Numerical simulation technology and analysis of communication in flight simulator in storm environment

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Abstract. Based on the particle system and aerodynamic effects, the natural phenomena in the snowstorm environment are simulated in real time. Through the hydrodynamic model, a wind model is established. The motion of the snowstorm in the hurricane environment is regarded as the comprehensive motion of the wind and the free falling body of the snow. According to the natural attributes of snow particles and the actual visual requirements of flight simulation, the mathematical calculation is simplified, and the special weather of snow is simulated. Finally, the collision between particles is briefly evaluated and analyzed.

1. Introduction
With the rapid development of computer graphics and image technology, the application of visual system is more and more extensive, and people's demand for the simulation fidelity of visual system is higher and higher. As snow will bring many visual obstacles to drivers of various mobile devices, which will bring corresponding operational difficulties, it is of great significance and wide application to create or study computer simulation of snow in the scene, whether from the perspective of computer graphics or from the perspective of simulation training. The simulation of snow and other complex natural phenomena has always been one of the challenging research directions in computer graphics. Considering the randomness and discreteness of snow itself, the authors use particle system method to simulate it. Particle system was first proposed by William Reeve in 1983 and has been widely used in the field of graphics and image.

Blizzard is one of the harsh natural phenomena. Blizzard has an important impact on the design of agricultural and industrial facilities and the growth and development of crops. It is very important to simulate snowfall and snowstorm in real time and vividly for the simulation and calculation of agricultural landscape.

At present, snow simulation in computer graphics and animation research is usually divided into two categories. One is to simulate snowflakes falling. It mainly studies the falling modes and paths of snowflakes under various external forces, including the effects of wind and gravity, as well as the collision between snowflakes. Most of these studies use particle systems to simulate snowflakes, such as Wang Runjie and Luo Weijia. Particle systems are used to simulate real-time rainfall and snow in three-dimensional scenes. Xu Liming and other researchers simulate rain and snow in real-time based on particle systems and OpenGL. Another type of research focuses on simulating snow storms on the ground. Law et al. simulated snowstorm on alpine terrain, their work mainly focused on visualizing a
real snowstorm layer in the future; Summers et al. proposed a simulation method for the deformation of sand, mud and snow, which realized the surface deformation of sand, mud and snow under external pressure; Nishita et al. used Metaballs to construct and draw snowstorm, and considered the light passing through the snow. Propagation path and scattering. Fearing introduced a complex snowstorm model and a stability model to construct a geometric representation of the snow scene. The disadvantage of this method is that the construction process is very complex and the scene data is huge, so it is difficult to apply to complex scenes. Haglund et al. skillfully used a two-dimensional matrix to preserve the height information of each snowstorm surface. When the snowflakes fall to the ground, the corresponding height values in the two-dimensional matrix containing the height information of the snowstorm will increase, and the surface of the snowstorm will be drawn by using the height information on the ground. Some researchers have also proposed a method of rendering Blizzard as a single pixel, which is very similar to shadow mapping method. Depth buffer is used to calculate how many snowflakes should fall on each surface, and 3D noise is used to simulate the illumination of the Blizzard surface. Recently, some researchers have proposed the method of using shadow buffer technology to simulate the shape of snowstorm and the discrete form based on Boltzmann equation to simulate the snowstorm scene driven by wind. It is rare to report snowstorm simulation in China. Chen Yanyun and others have proposed a method of using displacement mapping to construct snow blocks on objects constructed by polygons in large-scale scenes. But this method is complex to implement and can not simulate the process of snowstorm accumulation in real time. In this paper, according to the characteristics of agricultural scenes, a real-time simulation method of snow and Snowstorm Process Based on particle system is proposed and applied to agricultural scenes. The simulation results show that the method realizes the real-time simulation of snowfall and snowstorm in agricultural scenes, and has a strong sense of reality.

