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Computer Aided Animation Post Effects Editing on Accurate Dynamic Simulation of Ocean Scene

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Abstract. In the field of film and television animation production, especially in the editing of film and television animation post-special effects, the use of computer multimedia technology has gradually changed the traditional methods and ideas of post-special effects editing, and greatly improved the expression and influence of special effects editing. In the editing of special effects in film and animation, realistic and large-scale sea scene special effects have become an indispensable part. In order to achieve accurate dynamic simulation of ocean scene, it is necessary not only to give consideration to both realistic and real-time, but also to comprehensively analyze and optimize sea surface simulation, sky illumination model, scene rendering, etc. Firstly, Perlin noise of different frequencies is superimposed to generate noise classification surface, wave particles and projection grid rendering technology are used to simulate the dynamic change of sea surface, wave particles are used to track the movement of water waves, so as to quickly and easily realize the special effect of water waves generated by the movement of water surface on board. The main research content includes sea surface modeling and mapping; Ship sailing effect simulation in ocean scene; The sky and sea environment light effect simulation, and in the real-time and rendering aspects have achieved satisfactory results.

Keywords: Computer Aided; Film and Television Animation; Post Effect
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1 INTRODUCTION

People's material life has been greatly improved and spiritual culture has higher requirements. Aguilar et al [1] used Likert type perception tools to determine the least favored themes and perceived course delivery modes in animation NC II. Based on the research results, it can be concluded that the least learned theme found in animation is an important ability that students must pass the N-level exam. In this environment, ushered in an unprecedented opportunity for development. With the prosperity of animation industry, more and more digital special effects technology based on computer aided technology began to be applied. Asef and Kalyvas [2] believe that computer animation does not need to be filmed and developed to preview the results. Once problems are discovered, they can be modified on the computer, which is both convenient and time saving. Easier to control. While ensuring the quality of the screen, computer animation can edit far more layers than traditional animation, resulting in a much richer and more colorful effect and content. Even two-dimensional computer animation has simple yet complex and ever-changing computer shading effects, making it easier to present aesthetically pleasing animation effects. And three-dimensional animation naturally has a more three-dimensional sense and gives people a more immersive feeling. Compared to traditional manual animation, computer animation has many advantages. In summary, computer-aided animation has significant advantages in terms of expressiveness, production costs, and control, which can help creators better express and convey the information they want to convey. AYDIN et al. [3] Face detection is an important task in computer vision. Through facial detection algorithms, facial localization and tracking can be achieved in animations. This technology can be applied to fields such as virtual reality, gaming, and video surveillance. Motion capture technology can capture human motion by binding sensor devices, and convert it into computer recognizable code. Through motion capture technology, precise control of human motion can be achieved in animation, and highly simulated action effects can be achieved. Human pose estimation refers to obtaining human pose information through devices such as sensors or cameras, and converting it into computer recognizable code. Through human posture estimation technology, precise control of human posture can be achieved in animation, achieving highly simulated action effects. Fang and Guo [4] adopted measures to protect sensitive data in web applications to prevent unauthorized access. In CSA, authorized users can perform access control based on the content of the document. The content includes the title, label, abstract, main body, etc. of the document. Authorize users to determine access permissions for documents by examining their content. This method can effectively prevent unauthorized users from accessing sensitive data, while also protecting the integrity and security of documents.

