A Simulation System of Snow Based on Particle System

Tian zhuo[1], Libaicheng[2]

Information teaching and Management Center, Jilin Agricultural University, Changchun, Jilin, China

xiaomarkshaoqing@163.com, lbc@163.com

Keywords:particle system; snow simulation; texture mapping;billboarding

Abstract. The simulation of snow in virtual scene can greatly of particles will make both simulation and real-time of system more difficult. A method for simulating snow is presented in this paper based on the analysis of particle system and texture mapping technology. The basic idea of the method is using texture mapping to render snow particles. By the using of billboarding technology, the particles can always face to the direction of observers, the immersion of scene is improved, the usage of system resources is reduced, and the real-time of system is promoted.

Introduction

Simulation of natural scenery has been an important research of computer graphics, especially to irregular objects,due to the irregularity of shape, without any motion laws and changing all the time during movement, it is difficult to simulate them such as cloud, snow, smock, rain, etc, which serve as indispensable conditions in natural phenomena. As the essential part of natural scenery, how to represent the scene of snow flying is a hot research in computer graphics.

There are a variety of methods to simulate snow,however, it can't display the motion nature of objects and get the realistic image simply based on texture mapping technology. Particle system is regarded as the effective measure[1] to simulate irregular dynamic objects , it is an effective measure to construct complex objects using simple elements. There is an algorithm that can satisfy real-time request of snow simulation based on particle system:controlling the number of particles and using limited particles to render the scene, improving the efficiency of particles by the greatest extent, but the method of rendering particles is simple as mentioned above In this paper, we analyze the snow attributes based on particle system and use texture mapping technology to achieve a higher fidelity on the precondition of keeping the real-time of system.

Particle System

Particle system adopts a totally different method to render dynamic objects, it is regarded as the most successful tool to simulate irregular fuzzy phenomena so far. Particle system consists of plenty of simple primitives known as particles. Each particle is assigned with its individual attributes, such as shape, size, color, speed, position, life, etc.It is not a static system, as time goes on, not only the particles that have existed in the system change their shape and move all the time, but also new particles engage in the system, and old particles which surpass their predefined lifetime extinguish[2]. To simulate the growth and death of particles, we have to give each particle a lifetime so that it can experience the birth, growth, aging, death. The relevant parameters of particles are all controlled by stochastic process so that the dynamic phenomena represented by particle system is random. Fig.1 shows the structure of the particle system.

© 2015. The authors - Published by Atlantis Press

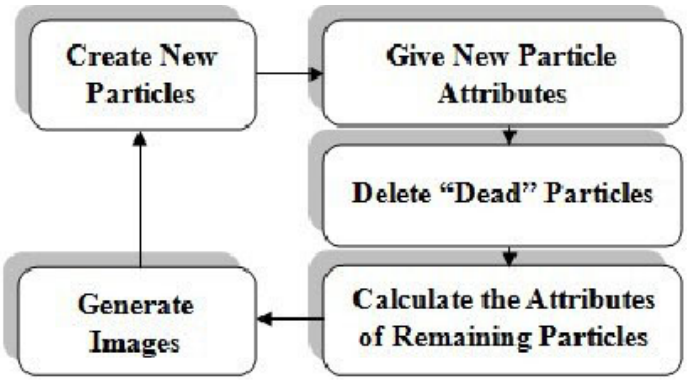

Figure 1. The structure of particle system

Simulation of Snow

Based on the above analysis, the paper chooses the texture mapping of OpenGL to render snow particles. OpenGL(Open Graphics Library) is a cross-platform graphics interface for producing 2D and 3D computer graphics. The function of texture mapping includes 1D texture mapping, 2D texture mapping, 3D texture mapping and complex environment mapping. It makes the snow scene more vivid.

Usage of Texture Mapping Technology. During the rendering process, the paper defines the basic natures of particles, choosing rectangle as the basic shape to draw a snowflake and finding proper snow texture. We should define the texture according to the characteristics of objects we simulated before. This paper makes use of 2D texture mapping and calls glTexImage2D function.2D texture is defined in a plane areas, the essence of 2D texture mapping is a mapping from the plane of 2D texture to the surface of 3D object. GL-BLEND is a fusion style combining some pixel color with the related pixel color which have been drawn on the screen. If the system renders excessive number of polygons during rendering living particles, it will increase the system expenses and affect the real-time to a certain extent, so we choose rectangle as the shape of particle, in addition, a particle represents a snowflake in this paper. The images of snow texture in this system are 24 bit bitmaps, as shown in the Fig.2 below.

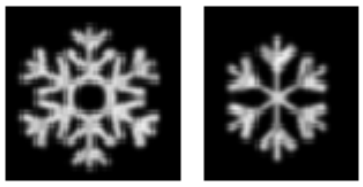

Figure 2. Different snow texture

The benefits of using texture mapping are:

(1) less system resources and calculation quantities are required.

(2)the running speed of the software are increased. In spite of distorted subject to the change of the interrelations between the particle surfaces and the sight lines in 3D space, it decreases the fidelity greatly. Billboarding technology[3] can resolve the problem we have discussed above.

Billboarding Technology. The main task of the billboarding is to control the texture direction so that the particles can face the observers throughout.