2. Flow Motion Model of Blizzard and Its Impact in Communication

Snow is greatly affected by wind. In order to simulate this phenomenon vividly, the author takes full account of the aerodynamic effect and uses snowflakes to reflect the movement of wind field.

2.1. Blizzard Impact Simulation Based on Particle System

Real air is bound to be viscous, and the boundary conditions of its potential flow will be changed at the snowflakes. On the premise of continuous medium, it is assumed that snowflakes are particles of air, and there is no relative motion between air and snowflakes, that is to say, the velocities of both are the same. The incompressible viscous gas can be described and calculated by the Navier-Stokes equation shown in the following formula: by using the numerical method, various specific viscous air flows can be obtained, and the whole wind field can be obtained by the superposition of the analytical solutions of the basic potential flow, which is shown in equation (1):

$$\sum_{i=x}^{z} \nabla_{i} \frac{\partial v_{i}}{\partial i} = -\frac{1}{\rho} \frac{\partial p}{\partial i} + \nu \nabla \varphi$$  \hspace{1cm} (1)

Particle system is one of the most commonly used graphics generation algorithms for simulating irregular objects. It is a process calculation model. The key to its normal operation is to determine the initial properties of particles, the changing rules of particles and the drawing of particles. The controllability of these attributes and changing rules of particle system makes it possible for particle system to simulate many dynamic natural phenomena (such as rain, snow, smoke, cloud, flame, etc.). At each moment of the particle's lifetime, the following five steps should be completed:

1. Particle source generates particles and gives them attributes and then joins the system.
2. Moving and changing the particles according to their dynamic attributes, and updating their attributes at the same time.
3. Judging the life value of particles;
4. Delete particles that have exceeded their life cycle;
5. Drawing and displaying graphics composed of living particles.
2.2. Hydraulic simulation of snowstorm
This paper uses CFD technology (Computational Fluid Dynamics). Also known as line-of-sight tracking technology, after determining the geometric center of particles, the coordinates of each vertex of particles are calculated by line-of-sight vector and other conditions, and then the particles are drawn according to the vertex coordinates. In this way, no matter how the particle system or the viewpoint moves, the texture mapping plane of the particle is always perpendicular to the line-of-sight direction, thus realizing the three-dimensional effect. The snowflakes used in simulation is shown in figure 1. In the simulation process, the effect of wind blowing is added to allow users to specify the direction and size of wind loaded into the scene. Because the change is real-time, users can adjust the direction and size of the wind at any time until satisfactory results are achieved. In order to simulate snowstorm more vividly, a triangular meshed surface is used to preserve the information of snowstorm thickness in ground and roof areas. The snowstorm area is divided into many small triangular meshes. When particles fall into the vertex area of the triangle, the snowstorm thickness of the vertex will increase. There are many methods for triangulation of discrete points. In the algorithm, uniform division of these discrete points is used. At the beginning, all vertices are traversed and two triangles are established for each of the four adjacent vertices. There are two different methods for division of each four vertices. Different triangulation methods have great influence on the rendering effect of Blizzard. This paper only simulates the effect of Blizzard. All of them only use a single division method, and the final stimulation result is shown in figure 2.

![Figure 1. Stimulation of the snowflakes.](image)

![Figure 2. Result of the snowstorm stimulation.](image)

