}(row-1)*dexW*3 & row[1,10]\\ (col-1)*dexW*3 & row=11\end{array}\right.\\ dexY=\left\{\begin{array}{ll}dexW+((row-1)\%5)*dexW*2.5 & row[1,10]\\ dexW+((col-1)\%5)*dexW*2.5 & row=11\end{array}\right.\end{array}\right. \tag{25}$$

$dexH$ is used to determine whether the current input is real data or the confidence of generating the data, and the half of the G generates the data, and the results are as follows:

$$dexH=\left\{\begin{array}{ll}Height_{source_F}-souY, & \text{Re}al\ Data\\ dexW-(row-1)^{*}dexW, & Generating\ Data\end{array}\right. \tag{26}$$

Among them, $dexX$ is a horizontal coordinate, $dexY$ is a longitudinal coordinate, and $dexH$ determines the confidence of the current input data, and $souY$ is the redistribution of the regional ordinate in the scene data of the source stage.

To sum up, by discriminating the generated sample data, we can determine the parameters of the stage creative scene in the process of construction with high authenticity in generating the creative stage scene. Further experimental verification is needed.

6. **Experimental results and simulation analysis.** The windows operation system is adopted, with 3DGANs technology as the 3D modeling tool. The script language of the model is MEL (Maya Embedded Language), which is used for data extraction and animation production. The main development language is C++, and Visual Studio to develop IDE. CryEngine is used as the simulation platform as the visual expression part of the simulation system. The data together with the server adopts Apache Tomcat, and the server side uses Java programming language.

In the process of simulation, stage data must be processed and synchronized. At the same time, the processed data will be input into the display system in time to display the 3D stage scene [16-18] in a continuous and intuitive way. The simulation process of the stage creative scene requires a large number of models, pictures, video and audio materials. Therefore, the hardware configuration of this experiment is: I7 3770CPU with strong computing power, memory size of 8G, size of 2T, speed of 2700 turn hard disk, and GTX680 card with strong rendering ability. Through simulation, the stage effect is displayed in real time to determine its feasibility, and the 3D stage scene generation process is like Figure 4.

6.1. **Dynamic three-dimensional effect of stage scene.** 3DGANs technology is used to set up a dynamic 3D simulation model of the stage. A full range of motion of the entire stage had been modified by accurately calculating the real time spatial relationship between each module with dynamic 3D of stage scene by reading the mechanical movement data of the modified stage of creative scene data, as figure 5.

6.2. **System performance analysis.** Input 20 picture files to the system, each of which is .Jpg, the size is 105KB, and the 6 video files are in the format of .Avi and the length of 14 seconds. The results of the experiment are shown in Table 1 below. From the processor utilization, the time of video image data reading and writing processing and other aspects of the analysis of the performance of the system, the multi thread processing can improve the processor utilization, shorten the video image data reading time, effectively reduce

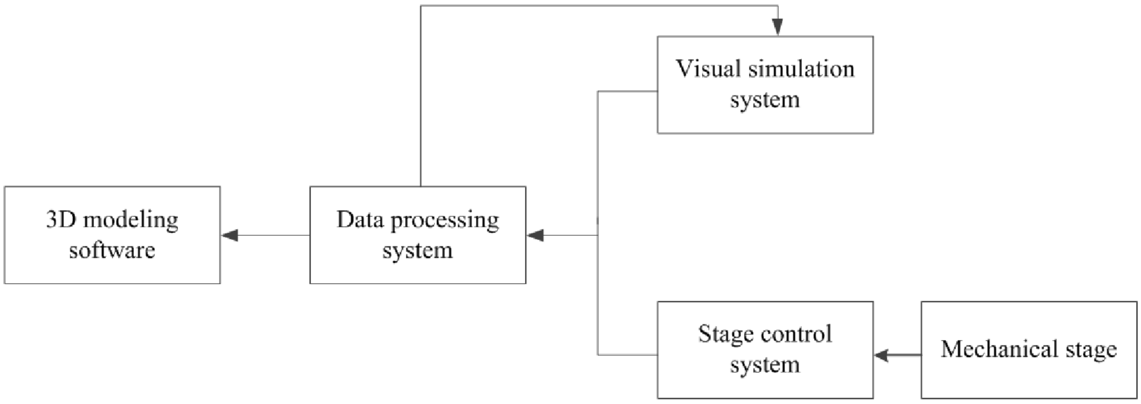


Figure 4. Three dimensional stage scene generation process

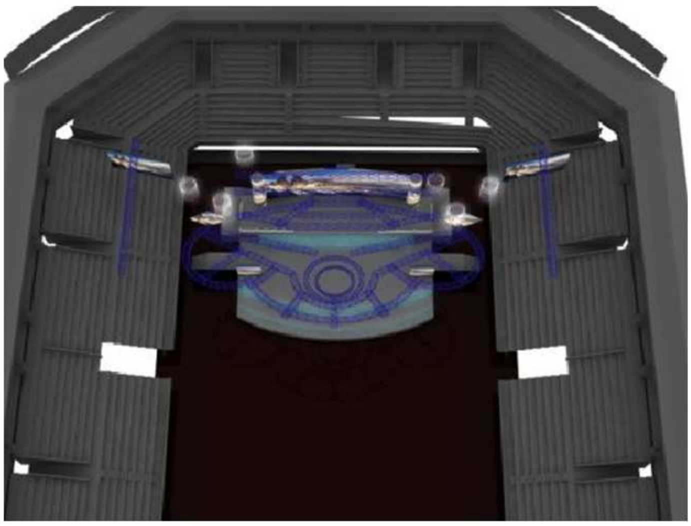


Figure 5. Dynamic three dimensional effect of stage scene

the switching time between different tasks, occupy less memory and improve the amount of throughput and concurrency system.