Computer 3D animation is a form of animation created using computer technology, which can generate realistic 3D scenes and animation effects. The production process of computer 3D animation includes steps such as pre-processing, post processing, and output. Goswami [5] established models and textures for 3D scenes and objects, and conducted animation design and production. In the post-processing stage, special effects software such as Photoshop and Premiere need to be used for post-processing and output, such as adding lighting, materials, textures, and other effects, to make the generated 3D animation more realistic and vivid. Computer 3D animation has a wide range of applications in modern film and television production and advertising production, which can generate realistic 3D scenes and animation effects, enhance the visual impact and attractiveness of film and television works and advertising. Jing and Song [6] compared 3D animation with traditional animation, and it can be seen that the presentation method is different. 3D animation can be presented in various ways, such as modeling, mapping, lighting, etc., while traditional animation can only be completed through manual drawing. At the same time, the viewing methods of the two are different: 3D animation can be viewed through devices such as 3D glasses, while traditional animation can only be viewed through paper media. In addition, the application scenarios of the two have different manifestations. 3D animation is usually presented through modeling, mapping, lighting, and other means, while traditional animation is presented through hand drawing, hand coloring, and other means. Traditional animation can usually only be completed by hand drawing, and the time effect is relatively limited. In summary, there are significant differences between 3D animation and traditional animation in terms of production methods, presentation methods, viewing methods, application scenarios, and presentation forms.

2 STATE OF THE ART

Traditional special effects include makeup, scenery, fireworks, and early film effects, which can be completed before the emergence of computers. CG special effects mainly include 3D special effects and synthetic special effects, which can be completed after the computer appears. For example, 3D special effects artists can perform dynamic animations, while synthetic special effects artists can complete the synthesis of various effects. When traditional special effects methods cannot meet the requirements of the film, CG special effects are needed to achieve, and CG special effects can achieve almost all the effects that humans can imagine. In short, computer-aided post effects in film and television animation include various methods such as traditional effects, CG effects, and synthetic effects, which can achieve various types of special effects and meet the needs of different types of film and television works and advertising production.

Pando et al. [7] conducted the collection, classification, organization, and archiving of workflow materials for multimedia assisted art animation. Firstly, determine the animation style and theme based on project requirements, and develop an animation production plan and schedule. Secondly, according to the plan, shoot in different shots. During the shooting process, attention should be paid to details such as image composition, camera motion, and sound effects to ensure the quality and effectiveness of the animation. Modeling, animation effects, scene design, and other aspects. During the production process, it is necessary to continuously optimize the animation effects and details, adjust the production progress and time, and ensure the quality and progress of animation production. Thakkar et al. [8] conducted post production such as editing, dubbing, sound processing, and special effects synthesis to make animation works more perfect and exciting. Publish animation works to relevant platforms or media for promotion and publicity, to enhance the visibility and influence of the works. In addition to pre preparation, filming, animation production, and post production, multimedia assisted art animation also needs to pay attention to the following aspects. It is necessary to design the layout, colors, lighting, and other details of the animation scene according to the script requirements to ensure the rationality and aesthetics of the scene design. Xie [9] uses professional animation production software to create animation effects, including character action effects, scene effects, sound effects, etc., to improve the visual effects and expressiveness of animation works. According to the plot needs, sound effects are processed, including background music, character voice, etc., to enhance the emotional expression and atmosphere of the animation work. Editing, synthesizing, and special effects synthesizing animations to make them more complete and exciting. Zhang [10] conducted automatic 3D animation generation based on the skeleton mesh animation system. The 3D animation automatic generation technology of UE4 engine mainly includes Bone and Mesh and Unreal Engine 4 animation systems. This system combines the deformation of the skeleton with vertex deformation based on deformation to construct complex animations. Use this system to create custom special actions. Apply damage effects or facial expressions by deforming the target, such as stretching steps and walls (using animated montages). Use skeleton control to directly control bone deformation, or create a logic-based state machine to determine which animation a character should use in a specific context. This system can be used to play and mix pre prepared animation sequences to make basic player movements appear more realistic, creating custom special actions such as stretching steps and walls (using animated montages). Zhang and Chen [11] apply damage effects or facial expressions to deformable targets, use skeleton control to directly control bone deformation, or create a logic-based state machine to determine which animation a character should use in a specific context. Zhao and Zhao [12] use computer aided virtual reality methods, including computer graphics, virtual reality technology, human-computer interaction technology and other aspects of research. Among them, virtual reality technology can provide designers with rich visual and interactive experiences. Computer aided virtual reality method can also use computer graphics and human-computer interaction technology. Through human-computer interaction technology, users can interact with the virtual world to achieve more natural and efficient design solutions.