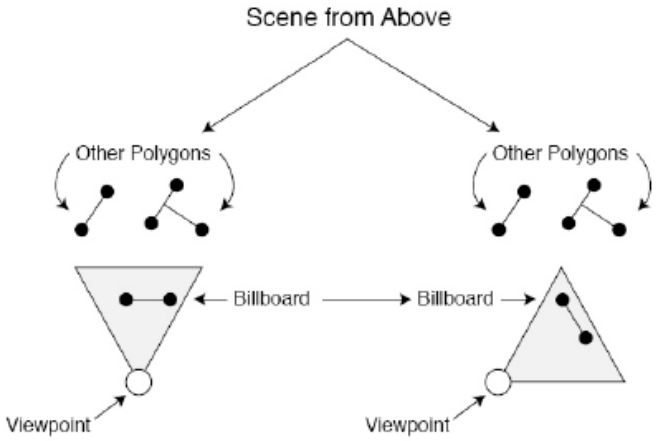

Figure 3. Billboarding Technology

As shown in Fig.3, no matter how viewpoint changes, the plane of texture mapping is always perpendicular to the view direction, it ensures the polygons toward the point of observation all the time. Billboarding is usually a polygon,2D texture maps onto this polygon. As illustrated in Fig.4,we use rectangular shape.

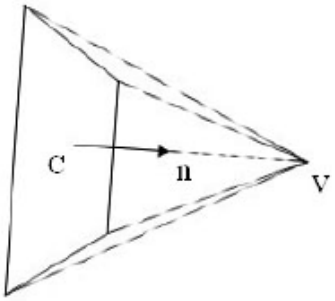

Figure 4. Relations between space objects and billboarding

Where, C is current coordinate of particle, Particlepos ={x,y, z}, V is coordinate[4] of viewpoint, Viewpos={xv, yv, zv}.

According to the upward vector quantity of scene,VectorUp={xu, yu, zu}, the relevant calculation as follows[7]:

- The normal vector in 3D space

$$n = Particlepos - Viewpos \quad (1)$$

- Compute the cross product between n and VectorUp

$$Vectortemp = n \times VectorUp \quad (2)$$

Thus, the Vectortemp must be perpendicular to the normal vector n.

- Get the result of normalized vector about Vectortemp

$$Normaltemp = \{xtemp, ytemp, ztemp\} \quad (3)$$

- Compute the four vertex coordinates of the rectangular

$$x1= xtemp - x; y1 = ytemp - yu; z1= ztemp - z;$$
$$x2= xtemp +x; y2 = ytemp - yu; z2= ztemp + z;$$
$$x3= xtemp +x; y3 = ytemp + yu; z3= ztemp + z;$$
$$x4= xtemp - x; y4 = ytemp + yu; z4= ztemp - z; \quad (4)$$

The rectangular drawn using this vertices is certainly perpendicular to view direction. From this vertex coordinates,

Simulation

The snow simulation system is completed by using C++ development environment and OpenGL

toolkits, the conditions of hardware are: Pentium(Core)CPU (2.50 GHz),512MB RAM, NVIDIA (128MB) video card, 1024 × 768 screen resolution. We can get a ideal result when the number of particles is controlled between 500 and 1000, Fig.5 and Fig.6 show the results of snow simulation. [5]

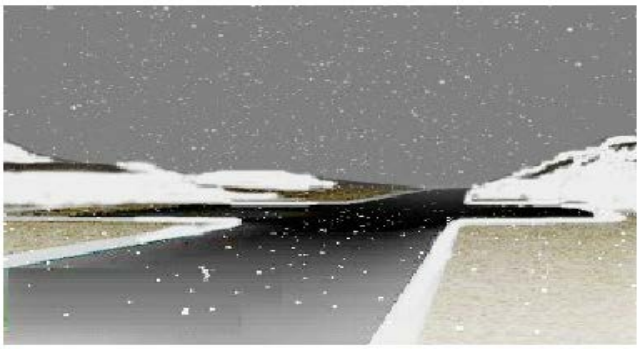

Figure 5 The light snow

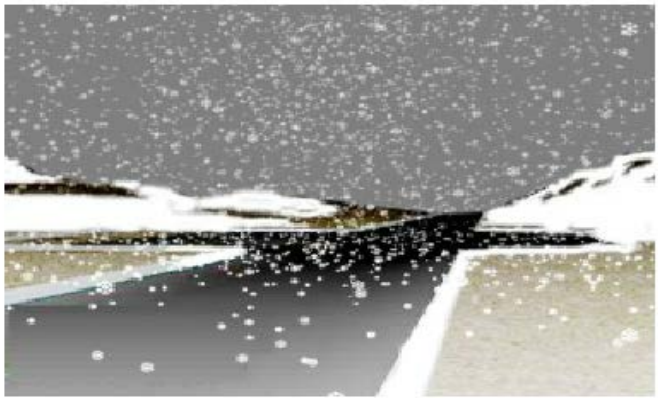

Figure 6. The heavy snow

Conclusions

Based on particle system, an algorithm combining texture mapping technology with billboarding technology is presented in this paper. It can not only improve the fidelity of snow simulation, but also increase the real-time of system to some extent. Because the physical model and force field established in this paper are simple, in the future research,we will make the following improvements: establishing physical model, analysing the status of snow under the wind force.

References

[1]Takeshi Sato, “wind Speed Dependence of Fracture and Accumulation of Snowflake on snow Surface,” Cold Regions Science and Technology, Vol.5, No.4, 2007, pp.1-11.

[2]Tngar Saltvik, “Parallel Methods for Real-time Visualization of Snow,” Norwegian University of Science and Technology, Norway,2006.

[3]W.T.Reeves, “Particle system- a technique for modeling a class of fuzzy objects,” Computer Graphics, Vol.17, No.3, 1983, pp.359-376.

[4]M. S. Langer, “A Spectral-particle Hybrid Method for Rendering Falling Snow,” Eurographics Symposium on Rendering, Vol.12, No.7,2004, pp.21-24.

[5]Kohe Tokoi, “A shadow Buffer Technique for Simulating Snow-covered Shapes,” the International Conference on Computer Graphics,Imaging and Visualisation, USA, 2006, pp.10-13.