Table 1. System performance analysis table

Group	CPU availability	Fetch time/s	Handling time/s	Write time /s
AGThread as 1	40%	99.65	20.44	163.02
BGThread as 5	63%	63.52	16.36	162.41
CGThread as 10	87%	40.30	10.42	162.89

Figure 6 and Figure 7 are the relationships between the speedup / parallel efficiency and the number of processors under the parallel processing of different processors in multithreading. As can be seen from Figure 6, the number of processors increases, the acceleration ratio increases, and the acceleration ratio increases slowly when the number of processors is greater than 20. From Figure 7, we can see that the increase of the number of processors can improve the parallel operation efficiency of the system, but

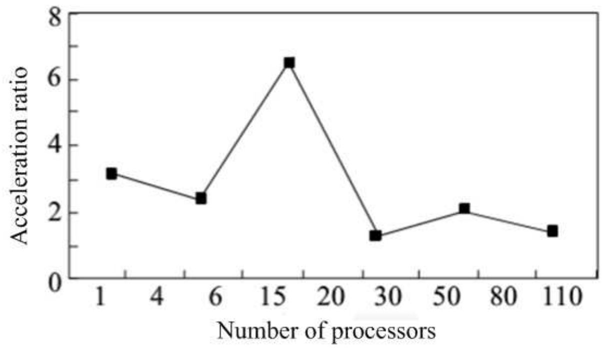


FIGURE 6. the relationship between the acceleration ratio and the number of processors

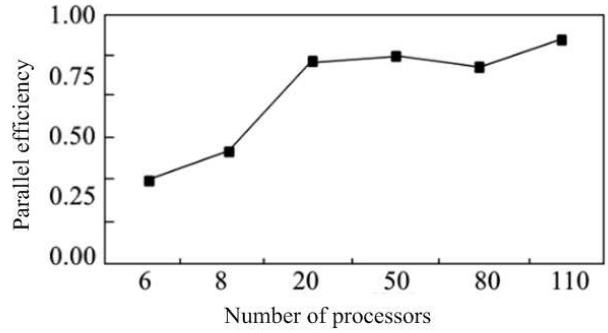


FIGURE 7. The relationship between parallel efficiency and the number of processors

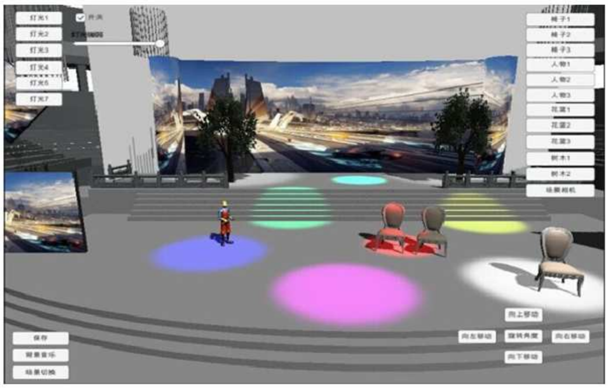
when the number of processors is less than 20, the efficiency increase is more obvious. When the number of processors is greater than 20, the efficiency of parallel computing increases slightly, and the parallel efficiency can reach more than 75% when the number of processors is 20. Comprehensive table 1 and Figure 6 show that the best number of processors should be selected as 20.

6.3. **Simulation effect of stage creative scene.** The use of literature and [9] in this paper, the source of video data and video data through the objective weight after the reorganization of image data, the computation is input to the simulation model of stage creative scene, and with the actual effect of the creative stage effect simulation scene, the results of the integration are shown in figure 8.

From figure 8, we can see that the simulation results in the literature can only show the overall effect of the stage fuzziness. Although the simulation is in high degree and visual range relatively narrow, it can not specify the specific location of props and technicians. The effect of the stage creative scenes simulated in this paper is more real, and it can accurately label the location of props and technicians, which is consistent with the actual stage effect, and can provide reference for the real-time effect of stage effect. The detailed description of the stage terrain is more accurate with high eye point and wide visual range.

7. **Conclusion.** With the persistent development of the implementation of stage creative scene technology, digital virtual stage has entered the era of the naked eye 3D technology, virtual simulation and the actual stage effect has achieved a seamless link. The 3D effect of the creative stage scene has brought about shocking visual impact for the audience with

(a) simulation results in literature[9]



(b) the simulation results of this method

Figure 8. Simulation effect of stage creative scene

the humanities and creative arts leaping to a new plateau. In this paper, the virtual reality scene simulation of 3DGANs technology is used to make research into the virtual simulation and dynamic management of the stage creative scene based on 3DGANs technology. Stage scenes simulation is created based on GANs technology through the extraction of stage data, revised data of creative stage scene. The simulation results show that the simulation of the creative stage scene generated by 3DGANs technology can synchronize the stage effect in real-time. The multi-thread processing can improve the processor utilization, shorten the video image data read time and effectively reduce the switching time between different tasks, improve the amount of leaf and swallow concurrency system and provide a support platform for virtual simulation and dynamic management of stage creative scene based on the 3DGANs technology.

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