3 METHODOLOGY

3.1 Ocean Model Based on Perlin Noise

Perlin noise function is essentially a natural noise generator, its basic idea is to take an integer as random number, but an ordinary random function passing the same parameter twice may produce different results. The ocean surface model can be regarded as an irregular surface in three-dimensional space, and the position of every point on the sea surface at a certain time is represented by coordinates (x, y, z). In order to represent the coordinates of each point of the sea surface and the dynamic changes of the coordinate points, a height field can be established to represent the sea surface. In general, the fractal noise function can be obtained by means of fractal superposition and simple weighting of Perlin noise functions of different frequencies. Figure 1 shows the construction method of one-dimensional fractal noise.

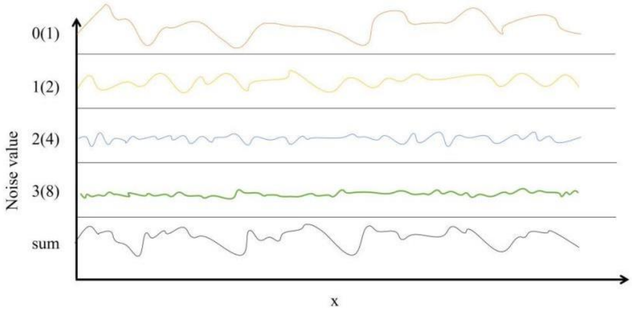

Figure 1: Construction of one-dimensional fractal noise.

The sea surface height field needs to be constructed with two-dimensional noise functions of different frequencies. Assume that the two-dimensional Perlin noise function is defined as noise (x, z). The specific construction method is as follows: Firstly, pseudo-random gradient g is constructed at each grid point, and the length value is 1. Then calculate the dot product of the vector from point (x, z) to each control point and the gradient of the control point in the area composed of the noise control points in the four fields of any point (x, z), and get their influence values on the noise at point (X,Z) respectively:

$$s = g(x_0, z_0) \cdot ((x,z) - (x_0, z_0)) \tag{1}$$

$$t = g(x_1, z_0) \cdot ((x,z) - (x_1, z_0)) \tag{2}$$

$$u = g(x_0, z_1) \cdot ((x,z) - (x_0, z_1)) \tag{3}$$

$$v = g(x_1, z_1) \cdot ((x,z) - (x_1, z_1)) \tag{4}$$

For s,t, u and v, cubic harmonic interpolation is carried out with function 3 respectively, and the results are expressed by a and b:

$$\begin{aligned} S_x &= 3(x-x_0)^2 - 2(x-x_0)^3 \\ a &= s + S_x(t-s) \\ b &= u + S_x(v-u) \end{aligned} \tag{5}$$

Similarly, the Perlin noise value y is obtained by interpolating the above a and b in the z direction:

$$S_x = 3(z-z_0)^2 - 2(z-z_0)^3 \tag{6}$$

$$y = a + S_x(b-a) \tag{7}$$

For two-dimensional Perlin noise fractal superposition, the two-dimensional noise fractal plane can be expressed as:

$$f_{noise}(x,z)=\sum_{i=0}^{N-1}\frac{noise(2^i\cdot x,2^i\cdot z)}{2^i} \tag{8}$$

3.2 Implementation Method of Sea Scene

Although Perlin noise can be used to generate a sea surface with strong sense of reality, the calculation of Perlin noise is complicated, which greatly reduces the real-time performance and operation efficiency, especially for large sea surface scenes, its efficiency is very low. Due to the randomness and directivity of Perlin noise function, this method is suitable for deep sea wave simulation, so its practicability is also limited. Ocean wave is a complex natural phenomenon, and how to better achieve dynamic simulation has been the direction of continuous efforts. The height field is a continuous liquid level function. The force between external force and object is offset on the water surface, which becomes the propagation velocity v of surface wave, satisfying the two-dimensional partial differential wave equation:

$$\frac{\partial^2 F}{\partial x^2}+\frac{\partial^2 F}{\partial z^2}=\frac{1}{v^2}\frac{\partial^2 F}{\partial t^2} \tag{9}$$