3. Impact Detection of Blizzard on Communication
Considering the actual speed and visual effect, and it is impossible to fly with heavy snow, it is assumed that the snow distribution area is within a certain range of the cone in front of the human eye, so the collision between snow and windshield and its related effects are not considered. It is generally assumed that a snowflake is a point-like or simple plane figure. Such a snowflake can be considered as a rigid body. If it is point shape, collision occurs during snowflakes falling, which can be described by point...
coincidence. But when all plane rigid bodies collide, they will inevitably penetrate each other. The collision algorithm between the two sets of models can be roughly divided into the space decomposition method and the hierarchical bounding box method. The space decomposition method divides the whole simulation space into equal volume cells, and only tests the intersection of geometric objects occupying the same cell or adjacent cells. This method is suitable for the number of pairs of geometric objects with uniform distribution in sparse environments. The core idea of hierarchical bounding box method is to approximate complex set objects by using bounding boxes with slightly larger volume and simple geometric characteristics. This method is more widely used and suitable for collision problems in complex environments. In snow simulation, because of the complex environment and the simple shape of particles, the bounding box method is used to detect the collision, and good results are obtained. For triangular particles, it is only necessary to detect whether the vertex of one triangle intersects with another triangle. Because of the heavy workload of collision detection, the speed of collision detection will be greatly improved when bounding box method is used and some spatial analysis methods are combined, such as octree method.

Visual C++ programming language and OpenGL graphics engine are used to implement the above simulation algorithm, and simulation experiments are carried out. The effect of blizzard on communication industry can be observed. During the simulation, the number of particles can be adjusted through the program interactive control interface to meet the snowscape size requirements of the scene. When the number of dynamic particles in the scene reaches 500, the scene roaming system can still roam at the speed of 24 frames per second, basically without affecting the real-time performance of the system.

![Figure 3](image)

**Figure 3.** Result of the stimulation with time. ((a) picture is original scene,(b) picture is the stimulation for 5 minutes and the (c) picture is the stimulation for 30 minutes)

Research shows that the area and size of Blizzard will increase exponentially over time, and the pressure on the telecommunications industry can not be estimated. In this regard, we should make a careful arrangement and deployment in advance of the early warning of blizzard, and prepare for the support team, emergency supplies, plans and other aspects. At the same time, personnel and materials should be allocated to do a good job in patrol and emergency repair of key networks, equipment and lines; in particular, the patrol and maintenance of mountain lines should be strengthened to ensure the safe operation of power supply systems in communication hubs and key bureaus. In case of equipment failure, ensure that the rush repair force is in place in time, and take effective measures to quickly rush through. Hubei Mobile will continue to do a good job in arranging and deploying the communication guarantee, and wait for it to ensure the stable operation of the communication network.

Through the research, we found that Blizzard has a serious threat to the environment, especially communication. Therefore, for public facilities such as power lines with potential safety hazards, we should immediately vacate and resettle personnel; for factories with potential safety hazards, we should prohibit the use of such facilities to ensure the safety of teachers and students; for other facilities with potential safety hazards, we should organize evacuation personnel first, and then reinforce them. Educational departments should strengthen school safety inspection and supervision; public security departments should intensify road duty, patrol command and traffic order maintenance to ensure that no major public security and traffic safety accidents occur due to disasters; traffic departments should
strengthen highway transportation management, passenger station inspection and road inspection and maintenance to effectively eliminate hidden dangers of road traffic safety; security supervision departments should strengthen mining and production. To carry out a major inspection of production safety in factories and equipment, we should eliminate all kinds of potential safety hazards in an all-round and timely manner, and urge production units to put all safeguards in place.

4. Conclusion

In this paper, a simulation method of snow and snowstorm process is proposed, which can simulate the realistic snowfall and snowstorm scenes in agricultural scenes on the basis of less computational cost. The method uses particle system to produce snow particles, and CFD technology to enhance the visual effect of snow particles. In the process of falling particles, the size and direction of wind can be adjusted in real time. In the simulation of snowstorm, a layer of triangular mesh is constructed on the ground and roof to preserve snow accumulation information. When particles fall into the vertex area of the triangle, the snowstorm thickness of the vertex will increase. At the same time, the algorithm considers the collision between the snow and the greenhouse wall during the falling process, and generates the effect of snow accumulation at the foot of the wall. In rendering, the average normal vector and the mixed vertex color are used to generate the smoothing effect. The simulation results are very realistic. It also lays a foundation for future research and calculation of greenhouse roof transmittance and solar radiation received by greenhouse under snowstorm.

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