Snow Accumulation And Generation

Introduction

In this project, my goal is to create the snow accumulation and falling effects. It is based on technique report from NVIDIA. The method used for snow accumulation is very like the shadow mapping. The snow falling effect is created by a simple particle system.

Snow Accumulation

Step1. Create a depth map from the view of sky using the orthographic camera model. This map stores the closest points to the sky in the scene.

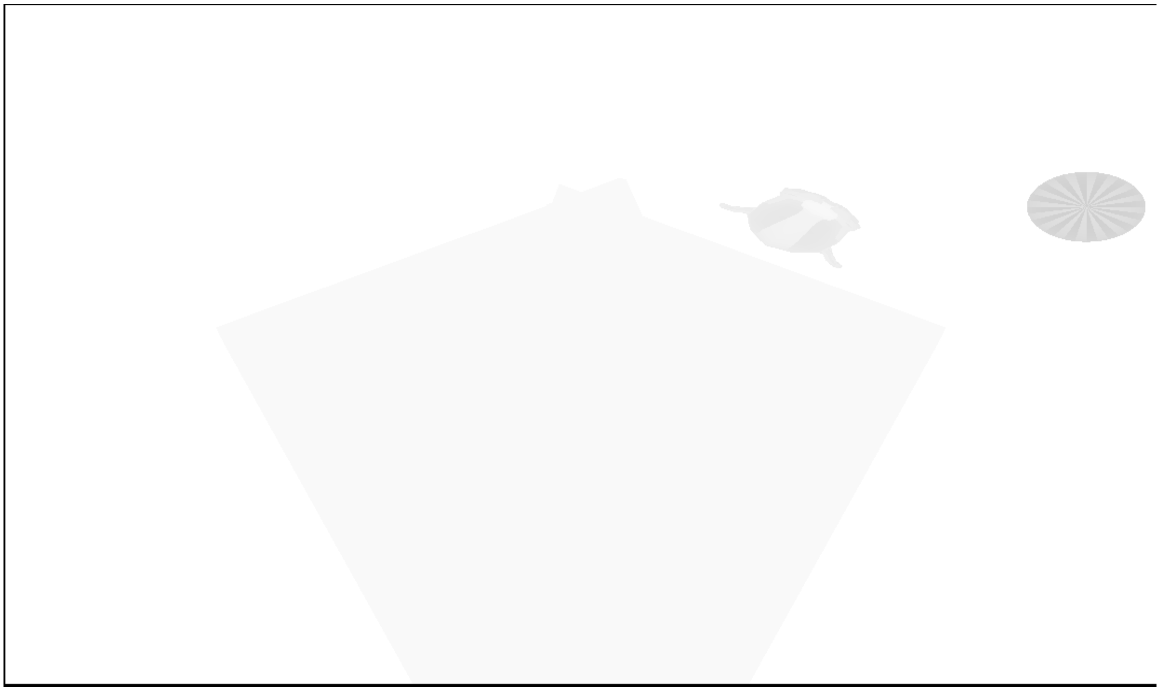

Figure 1Depth Map

Step2. Render objects with the depth map. Transform vertices into the orthographic view. Compare the depth of the vertices with stored depth. If less than stored vertices, then points can be occupied by the snow, else the points are occluded. Use the following matrices to for orthographic view projection:

VL = Ms * Mp * Mv * Mm * V
VL projected vertex from light source
Ms scale matrix (-1, 1) to (0, 1)
Mp light source projection
Mv light source view from world
Mm model to world

V vertices

Step3. Incline Coefficient

Slopes will accumulate less snow than flat ground, so this is a need to add an incline coefficient to represent this. To accomplish this, simply use the dot product of surface normal with Y axis. Use the incline coefficient to blend the object color with snow color. From the following picture, we could see that the top of the sphere accumulate more snow than lower part.