Wave particles are constructed by wave function, and the particles move on the water surface to form a wave surface. The waveform function should satisfy equation (10), the selected waveform function:

$$B_i(u)=\frac{1}{2}(\cos(\frac{2\pi u}{l_i})+1)\prod(\frac{u}{l_i}) \tag{10}$$

Where l represents the horizontal distance of particle i moving in a wave crest, and u represents the particle with local coordinates in the scene. The deviation function P of wave particle i at the corresponding time t is defined as:

$$P_i(S,t)=a_iB_i(S-S_i(t)) \tag{11}$$

S(t) is the horizontal position of the particle at time t. Each migration function and particle attributes, position, wave propagation direction are relatively fixed. This method reduces the simulation difficulty of tracking wave particle motion on a plane. Let the height field F(S, t) be:

$$F(S,t)=F_0+f_{noise}(S,t)\eta_F(S,t) \tag{12}$$

The starting height of the height field is Fo, f represents Perlin noise function, and the height deviation is expressed by the formula:

$$\eta_F(S,t)=\sum_i P_i(S,t) \tag{13}$$

Each set of deviation functions moves in relation to the velocity of the wave. The height field established at present only shows the transverse wave, but actually the water surface wave is composed of longitudinal wave and transverse wave, as shown in Figure 2.

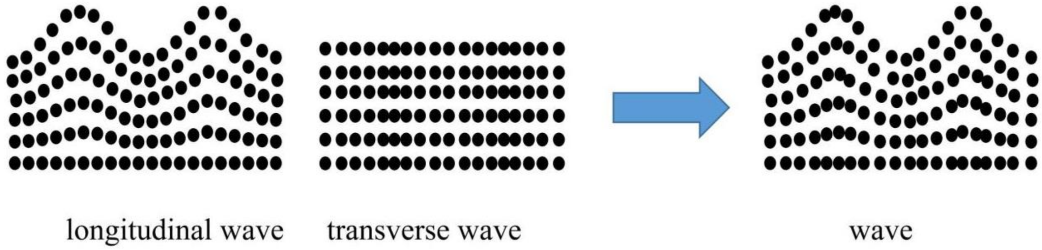

Figure 2: Composition of water wave.

The longitudinal wave plays an important role in many places, including simulating floating objects in reality interactive simulation, wave propagation and energy flow during superposition, etc., all of which provide people with a good idea to simulate water waves. The longitudinal deviation function can be expressed as:

$$P_i^L(S,t) = L_i(u_i(S - S_i)P_i(S,t)) \tag{14}$$

$$L_i(u) = -\sin(\frac{2\pi u}{l_i})\prod(\frac{u}{l_i})u_i \tag{15}$$

3.3 Modeling and Drawing Methods for Special Effects of Sea Scenes

Real-time updating of the visible area of the sea scene can achieve the purpose of sea roaming. The frame rate of the scene can be improved by using viewpoint correlation technology, because we only need to draw and render the visible part of the sea. As shown in Figure 3, the left side is invisible and we only need to draw the right side. The surface of the distance to zoom in, as the observer viewpoint to reduce unnecessary scene rendering.

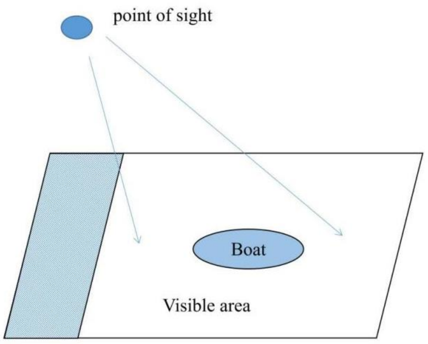

Figure 3: Schematic diagram of visual range.

