Project proposal for CG 100433 course

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Project title:
Weather Simulator

Motivation:
The work of the last class of seniors, Ray Tracing Spheres, deeply attracts us. They use the Ray tracing technology to create a scene full of artistic vision, which not only enables people to feel the power of technology, but also enables them to experience a kind of aesthetic feeling. The weather system in the game, as well as a small program to help sleep gave us inspiration. The idea for this project was born.

We hope that our work can add the light effect and particle effect that change with time, season and weather on the basis of the last seniors, and add some models and music to better reflect the change of weather and enhance the atmosphere. And we will try to increase the interactivity, so that users can freely control the change of the weather and perspective, greatly improve the whole scene to bring users immersive feeling. And most important，it's meaningful and enjoyable to create a fantasy sense.

The goal of the project：
(1) Build the basic model, include sky box, crystal ball, etc.
(2) In a sunny environment, using raytracing, texture mapping and other effects to simulate a realistic scene. The scene uses light and shade to reflect changes in time.
(3) Based on the previous stage, the scene under different weather conditions is simulated by changing the light and scene.
(4) Adding interactivity and audio (rain, wind, thunder) allows users to control the weather and freely control the camera, with audio for an immersive experience.

The scope of the project：
(1) Ray tracing only applies to specific models.
   In order to simplify the complexity and workload of the program, ray tracing is only applied to specific relatively simple models, and will not be used where modeling is more complex.

(2) Particle collisions occur only on the ground and water.

To simplify the rendering cycle, the detection of particle collisions does not occur between particles, but only on the ground and water surface.

Related CG techniques：

(1) Ray Tracing

To generate a visual image in a 3D computer graphics environment, ray tracing is a more realistic implementation than ray projection or scanline rendering. The method works by reverse-tracking the path of light that intersects the imaginary camera lens. Since a large number of similar lights cross the scene, the visual information of the scene seen from the camera Angle and the software-specific lighting conditions can be constructed. Calculates the reflection, refraction, and absorption of light when it intersects an object or medium in the scene.

(2) Particle System

Particle systems are a common name for techniques used to mimic natural phenomena such as smoke, dust, fireworks, rain, etc. What these phenomena have in common is that they are made up of a large number of small particles that move together in a way that constitutes a natural phenomenon.

(3) Texture Mapping

Texture mapping means to paste any type of image onto one or more surfaces of a 3D model. The image can be arbitrary but is often a generic pattern, such as bricks, plants, barren land, etc., to enhance the realism of the scene.

Project difficulties and solutions:

(1) The main disadvantage of ray tracing technology is its performance. Since ray tracing is based on the reflection and refraction of real light in the scene to simulate the real light, the calculation amount is very large and the performance is reduced.

Solution: With reference to the implementation of photon mapping, only part of the algorithm is implemented according to ray tracing technology, which simplifies the computation and improves the processing speed.

(2) Updating particles in the CPU requires the OpenGL driver to copy the vertex buffer data from GPU memory into CPU memory. This will have a big impact on the performance of our program, and the performance of our program will get worse as the number of particles increases.

Solution: The vertex information of the particle is processed using Transform Feedback, a new feature after OpenGL 3.0

(3) There may be a lack of maps that exactly match our needs.

Solution: Photoshop and other image processing software are used to generate the texture map required by the program.

Implementation plan：

First stage (Week 9-10): Set up the scene and implement camera movement and steering.

Second stage (Week 11-12): Paste textures on the model and add raytracing effects.

Third stage (Week 13-): Achieve different weather effects according to actual progress.

roles in group：

Group A: 周焕涛&林义凯&姚锐哲

- Responsible for setting up the scene and adding texture map.

Group B: 郑茗丹&刘泽润

- Responsible for moving and turning the lens and ray tracing effects.

Finally, the weather effect is divided according to the progress. But the grouping is pretty much the same.

Reference：

. https://zhuanlan.zhihu.com/p/88369641
. https://blog.51cto.com/yarin/380181