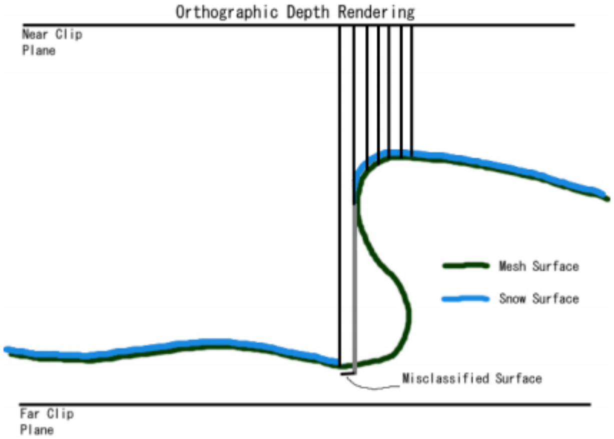

Figure 2 Incline Coefficient

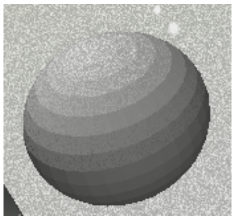

Figure 3 With Coefficient

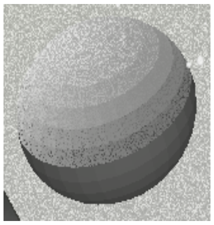

Figure 4 without Coefficient

Snow Generation

Use particles to represent snowflakes. Randomly generate speed, size, and positions for each particle. Then animate particles with vertex shader. For the realistic effects, I also calculate the alpha channel that the further points are more translucent. How to render the particles? I use the GL_POINTS, GL_POINT_SPRITE features in OpenGL.

Fog Effect

I use the exponential function to add fog in the fragment shader.