To achieve the dynamic sailing effect of ships in the ocean scene, the relative motion between ships and the sea must be well solved. There are two main ideas for the realization: Draw a large grid in the scene to generate a broad sea surface so that the ships have enough navigation space on the sea surface, so that the ships will not sail out of the sea. However, the disadvantage of this method is that the calculation is very time-consuming, because the height field of each grid needs to be calculated and updated. The second method is to align the coordinates of the boat with the center point of the grid, so that the boat and the grid move together. Although the calculation amount of the grid can be saved, since the ship and the sea are relatively static, the ship motion will also move together with the sea and cannot show the effect of the trailing wave when the ship is moving. In this paper, adaptive grid technique is used to show the relative motion of ship and sea surface and save computation.

To realize the relative motion between the ship and the sea, the grid can be made stationary, and the center coordinate of the grid receives the data of the ship's coordinate position in real time. In a fixed sea surface grid area (for example, the sea surface area is 400X400m and the grid resolution is 50X50m), when the accumulated distance of the ship sailing in a certain direction exceeds one grid, a grid line (black rectangular area) is automatically generated in the forward direction and a grid line (gray area) behind the ship is deleted. At this time, the accumulated value will be zeroed and the ship's position will be judged again. In this way, the ship can always be in the central position of the sea surface without increasing the number of grids and calculation amount in the sea surface area, so as to achieve the purpose of relative motion. Similarly, if the ship is going left or right, just make the direction judgment and then add and delete the grid.

4 RESULT ANALYSIS AND DISCUSSION

4.1 Simulation Platform and Implementation Method

In this paper, the windows operating system as the software platform, in the VisualStudio005 environment using DirectXSDK for development tools programming to achieve the simulation of the ocean scene. DimaX is a processing engine developed by Microsoft for computer multimedia control. Software developed with Direct X aPi(application Programming Interface) runs on the hardware Abstraction layer (HAL), which hides the features of the relevant hardware while taking advantage of the acceleration capabilities of the hardware system. Direct X programs can always be executed in an efficient manner by writing efficient device-independent code, so Direct X programs have the advantage of being easy to develop and efficient. Direct3D is Direct X 3D operation module, it is based on Microsoft Common Object Mode COM(Common Object Mode) 3D graphics API. It does not need to use the graphics display interface (GDI) and directly carry out various underlying operations of the hardware supporting the API, greatly improving the ability and speed of graphics processing. With the rapid development of computer technology, all kinds of computer hardware developed by people can well support the creation and display of 3D graphics. The real-time 3D animation model developed based on Direct3D is very close to the scene of the real world.

4.2 Functional Modules and Structure of Marine Scenarios

The program of Marine scene special effect demonstration system includes visualization subsystem and control subsystem. The main task of sea surface visualization subsystem is responsible for sea surface modeling and scene rendering, including sea surface generation module, sky effect module, illumination model, etc. The control module includes wave size control, ship navigation control module and view control module. The sea surface scene visualization and control module is an important part of the system, judging the visual range according to the position and direction of the user's viewpoint; Through sky and cloud simulation, the simplified model produces realistic sea surface environment effect; Calculate the color of the reflection and refraction effect of the sea light to generate a realistic ocean wave effect; The overall operation framework process of the system is shown in Figure 4.

