Real-time Volumetric Fog Simulation

Topic Overview

by

Lucia Tódová

## Goal

There exist many approaches to simulating and rendering volumetric clouds, fog and mist in indie game development. One is the use of commercial shaders, the other is simulation through particle-like effects. However, many of them tend to bear a few problems, the most common being either unrealistically-looking volumes (e.g. messed up refraction) or performance issues. Performance decrease can be especially visible in virtual reality games, where the approach to volume rendering must be slightly changed.

The goal of the project is to create a real-time cloud simulation shader in Unity. The motivation is to use it in an in-development student game The Elementalist VR, where it will be used to generate atmospheric fog around the terrain. Therefore, it will be especially tested on virtual reality headsets, including the most problematic Oculus Quest.

### Result

The result will consist of two things - a Unity shader (or, possibly, a group of shaders), and a Unity project containing a simple terrain where the shader will be used to show its performance.

Currently, at the start of the project, it’s in the state of an empty Unity project. For development, the shader language provided by Unity will be used.

### Resources

Over the years, there have been many articles and books that are focused on volumetric cloud rendering. Following is a list the project will be based on:

1. <https://is.muni.cz/th/d099f/thesis.pdf>
2. <https://github.com/yangrc1234/VolumeCloud>

And a list of scientific papers focused on this research:

1. <http://www.diva-portal.org/smash/get/diva2%3A1223894/FULLTEXT01.pdf>
2. <http://www.cs.unc.edu/xcms/wpfiles/dissertations/harris.pdf>
3. <https://www.researchgate.net/publication/320283577_A_New_Method_for_Modeling_Clouds_Combining_Procedural_and_Implicit_Models>
4. <http://www.markmark.net/PDFs/RTCloudsForGames_HarrisGDC2002.pdf>
5. Presentation available at: <https://www.guerrilla-games.com/read/the-real-time-volumetric-cloudscapes-of-horizon-zero-dawn>

During research, this list will be expanded.

A few helping papers during the implementation:

1. <http://jcgt.org/published/0007/03/04/> - Ray intersection paper

### Steps

1. Study existing materials and understand how rendering of volumetric clouds works
2. Learn the basics of Unity shading languages
3. Implement realistically-looking fog
4. Optimize fog so it can run real-time on mobile processor (Oculus Quest)

### State of the art

As already mentioned, there exist many softwares that focus on real-time rendering of volumetric clouds, fog or mist. This project is solely focused on how the clouds interact with each other (and does not involve player interaction with these volumetric objects), which makes some of its aspects easier to implement.

State of the art is already mentioned in the Resources section, where I’ve listed some of the most impressive works. However, the ideal for this project is to create a plugin similar to a few on the Unity AssetStore, e.g. <https://assetstore.unity.com/packages/vfx/shaders/fullscreen-camera-effects/volumetric-fog-mist-49858>.