$$fogFactor = e^{-(density * z)}$$

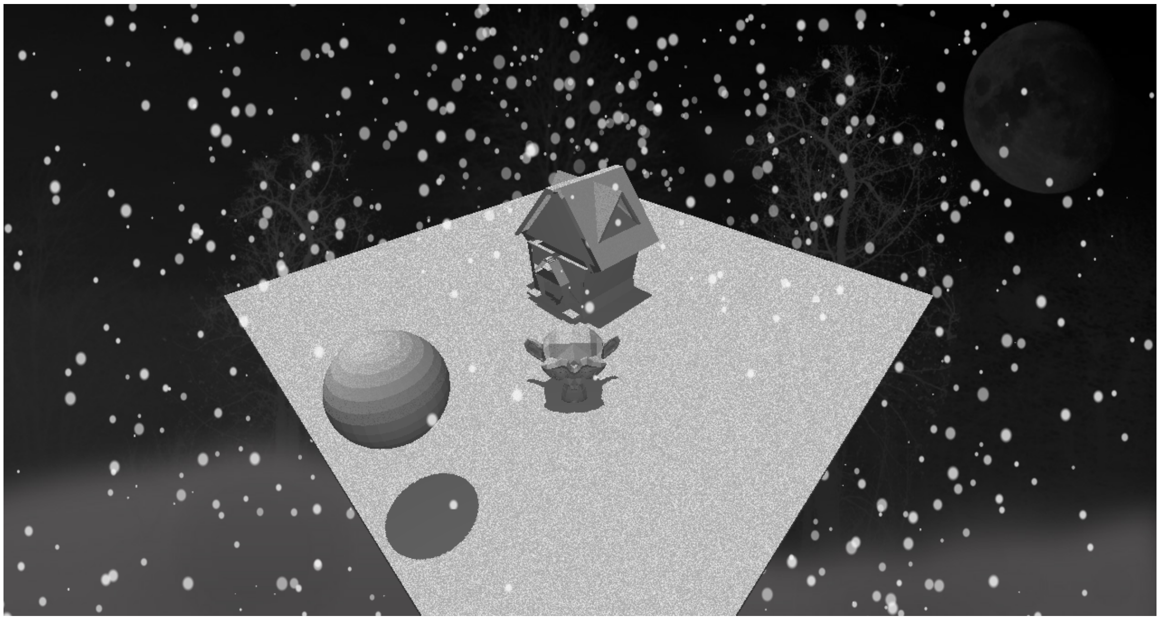

Figure 5 Without Fog

Result

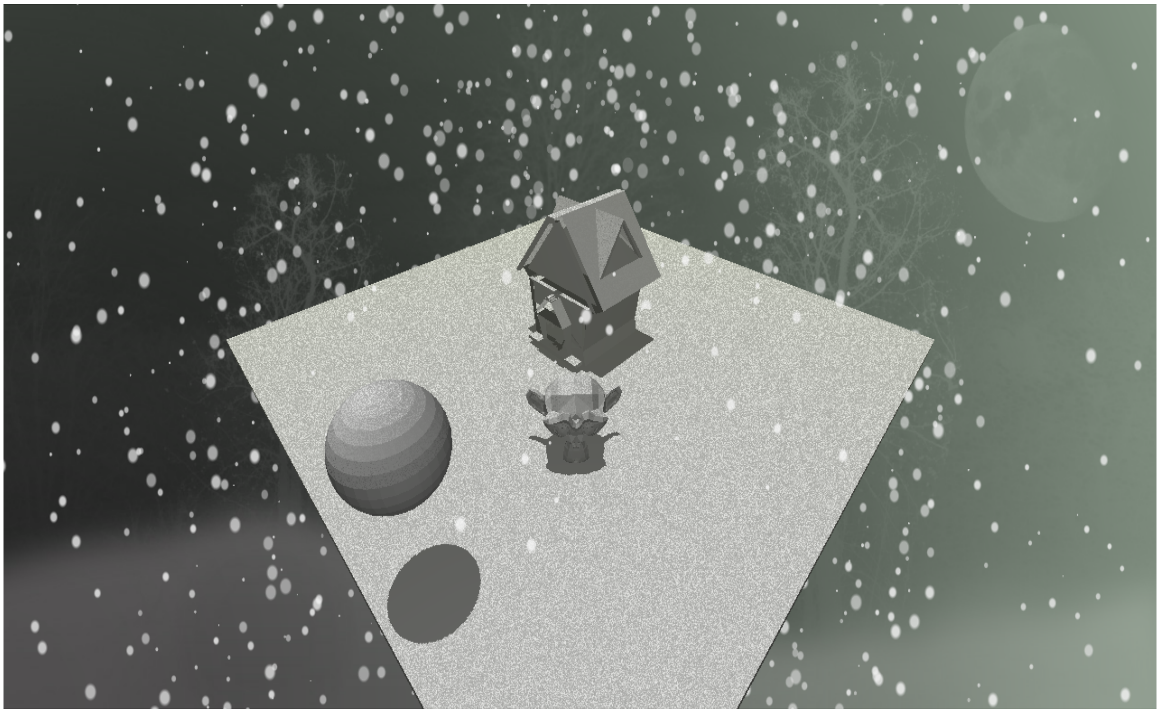

Figure 6 Final Result

Limitations

1. Cannot create the height of snow accumulation. This method just uses texture for snow effects. And whether points are occluded are only determined by the depth value from orthographic view.
2. This method fails in situations where there are winds. In such situations, points may be not exposed to the sky, but they may also be occupied by snow.

Reference:

http://http.download.nvidia.com/developer/SDK/Individual_Samples/DEMOS/Direct3D9/src/SnowAccumulation/Docs/SnowAccumulation.pdf

https://graphics.stanford.edu/wikis/cs248-11-winter/CS_248%3A_Interactive_Computer_Graphics?action=AttachFile&do=get&target=OpenGLParticles.pdf

http://www.ozone3d.net/tutorials/glsl_fog

http://www.opengl-tutorial.org/intermediate-tutorials/tutorial-16-shadow-mapping/

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