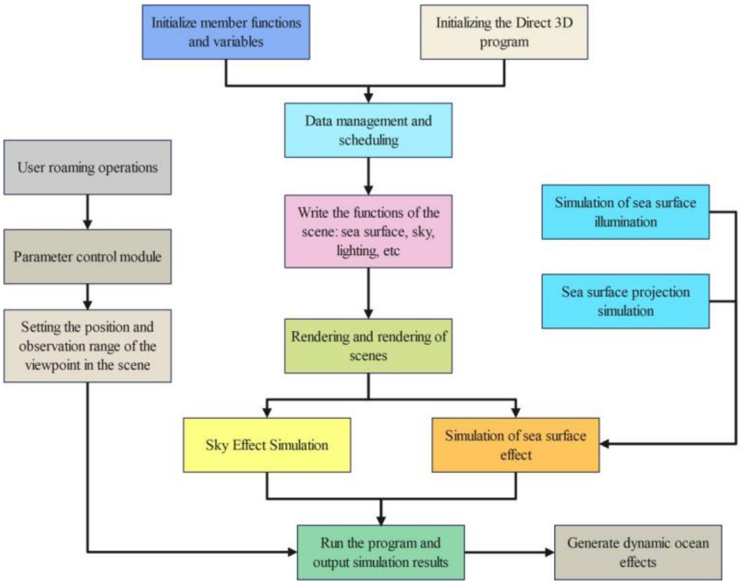

Figure 4: Flow chart of the framework for the operation of special effects in ocean scenes.

4.3 Experimental Data and Analysis

The vertex and chip processor in GPU are programmed to accelerate the calculation of sea surface, and the optical model of water wave is established by texture mapping technology, so as to achieve a very real simulation of water wave illumination effect and greatly improve its operation efficiency. The simulation experiment results are realistic and have good visual effects. In order to facilitate comparison, this paper also uses particle method to carry out simulation experiment, which updates the user's viewpoint in real time during roaming and generates a better realistic sea surface scene. In order to simulate more natural Perlin noise in the experiment, examples of Perlin noise in one-dimension and two-dimensional conditions are shown in Figure 5, with frequency doubling values of 2 and 8 respectively. However, in the actual application process, too large frequency doubling value often brings extra calculation amount, so the appropriate frequency doubling value should be selected according to the actual application scenario.

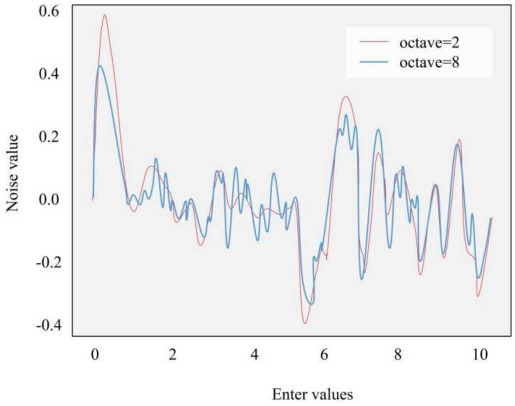

Figure 5: One-dimensional Perlin noise used in the ocean scene effects experiment.

In order to compare the simulation effects of various algorithms, the Perlin noise method, particle method and the method in this paper are respectively used to simulate the calm sea surface. The experimental data are shown in Figure 6. The experimental comparison shows that the proposed method not only has low memory consumption, but also has good real-time performance and real sense.

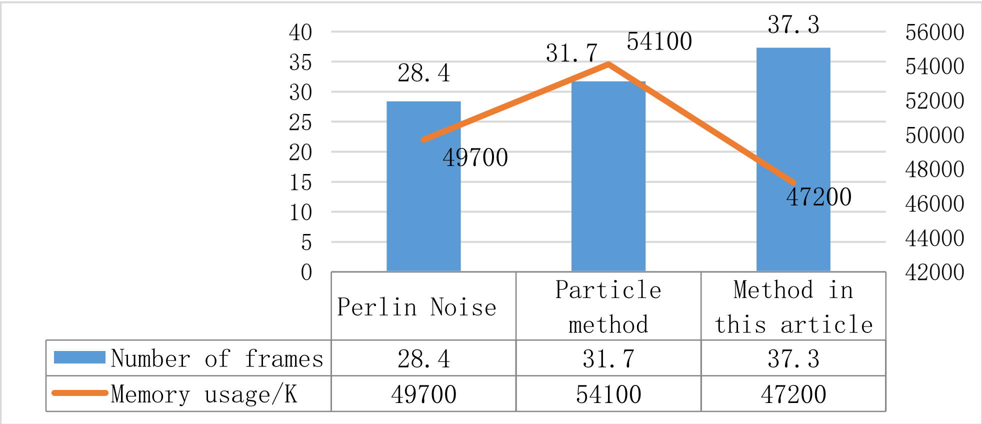

Figure 6: Comparison of simulated ocean efficiency of the three methods.

In the simulation process of Marine special effects, the main amount of computation is spent on solving the Perlin noise equation. We can see that the time complexity of solving the equation is O(kN2), so the time complexity of the whole simulation process is also O(kN2), where k is the number of Gauss-Seidel iterations, and N is the size of the grid. The time complexity of ocean effects simulation is only related to these two quantities. Grid size N and Gauss-Seidel iteration number k have a significant impact on the complexity of ocean special effects simulation algorithm. When the grid size is set as 64, experiments are carried out under the following conditions: 10, 20, 30 and 40 Gauss-Seidel iteration number k. The experimental results are shown in Figure 7.

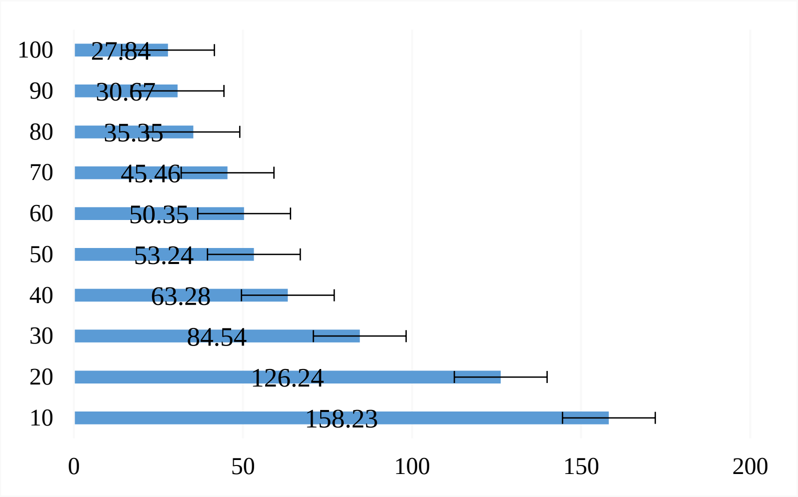

Figure 7: Influence of Gaussian iterations on algorithm time complexity.

When we fix the Gaussian. The number of Seidel iterations and the size of mesh size N were changed. The experimental results were shown in Figure 8, where Gauss was set. Seidel iteration is 20:

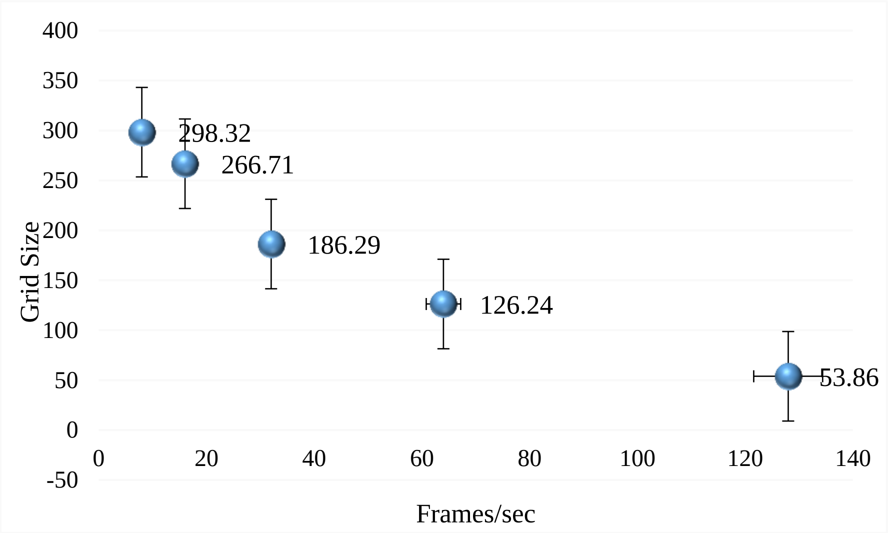

Figure 8: Influence of mesh size on algorithm time complexity.

In this paper, the parallelized part of Perlin noise equation solving process is moved to GPU. The grid size is set to 64x64, the Gauss-Seidel iterations are set to 20, and only CPU is used to solve the equation. The rendering frame rate of ocean effect is 28.37 frames per minute. By using the method of solving Perlin noise equation with GPU and CPU, the frame rate of flame rendering is increased to 37.3 frames per minute. Figure 9 compares the real-time rendering frame rate curves of the proposed algorithm and the FFT-based spectral statistical model algorithm, which uses 512×512 texture as the ocean base grid, respectively on CPU and GPU.As can be seen from Figure 8, the proposed algorithm is superior to the algorithm based solely on FFT spectrum statistical model in all cases. This is because the algorithm in this paper does not render the entire ocean grid in the visual range, but only render the grid near the view point. The distant view point is realized by Perlin noise, which has very little impact on the rendering performance. In addition, the implementation of the algorithm on the GPU also greatly improves the rendering performance.

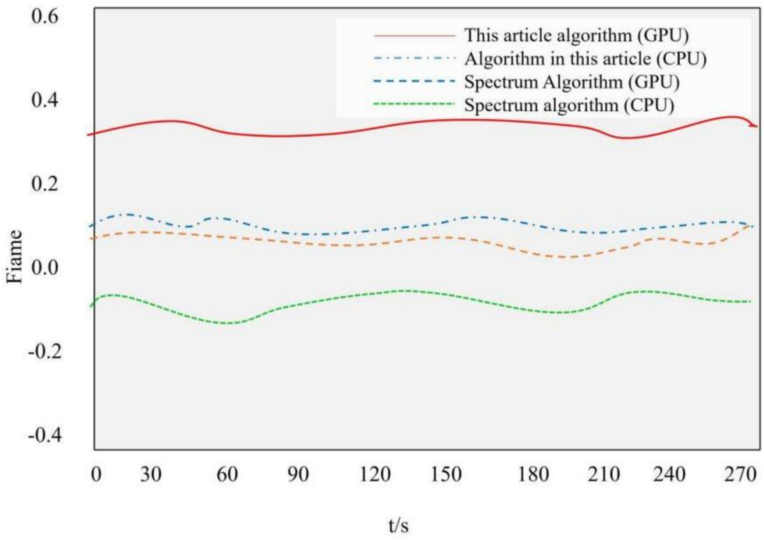

Figure 9: Real-time frame rate statistics of Marine special effects simulation under different algorithms.

5 CONCLUSION

Virtual scene modeling based on computer aided animation and so on has a wide range of applications and development space. As a part of natural scene simulation, water flow simulation is attracting more and more attention from researchers. Compared with other scenes, it is difficult to simulate water flow because of its complexity and irregularity. As a branch of water flow simulation, ocean scene rendering has become an indispensable part of many 3D games and animation special effects because of its realistic scenes and grand scenes. In order to achieve accurate dynamic simulation of ocean scenes, it is necessary to not only give consideration to both realistic and real-time, but also comprehensively analyze and optimize functional modules such as sea surface simulation, sky illumination model and scene rendering. In this paper, representative water flow simulation methods are introduced and their advantages and disadvantages are compared. Based on the research of fluid animation and virtual ocean scene modeling and rendering methods, a method of superposition of multiple Perlin noises and combination of wave particles is proposed to build real-time ocean animation scene. This method can effectively realize the simulation of complex ocean scenes and the special effect of water waves on ship sailing, and meet the requirements of real-time and realistic.

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